



CANADIAN DEFENCE PRODUCTS

1972

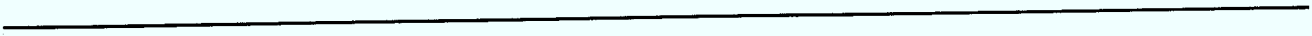
DEPARTMENT OF INDUSTRY
TRADE & COMMERCE
LIBRARY

JUN 14 1977

BIBLIOTHEQUE
MINISTÈRE DE L'INDUSTRIE
ET DU COMMERCE

R6
UF
535
C2A533
1972

CANADIAN DEFENCE PRODUCTS



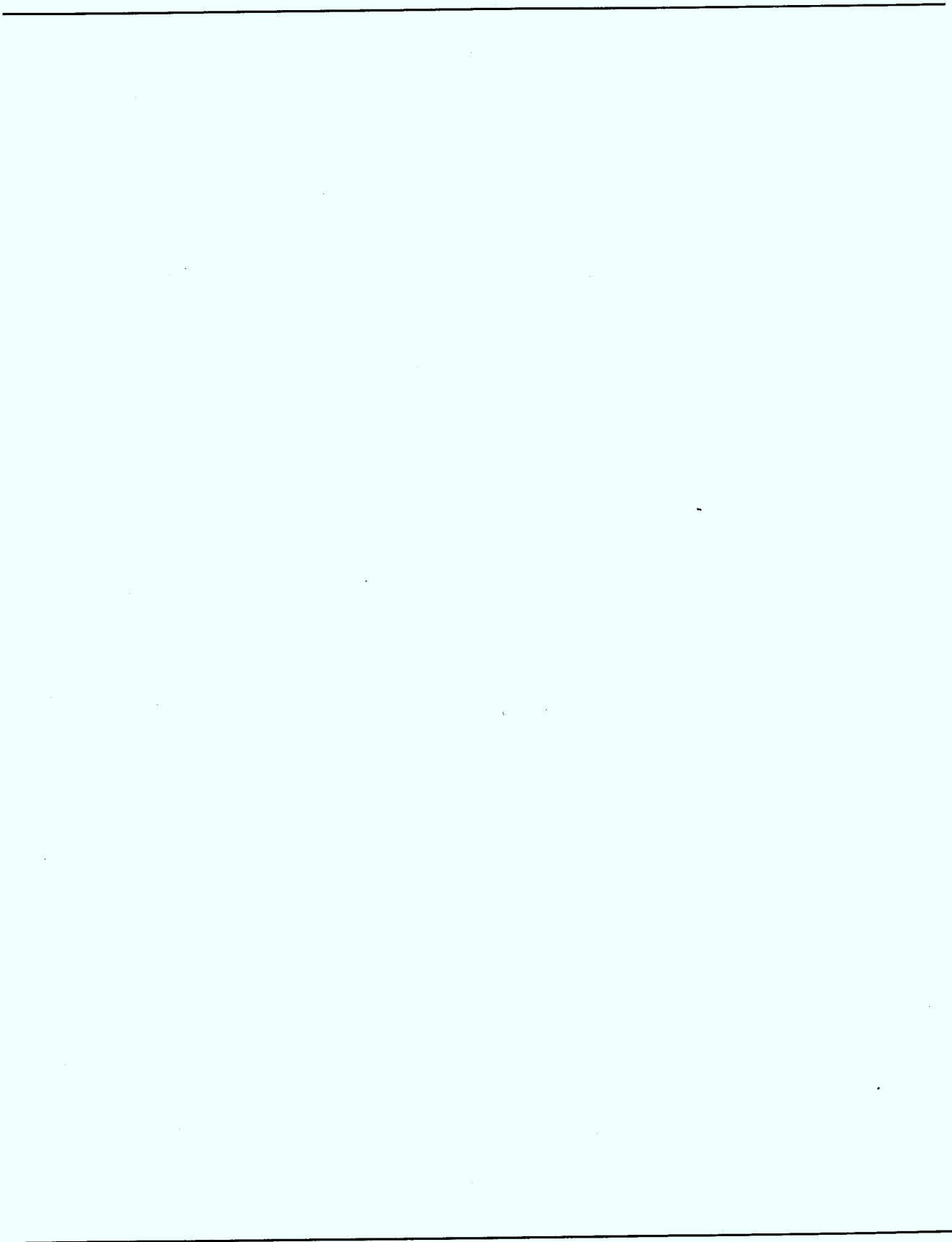
CANADIAN DEFENCE PRODUCTS

Department of Industry, Trade and Commerce

Le Ministère de l'Industrie et du Commerce

Fourth Edition

Ottawa 1972 Canada



The Editor gratefully acknowledges the assistance given in this production by

*The Department of National Defence and
The Department of Supply and Services*

CANADIAN DEFENCE PRODUCTS

During World War II and until the late nineteen fifties, Canada undertook the development and production of a wide variety of defence equipment to meet the requirements of its armed forces. The Canadian defence industry attained a high degree of competence, producing modern aircraft, ships, and weapon systems that have performed effectively in the defence of the free world. However, the development and production of modern systems has steadily become more complex and costly. No country, particularly one the size of Canada, with its relatively small requirements, can afford to design, to develop and to produce all of the equipment needed to meet today's defence requirements. Accordingly, in recent years Canada has recognized the need for greater international co-operation to harmonize defence requirements and to co-ordinate defence research, development, production and procurement programmes, on the most economical basis, among allied and friendly countries. In recognition of this principle, Canada examines the defence RDP programmes of allied and friendly nations, and, where appropriate, procures equipment abroad to meet Canadian requirements. The defence procurement authorities of other countries may similarly wish to examine the defence products available from Canada.

It has been Canadian policy to encourage Canadian industry to specialize in certain areas on the basis of natural advantage. The vast distances and other problems involved in opening up the Canadian hinterland generated requirements for equipment of certain kinds in which Canadian industry developed an early expertise. Typical of these are vertical/short takeoff and landing (V/STOL) aircraft, navigation systems, and communications equipment. Other areas of expertise, such as anti-submarine warfare electronics, derive directly from Canadian operational experience.

This book has been prepared to assist other countries interested in co-operative defence RDP and procurement. It is a collection of data covering both products and firms, arranged so as to simplify the location of sources of supply for equipments, parts, or services which may be required. Since the contents are largely concerned with defence items, the defence segment of Canadian industry is emphasized. Similarly, the activities shown principally indicate the defence-related capabilities of the listed companies.

The present edition differs very little from previous ones. The changes made are an attempt to

simplify the presentation. The U.S. Federal Supply Classification System is retained but has been reduced to main headings only. The detailed breakdown of sub-items will now be found under the individual description of each company. The four-digit numbers carried under each company listing is a direct cross reference to the Index of Products. The new 8.5 inch by 11 inch format allows a better graphical presentation, and should make for easier reading.

The services of the Canadian Commercial Corporation are still available and are detailed on the following pages. Requests for price and availability of specific items may be sent to CCC or to the listed manufacturers. Such requests may also be sent to

International Defence Programs Branch,
Department of Industry, Trade and Commerce,
112 Kent Street,
Ottawa, Ontario, K1A 0H5, Canada,

as well as all requests for information of a general nature.

In addition, both specific and general inquiries may be addressed to the appropriate office of the Canadian Foreign Trade Service, as listed on page 7.

CANADIAN COMMERCIAL CORPORATION

Canadian Commercial Corporation, which is wholly owned by the Government of Canada and is responsible to the Minister of Supply and Services, was established to act as the contracting agency when other governments wish to purchase defence or other supplies and services from Canada on a government-to-government basis. The management and staff of the Corporation are provided by the Department of Supply and Services. Accordingly, procurement in Canada which is undertaken by the Corporation for other governments, is carried out by the same officers and according to the same standards as procurement being undertaken for the Canadian Armed Forces and other Canadian Government agencies.

Upon receipt of a request for quotation or other such enquiry document, Canadian Commercial Corporation will, whenever possible, obtain competitive quotations from Canadian contractors or suppliers. These quotations will be evaluated in accordance with the procurement standards of the Government of Canada. Where a quotation meets these requirements, it will be submitted as a CCC offer to the enquiring government. If the offer is accepted, the Corporation will, on behalf of the Government of Canada, enter into contracts, containing identical terms and conditions, with the other government and with the Canadian supplier. This arrangement makes available to the other government the complete purchasing organization and procedures of the Government of Canada.

Some of the advantages to other governments in procuring supplies through Canadian Commercial Corporation are:

1. The Canadian supplier will be chosen where possible on a competitive basis and in any event in accordance with the procurement policies and procedures of the Department of Supply and Services.
2. The price paid by the other government will not be higher than that which would be paid by the Government of Canada were it purchasing for its own use in comparable circumstances.
3. The contract with the Canadian supplier will be subject to technical and management control during production by an experienced procurement staff, who will also facilitate any change action which may be required by the other government during the performance of the contract and will expedite delivery of the supplies.
4. Quality control, inspection and acceptance on behalf of other governments may be carried out in Canada by the Quality Assurance Branch of the Canadian Department of National Defence to the extent desired by the other government.
5. All billings of the Canadian supplier for work performed will be certified by Canadian Commercial Corporation according to Canadian Government practices before payment and the Corporation will pay the Canadian supplier on the basis of the payment terms of the contract between the Corporation and the other government.
6. If an audit of the Canadian supplier's account is required, such audit will be conducted by the Audit Services Bureau, Department of Supply and Services.
7. Arrangements for shipment of goods will be made by the Corporation as required.
8. All contracts entered into by the Corporation are guaranteed by the Government of Canada.

The services of Canadian Commercial Corporation, as outlined above, are available without charge to any other government in the procurement in Canada of defence or other supplies and services, with the exception that in certain special cases there may be a minimal charge for inspection.

It is to be noted that the availability of the services of the Corporation in no way precludes other governments from procuring in Canada directly from Canadian manufacturers if they so wish. In such circumstances, the Corporation will provide all possible advice and assistance as requested. Specific enquiries as to price and availability as well as requests for general information on Canadian defence products may, accordingly, be directed to:

Canadian Commercial Corporation,
70 Lyon Street,
Ottawa, Ontario, K1A 0S6,
Canada.

Such requests may also be directed to the Canadian Foreign Trade Service in the following locations:

ARGENTINA

Commercial Counsellor
Canadian Embassy
Casilla de Correo 3898
Suipacha 1111
Buenos Aires, Argentina
Territory:
Paraguay, Uruguay

AUSTRALIA

Commercial Counsellor
Canadian High Commission
Commonwealth Avenue
Yarralumla 2600
Canberra ACT, Australia

AUSTRIA

Commercial Counsellor
Canadian Embassy
P.O. Box 190
1013 Vienna, Austria
Street address:
Dr. Karl Luegerring 10
1010 Vienna, Austria

BELGIUM

Commercial Counsellor
Canadian Embassy
rue de la Science, 35
B-1040 Brussels, Belgium
Territory:
Luxembourg

BRAZIL

RIO DE JANEIRO
Commercial Counsellor
Canadian Embassy
Caixa Postal 2164-ZC-00
Edificio Metropol
Avenida Presidente Wilson 165
Rio de Janeiro, Brazil

BRITAIN

Counsellor (Defence Production)
Canadian High Commission
One Grosvenor Square
London, W1X, OAB, England

CEYLON

Commercial Division
Canadian High Commission
P.O. Box 1006
6 Gregory's Road
Cinnamon Gardens
Colombo, Ceylon

CHILE

Commercial Secretary
Canadian Embassy
Casilla 771
Edificio Ahumada, 10th Floor
Santiago, Chile

COLOMBIA

Commercial Counsellor
Canadian Embassy
Apartado Aereo 53531/2
Calle 58 No. 10-42
Bogota, Colombia

CONGO (see ZAIRE)**COSTA RICA**

Commercial Secretary
Canadian Embassy
Apartado Postal 10303
5th Floor, Edificio Amalia
Avenida 1 y Calle 7
San Jose, Costa Rica
Territory:
Canal Zone, Nicaragua, Panama

DENMARK

Commercial Counsellor
Canadian Embassy
Prinsesse Maries Allé 2
Copenhagen V, Denmark

FRANCE

Counsellor (Defence Production)
Canadian Embassy
35 Avenue Montaigne
Paris 8^e, France

GERMANY

Counsellor (Defence Production)
Canadian Embassy
Friedrich-Wilhelmstrasse 18
53 Bonn, West Germany

GREECE

Commercial Secretary
Canadian Embassy
4 Ioannou
Ghennadiou Street
Athens 140, Greece

GUATEMALA

Commercial Secretary
Canadian Embassy
Apartado 3A (airmail), 4A (seamail)
Edificio Etisa, Plazuela Espana
7a Avenida 12-19, Zone 9
Guatemala City, Guatemala, C.A.

Territory:

El Salvador, Honduras

INDIA

Commercial Counsellor for Canada
P.O. Box 11
13 Golf Links Road
New Delhi 1, India

Territory:

Bhutan, Nepal, Sikkim

INDONESIA

Commercial Secretary
Canadian Embassy
Djalan Budi Kemuliaan No. 6
Djakarta, Indonesia

IRAN

Commercial Secretary
Canadian Embassy
P.O. Box 1610
Bezrouke Building
Corner of Takht Jamshid Avenue and
Forsat Street
Tehran, Iran

IRELAND

Commercial Counsellor for Canada
66 Upper O'Connell Street
Dublin, Ireland

ITALY

Counsellor (Defence Production)
Canadian Embassy
Via G. B. De Rossi 27
00161 Rome, Italy
Territory:
Malta

IVORY COAST

Commercial Secretary
Canadian Embassy
P.O. Box 21194
Le General Building
Cor. Avenue du Commerce et
Bottreau-Roussel Plateau
Abidjan, Ivory Coast
Territory:
Guinea, Liberia, Mali, Mauritania, Niger,
Senegal, Upper Volta

JAMAICA

Commercial Secretary
Canadian High Commission
P.O. Box 1500
Tobago Road
Corner Trafalgar Road and Knutsford Boulevard
Kingston 10, Jamaica

JAPAN

Minister (Commercial)
Embassy of Canada
Akasaka Post Office
Tokyo 107, Japan
Territory:
Korea

KENYA

Commercial Secretary
Canadian High Commission
P.O. Box 3778
Industrial Promotion Services Building
Kimathi Street
Nairobi, Kenya
Territory:
Ethiopia, Malawi, Somali Republic,
Tanzania, Uganda, Zambia

LEBANON

Commercial Counsellor
Canadian Embassy
Boite Postale 2300
Alpha Building
Rue Clemenceau
Beirut, Lebanon
Territory:
Iraq, Jordan, Kuwait, Republic of Yemen (Aden),
Persian Gulf Area, Saudi Arabia, Syria,
Trucial States, Yemen Arab Republic

MALAYSIA

Commercial Secretary
Canadian High Commission
P.O. Box 990
A.I.A. Building, Ampang Road
Kuala Lumpur, Malaysia
Territory:
Brunei, Burma

MEXICO

Commercial Counsellor
Canadian Embassy
Apartado Postal 5-364
Melchor Ocampo 463, 7th Floor
Mexico 5, D.F., Mexico

NETHERLANDS

Commercial Counsellor
Canadian Embassy
Sophialaan 7
The Hague, Netherlands

NEW ZEALAND

Commercial Counsellor
Canadian High Commission
P.O. Box 12-049 Wellington North
ICI Building, 3rd Floor
Molesworth Street
Wellington, New Zealand

NIGERIA

Commercial Secretary
Canadian High Commission
P.O. Box 851
Niger House
1/5 Odunlami Street
Lagos, Nigeria
Territory:
Dahomey, Gambia, Ghana, Sierra Leone, Togo

NORWAY

Commercial Secretary
Canadian Embassy
Postuttak
Oslo 1, Norway
Territory:
Iceland

PAKISTAN

Commercial Secretary
Canadian High Commission
Hotel Shahrazed
Islamabad, Pakistan
Territory:
Afghanistan

PERU

Commercial Secretary
Canadian Embassy
Casilla 1212
Edificio El Pacifico
Corner Avenida Arequipa and Plaza Washington
Lima, Peru
Territory:
Bolivia

PHILIPPINES

Consul General and Senior Trade Commissioner
Canadian Consulate General
P.O. Box 1825
1414 Roxas Boulevard
Manila, Philippines

PORTUGAL

Commercial Counsellor
Canadian Embassy
Rua Rosa Araujo, 2-7º
Seventh Floor
Lisbon 2, Portugal

SINGAPORE

Commercial Counsellor
Canadian High Commission
P.O. Box 845
International Building, 11th Floor
360 Orchard Road
Singapore 1, Singapore

SPAIN

Commercial Counsellor
Canadian Embassy
Apartado 117
Edificio Espana
Avenida de Jose Antonio 88
Madrid, Spain
Territory:
Equatorial Guinea, Morocco

SWEDEN

Commercial Secretary
Canadian Embassy
P.O. Box 14042
Kungsgatan 24
S-104 40 Stockholm, Sweden
Territory:
Finland

SWITZERLAND

Commercial Counsellor
Canadian Embassy
Kirchenfeldstrasse 88
3000 Berne, Switzerland

THAILAND

Commercial Secretary and Consul
Canadian Embassy
P.O. Box 2090
Thai Farmers Bank Building, 7th Floor
142 Silom Road
Bangkok, Thailand

TRINIDAD AND TOBAGO

Commercial Secretary
Canadian High Commission
P.O. Box 1246
Colonial Building
72 South Quay
Port-of-Spain, Trinidad

TURKEY

Commercial Secretary
Canadian Embassy
Vali Dr. Resit Caddesi 52
Cankaya, Ankara, Turkey

VENEZUELA

Commercial Counsellor
Canadian Embassy
Apartado 62302
Avenida La Estancia No. 10
Ciudad Commercial Tamanaco
Caracas 106, Venezuela

YUGOSLAVIA

Commercial Secretary
Canadian Embassy
Proleterskih Brigada 69
Belgrade, Yugoslavia

ZAIRE

(Formerly Congo/Kinshasa)
Commercial Secretary
Canadian Embassy
P.O. Box 8341
Kinshasa, Zaire
Territory:
Cameroon, Chad, Central African Republic,
Gabon, Congo (Brazaville), Burundi, Rwanda

TABLE OF CONTENTS

INDEX OF COMMODITIES:	Group	Page
Aircraft; and Airframe Structural Components	15	22
Aircraft Components and Accessories	16	22
Aircraft Launching, Landing, and Ground Handling Equipment	17	23
Alarm and Signal System	63	41
Ammunition and Explosives	13	20
Bearings	31	28
Books, Maps, and Other Publications	76	44
Brushes, Paints, Sealers, and Adhesives	80	45
Chemicals and Chemical Products	68	43
Clothing, Individual Equipment, and Insignia	84	46
Communication, Detection, and Coherent Radiation Equipment	58	35
Construction and Building Materials	56	35
Construction, Mining, Excavating, and Highway Maintenance Equipment	38	30
Containers, Packaging, and Packing Supplies	81	45
Electric Wire, and Power Distribution Equipment	61	40
Electrical and Electronic Equipment Components	59	38
Engine Accessories	29	27
Engines, Turbines, and Components	28	27
Fire Control Equipment	12	19
Fire Fighting, Rescue, and Safety Equipment	42	31
Food Preparation and Serving Equipment	73	44
Fuels, Lubricants, Oils and Waxes	91	46
Furnace, Steam Plant, and Drying Equipment; and Nuclear Reactors	44	32
Furniture	71	44
Guided Missiles	14	22
Hand Tools	51	34
Hardware and Abrasives	53	34
Household and Commercial Furnishings and Appliances	72	44
Instruments and Laboratory Equipment	66	42
Lighting Fixtures and Lamps	62	41
Maintenance and Repair Shop Equipment	49	33
Materials Handling Equipment	39	31
Measuring Tools	52	34
Mechanical Power Transmission Equipment	30	28
Medical, Dental, and Veterinary Equipment and Supplies	65	41
Metal Bars, Sheets, and Shapes	95	46
Metal-working Machinery	34	28
Miscellaneous	99	47
Motor Vehicles, Trailers, and Cycles	23	26
Non-metallic Fabricated Materials	93	46
Nuclear Ordnance	11	19
Office Machines, Visible Record Equipment and Data Processing Equipment	74	44
Ores, Minerals, and Their Primary Products	96	47
Photographic Equipment	67	43
Pipe, Tubing, Hose, and Fittings	47	33
Plumbing, Heating, and Sanitation Equipment	45	33
Prefabricated Structures and Scaffolding	54	35
Pumps and Compressors	43	32
Railway Equipment	22	25
Recreational and Athletic Equipment	78	44
Refrigeration and Air Conditioning Equipment	41	31

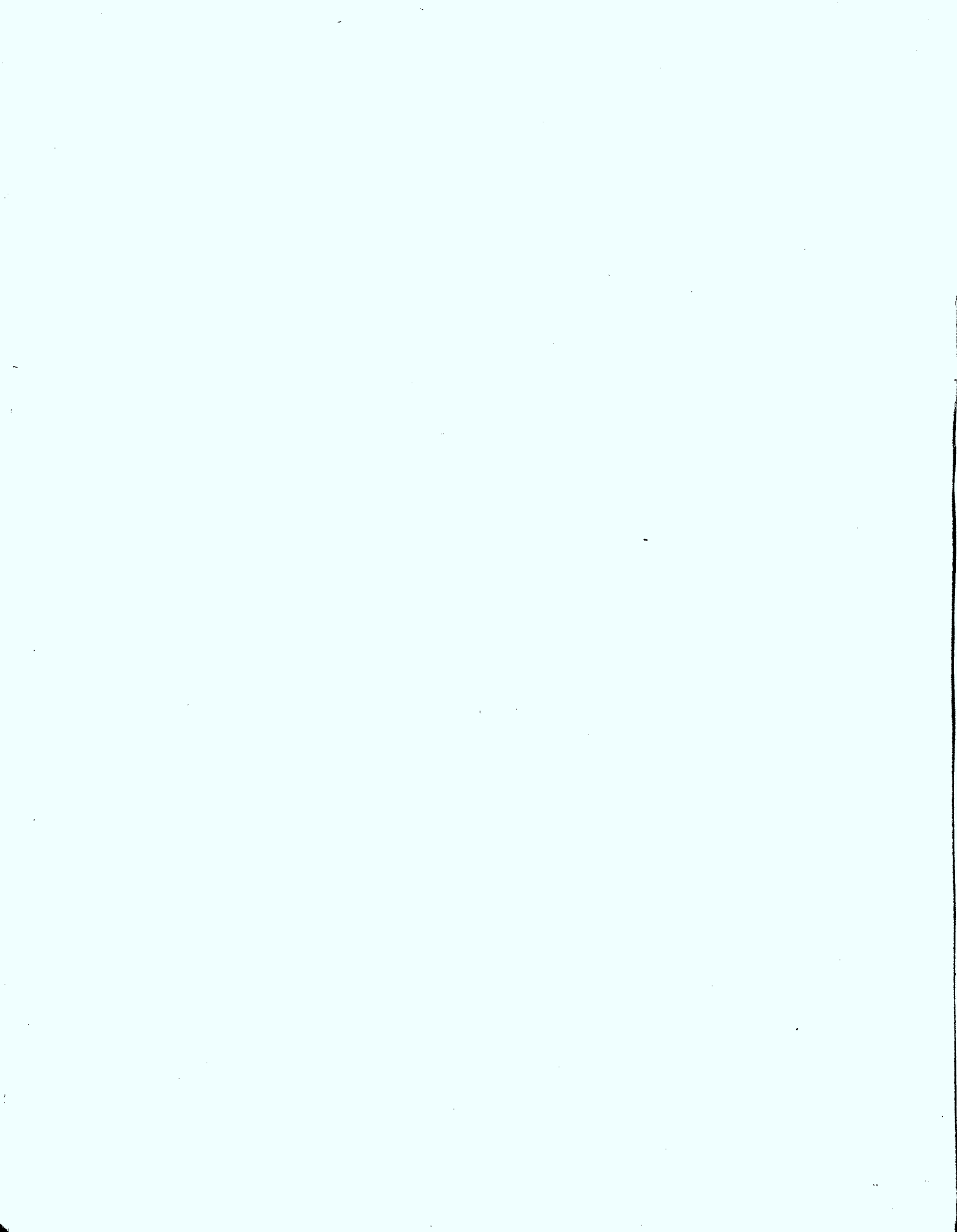
	Group	Page
INDEX OF COMMODITIES:		
Rope, Cable, Chain, and Fittings	40	31
Service and Trade Equipment	35	29
Ship and Marine Equipment	20	24
Ships, Small Craft, Pontoons, and Floating Docks	19	24
Ships, Small Craft, Pontoons, and Floating Docks	18	23
Space Vehicles	36	29
Special Industry Machinery	83	45
Textiles, Leather, and Furs	26	26
Tires and Tubes	24	26
Tractors	69	43
Training Aids and Devices	48	33
Valves	25	26
Vehicular Equipment, and Components	46	33
Water Purification and Sewage Treatment Equipment	10	19
Weapons	32	28
Woodworking Machinery and Equipment		
INDEX OF SERVICES		
Aerial Surveying, Mapping and Services		50
Antenna, Antenna Farm and Surface Installations		50
Arctic Products		51
Consulting and Design Services		55
Defence Systems Management		55
Radioactive Materials, Instrumentation and Power Plants		55
Reliability Studies		56
Repair and Overhaul		59
INDEX OF COMPANIES		
INDEX TO ILLUSTRATED SECTION		
AIRCRAFT AND AEROSPACE, PRODUCTS AND SERVICES		129
1. The DHC-6 Twin Otter		130
2. The DHC-5 "Buffalo"		132
3. The DHC-4 "Caribou"		134
4. Tilt-Wing Aircraft		136
5. CF-5/NF-5 Tactical Support Fighter		136
6. Amphibious Utility Transport (CL-215)		138
7. AN/USD-501 Airborne Surveillance Drone System		138
8. Flight Simulators		140
9. Black Brant Research Rockets		142
10. Gas Turbine Engines		144
11. Gas Turbine Engine Components and Assemblies		147
12. "JATO" Aircraft Rocket Engine		148
13. Aircraft Fuel Controls		149
14. Helicopter Landing Gear, UH-2		150
15. Flap Actuator/Control		151
16. Helicopter Landing Gear, CH4F		152
17. Aircraft Landing Gear, CL-84		153
18. Actuation Systems for Variable Geometry Aeroplanes		154
19. DHC-4 Main and Nose Landing Gears		156
20. DHC-5 Main and Nose Landing Gears		157
21. Airfield Lighting Power Supply Systems		158
22. Acrylic and Plastic Laminates		165

	Page
23. Crash Position Indicators and Flight Recorder Systems	166
24. Water Activated Air-Sea Rescue Beacons	176
25. Automatic Downed Aircraft Locators	178
26. Airport Visibility Equipment	179
27. Projected Map Display	180
28. Combined Display	181
29. Position and Homing Indicator (PHI)	182
30. AN/ARA-59 UHF Direction Finding Group	183
31. Weapon Release Computer Set	184
32. Mobile Automatic Test Set	186
33. LTN-51 System	188
34. AFTS-23 Digital Pressure Monitor	189
35. Programmable Pneumatic Signal Generator	190
36. Pressure-Temperature Test Set	193
37. Altimeters	194
38. Parachute Systems	198
40. Transportable and Mobile Air Traffic Control Towers	200
41. Airborne Avionics Systems	202
ADDENDUM	
DHC-7 STOL Airliner	494
COMMUNICATIONS, ELECTRONIC EQUIPMENTS AND COMPONENTS	207
1. Aerospace Programmes and Satellite Sub-Systems	208
2. Satellite Earth Stations	210
3. Receiver/Transmitter Control Group	212
4. High Power Low Frequency Systems	214
5. Microwave Radio Relay	215
6. Microwave Communication System	216
7. Radio Relay Equipment, GRC-103	218
8. Microwave Radio Systems	220
9. Telephone and Telegraph Multiplex Terminal	222
10. VLF-VHF Direction Finder	224
11. Data Transmission Sets	227
12. Teletypewriters	228
13. Transceivers	230
14. 20 Watt VHF-AM Transmitter	232
15. VHF-AM Receiver	233
16. Spectrum and Frequency Monitoring Receiver	234
17. UHF Transceiver AN/PRC-66	236
18. Public Address System	237
19. Message Header Formatter 101	238
20. PHI-Tran for Data Acquisition	238
21. Signal Distortion Analyzer	240
22. Test Message Generator	241
23. Printed Circuit Boards and Edge Lighted Panels	242
25. Micro-Electronics	243
26. Micro-Electronics Situation Display	244
27. Graphic to Digital Converter	245
28. Touch Sensitive Digitizer	248
29. Communication and Power Transmission Cable	250
30. Signal Processing and Applied Research Programme	252

	Page
MARINE EQUIPMENTS AND DESIGN	253
1. Replenishment at Sea (RAS)	254
2. Hydrographic and Oceanographic Survey Vessel	257
3. Naval Ship Design and Construction	258
4. Bulk Carriers	260
5. Ferry Services	261
6. Hydrofoil Development	262
7. Underway Replenishment of Ships	264
8. Underway Replenishment System	266
9. Oceanographic Winch	266
10. Winch Systems	268
11. Launching and Retrieving Systems-VDS	271
12. Deep Sea Towing	272
13. Deck Machinery	274
14. Shipboard Helicopter Handling System	276
15. Helicopter Landing and Securing System	278
16. Telescopic Hangars	279
17. Stabilized Horizon Bar	280
18. Sonar Equipments	282
19. Sonar Ship Detector	285
20. Minesweeper and Oceanographic Plotter	288
21. Alpha Computer System (ASW)	290
22. Sonobuoys	292
23. Solid State Electronic Transducer Scanner	293
24. Transistorized Marine Radar	294
25. Temperature Depth and Salinity Systems	296
26. Outboard Motors	297
27. Marine Design and Drafting	298
28. VHF/UHF Antenna Group	300
WHEELED AND TRACKED VEHICLES	301
1. Off-Highway Vehicles – Flextrac Nodwell	302
2. Off-Highway Vehicles – Foremost	306
3. Load Carriers, Construction, Maintenance – Safety Vehicles	308
4. Earth Moving Equipment	312
5. Over-Burden Drilling Equipment	316
6. Material Handling Equipment – Travelling Cranes	320
7. Excavators	322
8. Hydraulic Cranes	322
9. Bush Clearance and Logging Equipment	323
10. Pollution Control and Sanitary Landfill Equipment	324
11. Lightweight Snow Vehicles – Bombardier	326
12. Lightweight Snow Vehicles – Outboard Marine Corporation	328
13. Tracked Snowplows	329
14. Lightweight Amphibious Tracked Vehicles	330

	Page
MILITARY CLOTHING AND PERSONAL EQUIPMENT	331
1. Introduction	332
2. Combat Clothing	
Tropical	334
Temperate	335
Cold Weather	336
Camouflage, Cold Weather	337
3. Air Crew Clothing	338
4. Flight Line Clothing	340
5. Special Clothing	
Armoured Fighting Vehicle	342
Chemical Warfare Protective Clothing	343
Parka and Trousers, Foul Weather, Naval	343
Mask Protective, NBCW	344
6. Handwear and Footwear	
Handwear	346
Footwear	350
7. Combat Spectacles	356
8. Web and Load Carrying Equipment	358
9. Water Containers	361
10. Tentage and Sleeping Equipment	362
11. Over-Snow Equipment	
Snow Kit	367
Toboggans	368
Snowshoes	370
Snowshoe Bindings	370
Skis, Poles and Bindings	371
Ski Maintenance Kit	372
12. Plastic Hardware	373
OPTICAL AND MECHANICAL FIRE CONTROL	375
1. Gun Alignment and Control System	376
2. Stabilized Electro-Optical Mounts	380
3. Optical Equipments and Services	
Optical Ray Tracing	382
Modulation Transfer Function Analyzer	382
High Vacuum	382
Fire Control Equipments	383
Day-Night Sight	384
Sniper Sight	384
Binoculars	386
Sightunit C2	386
Internal Immersion Lenses for Submersibles	388
Lenses for Aerial Reconnaissance Cameras and Multi-Spectral Photography	390

	Page
NBCW EQUIPMENTS	393
1. Paper Detector, Liquid Chemical Agent	394
2. Detector, Chemical Agent, Nerve Vapour	396
3. Mitt, Decontaminating, CW Agent	397
4. Protective Material Kit, NBCW	397
5. Decontaminating Apparatus, Portable	398
6. Decontaminating Agent, C-1	398
7. Radiation Detection Set, Airborne	399
8. Radiac Set, Remote Monitor and Alarm	400
9. Computer Indicator Radiac Tactical Dosimeter Reader	401
10. Quartz Fibre Dosimeters	402
11. Charger, Radiac Detector Radiacmeter	402
12. Radiacmeter Remote Monitoring Single Probe	404
13. Calibration Set, Radiac, AN/UDM-501(V)	406
14. Calibration Set, Radiac, AN/UDM-502	408
15. Simulator, Radiation Detection Set	409
16. Radiac Training Set, RST 8500	410
NATIONAL RESEARCH COUNCIL	411
1. The National Aeronautical Establishment	412
2. Radio and Electrical Engineering Division and Astrophysics Branch	419
3. Division of Mechanical Engineering	425
4. Division of Building Research	429
MISCELLANEOUS EQUIPMENTS AND SERVICES	437
1. Land Navigation Systems	438
2. Firemapper	442
3. Remote Sensing	443
4. Nuclear Power Plant Instrumentation	448
5. Sterilization Plant-Cobalt 60	450
6. Cancer Therapy Units	451
7. Cobalt 60 Electrical Generator	452
8. Transportable Generating Sets	453
9. Custom Machine Shops	454
10. Defence Research Board	457
11. Repair and Overhaul Facilities	460
12. Oil Pollutant Recovery	462
13. General Steel Fabrication	464
14. Air Cushion Vehicles	466
15. Electroplate Fusing System	467
16. Asphalt, Crushers and Paving Plant	468
17. Chain Saws	473
18. Canadian Arsenals Limited	474
19. Ammunition Design and Development	476
20. Impact Extrusion Components	477
21. Mine Anti-Personnel, Non-Metallic	478
22. Fuse Assemblies and Precision Metal Parts	479
23. Transportable Shelters and Housing Units	480
24. Smoke Generator, Aircraft, Orange	485
25. Support Kit, Overhead Protection (SKOP)	486
26. Container Heater Cartridge	488
27. Fastening and Closure Devices	489



GROUP 10**WEAPONS**

1005 – Guns through 30 mm

Atlas Steels Co.
 Canada Cycle & Motor Co. Ltd.
 Canadian Arsenals Limited
 Canadian General Electric (Plastics)
 Universal Die & Tool Mfg.

1010 – Guns over 30 mm up to 75 mm

Atlas Steels Co.
 Menasco of Canada, Ltd.
 Universal Die & Tool Mfg.

1015 – Guns 75 mm through 125 mm

Atlas Steels Co.
 Menasco of Canada, Ltd.
 Uniroyal Ltd.
 Universal Die & Tool Mfg.

1020 – Guns over 125 mm through 150 mm

Atlas Steels Co.
 Menasco of Canada, Ltd.
 Uniroyal Ltd.

1025 – Guns over 150 mm through 200 mm

Menasco of Canada, Ltd.

1045 – Launchers, Torpedo and Depth Charge

Canadian Vickers Ltd.
 Fleet Mfg. Ltd.
 Irvin Industries Canada Ltd.

1055 – Launchers, Rocket and Pyrotechnic

Irvin Industries Canada Ltd.

1075 – Degaussing and Mine Sweeping Equipment

Canada Wire & Cable

1095 – Miscellaneous Weapons

Canada Cycle & Motor Co. Ltd.
 Universal Die & Tool Mfg.

GROUP 11**NUCLEAR ORDNANCE**

1190 – Specialized Test and Handling Equipment, Nuclear Ordnance

Canadian Vickers Ltd.

GROUP 12**FIRE CONTROL EQUIPMENT**

1210 – Fire Control Directors

Canadian General Electric (Aerospace)
 Computing Devices of Canada

1220 – Fire Control Computing Sights and Devices

Aviation Electric Ltd.
 Canadian General Electric (Aerospace)
 Computing Devices of Canada
 Marsland Engineering Ltd.
 O & W Electronics Ltd.
 Stanley Manufacturing Co. Ltd.

1230 – Fire Control Systems, Complete

Aviation Electric Ltd.
 CAE Electronics Ltd.
 Canadian General Electric (Aerospace)
 Computing Devices of Canada
 RCA Ltd.

1240 – Optical Sighting and Ranging Equipment

Canadian Arsenals Limited
 Canadian General Electric (Aerospace)
 Ernst Leitz Canada Ltd.

1265 – Fire Control Transmitting and Receiving Equipment, Except Airborne

Canadian General Electric (Aerospace)
 RCA Ltd.

1285 – Fire Control Radar Equipment, Except Airborne

CAE Electronics Ltd.
 RCA Ltd.

1287 – Fire Control Sonar Equipment

Computing Devices of Canada

1290 – Miscellaneous Fire Control Equipment

Computing Devices of Canada
Ernst Leitz Canada Ltd.
O & W Electronics Ltd.
Stanley Manufacturing Co. Ltd.
Universal Die & Tool Mfg.

Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Space Research Corp. (Quebec) Inc.
Valcartier Industries Inc.

GROUP 13**AMMUNITION AND EXPLOSIVES**

1305 – Ammunition, Through 30 mm

Canadian Arsenals Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Valcartier Industries Inc.

1325 – Bombs

Bristol Aerospace (1968) Ltd.
Canada Cycle & Motor Co. Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
Hawker Siddeley Canada Ltd.
(Canadian Steel Foundries)
Lacal Industries Ltd.
Space Research Corp. (Quebec) Ltd.
Valcartier Industries Inc.

1310 – Ammunition, Over 30 mm up to 75 mm

Bristol Aerospace (1968) Ltd.
Canada Cycle & Motor Co. Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Marsland Engineering Ltd.
Space Research Corp. (Quebec) Inc.
Triplex Engineering Co. Ltd.
Valcartier Industries Inc.

1330 – Grenades

Bristol Aerospace (1968) Ltd.
Canada Cycle & Motor Co. Ltd.
Canadian Arsenals Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
Canadian Safety Fuse
General Impact Extrusions Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Steel Foundries)
Lacal Industries Ltd.

1315 – Ammunition, 75 mm through 125 mm

Bristol Aerospace (1968) Ltd.
Canada Cycle & Motor Co. Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Marsland Engineering Ltd.
Space Research Corp. (Quebec) Inc.
Triplex Engineering Co. Ltd.
Valcartier Industries Inc.

1336 – Guided Missile Warheads and Explosive Components

Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Triplex Engineering Co. Ltd.

1320 – Ammunition, over 125 mm

Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.

1337 – Guided Missile and Space Vehicle Explosive Propulsion Units Solid Fuel: and Components

Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)

-
- 1340 – Rockets and Rocket Ammunition
Bristol Aerospace (1968) Ltd.
Canada Cycle & Motor Co. Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
Canadian Vickers Ltd.
General Impact Extrusions Ltd.
Lacal Industries Ltd.
Space Research Corp. (Quebec) Inc.
Triplex Engineering Co. Ltd.
- 1345 – Land Mines
Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Impact Extrusions Ltd.
Triplex Engineering Co. Ltd.
- 1350 – Underwater Mine Inert Components
Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Fleet Mfg. Ltd.
General Impact Extrusions Ltd.
Triplex Engineering Co. Ltd.
- 1351 – Underwater Mine Explosive Components
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
- 1355 – Torpedo Inert Components
Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
General Impact Extrusions Ltd.
Marsland Engineering Ltd.
- 1356 – Torpedo Explosive Components
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
- 1360 – Depth Charge Inert Components
Canadian Flight Equipment Co. Ltd.
General Impact Extrusions Ltd.
Triplex Engineering Co. Ltd.
- 1361 – Depth Charge Explosive Components
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
- 1365 – Military Chemical Agents
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
- 1370 – Pyrotechnics
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
Canadian Safety Fuse
- 1375 – Demolition Material
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
Canadian Safety Fuse
Greening Donald Ltd.
- 1376 – Bulk Explosives
Canadian Arsenals Ltd.
Canadian Industries Ltd. (Ammunition)
- 1377 – Cartridge and Propellant Actuated Devices and Components
Bristol Aerospace (1968) Ltd.
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
- 1390 – Fuses and Primers
Canadian Arsenals Ltd.
Canadian Flight Equipment Co. Ltd.
Canadian General Electric (Plastics)
Canadian Industries Ltd. (Ammunition)
General Time of Canada Ltd.
Marsland Engineering Ltd.
Triplex Engineering Co. Ltd.
Valcartier Industries Inc.
- 1395 – Miscellaneous Ammunition
Canadian General Electric (Plastics)
General Impact Extrusions Ltd.
-

Lacal Industries Ltd.
Space Research Corp. (Quebec) Inc.
Valcartier Industries Inc.

GROUP 14**GUIDED MISSILES**

1410 – Guided Missiles

Bristol Aerospace (1968) Ltd.
Canadair Ltd.
Computing Devices of Canada

1420 – Guided Missile Components

Bristol Aerospace (1968) Ltd.
Canadair Ltd.
Canadian Flight Equipment Co. Ltd.
Computing Devices of Canada
Dowty Equipment of Canada
Fleet Mfg. Ltd.
Garrett Mfg. Ltd.
Menasco of Canada, Ltd.

1430 – Guided Missile Remote Control Systems

Canadair Ltd.
Computing Devices of Canada
Garrett Mfg. Ltd.
RCA Ltd.
Space Research Corp. (Quebec) Inc.

1440 – Launchers, Guided Missile

Bristol Aerospace (1968) Ltd.
Canadair Ltd.
Canadian Vickers Ltd.
Computing Devices of Canada
Fleet Mfg. Ltd.

1450 – Guided Missile Handling and Servicing Equipment

Canadair Ltd.
Canadian Vickers Ltd.
Computing Devices of Canada
Hawker Siddeley Canada Ltd.
(Canadian Car)
Irvin Industries Canada Ltd.

GROUP 15**AIRCRAFT: AND AIRFRAME
STRUCTURAL COMPONENTS**

1510 – Aircraft, Fixed Wing

Canadair Ltd.
De Havilland Aircraft of Canada

1560 – Airframe Structural Components

Bristol Aerospace (1968) Ltd.
Canadair Ltd.
Canadian Aircraft Products Ltd.
Canadian General Electric (Plastics)
De Havilland Aircraft of Canada
Fleet Mfg. Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car)
Leigh Instruments Ltd.
Menasco of Canada, Ltd.
Northwest Industries Ltd.
O & W Electronics Ltd.
Plastal Mfg. Ltd.
Uniroyal Ltd.
Universal Die & Tool Mfg.
Westhill Industries Ltd.

GROUP 16**AIRCRAFT COMPONENTS AND
ACCESSORIES**

1620 – Aircraft Landing Gear Components

Canadair Ltd.
Canadian Vickers Ltd.
De Havilland Aircraft of Canada
Dowty Equipment of Canada
Menasco of Canada, Ltd.

1630 – Aircraft Wheel and Brake Systems

Aviation Electric Ltd.
Bristol Aerospace (1968) Ltd.
Canadian Aircraft Products Ltd.
Canadian Vickers Ltd.
Dowty Equipment of Canada
Fleet Mfg. Ltd.
Menasco of Canada, Ltd.

1650 – Aircraft Hydraulic, Vacuum, and De-Icing

System Components
 Bristol Aerospace (1968) Ltd.
 Canadian Flight Equipment Co. Ltd.
 Dowty Equipment of Canada
 Garrett Mfg. Ltd.
 Godfrey Engineering Co. Ltd.
 Menasco of Canada, Ltd.
 Westhill Industries Ltd.

Dominion Aluminum Fabricating Ltd.
 Greening Donald Ltd.

1720 – Aircraft Launching Equipment

Greening Donald Ltd.
 Canadian Arsenals Limited

1660 – Aircraft Air Conditioning, Heating and Pressurizing Equipment

Dominion Helicopters Ltd.
 Garrett Mfg. Ltd.
 Godfrey Engineering Co. Ltd.
 Uniroyal Ltd.

1730 – Aircraft Ground Servicing Equipment

Aviation Electric Ltd.
 Bristol Aerospace (1968) Ltd.
 Canadair Ltd.
 De Havilland Aircraft of Canada
 Dowty Equipment of Canada
 Fleet Mfg. Ltd.
 Godfrey Engineering Co. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Menasco of Canada, Ltd.
 Rousseau Controls Ltd.
 Uniroyal Ltd.
 Universal Die & Tool Mfg.

1670 – Parachutes and Aerial Pick Up, Delivery and Cargo Tie Down Equipment

Canadian Flight Equipment Co. Ltd.
 De Havilland Aircraft of Canada
 Dominion Helicopters Ltd.
 Fleet Mfg. Ltd.
 Irvin Industries Canada Ltd.

1680 – Miscellaneous Aircraft Accessories and Components

Beckman Instruments Inc. (Helipot)
 Bristol Aerospace (1968) Ltd.
 Canadair Ltd.
 Canadian Flight Equipment Co. Ltd.
 Dominion Helicopters Ltd.
 Dowty Equipment of Canada
 Fleet Mfg. Ltd.
 Godfrey Engineering Co. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Menasco of Canada, Ltd.
 Irvin Industries Canada Ltd.
 Universal Die & Tool Mfg.

1740 – Airfield Specialized Trucks and Trailers

ATCO Industries Ltd.
 Fleet Mfg. Ltd.
 Godfrey Engineering Co. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Sicard Inc.

GROUP 17**AIRCRAFT LAUNCHING, LANDING,
AND GROUND HANDLING EQUIPMENT**

1710 – Aircraft Arresting, Barrier and Barricade Equipment

GROUP 18**SPACE VEHICLES**

1850 – Space Vehicle Handling and Servicing Equipment

Canadian Vickers Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)

GROUP 19**SHIPS, SMALL CRAFT, PONTOONS
AND FLOATING DOCKS**

1905 – Combat Ships and Landing Vessels

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1910 – Transport Vessels, Passenger and Troop

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1915 – Cargo and Tanker Vessels

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1920 – Fishing Vessels

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Saint John Shipbuilding & Dry Dock

1925 – Special Service Vessels

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1930 – Barges and Lighters, Cargo

Canron Ltd. (Eastern Structural)
Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1935 – Barges and Lighters, Special Purpose

Canron Ltd. (Eastern Structural)

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1940 – Small Craft

Canadian Aircraft Products Ltd.
Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Saint John Shipbuilding & Dry Dock
Uniroyal Ltd.

1945 – Pontoons and Floating Docks

Canadian Aircraft Products Ltd.
Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock
Uniroyal Ltd.

1950 – Floating Drydocks

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Marine Industries Ltd.
Saint John Shipbuilding & Dry Dock

1955 – Dredges

Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Saint John Shipbuilding & Dry Dock

GROUP 20**SHIP AND MARINE EQUIPMENT**

2010 – Ship and Boat Propulsion Components

Davie Shipbuilding Ltd.
Dowty Equipment of Canada
Garrett Mfg. Ltd.
Hawker Siddeley Canada Ltd.
(Trenton Works)

2020 – Rigging and Rigging Gear

Canadian Vickers Ltd.
 Davie Shipbuilding Ltd.
 Garrett Mfg. Ltd.
 Greening Donald Ltd.
 John T. Hepburn Ltd.
 Saint John Shipbuilding & Dry Dock

2030 – Deck Machinery

Canadian Vickers Ltd.
 Davie Shipbuilding Ltd.
 Dowty Equipment of Canada
 Fleet Mfg. Ltd.
 Garrett Mfg. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car Pacific)
 Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 John T. Hepburn Ltd.
 Menasco of Canada, Ltd.
 Swann Winches Ltd.

2040 – Marine Hardware and Hull Items

Allied Enterprises Ltd.
 Beclawat (Canada) Ltd.
 Canadian Vickers Ltd.
 Davie Shipbuilding Ltd.
 Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 Hawker Siddeley Canada Ltd.
 (Trenton Works)
 John T. Hepburn Ltd.
 Lecal Industries Ltd.
 Saint John Shipbuilding & Dry Dock
 Uniroyal Ltd.

2050 – Buoys

Bristol Aerospace (1968) Ltd.
 Canadian General Electric (Plastics)
 Canadian Vickers Ltd.
 Dahmer Steel Ltd.
 Davie Shipbuilding Ltd.
 Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 Hawker Siddeley Canada Ltd.
 (Trenton Works)
 Marine Industries Ltd.
 Saint John Shipbuilding & Dry Dock
 Uniroyal Ltd.

2090 – Miscellaneous Ship and Marine Equipment

Allied Enterprises Ltd.
 Canadian Vickers Ltd.
 Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 Saint John Shipbuilding & Dry Dock
 Co. Ltd.
 Uniroyal Ltd.

GROUP 22**RAILWAY EQUIPMENT**

2210 – Locomotives

Canadian General Electric
 (Industrial Apparatus)

2220 – Rail Cars

Canadian Vickers Ltd.
 Davie Shipbuilding Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Hawker Siddeley Canada Ltd.
 (Trenton Works)
 Marine Industries Ltd.

2230 – Right-of-Way Construction and Maintenance Equipment, Railroad

Hawker Siddeley Canada Ltd.
 (Canadian Steel Foundries)
 Hawker Siddeley Canada Ltd.
 (Trenton Works)

2240 – Locomotive and Rail Car Accessories and Components

Beclawat (Canada) Ltd.
 Canadian Flight Equipment Co. Ltd.
 Canadian General Electric (Plastics)
 Canadian Vickers Ltd.
 Hawker Siddeley Canada Ltd.
 (Trenton Works)
 Marine Industries Ltd.

2250 – Track Materials, Railroad

Hawker Siddeley Canada Ltd.
 (Trenton Works)

GROUP 23**MOTOR VEHICLES, TRAILERS,
AND CYCLES**

2310 – Passenger Motor Vehicles

Bombardier Ltd.
 Canadair Ltd.
 Canadian Vickers Ltd.

2320 – Trucks and Truck Tractors

Bomag (Canada) Ltd.
 Bombardier Ltd.
 John Deere Ltd.
 Flextrac-Nodwell Ltd.
 Foremost Tracked Vehicles Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Koehring-Waterous Ltd.
 OTACO
 Sicard Inc.

2330 – Trailers

ATCO
 Bombardier Ltd.
 Flextrac-Nodwell Ltd.
 Foremost Tracked Vehicles Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 OTACO

GROUP 24**TRACTORS**

2410 – Tractors, Full Track Low Speed

Bombardier Ltd.
 Flextrac-Nodwell Ltd.
 Foremost Tracked Vehicles Ltd.
 Valcartier Industries Inc.

2430 – Tractors, Track Laying, High Speed

Bombardier Ltd.
 Flextrac-Nodwell Ltd.
 Foremost Tracked Vehicles Ltd.
 Outboard Marine Corp. of Canada Ltd.

GROUP 25**VEHICULAR EQUIPMENT COMPONENTS**2510 – Vehicular Cab, Body, and Frame
Structural Components

ATCO Industries Ltd.
 Beclawat (Canada) Ltd.
 Canadian General Electric (Plastics)
 Canadian Vickers Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 OTACO Ltd.
 Uniroyal Ltd.
 Universal Dye & Tool Mfg.
 Valcartier Industries Inc.

2520 – Vehicular Power Transmission
Components

Dowty Equipment of Canada
 Rex Chainbelt (Canada) Ltd.

2530 – Vehicular Brake, Steering Axle, Wheel and
Track Components

Flextrac-Nodwell Ltd.
 OTACO
 Uniroyal Ltd.
 Valcartier Industries Inc.

2540 – Vehicular Furniture and Accessories

Canadian General Electric (Plastics)
 Gabriel of Canada
 Uniroyal Ltd.

2590 – Miscellaneous Vehicular Components

Uniroyal Ltd.

GROUP 26**TIRES AND TUBES**2610 – Tires and Tubes, Pneumatic,
Except Aircraft

Uniroyal Ltd.

2620 – Tires and Tubes, Pneumatic, Aircraft
Uniroyal Ltd.

2630 – Tires, Solid and Cushion
Uniroyal Ltd.

2640 – Tire Rebuilding and Tire and Tube Repair
Materials
Uniroyal Ltd.

GROUP 28

ENGINES, TURBINES, AND COMPONENTS

2805 – Gasoline Reciprocating Engines, Except
Aircraft, and Components
Canadian Acme Screw & Gear Ltd.
Cummins (Ontario) Ltd.
Deutz Diesel (Canada) Ltd.
Outboard Marine Corp. of Canada
Uniroyal Ltd.

2810 – Gasoline Reciprocating Engines, Aircraft:
and Components
Uniroyal Ltd.
United Aircraft of Canada Ltd.

2815 – Diesel Engines and Components
Canadian Vickers Ltd.
Cummins (Ontario) Ltd.
Deutz Diesel (Canada) Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car Pacific)
Uniroyal Ltd.

2820 – Steam Engines, Reciprocating:
and Components
Babcock & Wilcox Canada Ltd.
Canadian Vickers Ltd.

2825 – Steam Turbines and Components
Canadian Ingersoll-Rand Co., Ltd.
Canadian Vickers Ltd.
Howden & Parsons of Canada Ltd.
Marine Industries Ltd.
Westinghouse Canada Ltd.
(Turbine & Generator)

2835 – Gas Turbines and Jet Engines, Except
Aircraft, and Components
Bristol Aerospace (1968) Ltd.
Deutz Diesel (Canada) Ltd.
United Aircraft of Canada Ltd.

2840 – Gas Turbines and Jet Engines, Aircraft:
and Components
Aviation Electric
Bristol Aerospace (1968) Ltd.
Preci-Tools Ltd.
United Aircraft of Canada Ltd.

2895 – Miscellaneous Engines and Components
Deutz Diesel (Canada) Ltd.
Dowty Equipment of Canada

GROUP 29

ENGINE ACCESSORIES

2910 – Engines Fuel System Components,
Non-Aircraft
Menasco of Canada, Ltd.
Uniroyal Ltd.

2915 – Engine Fuel System Components, Aircraft
Aircraft Appliances & Equipment
Dowty Equipment of Canada
Menasco of Canada, Ltd.
Uniroyal Ltd.

2925 – Engines Electrical System Components,
Aircraft
Aircraft Appliances & Equipment
Aviation Electric Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car)

2930 – Engine Cooling System Components,
Non-Aircraft
Uniroyal Ltd.

2935 – Engine Cooling System Components,
Aircraft

Aircraft Appliances & Equipment
Orenda Ltd.

Uniroyal Ltd.

2940 – Engine Air and Oil Filters, Strainers and
Cleaners, Non-Aircraft

Aircraft Appliances & Equipment
Orenda Ltd.

2045 – Engine Air and Oil Filters, Strainers and
Cleaners, Aircraft

Aircraft Appliances & Equipment

2990 – Miscellaneous Engine Accessories,
Non-Aircraft

Armstrong Jones Ltd.

2995 – Miscellaneous Engine Accessories,
Aircraft

Abex Industries of Canada Ltd.
Aircraft Appliances & Equipment
Dowty Equipment of Canada
Menasco of Canada, Ltd.
Orenda Ltd.
United Aircraft of Canada Ltd.

GROUP 30

MECHANICAL POWER TRANSMISSION EQUIPMENT

3010 – Torque Converters and Speed Changers

Canadian Acme Screw & Gear Ltd.
Dominion Road Machinery
Dowty Equipment of Canada
Rex Chainbelt (Canada) Ltd.

3020 – Gears, Pulleys, Sprockets and
Transmission Chain

Canadian Acme Screw & Gear Ltd.
Canadian General Electric
(Meter & Instrument)

Leigh Instruments Ltd.
Marsland Engineering Ltd.
Rex Chainbelt (Canada) Ltd.
Standard-Modern Tool Co. Ltd.

3030 – Belting, Drive Belts, Fan Belts,
and Accessories

Uniroyal Ltd.

3040 – Miscellaneous Power Transmission
Equipment

Marine Industries Ltd.
Rex Chainbelt (Canada) Ltd.

GROUP 31

BEARINGS

3110 – Bearings, Anti-Friction, Unmounted

FAG Bearings Ltd.

3130 – Bearings, Mounted

FAG Bearings Ltd.
Rex Chainbelt (Canada) Ltd.

GROUP 32

WOODWORKING MACHINERY AND EQUIPMENT

3210 – Sawmill and Planing Machinery

Canadian Ingersoll-Rand Co., Ltd.
Clark Equipment of Canada Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car Pacific)
Koehring-Waterous Ltd.

GROUP 34

METALWORKING MACHINERY

3413 – Drilling Machines

Preci-Tools Ltd.
Standard-Modern Tool Co. Ltd.

-
- 3416 – Lathes
 Preci-Tool Ltd.
 Standard-Modern Tool Co. Ltd.
- 3419 – Miscellaneous Machine Tools
 John T. Hepburn Ltd.
 Preci-Tools Ltd.
 Standard-Modern Tool Co. Ltd.
- 3422 – Rolling Mills and Drawing Machines
 John T. Hepburn Ltd.
- 3426 – Metal Finishing Equipment
 Union Carbide (Gas Products) Canada Ltd.
- 3431 – Electric Arc Welding Equipment
 Union Carbide (Gas Products) Canada Ltd.
- 3433 – Gas Welding, Heat Cutting and
 Metalizing Equipment
 Union Carbide (Gas Products) Canada Ltd.
- 3439 – Miscellaneous Welding, Soldering, and
 Brazing Supplies and Accessories
 Canada Wire & Cable Co. Ltd.
 Electrovert Mfg. Co. Ltd.
 Union Carbide (Gas Products) Canada Ltd.
- 3442 – Hydraulic and Pneumatic Presses,
 Power Driven
 Davie Shipbuilding Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car Pacific)
- 3443 – Mechanical Presses, Power Driven
 Preci-Tools Ltd.
- 3449 – Miscellaneous Secondary Metal Forming
 and Cutting Machines
 Union Carbide (Gas Products) Canada Ltd.
- 3455 – Cutting Tools for Machine Tools
 Canadian General Electric
 (Chemical & Metallurgical)
- 3456 – Cutting and Forming Tools for Secondary
 Metal-working Machinery
 Canadian General Electric
 (Chemical & Metallurgical)
 Preci-Tools Ltd.
 Standard-Modern Tool Co. Ltd.
 Uniroyal Ltd.
 Valcartier Industries Inc.
- 3460 – Machine Tool Accessories
 Canadian General Electric
 (Chemical & Metallurgical)
 Standard-Modern Tool Co. Ltd.
- 3465 – Production Jigs, Fixtures and Templates
 Bristol Aerospace (1968) Ltd.
 Canadair Ltd.
 Canadian Flight Equipment Co. Ltd.
 Fleet Mfg. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Standard-Modern Tool Co. Ltd.
 Uniroyal Ltd.
 Universal Dye & Tool Mfg. Ltd.
- GROUP 35**
SERVICE AND TRADE EQUIPMENT
- 3520 – Shoe Repairing Equipment
 Valcartier Industries Inc.
- GROUP 36**
SPECIAL INDUSTRY MACHINERY
- 3615 – Pulp and Paper Industries Machinery
 Canadian General Electric (Plastics)
 Canadian Ingersoll-Rand Co., Ltd.
 Canadian Vickers Ltd.
 Davie Shipbuilding Ltd.
 Greening Donald Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car)
 Hawker Siddeley Canada Ltd.
 (Canadian Car Pacific)
 John T. Hepburn
 Koehring-Waterous Ltd.
 Northwest Industries Ltd.
 Uniroyal Ltd.
-

3620 – Rubber and Plastics Working Machinery
Uniroyal Ltd.

3650 – Chemical and Pharmaceutical Products
Manufacturing Machinery
Dahmer Steel Ltd.
Foster Wheeler Ltd.
Greening Donald Ltd.

3655 – Gas Generating and Dispensing Systems,
Fixed or Mobile
Union Carbide (Gas Products)
Canada Ltd.

3695 – Miscellaneous Special Industry Machinery
Armstrong Jones Ltd.
Canadian Vickers Ltd.
Clark Equipment of Canada Ltd.
Dahmer Steel Ltd.
Davie Shipbuilding Ltd.
John Deere Ltd.
Dowty Equipment of Canada
Greening Donald Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car)
Hawker Siddeley Canada Ltd.
(Trenton Works)
John T. Hepburn Ltd.
Koehring-Waterous Ltd.
Outboard Marine Corp, of Canada Ltd.
Pioneer Saws Ltd.
Standard-Modern Tool Co. Ltd.

GROUP 38

CONSTRUCTION, MINING EXCAVATING AND HIGHWAY MAINTENANCE EQUIPMENT

3805 – Earth Moving and Excavating Equipment
Barber-Greene Canada Ltd.
Clark Equipment of Canada Ltd.
John Deere Ltd.
Dominion Road Machinery
Koehring-Waterous Ltd.
WABCO Equipment Canada Ltd.

3810 – Cranes and Crane-Shoivers
FMC of Canada Ltd.
Koehring-Waterous Ltd.

3815 – Crane and Crane – Shovel Attachments
Koehring-Waterous Ltd.

3820 – Mining, Rock Drilling, Earth Boring,
and Related Equipment

Atlas Steel Company
Babcock & Wilcox Canada Ltd.
Barber-Greene Canada Ltd.
Becker Drills Ltd.
Brunner & Lay (Canada) Ltd.
Canadian Ingersoll-Rand Co. Ltd.
Canadian Vickers Ltd.
Delro Industries Ltd.
Foster Wheeler Ltd.
Gardner-Denver Co. (Canada) Ltd.
Greening Donald-Ltd.
Hawker Siddeley Canada Ltd.
(Trenton Works)
John T. Hepburn Ltd.
Koehring-Waterous Ltd.

3825 – Road Clearing and Cleaning Equipment
Clark Equipment of Canada Ltd.
Dominion Road Machinery
Sicard Inc.
WABCO Equipment Canada Ltd.

3895 – Miscellaneous Construction Equipment
Barber-Greene Canada Ltd.
Davie Shipbuilding Ltd.
John Deere Ltd.
Jaeger Machine Co. of Canada Ltd.
Koehring-Waterous Ltd.
Rex Chainbelt (Canada) Ltd.
Uniroyal Ltd.

GROUP 39

MATERIALS HANDLING EQUIPMENT

3910 – Conveyors
Armstrong Jones Ltd.
Barber-Greene Canada Ltd.
Rex Chainbelt (Canada) Ltd.
Uniroyal Ltd.

GROUP 40**ROPE, CABLE, CHAIN, AND FITTINGS**

3920 – Materials Handling Equipment,
Nonself-Propelled

Armstrong Jones Ltd.
ATCO Industries Ltd.
Barber-Greene Canada Ltd.
Magline of Canada Ltd.
OTACO
Uniroyal Ltd.

3930 – Warehouse Trucks and Tractors,
Self-Propelled

Dahmer Steel Ltd.
Eaton, Yale Ltd.

3940 – Blocks, Tackle, Rigging and Slings

Greening Donald Ltd.

3950 – Winches, Hoists, Cranes and Derricks

Canadian Vickers Ltd.
Canron Ltd. (Eastern Structural)
Dahmer Steel Ltd.
Davie Shipbuilding Ltd.
Dowty Equipment of Canada
Fleet Mfg. Ltd.
Garrett Mfg. Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Bridge)
Hawker Siddeley Canada Ltd.
(Trenton Works)
John T. Hepburn Ltd.
Koehring-Waterous Ltd.
Swann Winches Ltd.

3960 – Elevators and Escalators

John T. Hepburn Ltd.

3990 – Miscellaneous Materials Handling
Equipment

ATCO Industries Ltd.
Barber-Greene Canada Ltd.
Canadian General Electric (Plastics)
Canron Ltd.
Heroux Ltd.
Magline of Canada Ltd.
Rex Chainbelt (Canada) Ltd.
Uniroyal Ltd.

4010 – Chain and Wire Rope

Greening Donald Ltd.
Rex Chainbelt (Canada) Ltd.

GROUP 41**REFRIGERATION AND AIR
CONDITIONING EQUIPMENT**

4110 – Self-Contained Refrigeration Units
and Accessories

Galt Equipment Ltd.
Godfrey Engineering Co. Ltd.
Hussman Refrigerator Co. Ltd.
Union Carbide (Gas Products)

4120 – Self-Contained Air Conditioning Units
and Accessories

Garrett Mfg. Ltd.
Godfrey Engineering Co. Ltd.
Howden & Parsons of Canada Ltd.
Hussman Refrigerator Co. Ltd.

4130 – Refrigeration and Air Conditioning Plants
and Components

Hussman Refrigerator Co. Ltd.
Union Carbide (Gas Products)

GROUP 42**FIRE FIGHTING, RESCUE
AND SAFETY EQUIPMENT**

4210 – Fire Fighting Equipment

Deutz Diesel (Canada) Ltd.
Flag Fire Equipment Ltd.
Flextrac-Nodwell Ltd.
Sicard Inc.
Pierre Thibault (Canada) Ltd.

4220 – Marine Lifesaving and Diving Equipment

Uniroyal Ltd.

4230 – Decontaminating and Impregnating Equipment

Universal Die & Tool Mfg. Ltd.

4240 – Safety and Rescue Equipment

Canadian General Electric (Plastics)
Consumers Glove Co.
Irvin Industries Canada Ltd.
Union Carbide (Gas Products)
Uniroyal Ltd.

GROUP 43

PUMPS AND COMPRESSORS

4310 – Compressors and Vacuum Pumps

Canadian General Electric (Plastics)
Canadian Ingersoll-Rand Co., Ltd.
Deutz Diesel (Canada) Ltd.
Gardner-Denver Co. (Canada) Ltd.
Godfrey Engineering Co. Ltd.
Jaeger Machine Co. of Canada Ltd.

4320 – Power and Hand Pumps

Babcock & Wilcox Canada Ltd.
Canadian Ingersoll-Rand Co., Ltd.
Canadian Vickers Ltd.
Deutz Diesel (Canada) Ltd.
Godfrey Engineering Co. Ltd.
Jaeger Machine Co. of Canada Ltd.
Menasco of Canada, Ltd.
Swann Winches Ltd.

4330 – Centrifuges, Separators,
and Pressure & Vacuum Filters

Aircraft Appliances & Equipment
Armstrong Jones Ltd.
Canadian Ingersoll-Rand Co., Ltd.
R.B.H. Cybernetics

GROUP 44

**FURNACE, STEAM PLANT, AND DRYING
EQUIPMENT AND NUCLEAR REACTORS**

4410 – Industrial Boilers

Babcock & Wilcox Canada Ltd.

Canadian General Electric
(Devices, Conduit & Lighting)
Canadian Ingersoll-Rand
Canadian Vickers Ltd.
Davie Shipbuilding Ltd.
Foster Wheeler Ltd.
Marine Industries Ltd.
Volcano Ltd.

4420 – Heat Exchangers and Steam Condensers

Canadian Ingersoll-Rand Ltd.
Canadian Vickers Ltd.
Davie Shipbuilding Ltd.
Foster Wheeler Ltd.
Howden & Parsons of Canada Ltd.
Marine Industries Ltd.
Volcano Ltd.

4430 – Industrial Furnaces, Kilns, Lehrs,
and Ovens

Davie Shipbuilding Ltd.
Union Carbide (Metals & Carbon)
Canada Ltd.

4440 – Driers, Dehydrators and Anhydrators

Barber-Greene Canada Ltd.
Foster Wheeler Ltd.
Volcano Ltd.

4450 – Industrial Fand Blower Equipment

Godfrey Engineering Co. Ltd.
Howden & Parsons of Canada Ltd.

4460 – Air Purification Equipment

Barber-Greene Canada Ltd.
Foster Wheeler Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Bridge)
Howden & Parsons of Canada Ltd.

4470 – Nuclear Reactors

Babcock & Wilcox Canada Ltd.
Canadian General Electric
(Nuclear Products)
Canadian Vickers Ltd.
Davie Shipbuilding Ltd.

GROUP 45**PLUMBING, HEATING, AND
SANITATION EQUIPMENT**

4510 – Plumbing Fixtures and Accessories

Hawker Siddeley Canada Ltd.
(Halifax Shipyards)

4520 – Space Heating Equipment
and Domestic Water Heaters

Canadian General Electric
(Devices, Conduit & Lighting)
Canadian Vickers Ltd.
Foster Wheeler Ltd.
Volcano Ltd.

4530 – Fuel Burning Equipment Units

Babcock & Wilcox Canada Ltd.
CAE Electronics
Foster Wheeler Ltd.

GROUP 46**WATER PURIFICATION AND SEWAGE
TREATMENT EQUIPMENT**

4630 – Sewage Treatment Equipment

Hawker Siddeley Canada Ltd.
(Canadian Bridge)
Rex Chainbelt (Canada) Ltd.

GROUP 47**PIPE, TUBING, HOSE AND FITTINGS**

4710 – Pipe and Tube

Atlas Steels Co.
Canadian General Electric (Plastics)
Davie Shipbuilding Ltd.
Northwest Industries Ltd.
Union Carbide (Metals and Carbon)
Canada Ltd.
Uniroyal Ltd.

4720 – Hose and Tubing Flexible

Uniroyal Ltd.

4730 – Fittings and Specialities:
Hose, Pipe and Tube

Canadian General Electric (Plastics)
General Impact Extrusions Ltd.

GROUP 48**VALVES**

4810 – Valves, Powered

Armstrong Jones Ltd.
Canadian Vickers Ltd.
Dowty Equipment of Canada
Hawker Siddeley Canada Ltd.
(Canadian Car Pacific)
Howden & Parsons of Canada Ltd.

4820 – Valves, Non-Powered

Armstrong Jones Ltd.
Canadair Ltd.
Dominion Road Machinery
Hawker Siddeley Canada Ltd.
(Canadian Car Pacific)
Howden & Parsons Canada Ltd.
Marsland Engineering Ltd.
Menasco of Canada, Ltd.

GROUP 49**MAINTENANCE AND REPAIR SHOP
EQUIPMENT**4910 – Motor Vehicle Maintenance and Repair
Shop Specialized Equipment

Rousseau Controls Ltd.

4920 – Aircraft Maintenance and Repair Shop
Specialized Equipment

Aviation Electric Ltd.
Canadair Ltd.
Canadian Vickers Ltd.
De Havilland Aircraft of Canada

Garrett Mfg. Ltd.
Godfrey Engineering Co. Ltd.
Leigh Instruments Ltd.
Menasco of Canada, Ltd.
Rousseau Controls Ltd.

4930 – Lubrication and Fuel Dispensing
Equipment

Aviation Electric Ltd.

4931 – Fire Control; Maintenance and Repair
Shop Specialized Equipment

CAE Electronics Ltd.

4940 – Miscellaneous Maintenance and Repair
Shop Specialized

Standard-Modern Tool Co. Ltd.

GROUP 51

HAND TOOLS

5110 – Hand Tools, Edged, Non-Powered

Standard-Modern Tool Co. Ltd.
Valcartier Industries Inc.

5120 – Hand Tools, Non-Edged, Non-Powered

Dowty Equipment of Canada

5130 – Hand Tools, Power Driven

Pioneer Saws Ltd.

5133 – Drill Bits, Counterbores and Countersinks:
Hand & Machine

Canadian General Electric
(Chemical & Metallurgical)

5136 – Taps, Dies and Collets: Hand and Machine

Canadian General Electric
(Chemical & Metallurgical)
Standard-Modern Tool Co. Ltd.

5140 – Tool and Hardware Boxes

Canadian General Electric (Plastics)

5180 – Sets, Kits, and Outfits of Hand Tools

Delro Industries Ltd.

GROUP 52

MEASURING TOOLS

5210 – Measuring Tools, Craftsmen's

Canadian Arsenals Ltd.
Standard-Modern Tool Co. Ltd.
Valcartier Industries Inc.

5220 – Inspection Gauges and Precision
Layout Tools

Canadian Arsenals Ltd.
Valcartier Industries Inc.

GROUP 53

HARDWARE AND ABRASIVES

5305 – Screws

Triplex Engineering Co. Ltd.

5306 – Bolts

Triplex Engineering Co. Ltd.

5307 – Studs

Triplex Engineering Co. Ltd.

5310 – Nuts and Washers

Canadian General Electric
(Chemicals & Metallurgical)
Triplex Engineering Co. Ltd.

5325 – Fastening Devices

Canadian Velcro Ltd.

5330 – Packing and Gasket Materials

Dowty Equipment of Canada
Union Carbide (Metals & Carbon)
Uniroyal Ltd.

5335 – Metal Screening

Greening Donald Ltd.

5340 – Miscellaneous Hardware

Canadian General Electric (Plastics)
O & W Electronics Ltd.
Uniroyal Ltd.
Universal Dye & Tool Mfg. Ltd.

5345 – Disks and Stones, Abrasive
Canadian Ingersoll-Rand Ltd.

5350 – Abrasive Materials
Union Carbide (Gas Products)

5355 – Knobs and Pointers
O & W Electronics Ltd.

GROUP 54

PREFABRICATED STRUCTURES AND SCAFFOLDING

5410 – Prefabricated and Portable Buildings
ATCO Industries Ltd.
Canadair Ltd.
Canadian General Electric (Plastics)
Canron Ltd. (Eastern Structural)
Dominion Aluminum Fabricating Ltd.
Fleet Mfg. Ltd.
Uniroyal Ltd.

5420 – Bridges, Fixed and Floating
Canron Ltd. (Eastern Structural)
Hawker Siddeley Canada Ltd.
(Halifax Shipyards)
Uniroyal Ltd.

5430 – Storage Tanks
Babcock & Wilcox Canada Ltd.
Canadian General Electric (Plastics)
Canron Ltd. (Eastern Structural)
Dahmer Steel Ltd.
Davie Shipbuilding Ltd.
Elco-Wood Industries Ltd.
Foster Wheeler Ltd.
Marine Industries Ltd.
Northwest Industries Ltd.
Uniroyal Ltd.

5440 – Scaffolding Equipment and
Concrete Forms
Magline of Canada Ltd.

5445 – Prefabricated Tower Structures
Canron Ltd. (Eastern Structural)
Dahmer Steel Ltd.
Davie Shipbuilding Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Bridge)

5450 – Miscellaneous Prefabricated Structures
Canadian Vickers Ltd.
Canron Ltd. (Eastern Structural)
Dahmer Steel Ltd.
Davie Shipbuilding Ltd.

GROUP 56

CONSTRUCTION AND BUILDING MATERIALS

5640 – Wallboard, Building Paper, and Thermal
Insulation Materials
Uniroyal Ltd.

5660 – Fencing, Fences, and Gates
Greening Donald Ltd.

5670 – Architectural and Related Metal Products
Allied Enterprises Ltd.
Beclawat (Canada) Ltd.
Dominion Aluminum Fabricating Ltd.
Greening Donald Ltd.

5680 – Miscellaneous Construction Materials
Armstrong Jones Ltd.
Electrovert Ltd.
Greening Donald Ltd.

GROUP 58

COMMUNICATION, DETECTION, AND COHERENT RADIATION EQUIPMENT

5805 – Telephone and Telegraph Equipment
CAE Electronics Ltd.
Canada Wire & Cable Co. Ltd.
Canadian General Electric (Aerospace)

-
- Collins Radio Co. of Canada Ltd.
Computing Devices of Canada
Electro-Vox Industries Inc.
ITT Canada Ltd. (Communications)
Lenkurt Electric Co. of Canada Ltd.
Marsland Engineering Ltd.
Microsystems International
Northern Electric Co. Ltd.
Northern Radio Mfg. Co. Ltd.
Radio Engineering Products Ltd.
RCA Ltd.
Spilsbury & Tindall Ltd.
TMC (Canada) Ltd.
- 5810 – Communications Security Equipment and Components
- CAE Electronics Ltd.
Litton Systems (Canada) Ltd.
Northern Radio Mfg. Co. Ltd.
RCA Ltd.
- 5815 – Teletype and Facsimile Equipment
- CAE Electronics Ltd.
Computing Devices of Canada
Electro-Vox Industries Inc.
Marsland Engineering Ltd.
Northern Radio Mfg. Co. Ltd.
Radio Engineering Products Ltd.
RCA Ltd.
TMC (Canada) Ltd.
- 5820 – Radio and Television Communication Equipment, Except Airborne
- Beaconing Optical & Precision Materials Co. Ltd.
CAE Electronics Ltd.
Canadian General Electric (Aerospace)
Canadian General Electric (Meter & Instrument)
Canadian Marconi Co. (Marine & Land Communications)
Canadian Marconi Co. (Telecommunications)
Collins Radio Co. of Canada
Computing Devices of Canada
Electro-Vox Industries Inc.
Fleet Mfg. Ltd.
General Precision Industries Ltd.
ITT Canada Ltd. (Communications)
Lenkurt Electric Co. of Canada Ltd.
- Marsland Engineering Ltd.
Northern Radio Mfg. Co. Ltd.
RCA Ltd.
C. R. Snelgrove Co. Ltd.
Sparton of Canada Ltd.
Spilsbury & Tindall Ltd.
TMC (Canada) Ltd.
Westinghouse Canada Ltd. (Electronic Systems)
- 5821 – Radio and Television Communications Equipment, Airborne
- Beaconing Optical & Precision Materials Co. Ltd.
Bristol Aerospace (1968) Ltd.
CAE Electronics Ltd.
Collins Radio Co. of Canada
Computing Devices of Canada
General Precision Industries Ltd.
ITT Canada Ltd. (Communications)
Instronics Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Spilsbury & Tindall Ltd.
Westinghouse Canada Ltd. (Electronic Systems)
- 5825 – Radio Navigation Equipment, Except Airborne
- CAE Electronics Ltd.
Canadian General Electric (Aerospace)
Computing Devices of Canada
C-Tech Ltd.
Fleet Mfg. Ltd.
General Precision Industries Ltd.
ITT Canada Ltd. (Communications)
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
RCA Ltd.
- 5826 – Radio Navigation Equipment, Airborne
- CAE Electronics Ltd.
Canadian Marconi Co. (Avionics)
Collins Radio Co. of Canada Ltd.
Computing Devices of Canada Ltd.
Fleet Mfg. Ltd.
ITT Canada Ltd. (Communications)
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
RCA Ltd.
-

-
- 5830 – Intercommunication and Public Address Systems, Except Airborne
- Electro-Vox Industries Inc.
Fleet Mfg. Ltd.
Marsland Engineering Ltd.
RCA Ltd.
- 5831 – Intercommunication and Public Address Systems, Airborne
- Collins Radio Co. of Canada Ltd.
Fleet Mfg. Ltd.
Marsland Engineering Ltd.
RCA Ltd.
- 5835 – Sound Recording and Reproducing Equipment
- CAE Electronics Ltd.
Computing Devices of Canada Ltd.
Electro-Vox Industries Inc.
Leigh Industries Ltd.
Marsland Engineering Ltd.
RCA Ltd.
- 5840 – Radar Equipment, Except Airborne
- Beaconing Optical and Precision Materials
CAE Electronics Ltd.
Canadian General Electric Co. Ltd. (Aerospace)
Canadian Marconi Company (Marine & Land Communications)
Fleet Mfg. Ltd.
Marsland Engineering Ltd.
Space Research Corporation (Quebec) Inc.
Westinghouse Canada Ltd. (Electronic Systems)
- 5841 – Radar Equipment, Airborne
- CAE Electronics Ltd.
Canadian General Electric Co. Ltd. (Aerospace)
Fleet Mfg. Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Westinghouse Canada Ltd. (Electronic Systems)
- 5845 – Underwater Sound Equipment
- CAE Electronics Ltd.
Canada Wire and Cable Co.
- Canadian General Electric Co. Ltd. (Aerospace)
Computing Devices of Canada Ltd.
C-Tech Ltd.
Fleet Mfg. Ltd.
Hermes Electrical Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Sparton of Canada Ltd.
Westinghouse Canada Ltd. (Electronic Systems)
- 5850 – Visible and Invisible Light Communication Equipment
- Canadian General Electric Co. Ltd. (Aerospace)
Computing Devices of Canada
RCA Ltd.
- 5855 – Night Vision Equipment, Emitted and Reflected Radiation
- Canadian General Electric Co. Ltd. (Aerospace)
Computing Devices of Canada Ltd.
RCA Ltd.
- 5860 – Stimulated Coherent Radiation Devices, Components and Accessories
- Computing Devices of Canada Ltd.
- 5895 – Miscellaneous Communication Equipment
- Beaconing Optical and Precision Materials
CAE Electronics Ltd.
Canadian General Electric Co. Ltd. (Aerospace)
Canadian General Electric Co. Ltd. (Plastics)
Canadian Marconi Co. (Marine and Land Communications)
Canadian Vickers Ltd.
Collins Radio Co. of Canada Ltd.
Computing Devices of Canada Ltd.
Electro-Vox Industries Inc.
Fleet Mfg. Ltd.
Garrett Mfg. Ltd.
Instronics Ltd.
General Precisions Industries Ltd.
Hermes Electronics Ltd.
ITT Canada Ltd. (Communications)
Leigh Instruments Ltd.
Lenkurt Electric Co. of Canada Ltd.
Marsland Engineering Ltd.
-

Microsystems International Ltd.
 Northern Electric Co. Ltd.
 Northern Radio Mfg. Co. Ltd.
 RCA Ltd.
 Radio Engineering Products Ltd.
 TMC (Canada) Ltd.

GROUP 59**ELECTRICAL AND ELECTRONIC
EQUIPMENT COMPONENTS****5905 – Resistors**

Beckman Instruments Inc. (Helipot)
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Garrett Mfg. Ltd.
 Guildline Instruments Ltd.
 Marsland Engineering Ltd.

5910 – Capacitors

Lenkurt Electric Co. of Canada Ltd.

5915 – Filters and Networks

CAE Electronics Ltd.
 Canadian Marconi Co. (Avionics)
 Collins Radio Co. of Canada Ltd.
 Computing Devices of Canada Ltd.
 Garrett Mfg. Ltd.
 Lenkurt Electric Co. of Canada Ltd.
 Microsystems International Ltd.
 RCA Ltd.
 Radio Engineering Products Ltd.
 C. R. Snelgrove Co. Ltd.
 TMC (Canada) Ltd.

5920 – Fuses and Lightning Arrestors

Canadian General Electric Co. Ltd.
 (D. and S. Transformer)

5925 – Circuit Breakers

Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Westinghouse Canada Ltd.
 (Switchgear and Control)

5930 – Switches

Aircraft Appliances & Equipment
 Andrew Antenna Company Ltd.
 Beaconing Optical and Precision Materials
 Beckman Instruments Inc. (Helipot)
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)

5935 – Connectors, Electrical

Canada Wire and Cable Co.
 Lacle Industries Ltd.
 Radio Engineering Products Ltd.
 Triplex Engineering Co. Ltd.

5940 – Lugs, Terminals, and Terminal Strips

Bedard-Girard Ltd.
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Graphico Precision Works Ltd.
 O & W Electronics Ltd.

5945 – Relays, Contactors, and Solenoids

Aircraft Appliances & Equipment Ltd.
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 RCA Ltd.
 Westinghouse Canada Ltd.
 (Switchgear & Control)

5950 – Coils and Transformers

Beaconing Optical and Precision
 Canadian General Electric Co. Ltd.
 (D. & S. Transformer)
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Canadian General Electric
 (Meter and Instrument)
 Canadian Marconi
 Lenkurt Electric Co. of Canada Ltd.
 Marsland Engineering Ltd.
 RCA Ltd.
 TMC (Canada) Ltd.
 Westinghouse Canada Ltd.
 (Switchgear & Control)

5955 – Piezoelectric Crystals

C. R. Snelgrove Co. Ltd.

5960 – Electron Tubes and Associated Hardware

Canadian Admiral Corp. Ltd.
Microsystems International Ltd.
RCA Ltd.
Varian Associates of Canada Ltd.

5961 – Semi-Conductor Devices and Associated Hardware

Canadian General Electric Co. Ltd.
(Industrial Apparatus)
Microsystems International Ltd.

5965 – Headsets, Handsets, Microphones and Speakers

Marsland Engineering Ltd.
Radio Engineering Products Ltd.

5970 – Electrical Insulators and Insulating Materials

Armstrong Jones Ltd.
Canada Wire and Cable Co.
Union Carbide Canada Ltd.
(Plastics and Chemicals)
Uniroyal Ltd.

5975 – Electrical Hardware and Supplies

Canada Wire and Cable Co.
Canadian General Electric
(Devices, Conduit and Lighting)
Canadian General Electric (Plastics)
Electrovert Ltd.
Fleet Mfg. Ltd.
Garrett Mfg. Ltd.
Hussman Refrigerator Co. Ltd.
Lacal Industries Ltd.
Lenkurt Electric Co. of Canada
Marsland Engineering Ltd.
TMC (Canada) Ltd.

5977 – Electrical Contact Brushes and Electrodes

Union Carbide Canada Ltd.
(Metals and Carbon)

5985 – Antennas, Waveguides, and Related Equipment

Andrew Antenna Co. Ltd.
Beaconing Optical and Precision
CAE Electronics Ltd.
Canada Wire and Cable Co.

Canadian General Electric (Aerospace)
Canadian General Electric (Plastics)
Canron Ltd. (Eastern Structural)
Collins Radio Co. of Canada Ltd.
Computing Devices of Canada Ltd.
Fleet Mfg. Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Bridge)
Lenkurt Electric Co. of Canada Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Radio Engineering Products Ltd.
Spilsbury and Tindall Ltd.
TMC (Canada) Ltd.
Uniroyal Ltd.

5990 – Synchros and Resolvers

RCA Ltd.

5995 – Cable, Cord, and Wire Assemblies: Communication Equipment

CAE Electronics Ltd.
Computing Devices of Canada
Electrovert Ltd.
Lenkurt Electric Co. of Canada Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
Radio Engineering Products Ltd.
TMC (Canada) Ltd.

5999 – Antennas, Waveguides, and Related Equipment

Aviation Electric Ltd.
Beckman Instruments Inc. (Helipot)
CAE Electronics Ltd.
Canadian General Electric Co. Ltd.
(Aerospace)
Canadian General Electric Co. Ltd.
(Meter and Instrument)
Canadian Marconi Co. (Avionics)
Computing Devices of Canada Ltd.
Electrovert Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car Pacific)
Garrett Mfg. Ltd.
Graphico Precision Works Ltd.
Lenkurt Electric Co. of Canada Ltd.
Lightning Circuits
Marsland Engineering Ltd.
Microsystems International Ltd.
OTACO Ltd.

RCA Ltd.
 Sparton of Canada Ltd.
 TMC (Canada) Ltd.
 Westinghouse Canada Ltd.
 (Electronic Systems)
 Westinghouse Canada Ltd.
 (Solid State Devices)
 Will-Hart Ltd.

Lenkurt Electric Co. of Canada Ltd.
 Litton Systems (Canada) Ltd.
 Marsland Engineering Ltd.
 O & W Electronics Ltd.
 Westinghouse Canada Ltd.
 (Electronic Systems)
 Westinghouse Canada Ltd.
 (Switchgear and Control)

GROUP 61**ELECTRICAL WIRE, AND POWER
AND DISTRIBUTION EQUIPMENT**

6105 – Motors, Electrical,
 (Alternating Current)

Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Canron Ltd. (Electrical)
 Westinghouse Canada Co. Ltd.
 (Apparatus)

6105 – Motors, Electrical,
 (Direct Current)

Canron Ltd. (Electrical)
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Westinghouse Canada Ltd. (Apparatus)

6105 – Motors, Electrical,
 (Servo etc)

Canron Ltd. (Electrical)

6105 – Motors, Electrical (Parts)

Canadian General Electric Co. Ltd.
 (Plastics)
 Canron Ltd. (Electrical)

6110 – Electrical Control Equipment

Bedard-Girard Ltd.
 CAE Electronics Ltd.
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Computing Devices of Canada
 Canron Ltd. (Electrical)
 Garrett Mfg. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car Pacific)
 Leigh Instruments Ltd.

6115 – Generators and Generator Sets,
 Electrical

Aircraft Appliances & Equipment
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Canron Ltd. (Electrical)
 Cummins Ontario Ltd.
 Deutz Diesel (Canada) Ltd.
 Garrett Mfg. Ltd.
 Hawker Siddeley Canada Ltd.
 (Canadian Car Pacific)
 Marine Industries Ltd.
 Orenda Ltd.
 TMC (Canada) Ltd.
 Westinghouse Canada Ltd.
 (Turbine & Generator)

6120 – Transformer, Distribution and
 Power Station

Canadian General Electric Co. Ltd.
 (D. and S. Transformer)
 Westinghouse Canada Ltd.
 (Switchgear and Control)

6125 – Converters, Electrical, Rotating

Aircraft Appliances & Equipment
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)

6130 – Converters, Electrical, Non-Rotating

Aircraft Appliances & Equipment
 CAE Electronics Ltd.
 Canadian General Electric Co. Ltd.
 (Industrial Apparatus)
 Garrett Mfg. Ltd.
 Lenkurt Electric Co. of Canada Ltd.
 Litton Systems (Canada) Ltd.
 Marsland Engineering Ltd.
 RCA Ltd.
 TMC (Canada) Ltd.
 Westinghouse Canada Ltd.
 (Switchgear & Control)

6135 – Batteries, Primary

Canadian General Electric Co. Ltd.
(Chemical & Metallurgical)
Canadian General Electric Co. Ltd.
(Plastics)
Union Carbide Co. Ltd.
(Consumer Products)

6145 – Wire and Cable, Electrical

Andrew Antenna Co. Ltd.
Canada Wire and Cable Co. Ltd.
Canadian General Electric
(Industrial Apparatus)
Greening Donald Ltd.
Northern Electric Co. Ltd.
Phillips Cables Co. Ltd.
Pirelli Cables Ltd.

6150 – Miscellaneous Electric Power and
Distribution Equipment

Canada Wire & Cable Co. Ltd.
Canadian General Electric Co. Ltd.
(Devices Conduit and Lighting)
Electrovert Ltd.
Pirelli Cables Ltd.
Westinghouse Canada Ltd.
(Switchgear and Control)

GROUP 62**LIGHTING FIXTURES AND LAMPS**6210 – Indoor and Outdoor Electric
Lighting Fixtures

Beaconing Optical and Precision
Canadian General Electric Co. Ltd.
(Devices, Conduit & Lighting)
Dominion Aluminum Fabricating Ltd.

6220 – Electric Vehicular Lights and Fixtures

6230 – Electric Portable and Hand
Lighting Equipment

Union Carbide Canada Ltd.
(Consumer Products)

6240 – Electric Lamps

Canadian General Electric Co. Ltd. (Lamp)

6250 – Ballasts, Lampholders, and Starters

Canadian General Electric Co. Ltd.
(Devices, Conduit and Lighting)
Canadian General Electric Co. Ltd.
(D. and S. Transformer)

GROUP 63**ALARM AND SIGNAL SYSTEMS**

6310 – Traffic and Transit Signal Systems

Bedard-Girard Ltd.
Canadian General Electric Co. Ltd.
(Devices, Conduit and Lighting)
Computing Devices of Canada Ltd.

6320 – Shipboard Alarm and Signal Systems

Bedard-Girard Ltd.
Canadian General Electric Co. Ltd.
(Devices, Conduit and Lighting)
Computing Devices of Canada Ltd.
Edwards of Canada
Marsland Engineering Ltd.

6330 – Railroad Signal and
Warning Devices

Canadian General Electric Co. Ltd.
(Devices, Conduit and Lighting)

6350 – Miscellaneous Alarm and
Signal Systems

Bedard-Girard Ltd.
Barringer Research Ltd.
Computing Devices of Canada Ltd.
Edwards of Canada
Lenkurt Electric Co. of Canada Ltd.

GROUP 65**MEDICAL, DENTAL, AND VETERINARY
EQUIPMENT AND SUPPLIES**6515 – Medical and Surgical Instruments,
Equipment and Supplies

Irvin Industries Canada Ltd.
Preci-Tools Ltd.
Union Carbide Ltd. (Gas Products)
Uniroyal Ltd.

6525 – X-Ray Equipment, and Supplies:
Medical, Dental, Veterinary
Atomic Energy of Canada Ltd.

6530 – Hospital Furniture, Equipment,
Utensils, and Supplies
Irvin Industries Canada Ltd.

GROUP 66

INSTRUMENTS AND LABORATORY EQUIPMENT

6605 – Navigational Instruments

Computing Devices of Canada Ltd.
Garrett Mfg. Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
O & W Electronics Ltd.
Stanley Mfg. Co. Ltd.

6610 – Flight Instruments

CAE Electronics Ltd.
Computing Devices of Canada Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Space Research Corp. (Quebec) Inc.

6615 – Automatic Pilot Mechanisms and
Airborne Gyro Components

CAE Electronics Ltd.
De Havilland Aircraft of Canada Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.

6620 – Engine Instruments

Aircraft Appliances & Equipment Ltd.

6625 – Electrical and Electronic Properties
Measuring and Testing Instruments

Aircraft Appliances & Equipment Ltd.
Beaconing Optical and Precision Materials
CAE Electronics Ltd.
Canadian General Electric Co. Ltd.
(Meter and Instrument)
Computing Devices of Canada Ltd.

C-Tech Ltd.
Garrett Mfg. Ltd.
Guildline Instruments Ltd.
Hermes Electronics Ltd.
Instronics Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Space Research Corp. (Quebec) Inc.
Sparton of Canada Ltd.
TMC (Canada) Ltd.
Westinghouse Canada Ltd.
(Switchgear and Control)

6630 – Chemical Analysis Instruments

Barringer Research Ltd.
Leigh Instruments Ltd.
Union Carbide Canada Ltd. (Gas Products)

6635 – Physical Properties Testing Equipment

Union Carbide Canada Ltd. (Gas Products)

6640 – Laboratory Equipment and Supplies

Atomic Energy of Canada Ltd.
Union Carbide Canada Ltd. (Gas Products)

6645 – Time Measuring Instruments

Leigh Instruments Ltd.
Marsland Engineering Ltd.

6650 – Optical Instruments

Barringer Research Ltd.
Ernst Leitz Canada Ltd.
Space Research Corp. (Quebec) Inc.

6655 – Geophysical and Astronomical
Instruments

Barringer Research Ltd.
CAE Electronics Ltd.
Canadian Vickers Ltd.
Computing Devices of Canada Ltd.
Fleet Mfg. Ltd.
Hermes Electronics Ltd.
Huntec ('70) Ltd.
Marsland Engineering Ltd.
Sparton of Canada Ltd.
Swann Winches Ltd.

6660 – Meteorological Instruments and Apparatus

CAE Electronics Ltd.
Garrett Mfg. Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Space Research Corp. (Quebec) Inc.

6665 – Hazard-Detecting Instruments and Apparatus

Barringer Research Ltd.
CAE Electronics Ltd.
Canadian Admiral Corp. Ltd.
Computing Devices of Canada Ltd.
Hermes Electronics Ltd.
Leigh Instruments Ltd.
Marsland Engineering Ltd.
RCA Ltd.

6680 – Liquid and Gas Flow, Liquid Level, and Mechanical Motion Measuring Instruments

Marsland Engineering Ltd.
Union Carbide Canada Ltd. (Gas Products)

6685 – Pressure, Temperature, and Humidity Measuring and Controlling Instruments

Garrett Mfg. Ltd.
Leigh Instruments Ltd.

6695 – Combination and Miscellaneous Instruments

Leigh Instruments Ltd.
Marsland Engineering Ltd.

GROUP 67**PHOTOGRAPHIC EQUIPMENT**

6710 – Cameras, Motion Picture

Computing Devices of Canada Ltd.
Ernst Leitz Canada Ltd.

6720 – Cameras, Still Picture

Ernst Leitz Canada Ltd.

6750 – Photographic Supplies

Canadian General Electric Co. Ltd. (Lamp)

6760 – Photographic Equipment and Accessories

Ernst Leitz Canada Ltd.

GROUP 68**CHEMICALS AND CHEMICAL PRODUCTS**

6810 – Chemicals

Union Carbide Canada Ltd.
(Plastics and Chemicals)
Uniroyal Ltd.

6830 – Gases: Compressed and Liquefied

Union Carbide Canada Ltd. (Gas Products)

6840 – Pest Control Agents and Disinfectants

Uniroyal Ltd.

6850 – Miscellaneous Chemical Specialties

Union Carbide Canada Ltd.
(Consumer Products)
Union Carbide Canada Ltd.
(Plastics & Chemicals)
Uniroyal Ltd.

GROUP 69**TRAINING AIDS AND DEVICES**

6910 – Training Aids

Atomic Energy of Canada Ltd.
CAE Electronics Ltd.
Canadair Ltd.
Computing Devices of Canada Ltd.
Fleet Mfg. Ltd.
Marsland Engineering Ltd.
O & W Electronics Ltd.
RCA Ltd.
Space Research Corp. (Quebec) Inc.
Sparton of Canada Ltd.

6920 – Armament Training Devices

CAE Electronics Ltd.
Canadair Ltd.
Universal Die & Tool Mfg. Ltd.

6930 – Operational Training Devices

CAE Electronics Ltd.
Canadair Ltd.
Computing Devices of Canada Ltd.
Marsland Engineering Ltd.
RCA Ltd.
Space Research Corp. (Quebec) Inc.

6940 – Communication Training Devices

CAE Electronics
 Computing Devices of Canada Ltd.
 Marsland Engineering Ltd.
 RCA Ltd.
 Westinghouse Canada Ltd.
 (Electronic Systems)

GROUP 71**FURNITURE**

7110 – Office Furniture

ATCO Industries Ltd.
 Saint John Shipbuilding &
 Dry Dock Co. Ltd.

7125 – Cabinets, Lockers, Bins and Shelving

Armstrong Jones Ltd.
 Canadian General Electric Co. Ltd.
 (Pastics)
 Canadian Vickers Ltd.
 Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 Hussman Refrigerator Co. Ltd.
 Saint John Shipbuilding &
 Dry Dock Co. Ltd.

7195 – Miscellaneous Furniture and Fixtures

Hawker Siddeley Canada Ltd.
 (Halifax Shipyards)
 Saint John Shipbuilding &
 Dry Dock Co. Ltd.

GROUP 72**HOUSEHOLD AND COMMERCIAL
FURNISHINGS AND APPLIANCES**7240 – Household and Commercial Utility
Containers

Union Carbide Canada Ltd.
 (Consumer Products)

GROUP 73**FOOD COOKING, BAKING AND
WARMING EQUIPMENT**

7340 – Cutlery and Flatware

Universal Die & Tool Mfg. Ltd.

GROUP 74**OFFICE MACHINES, VISIBLE RECORD
EQUIPMENT, AND DATA PROCESSING
EQUIPMENT**7440 – Automatic Data Processing Systems:
Industrial, Scientific and Office Types

CAE Electronics Ltd.
 Computing Devices of Canada Ltd.
 ITT Canada Ltd. (Communications)
 Instronics Ltd.
 Marsland Engineering Ltd.
 RCA Ltd.
 TMC (Canada) Ltd.

GROUP 76**BOOKS, MAPS, AND OTHER
PUBLICATIONS**

7610 – Books and Pamphlets

Canadair Ltd.
 Canadian Marconi Co. (Avionico)
 Computing Devices of Canada Ltd.
 Menasco of Canada, Ltd.
 RCA Ltd.
 United Aircraft of Canada Ltd.

7640 – Maps, Atlases, Charts and Globes

Sparton Aero Ltd.

GROUP 78**RECREATIONAL AND ATHLETIC
EQUIPMENT**

7810 – Athletic and Sporting Equipment

Canada Cycle & Motor Co. Ltd.

7830 – Recreational and Gymnastic Equipment

Canada Cycle & Motor Co. Ltd.

GROUP 80**BRUSHES, PAINTS, SEALERS, AND ADHESIVES**

8010 – Paints, Dopes, Varnishes and Related Products

Canadian General Electric Co. Ltd.
(Chemical and Metallurgical)
Uniroyal Ltd.

8030 – Preservative and Sealing Compounds

Canadian General Electric Co. Ltd.
(Chemical and Metallurgical)
Leigh Industries Ltd.
Union Carbide Canada Ltd.
(Plastics and Chemicals)
Uniroyal Ltd.

8040 – Adhesives

Union Carbide Canada Ltd.
(Plastics and Chemicals)
Uniroyal Ltd.**GROUP 81****CONTAINERS, PACKAGING, AND PACKING SUPPLIES**

8105 – Bags and Sacks

Union Carbide Canada Ltd.
(Plastics and Chemicals)

8110 – Drums and Cans

Dominion Aluminum Fabricating Ltd.
General Impact Extrusions (Mfg.) Ltd.

8115 – Boxes, Cartons, and Crates

ATCO Industries Ltd.
Canadian Aircraft Products Ltd.
Canadian General Electric Co. Ltd.
(Plastics)
Dominion Aluminum Fabricating Ltd.
General Impact Extrusions (Mfg.) Ltd.
Greening Donald Ltd.

8120 – Commercial and Industrial Gas Cylinders

Canadian Vickers Ltd.
Davie Shipbuilding Ltd.

Foster Wheeler Ltd.

Hawker Siddeley Canada Ltd.
(Trenton Works)

Marine Industries Ltd.

Union Carbide Canada Ltd. (Gas Products)

8125 – Bottles and Jars

Valcartier Industries Inc.

8130 – Reels and Spools

Canadian General Electric Co. Ltd.
(Plastics)

8135 – Packaging and Packing Bulk Materials

Union Carbide Canada Ltd.
(Plastics and Chemicals)

8140 – Ammunition Boxes, Packages, and Special Containers

ATCO Industries Ltd.
Canadian Aircraft Products Ltd.
Canadian General Electric Co. Ltd.
(Plastics)
Canron Ltd. (Eastern Structural)
Dominion Aluminum Fabricating Ltd.
General Impact Extrusions (Mfg.) Ltd.
Hussman Refrigerator Co. Ltd.
Magline of Canada Ltd.
Uniroyal Ltd.**GROUP 83****TEXTILE, LEATHER, FURS, APPAREL AND SHOE FINDINGS, TENTS, AND FLAGS**

8305 – Textile Fabrics

Textile Industries Ltd.
Union Carbide Canada Ltd. (Fibres)

8340 – Tents and Tarpaulins

Magline of Canada Ltd.

GROUP 84**CLOTHING, INDIVIDUAL EQUIPMENT,
AND INSIGNIA**

- 8405 – Outwear, Men's
Dorothea Knitting Mills Ltd.
- 8410 – Outwear, Women's
Dorothea Knitting Mills Ltd.
- 8415 – Clothing, Special Purpose
Canadian General Electric Co. Ltd.
(Plastics)
Consumers Glove Company Ltd.
Irvin Industries Canada Ltd.
- 8430 – Footwear, Men's
Consumers Glove Company Ltd.
- 8435 – Footwear, Women's
Consumers Glove Company Ltd.
- 8440 – Hosiery, Handwear, and Clothing
Accessories, Men's
Consumers Glove Co. Ltd.
- 8445 – Hosiery, Handwear, and Clothing
Accessories, Women's
Consumers Glove Co. Ltd.
- 8465 – Individual Equipment
Canadian General Electric Co. Ltd.
(Plastics)
Irvin Industries Canada Ltd.
Magline of Canada Ltd.
Uniroyal Ltd.
- 8475 – Specialized Flight Clothing and
Accessories
Irvin Industries Canada Ltd.

GROUP 91**FUELS, LUBRICANTS, OILS, AND
WAXES**

- 9135 – Liquid Propellant Fuels and Oxidizers;
Chemical Base
Union Carbide Canada Ltd. (Gas Products)

GROUP 93**NON-METALLIC FABRICATED
MATERIALS**

- 9320 – Rubber Fabricated Materials
Uniroyal Ltd.
- 9330 – Plastics Fabricated Materials
Canadair Ltd.
Canadian General Electric Co. Ltd.
(Plastics)
Fleet Mfg. Ltd.
Hawker Siddeley Canada Ltd.
(Canadian Car)
Northwest Industries Ltd.
O & W Electronics Ltd.
Union Carbide Canada Ltd.
(Plastics and Chemicals)
Uniroyal Ltd.
Valcartier Industries Inc.

GROUP 95**METAL BARS, SHEETS, AND SHAPES**

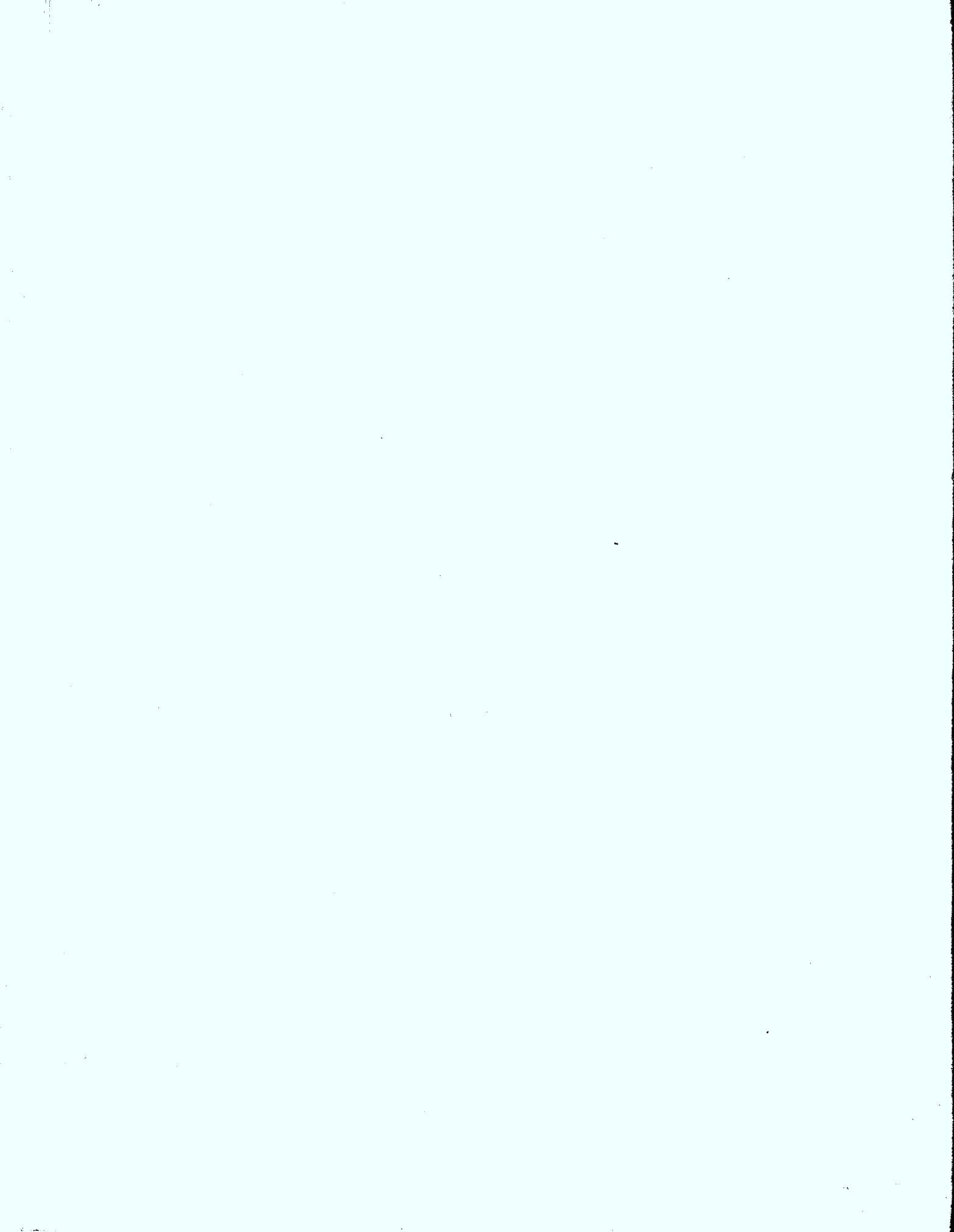
- 9505 – Wire, Non-Electrical, Iron and Steel
Atlas Steels Co.
Greening Donald Ltd.
- 9510 – Bars and Rods, Iron and Steel
Atlas Steels Co.
- 9515 – Plate, Sheet, and Strip: Iron and Steel
Atlas Steels Co.
Greening Donald Ltd.
- 9525 – Wire, Non-Electrical, Non-Ferrous
Base Metal
Atlas Steels Co.
Canada Wire and Cable Co. Ltd.
Greening Donald Ltd.
- 9530 – Bars and Rods, Non-Ferrous Base Metal
Atlas Steels Co.
- 9535 – Plate, Sheet, Strip and Foil:
Non-Ferrous Base Metal
Atlas Steels Co.
Greening Donald Ltd.

GROUP 96**ORES, MINERALS, AND THEIR
PRIMARY PRODUCTS**

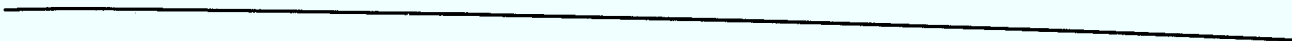
9610 – Ores

Atomic Energy of Canada Ltd.

GROUP 99**MISCELLANEOUS**9905 – Signs, Advertising Displays, and
Identification PlatesO & W Electronics Ltd.
Stanley Mfg. Co. Ltd.



INDEX OF SERVICES



AERIAL SURVEYING, MAPPING AND SERVICES

1. Aerial photography.
2. Air photo interpretation.
3. Airborne distance measuring.
4. Airborne geochemistry.
5. Airborne geophysics.
6. Computer assisted mapping.
7. Control surveys.
8. Forest inventory and forest engineering.
9. Geochemical analysis.
10. Geological and geophysical surveys.
11. Instrument designs.
12. Land-use surveys.
13. Magnetometer surveys.
14. Photogrammetric plotting and map production.
15. Relief models.
16. Stabilized and steered camera mounts, airborne.

Barringer Research Ltd.
4.5.6.9.11.

Leigh Instruments Ltd.
11.

Spartan Aero Ltd.
1.2.3.5.6.7.8.10.12.13.14.15.

Westinghouse Canada Ltd. (Electronic Systems)
16.

ANTENNA, ANTENNA FARM AND SURFACE INSTALLATIONS

1. Antenna farms.
2. Microwave, scatter.
3. Radar.
4. Radio navigation sites.
5. Telecon cable systems .
6. Towers, antenna.

Andrew Antenna Co. Ltd.
1.5.6.

CAE Electronics Ltd.
1.2.3.4.

Canadian General Electric (Aerospace)
1.3.4.

Canadian Marconi (Special Services)
1.2.3.4.

Canron Ltd. (Eastern Structural)
1.2.3.4.6.

Collins Radio Co. of Canada Ltd.
1.2.

Computing Devices of Canada Ltd.
4.

Hawker Siddeley Canada Ltd. (Canadian Bridge)
1.6.

ITT Canada Ltd. (Communications)
1.2.3.4.

Leigh Instruments Ltd.
3.4.

Lenkurt Electric Co. of Canada Ltd.
2.

Northern Electric Co. Ltd.
1.2.3.4.5.

RCA Ltd.
2.4.

Westinghouse Canada Ltd. (Electronic Systems)
1.2.3.4.6.

ARCTIC PRODUCTS

As might be expected in a country with a winter climate such as Northern Canada's there are firms producing products with a special application for Arctic and Sub-Arctic use. Everest expeditions have availed themselves of these products and facilities.

These products include such diversified items as snowknives for the production of snow shelters to face creams to protect against sun and wind burn so common in Arctic regions. In the transportation field they may range from magnesium snow shoes to completely mobile trailer camps with a multitude of applications. Dry goods products vary from sleeping bags to nose-hangers for aircraft.

Due to the great diversification of products it is suggested that any requirements of this nature should be referred directly to this department where the specialized knowledge for such equipments can be best applied.

CONSULTING AND DESIGN SERVICES

1. Aerial engineering and survey.
 2. Aerodynamic.
 3. Air conditioning systems, airborne.
 4. Aircraft floats.
 5. Aircraft ground support equipment and systems.
 - a. air conditioning trailers
 - b. galley refrigerators
 - c. water system servicing vehicles
 - d. pneumatic system servicing units
 - e. heating
 6. Aircraft, interiors and structural mods.
 7. Airports fire and crash equipment.
 8. Ammunition-medium and heavy calibre.
 9. Analysis, automation and control.
 10. Analysis, communications networks.
 11. Analysis, electromagnetic interference.
 12. Analysis, radio propagation.
 13. Arctic ground transportation equipment.
 14. ASW weapons.
 15. Ballistics/acoustic acquisition techniques.
 16. Cable and wire systems, electric.
 17. Cargo handling systems.
 18. Cells, photoelectric.
 19. Ceramic, inorganic materials.
 20. Chemical engineering.
 21. Closures and fasteners, clothing and equipment.
 22. Communications.
 23. Computers.
 24. Control systems, electric.
 25. Control systems, environmental.
 26. Control systems, hydraulic.
 27. Control systems, shipboard.
 28. Controls, flight, powered.
 29. Controls, hydro-mechanical.
 30. Cryogenics.
 31. Data communications special purpose and test equipment.
 32. De-frosters, dome.
 33. Detonating devices.
 34. Docking facilities.
 35. Drives, variable speed.
 36. Edge lighted panels.
 37. Electrical power distribution and control.
 38. Electrical standards.
 39. Electro-magnetic systems, airborne.
 40. Electro-mechanical devices.
 41. Electro-optics.
 42. Electronic.
 43. Engines, gas turbine.
 44. Environmental data acquisition and interpretation.
 45. EW (ECM and ECCM) systems.
 46. Explosive devices and powders.
 47. Feasibility studies and systems analysis of gas and vapour detection and monitoring.
 48. Film drying equipment, microwave.
 49. Fire control equipment and systems, optical-mechanical.
 50. Flight kitchens and containers.
 51. Fluidic devices and systems.
 52. Fuel controls, aircraft.
 53. Fuel systems, marine boiler.
 54. Gas detection and monitoring instruments.
 55. Generating equipment, steam.
 56. Fuels systems, marine boiler.
 57. Generators electrical, cobalt 60.
 58. Geology and geo-chemistry.
 59. Geophysical instruments.
 60. Graphic panels.
 61. Hangar systems, shipboard.
 62. Heat transfer equipment.
 63. Heaters, cabin, helicopter.
 64. Helicopter, ground handling.
 65. Helicopter, in-flight securing devices
 66. Housing systems, air and surface transportable.
 67. Hydraulics.
 68. Hydraulics, (pumps).
 69. Hydrographic survey equipment.
 70. Information display systems.
 71. Information systems, action.
 72. Integrated circuits, linear.
 73. Klystrons.
 74. Landing gear, aircraft.
 75. Landing gear, helicopter.
 76. Laser communications.
 77. Lasers.
 78. Laser holography.
 79. Lenses, air reconnaissance etc.
 80. Life support equipment.
 81. Machines and tools.
 82. Magnesium product development.
 83. Marine.
 84. Marine drawings.
 85. Marine feasibility studies.
 86. Marine hulls for hydrofoils and submersibles.
 87. Marine mock-ups and models.
 88. Marine specifications.
 89. Marine technology.
 90. Material handling.
 91. Mechanical.
-

-
92. Mechanical configurations for electronic and electro-mechanical circuits and devices.
 93. Medico-surgical equipment.
 94. Metallurgical.
 95. Meteorology.
 96. Micro-oven drying.
 97. Microwave tubes.
 98. Mining installations.
 99. Navigation displays.
 100. Navigation equipment.
 101. Navigation systems.
 102. Nuclear instrumentation.
 103. Nuclear particle detection.
 104. Oceanographic measurements.
 105. Oceanographic towed bodies.
 106. Operational research.
 107. Optics.
 108. Optical systems.
 109. Parachute equipment.
 110. Plasmaphysics.
 111. Plastic components, aerospace.
 112. Plastics.
 113. Polarization transmitters and receivers.
 114. Pollution, marine oil spills.
 115. Pollution monitors.
 116. Power distribution hardware.
 117. Printed circuit boards.
 118. Programmable power supplies.
 119. Pulp and paper machinery.
 120. Pumps, nuclear generators.
 121. Radar, marine.
 122. Radio-chemicals.
 123. Radioisotope employment.
 124. Replenishment systems, shipboard.
 125. Rockets, gun launched.
 126. Rubber and plastics.
 127. Seals, metallic, static and dynamic.
 128. Seismic profiling systems, land and marine.
 129. Semi-conductor research.
 130. Shock absorbers, vehicular and commercial.
 131. Sight and sighting systems, optical-mechanical.
 132. Sleds, magnesium and aluminum.
 133. Snow melters.
 134. Snow shoes, magnesium.
 135. Sonar, mechanical.
 136. Sonar systems.
 137. Sonobuoys.
 138. Specialized machinery
 - a. mining
 - b. smelting
 - c. refining
 - d. pulp and paper
 - e. plastics
 - f. marine
 139. Spectrophotometry (I.R.) analysis.
 140. Stabilized and steered camera mounts.
 141. Steel plate fabrications.
 142. Structural steel.
 143. Structures, air transportable.
 144. Systems, actuation.
 145. Systems, electrical circuit.
 146. Systems, electro-mechanical.
 147. Systems engineering and analysis, digital computers.
 148. Systems engineering, analysis, digital information.
 149. Systems engineering and analysis, micro-wave.
 150. Systems engineering and analysis, radio.
 151. Systems engineering and analysis, satellite.
 152. Systems engineering and analysis, scatter.
 153. Temperature control systems for in-transit perishables.
 154. Temperature measuring equipment.
 155. Thrust measurement — jet engines.
 156. Toboggans, magnesium and aluminum.
 157. Trailers, specialized.
 158. Trainers and simulators, aircraft and helicopter.
 159. Transducers.
 160. Transducers, electro-mechanical.
 161. Transportation logistics.
 162. Underwater sound generators.
 163. Vehicles, booms and grapples.
 164. Vehicles, front-end loaders.
 165. Vehicles, skidders.
 166. Vehicles, tracked.
 167. Video-tape cleaning.
 168. Waste-water treatment equipment.
 169. Weapon systems, integrated.
 170. Weapon systems, shipboard.
 171. Winches.
 172. Window heating systems.
 173. Window systems.
 174. Windows, blast resistant.
-

Acres InterTel Ltd. 22-149-151.	Canadian Marconi (Avionics) 23.42.100.121.
Andrew Antenna Co. Ltd. 12.22.42.152.	Canadian Marconi (Telecon) 22.42.
Atco Industries Ltd. 17.32.66.91.143.157.161.	Canadian Safety Fuse Co. Ltd. 33.46.
Atomic Energy of Canada Ltd. 57.122.123.	Canadian Velcro Ltd. 21.
Aviation Electric Ltd. 9.23.24.26.29.42.51.52.91.100.131.139.145.146.	Canadian Vickers Ltd. 83.91.
Babcock and Wilcox Canada Ltd. 55.62.120.	Canron Ltd. (Electrical Div.) 35.56.
Barringer Research Ltd. 41.42.47.54.58.	Collins Radio Co. of Canada Ltd. 9.10.22.23.42.100.146.147.148.149.151.152.
Beckman Instruments Inc. 160.	Computing Devices of Canada Ltd. 15.23.25.31.40.44.78.89.99.100.118.147.148.155.
Beclawat (Canada) Ltd. 172.173.174.	C-Tech Ltd. 69.
Bedard-Girard Ltd. 37.	Dahmer Steel Ltd. 142.
Bombardier Ltd. 13.166.	Davie Shipbuilding Ltd. 83.119.141.
Bristol Aerospace (1969) Ltd. 2.19.42.46.112.145.148.151.	John Deere Ltd. 163.164.165.
CAE Electronics Ltd. 11.22.24.37.42.	De Havilland Aircraft of Canada Ltd. 2.6.17.83.94.106.
Canada Wire and Cable Co. Ltd. 16.	Dominion Aluminum Fabricating Ltd. 61.65.143.
Canadair Ltd. 2.91.	Dominion Helicopters Ltd. 63.64.75.
Canadian Aircraft Products Ltd. 4.86.	Dowty Equipment of Canada Ltd. 67.74.75.
Canadian Arsenals Ltd. 46.	Fleet Manufacturing Ltd. 26.91.135.171.
Canadian General Electric (Aerospace) 22.42.91.	Flextrac-Nodwell Ltd. 166.
Canadian General Electric (Industrial Apparatus) 37.	Foremost Tracked Vehicles Ltd. 13.166.
Canadian General Electric (Plastics) 112.	Gabriel of Canada Ltd. 130.
Canadian Industries Ltd. 20.	Galt Equipment Ltd. 153.

Garrett Manufacturing Ltd.
23.27.42.83.124.171.

Godfrey Engineering Co. Ltd.
3.5.(a.b.c.d.e.)

Guideline Instruments Ltd.
38.95.104.154.

John T. Hepburn Ltd.
17.81.83.90.91.119.124.138.

Hermes Electronics Ltd.
22.96.102.105.115.167.

Huntec ('70) Ltd.
39.59.113.128.

Indesco International Ltd.
7.22.34.81.90.98.112.

Irvin Industries of Canada Ltd.
80.109.143.

ITT Canada Ltd.
42.100.

Lacal Industries Ltd.
116.

Leigh Instruments Ltd.
2.9.18.22.42.100.148.149.

Ernst Leitz Canada Ltd.
49.77.79.107.108.131.

Lenkurt Electric Co. of Canada Ltd.
10.12.22.42.149.150.152.

Lightning Circuits
117.

Magline of Canada Ltd.
82.90.132.134.156.

Marine Services & Systems
27.53.83.84.85.87.88.89.

Marsland Engineering Ltd.
22.23.24.81.91.100.145.146.148.150.

Menasco of Canada Ltd.
28.74.75.144.146.

The National Research Council
(Due to the wide range of activities of this facility
you are asked to refer to pages 411 to 436)

Northern Electric Co. Ltd.
22.42.100.

Northwest Industries Ltd.
6.112.

O & W Electronics Ltd.
36.117.

Ontario Research Foundation
2.19.20.22.23.30.42.48.68.77.81.91.94.103.106.112.
123.126.127.129.145.146.147.148.152.

Orenda Ltd.
43.

Plastal Manufacturing Ltd.
111.

Preci-Tools Ltd.
93.

R.B.H. Cybernetics
114.

RCA Ltd.
10.11.12.22.23.42.76.103.110.129.149.150.151.152.

Rex Chainbelt (Canada) Ltd.
168.

Rousseau Controls Ltd.
50.

Space Research Corp. (Quebec) Inc.
2.8.24.42.46.81.91.108.125.

Sparton Aero Ltd.
1.

Sparton of Canada Ltd.
137.159.162.

Standard-Modern Tool Co. Ltd.
81.91.

Swann Winches Ltd.
171.

T.M.C. (Canada) Ltd.
22.42.

Uniroyal Ltd.
20.83.90.112.126.

United Aircraft of Canada Ltd.
43.155.

Varian Associates of Canada
73.97.

Westinghouse Canada Ltd.
(Electronic Systems Div.)
14.22.42.45.70.71.83.91.92.101.136.140.169.170.

Westinghouse Canada Ltd.
(Solid State Devices)
72.

Will-Hart Ltd.
36.60.

DEFENCE SYSTEMS MANAGEMENT

Bristol Aerospace (1968) Ltd.
CAE Electronics Ltd.
Canadair Ltd.
Canadian General Electric (Aerospace) Ltd.
Collins Radio Co. of Canada Ltd.
Computing Devices of Canada Ltd.
Leigh Instruments Ltd.
Litton Systems (Canada) Ltd.
RCA Ltd.
Space Research Corp.
Westinghouse Canada Ltd. (Electronic Systems)

RADIOACTIVE MATERIALS, INSTRUMENTATION AND POWER PLANTS

1. Boilers.
2. Cobalt 60.
3. Control systems, automatic.
4. Coolant systems.
5. Gamma irradiation facilities.
6. Instrumentation.
7. Irradiation services.
8. Isotope teletherapy equipment.
9. Neutron sources.
10. Nuclear fuels.
11. Nuclear plant components.
12. Pumps, nuclear.
13. Radiac detectors.
14. Radiation meters.
15. Reactors.
16. Reactor produced isotopes.
17. Valves.

Atomic Energy of Canada Ltd.
2.5.6.7.8.9.15.16.

Aviation Electric Ltd.
6.17.

Babcock & Wilcox Canada Ltd.
1.12.

Barringer Research Ltd.
6.

Bristol Aerospace (1968) Ltd.
4.11.

Canadian Admiral Corp. Ltd.
6.13.14.

Canadian General Electric Ltd.
(Chemical and Metallurgical)
10.

Canadian General Electric Ltd.
(Nuclear Products)
10.11.15.

Canadian Vickers Ltd.
15.

Computing Devices of Canada Ltd.
3.13.

Dominion Bridge Co. Ltd.
11.15.

Davie Shipbuilding Ltd.
11.

Foster Wheeler Ltd.
13.15.

Hawker Siddeley Canada Ltd.
(Canadian Foundries)
11.

Hermes Electronics Ltd.
6.

Leigh Instruments Ltd.
3.6.

Marsland Engineering
3.6.12.14.

Orenda Ltd.
4.6.11.

Preci-Tools Ltd.
11.17.

RELIABILITY STUDIES

ATCO Industries Ltd.

Computing Devices of Canada Ltd.

Leigh Instruments Ltd.

RCA Ltd.

REPAIR AND OVERHAUL

1. Aircraft.
 2. Aircraft engines (Wright R3350, R1820 & R1300).
 3. Aircraft fuel injection systems.
 4. Aircraft gear boxes.
 5. Aircraft ignition systems.
 6. Auxiliary power units, airborne.
 7. Boost controls, aircraft.
 8. Calibration
 - a. electric instruments.
 - b. electronic instruments.
 - c. laboratory instruments.
 9. Carburetors, aircraft.
 10. Communication equipments.
 11. Communication equipments, aircraft.
 12. Computers.
 13. Controls, flight, powered.
 14. Conversion, aircraft.
 15. Conversion, interior, aircraft.
 16. Electric motors up to 300 HP and switchgear.
 17. Electrical.
 18. Electro-mechanical systems.
 19. Electronic.
 20. Engines, aircraft.
 21. Engines, gas turbine.
 22. Flight instruments, aircraft.
 23. Flight instruments, A/C test sets.
 24. Flight recorders and systems.
 25. Flight simulators.
 26. Floats, aircraft.
 27. Fuel controls, hydraulic.
 28. Fuel controls, pneumatic.
 29. Fuel injection systems, aircraft.
 30. Generating equipment fossil and nuclear, heavy plant.
 31. Landing gear, aircraft.
 32. Life support equipment.
 33. Helicopter.
 34. Hydraulics, aircraft.
 35. Hydraulics, pumps.
 36. Ignition systems, aircraft.
 37. Marine repairs, ship.
 38. Marine repairs, ship accessories.
 39. Motors, servo.
 40. Navigation equipments.
 41. Navigation systems, aircraft.
 42. Nuclear detection instrumentation.
 43. Nuclear power plant components, mechanical.
 44. Optical systems.
 45. Propellant actuated seats and devices.
 46. Propeller, aircraft.
 47. Pumps, gas turbine, marine.
 48. Radar equipments.
 49. Seats, aircraft.
 50. Sonar transducers and associated equipments.
 51. Starting generators, aircraft.
 52. Systems, actuation.
 53. Systems, hydro-mechanical.
 54. Weapon delivery systems, airborne.
- Aircraft Appliances & Equipment Ltd.
17.22.34.
- Aviation Electric Ltd.
6.8.(a.b.)9.17.18.19.22.27.28.29.34.36.41.47.52.53.
- Babcock & Wilcox Canada Ltd.
30.43.
- Beaconing Optical & Precision Materials Co. Ltd.
17.18.19.
- Bedard Girard Ltd.
16. -
- Bristol Aerospace (1968) Ltd.
1.7.8.(a.b.)11.14.15.17.19.22.26.33.34.49.53.
- Bristol Aero-Industries (Montreal) Ltd.
2.3.4.5.7.9.
- CAE Electronics Ltd.
17.19.25.
- Canadair Ltd.
1.14.15.20.34.36.
- Canadian Admiral Corp. Ltd.
42.
- Canadian General Electric (Aerospace)
8.(a.b.c.)10.11.19.39.
- Canadian General Electric (Meter Instruments)
17.
- Canadian Marconi (Avionics)
19.41.
- Canadian Marconi (Special Services)
10.19.48.
- Canadian Flight Equipment Co. Ltd.
45.49.
- Canadian Vickers Ltd.
43.
- Canadian Vickers Ltd. (Ship Repairs)
37.38.

Computing Devices of Canada Ltd.
11.18.19.22.41.

C-Tech Ltd.
50.

Davie Shipbuilding Ltd.
37.38.

De Havilland Aircraft of Canada
1.14.19.20.21.26.31.34.46.49.

Dominion Helicopters Ltd.
33.

Dowty Equipment of Canada Ltd.
31.34.35.

Garrett Manufacturing Ltd.
8.(a.)17.19.22.23.

Godfrey Engineering Co. Ltd.
17.34.39.52.

Hawker Siddeley Canada Ltd. (Halifax Shipyards)
37.38.

Irvin Industries Canada Ltd.
32.

ITT Canada Ltd.
8.(a.b.)11.19.41.

Leigh Instruments Ltd.
11.17.18.19.22.24.41.

Ernst Leitz Canada Ltd.
44.

Litton Systems (Canada) Ltd.
12.19.41.54.

Marine Industries Ltd.
37.38.

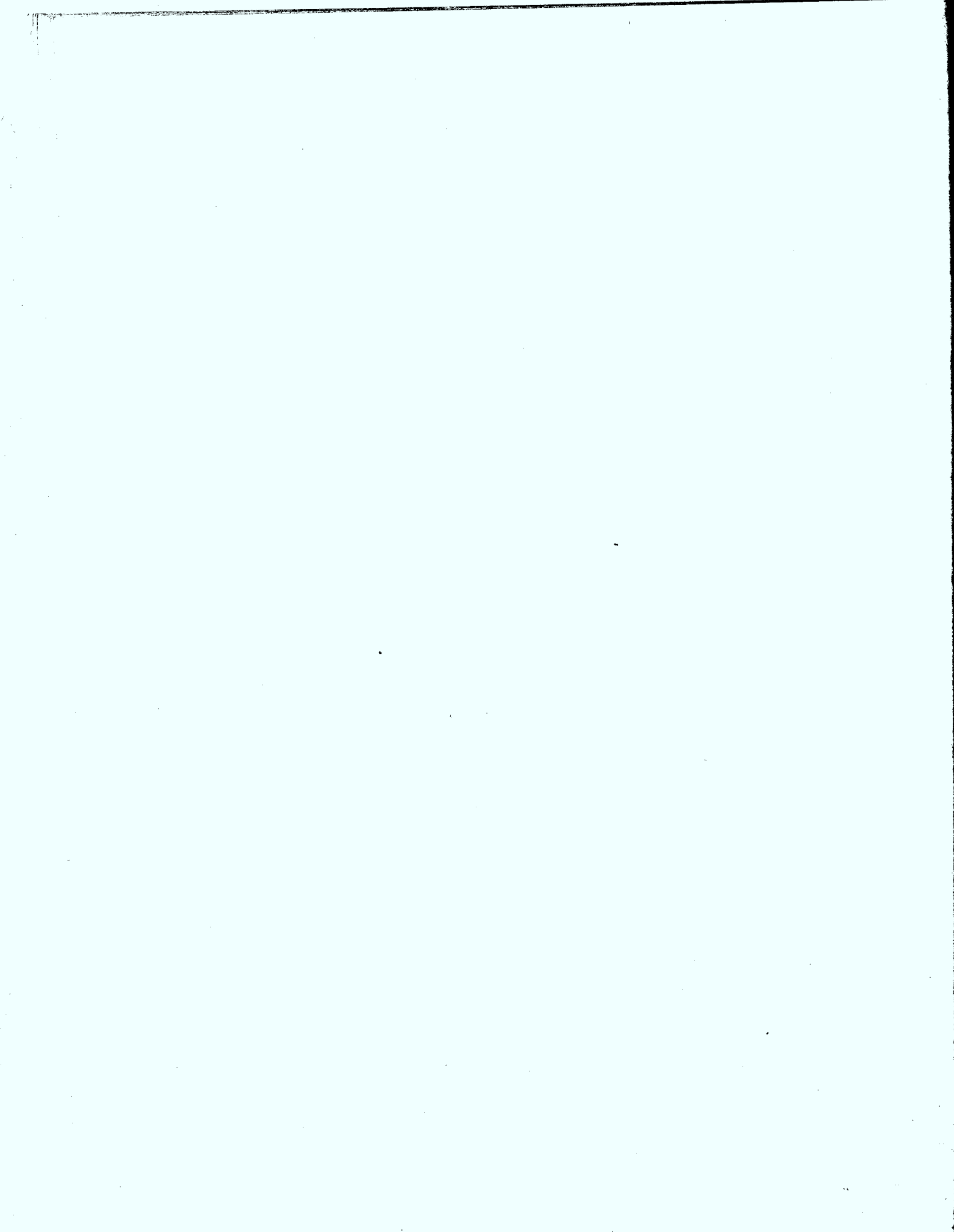
Marsland Engineering Ltd.
8.(a.b.c.)11.12.13.17.18.19.

Menasco of Canada Ltd.
13.31.34.53.

Northwest Industries Ltd.
1.11.14.15.20.22.26.31.34.36.49.

Orenda Ltd.
21.

RCA Ltd.
10.11.19.



Acres InterTel Limited
151 Slater Street
Ottawa, Ontario K1P 5H3

Telephone: 613 236-0124
Telex: 013 209
TWX: 610 562 1929
Cable: INTERTEL OTT

President: Frederick Gall

Sales Contact: René M. Cardis, Vice President

Acres InterTel Limited are involved in many diverse activities in the broad field of telecommunications. The spectrum of services performed range from consultancy at the broadest policy level (technical, socio-economical) for national, regional or international telecommunications to quite specific tasks in a diversity of situations. Acres InterTel field experience, often in rugged environments, covers the North American continent from the Canadian North down to Tierra del Fuego at the southernmost tip of South America, as well as in Europe, the Far East and Africa.

The company is the telecommunications/electronics component of Acres Consulting Services Ltd. the largest consulting engineering organization in Canada, which encompass as a comprehensive spectrum of competence both "specialist" and "service" disciplines. The former cover expertise in the various technologies (power, civil, communications, structural, etc.). The latter cover supporting or adjunctive capabilities such as economics, mathematics, computer data processing, etc. The Group maintains offices from coast to coast in Canada, in New York, Nassau, Buenos Aires, Kuala Lumpur, Tokyo and Cotonou, Dahomey. The total staff amounts to over 1,000. About one half of these are professional engineers or equivalent. The remainder comprise draftsmen, technical assistants, accountants, clerical and secretarial staff. Typical of the tasks performed by the company are design of telecommunications systems for administration, telemetry, protection and remote control; HF and VHF communications networks; police telecommunications systems; engineering assistance on Satellite communications systems; military telecommunications systems; micro-wave systems for voice toll traffic and TV; cataloguing of telecommunications systems in Northern Canada; Cable TV system design and path surveys; market surveys for telecommunications equipment and airport ground handling

equipment; technical advice on proposals on financing projects; feasibility and costs studies on tactical radio equipment; integration of military communication systems.

Page 51

Aircraft Appliances & Equipment Limited,
152 East Drive,
Bramalea, Ontario.

Telephone: (416) 454-1250
Telex: 069-7540
TWX: 610-492-4396

President: L. V. Myslivec

Contact: Donald S. Adams, Export Sales Manager

This company produces gasoline and diesel engine driven generator sets of 5, 10, 15, 20 and 30 KW output at 60 and 400 HZ both AC and DC. Motor generator sets to 40 KVA and AC generators to 30 KW at 60 HZ are also standard items. The Company also manufactures tachometer generators qualified in accordance with QPL 5413, 9398 and 26611 as well as variety of custom designed aircraft voltage regulators and other special electrical instruments. Mechanical and hydraulic equipment, customer designed as well as a complete range of aircraft lube, hydraulic and fuel filters is also available. A complete repair and overhaul facility for AC and DC electrical equipment is maintained.

2915	2925	2935	2940	2945	2995	4330
5930	5945	6115	6125	6130	6620	6625

Allied Enterprises Limited,
655 Montée de Liesse,
St. Laurent, Quebec.

Telephone: (514) 341-3816
Vice-Pres. & Gen. Man.: Stewart C. Knox
Contact: Leo Lussier, Asst. Mgr.

This firm is a proven supplier of sheet metal products particularly meeting the requirements of marine users. Aluminum and steel doors, both hollow metal and plate including fireproof doors and manholes are supplied. The company also produces hatches, lockers and lavatory cabinets as well as shelves, bins and cabinets in aluminum, steel and stainless steel. Product approval includes Lloyds.

2040 2090 5670

Andrew Antenna Company Limited,

606 Beech Street,
Whitby, Ontario.

Telephone: (416) 668-3348
Telex: 06-981269
TWX: 610-384-2754
Cable: ANDCORP WHITBY

President: R. P. Matthews

Contact: G. J. Wilson, Sales Manager

The company is a manufacturer of microwave antenna systems and related components. A complete line of parabolic antennas from .6 to 4.57 m (2 to 15 ft.) in diameter is produced for frequencies in the 450 MHz to 15 GHz range. A complete complimentary line of accessories, including mounts and radomes, both heated and unheated is available.

Ground station antennas for use with geostationary satellites have been developed. Troposcatter antennas in sizes up to 25.9 m (85 ft.) are available.

The company also manufactures Heliac co-axial cables and rigid co-axial transmission lines along with co-axial switches and hi-power co-axial patch panels and switching matrices. Heliac flexible elliptical waveguide is also produced along with rigid waveguide and accessories in all common sizes. Dry air pressurization for transmission lines is also produced.

The company maintains a full technical staff including both Electrical and Mechanical engineers and two completely equipped antenna pattern ranges are maintained for development projects.

5930 5985 6545 and pages 50 and 51

Armstrong Jones Ltd.,

83 Sunrise Avenue,
Toronto 16, Ontario.

Telephone: (416) 751-2380
Telex: 02-29675
Cable: ARJON

General Manager: W. H. Jones, P.Eng.

Contact: F. Branstrom

Armstrong Jones Ltd. is a completely Canadian owned and operated manufacturing company active in several areas.

A complete line of Armstrong Jones — Kittell silencers and mufflers are manufactured for

compressor intakes, diesel and turbine intakes and exhausts, steam and high pressure air exhaust and pressure blower intakes. Standard and special mobile vehicle silencers and marine silencers are manufactured.

In the area of industrial sound control equipment the company manufactures Sound Soaker Panels of a modular section design, that can be used singly or attached together to absorb or block noise. These panels interlock so that they can be assembled into semi or complete enclosures for noisy machinery or soundproof rooms for people working in noisy areas.

In the area of bulk materials handling, Armstrong Jones are active in two specific areas:

- Solids material gate valves for controlling discharge of materials from bins, chutes, hoppers, etc.
- Volumetric feeders, gravimetric feeders, bin dischargers, etc., for the precision continuous feeding of solids materials such as grain, flour, zinc dust, iron ore, lime, chemicals, food materials, etc.

Armstrong Jones Ltd. manufacture knitted metal or plastic mesh liquid entrainment separators for separating entrained liquid droplets from a gaseous stream. These are used in food industry, petroleum refining industry, mining and paper mill operations, and as well as being an aid to overcoming pollution they improve yield and profit.

2990 3695 3910 3920 4330 4810 4820
5680 5970 7125

Atco Industries Ltd.,

1243 McKnight Blvd., N.E.,
Calgary 67, Alberta.

Telephone: (403) 276-1101
Telex: 038-22697
R&D Center:
Telephone: (403) 249-5541
Telex: 038-24739

President: R. D. Southern

Contact: J. Susnir, General Manager.

Over the years that this firm has been a major supplier to the Canadian Services they have evolved a system of lightweight units which are air-transportable, including helicopter, which allows sophisticated shelter to be made available under the most exacting conditions with little lead time required.

Their production also includes all types of custom designed laboratories, hospitals and other special services units; completely furnished mobile, factory-built and on-site homes; relocatable

schools, motels and offices; relocatable metal buildings; vacation trailers; custom furniture and interior furnishings; research, design, development and consulting services in the field of structural, mechanical and civil engineering; specialized trailers, containers, shelters, EMI shielded shelters and pallets.

1740 2330 2510 3920 1670 3990 5410
7110 8115 8140 and pages 51, 55 and 481

Atlas Steels Company,
A Division of Rio Algom Mines Limited,
Welland, Ontario.

Telephone: (416) 735-5661
Telex: 0215114 and 0215190

Contact: A. V. Orr, Vice-Pres.
Sales and Marketing

R. F. Larson, Product Manager
Tool & Machinery Steels

W. D. Harris, Product Manager
Stainless Steels

D. R. McCutcheon, Product Manager
Carbon, SAE Alloy, VAR and
Mining Steels

T. J. Callaghan, Product Manager
Titanium

Atlas Steels, the largest specialty steel producer in Canada, has maintained a continuing program of expansion and modernization which dates back to 1828 when the company was founded.

Today, Atlas products include stainless steels, tool steels, high speed steels, machinery steels, hollow drill mining steels, special purpose alloy steels and titanium. These are produced in sheet, plate, strip, tube, billet, slab, bar, rod and wire forms.

Made to exacting quality standards to suit a broad range of applications, these specialty steel and titanium products are regularly produced to conform to automotive, industrial, aerospace and military specification codes. Atlas rolled, forged or drawn products are employed as component material in small arms, artillery ordnance, military vehicles, marine and aerospace applications.

At both plants Welland, Ontario and Tracy, Quebec, selected steel scrap and alloying elements are melted and refined into specialty steels which are then fashioned into a wide range of mill shapes and sizes. High quality standards are insured by using modern melting, rolling and finishing processes throughout operations.

The Atlas continuous casting machine, introduced in Welland in 1953, casts steel slabs directly from

molten metal and was the first such unit to go into commercial operation in North America. Similarly Atlas pioneered hot planetary rolling which reduces stainless slab into coiled strip form in a single rolling pass. At the Tracy facility continuous casting and planetary rolling are employed to produce 121.9 cm (48 in.) wide stainless sheet/strip. Advanced vacuum processes for superior Atlas product quality are employed in basic melting and remelting operations as well as in final annealing stages.

The company's research and development activities are geared to constant improvement of steel-making technology and new product development. Recent R & D activities resulted in new hollow drill mining steels; longer life tool steel for plastic moulds and die casting dies; free-machining stainless bar products; and scruff and scratch resistant stainless steel sheet and strip.

A world-wide organization of representatives and service centres distribute Atlas products throughout Canada, the United States, Mexico and South America, the United Kingdom, Europe and Australasia.

1005 1010 1015 1020 3820 4710 9505
9510 9515 9525 9530 9535

Atomic Energy of Canada Limited,
P.O. Box 6300,
Postal Station J,
Ottawa, Ontario. K2A 3W3

Telephone: (613) 836-2790
Cable: NEMOTA

Contact: H. G. Gay, Director of Marketing

Radiation and Radioisotopes are now widely used throughout the world in medicine and industry. Commercial Products division of Atomic Energy of Canada Limited is one of the leading suppliers today of materials and equipment in this line. The company manufactures and markets Cancer Therapy Units, a wide range of radio-chemicals used in nuclear medicine and industrial processes and supplies radioactive sources. The sterilization of medical disposables is a rapidly growing manufacturing process and AECL is a world leader in the design production and marketing of full scale irradiators. There are more than twenty-five AECL plants in operation today in various countries. AECL has also designed and built full scale irradiation facilities for food irradiation.

All of these irradiation facilities are fully automatic and capable of handling production on a twenty-four hour a day basis. AECL also produces a range of research irradiators which are used

the world over for investigation into radiation techniques and processes.

In 1970 AECL engineers developed a small low powered reactor called 'Slowpoke'. This reactor is now commercially available and has wide potential use in the field of activation analysis, production of short-lived isotope and various investigations employing nuclear techniques.

The company has also developed a Cobalt 60 electrical generator. This equipment is capable of producing electrical power up to 50 watts. These generators are highly suited for applications in space, under water and remote locations because they require no maintenance and are capable of producing electrical power for several years without refuelling. At the same time AECL is actively pursuing developments using other radioisotopes to produce smaller amounts of electrical energy suitable for medical applications such as heart 'Pacemakers'.

In the past few years the company has also developed processes for the production of new materials such as wood polymers and textiles. AECL can also supply special sources used to train military and civilian personnel in radioactive recover, handling and disposal techniques.

6525 6640 6910 9610 and pages 51, 55,
450 451 and 452

Aviation Electric Ltd.,
P.O. Box 2140,
200 Laurentien Blvd.,
Montreal 379, Quebec.

Telephone: (514) 744-2811

Chairman of the Board: A. Bandi

President: R. D. Taylor

Contact: C. D. Garbutt, Director of Sales

Aviation Electric, founded in 1931, was initially engaged in the sale, repair and overhaul of aircraft accessories and instruments. However the company subsequently expanded its operations to provide high precision manufacturing in both the aviation and industrial fields supplemented by complete engineering services in the areas of research, development and product design. Disciplines covered are electro-mechanics, electrical, electronics, fluidics, geomagnetics and high 'G' technology. In general the company specializes in the broad field of control systems and control components for the aerospace field and industry.

The Canadian Force's Land Navigation System, still considered to lead in its field, is not only produced by A.E.L. but the company also played a major role in the original development of the system and have since researched and developed further models which have attracted world-wide attention. Advanced technology is also applied in the production of artillery fire control systems and accessories such as electronic plotting boards. Their production in the aviation field now is concentrated in the following areas:

- Portable gas turbine auxiliary power units.
- Fuel nozzles & After burners.
- Fuel controls & Fuel system test stands.
- Hydraulic systems and components.
- Hydraulic and pneumatic test sets.
- Auto pilot test stands.

The repair and overhaul facilities operated by AEL are a further assurance to the user that the high performance requirements of these equipments are indeed supported by proven technologies which are available either in-plant or support in the field. This division covers instrument accessories and avionics. Engineering consulting and design services cover automation and control, electric control systems, hydraulic control systems, fluidic control systems and devices, electronics, fire control, land navigation equipment and systems design.

1220 1230 1630 1730 2840 2925 4920
4930 5999 and pages 51 55 56 149 376
438 and 460

Air Vision Industries Inc.,
153 Oneida Drive,
Pointe Claire, Quebec.

Telephone (514) 695-1883

Cable: AIRVICAN MONTREAL

Telex: 05-267659

President: Natal Eycken

Contact: Harold Gillmeister, Vice-Pres.

This company is engaged in the design, development and manufacture of air traffic control towers. The towers cover mobile, air transportable and permanent installations. All custom requirements including military and civil operational roles are met.

A complete service is offered with Telecommunications, Meteorological and Navigational equipments being incorporated on request. Further services include the installation of a complete functioning air traffic control tower as well as the training of the personnel with respect to the functioning of the tower and all equipment in it.

pages 51 and 200

Babcock & Wilcox Canada Ltd.,
Coronation Blvd.,
Galt, Ontario.

Telephone: (519) 621-2130
Telex: 0295-771

President: J. M. Douglas

Contact: C. W. D. Fowler

Babcock & Wilcox Canada Ltd. is a major manufacturer of steam generating equipment, heat transfer apparatus, pump and custom-built machinery for domestic and export markets. As a major supplier to the Hydro Electric Commission of Ontario and other Canadian and export utilities, B&W has become an integral part of that group of our industries who are producing and erecting some of the most modern electric generating plants in the world.

This company was one of the major suppliers of boilers to the Ontario Hydro nuclear powered Pickering G.S. near Toronto, as well as the Atomic Energy of Canada Limited heavy water plant and Ontario Hydro Generating Station at Douglas Point. B&W is presently producing all of the major boilers for the new Ontario Hydro fossil fuel generating plant at Nanticoke, near Hamilton.

A Canadian pioneer in the design and production of nuclear steam generating equipment, the Galt firm has supplied equipment to Atomic Energy of Canada's Chalk River nuclear facility and steam generators for the KANUPP (Karachi Nuclear Power Project) nuclear generating station in West Pakistan.

To compliment this work a range of nuclear pumps are also produced as well as a complete system of boilers for the pulp and paper industry.

Standard marine boilers, condensers, centrifugal and axial flow pumps, stokers and pulverizers together with oil, gas and coal burners are available or can be designed to meet custom requirements. Pressure vessels and other demanding heavy plate work is produced from this plant which also maintains repair and overhaul facilities.

2820 3820 4320 4410 4470 4530 5430
pages 51 55 and 56

Barber-Greene Canada Ltd.,
81 Barber-Greene Road,
Don Mills 403, Ontario.

Telephone: (416) 444-8481
Telex: 02-2669

Plant Manager: John A. Kay

Contact: B. B. MacKenzie,
Manager National Services

Military encampments, whether permanent or temporary, require modern construction techniques which will not only ensure their effective operation but will also reduce capital expenditure. The broad range of equipment for asphalt paving, materials handling and processing, aggregate production, and excavating and trenching operations will produce these criteria for efficient construction.

Its product line includes both batch type and continuous asphalt mixing plants for both portable and permanent applications, self-erecting batch plants, surge plants that combine mixing and storage in a single unit, surge storage systems, dryers, dust collection equipment, and aggregate and fines feeding and proportioning equipment; stabilization plants for producing high quality base materials; crawler and pneumatic tire mounted asphalt finishers for paving roads, streets, highways, parking lots, and airport runways and taxi areas.

Portable and stationary aggregate plants and equipment, including crushers, vibrating screens, washing equipment, sand washing and classifying units. A full line of materials handling equipment including permanent and portable belt conveyors, bucket elevators, stockpiling and reclaiming systems, portable conveyor screening plants, hopper car unloaders, and truck unloaders. Continuous excavators in both single and double wheel models, and wheel type ditchers are also produced.

3805 3820 3895 3910 3920 3990
4440 4460 and page 468

Barringer Research Limited,
304 Carlingview Drive,
Rexdale, Ontario.

Telephone: (416) 677-2491
Telex: 06-217893
Cable: BARESEARCH

President: A. R. Barringer

Contact: D. A. Whiteman, Vice-Pres. Marketing

Barringer Research Limited operations are broadly based on the earth sciences, namely geophysics, geology and geochemistry for which the company offers a wide range of specialized services and advanced techniques and instrumentation. A natural outgrowth of this activity has been the application of these techniques and expertise to the growing problems of the environment particularly in the detection and monitoring of airborne gaseous substances.

The major activities of the company may be summarized as follows:

- **Consulting and Laboratory Services:**
They offer a world-wide geology and geochemistry consulting service and extensive laboratory facilities for custom analysis of soil, rock and biogeochemical samples using atomic absorption spectro-photometry, colourimetry and wet chemistry. The company is heavily involved in the electro-optical instrumentation field and has developed unique atomic absorption equipment for the detection of atmospheric mercury in the parts per trillion range and for analyzing soil samples with sensitivities of a few parts per billion of mercury. In addition, the company's patents in the atomic absorption field provide the basis for the future development of extremely high sensitivity analytical equipment for a broad range of metals.
- **Geophysics:**
They have specialized for a number of years in remote sensing instrumentation. It has developed the INPUT[®] or INduced PUIse Transient airborne prospecting system which is now in worldwide service. More recent developments are the helicopter EM (Electro Magnetic) system and the RADIOPHASE/E-PHASE airborne conductivity mapping systems. These rank among the most advanced systems of their kind in use today. Electromagnetic prospecting systems and services are available for airborne (fixed wing aircraft and helicopter) and ground-based surveys.
- **Gas/Vapour Detection, Atmospheric Sampling:**
Since 1964 Barringer Research has been continuously engaged in the development of electro-optical sensors for the detection and monitoring of trace gases and atmospheric

contaminants. These activities have culminated in a family of air pollution sensors including the Barringer In-stack SO₂ monitor, the remote sensing SO₂/NO₂ correlation spectrometer and collimated light source, and the Barringer airborne air sampling mercury spectrometer. Current design projects include the design and development of a remote sensing correlation interferometer for monitoring of carbon monoxide from aircraft and spacecraft and the application of patented electro-optical techniques to other gases of interest including NO, NH₃, HCl, HF, I₂ and Ozone. Present activities also include the development of high sensitivity multi sensor airborne systems for geochemical exploration. Airborne geochemical services are expected to be available shortly for surveys of airborne trace elements and compounds including SO₂, CO, Hg and most halogens with remote sensing correlation spectrometers and continuous air sampling analyzers.

- **Liquid Analysis:**
The company also has competence in liquid analysis instrumentation as demonstrated by the recent development of heavy water (D₂O) loss monitors for the Atomic Energy of Canada which are now in service at the Ontario Hydro Electric Commission's Douglas Point and Pickering nuclear power generating stations.
- **Data Reduction and Computer-Assisted Mapping:**
The company offers comprehensive photo interpretation, computerized data reduction and mapping services for all types of geophysical, geological, geochemical and air pollution surveys.
- **Research and Development, Instrument Design:**
The company has a research and development oriented staff of scientists and engineers with specialized expertise in the design and application of analytical instruments as related to remote detection and continuous flow analysis. The company offers a systems study, feasibility and analysis service and custom engineering of single instruments and multi-sensor systems for ground-based and airborne geophysical, geochemical and air pollution surveys.

6350 6630 6650 6655 6665
and pages 50 51 55 443 and 448

**Beaconing Optical and Precision Materials
Company Limited,**

P.O. Box 88,
Place Bonaventure,
Montreal 114, Quebec.

Telephone: (514) 866-8395
Cable: BOPHAR
Telex: 610-532-6561

President: H. M. Calpakis

Contact: J. C. Carter, Vice-Pres., Marketing

Manufacturers of HF and UHF communications equipment, airborne searchlights, ancillary radar equipment, precision electro-mechanical components and assemblies. Military end items produced by this company include:

- Radio set, AN/VRC-24
- Radio set, AN/TRC-68
- Searchlight set, AN/AVQ-2C
- Transmitter, T-216A/GR
- Range-Height Data Converter, CV-601/FPS-6A

The company is also a supplier of various major assemblies and precision components used in:

- Radio set, AN/URC-9
- Radio sets, AN/SRC-20 and 21

5820 5821 5840 5895 5930 5950 5985
6210 6625

Becker Drills Ltd.,
315 - 19th Street S.E.,
Calgary 62, Alberta.

Telephone: (403) 272-8731

Contact: C. W. Galbraith, General Manager

Manufacturers of readily transportable, compact hammer drills for overburden drilling in gravel, sand and boulder formations.

3820 and page 316

Beckman Instruments Inc.,
(Helipot Division)
901 Oxford Street,
Toronto 18, Ontario.

Telephone: (416) 251-5251
TWX: 610-492-1301

Contacts: N. R. McCormack, Manager
R. Kolu, Sales
D. McBride, Sales

The Helipot Division of Beckman Instruments is a prime manufacturer of precision wire-wound

linear and non-linear potentiometers, both single and multi-turn types. Linear motion potentiometers, a wide range of military and industrial types of trimming potentiometers of essentially infinite resolution, turns counting dials, low voltage regulated power supplies, conductive plastic and cermet potentiometers, form a part of the division's capability.

A wide selection of precision potentiometers, trimming potentiometers and dials are available from a comprehensive stock.

A complete in-house custom capability is available for special modifications to standard products or complete design and manufacturing facilities for the production of electro mechanical transducers incorporating potentiometers.

1680 5905 5930 5999 and page 51

Beclawat (Canada) Ltd.,
171 Hymus Boulevard,
Pointe Claire 730, Quebec.

Telephone: (514) 747-9878
Telex: 01-26507
Cable: BECLAWAT

President: G. W. Millar

Contact: J. M. Hendren, Vice-Pres. and
General Manager

Manufacturers of windows (frames and glass) of aluminum, brass, stainless steel, including electrically heated for de-icing and de-misting. All explicitly designed for use on ships, road and tracked vehicles; rail cars and other transportation equipment. The engineering staff is well experienced in window system designs for both the transportation and architectural fields and is available for consultation. Blast resistant window designs, basically for naval requirements, but applicable to other fields, are also available.

Sliding door equipment, freight car emergency brakes, aluminum flooring are produced for custom requirement.

2040 2240 2510 5670 and page 51

Bedard Girard Ltd.,
117 Lagachetiere Street West,
Montreal 128, Quebec.

Telephone: (514) 861-5631
Telex: 05-25142
Cable: GIRBED

President: J. Phaneuf

Contact: K. G. Chapman, Marketing Mgr.

This company produces custom-built equipment for electrical power, control and electronic systems and a line of standardized annunciators, both relay and solid state type. Power and distribution switchgear up to 34.5 KV using circuit breakers of load-break switches, switchboards and panels for control, protection, metering and indicating are constantly in production. In design and production at this time is 11.2 kV switchgear for a power station in Africa while the control panel for a nuclear station including the synchro system for the turbines with start-up power lines and load control systems for a standby diesel generator set in the event of failure in the main supplies.

Switchboards, navigation light panels, terminal boxes and motor control centres are built to marine requirements, including shock resistance where necessary and in this field the firm has recently completed shock-proof control centres for the Canadian Navy's Operational Support Ships which are described on page 254. Automatic engine starting and protective panels and generator control systems, remote control systems and alarm systems are built for land and marine applications. A staff of engineers and technicians carries out design of equipment and also of complete electrical power, distribution and control systems and here they have designed and produced the complete equipment for the supply of track current for the Montreal underground transportation system which also includes the solid state rectifying equipment. A similar project is now underway for Mexico City.

The Company also designs and produces traffic control equipment for railways and transit systems and access control systems. A separate group specializes in repair of electrical motors up to 300 HP switchgear and controls.

5940 6110 6310 6320 6350
and pages 51 and 56

Bomag (Canada) Limited,
1300 Aerowood Drive,
Mississauga, Ontario.

Telephone: (416) 625-6611
Telex: 06-961250
Cable: BOMAGS

General Manager: Walter Kuettnner

Contact: C. R. Wettlaufer, General Sales Manager

This Company manufactures self-propelled, heavy duty earth and sanitary landfill compactors. The complete product line also includes walk-behind rollers, vibratory plate compactors, vibratory slope compactors, vibratory self-propelled ride-on rollers, static rollers and pneumatic rollers.

2320 and page 324

Bombardier Limited,
Valcourt,
Co. Shefford, Quebec.

Telephone: (514) 532-2211
Telex: 018-3120
Cable: BOMBARDSNO

President: Laurent Beaudoin, C.A.

Contact: A. Morin, Vice-Pres. Marketing

Bombardier and "Ski-Doo" are synonyms for rugged, reliable over-snow transport. In this field two-passenger snow scooters for both patrol and recreation pursuits are produced along with multi-passenger enclosed type snowmobiles are in use throughout the northern and southern hemispheres.

Their Muskeg type tractors and carriers are working in off-highway locations throughout the world and are used in every variety of work from transporting basic construction equipment and supplies to isolated sites to grooming ski slopes. Side-walk type snow removal tractors operate on city streets as efficiently as they clear the snow in close-in work around pursuit type or jumbo jets on airfields.

At the same time the company maintains a competent staff of design and mechanical engineers who through research and product development have been able to adapt existing equipment and design new equipment for all types of terrain and conditions.

2310 2320 2330 2410 2430
and pages 51 308 326 and 329

Bristol Aerospace (1968) Limited,
 (Winnipeg International Airport)
 P.O. Box 874,
 Winnipeg, Manitoba.

Telephone: (204) 775-8331
 Telex: 03-5587
 TWX: 610-671-3598
 Cable: BRISTAIRCO

President: W. M. Auld

Contact: R. H. May, Vice-Pres. Marketing

The company's activities are divided into the following four main areas.

- **Gas Turbines:**
 The company has developed advanced techniques in the forming, welding, machining and processing of high strength heat resistant materials as used in the manufacture of gas turbine components and especially those in the hot section of the engine. Such components include afterburners, exhaust ducting, flame tubes, combustors, etc. Overhaul and refurbishing facilities for gas turbine hot section components are also available to augment new component manufacture.
- **Rockets:**
 A range of research rockets, the Black Brants, have been designed and developed and are manufactured at the Winnipeg facility, with motors filled with propellant at the Rockwood plant.
 A total system is supplied from design through manufacture of the propulsion unit, design and manufacture of electronics, and production and filling of motors. Engineering support at launch is available should it be required.
 The requirements to produce a complete system are engineering (design and development), propulsion unit manufacture (rocket motor casing, fins, nose cones and propellant production) and experiment production (electronics and telemetry equipment); each of these areas is separate from the other and can be offered individually to meet customer requirements.
 Engineering is continually being applied in new areas such as satellite technology, meteorological reports via rocket, environmental sensing and control, etc.
 The manufacture of rocket hardware is similarly available upon a custom basis, fuses and fins together with vehicle launchers are supplied to specification. The application of aerodynamic principles is also applied to hydrodynamic systems such as torpedoes and sub-surface buoys.
 Propellant is available either in component form, such as a research rocket or JATO unit,

or may be supplied for installation to a vehicle at a customer's plant.

The electronics and telemetry technology is readily adaptable to monitoring remote sites such as oil pipe line pumping stations or satellite activity.

- **Airframe Component Manufacture:**
 Airframe component manufacture embraces production of items for light aircraft through to items for the new generation of large airliners. Components manufactured include doors, engine mounts, fuel and oil tanks, air pressure regulators and compressed air storage vessels, floats and skis, pylons, wing sections and fuselage sections. Materials used include aluminum, stainless steel, titanium, plastics, glass fibre and advanced composites.
- **Aircraft Overhaul:**
 Aircraft overhaul includes both civil and military fixed and rotary wing with gross weights up to 34,020 kg. (75,000 lbs.). Complete facilities are available for component and sub-systems overhaul, together with radio and instrument test facilities.
 In addition to the four main areas of endeavour, the Company maintains divisions for the design development and manufacture of nuclear reactor components and for the development and manufacture of components using composite materials, including glass fibre and plastics. Components manufactured in these materials include oceanographic buoys, pressure vessels and torpedo casings.
 All manufacturing tooling and special inspection gauges are designed and produced within the facility which lends further quality control features to all production and the same procedures apply to such processing facilities as heat treat, anodizing, pickling, etc.
 Engineering and quality control groups ensure conformance of manufacture or overhaul to the respective civil or military specification applicable. Approvals in specific areas are presently held with DOT, FAA, CAF, USAF and others.

1310	1315	1325	1330	1336	1337	1340
1345	1350	1355	1377	1410	1420	1440
1560	1630	1650	1680	1730	2050	2835
2840	3465	5821	and pages 51		55	56 142
147 and 148						

Bristol Aero-Industries (Montreal) Limited,
10210 Pie IX Boulevard,
Montreal 459, Quebec.

Telephone: (514) 321-1330
Telex: 05-368833
Cable: BRISTAERO

Vice-Pres. & General Manager: J. R. Alarie

Contact: T. J. Bagg, Secretary

Repair and overhaul facilities for Wright R3350, R1820 and R1300 aircraft reciprocating engines; gear boxes; carburetors; fuel injection systems; ignition systems and boost controls. Plating facilities for cadmium, copper, chrome, lead/tin and silver.

page 56

Brunner & Lay (Canada) Limited,
2280 - 43rd Avenue,
Lachine, Quebec.

Telephone: (514) 631-8588
Telex: 05-268749
Cable: BRUNLAY LACHINE

Contact: R. C. Benston, General Manager

This company produces a line of expendable accessory tools used on pneumatic hammers and drills. Their basic lines may be divided into two major sections; accessory tools for non-rotating or concrete breaking and clay digging pneumatic hammers. The major items in this line are moil points, narrow and wide chisels, clay spades, digging chisels, asphalt cutters, chipping hammer accessory tools and bushing tools as well as standard specialty items for this type of machinery.

The second major branch of this production covers expendable accessories for rotating pneumatic drills for all sizes and types for underground mining as well as quarrying. Major items in this sector include striking bars, couplings, extension drill steel, detachable carbide inserted drill bits as well as specialty accessories. Threaded carbon drill steel and tungsten carbide inserted chisel drill steel is also available.

3820

CAE Electronics Ltd.,
P.O. Box 1800,
St. Laurent,
Montreal 379, Quebec.

Telephone: (514) 341-6780
Telex: CAE 01-20708
TWX: CAE MTL 610-422-3063

President: R. W. Cooke

Contact: J. A. Morley, Vice-Pres., Simulators
S. Roth, Vice-Pres., Advanced Programs

CAE Electronics Ltd., is one of the world's largest and most respected designers and manufacturers of commercial and military Flight Simulators, and is currently building simulators for standard jet aircraft and all wide-bodied jets, such as DC9, DC8, L1011, B747 and DC-10. For simulator motion excursions CAE offers three, four or six-degrees-of-freedom motion systems. CAE has under development a 600 line closed loop colour TV Visual System, which is being incorporated in the DC-10 simulator being supplied to ANZ. This Visual System is available for attachment to the complete range of Flight Simulators. In addition CAE produces supervisory control systems for power-generating, gas and oil industries, such as pipeline, hydro and oil field control; transistorized telecommunications equipment and data terminals; weather satellite photo receivers; air cargo volume measuring devices; magnetic anomaly detection equipment for locating submarines and for geophysical exploration.

CAE Electronics Ltd. is Program Manager for the combined Canada-U.S. development of a Tactical Guidance System (TAGS). This program includes development of a helicopter research simulator and test facility.

1230	1285	4530	4931	5805	5810	5815
5820	5821	5825	5826	5835	5840	5841
5845	5895	5915	5985	5995	5999	6110
6130	6610	6615	6625	6655	6660	6665
6910	6920	6930	6940	7440		

and pages 50 , 51 , 55 , 56 and 140

Canada Cycle & Motor Co. Ltd.,
2015 Lawrence Avenue West,
Weston, Ontario.

Telephone: (416) 241-9121
Telex: 02-21336

Vice- Pres. and Gen. Manager: E. R. Amerie

Contact: F. L. Sainsbury, Mgr. of Research
& Development

Stamped and machined parts for small arms as well as for rockets, mortar and aero bombs. A wide range of sports products such as skates, hockey sticks, hockey gloves and helmets, pads and shin protectors. Bicycles and exercise machines round out the production of this quality producer of internationally known products.

1005	1095	1310	1315	1325	1330	1340
7810	7830					

Canada Wire and Cable Company Limited,
22 Commercial Road,
Toronto 352, Ontario.

Telephone: (416) 421-0440
Telex: 06-219556
Cable: CANWIRINTL

President: J. H. Stevens

Contact: D. Trillwood, Export Sales Manager

This company offers design, development and production facilities as well as consulting services for all forms of bare and insulated wires and cables for the electrical and electronics industry in low and high voltage types.

The Canadian Armed Forces as well as many of our allies use the special types evolved for ship-board use and including such specialties as sonar, degaussing, mine-sweeping cables as well as meeting oceanographic requirements. The land and air elements of the forces are also served from the some 15,000 varieties carried within this field by the company.

A wide line of hardware with such representative items as potheads, insulators, bus and bus duct systems, cable and wire systems are also produced.

1075	3439	5805	5845	5935	5970	5975
5985	6145	6150	9525			

and pages 51 and 250

Canadair Limited,
P.O. Box 6087,
Montreal 101, Quebec.

Telephone: (514) 744-1511
Cable: CANADAIR MONTREAL

President & General Manager: F. R. Kearns

Contact: G. E. McKusick, Vice-Pres., Marketing

Manufacturers of:

- Aircraft — Strike Reconnaissance Supersonic Jet Aircraft, Airborne Surveillance Drone Systems, Two-seater Jet Pilot Trainers, VSTOL Aircraft, Amphibian Fire Fighting Aircraft, Repair and overhaul of aircraft components, Test Equipment, Defence Systems Management.
- Canadair has the capability to design, develop, test and manufacture a complete range of aircraft, missiles, drones or other aerospace products, both military and commercial defence equipment.

1410 1420 1430 1440 1450 1510 1550
1560 1620 1680 1730 2310 3465 4820
4920 5410 6910 6920 6930 7610 9330
and pages 51 55 56 136 and 138

Canadian Acme Screw & Gear Limited,
207 Weston Road,
Toronto 9, Ontario.

Telephone: (416) 767-1131
Telex: 02-29137

General Manager: L. E. Hamilton

Contact: J. Fearn, Manager Contract Sales

The Transmission, Differential and Gear Divisions have been major parts suppliers to the North American automotive and heavy earth-moving equipment markets for nearly 50 years. During this same period, our Defence Forces have come to rely on Canadian Acme as a proven source for quality gearing in a wide range of sizes and materials. Gears include spur, miter, change, helical, bevel and worm types. Shafts are keyed, involute and straight spline. A prime source for the supply of M-151 "Mutt" military vehicle transmissions and differential assemblies. The company manufactures a wide range of products such as Mechanical and Hydrostatic Transmissions, Right Angle Drive Gearboxes, Screw Machine Products, Vehicle Shock Absorbers — generally in high volume to customer requirements.

2805 3010 3020

Canadian Admiral Corporation Limited,
501 Lakeshore Road E.,
Port Credit, Ontario.

Telephone: (416) 278-5561

President: S. D. Brownlee

Contact: R. F. Maskell, Manager,
Special Products Division

Canadian Admiral manufactures Radio & TV receivers and tuners and radio sub-assemblies, Radar Test Sets and aircraft R/T sets for military communication bands. Military test meters and assemblies are also manufactured. For the past 10 years nuclear instrumentation such as ionization chambers and complete radiac detection equipment using ion chambers and geiger tubes have been made in large quantities (35,000 to 50,000 quantities). A new line of nuclear instrumentation for health physics use around nuclear reactors and generating stations is now being produced. These instruments include monitoring equipment for alpha, beta and gamma radiation in both fixed and portable models and special contamination instrumentation for hand and foot monitoring and tritium-in-air and tritium-in-water monitoring.

5960 6665 and pages 51 349 400 and 402

Canadian Aircraft Products Ltd.,
261 Viscount Way,
Richmond, B.C.

Telephone: (604) 278-9821
Cable: CANAPRA

President and General Manager: D. C. Cameron

The company is engaged in the design, engineering and fabrication of aircraft components and other light gauge structures. The main product line is aircraft floats which are produced both for the general market and for specific sub-contracts. At the same time the company produces component parts for aircraft manufacturers and specialized marine hulls and frames for such as hydrofoils and submersibles. Light weight, portable docks and small metal pleasure craft are also produced. Buoys, ammunition boxes and other light gauge steel components are also produced to custom order. The design staff is qualified in many areas and specializes in aircraft structure design, test and certification.

1560 1630 1940 1945 8115 8140
and page 51

Canadian Arsenals Limited,
P.O. Box 717,
Ottawa, Ontario.

Telephone: (613) 992-6443

Contact: H. G. Budowski, Director of Operations

FILLING DIVISION

This Crown-owned facility is useful in the loading and assembly of:

- Artillery ammunition, bombs, rockets, anti-submarine projectiles, torpedo warheads, mines, grenades, signal underwater sound, special explosive devices, military pyrotechnics, fuzes, delays, tracers, primers and detonators.
- It also manufactures numerous types of initiatory and delay powders and special ordnance gauges and fixtures.

1305 1310 1315 1320 1325 1330 1336
1337 1340 1345 1350 1351 1356 1361
1370 1375 1376 1377 1390 5210 5220
and pages 51 and 474

SMALL ARMS DIVISION

Manufacturers of: Military Small Arms and Ancillaries; clips, links and magazines; ordnance gauges; high precision machining services; metrology laboratory; internal and external metal polishing, plating and surface finishing. Deep hole drilling, broaching and honing to ordnance standards.

1005 1240 1720 5210 5220 and page 475

Canadian Flight Equipment Co. Limited,
374 Sidney Street, Box 1500,
Trenton, Ontario.

Telephone: (613) 392-6584
Cable: CANFLIGHT

Contact: R. A. Borthwick, General Manager

Manufacturers of: Propellant actuated devices; rocket catapults; thrusters; initiators and other mechanical and electro-mechanical devices. Hydraulic mechanisms and components as well as metal components for shells, mortar bombs and rockets. Aircraft seats (crew and passenger); fabric covers and tie-down equipment for boats and aircraft; repair and overhaul of propellant actuated devices and aircraft seats.

1310 1315 1320 1325 1336 1340 1345
1350 1355 1360 1377 1390 1420 1650
1670 1680 2240 3465 and page 56

Canadian General Electric Company Limited,
(Aerospace Section)
830 Lansdowne Avenue,
Toronto 4, Ontario.

Telephone: (416) 534-6511
Cable: GELECTRON

Manager: G. F. Miller

Contact: J. O. Cann, Sales Manager

The basic activities of this section of the Company are largely based in the specialty electronic equipment, electronic equipment repair/overhaul and aircraft jet engine fields including industrial applications of jet engines for marine propulsion and natural gas pumping.

A complete line of air traffic control ground-to-air VHF communications equipment designed to the exacting standards of the Canadian Ministry of Transport can be readily adapted for defence application. Resulting from extensive applied research in the field of signal processing are a number of radar system improvement modifications such as pulse coding techniques, digital MTI and pulse compression to enhance target reception in non ideal environments.

The Company has repair and overhaul capability across a broad spectrum of electronic equipment including ground and airborne communications equipment, ground and airborne radar and fire control equipment, pollution monitoring instrumentation and specialized test equipment.

1210 1220 1230 1240 1265 5805 5820
5825 5840 5841 5845 5850 5855 5895
5985 5999 and pages 50 51 55 56 232
233 and 252

Canadian General Electric Co. Ltd.,
(Chemical and Metallurgical Section)
940 Lansdowne Avenue,
Toronto 4, Ontario

Telephone: (416) 534-6511

Contact: W. E. Noble, Manager

Manufacturers of alkyd resins and polyester resins, insulating varnishes and wire enamels. Plasticisers; cemented tungsten carbide; blanks, cutting tools, rock bit inserts, masonry drills, tool holders and inserts. Carbide draw dies and die sections.
Uranium oxide, reactor fuel pellets.

3455 3456 3460 5133 5136 5310 6135
8010 8030 and page 55 and 56

Canadian General Electric Co. Ltd.,
(Devices, Conduit and Lighting)
24 Ward Street,
Toronto 4, Ontario.

Telephone: (416) 534-6511

Contact: T. J. Carey, Manager

Manufacturers of conduit, rigid and E.M.T., steel aluminum and plastic. Floodlighting equipment. Lighting equipment, street and highway incandescent mercury and fluorescent. Traffic control equipment; wiring systems, underfloor and steel.

Heaters and heating devices for domestic, commercial and industrial application.

4410 4520 5975 6150 6210 6250 6310
6320 6330

Canadian General Electric Co. Ltd.,
(Distribution and Specialty Transformer Section)
940 Lansdowne Avenue,
Toronto 4, Ontario.

Telephone: (416) 534-6511

Contact: J. K. McLinden, Manager

Manufacturers of atmosphere generators, exothermic, endothermic and nitrogen; ballasts. Fluorescent and mercury lamps. Transformers, distribution, up to 500 kva. Boilers, steam, electric, capacities up to 3500 B.H.P.

Furnaces, industrial, electric, gas and oil, for metal treating and processing. Heaters, process and comfort, quartz tube and metal-sheathed infra-red.

5920 5950 6120 6250

Canadian General Electric Co. Ltd.,
(Lamp Department)
165 Dufferin Street,
Toronto 3, Ontario.

Telephone: (416) 537-4481

General Manager: R. Story

Contact: H. W. Johnson

Manufacturers of incandescent, fluorescent and mercury lamps. Sealed beam, flood, spot and automotive lamps. Photoflash and projection lamps. Infra-red, exciter, switchboard and miniature lamps.

6240 6750

Canadian General Electric Co. Ltd.,
(Industrial Apparatus Department)
107 Park Street North,
Peterborough, Ontario.

Telephone: (705) 742-7711

General Manager: S. R. Adamson

Contact: W. V. Lodge, International Sales

Manufacturers of motors, motor controls, generators and motor-generator sets. Switchgear, power circuit breakers, air circuit breakers, power rectifiers, power capacitors and relays. General-purpose control and process computers.

2210 5905 5925 5930 5940 5945 5950
5961 6105 6110 6115 6125 6130 6145
and page 51

Canadian General Electric Co. Ltd.,
(Meter and Instrument Section)
1130 Charest Blvd. W.,
Quebec 8, P.Q.

Telephone: (418) 683-3431

Manager: Guy Babineau

Contact: G. R. Carruthers, Sales Manager.

Manufacturers of watthour meters and panel meters together with switchboard instruments, carrier current controllers, single and multi-channel as well as range and radio timers. Permanent magnets for speakers, industrial applications, telephone and magnetic separation. Repair and overhaul facilities.

3020 5820 5950 5999 6625 and page 56

Canadian General Electric Co. Ltd.,
(Nuclear Products Department)
107 Park Street North,
Peterborough, Ontario.

Telephone: (705) 742-7711

Contact: R. C. Johnston, Manager

This department has been involved with nuclear generators from their inception and built our first complete plant at Rolphton and has since been involved with the Douglas Point, Pickering and Bruce projects all nuclear generators. They have also been responsible for the plant in Pakistan.

Their activities cover the following fields:

- Nuclear reactors and associated equipment
- Nuclear Fuels:
 - Power reactor fuels — research reactor fuels — heavy water — fuels manufacturing plants.
- Fuel Handling Systems for Nuclear Reactors:
 - Engineering and development — supply — production testing — installation and commissioning — service.
- Components for Nuclear Installations:
 - Zirconium components — fuel channel and assemblies — reactivity control drive mechanisms — reactor control and regulating systems — reactor structures — parts supply for reactor service — miscellaneous specialty equipment and instrumentation for nuclear applications.
- Development:
 - Fuel development — materials development — components and mechanisms development.

4470 and page 55

Canadian General Electric Co. Ltd.,

(Plastics Section)
755 Division Street North,
Coburg, Ontario.

Telephone: (416) 372-5411

Manager (Plastic): D. I. Ireland

Contact: K. R. Fowler

Manufacturers of semi-automatic and automatic moulding of thermoset plastics by compression and transfer. Fibreglass reinforced plastics by matched metal die, preform and premix, auto-clave moulding. Filament winding and electrical laminates. Semi-automatic and automatic injection moulding. Blow moulding, extruded shapes in thermoplastic and expanded polystyrene moulded shapes. Moulding of rigid and semi-rigid polyurethane shapes. Technical design facilities, research and development group with tool room and laboratory facilities.

1005	1305	1310	1315	1320	1325	1330
1340	1345	1350	1355	1390	1395	1560
2050	2240	2510	2540	3615	3990	4240
4310	4710	4730	5140	5340	5410	5430
5895	5975	5985	6105	6135	7125	8115
8130	8140	8415	8465	9330	and page 51.	

Canadian Industries Limited,

(Ammunition Division)
630 Dorchester Blvd. West,
Montreal 101, Quebec.

Telephone: (514) 874-3000

Telex: 05-25297

Cable: CANDUSTRY

Division Manager: J. R. Brisson

Telephone: (514) 874-5803

Sales Manager, Defence Products:

A. S. Donohoe

Telephone: (514) 874-3355

Canadian Industries Limited is today the largest manufacturer of chemicals and allied products in Canada, with 26 plant locations from coast to coast. Further, it has one of the largest industrial research and development establishments in Canada. The Company's explosives, industrial chemicals and fertilizer products serve the country's major resource industries —

- Mining, pulp and paper, and agriculture, while its ammunition, paints and plastics products serve the primary, secondary and consumer goods industries. In addition, many other products, ranging from water treatment chemicals to golf equipment, are available through subsidiary and associated companies.

De Salaberry Works

- The products of the De Salaberry Works include all types of explosives and propellants in support of Canada's defence forces. Among the propellants produced are those manufactured by the solvent process — single base, double base and triple base (nitroguanidine) propellants. Completely integrated nitric acid manufacturing, sulphuric acid recovery, nitrocellulose and nitroglycerine manufacturing solvent recovery facilities allow for the most economic production of these propellants. Facilities exist, also, for the production of propellant by the solventless process. Propellant grains for 2.75" rockets and 5" Sidewinder rockets are produced in these facilities.
- In addition to the propellants manufactured for military small arms, mortars and artillery ammunition, a full range of propellants for sporting ammunition is manufactured at the De Salaberry Works and used by all leading manufacturers of sporting ammunition in Canada, U.S.A. and Mexico.
- The De Salaberry Works produces all types of military high explosives. This plant contains the only commercial facilities in Canada and the U.S.A. for the manufacture of T.N.T. and RDX and thus has the capability of producing all military high explosives using these materials. These include Comp B, Comp A, Comp C4 and all other compositions used in shell filling, bomb loading and demolition charges. Another

unique capability of the De Salaberry Works is the manufacture of ammonium picrate used in the filling of H.E. shells for 5" Naval Guns.

Beloeil Works

- CIL produces all types of commercial explosives in plants located coast to coast across Canada. The principal of these commercial explosives plants is Beloeil which manufactures all types of dynamites, slurry explosives, black powder, T.N.T., P.E.T.N., and sodium azide. These commercial explosives facilities are available to supply defence products such as T.N.T. products, black powder and military dynamite. Sodium azide manufactured at Beloeil is used throughout North America in the production of lead azide.

Brownsburg Works

- The manufacture of sporting ammunition and explosive accessories is centred at this location. CIL manufactures the well-known "Imperial" and "Canuck" brands of sporting ammunition which are distributed throughout Canada and the U.S.A.
- This plant is totally integrated for the manufacture of primers and detonators having facilities for the production of lead styphnate, lead azide and all other chemicals used in the manufacture of these priming devices. Automatic machines for the manufacture of detonators allow the most economic manufacture of these devices.

Pyrotechnics

- CIL possesses an excellent capability for the manufacture and assembly of pyrotechnic devices. This capability is maintained at both De Salaberry and Brownsburg. At De Salaberry, experience has been gained in the manufacture of photoflash rounds, marine markers, grenades and ground burst simulators. The De Salaberry capability is available for the manufacture of devices similar to these already manufactured. At Brownsburg, underwater sounding devices, squibs, practice anti-personnel mines, railway fuses and road signalling flares, grenade fuses.

Research and Development Facilities

- The vast manufacturing capabilities of CIL are supported by one of the largest research and development establishments in Canada.
- Basic research in all of CIL activities is conducted at the Central Research Laboratory. At this establishment basic research in explosives and propellants is conducted on behalf of the defence products activity of CIL. CIL has developed a top reputation throughout Canada and the U.S.A. as a designer of propellants for new guns. CIL is a leader in the field of slurry explosives for commercial purposes and has put this background to the service of the defence products area in developing slurry explosives for military uses.
- The work of the Central Research Laboratory is supported within the CIL organization by development laboratories in all areas of CIL interest.

The explosives and propellants field is supported by the development laboratories at Beloeil, De Salaberry and Brownsburg.

1305 1310 1315 1320 1325 1336 1337
1340 1345 1351 1356 1361 1365 1370
1375 1376 1390 and pages 51 and 478

Canadian Ingersoll-Rand Company Limited,
620 Cathcart Street,
Montreal 111, Quebec.

Telephone: (514) 395-7321
Telex: 1-26157
Cable: Randrill

President: R. D. Wendeborn

Contact: R. A. Tait, Vice-Pres. Marketing

In the preparation of camp site, harbour facility or in runway and airfield construction, the drill, drill rigs, compressors and where required, demolition equipment of this firm will be found when reliability, cost and service are the users' criteria.

For the completed plant for such establishments as noted above high pressure pumps, large water supply pumps motor-pumps for liquid handling and large compressors for in-plants air are available as well as industrial power tools for maintenance or production.

In the pure industrial fields they have for over 10 years, pioneered in the pulp and paper fields with de-barkers, pulp screens and pulp washers together with material handling hoists.

The oil and gas industries are supplied with compressors while mining and tunneling operations will use drilling jumbos and large centrifugal compressors. Canadian Ingersoll-Rand have designed and produced construction and plant equipment for much of Canada's primary industry and their standards of quality, are maintained by assiduous attention to detail and the application of new technologies in their basic fields. An engineering and design staff is available to meet custom problems or requirements.

2825 3210 3615 3820 4310 4320 4330
4410 4420 5345

Canadian Marconi Company,
2442 Trenton Avenue,
Montreal 301, Quebec.

Telephone: (514) 343-3411
Telex: 05-267563
Cable: ARCON
President: L. M. Daley

Avionics Division
Contact: K. C. M. Glegg

Marine and Land Communications Division
Contact: N. E. Thomas

Special Services Division
Contact: R. MacLead

Telecommunications Division
Contact: Dr. V. W. Dodds

Avionics Division:

The primary activity of the Avionics Division is the manufacture of airborne electronics equipment. Current products include Doppler navigation sensors for fixed and rotary wing aircraft, navigation computers, moving map displays, radar altimeters, and indicators. Equipments being developed include automatic Omega, area navigation systems, and satellite navigation receivers. Secondary products include custom designed printed circuit boards, integrated circuits, coils, transformers, filters, and networks of many types. In addition to providing repair and overhaul facilities for all products and consulting service for electronics, the division offers a complete writing and layout facility for manuals dealing with operation, maintenance, and parts lists.

5826 5915 5950 5999 7610
and pages 51 56 202 216 218 and 230

Marine and Land Communications Division:

Among a wide variety of equipments produced by the Marine and Land Communications Division, the H/F Single Sideband Radio Telephone is one of the most popular on world markets. The H/F SSB is available in both portable and mobile form at several different power outputs. The division also provides VHF F/M and UHF F/M equipments in fixed, mobile, or portable form for land or marine use, complete with selective and tone calling units. Marine radar is offered in varying power outputs, ranges, and screen sizes.

5820 5840 5895

Special Services Division:

The Special Services Division specialize in installation of ground radar, communications, and microwave systems, including antennas and towers. Complete repair and overhaul services can be performed on all types of radar, communications, and navigation equipments, both ground and airborne, and on specialized anti-submarine warfare devices. In addition to the repair and calibration of military and commercial test equipment, the division offers the repair, rewinding, and testing of radar pulse transformers and reactors.

pages 50 and 56

Telecommunications Division:

The main product area of the division is military tactical microwave radio relay equipment and systems. This comprises the necessary transmitters, receivers, pulse code modulated (PCM) combiners and multiplex. A recent addition to the product line is a commercial PCM microwave communications system which combines multiplex with radio and provides from 24 to 120 channels. The division also offers consulting service for communications systems.

5820 and page 51

Canadian Safety Fuse Company Limited,
Brownsburg, Quebec.

Telephone: (514) 533-4251
Telex: 05-268668

President: E. L. Hamilton

Contact: J. C. Finlayson, Marketing Manager

This company offers a complete line of items in the field of detonating devices and includes such basics as detonating and ignitor cord and connectors as well as safety fuse and other related items. Consulting and design services are also maintained.

1330 1370 1375 and page 51

Canadian Velcro Ltd.,
Sales Division,
114 East Drive,
Bramalea, Ontario.

Telephone: (416) 625-7211

Contact: John B. Coles, Sales Manager

Canadian Velcro produce a hook and loop-type fastener, produced from woven nylon, polyester, nomex, stainless steel, nomex and stainless steel, beta glass/teflon and moulded materials. This fastening device is now widely used throughout the aircraft industry and is being employed by the Canadian Forces in clothing, tents, sleeping bags and other areas which once relied on the older type fasteners.

5325 and pages 51 and 489

Canadian Vickers Limited,
5000 Notre Dame St. E.,
Montreal 404, Quebec.

Telephone: (514) 256-2651
Cable: "VICKERS, MONTREAL"
Telex: 01-20287

President: E. Harrington

Contact: T. J. Farrell, Vice-Pres. — Sales.

Canadian Vickers has produced components for the nuclear powered submarines of both Great Britain and the United States and this production has included such items as: torpedo tubes, sonar domes, stabilizers, depth control tanks, escape hatches, sail weldments, hydraulic cylinders for accumulators and antenna masts.

For many years Vickers has been one of the foremost designers and manufacturers of hydro-electric gates and controls having supplied the mitre gates and operating mechanism for all the Canadian locks in the St. Lawrence Seaway, also the 48 control gates at the Iroquois Dam, Churchill Falls, Manicouagan and many other hydro power sites. They also manufacture hydraulic turbines in association with one of the world's leading designers, "NOHAB" of Sweden.

Years of experience in machining alloy steels and fabricating steel plates including HY-80 and HY-100 have since given the company a reputation as a proven source in a wide field of steel fabrication.

Of particular importance at Canadian Vickers is its furnished testing laboratory which contains a wide range of electrical and electronic testing equipment for non-destructive testing and is available as a service facility to other users.

Their production covers the following areas:

- Nuclear Equipment
Components have been built for reactors in the provinces of Quebec and Manitoba and for the Government of India. These encompass reactor supply and assembly, reactor components, fuelling machine carriages, spent fuel systems, pressure relief valves and main heat transfer piping systems.
- Heat Exchangers
A full range of heat exchangers for the chemical, refining, nuclear and allied industries with pressures up to 350 kg/cm² (5,000 in²).
- Metal Forming and Extrusion Presses
Metal forming and general purpose presses to 5,000 tons, also extrusion presses to 2,500 tons have been manufactured for Canadian and overseas companies.
- Wind Tunnels
In a consortium, wind tunnels have been designed and built for the Governments of Canada and India.
- Steam Condensers
Surface condensers of all sizes are manufactured with the large units being shipped to job site in sections and field erected by their own construction crews.
- Copper and Plate Work
Canadian Vickers has very active and up-to-date engineering and manufacturing facilities for the design, fabrication, erection and start-up of distillation, evaporation and food product plants in copper and/or stainless steel for Canada and abroad. The range of equipment manufactured in copper and stainless steel is as varied as a customer wishes and includes pot stills, stripping columns, rectification columns, condensers, dephlegmators, calandria's tanks, vessels, piping, fitting coils, etc. These equipments are in use in many parts of the world.
- Mining Equipment
Crushers, mills, kilns and driers.
- Pulp and Paper Equipment
Paper machines for board, specialty and non-woven papers. Pulp de-watering presses, pulp flash drying units, paper winding and rewinding equipment.

1045	1190	1340	1440	1450	1620	1630
1805	2020	2030	2040	2050	2090	2220
2240	2310	2510	2815	2820	2825	3615
3695	3820	3950	4320	4410	4420	4470
4520	4810	4920	5450	5895	6655	7125
8120	and pages 51		and 56			

Canadian Vickers Limited,
(Ship Repairs Division)
5000 Notre Dame St. E.,
Montreal 404, Quebec.

Telephone: (514) 256-2651
Cable: "VICKERS, MONTREAL"
Telex: 01-20287

Marine Controller: C. D. Atkins

Contact: W. Rhodes, Manager.

Three floating drydocks capable of 27,500 tons capacity and ships 228 m (750 ft.) long; 927 m (1400 ft.) of outfit wharfs with a 275 tons floating crane available. Ship repairing facilities for all major and minor repairs to hulls, main propulsion and auxiliary machinery as well as all deck machinery, boilers and accommodation. Conversions and refit on all types of naval and commercial vessels backed by design and drawing office services. Quick turnaround and facilities open year round. Estimates are provided on request and annual and quadrennial surveys are carried out. St. Lawrence Seaway Fittings are available for rental or purchase.

1905 1910 1915 1920 1925 1930 1935
1940 1955 and page 56 .

Canron Limited,
(Eastern Structural Division)
100 Disco Road,
Rexdale, Ontario.

Telephone: (416) 677-2700
Telex: 02-29942

Group Vice-Pres.: W. S. Cullens

Contact: S. S. Wilkinson, Chief Purchasing Agent

The Structural Division of Canron are metal fabricators whose product lines include the following items; non-propelled barges, all types building frames, permanent and portable railway and highway bridges, galvanized or painted towers — guyed or self-supporting, transmission, microwave, radio, T.V. scatter, radar, aero-space communication, and missile tracking. Switching structures and related equipment are available together with a wide range of storage tanks, and rigid or collapsible cargo containers are also produced. Bridge and gantry cranes, gates and stop logs further illustrate the diversity of this facility.

1930 1935 3950 3990 5410 5420 5430
5445 5450 5985 8140 and page 50

Canron Limited,
(Electrical Division)
160 St. Joseph Boulevard,
Lachine 640,
Montreal, Quebec.

Telephone: (514) 637-5531
Telex: 01-2715
Cable: CANRON MTL

General Manager: K. C. Hague

Contact: T. E. Duffield, Assistant General Manager

Manufacturer of AC and DC rotating equipment ranging from fractional horsepower motors to large induction and synchronous machines. While the standard line is offered to satisfy commercial and normal defense needs, the company has a design capability for the supply of special rotating equipment such as 400 cycle generators, no-break generating sets, all types of horizontal and vertical induction motors, and all major types of variable speed drive systems up to 2500 HP. Motor and control propulsion systems are also available for the transportation industry. The company has a manufacturing capability for the supply of either special items, or long runs of high volume items.

6105 6110 6115 and page 51

Clark Equipment of Canada, Ltd.,
Michigan Boulevard,
St. Thomas, Ontario.

Telephone: (519) 631-9420
Telex: 024-73550
Cable: CLARCAN

Vice-President and General Manager: J. A. Meyer

Contact: F. E. Cathers, Sales

The basic construction problems of most military establishments are invariably ones of logistics in moving natural materials in or off the site to produce pre-stated grade requirements or to remove forest over-burden. For this field Clark Equipment of Canada Ltd. manufacture construction and material handling equipment including tractor shovels, dozers, loggers and log skidders to satisfy these needs. Nine models of rubber tired tractor shovels are available, ranging in standard bucket sizes from .96 m³ to 9 m³ (1 ¼ yd.³ to 12 yd.³). Special purpose attachments and buckets are also available for

each model tractor shovel, allowing it to be adapted to specific applications. Three models of rubber tired tractor dozers are available ranging in sizes from 170 h.p. with a standard blade width of 795 cm (26'1") to 500 h.p. with a standard blade width of 859 cm (28'2"). Various attachments are also available for tractor dozers to meet specific applications. Nine models of log loaders are available with a load capacity ranging from 1680 kg. (3700 lbs.) to 31,752 kg. (70,000 lbs.). Three models of log skidders are currently available, the smallest weighing 6900 kg. (15,200 lbs.) and having a winch line pull of 11,760 kg. (25,900 lbs.). The largest skidder currently produced weighs 10,864 kg. (23,930 lbs.) and has a winch line pull of 28,140 kg. (42,500 lbs.). Tractor shovels, dozers, and loggers are marketed by Clark Equipment under the MICHIGAN trade name. Skidders are marketed under the RANGER trade name.

3210 3695 3805 3825

Coldstream Products of Canada Ltd.,

(Aircraft & Marine Division)

1855 Sargent Avenue,

Winnipeg 21, Manitoba.

Telephone: (204) 775-8274

Telex: 07-57152

Contact: C. M. Fleming, President

This company is currently in production on galley refrigerators for the Lockheed LN 1011, TriStar which will indicate the degree of acceptance which this firm enjoys in the field of aviation. The company also designs and manufactures a line of walk-in refrigerators ranging from 510 litres (18 ft.³) to 1,755 litres (62 ft.³) which have been used extensively in the marine services. Cold rooms and walk-in refrigerators have been produced for both shore and marine use. Foamed in place polyurethane, utilizing interlocking tongue and groove construction, is used throughout the stainless steel or aluminum bodies.

1680 4110 4130

Collins Radio Company of Canada Ltd.,

150 Bartley Drive,
Toronto 16, Ontario.

Telephone: (416) 757-1101

Cable: COLINRAD TORONTO

Vice-Pres.: S. F. Jackson

Contact: G. J. Bury, Director of Marketing

Collins Canada is a communications equipment and system oriented organization. Whether it is a single station or a far flung network the Company is equipped to design, manufacture, install, test and support communications systems in any environment. The total capability encompasses microwave, data, HF single sideband and scatter ground communications systems. Airborne communications from HF through UHF as well as navigation receivers have been supplied by them.

- Research and development facilities include the latest advances in modern laboratory test equipment. Advanced equipment will be found in the laboratories devoted to the development of thin film hybrid circuits. The environmental facility is fully equipped to test equipment to AGREE III standards thereby assuring only the highest quality equipment is produced.
- Current items in production include the AN/PRC-66 UHF Transceiver. It is a miniature 3500 channel transceiver operating in the 225 - 400 MHz band. The 32MS-1C and 32RS-1D HF single sideband transceivers are manufactured for fixed station and mobile applications. They are also manufacturing MX-106 multiplex equipment and microwave systems for installation in Canada and also export.

5805 5820 5821 5826 5831 5895 5915
5985 and pages 50 51 55 183 and 226

Computing Devices of Canada Limited,
P.O. Box 8508,
Ottawa, Ontario. K1G-3M9

Telephone: (613) 829-1800
Telex: 013-439
Cable: COMDEVCAN OTT

President: E. B. Daubney

Contact: R. Montgomery, Vice-President Mktg.

Computing Devices of Canada manufactures the Position and Homing Indicator (PHI) a short range navigation device and the standard pilot navigation display for twelve NATO air forces. Successor to the PHI is the Projected Map System (PMS) which has been developed for use with both simple and complex avionics systems. Two variants of the PMS are the Area Navigation System, a fully automated pictorial display of aircraft routes, and the automatic Chart System, a dynamic display of aircraft position as calculated by an Area Navigation Computer.

Other Avionics systems are an Integrated Display of Situation, the Synchronous Astro Compass Controller, the Spherical Data Unit, the Tactical Display System, ANTAC, and a Camera Control System for photo reconnaissance. The Company is supplying programmable power supplies to the U.S. Navy Versatile Avionics Shop Test (VAST) Program, and complete test equipment in support of the A7D and A7E Programs.

Fire Control systems including sonar equipment together with the back-up computer and combat display units are produced and training aids or simulators may accompany these as well as for the majority of this CDC systems.

Computing Devices designs, develops and verifies large-scale data processing systems with emphasis on computerized signal detection and pattern recognition techniques.

New product areas for the company are data Communications and pollution monitoring.

Specific data communication equipments now available are:

- the Message Header Formatter (MHF-101) for AUTODIN error free message preparation,
- the Signal Distortion Analyzer (SDS-101),
- the Date Time Clock (DTC-100),
- the Date Time Formatter (DTF-101),
- the Test Message Generator (TMG-100),
- the portable Test Message Generator (TMG-300)

and the Cadet-101 for error free Stores Message Preparation.

Other products are an infra-red sensing unit designed to assist in forest fire fighting, and the PHI-tran system for fully automatic acquisition of weather or other data from unmanned remote locations. The Company also designs and manufactures customized test equipment for testing

of components, sub-assemblies, box wiring, units and systems. Computing logic circuits, potted circuits, symbol generating circuits and networks are custom produced.

Other services available are: aerophysics research; pollution monitoring; data reduction, processing and analysis; hydrographic and oceanographic surveys; marine survey consultants and ship automation and instrumentation as well as by repair and overhaul and environmental test facilities; engineering field services; technical and operational training; systems design, development and management; technical operating and maintenance manuals.

1210	1420	5820	5850	5995	6605	6910
1220	1430	5821	5855	5999	6610	6930
1230	1440	5825	5860	6110	6625	6940
1287	1450	5826	5895	6310	6655	7440
1290	5805	5835	5915	6320	6665	7610
1410	5815	5845	5985	6350	6710	
and pages 50		51	55	56	180	181 182 238
240		241	290	and 442		

Consumers Glove Company Limited,
3925 Rachel Street East,
Montreal 406, Quebec.

Telephone: (514) 254-5331

President: Charles S. Davis

Contact: A. Dubé

Consumers Glove, throughout World War II and to the present, have been a major supplier of handwear to our Forces. Their production includes such items as the Temperate Gloves (shell and liner) and the Cold Weather Mitten Shells and Inserts. The Anti-Contact Glove to facilitate the handling of metals in frigid weather is also produced. Plastic and thermal insoles, part of the Canadian Forces' cold weather footwear system, are manufactured here.

A wide variety of leather gloves for industrial uses made from leather or asbestos, including welder's gloves, are also produced.

4240	8415	8430	8435	8440	8445
and pages 346 and 348					

C-Tech Ltd.,
P.O. Box 145,
Cornwall, Ontario.

Telephone: (613) 933-7970

President: H. M. Johnson

Contact: R. R. Walker

This company designs and produces anti-submarine warfare systems; solid state electronic transducer scanners; verifying digitizers and digital depth sounders; survey sounders; sonar transducers; omni-directional scanning sonar for fishing, hydrographic surveys and navigation. A fully instrumented underwater acoustic test site is also available and is used exclusively for testing of all electronic and electro-acoustic components and apparatus. The company maintains a repair facility for sonar transducers and associated equipments.

5825 5845 6625 and pages 51 and 293

Cummins Ontario Limited,
P.O. Box 40 Station "U",
Toronto 18, Ontario.

Telephone: (416) 239-8181

President: H. D. Lockhart

Contact: W. R. McNeill, General Sales Manager

Manufacturers of: Diesel generating sets; diesel powered pumping units; marine auxiliaries; diesel marine propulsion units; local and/or remote controls for above equipment for manual, semi-automatic or fully automatic operation of single or multiple units for all types of site conditions.

2805 2815 6115

Dahmer Steel Limited,
68 Shirley Avenue,
Kitchener, Ontario.

Telephone: (519) 744-2291
Telex: 0295-784

President and General Manager: Roy Dahmer

Contact: B. L. Hennessy,
Manager of Operations Control

Dahmer designs and manufactures a family of self propelled hydraulic cranes, including 360° rotating boom types, all of which offer efficient approaches to material handling in many areas and has been particularly tested and proven in port and dock areas.

Plate and structural steel designers and fabricators of products for diversified applications to stringent codes and specifications to meet exacting performance standards such as heavy duty weldments, pressure vessels, stainless steel, and high temperature alloys.

2050 3650 3695 3930 3950 5430 5445
5450 and pages 320 and 464

Davie Shipbuilding Limited,
P.O. Box 130,
Lauzon, Lévis, Quebec.

Telephone: (418) 837-5841
Telex: 011-254
Cable: DAVIE SHIP

General Manager: T. Velliotis

Contact: P. J. Gwyn

Marine Division:

The division's activities are ship building, heavy steel fabrications and machining where ships of up to 80,000 tons dead weight have been built. It has built and repaired ships of all kinds such as combat ships and landing vessels; transport, passenger, troop, cargo, tanker, and fishing vessels; special service vessels such as tenders and tugs; barges and lighters, cargo and special purpose; small crafts, pontoons and floating docks, drydocks and dredges, ice breakers.

1905 1910 1915 1920 1925 1930 1935
1940 1945 1950 1955

General Engineering Division:

The Division is responsible for Industrial Engineering projects and military sub-contract work. It manufactures custom designed steel fabrications for the varied needs of heavy industry. Its products include:

Ship and marine equipment; ship and propulsion components, booms and masts, marine hardware, hull items and steel buoys.

Tank cars and hopper cars for the railroad industry.

Under industrial machinery, the Division is experienced in the manufacture of presses, pulp and paper machinery, kilns, dryers, autoclaves, pressure vessels of all kinds, kettles, etc.

The design and production of materials handling equipment such as winches, hoist wire and rope, cranes bridges, gantry overhead and travelling, capstans and windlasses.

The Division also fabricates boilers for industrial purposes, heat exchangers and steam condensers, steam jet, kilns, etc.

The fabrication of equipment for nuclear reactors and nuclear plant components.

The manufacture of large diameter pipes and pipelines.

The design and fabrication of metal tanks for various purposes such as storage tanks; tower structures; penstocks, gates, towers fractioning; wind tunnel.

Commercial and industrial gas cylinders.

Davie Shipbuilding Limited, with some 1220 metres (4000 ft.) of wharfs, is located on the St. Lawrence River, across from Quebec City, permitting year round ocean-going shipping.

2010 2020 2030 2040 2050 2220 3442
3615 3695 3895 3950 4410 4420 4430
4470 4710 5430 5445 5450 8120
and pages 51 53 55 56 and 258

John Deere Limited,
Box 2025, Main Post Office,
Hamilton, Ontario.

Telephone: (416) 525-9200
Telex: 021-672

President: J. H. Graflund

Contact: E. G. Reed, Mgr. Government Sales

John Deere's manufacturing facilities in Canada are backed up by a world-wide service organization which is available to most parts of the world. This network insures a ready service and technological back-up for any operation, whether purely military, in the construction and maintenance of a camp area, highway network or in the forestry and agricultural fields.

Front-end loaders with HP ratings of 104 to 141 (SAE) and Buckets from 1.14 to 3.44 m³ (1.5 to 4.5 yds.³) and skidders with HP ratings of 75.5 to 104 (SAE) with winching capabilities from 7847 to 9979 kg (17,300 to 22,000 lbs.) will provide economic advantages to site clearances as well as their more obvious uses in the logging and pulp industries.

Log loaders are another production item which, like the skidder, can add savings to site clearances by the economical and selective handling of timber. The 3805 and 3807 models will reach out 6.09 m (20 ft.) with their "knuckle" booms, handle logs from 15.24 to 101 cm (6 to 40 in.); rotate through 270° and load to a height nearly 8.8 m (29 ft.).

2320 3695 3805 3895

The de Havilland Aircraft of Canada Limited,
Downsview, Ontario.

Telephone: (416) 633-7310
Telex: 06-22128
Cable: MOTH TORONTO

President: B. B. Bundesman

Contact: D. L. Buchanan, Vice-Pres. Sales

De Havilland Aircraft of Canada Limited is one of the world leaders in the manufacture of STOL (short takeoff and landing) aircraft for commercial and military use.

Currently in production at the Downsview plant are the 41 passenger Buffalo, the 30 passenger Caribou and the very successful DHC-6, 20 passenger Twin Otter.

Since 1947, the Company has concentrated on the design and manufacture of rugged utility aircraft for use in outlying areas on wheels, skis and floats.

The larger twin-engined Caribou and Buffalo have found wide acceptance in the military services for bulk handling and special transport exercises including cargo delivery.

Spare parts supply for all DHC models is managed through world wide product support outlets. Service equipment and associated aids for field support are also available.

In the field of new design, de Havilland is the prime contractor in the construction of the Canadian Armed Forces hydrofoil *HMCS Bras D'or*, FHE 400 — presently in advanced rough water speed trials. De Havilland is also joined with the Boeing Company and Rolls Royce Canada in a joint U.S./Canadian Government test program on the revolutionary Augmentor — Wing concept. A NASA owned DHC-5 Buffalo is presently being prepared for the project. De Havilland Canada with Rolls as major sub-contractor is responsible for the design and manufacture of the complete nacelle package and will take part in the eventual flight test program.

A major design study underway at de Havilland, which involves the future concept of inter-city STOL is the DHC-7 "quiet STOL airliner". The 48 passenger 4 engine turboprop is planned around the latest version of the Canadian Pratt & Whitney PT6A-50 'low noise' engine.

During 1970, de Havilland introduced a new programme of sub-contract engineering offering a wide range of special aeronautical services. Included among these new facilities are structural and environmental test, experimental flight test, materials laboratory, aerial photography, engineering development, value assurance, program management services, technical publications, instrumentation metrology, general aviation repair and overhaul, custom interior and aircraft painting.

1510 1560 1620 1670 1730 4920 6615
and pages 51 56 130 132 134 and 262

Delro Industries,
(Division of G.N.C. Industries Ltd.)
1072 King Edward Street,
Winnipeg 21, Manitoba.

Telephone: (204) 775-7081
Telex: 03-5388
Cable: DELRO

R. J. Wright, General Manager

Contact: R. J. George Jr., Sales

This company manufactures down-hole equipment for diamond drilling exploration work. Products include a complete line of diamond drill bits including both coring and non-coring types, ranging in size from XRT to H. Complementary drill rod, casing, and core barrels are also produced and sold. On the industrial side Delro produces thin wall diamond set masonry bits, segmented diamond saws in various sizes and specifications, and diamond tool dressers. The firm is also active in custom machining on a production basis in the light to medium area. Equipment includes automated lathes with tracing capability.

3820 5180

Deutz Diesel (Canada) Ltd.,
90 Montee de Liesse,
Montreal 376, Quebec.

Telephone: (514) 341-6540
Telex: 01-20709
Cable: AIRDIESEL

Contact: W. Loevinsohn, Vice-President &
General Manager

The company manufactures complete diesel and gas turbine-powered electricity generating systems for all defence applications. This includes fixed, portable, mobile and air-transportable diesel and gas turbine generating sets for both prime power and standby applications. A specialty is the design of unattended electric generating systems.

The company designs and manufactures its own automatic controls and complete switchboards to CSA specifications. In addition, the activities of the company include the provision of fixed, portable and mobile gas turbine fire and salvage pumping units, for service afloat and ashore.

2805 2815 2835 2895 4210 4310
4320 6115 and page 453

Dominion Aluminum Fabricating Limited,
136 The East Mall,
Toronto 18, Ontario.

Telephone: (416) 239-4855
Telex: 02-29029

President & General Manager: Murray R. Maynard

Contact: Charles F. Wood, Chief Engineer

Dominion Aluminum Fabricating Limited serves the defence and industrial fields with a wide range of aluminum fabrications, weldments and components for which they maintain engineering and design services to meet custom requirements. Repair and overhaul facilities further ensure product reliability.

The telescopic aluminum hangar designed and produced by Dominion Aluminum and now in international use has a complimentary device, the Helicopter Hauldown and Rapid Securing System, which provides for the landing, manoeuvre, shelter and maintenance of helicopters on ships.

Other items include assault bridges, walkways, pipe trusses and towers. Portable buildings and shelters find both defence and industrial uses while expansion joints, light standards and railings further define the diversification of the firm's production.

1710 5410 5670 6210 8110 8115 8140
and pages 51 278 and 279

Dominion Helicopters Limited,
R.R. No. 1,
P.O. Box 340,
King City, Ontario.

Telephone: (416) 925-6375
or 832-2214

Contact: J. M. Fleming, President

Dominion Helicopters have contributed greatly to the airworthy capabilities of helicopters through their development and production of cabin heaters, pre-heaters and cold weather cowlings. They have also produced ground handling equipment, cargo racks and skis for these craft. Complete overhaul facilities for light helicopters are maintained.

1660 1670 1680 and page 51

The Dominion Road Machinery Company Limited,
Maitland Road,
Goderich, Ontario.

Telephone: (519) 524-7374
Telex: 029-5520
Cable: DRMCO

Vice-Pres. & Gen. Mgr.: E. C. Hill

Contact: J. T. Morris, Sales Manager

This Company is the Designer and manufacturer of a line of diesel motor graders (100 to 200 H.P.) and attachments for road building, road maintenance and snow removal. These equipments are sold on a world-wide basis and a chain of facilities ensure that service is readily available.

The Company also designs and manufactures mechanical power train components (mechanical transmissions, hydra-planetary transmissions) and low pressure hydraulic components (series-type hydraulic valves, double-acting hydraulic cylinders) suitable for application in custom-designed heavy and off-highway vehicles.

3010 3805 3825 4820

Dorothea Knitting Mills Ltd.,
20 Research Road,
Toronto 17, Ontario.

Telephone: (416) 421-3773
Telex: DOROTHEA

General Manager and President: B. Borsook

Contact: L. Borsook, Chairman

This company has produced custom knitwear items not only for the Department of National Defence and to their rigid specifications but has also produced for various other countries a wide range of wear. Some of these items include military style berets, glengarries, balmorals as well as scarves, woolen winter helmets and toques for wear under protective headgear. Service quality sweaters have also been produced for men and women.

8405 8410 and page 335

Dowty Equipment of Canada Limited,
574 Monarch Avenue,
Ajax, Ontario.

Telephone: Ajax (416) 942-3100
Toronto (416) 929-3115
Telex: 06-981295
Cable: DOWTYS

Director & General Manager: G. M. F. Donnelly

Contact: H. A. Reid, General Sales Manager

Dowty Equipment of Canada Limited is divided into an Aircraft Division, which is primarily involved with the design and manufacture of aircraft landing gear and hydraulic systems components and a Hydraulic Systems Division, which has many years experience in the application of hydraulics to the construction, machine tool, paper-making, logging, marine and military equipment fields.

Aircraft Division

The Aircraft Division designs, develops, tests and manufactures hydraulic components for guided missiles; aircraft landing gear systems and components; aircraft wheel and brake systems and associated brakes, brake cylinders, fittings, hydraulic systems, retractable struts, hydraulic valves and wheels; aircraft hydraulic systems and associated actuators, pumps and valves and de-icing system components; linear electro-mechanical actuators and winches for aircraft; hydraulic jacks for aircraft ground servicing equipment; fuel pumps for aircraft engines and miscellaneous aircraft engine hydraulic accumulators, hydraulic pumps and hydraulic valves.

In addition to the designs pictured in the Illustrated Section, experience of the Aircraft Division has included the design, qualification and production of the dual-wheeled main landing gear for the Kaman Model H-2 helicopter; the two-position nose landing gear for the Canadair CF/NF-5 versions of the Northrop F-5 jet fighter; the main landing gear for the Canadian Forces CL-41A jet trainer and manufacture of the nose landing gear for the Lockheed F-104G fighter. Recent projects are the design, development, qualification and production of liquid centering springs for tail arrester hooks in U.S. Navy A-7 and S-3A aircraft.

The precision and general machining capability of the Aircraft Division is demonstrated in the manufacture of close tolerance aircraft landing gear and hydraulic components, end fitting journal rings for the Bruce Generating Station of Atomic Energy of Canada, components for the U.S. Navy's Lance Missile and miscellaneous plastic moulds.

Hydraulic Systems Division

The Hydraulic Systems Division designs, develops, tests and supplies specialized hydraulic systems and components including hydro-jet propulsion devices for ships and miscellaneous engines including non-aircraft gas turbines and jet engines; winches for ship decks; hydraulic motors and transmissions for vehicular power; actuators, hydraulic power transmission equipment for torque converters and speed changers; hydraulic pit props for the mining industry; capstans, overhead travelling cranes and winches (including hydraulic); hydraulic motors and pumps, power-driven rotary pumps, variable delivery pumps and hydraulic rams; electro-hydraulic and hydraulic powered valves; check, disc, globe, hydraulic and pressure regulating valves; hydraulic hand pumps; and rubber seals.

- Test facilities include drop test rigs for aircraft landing gear; comprehensive strength testing machines; environmental test facilities covering a temperature range of -73°C to 149°C (-100°F to $+300^{\circ}\text{F}$); vibration and metallurgical equipment. Repair and overhaul services are provided for a wide range of landing gear, hydraulic and brake equipment manufactured by Dowty and other companies.

1420	1620	1630	1650	1680	1730	2010
2030	2520	2835	2895	2915	2995	3010
3695	3950	4320	4810	5120	5330	

and pages 51 56 150 and 151

Eaton, Yale Ltd.,
(Industrial Truck Division)
10 Vulcan Street,
Rexdale, Ontario.

Telephone: (416) 241-5221
Telex: 06-22543

F. B. Dickie, Zone Manager

Contact: W. S. Leyland, District Manager Sales

This company produces industrial fork lift trucks for use in warehousing, stevedoring, vehicle loading or air cargo handling. They may be powered by gasoline, diesel, liquid propane or electric motors and have solid or pneumatic tires. The series cover lifting capacities from 453 kg (1,000 lb.) to 90,720 kg (200,000 lb.).

3930

Edwards of Canada,
Owen Sound, Ontario.

Telephone: (519) 376-2430

President: R. A. Yates

Contact: D. B. Campbell, Manager,
Marketing Services

For over half a century Edwards has designed and produced fire alarm, smoke detection and annunciator systems to meet Canadian requirements. Edwards fire alarm systems, for example, protect many of Canada's International Air Terminals, including those in Toronto, Vancouver, Winnipeg and Montreal. In addition, Edwards engineering designs have satisfied user requirements throughout the world.

Edwards have recently announced their new "Custom 6500" Fire Alarm System. In this new system all major functions are contained in separate modules, which are combined according to individual job requirements. This building block principle enables project designers to specify fire alarm systems to meet specific individual requirements, at no extra cost.

Further economies will result as the modular design makes it easier to expand a system as buildings are enlarged or usage changes. As well, all panels are designed to be suitable for installation in entrance lobbies of new buildings or similar places where decor is important.

Signalling Control Centres are available from Edwards, engineered to provide operational control of a number of systems installed throughout individual buildings or large multi-building projects such as hangar areas, barracks, stores, campus-type projects or penal institutions.

Control centres can be designed to provide central monitoring and control of Fire Alarm, watchman's tour, door alarm and clock and program systems. Such systems can also provide control facilities for many additional ancillary functions, including elevator alarms, annunciator circuits protecting auxiliary generators, perimeter lighting systems and door latch control. As well, closed circuit TV may also be integrated in the control console system.

General Signalling Equipment required to complete most types of alarm or calling signal systems is available and the range of signals are designed for AC or DC operation over the voltage ranges from 3V to 250V and for 50 or 60 hz operation. Where required, tropicalization of components can also be provided. Included in the Edwards line are signalling bells, both single-stroke and vibrating, with gong sizes ranging from 7.62 to 25.4 cm (3 in. to 10 in.). Adjustable signal horns are provided for flush, surface, projector style and weatherproof mounting. Sirens are manufactured for paging, warning and alarm systems and include a new design that can be easily adjusted to provide a distinctive horn sound. Actuating push-buttons for low or high voltage operation are available, as are adjustable buzzers for low voltage inter-office communication systems. The up-dating or new construction of military and civil hospitals or convalescent facilities should always take into account the technologies in all fields of research and here in the nurse call systems it will be found that Edwards have made significant advances where their Audio-Visual system provides instant communication between nurse and patient, without dialing or press-to-talk operation. The nurse controls all ward communications; she can choose which call to answer first; reply from a remote station; monitor bedside stations and communicate with other staff locations.

Also available from Edwards are Visual Nurse Call Systems which are an effective means of providing economical patient-nurse communication. With these systems there is no voice communication between the nurse and patient. Patients request assistance by simply pressing a calling-cord button or pulling the cord on their bedside calling station. Two visual calling systems are available.

6320 6350

Electrovert Manufacturing Co. Ltd.,
3285 Cavendish Blvd.,
Montreal 261, Quebec.

Telephone: (514) 488-2521
Telex: 05-267561
Cable: RECTIFIER

President: N. J. Fodor

Contact: C. Johnson, Export Manager

Electrovert has pioneered many of the accepted soldering techniques and kindred equipment now in use in the electronics industry. The company manufactures equipment for use in many phases of printed circuit board production, including the re-flow-melting and fusing of electroplate, the assembly and inspection of P.C. boards, fluxing, pre-heating, automated soldering and post-cleaning.

Electrovert has agents located throughout the world and maintains service offices and demonstration facilities in London, England and Hong Kong, as well as in North America.

3439 and page 467

Electrovert Ltd.,
3285 Cavendish Blvd.,
Montreal 261, Quebec.

Telephone: (514) 488-2521
Telex: 05-267561
Cable: RECTIFIER

President: N. J. Fodor

Contact: E. Pallavicini, Vice-President

Manufacturers of "Cantrough" cable tray — a system of metal trays and fittings used for power, control and communications cables. Cable-carrying systems are in great demand in the chemical and pulp and paper industries, utilities and wherever cable supports are required. Electrovert's "Cantruss" framing and support system is used in conjunction with Cantrough as well as for raceways, ceiling supports, general lighting fixture supports, tunnel installations and storage racks. Electrovert also manufactures P-Type clamps for pipe and cable supports. Electrovert produces a wide variety of wire and cable-marking, harnessing and electrical accessory products, including ELECTRO-TY®, cable ties, adjustable P-Clips, ELECTRO-DUCT®, Spiroband and permanent Z-Type wire and cable markers.

5680 5975 5995 5999 6150

Electro-Vox Industries Inc.,
2626 Bates Road,
Montreal 251, Quebec.

Telephone: (514) 739-1981
Cable: ELEVOX

President: P. E. Chaput

Contact: Richard Lavoie, General Manager

This firm produces audio communication equipment including intercom sets and public address systems. A variety of loudspeakers, horns and electronic megaphones are also available together with audio, power supply and DC amplifiers.

5805 5815 5820 5830 5835 5895

FAG Bearings Limited,
P.O. Box 280,
Stratford, Ontario.

Telephone: (519) 271-3230
Telex: 029-5518
Cable: CANFAG

Managing Director: Otto Weth

Contact: Robert E. Leeming,
Manager of Marketing

A manufacturer of precision instrument bearings for electronic and aerospace applications. These bearings, both to inch and metric dimensions, are manufactured in conformity with AFBMA precision standards and meet MIL-B-23063 specifications. Extensive gauge room facilities are provided to measure accuracies as fine as 1 millionth of an inch. Assembly and testing of all precision instrument bearings is conducted only with scrupulous "clean room" techniques.

In addition, FAG manufactures a wide range of automotive bearings, for alternators, transmissions, rear wheels and water pumps.

Also included in the production program are a wide variety and size range of precision ball bearings in open shielded and sealed designs for most industrial purposes.

3110 3130

Flag Fire Equipment Ltd.,
1680 Kildare Road,
Windsor 20, Ontario.

Telephone: (519) 252-5725

General Sales Manager: George Sava

The wide range of hand portable fire extinguishers produced by Flag have found wide acceptance and use in all three services and in both seaborne and airborne roles.

Their models include soda acid, foam, dry chemical, carbon dioxide, water pump, cartridge and water pressure types. In capacity they range from 11.4 to 22.8 lit. (2½ to 5 gals.) in the water types and to 11.3 to 13.6 kg (2.5 to 30 lbs.) in the chemical types.

4210

Fleet Manufacturing Limited,
P.O. Box 300,
Gilmour Rd.,
Fort Erie, Ontario.

Telephone: (416) 871-2100
Telex: 021-5165
TWX: 610-373-0101

President: R. K. Fraser

Contact: A. Cook, Marketing Manager.

Fleet Manufacturing has always been involved with aircraft work — from the design and building of small aircraft to manufacturing major components, both military and commercial, for the principal aircraft firms in Canada and the United States. As a multi-shop plant engaged in custom work, our diversity of skill has been applied to products other than aircraft. The company is a significant producer of radar antennae hardware systems, sonar equipment, sonar heat exchanger cabinets, electronic cabinets, and microwave units for the telephone utilities. They have also been working with close tolerance bonded honeycomb structures and have been major suppliers to some of the American aircraft companies where this type of structure is used in doors, flaps, etc. Fleet's design engineering skill and manufacturing capabilities are further demonstrated in the production of variable depth sonar mechanical systems for both conventional and hydrofoil ships.

A company meeting the advanced requirements of high quality precision work at minimum tolerances, using the latest materials and processes, and backed by a quality assurance programme meeting the requirements of both Canadian Government and United States Military specifications.

1045	1350	1420	1440	1560	1630	1670
1680	1730	1740	2030	3465	3950	5410
5820	5825	5826	5830	5831	5840	5841
5845	5895	5975	5985	6655	6910	9330

and pages 51 and 271

Flextrac Nodwell Ltd.,
P.O. Box 5544, Station A, 9
1201 42nd Avenue S.E., 24
Calgary, Alberta.

Telephone: (403) 287-2280
Telex: 038-21566

Vice-Pres. and General Manager: W. L. Gibson
Contact, Vice-Pres. Sales: G. C. Agassiz

Flextrac Nodwell enjoy a degree of leadership in the tracked vehicle field which is acknowledged by many Northern users. The following services and products develop the reputation for this position in the field.

- **Engineering Capability**
The Engineering Division is a flexible organization permitting ready adaptation of the various functions to meet the requirements of a particular customer. It is capable of furnishing all services and material required to successfully perform the design, testing and production engineering needed for any given program. The Division is set up by departmental functions according to the different specialized fields of design engineering. The responsibility of each of these departments is to develop its part of the product, and advance the state of the art in its own particular field. Each department is headed up by a highly qualified specialist and staffed with competent engineering personnel.
- **XM571 All-Terrain Tracked Vehicle:** design, development and production engineering, liaison with Canadian and United States Government development technical and test agencies, manufacture and support of several prototypes and limited production contracts.
- **Commercial Off-Highway Tracked & Wheeled Vehicles:** design and manufacture of 1/2 to 30-ton carriers. Provide product support.
- **Fire Service Crash Tender and T-3 Tanker-Fire-Trailer:** design and manufacture prototypes.
- **Tests and service trials support.**
In addition to their various programs, engineering personnel have done and are currently undertaking studies in the automotive and mechanical engineering design fields and rolling track Marginal Terrain Vehicles.
- **Maintenance Engineering**
The Maintenance Department is responsible for assuring that optimum maintainability is incorporated as an inherent characteristic in all Flextrac Nodwell products. Maintainability decisions are based on the wide experience gained by personnel in military and commercial programs, and by the application of prescribed factors and data collection throughout the development cycle. An effective interface is maintained between the Maintenance Department and the design, checking and test departments to ensure co-ordinated

efforts and an organized approach in achieving its goal. Liaison is maintained with the operators of Flextrac Nodwell equipment for the life of that equipment. Cataloguing and provisioning are also specific functions of the department.

- **Products and Services**

Backgrounds and experience cover the following fields:

Agricultural Equipment, Tracked Vehicles, Military and Commercial, Electrical and Hydraulic Installations, Elevators and Belt Conveyors, Compressor Stations, Tool Design, Trucks, Industrial, Pipeline, Marine, Pressure Vessels, Topography and Aircraft.

This wide range of capabilities offers complete versatility, and work can be accepted into the section with little change of pace and no delays due to the hiring of specialists to handle specific tasks.

The type of work which can be handled spans facility sketches or layouts for immediate production of hardware, to the precision detailed drawings suitable for microfilming. The drafting staff is fully conversant with the drawing practices prescribed by U.S. Mil. Std. 100A and quality assurance requirements of U.S. Specification MIL-Q-9858A or Canadian Standard DND 1015.

A design Checking Section plays a key role in the department. This section checks and ensures the technical accuracy of the design and the presentation of the design to contract requirements. To accomplish these tasks, versatile checkers who are selected by education and their varied experience in performing different design engineering work have been developed. Each is well qualified in one of the fields of engineering and has at least eight years of actual design experience and his prime purpose is to assure that the design and documentation parameters of the company and the contract have been met.

- **Production Capability**

Flextrac Nodwell has produced more than 2,000 vehicles for military and commercial uses in such divergent fields as the Arctic and the Antarctic as well as in Europe, Australia and the Americas.

- **Research and Development**

Active research and development is a major Flextrac Nodwell policy. The company with diverse automotive and mechanical engineering backgrounds. This group is engaged in work centred around improvements in the products outlined as well as the conception and prototype building of new product lines. Research into current and future trends in power trains, steering systems, suspension and track designs is an essential part of R & D work. A specialist activity within the group requires an up-to-date analysis of new material developments and manufacturing techniques

to be maintained in order that production, and the ultimate customer, may benefit from state-of-the-art trends. The R & D department has its own self-contained development shop for prototypes and initial production vehicles are trialed by the Test Group which is also a functional element of R & D.

2320 2330 2410 2430 2530 4210
and pages 51 and 302

FMC of Canada Ltd.,
(Link-Belt Speeder Division)
P.O. Box 190,
Woodstock, Ontario.

Telephone: (519) 539-9844
Telex: 024-7410

Contact: D. E. Crabbs, Plant Superintendent

Link-Belt manufacture a line of rubber tired and crawler mounted shovel cranes from .57 m³ to 1.15 m³ (¾ to 1½ yd³).

3810

Foremost Tracked Vehicles Ltd.,
1616 Meridian Road N.E.,
Calgary 62, Alberta.

Telephone: (403) 272-3322
Telex: 038-22772
Cable: FOREMOST CALGARY

President: J. H. Nodwell

Contact: W. B. Nodwell, Vice-President, Marketing

The company's chief interest is solving transportation problems over adverse off-highway terrain utilizing a full track unit. With eleven basic models ranging in payload capacities from ½ ton to 45 tons the customer is able to get a vehicle tailored to his application. The combination steel and rubber tracks allow for a very low ground bearing pressure; coupled with remarkable stability, the units can be employed for any muskeg, snow or hilly operations. Tracked trailers are also available in ranges from 1 ton to 30 tons payload capacities.

The Dawson series utilizes a standard truck type frame configuration allowing mounting of truck attachments (i.e. back-hoes, etc.) with a minimum

of alterations and in this way the units can be employed for personnel carriers, drilling, rescue, reconnaissance, survey, mining, lumbering, construction or a host of other applications where operation with conventional wheeled vehicles is impossible. Years of tracked vehicle experience and construction allows for various design modifications to suit the customer's particular application.

2320 2330 2410 2430 and pages 51 and 306

Foster Wheeler Limited,
P.O. Box 1007,
St. Catharines, Ontario.

Telephone: (416) 684-8321

President: E. E. Kovacs

Contact: R. W. Boyd, Gen. Sales Mgr.

Manufacturers of:

- Steam generating units and auxiliaries: Indoor and outdoor package field erected, watertube, central station, marine, superheaters, economizers, air heaters, high temperature water generators. Surface condensers, high temperature vaporizers, heat exchangers, waste heat boilers, evaporators, feedwater heaters, distillers, steam jet air ejectors, desuperheaters. Pulverizers, burners, stokers, pneumatic feeders, bark and waste wood furnaces, bagasse burning equipment.
- Mine air heating systems. Gas turbine regenerators. Petroleum refineries and chemical plant components such as: Steam generators, calandrias, moderator coolers.
- Miscellaneous equipment: Pressure vessels, autoclaves, tanks, ducts, weldments, dryers, fired heaters, sulphur burners.

3650 3820 4410 4420 4440 4460 4520
4530 5430 8120 and page 55

Gabriel of Canada,
3600 Lakeshore Blvd. W.,
Toronto 14, Ontario.

Telephone: (416) 252-5111
Telex: 06-217610
TWX: 610-492-2548

Executive Vice-Pres.: V. L. Van Der Hout

Contact: K. A. Culver, Assistant General Manager

This company manufactures hydraulic dampening devices in the form of telescopic shock absorbers for use in suspension and steering systems.

A complete line of bore sizes are available to accommodate specific customer requirements in automotive and industrial applications. Design and development services are also maintained to meet new custom requirements.

2540

Galt Equipment Limited,
47 Marie Victorin Blvd.,
Candiac, Montreal, Quebec.

Telephone: (514) 659-9644
Cable: "Springer Montreal"

President: J. C. Springer

Contact: J. K. Foessl

This company produces a line of equipment, known as the Thermotrol Cartridges system, for the protection of temperature effected or perishable foods or other commodities in transit. The system was designed for use in International Standards Organization Freight containers and is considered to be unique in the field. The product line includes a close control refrigeration unit and less expensive heaters and coolers which are easily and quickly inserted into the containers. A development program includes venting and de-humidifier units.

4110 and pages 51 and 488

Gardner-Denver Co. (Canada) Ltd.,
1800 Ellesmere Rd.,
Scarborough, Ontario.

Telephone 416: 291-2551
Telex: 022-320

President: Mr. J. P. Finnigan

Contact: Mr. J. E. Wray, General Sales Manager

This company is a manufacturer of compressed air equipment and compressed air powered equipment. This includes tank mounted reciprocating air compressors from 1/4 HP to 20 HP — reciprocating air compressors from 28.3 to 1699 litres (1 to 60 ft.³/min.) in pressure ranges to 24.5 kg/cm² (350 lb./in.²). Screw-type stationary compressors in 30, 40, 50, 60 HP sizes — portable air compressors (normally operating at 7 kg/cm² (100 lb./in.²), on heavy duty spring mounted pneumatic tire mountings, gasoline or diesel engine powered) in 2407 litres/min. (rotary vane), 4848, 5239, 16990 and 21238 litres/min. (85 ft.³/min. rotary vane, 150, 185, 600 and 750 ft.³/min.) where the 2407/150 and up are screw type compressors.

Sinker drills, feed led drills, stoping drills and mining "Jumbos" (mechanized multiple drill rigs) are also all part of normal production.

3820 4310

Garrett Manufacturing Limited,
255 Attwell Drive,
Rexdale, Ontario.

Telephone: (416) 677-1410
Telex: 02-21673
TWX: 610-492-4352
Cable: GARRETT TOR

Vice-Pres.: W. C. Tate

Contact: J. L. Gardner, Sales Manager.

Manufacturers of Equipment in the following product lines —

Electronic Systems

- Temperature Control Systems:
 - Manufacturers of Aerospace Temperature Control Systems for use in
 - crew compartments
 - cabins
 - electronic bays.

Windshield De-icing Temperature Control Systems

Cabin and Electronic Bay Flow Control Systems
Temperature and Speed Sensors for both
Aerospace and Industrial applications

- Solid State Over Temperature Switches.
- Flight Instrument Test Sets:
Test Sets for calibration and test on the ground, both flight line and base level, of Airborne Air Data Computers and Airspeed and Altimetry Systems.
- Pressure Standards:
For use in any situation which requires precise measurement, e.g., as a transfer standard; for calibration of other pressure measuring equipment; calibration of aircraft instruments both in and out of aircraft; weather stations.
- Mesometeorological Data Measuring and Collection Systems:
For use in airports or remote weather stations.
- Microelectronic Devices:
 - Thin and thick film custom hybrids.
 - Thin and thick film resistor networks.
 - Thick film multilayer circuit boards.
- Emergency Locator Beacons:
 - Water activated Air-Sea Rescue Beacons.
 - Automatic Downed Aircraft Locators.

Marine Systems —

- Underway Replenishment:
Complete systems design and hardware for the ship to ship and shipboard handling systems for both supply and receiving ships.
- Special Military Sub-systems:
These are special systems in the medium to heavy engineering category with electric, hydraulic, pneumatic or diesel drives. Tension, velocity or positional sensing and control by electronic, hydraulic or mechanical means.
- Waterjet Propulsion Systems:
The patented "Aquajet" with its weed cutter and 360° steering nozzle is developed primarily for military amphibians and has proved to be very effective in areas of heavy marine growth. Commercial units are also available.
- Shipboard Equipment:
This equipment consists of Automatic Mooring Winches, Cargo Winches, Windlasses, Capstans, Deck Cranes and special shipboard cargo handling systems.
- Engineering Studies:
A qualified consulting service is offered in the areas of underway replenishment, shipboard materials handling, machinery design, systems management.

1420	1430	1650	1660	2010	2020	2030
3950	4120	4920	5820	5821	5825	5826
5845	5895	5905	5915	5975	5999	6110
6115	6130	6605	6625	6660	6685	

and pages 51 56 176 178 189 190 193 264 272
274 and 280

General Impact Extrusions (Manufacturing) Ltd.,
191 Evans Avenue,
P.O. Box 220, Station "U",
Toronto 18, Ontario.

Telephone: (416) 252-5131
Cable: GENIMPEX

Executive Vice-Pres. and General Manager:
W. S. Campbell

Contact: Donald S. Arnott, Vice-Pres. Sales

This company is one of the largest manufacturers of aluminum impact extrusions in Canada and have for many years produced a great variety of components for the Canadian defence industry. They produce cartridge cases, cartridge clips, dummy cartridge cases, metal components, fin assemblies and artillery shell forgings for ammunition through 30mm, 75mm and 105mm varieties. They produce shells, metal parts, fin assemblies, forged components, bomb tail fuzes and arming vanes for a great variety of bombs. Under the general-category of grenades they produce practice grenade bodies, practice rifle fin assemblies, forged components and empty components for grenades. Metal components are produced for guided missile war-heads and explosive components. Also produced for rocket and rocket ammunition are metal components, drills for rocket bodies and rocket motor assemblies, fins and fin assemblies, forged components and metal parts for rockets. Metal and empty components are manufactured for land mines. The metal components for underwater mine inert components are manufactured as well as inert metal components for torpedo inert components and depth charge inert components. Aluminum shapes, blanks, discs, cups, rotating band, cartridge cases, forged components and shell components are manufactured for miscellaneous ammunition. G.I.E. produces caps and tubes for fittings and specialities: hose, pipe and tube. Aluminum, collapsible and non-collapsible metal tubes are manufactured for drums and cans as well as for ammunition boxes, packages, and special containers. Aluminum boxes and food containers are manufactured for boxes, cartons and crates.

1305	1310	1315	1320	1330	1336	1340
1345	1350	1355	1360	1395	4730	8110
8115	8140	and page		477		

General Precision Industries Limited,
P.O. Box 88,
Place Bonaventure,
Montreal 114, Quebec.

Telephone: (514) 866-8395
Cable: BOPHAR
Telex: 610-532-6561

President: T. Toczyłowski

Designers and manufacturers of fixed and mobile radio direction finders and special purpose radio receivers for electronic surveillance purposes. Military end items designed and manufactured by this company include:

- Receiving set, radio, AN/FRR-68
- Receiving set, radio, AN/FRR/80
- Direction finder, AN/GRD-501
- Direction Finder, AN/SRD-501

This company has recently introduced a new line of miniaturized electronic surveillance equipment with models available at customers' option in single two or three channel configuration covering any or all of 10 KHz-2 MHz, 2 MHz-30 MHz and 30 MHz-180 MHz bands, with or without antennae.

5820 5821 5825 5895 and pages 224 and 234

General Time of Canada Limited,
P.O. Box 239,
Peterborough, Ontario.

Telephone: (705) 742-4231
Telex: 029-849

President: F. R. Pope

Contact: M. B. A. Hendren,
Process Planning Manager

This company, established in Canada over 50 years ago, is engaged primarily in the manufacture of time pieces and related products.

These include:

- Spring, electric and battery operated clocks, non-jewelled pocket watches, industrial controls, ammunition components and fuze mechanisms.

The ammunition components and fuze mechanisms which have been or are being manufactured consist of Mark 14, 15 and 16 Rear Fitting Safety Device, M84 Time Fuze, M65A1 Time Fuze and M125A1 Booster.

In addition to the above, this company offers a complete manufacturing facility for a variety of work in the mechanical and electro-mechanical field on a contract basis. Items such as key

boards for data processing equipment have been assembled as well as a wide variety of precision sub-assemblies.

1390

Godfrey Engineering Co. Ltd.,
480 Montreal-Toronto Blvd.,
Lachine 640, Montreal, Quebec.

Telephone: (514) 637-1122
Telex: 01-20457
Cable: GODFREPART

President: E. D. Cornell

Contact: L. C. Gillespie, Vice-Pres.

The company is engaged in the design, development and manufacture of Airborne Air Conditioning systems and equipment including cabin superchargers, vapour and air cycle cooling turbines and related components. In addition, a wide range of aircraft ground support equipment, including air conditioning trailers, galley refrigerators, water system servicing vehicles; toilet system servicing units, hydraulic and pneumatic system servicing units together with heating units is designed and manufactured for both military and commercial use.

A variety of compressors, air filters and vacuum pumps along with centrifugal and rotary pumps are designed and produced to exacting aeronautical standards.

1650 1660 1680 1730 1740 4110 4120
4310 4320 4450 4920 and page 51

Graphico Precision Works Ltd.,
1100 Bellamy Road,
Scarborough, Ontario.

Telephone: (416) 293-8266
TWX: 610-492-4371

President: Rudy Scherenzel

Contact: W. M. Stubbs, Sales Manager

Graphico's basic production is printed circuit and terminal boards.

The Circuit Boards Include:

- Multi-layer, flexible, flush switches, single and double sided with plated-through holes, and are available in various finishes including tin/lead, tintillate, copper, nickel, silver, gold

and rhodium. The Terminal Boards are phenolic, epoxy-glass or nylon and are complete with variations of hardware. Chemical milling, electro-forming and photo-etching services are available to meet custom requirements.

5940 5999

Greening Donald Ltd.,
55 Queen Street North,
Hamilton 13, Ontario.

Telephone: (416) 528-5971
Telex: 021-601
Cable: GREENDON HAMILTON

President: H. S. Baldwin

Contact: R. A. Johnson, General Sales Manager

The activities of this company can be broken into five basic areas as follows:

- **Wire Rope and Wire Rope Assemblies**
In this major area, a complete line of wire rope, slings and assemblies for many uses such as blasting mats, rigging gear, aircraft arresting cables and launching assemblies for aircraft are manufactured.
- **Woven Wire Cloth and Wire Screens**
Woven wire cloth and screens are manufactured in all types of ferrous and non-ferrous metals for uses such as filter screens, chip and vibrating screens.
- **Perforated Metals**
Perforated metals are available in sheet and plate in both ferrous and non-ferrous metals for uses such as partitions, filter screens and ornamental grills.
- **Specialty Wire**
Wire is manufactured in many materials such as Hi-Carbon, low carbon, galvanized and tinned steel as well as alloys such as, aluminum, brass, phosphor bronze, Inconel, Monel, nickel stainless steel and electrical resistance wire.
- **Fabricated Products**
This division manufactures welded steel wire mesh, welded mesh containers, wire security partitions and doors as well as other specialty welded mesh products.

1375	1710	1720	2020	3210	3615	3650
3695	3820	3940	4010	5335	5660	5670
5680	6145	8115	9505	9515	9525	9535

Guildline Instruments Limited,
Churchill Crescent,
P.O. Box 99,
Smiths Falls, Ontario.

Telephone: (613) 283-3000
Cable: GUILDLINE

President and General Manager: J. Sutcliffe

Contact: D. M. Martin, Marketing Manager

Guildline Instruments Limited is a manufacturer of electrical and temperature measuring instruments and standards of the highest accuracy and precision. Close collaboration with the National Research Council at Ottawa, combined with an innovative research and engineering facility, ensures that Guildline products meet the most exacting performance standards.

The Company's product line includes measuring potentiometers and bridges of seven digit accuracy and resolution, a complete range of first echelon voltage and resistance standards, and a line of accessory and peripheral equipment for the standards and research laboratory such as air and oil baths, switches, detectors, etc.

Recent developments include test sets for the calibration of current and potential instrument transformers, a high voltage capacitance bridge ten times more accurate than the classical designs, and a digital teraohmometer for 5 and 6 digit measurements of resistance to 10^{15} ohms. In the oceanography field Guildline has recently introduced several instruments for the 'in situ' investigation of ocean or inland water temperature, salinity and depth.

5905 6625 and pages 51 and 296

Hawker Siddeley Canada Ltd.,
7 King Street East,
Toronto 1, Ontario.

Telephone: (416) 362-2941

Telex: 02-2605

Cables: HAWSIDCAN

President: R. S. Faulkner

Director of Marketing: L. G. Main

Canadian Bridge Division

The Division designs and manufactures galvanized power transmission towers and poles, electronic structures such as radar and scatter antennae, and masts of all types for radio, television, micro-wave etc. Complete facilities exist for the structural testing of mast and towers. The plant manufactures a range of MONOBOX overhead travelling cranes. Pollution control devices to BELCO designs are produced including electrostatic precipitators, high efficiency mechanical cyclone collectors and water pollution control devices.

3950 4460 4630 5895 and page 50

Canadian Car Division

The Division is experienced in building major aircraft structural components, wing-tip and pylon mounted fuel tanks, ground handling and wheeled test equipment, and airframe plastic reinforced components. Die, jig, fixture and template work is carried out and the plant is equipped to produce sheet metal fabrications and bulge-formed skins. A complete line of highway trailers is manufactured and trailers to special design can be produced. The Division manufactures a range of woodlands equipment including rubber-tired tractor skidders which can be adapted for a number of off-highway transportation uses. The plant pioneered the development of the long, lightweight passenger railcar in North America and manufactures them for subway, commuter and mainline applications.

1450 1560 1680 1730 1740 1850 2220
2320 2330 2510 2925 3615 3465
3695 9330

Canadian Car (Pacific) Division

The Division designs and manufactures a specialized sawmill, lumber and pulp and paper machinery, including chip and saw machines, log decks, log turners, block chippers, waste-wood chippers, chip screens, edge chippers, timber sorters. Hydro-electric equipment produced includes tunnel liner forms and plates, hydraulic gates and valves. Diesel engine parts are manufactured. A separate facility designs and manufactures electric-electronic control

equipment for the forest, mining, plastics and packaging industries and machine manufacturers. Controls are also built for marine applications such as in tug-boats, and for docking, winches and bulk-loading facilities.

2030 2815 3210 3442 3615 4810 4820
5999 6110 6115

Canadian Steel Foundries Division

The Division produces castings in mild and alloy steels, austenitic manganese and stainless steels in weights up to 150 tons for railway equipment applications and a wide range of industrial uses. Special purpose castings are poured in Ni-hard and Ductile irons. Products made include mill roll housings, feed heads, hydro-electric and thermal power runners, slag pots, cement kiln tires, motor frames and castings for the shipbuilding, automobile, mining and pulp and paper industries. The foundry is fully qualified to pour castings for nuclear power applications. A fully-equipped machine shop is maintained together with an extensive range of non-destructive testing equipment which includes a 7.5 MeV linear accelerator. The Division also makes up trackwork for sub-way, surface, mining and industrial plant layouts.

1325 1330 2230 and page 51

Halifax Shipyards Division

The Division constructs barges, lighters, dredges, landing craft, small craft, tugs, cargo vessels, tankers, combat ships, special service vessels, fishing vessels, transport vessels including passenger and troop, pontoons, floating docks, floating dry docks, and offshore drilling vessels, production platforms and support vessels.

The shipyard has a 185 m (600 ft.) drydock, a 176 m (570 ft.) graving dock, two 111 m (360 ft.) building berths and three outfitting berths. It is equipped to carry out all types of repairs and has complete machine shop facilities in addition to plate, boiler, blacksmith, electrical, pipe and sheetmetal shops, and a joiner shop which can produce custom-made cabinets, etc. A separate facility has six marine railways capable of handling ships up to 3,000 tons and 91 m (300 ft.) in length.

1905 1910 1915 1920 1925 1930 1935
1940 1945 1950 1955 2030 2040 2050
2090 4510 5420 7125 7195 and page 56

Trenton Works Division

The Division manufactures all types of railway freight cars and tank cars, mine cars, railway equipment components, and pressure vessels. A range of equipment produces forgings of all types and includes a press of 7000-ton capacity capable of producing heavy forgings such as turbine, generator and marine shafts. Railway axles are manufactured using special forging, heat treatment and automatic machining equipment. The plant has extensive machine shop facilities. Custom steel fabrication work is carried out and equipment is built for the mining, pulp and paper, steel and other industries.

2010	2040	2050	2220	2230	2240	2250
3820	3695	3950	8120			

John T. Hepburn, Limited,
914 Dupont Street,
Toronto 173, Ontario.

Telephone: (416) 534-8871
Telex: 02-21305
Cable: HEPBURN

General Manager, Mechanical Division:
V. S. Grater, P.Eng.

Contact: J. Alderton, Marine Sales Manager

In a logical extension of experience since 1905 with cranes, hoisting machinery and other materials handling equipment the Company is actively engaged in designing and manufacturing marine equipment for naval and other ships. Their cranes, elevators, deck machinery and ancillary equipment have been evaluated and accepted as a satisfactory mode of operation for all day to day requirements under all environmental sea and climatic conditions. Some of these items and systems are described below.

- **Underway Replenishment Systems:**
An important part of the Company's activities in the marine area has been the development of proven underway replenishment system in operation for the transfer of fuels and/or solids at sea. These highly efficient systems may include the following or other equipment: Ram tensioning units, high-line winches, high-line control drums, saddle winches, anti-slack devices, sliding pad eyes, travellers and trolley blocks.
- **Other marine products include the following:**
- **Ships Cranes:**
Cranes may be of fixed pedestal, rolling gantry or overhead type or of the level luffing type with electric or hydraulic drives or a combination of the two. Deck cranes are available as a

standard unit or designed to meet specific requirements for any loading, handling or discharging system.

- **Winches:**
Stern anchor, mooring, towing, buoy or cargo handling, trawl, oceanographic, bathythermograph, inhaul-outhaul, high-line, helicopter haul-down, trawl, purse seine, metering, line tending or special purpose. Types may be powered by hydraulic, electric, steam or diesel as applicable and available in capacities to meet individual applications.
- **Capstans:**
Forward and after mooring, buoy handling, special purpose which may be hydraulic, electric, steam or diesel powered as required.
- **Windlasses Anchor:**
Forward or stern, horizontal or vertical, constant tension if required and powered by hydraulic, electric, steam or diesel power.
- **Elevators:**
Stores, ammunition and helicopter elevators: Units may have a flush deck watertight hatch cover or the platform when elevated to deck level may form a flush watertight hatch. Types available include simple scissor lift, direct lift with hydraulic rams or electric hoist through wire ropes and may have simple platform or they could have an integrated automated handling system.
- **Hatch Covers:**
Hydraulically actuated, these covers may take the form of a simple one piece hinge-up type through the articulated double folding installation to the more sophisticated multi-section rolling type. Operation by hydraulic cylinders or rotary actuators are options.
- **Doors:**
Side, stern and bow.
- **Hydraulic Presses:**
Many different types including presses for forming, drawing, blanking, straightening, trimming, die spotting, powder compression, baling, laminating, extruding, compression moulding, forging, stripping, punching, stretching, briquetting, curing, toolroom and laboratory applications in addition to custom designed equipment to meet specific requirements.
- **Pulp and Paper Industry Machinery:**
Pulp baling presses, cranes and specialized machinery.
- **Mining Equipment:**
Mine hoists, ore breakers, cranes and specialized machinery.
- **Steel Mill Equipment:**
The following broad categories of steel mill equipment are available:— Cranes, mill stands, shears, conveyors, cooling beds, tables, upenders, transfer cars, and repeaters.
- **Miscellaneous Machine Tools:**
Single purpose turning and boring machines for shells and other projectiles.

- **Miscellaneous Special Industry Machinery:** Includes medium to heavy machinery specially designed and built to customers specifications. The following is a cross-section of the industries served: Basic steel, mining, smelting and refining, plastics, sheet and coil processing, non-ferrous, automotive, pulp and paper, metal-working, medical research.

- **Gears:**

Chain, transmission sprocket; drives, roller chain; drives, silent chain; gear blanks; gears cut and cast tooth; gears, medium; gears, precision; gears, small; gears, spur, helical; idlers, belt conveyor; pillow blocks; pulleys; ring gears; shafting; sheaves; sprockets, take ups.

- **Engineering:**

A staff of Professional Engineers and Technicians is retained and their experience is applied to all facets of the structural, mechanical, casting, hydraulic, electrical and metallurgical designs of marine machinery and industrial equipment.

- **Manufacturing:**

Mechanical Division has its own fabrication, machining, assembly, electrical, hydraulic, test and inspection departments and these combined with the facilities of our Foundry Division which supplies gray iron, ductile and Meehanite castings, permits direct control over a great percentage of the manufacturing process.

2020 2030 2040 3419 3422 3615 3695
3820 3950 3960 and pages: 51 266 and 267

Hermes Electronics Limited,
Dartmouth, Nova Scotia.

Telephone: (902) 466-7491
Telex: 014-422744
TWX: 610-271-1973

Gen. Manager: R. M. Campbell

Contact: A. G. B. Judd, Vice-Pres. Marketing

Hermes products are associated with the fields of HF communications, and ocean engineering; and through its subsidiary (Advanced Transducer Systems of Toronto) another series of products for monitoring pollution, nuclear instrumentation, video tape cleaning, microwave drying and air support bearings for processing material using air as a cushion and contact. In communications Hermes produces 3rd generation HF ionospheric sounding equipment for military and commercial use; including vertical and oblique single pulse and oblique pulse

compression transmitters and receivers. The omni-directional receive antenna can function in one-hundredth of the space required for traditional and conventional antenna farm. The company produces adaptive communications systems and designs HF data links for buoy or ship mounting.

In ocean engineering, Hermes produces deep and shallow 1, 2, & 3 stage buoy systems including automatic mooring to 6096 m (20,000 ft.) and minimum watch circle for use in oceanographic and military data collection. Other products include air-launched bathythermograph buoys producing ocean temperature profiles to 304 m (1,000 ft.) depth; anti-submarine towed sonar; and for oceanographers a small compact underwater towed body that can be deployed from a vessel only 13.71 m (45 ft.) in length to measure small scale changes in the ocean in a vertical path to 182.88 m (600 ft.) for salinity, depth, copepod, turbidity, echo sounding and temperature at speeds up to 14 knots.

5845 5895 6625 6655 6665 and pages 51 and 410

James Howden & Parsons of Canada Limited,
1510 Birchmount Road,
Scarborough 733, Ontario.

Telephone: (416) 759-2271
Telex: 02-2712

President: W. MacOwan

Contact: I. L. Smith, General Sales Manager

Marine operations, power generation facilities and heavy industrial plants throughout the world have made constant and wide use of the design and production facilities of this firm.

- **Air Pre-heaters:**

The Howden - Ljungstrom Regenerative Air Pre-heaters are extremely efficient and compact heater exchangers are used extensively on steam boilers of 22,680 kg (50,000 lb.) hour capacity and upwards. Other uses include heat recovery on petroleum refinery crude furnaces, indirect heating of air to copper reverberatory furnaces and fume incineration systems. Dust collectors, cyclones with single and multiple cell arrangements are of growing importance when associated with pollution hazards for their application to the extraction of fly ash, cement dust, are processing residues, lints dust or incinerators is the basic and normal functions. This same line of equipment is backed up by a line of dust flaps and valves.

These equipments taken with a broad range of mechanical draft fans and blowers present a complete plant spectrum. Turbo generating plant from 30 MW upwards, complete with condensers, feed heating etc. have powered Canadian hydro systems as well as projects in South America, United Kingdom, Australia, New Zealand, India, Mexico and others. To complete the range of their ground production specialized designs and weldments in carbon and stainless steel plate are produced together with the following range of butterfly type valves:

- Low pressure wafer 7.62 cm to 60.96 cm (3 in. to 24 in.) with bore pressures to 7 kg/cm² (100 lb./in.²)
- Low pressure flanged 45.72 cm (18 in.) bore and upwards with bore pressures to 7 kg/cm² (100 lb./in.²)
- High pressure flanged 45.72 cm (18 in.) bore and upwards with pressures to 24 kg/cm² (350 lb./in.²)

A complete range of "instant" valves are available.

2825 4420 4460 4450 4120 4810 4820

Huntec ('70) Limited,
1450 O'Connor Drive,
Toronto 374, Ontario.

Telephone: (416) 751-8055
Telex: 06-22797
Cable: HUNTOR

President: R. C. Carroll

Contact: J. R. Hamilton

Huntec is engaged in the design, development and manufacture of advanced geophysical instruments. The marine seismic sub-bottom profiling system together with its land variant, which also has a portable system, have particular applications to the siting of airports, landing strips, camps or bridge abutments and piers. Helicopter-airborne electromagnetic systems and induced polarization transmitters and receivers are also produced. Huntec maintains a substantial research facility to meet increased technological demands as well as custom requirements.

6655 and page 51

Hussmann Refrigerator Co. Limited,
P.O. Box 550,
58 Frank Street,
Brantford, Ontario.

Telephone: (519) 756-6351
Telex: 02181120
Cable: HUSSREF BRANTFORD

Hussmann manufactures display and storage equipment for large and small food stores (including military base requirements.) They manufacture refrigerated display cases, both low and medium temperature applications, sectional, steel prefabricated walk-in coolers, semi-hermetic condensing units (from 1/2 to 20 horsepower), central refrigeration systems (to 160 horsepower), fin and blower coils.

Adjustable steel shelving and related fixtures, mechanical and non-mechanical checkout counters, as well as a complete line of display shelving and fixtures for department stores, and other non-food applications are available or designed to meet custom requirement. The application of such time proven handling systems to military usages invariably results in greater efficiencies as well as in obvious savings.

4110 4120 4130 5975 7125 8140

Indesco International Limited,
46 St. Clair Avenue East,
Toronto 290, Ontario.

Telephone: (416) 925-5571

Contact: W. F. Chmela, President

Engineering and design services are carried out at their home office or the clients premises: specializing in mechanical, electrical, instrumentation, civil and structural engineering for light and heavy industrial projects, such as petrochemical, mining facilities, ore treatment, steel mills, material handling, machine design and construction supervision.

Page 51

Instronics Ltd.,
Stittsville, Ontario.

Telephone: (613) 836-4411
Telex: 013-415

President: John E. Knowles

Contact: Mr. L. J. Robert,
International Marketing Manager.

This company is largely engaged in the design and production of graphical to digital converters for second and third dimension conversion for photogrammetrics, cartographics, architecture, medical and other applications where graphical information must be prepared for data processing.

Other activities include exciters for communication systems; power sources for Peltier cooling; telegraph distortion measuring equipment; parity detectors and process monitoring equipment.

5821 5895 6625 7440
and pages 245 and 248

Irvin Industries Canada Ltd.,
479 Central Ave.,
Fort Erie, Ontario.

Telephone: (416) 871-6510
Telex: 021-5169

President: Clifford Bonn

Contact: David A. Wright, Manager Engineering

This company is primarily interested in the development and manufacturing of all types of parachutes, cargo handling equipment and safety and survival equipment.

The complete line of parachute types includes personnel, emergency and troop, flare, aircraft deceleration and cargo parachutes as large as

30 m (100 ft.) in diameter. Extensive work has also been done in protective clothing for environmental extremes such as heat, cold and positive and negative 'G' conditions. The inflatable life rafts and life preserver line has just been expanded with the introduction of inflatable portable buildings and development in inflatable restraint devices for vehicles of all types.

- Cargo handling products include cargo tie-down webbings, helicopter nets, pallets and containers. Web type aircraft arresting nets, launcher covers, hospital mattress covers and straps, aircraft and automobile safety harnesses and lap belts, emergency seat containers and military and industrial webbing and fabric components of all types round out the product line.

The equipment range listed is supported by a complete repair and overhaul capability together with design/consulting services.

1045 1055 1450 1670 1680 1710 2420
6515 6530 8415 8465 8475
and pages 51 and 198

ITT Canada Limited,
(Communications Division)
Guelph, Ontario.

Telephone: (519) 821-2000
Telex: 0295-6547

President & General Manager: W. G. Bruner

Contact: J. U. Ludtke

This company operates in three areas:

- Electronic equipments for the Military and the Department of Transport; Equipments for teletype and telephone operating companies; and Automatic document handling system.
- Electronic equipments offered include Precision Approach Radars, Instrument Landing System, ground and airborne TACAN and DME; UHF, VHF and HF transmitters and receivers.
- Telephone and teletype equipments include Subscriber Loop devices, Microwave and Carrier equipments, telephone apparatus and broadband switching equipment.
- The Document Handling system codes and automatically sorts mail.

A service engineering group meets design engineering and engineering investigations for custom requirements.

A technical services group establishes and operates calibration, repair and overhaul facilities for radar, navigation and communication equipments both at their own plants and at customer locations.

5805 5820 5821 5825 5826 5895 7440
and pages 50, 51 and 56

Jaeger Machine Company of Canada Ltd.,
43 Gaylord Road,
St. Thomas, Ontario.

Telephone: (519) 631-5100
Telex: 024-73535

- Portable Plaster Mixers:
From 3058 to 6116 litres (4 to 8 ft.³) and/or gas
or electric or diesel driven.

3895 4310 4320

Vice-Pres. and General Manager: J. A. O'Dea

The principal products manufactured by this company are related to the construction industry and the reliability of their operation has been shown on many sites such as permanent and temporary military camps as well as airfield construction. This broad line includes:

- Air Compressors:
Two stage, oil cooled rotary sliding vane design. Capacities include 2025, 2410, 3540, 4250, 4855, 7080, 10,355, 25,485, litres at 7 kg/cm² (75, 85, 125, 150, 175, 250, 365, 900 ft.³/min. at 100 lb./in.²). Electric, gas or diesel powered with portable and stationary models.
- Water Pumps:
Centrifugal, de-watering pumps capacities 22,730 litres/hr. to 1,136,500 litres/hr. (5,000 gals./hr. to 250,000 gals./hr.). Gas, diesel and electric powered. High pressure jet pumps for fire fighting, pile jetting and jetting large well point systems and long distance supply pumping. Sizes are from 5.08 to 15.24 cm (2 in. to 6 in.) with pressures to 19.3 kg/cm² (275 lb./in.²).
- Diaphragm Pumps:
5.08, 7.62 and 10.16 cm (2, 3 and 4 in.) sizes for pumping low seepage, muddy trenches, sludge pits and collecting basins containing high percentages of solids.
- Portable Building Mixers:
Capacities from 99 litres (3.5 ft.³) tilter mixers including 170, 310 and 455 litres (6, 11 and 16 ft.³) skip loading non-tilting drums and gas, electric or diesel powered.
- Concrete Pumps:
Stationary and portable. Capacities from 990 to 2265 litres/hr. (35 yds.³/hr. to 80 yds.³/hr.). Pumping distances 45.7 m (150 ft.) vertical; 152 m (500 ft.) horizontal through 10.16 cm (4 in.) lines and also gas, diesel or electric powered.
- Truck Mixers:
Transit-type truck mixers, 4587 and 9175 litres (6 to 12 yd.³) capacity. Self-contained power units. Mixer can be mounted on truck chassis for mixing and transporting concrete from batch-site to job-site with gas or diesel power.
- Crawler Drills:
Crawler-type percussion drills with 11.4 and 12.7 cm (4.5 and 5 in.) drifters. Independent rotation for quarry, road or demolition work.

Koehring-Waterous Limited,
P.O. Box 490,
Brantford, Ontario.

Telephone: (519) 752-6571
Telex: 021-81117
TWX: 610-379-0102

President: P. A. Huffaker

Contact: W. J. Bell, Vice-Pres., Sales

Koehring-Waterous Ltd., is an incorporated Canadian Company. In Brantford they manufacture construction equipment which is of Koehring Company design; pulp and paper mill machinery and logging machinery, both of which are designed and developed in Canada.

Construction machinery is marketed under the names Koehring, Bantam, Lorain and Johnson and includes excavators, both cable and hydraulic from .38 m³ (.5 yd.³) to 1.9 m³ (2.5 yd.³) capacity, cable and hydraulic cranes from 9 to 150 tons and concrete batch plants.

For pulp and paper mills, they build pulpwood grinders used principally in the manufacture of newsprint. Three models are available; Waterous Great Northern, Super Hydraulic Magazine and Continuous Chain Grinders.

For logging they manufacture the Koehring Harvester which is a fully mechanical short-wood stump area processor, centre frame articulated with four wheel hydrostatic drive and 37.5 x 39 low pressure tires. The Harvester fells, de-limbs, tops and cuts the trees into 2.4 m (8 ft.) lengths and forwards a payload of 23.9 m³ (6.6 cords) to roadside. Also manufactured is a full tree feller skidder utilizing the same basic vehicle.

Carthage pulpwood chippers, and Nordberg Crushers and screens as well as cable and hydraulic log loaders, mounted on tractor type crawlers or self-propelled rubber, with capacities up to 65 tons at 3.65 m (12 ft.) radius are also produced.

2320 3210 3615 3695 3805 3810 3815
3820 3895 3950 and pages 322 and 323

Lacal Industries Limited,
56 Charles Street,
Newmarket, Ontario.

General Manager: R. W. Hipwell

Telephone: (416) 364-5271
Telex: 02-2020

Contact: A. K. Kingdon, Sales Manager

Founded in 1928 as a manufacturer of pole line hardware, Lacal is now a major supplier of extra high voltage, transmission and distribution hardware to all major Canadian power companies.

Standard items include:

- Anchors • anchor rods • bolts • braces • clamps • clevises • connectors • eyebolts • ferrules • ground rods • guards • guy clamps • guy hooks • nuts • insulator pins • pole steps • sectional steel poles • racks • shackles • splicing sleeves • sub-stations • terminals • washers • yokeplates.

Lacal's strength rests in its ability to offer a flexible but integrated, engineering and manufacturing service including closed die forgings in steel, stainless steel and aluminum further supported by a sand and permanent mould casting facility in bronze and aluminum. Hot dip galvanizing machining and assembly further augment in-house production.

Lacal designed products have included spacer dampers for the Bonneville Power Authority, 735 KV guying hardware for the Churchill Falls Power Project and dead ends for the 450,000 H.V.D.C. Nelson River Line.

The companies activities and products have been as diversified as stanchions for the Canadian Navy, bomb lugs for the U.S. military and a component for the landing gear on Apollo 11's LEM together with their custom forgings and castings for the automotive, marine and railroad markets.

1325 1330 1340 1395 2040 5935 5975
and page 51

Leigh Instruments Limited,
(Avionics Division)
P.O. Box 820,
Carleton Place, Ontario.

Telephone: (613) 257-3883
Telex: 013-448

General Manager: J. S. Farrell

H. V. Kneen, Marketing Manager

Since 1961, Leigh Instruments Limited activities have been based in the design, development and manufacture of precision aircraft instrumentation, Crash Position Indicators, Flight Recorder-Locator Systems, Flight Data Recorders, Cockpit Voice Recorders, Structural Loads Recorders, Aerial Delivery Systems, Pressure Driven and Servo Driven Instruments. The company has over 2000 systems in military and commercial aircraft and over 2500 instruments in service.

The company has considerable experience and excellent facilities to conduct environmental testing, with over 200,000 testing hours to MIL-STD-810, MIL-STD-826, MIL-T-5422, TSO-C-51A and RTCA-DO-126.

Leigh Instruments is a member of the Leigh group of companies, and the resources of the entire group are made available to each corporate enterprise as required. Leigh Instruments Limited has specialized in short run production of flight data acquisition and recording systems, aircraft instrumentation and electronic devices for over seven years. Over 50 professional engineers and 175 technical trained personnel are staffed to council, design and develop custom engineered products for specific customer requirements.

Custom engineering is summarized as follows:

- Aircraft Instruments both pressure and servo driven
- Instrument Landing Systems
- R.F. Electronics (MHz range, antenna and power source development)
- Aerial Delivery Systems (Airfoils)
- Data Acquisition Systems and Equipment
- Data Processing Systems and Equipment
- Systems Design and Management
- Training Aids
- Technical Publications
- UHF and VHF Homing Devices
- Radar Systems (small)
- Sonar Systems (small)
- Aerospace Ground Equipment
- Tape Recorders

During the period from 1961, Leigh Instruments has developed the following supporting engineering disciplines:

- Analog circuit design
- Servo mechanisms and analog feedback
- Instrument lighting design
- Altimetry
- Pressure instruments design
- Plastics (fibreglass, epoxy, polyesters, polyurethane foam)
- Aerodynamics
- Digital circuit design
- Computer application and interface design
- R.F. circuit design
- Antenna design
- Power supplies design (on-line and self-contained)
- Vibration jigs design
- Avionic systems installation design
- Recorder mechanism designs

The following new technology product lines and capabilities are part of Leigh's current activities.

- Satellite beacon technology
- Homing and DF devices for ground vehicles
- Low frequency communication systems
- High environment tape recorders
- Computer cassette peripherals
- Shipborne recorders
- Area navigation systems
- Display systems
- Radar digitizers
- Doppler systems

1560 3030 4920 5825 5826 5835 5841
 5895 6110 6605 6610 6615 6625 6630
 6645 6665 6685 6695 8030 and pages 50
 51 55 56 166 and 194

Ernst Leitz Canada Limited,
 122 Ellen Street,
 Midland, Ontario.

Telephone: (705) 526-5401
 Cable: ELCAN

W. G. Kluck, Vice-President

The Canadian company was established 20 years ago and has been active in the areas of development, design and manufacture of optical and precision mechanical instruments, as well as providing consulting services in this field. More specifically, the company has included in its program the following categories, instruments, or systems:

- Fire Control Equipment such as Sightunits and, in particular Model C2 which has been developed in Canada and manufactured in large quantities for many countries throughout

the Western world. In addition, the U.S. version, M53 was manufactured in quantities of several thousands. Also, Aiming Circles and Fuse Setters have been produced in this category.

- Optical Sighting and Ranging Equipment including Binoculars, Collimators, Sniper-scopes, Telescopic Sights and Rangefinders have been developed and manufactured by the company. To produce these, the company has in-house facility for the design and manufacture of all components including lenses, prisms, reticles, mirrors, high vacuum techniques, and can offer these components also as individual items.
- Optical Systems for Low Light Level Equipment of the more recent company development areas, and numerous optical systems of high aperture in different focal lengths have been optimised for specific wavelengths.
- Photographic Equipment the largest product line of the company, consisting primarily of lenses for camera formats up to 115 x 115 mm (4½" x 4½"). A 16 mm Instrumentation Camera, however, has been also a standard item with the company, and has been continuously up-dated for more than a decade to ensure compatibility with modern requirements.

1210 1240 1290 5855 6650 6710 6720
 6760 and pages 51 56 382 383 384 386 388
 and 390

Lenkurt Electric Co. of Canada, Ltd.,
 7018 Lougheed Highway,
 Burnaby 2, B.C.

Telephone: (604) 298-2464
 Telex: 04-54309
 Cable: GENTELINT

President: H. R. Herron

Contact: R. A. Marsh, Manager, Export Marketing

This Company is a leading supplier of modern telecommunications systems and equipment to telephone and power utilities, railways, petroleum and pipeline industries and various government agencies both in Canada and abroad. The quality and unique design features of their products have led to a rapidly expanding export business, which in 1971 included customers in 28 different countries.

A complete line of products is offered for multi-channel radio and multiplex systems, data and supervisory systems, which are supported by highly competent design teams, systems engineers and installation crews and factory service personnel. At present, approximately 50% of annual production represents all-Canadian design. A complete telecommunication systems

consultant service is available separately from equipment orders, if desired.

While the head office, research and development facility and the main manufacturing plant are located in Burnaby, British Columbia a smaller plant in Rimouski, Quebec supplies some fabricated metal parts to the main plant in Burnaby and a similar plant in Regina, Saskatchewan manufactures precision wave guides for micro-wave relay installations.

Lenkurt is a subsidiary of GTE International, which has numerous manufacturing and marketing organizations throughout the world. Thus, in addition to their own resources in Canada, Lenkurt is able to draw upon the world wide design talents and resources of other GTEI organizations to provide equipments and systems best suited to the needs of customers throughout the world.

- Radio Systems
 - VHF, UHF and SHF Bands
 - Up to 1800 voice channel capacity or video transmission
 - Line of Sight and Scatter Systems
 - Service Channel (Order Wire), Baseband and IF Protection Switching systems, Group Delay Equalizers, TV Clampers and other ancillary equipment
- Multiplex Systems
 - Various types for open wire, cable pair, coaxial cable and radio transmission facilities
 - Systems to 1800 voice channel capacity
 - In band or Out of band signalling equipments available, also group connectors, group and supergroup regulators, baseband equalizers, wideband modulators, etc.
- Data Systems
 - VF telegraph and similar speed data assemblies
 - Synchronous and Asynchronous data modems for up to 50 kb/s
 - Line conditioning equalizers
- Supervisory and Control Systems
 - Solid state reporting systems for large or small networks, as required
 - Lamp display, also data logging and alarm pattern analysis with computer based models
 - Solid state control systems, manually or computer actuated
- Test Equipment
 - Specialized test sets, cords, adapters and module extenders for efficient maintenance
- Customer Services
 - Systems Design Engineering: Planning, transmission studies, equipment engineering, Engineering Briefs and License Applications
 - Engineer, Furnish and Install: Overall or partial management of planning, engineering, construction, installation and commissioning of a system including related buildings, power and services
 - Customer Training
 - Factory Repair, replacement and refurbishing of all Lenkurt equipment

— Technical Publications: engineering, ordering, description, installation, alignment and drawings of Lenkurt systems and equipment

5805 5820 5895 5910 5915 5950 5975
5985 5995 5999 6110 6130 6350
and pages 50 51 220 and 229

Lightning Circuits,

(A Division of Lightning Fastener —
Lightning Division of Textron, Canada, Limited)

P.O. Box 940,
Victoria Street,
Niagara-On-The-Lake, Ontario.

Telephone: (416) 366-1421
Telex: 021-5122
Cable: LIGHTNING, ST. CATHARINES

Vice-Pres. & Gen. Mgr.: T. C. Stewart

Contact: Joseph Foran

Lightning design and produce rigid printed circuits of all types using both print and etching processes. Single and double sided boards with plated through holes are part of their normal production and all plating is to MIL Std. 275.

5999

Litton Systems (Canada) Ltd.,

25 Cityview Drive,
Rexdale, Ontario.

Telephone: (416) 249-1231

President & General Manager: R. R. Keating

Contact: V. V. R. Symonds,
Vice-Pres. of Marketing

Litton Systems (Canada) Limited, was established for the production of inertial navigation components in support of RCAF aircraft programmes. This capability rapidly expanded to the production of complete inertial systems and supporting test equipment. Currently the company's product line includes: weapons release computers, automated test equipment, and land, sea and airborne, tactical computers and display systems. In concert with this growth, a strong engineering division was established, and over the year has evolved from a production support activity into a comprehensive facility for pure and applied

research, advanced development, and product design. In recent years the division has been active in exotic gyroscope technology, bio-medical electronics, computer architecture, signal processing, digital communications, pattern recognition, error correcting codes, coherent optics and holography, automata theory, optical character recognition, and integrated circuit technology.

The engineering division has over the past few years engaged in industrial projects in such diverse fields as marshalling yard automation for rail systems, automated on-line banking systems, character recognition, advanced navigation systems, and numerical machine tool control.

The scope of our activities is summarized below:

- World-wide responsibility for the LN-3 Inertial Navigation System employed in the F-104 Starfighter aircraft.
- A Mobile Automatic Test Set (MATS) for LN-3 Inertial Navigation System is employed by the air forces of three NATO nations. An advanced MATS for the LN-2C system for the P3 A/B aircraft is in production for the U.S. Navy.
- The production of P-200 platforms, computers, and AGE for the LN-12 system in the F4 aircraft has been followed by the production of a P-280 platform for the LN-14 system in the F-111 aircraft.
- Production has been initiated on the second generation LTN-51 inertial system for commercial airlines.
- LSL is the sole facility for the sophisticated LTN-51 commercial inertial navigation system.
- Weapons Release System (AN/ASQ-91) for USAF Phantom production.
- A Company developed low cost inertial system employing a novel integrated circuit computer.
- A Command and Control System (CCS 280) for use on board the Canadian Forces fleet of helicopter-equipped destroyers (DDH-280 class).
- A highly specialized Airborne Inertial Data System for a NASA investigation of clear air turbulence.
- Special purpose computers for banking and credit control.
- A Commercial optical character reader development program.
- Research on Pattern Recognition including holographic fingerprint identification and computer theory.
- An advanced commercial navigation system development program.

Litton Canada has grown from a manufacturing satellite into an autonomous and diversified organization based on a command of advanced technology and in doing so it has achieved a reputation for the ability to rapidly produce and supply reliable sophisticated systems for a world market.

1420	5810	5825	5826	5841	5995	6110
6130	6605	6610	6615	6625	and pages	
55, 56, 184		186	188	and 244		

Magline of Canada Limited,
P.O. Box 219,
Highway 17,
Renfrew, Ontario.

Telephone: (613) 432-3253

D. A. Tetu: General Manager

This firm designs and produces a wide range of light-weight products in magnesium and aluminum alloys.

- Aircraft and extension ladders — ammunitions containers — tent poles and pins — mobile loading ramps, dockboards and portable bridges — magnesium and aluminum sleds and toboggans — magnesium snowshoes and factory trucks.

3920 3990 5440 8140 8340 8465

Marine Industries Limited,
1405 Peel Street,
Montreal 110, Quebec.
(Shipyard & Works, Sorel, Que.)

Telephone: (514) 849-2131

Telex: 01-26339

Cable: MARINDUS

Executive Vice-Pres.: Louis Rochette

This company is exceptionally well equipped to build naval vessels of all types up to a maximum length of 167 m O.A. (550 ft.) and 26 m beam (85 ft.). Awarded the contract as lead yard for Canada's DDH 280 class program it has built destroyers, hydrofoils, naval icebreakers, minesweepers, corvettes, frigates, supply vessels, landing ships, transport ships, as well as non-combatant ships such as tugs, floating cranes, floating docks, tankers and cargo vessels.

An engineering staff of some 25 to 30 includes naval architects and marine engineers who are specialists in all branches of shipbuilding. The company also manufactures railway cars, hydraulic turbines and generators and, through its subsidiaries, pressure vessels, storage tanks, autoclaves, mechanical power transmissions, steam boilers and steam generators.

1905 1910 1915 1925 1930 1935 1945
1950 2050 2220 2240 2825 3040 4410
4420 6115 8120 and page 258

Marine Services & Systems,
(Div. of Canadian Vickers Ltd.)
5000 Notre Dame Street East,
Montreal 404, Quebec.

Telephone: (514) 256-2651

Telex: 01-20287

Cable: VICKERS MONTREAL

Marine Controller: C. D. Atkins

Contact: R. A. Phillips, Manager

This firm will supply conceptual and basic design for new construction including modernization and/or conversion of naval or commercial vessels supported by models and mock-ups. This system will also produce contract design drawings and specifications followed by working drawings, bills of material and allied documentation.

Management control systems covering purchase specifications and requisitions; together with a technical review of the manufacturer's drawings and equipment as well as his production specifications and standards are also available.

Market research, feasibility studies, value engineering analysis, as-fitted drawings, master composite drawings and drawing quality assurance and control programme may be applied to any productions.

Weight control programmes, corrosion control consultant services estimating, computerized planning and scheduling including networks, microfilm standards and apprentice training programme may be initiated.

Pages 51 and 298

Marsland Engineering Limited,
(A member of the Leigh Group),
350 Weber Street North,
Waterloo, Ontario.

Telephone: (519) 884-4510

Telex: 029-5440

President: E. J. Pollock — President and General Manager.

Contact: J. P. Stahle, Manager of Marketing.

Marsland Engineering Limited is an established company (since 1926) utilizing qualified personnel in the design and manufacture of complex electronic, electro-mechanical systems and components.

They have been active in the development of ASW equipment, including Plotting Displays, Echo Range and Bearing Recorders, Sonar Simulators, Sound Measuring Sets and Torpedo Depth Control Systems. Their broad background has enabled

effective design/manufacture of specialized airborne and sea-going tactical and navigation equipments for commercial and military customers, this includes intercommunications systems, rotary transducers, insert controllers and special d.c. power supplies. The Public Address/Entertainment Broadcast System, AN/SIH-503, installed in the DDH 280 Class of Destroyers was engineered by Marsland utilizing "state-of-the-art" technology to RCN specifications. Standard Marsland products such as special loudspeaker systems and microphones were supplied with this equipment.

Meteorological systems consisting of Automatic Weather Stations, and sensor equipments such as Wind Speed and Direction, Transmissometer, Ceilometer and Digital Altimeter Display Systems are also produced for use by various airports and forecasting authorities throughout the world.

Teletypewriters are manufactured in five (5) and eight (8) level codes for automatic sending of narrative and computer data. Models are available in Receive Only (RO), Keyboard — Send/Receive (KSR) and Automatic Send/Receive (ASR).

Extensive machine shop, stamping, plating and assembly areas have permitted them to become a leading supplier of inert fuses and primers, related radar equipment, and precision components for industrial and military markets.

In addition to their extensive environmental test and standards laboratory our facilities include production orientated transformer, coil, speaker and related radio and television product assemblies and engineering. Memory core planes and special assemblies are manufactured for the computer industry.

1220	1310	1315	1355	1390	3020	4820
5805	5815	5820	5821	5825	5826	5830
5831	5835	5840	5841	5845	5895	5905
5950	5965	5975	5985	5995	5999	6110
6130	6320	6605	6625	6645	6655	6660
6665	6680	6695	6910	6930	6940	7440

and pages 51 55 56 179 228 237, 288 and 479

Menasco of Canada, Ltd.,
3495 Cote Vertu Road,
Montreal 382, Quebec.

Telephone: (514) 332-3330
Telex: 01-26683
TWX: 610-421-3627

President: A. C. Haines

Contact: J. Van Hemert, Vice-President

Design, development and manufacturing facilities for:

- Hydraulic power systems; aircraft and helicopter landing gear and powered flight controls.

- Recoil mechanisms and power drives for ordnance up to 155 mm.
- Engine fuel system components for aircraft and non-aircraft.
- Ship steering systems; shock absorbing systems; hydraulic valves, motors and pumps; high efficiency rotary actuation systems; consultant and design service for landing gear and powered flight controls; complete machining facilities; complete repair and overhaul facilities for landing gear and hydraulic system components.

1010	1015	1020	1025	1420	1560	1620
1630	1650	1680	1730	2030	2910	2915
2995	4320	4810	4820	4920	7610	

and pages 51 56 152 153 154 156 and 157

Microsystems International Limited,
800 Dorchester Blvd. West,
Montreal, Quebec.

Telephone: (514) 875-2814
TWX: 610-421-4647

Contact: O. A. Falworth, Director of
International Marketing

Designers and manufacturers to military, commercial, standard and custom specifications of: Bipolar linear I.C.'s: operational amplifiers — single, dual, general-purpose, high-performance, frequency-compensated, high-frequency precision instrument, micropower; precision voltage regulators; voltage references; transistor arrays; line drivers and receivers; comparators; clock drivers; and phase-locked loops.

MOS LSI silicon-gate: shift registers — static and dynamic, single, dual and quad; memories — RAMS, ROMS and PROMS; arithmetic units; CPU's.

Hybrids: telecom subsystems, thin and thick film, multi-chip; tone generators — telephone and multi-frequency; amplifiers — headset and microphone; 2W-4W networks; tone ringers; D/A converters; voltage references; tone receivers; out-pulsers; electronic switches; LED photo-cells; LED displays; channel transmitters and receivers; high voltage-high current drivers.

Discrete components; specialized transistors and diodes, LED's.

5895	5805	5915	5960	5961	5999
------	------	------	------	------	------

and page 243

Northern Electric Company Limited,
Head Office,
P.O. Box 6123,
1600 Dorchester Blvd. W.,
Montreal, Quebec.

Telephone: (514) 931-5711

Contact: J. M. Gorman, Vice-Pres., Sales

Switching Division:

Stored program electronic switching systems, common control crossbar switching systems. Power plants and rectifiers. Test sets, test desks, partial and complete turnkey service.

Transmission Division:

A complete range of transmission equipment and systems available. Engineered, furnished and installed equipments on turnkey or any other basis, depending upon requirements. Multiplex equipment for light or heavy density routes to meet North American or CCITT frequency plans. Wire line entrance links, cable carrier and line equipment for PCM or FDM systems. Microwave radio equipment designed and manufactured to meet North American or CCIR requirements. Alarm and control, VF terminal and repeater equipment, noise-measuring sets, power plants, etc.

Contact: W. Pardy, Vice-Pres., Sales

Apparatus Division:

Telephone sets including: pay stations, NE-500 and NE-2500 telephone sets, business telephone sets and consoles with rotary or push-button dial options. Data sets: NE-1A1, NE-1A2 and key telephone systems; interphone systems; private automatic switching systems; station connections material; outside plant apparatus; station plant maintenance material.

Wire and Cable Division:

Complete range of communication wires and cables. Custom built cables and complete coaxial cable systems are supplied. Power wires and cables, high and low voltage.

5805 5895 6145

Northwest Industries Limited,
P.O. Box 517,
Edmonton, Alberta,

Telephone: (403) 455-3161
Telex: 037-2681

Vice-Pres. and General Manager: K. S. Pollock

Contact: F. A. Maybee — Director,
Marketing and Contracts

The activities of Northwest Industries Limited are centred in the various phases of aviation, including major component manufacturing, airframe

modifications, repair and overhaul and instruments and accessories repair and overhaul. Northwest Industries is engaged also in the custom design and manufacture of fibreglass reinforced plastic products.

The Company's capability for component manufacturing ranges from sophisticated computer and equipment racks for aircraft and missiles through complete empennage assemblies and at present includes landing-gear doors, bulkheads, and floor sections for the new generation of wide body jet aircraft. N.W.I. has, in addition, complete facilities for production of close tolerance fibreglass reinforced plastic products for the aviation field.

The company possesses the facilities and trained personnel to undertake modification, maintenance and repair and overhaul programs on a wide variety of aircraft and engine types. These same facilities are also capable of flight instrument and accessories repair and overhaul. Fibreglass reinforced plastic products have provided Northwest Industries with entry into new and diversified markets in the petroleum, chemical and pulp and paper industries. The Company produces filament-wound fibreglass for corrosion applications and fibreglass pipe of continuous lengths up to 22.8 m (75 ft.) and up to 137 cm (54 in.) in diameter for effluent disposal.

1560 3615 4710 5430 9330 and pages
51 and 56

Northern Radio Manufacturing Co. Ltd.,
1950 Bank Street,
Ottawa, Ontario.

Telephone: (613) 733-4440
Telex: 013-274

President: J. G. Macmillan

Contact: W. Dover, Secretary-Treasurer

Northern Radio manufactures a wide range of products for use in telegraph and data transmission systems. The list of products includes:—

- Voice Frequency Channel Telegraph System: The voice frequency channel telegraph (VFCT) systems are made in multi-channel and single channel versions. Two standard 18 channel packages are available; these being the NR2 and NR3. The NR2 version is used where the leg units and monitoring facilities are required on the equipment bays. The NR3 is used where the monitoring facilities are located at a central patch and test bay. The NR4 system is built around 6 channel assemblies so that the user may have a full 24 channel CCITT system but may use fewer

shelves where fewer channels are needed.

A single channel subscriber set is available so that a tone loop can be terminated directly at a subscribers premises. The sub-set can be mounted directly in the base of most standard teletype machines.

All the VFCT systems employ the same channel units which are available at all international standard frequencies and in all signalling speeds up to 300 bauds.

Time Division Multiplex Systems:

Northern Radio is currently producing a range of Time Division Multiplex (TDM) systems for use with 2400 and 4800 bit modems. The TDM systems accommodate a variety of channel speeds and codes, however, perhaps the most useful version is the one designed specifically for use on telex trunks. This model transmits both the signalling information and the data and transmits 50 channels, each at 50 bauds, over a 2400 bit modem.

Speech plus Duplex Sets:

In many applications there is a requirement for 1, 2 or 3 channels of telegraph information or data to be passed, in addition to speech on a voice circuit. The company manufactures the complete terminal to which the telephones and the teleprinters or similar equipment may be connected. The sets are made with high grade dual HP/LP filters and ring-down facilities may be provided when required.

Telegraph Test Sets:

These sets are used to test the distortion on each channel of multichannel VFCT systems. They include a reversal generator and also enable the technician to terminate the send and receive loops.

Data Generator:

Their design facilities have produced a low-cost data generator whose small size permits it to be carried in a technician's kit box. The generator can produce any repeated 5 or 8 level character and also a repeated, pre-programmed test line such as Q.9.S.

Auto-diallers:

Two basic models of the auto-dialler are currently manufactured. The first of these is one which produces a single programmed sequence of digits when required. The second model can be equipped to produce any one of 6 or 11 pre-programmed sequences. If required, the auto-diallers can be fitted with facilities which automatically generate other characters, for example, Figure Shift and D, after the number sequence ends.

Sequential Selectors:

These units are usually employed on private wire telegraph systems where a central office polls, in sequence, a series of out-stations and controls the traffic to and from all of the out-stations. The selectors can be adapted to a variety of codes and interrogation and answer sequences.

2/4 Wire Adapters:

These adapters provide the interface between a standard, common battery 2-wire subscribers set and a 4 wire circuit. Again, this is a versatile unit which can be used with a variety of different system configurations.

Regenerative and Hub Repeaters:

A whole range of repeaters exists for a variety of applications. For telex use Northern Radio has a special Regenerative Repeater fitted with a dial pulse by-pass unit. For general telegraph and data transmission, a Universal Regenerative Repeater has been produced. This unit can be set to accommodate any code having from 2 to 15 elements. This repeater can operate at 50, 75 or 110 bauds and has an additional speed position for any special application. Northern Radio has manufactured many thousands of all solid state hub repeaters which use high-speed electronic relays.

5805 5810 5815 5820 5895.

Ontario Research Foundation,
Sheridan Park, Ontario.

Telephone: (416) 822-4111
TWX: 610-492-2524

President: W. R. Stadelman

Contact: J. D. Jones — Director,
Project Development

The Foundation is a research and development organization embracing a wide range of scientific disciplines and industrial technology. It develops new materials and processes in the field of ceramics, glasses, plastics, finishes, adhesives, alloys, powder metallurgy, waste disposal, water treatment, chemical synthesis and textiles. The ORF also undertakes engineering design and development to prototype stage of electronic and mechanical devices. It possesses equipment and staff which permit it to undertake materials and environmental testing, scanning electron probe analysis, scanning electron and optical microscopy, wet and spectrographic chemical analysis, failure analysis, strain-gauging and computerized stress analysis with temperature and vibration inputs.

Page 51

Orenda Limited,
Box 6001,
Toronto International Airport,
Ontario.

Telephone: 416: 677-3250
Telex: 02-29933
Cable: ORENDA

President: M. E. Davis

Director of Marketing: D. J. Caple

Contracts Mgr.: C. Johnson

Orenda Limited designed and developed the first two all-Canadian aircraft gas turbine engines — the 'Chinook' and the 'Orenda'. Through constant development, the 'Orenda' passed through a number of marks or types, each increasing in power, efficiency and reliability and they are still in use in the air forces of many countries. Starting in 1961, and using the technology acquired in the design, development and manufacture of aircraft gas turbines, Orenda designed and now manufactures a range of industrial gas turbines which have been well proven in use in many countries of the world under extremes of climatic conditions.

A complete overhaul service, including test facilities for engines up to 15,000 lb. thrust, static, is maintained for speedy and economical reconditioning of major assemblies and time-expired engines. Service engineers make a constant study of engine field experience with the object of reducing overhaul costs and at the same time maintaining a high standard of reliability.

All phases of design and manufacture are supported by the Engineering Laboratories which are housed in a separate building adjacent to the main Orenda plant and cover an area of approximately 36,000 square feet. The facility is air conditioned and temperature controlled throughout, and is one of the best equipped laboratories in Canada. Services offered include chemical and metallurgical testing, welding engineering, environmental testing, repair and calibration of instrumentation and manufacture of specialized test instrumentation and controls.

2835 2840 2995 6115 and pages 51 and 56

Otaco Limited,
West Street South,
Orillia, Ontario.

Telephone: (705) 325-6121
Telex: 0687-5588
Cable: OTACO

President: R. Howard McRae

Contact: W. Simpson, Sales Manager

Otaco is widely known for the manufacture of All Terrain Vehicles both gasoline and diesel powered. In addition the company manufactures pumps for both water supply and sump; flow developers; wagons, towed, pneumatic tired with 3 to 8 ton capacity; heavy duty arctic sleds with 10, 20 and 30 ton capacities; wheels, hubs, axles, springs and complete running gear for towed equipment. The company also produces custom castings in ductile, gray and steel.

2330 2510 2530 3920 4320 2320 5999

Outboard Marine Corporation of Canada Ltd.,
910 Monaghan Road,
Peterborough, Ontario.

Telephone: (705) 743-2261
Telex: 029-819

President: T. P. McMillan

Contact: Bruce L. Payne, Vice-Pres.

Manufacturers of outboard marine motors, snow-mobiles, power lawn mowers, power chain-saws, and 3 H.P. 2 stroke internal combustion gasoline engines. The company is equipped to do special die casting in both aluminum and magnesium, and also produces automatic screw-machine products.

2430 2805 3695 5130 and page 297

O & W. Electronics Ltd.,
28 Rolark Drive,
Scarborough, Ontario.

Telephone: (416) 291-8821
Telex: 02-2081
Cable: OKITOR

General Manager: R. B. Bozek

Contact: R. Liddell, Marketing Manager

This firm has enjoyed the confidence of both the Canadian and United States aerospace markets where they have been suppliers of Printed Circuit Boards and Edge Lighted panels. More recently the automotive industry has made wide use of their flexible circuits while modulear display units in many fields are now making use of the Edge Lighted panel techniques.

A wide range of assorted hardware is also produced in knobs, dials pointers, fire control dials and fans.

1220 1290 1560 5340 5355 5940 5999
6110 6605 6910 9330 9905 and pages 51
and 242

Phillips Cables Limited,
550 King Street West,
Brockville, Ontario.

Telephone: (613) 345-5666

President: T. A. Lindsay

Contact: J. E. Thomas, Vice-Pres.

This company produces virtually all types of communication wire and cable including coaxial, multi-core and radio frequency (RG Series). They also produce all types of copper and aluminum wire and cable, both bare and insulated, for the electrical industry.

6145

Pierre Thibault (Canada) Limited,
Pierreville, Quebec.

Telephone: (514) 568-3331
Telex: 01-26265

President: Charles E. Douville

Contact: Marcel L'Heureux, Export Manager

This company produces a range of fire trucks and trailers as well as a variety of pumps including portable models.

Specialized equipments for airfield use are also produced, including fire/crash trucks and fire rescue trucks. Foam systems are available on most types.

Fire ladders, including aerial types, and other accessories common to this field are also produced.

4210

Pioneer Saws Ltd.,
(Subsidiary of Outboard Marine Corporation of Canada Ltd.)
910 Monaghan Road,
Peterborough, Ontario.

Telephone: (705) 743-2261
Telex: 029-819

President: T. P. McMillan

Contact: Bruce L. Payne, Ex. Vice-Pres.

With nearly a half century of experience in the production of outboard motors behind them this

firm now offers a line of power chain saws, saw chain and guide bars that carry the same degree of reliability that has been associated with their marine products.

3695 5130 and page 473

Pirelli Cables Limited,
77 Richelieu Street,
St. Jean, Quebec.

Telephone: (514) 346-6831
Telex: 05-831532
Cable: PIRELCABLE

Contact: P. Lord, Export Manager

Pirelli produce a wide range of cable and wire as well as custom assemblies. In particular their production includes:

- Electric Cable; shipboard, ignition, ignition shielded, microphone, communication multi-core, power, shielded power, radio frequency, spark plug, special purpose, switchboard, flexible armoured, subterranean, submarine and coaxial, radio frequency (RG Series).
- Electrical Wire; antenna, braid, hookup, shielded hookup, ignition, insulated, and magnet.
- Electrical cord, lampcord and copper braid are also produced.

6145 6150

Plastal Manufacturing Ltd.,
476 Edouard Street,
Granby, Quebec.

Telephone: (514) 866-3224

Cable: PLASCAN

President: G. C. Keefer

The company has specialized in the manufacture of plastic components for the aerospace industry. Products include aircraft canopies and helicopter bubbles, thermo-formed seat components and interior panels, and fiberglass reinforced structural parts by vacuum bag and press moulding. The executive and design staff has had long experience in the Canadian and UK aircraft industry. Products are exported world-wide and the company has excellent capabilities in serving defence and civil aerospace customers. In the civil field, the company has diversified to anti-corrosion reinforced plastic products many of which have defence applications.

1560 and page 165

Preci-Tools Limited,
8565 Devonshire Place,
Town of Mount Royal,
Montreal 307, Quebec.

Telephone: (514) 342-9732

Sec. Treas. and Gen. Mgr. — Marcel Grunwald

Contact: Raymond Grunwald, Vice-Pres. — Sales

This company specializes in the manufacture of precision components and assemblies with the capability of producing for both short pilot runs and volume quantities.

An important factor in the growth of the company has been the continual endeavour to design, manufacture and market special machinery and equipment.

A notable area has been in medico-surgical equipment. The Pneumotanic Guide X-Ray Localizer, the Universal Tele-Stereotaxic Guide and the Vascular Stuturing Instruments being in the vanguard of these endeavours.

In recent years the addition of a number of numerically controlled machining centres with tool change capacity varying from 15 to 30 fully contouring plus computer assist has enabled the company to be in a position to supply industry with high precision components for installation in some of the most sophisticated devices extant.

2840 3413 3416 3419 3443 3456 6515
and page 51

Radio Engineering Products Ltd.,
P.O. Box 460,
Montreal 248, Quebec.

Telephone: (514) 731-3251
TWX: 610-421-3726
Telex: 05-25225
Cable: RADENPRO MONTREAL

President: C. B. Fisher

Contact: S. T. Fisher, Vice-President

This company has specialized for many years in the development and production of military tactical communication equipment, primarily telephone multiplex systems for use over VHF radio sets. The systems currently being delivered have as their principal component the TH-81/GCC Telegraph-Telephone Terminal. This provides 4 telephone message channels, 4 full-duplex telegraph channels and one telephone order-wire channel, and is used in the following systems:

- AN/PCC-1 Terminal Set, used with the AN/PRC-77 Radio Set to form the AN/TRC-166 Radio Terminal Set, with a capacity of 1 plus 4 plus 4 channels.
- AN/TCC-70 Terminal Set, used with the AN/VRC-12 Radio Set to form the AN/GRC-163 Radio Terminal Set, with a capacity of 1 plus 2 plus 4 channels.
- AN/VCC-1 Terminal Set, used with the AN/VRC-12 Radio Set to form the AN/MRC-134 Radio Terminal Set, with a capacity of 1 plus 4 plus 4 channels.
- AN/VCC-2 Terminal Set, used with the AN/VRC-12 Radio Set to form the AN/MRC-135 Radio Terminal Set, with a capacity of 2 plus 8 plus 8 channels.
- AN/VCC-3 Terminal Set, used with the AN/VRC-12 or C-50 Radio Set, with a capacity of 3 plus 12 plus 12 channels.
- AN/GCC-14(V) Terminal Set, used with the AN/TRC-24, AN/GRC-50, AN/TRC-97 and AN/GRC-103 Radio Sets, with a capacity up to 15 plus 60 plus 60 channels.

The company also produces fully militarized telephone and telegraph multiplex equipment for the first two super-groups, to be extended shortly to ten super-groups, in accordance with DCA, CCITT and NATO technical standards. Other products are the U-185()/G, U-186()/G, and U-187()/G Connectors and other components of the 26-pair field cable system, TA-312/PT Telephone Sets, RC-292 and AS-2369/TRC Antenna equipments, AB-577/G, AB-621/G, and AB-1120/TRC Masts, CU-1857/TRC Antenna Duplexers, VHF and UHF antenna multi-couplers, and other components of military ground and amphibious ship communication systems.

5805 5815 5895 5915 5935 5965
5985 5995 and page 222

R.B.H. Cybernetics, Patents & Processes Ltd.,
P.O. Box 4205,
Postal Station A,
Victoria, British Columbia.

Telephone: (604) 658-5713

Contact: V. N. R. Sewell, General Manager

This company produces an oil-pollution control system based on the "preferential-wetting" system of removing oil from water surfaces. The package includes a choice of boats to carry the basic equipment and booms to enclose spilled oil, and collapsible polyurethane containers to hold the recovered oil. This system has been proven effective in major spills. This system ("Slicklicker") also has many applications in industrial fields, since it is a very efficient method of separating oil from water. It can pick up emulsions, and to a large extent break them down into their oil and water components by mechanical means. It is of use in refineries, sewage disposal plants, barrel cleaning plants, etc. Machines can be individually designed for specific uses. The equipment can pick up oil from water surfaces at a rate of up to 204.5 litres (45 Imp. gals.) a minute. Separation of the oil is by "preferential-wetting," and oil picked up contains less than 5% water.

4330 and pages 51 and 462

RCA Limited,
21001 North Service Road,
Trans-Canada Highway,
Ste. Anne de Bellevue, 810, Quebec.

Telephone: Ste. Anne de Bellevue (514) 453-9000
Telex: 05-821572
TWX: 610-422-3932

President: J. D. Houlding

Contacts: I. A. Mayson, V.P. and General Manager,
Government and Commercial
Systems Division

D. D. McLean, Manager,
Program Development,
Aerospace and Government Systems

B. R. Machum, Manager,
Sales and Merchandising,
Communications Systems

W. H. Holroyd, Manager,
Sales and Merchandising,
Broadcast and TV Systems

- Aerospace Programmes:
Under this marketing function continuous contact is made with the aerospace industry and

users of aerospace systems. The prime areas of supply are experimental and communications satellites and subsystems thereof, which includes Telemetry, Tracking and Command and associated units, such as transmitters, encoders and decoders, multiplexers and receivers; Power Conditioning and Protection equipments are also supplied. For communications satellites RCA Limited will supply wide band, solid state transponders and antennae. Also within this marketing function, equipment and services are provided for special defense programs. Major areas of interest are in the provision of radio communications transmitters and receivers and custom built internal ship-board communications systems, plus various forms of radar systems and equipment. Additional services for instrument repair and calibration, environmental testing and the repair, overhaul and field maintenance of electronics equipment and systems are also provided to both the defense and industrial markets.

• **Communications Systems:**

The two main markets served by this operation are microwave radio relay and communications satellite earth stations.

Short-haul and long-haul solid state radio relay systems are available in the 2, 4, 6 and 7 GHz bands. This microwave radio relay equipment (RCA 9000 series) is well field-proven, having been supplied for major telephony and TV systems both in Canada and many countries around the world. Developing from this equipment are such items as high performance, wide band solid state 70 MHz modulators and demodulators and specialty test equipment. Communications satellite earth stations and especially sub-systems thereof, such as low noise antenna feed systems, wide band solid state communications systems and 6 GHz power amplifiers etc. are available to users and prospective users of the INTELSAT global communications system.

In addition, repair, overhaul and field maintenance of all these communications systems and equipment are available.

• **Broadcast and Television Systems:**

This group provides equipment and services for broadcast and television transmitters and the associated studio equipment such as cameras, consoles etc., also audio, RF and video amplifiers. Data handling equipment, with particular attention to Digital to Video Converters under the RCA Limited trade name DIVCON is also available.

Repair, overhaul and field maintenance of these systems and equipment can readily be provided.

In addition to the products and services defined above, RCA Limited manufactures and supplies miniature receiving tubes; monochrome and color TV picture tubes; semi-conductors; nuclear particle detectors and photodiodes.

1230	1265	1285	1430	5805	5810	5815
5820	5821	5825	5826	5830	5831	5835
5841	5845	5850	5855	5895	5915	5945
5950	5960	5985	5990	5999	6130	6625
6660	6665	6910	6930	6940	7440	7610

and pages 50 51 55 56 208 210 212 and 214

Rex Chainbelt Canada Ltd.,
1181 Sheppard Avenue East,
Wellowdale, Ontario.

Telephone: (416) 221-9361
Telex: 06-22153

President: L. P. Commerford

Contact: F. C. Stapley, Toronto District
Sales Manager

This company is engaged in the manufacture and sale of bulk material handling equipment; mechanical power transmission products and environmental control equipment.

• **Bulk Material Handling Equipment:**
Including belt conveyors; bucket elevators; vibrating conveyors; vibrating feeders; rotary table feeders and drag chain conveyors or complete systems for the handling of bulk products such as cement or coal aggregate are designed and produced.

• **Mechanical Power Transmission:**
The product line consists of mounted roller bearings; sprockets for all types of chain; cast chains and heavy duty roller chains, all of which are generally associated with prime material handling lines.

The environmental control group of the company is responsible for the design and manufacture of water and waste-water treatment equipment. There is a large variety of equipment from which to choose. Briefly these may be categorized thus; screens, grit collectors; flocculators; clarifiers (rectangular and circular); skimming equipment; air flotation equipment; aerators and vacuum filters. Many of these equipments have been supplied to Canadian Forces Bases and are used in the treatment of sewage. Other equipment is used to treat raw water supplies to produce potable water. More sophisticated equipment of a complex nature is available to treat waste other

than sewage, such as water contaminated with oil or other petroleum based products; laundry waste water, aircraft maintenance and washing, etc. For such custom requirements you are requested to forward your enquiries to the company.

2520 3010 3020 3040 3130 3895 3910
3990 4010 4630 and page 51

Rousseau Controls Limited,
271 Labrosse Avenue,
Pointe Claire, Quebec.

Telephone: (514) 695-1240

President: D. Casgrain

Activities include hydraulic and pneumatic systems and assemblies in the areas of aircraft ground servicing equipment, industrial maintenance and repair shop equipment and aircraft maintenance and repair shop specialized equipment; test equipment, industrial and aircraft, hydraulic jacks, hydraulic platforms, hydraulic actuators airborne and non-airborne. Production also includes the design and manufacturing of truck-borne hydraulic cargo loading platforms, flight kitchens, etc., for servicing of large aircraft both military and commercial.

1730 4910 4920 and page 51

Saint John Shipbuilding & Dry Dock Co. Ltd.,

P.O. Box 970,
Saint John, New Brunswick.

Telephone: (506) 693-9941
Telex: 014-47243

Contact: A. A. McArthur, General Manager
J. R. Elder, Technical Manager

Strategically located on a sheltered bay, adjacent to Saint John Harbour, the shipyard has had over forty years experience in building, repairing and refitting of ships of all classes. It has one of the largest drydocks in North America, with building berths, fitting-out piers and work shop facilities to accommodate some of the largest ships afloat. The yard is fully equipped to provide fast ship repairs and complete auxiliary services. Located in an area of 291,375 m² (72 acres) the main dry dock measures 350.5 × 38 m (1150 × 125 ft.) and has 12.8 m (42 ft.) of water over the sill at high tide. This dock can be converted into two separate docks of 198 m and 152.4 m (650 and 500 ft.) long separated by a floating caisson gate. An additional drydock of 134 m × 18.2 m (440 ft. × 60 ft.) is also capable of handling all phases of ship construction, conversions or repairs.

New ship construction has covered virtually all types of marine surface transport and recent additions have been Operational Support Ships as well as hydrographic and oceanographic survey vessels which are more fully covered in the illustrated section of this book. The production covers such diversities as tankers (under construction) fishing vessels of various types together with sea-going passenger/vehicle ferries. As steel fabricators pontoons, floating, docks and dry docks, dredges and buoys are obvious by Saint John has also been a custom supplier of fabrications to such industries as mining, smelting, oil refineries, chemical plants, pulp and paper and thermal and hydro-electric developments. It is also only natural, being located near a forestry region and still with the memory of masted ships, that one of the custom productions, in which fine craftsmanship is still a trademark, is the wooden furniture which can be supplied to meet discriminating requirements.

1905 1910 1915 1920 1925 1930 1935
1940 1945 1950 1955 2020 2040 2050
2090 7110 7125 7195 and pages 56 254 257
260 and 261

Sicard Incorporated,
Sicard Street,
P.O. Box 600,
Ste. Therese, Quebec.

Telephone: (514) 435-6171
Telex: 018-3715
TWX: 610-422-4031
Cable: SICARIN

President: J. C. Pigott

Contact: P. J. Bruton, Vice-President Marketing

The Sicard Company is actively engaged in manufacturing snow blowers, airfield sweepers, highway truck tractors, dumper type truck, off-highway vehicles of various types and to 150 ton capacity. Special application off-highway tractor trailers, bottom dumpers up to 250 ton capacity. Special application crash-rescue vehicles to N.F.P.A. and I.C.A.O. standards together with aircraft towing equipments and also part of their normal production.

1740 2320 3825 4210

C. R. Snelgrove Co. Limited,
(A member of the Leigh Group)
141 Bond Avenue,
Don Mills, Ontario.

Telephone: (416) 447-8531
Telex: 02-21598
TWX: 610-492-1354
Cable: SNELCRYSTL

President & General Manager: W. C. Hickling

Contact: (Miss) Helga Silla, Sales Manager

The production of frequency control devices by this company includes quartz crystals from 4 kHz to 200 MHz as well as cold weld packages above 1.5 MHz. Crystal ovens with thermostat and proportional controls, crystal filters of conventional and monolithic designs together with crystal oscillators which are oven controlled and of the TCXO and VCXO types are all produced to international standards.

5820 5915 5955

Space Research Corporation (Quebec) Inc.,
2055 Peel Street,
Suite 175,
Montreal 110, Quebec.

Telephone: (514) 288-8174
Telex: 05-26753

President: Dr. G. V. Bull

Contact: W. H. Friend, Vice-Pres.

The company's primary activity is the design and development of ammunition for medium and large calibre guns. To this end the company operates extensive test and instrumentation facilities which has given rise to diversification into many related areas.

A wide range of full-bore and sub-calibre ammunition has been designed for extended range application for guns from 105 mm to 406 mm. Special purpose ammunition has encompassed the full range of conventional ordnance payloads. A number of novel increased performance rounds have been developed. Gun launched rockets have been developed over the same range of calibres. Of particular interest is a family of upper atmosphere meteorological probes for use with either high performance smooth-bore guns or conventional rifled service guns.

Guidance and control systems have been designed for in-flight control and boosted and un-boosted ordnance. Extensive instrumentation capability has been built up with emphasis on optics and electronics capabilities. A wide range of products has been developed including a highly successful air traffic control radar simulator.

1310 1315 1320 1325 1340 1395 1430
5840 6610 6625 6650 6660 6910 6930
and pages 51, 55 and 476

Spartan Aero Limited,
380 Hunt Club Road,
Ottawa, Ontario. K1G 3N3

Telephone: (613) 822-0121
Telex: 013-473
Cable: SPARTAERO

President: Douglas G. MacKay

Contact: E. C. Anderson

The basic activities of this company are the collection, processing and interpretation of airborne and ground data for photogrammetric engineering, geophysical exploration and other resource developments.

For these purposes the company conducts aerial photographic surveys and air-photo interpretation; airborne distance measurements for geodetic control surveys; airborne geophysical surveys for mineral and oil exploration; computer mapping for topographic and geophysical applications; control surveys for geodetic purposes; forest inventories for commercial and national agencies; geological and geophysical airborne and ground surveys employing magnetometers, electro-magnetometers and scintillation counters; land-use surveys both actual and potential by air-photo analysis and ground sampling; photogrammetric aerotriangulation and plotting for map production; relief models based on photogrammetric techniques; design engineering for railways and roads; location surveys for transmission lines, microwave and communication routes; interpretation of geophysical data.

7640 and page 50

Sparton of Canada Limited,
100 Elm Street,
P.O. Box 5125,
London, Ontario.

Telephone: (519) 455-6320

President & General Manager: J. H. Gregson

Contact: A. S. Logan, Marketing Manager

The company's chief area of operation is in the underwater acoustic phase of Anti-Submarine Warfare. It designs and manufactures active and passive sonobuoys for military use and passive sonobuoys for use in underwater seismic surveying. It also designs and manufactures test equipment in the form of Wave Analyzers and Frequency and Deviation Meters. It has designed and manufactured a variety of equipments in the R.R. Communications field, such as H.F. and U.H.F. receivers, specialized sonobuoy receivers, radio control devices and is well qualified in the use of ceramic transducers as sensors and transmitters in the sonic and ultra-sonic fields. Radiation detection training devices have also been designed and manufactured.

The company also manufactures light wire and sheet metal parts such as electronic chassis, tool boxes, refrigerator shelves, etc. and has facilities for nickel, chrome and zinc plating to commercial and Military specifications.

5820 5845 5999 6625 6655 6910
and pages 51 and 292

Spilsbury & Tindall Ltd.,
120 East Cordova St.,
Vancouver 4, B.C.

Telephone: (604) 684-4131
Cable: SPILTIN

President: A. J. Spilsbury

Contact: R. E. Macpherson, Export Manager

This firm produces a range of single sideband (SSB) radio-telephones in power ranges of 10, 60, 120 and 500 watts where the prime use of the equipment will be point to point service, mobile roles, airborne service and ship to shore communications. Together with these equipments, non-directional beacons (low frequency (LF) 50 watt) particularly suitable for small airports. A wide variety of specialized antenna tuning units, antenna switchers and tuneable, high frequency (HF) whip antennas are produced for mobile, marine and airborne applications.

5805 5820 5821 5985

Standard-Modern Tool Company Limited,
69 Montcalm Avenue,
Toronto 10, Ontario.

Telephone: (416) 787-2494
Telex: 02-29421
Cable: STANMODCO

Vice-Pres. & Gen. Mgr.: R. J. Barrett

Contact: A. E. Essex, Sales Manager

The main activities of the company are in the design and manufacture of machine tools and related equipment. A complete line of standard machines has been developed to meet the requirements of industry, defence and education. These standard machines include geared head lathes with capacities from 23 mm to 48 mm (9 in. - 19 in.) swing, numerically controlled lathes to 43 mm (17 in.) swing, profiling lathes, radial drills, milling tables, index machines, tapping machines and coil winders. Custom designed versions of these standard machines are made to meet special requirements such as ship board installation or truck mounted versions for field repair shops. An experienced design and manufacturing group enables the company to produce a wide variety of special purpose custom built machinery for the drilling, tapping, boring and milling of metal components plus assembly, packaging, leak testing and sound testing machines. The design staff provides consulting and design services for machine tools including prototype development.

Precision machined components and assemblies such as gears, gear boxes can be made to ordnance standards.

A well equipped toolroom provides design and manufacturing capability for progressive and single operation dies to draw, form, pierce, stamp and press sheet metal components. Jigs and fixtures are produced in all types and sizes plus receiver and special gauges.

3020 3413 3416 3419 3456 3460 3465
3695 4940 5110 5136 5210 and page 51

The Stanley Manufacturing Company Limited,
230 Bartley Drive,
Toronto 375, Ontario.

Telephone: (416) 757-3221

President: J. W. Patterson

Contact: F. Mendham, General Sales Manager

Stanley Manufacturing is a prime and proven source for our Canadian Forces and Allies for a great variety of calculators, dials, scales, rulers and gauges printed on or made from sheet plastic and used in Fire Control roles. The company has also produced mortar plotting boards capable of withstanding field use and still maintaining their original high accuracy. The firm also produce plastic name plates, instruction plates or sheets and virtually any requirement printed on plastic.

1220 1290 6605 9905

Swann Winches Ltd.,
1494 Powell Street,
Vancouver 6, B.C.

Telephone: (604) 253-1196

Contact: W. Robblins, General Manager

This firm is engaged in the design and production of winches, windlasses and capstans for all types of marine craft. They also design and produce hydraulic motors and controls for deck equipment.

A comprehensive line of oceanographic and bathythermograph winches and trawl equipment is also produced.

2030 3950 4320 6655 and pages 51 and 268

Textile Industries Limited,

P.O. Box 150,
Guelph, Ontario.

Telephone: (519) 824-3450 — Guelph
(416) 924-7558 — Toronto
Telex: 0295-6562

Contact: Mr. C. A. Wright, Vice-Pres.

This firm has been a major supplier of web equipment to the Canadian Forces for many years and over this same period many of our allied have taken advantage of their performance which meets rigid specifications at competitive costs. Some of their production has included such items as:

- Web waist belts — Pistol holsters — Mess tin Carriers — Shoulder straps — Medical carrying cases — Grenade carriers — Snow shoe bindings — Ski bindings — Packs — Kit bags — Bunker suits — Firefighter's jackets and trousers — Anklets — Canteen carriers — Compass cases — Respirator carrying cases — Entrenching tool cases — Tool rolls — Haversacks

8305 and page 358

TMC (Canada) Limited,

R.R. 5, Ottawa, Ontario.

K1G 3N3

Telephone: (613) 822-0244

Telex: 013-416

Cable: TEPEI OTTAWA

President & Managing Director: D. V. Carroll

Contact: Wm. F. Potter, Sales Manager

This company manufactures as well as designs, for domestic or international markets both commercial and military Communications Electronics equipment (except airborne) from low frequency to high frequency (30 mhz) with limited production in VHF (e.g., transmitters, receivers, multi-couplers). A highly specialized part of the production line is devoted to Single Sideband equipment. A complete range of transmitters (100 watts to 40 kilowatts), receivers, accessories, control equipment and AF/RF patching systems can be offered.

Other special product lines include Time Division Multiplex, CRT data terminal equipment, receiving multi-couplers, filters, broadband RF transformers, dummy loads and static no-break power systems. A very versatile manufacturing capacity is available for customized design or subcontract work (e.g., electronic/printing circuit/rack and

cabinet assembly, cable harnessing). In addition, complete communication systems, surveys, training and experienced installation services can be offered.

5805 5815 5820 5895 5915 5950 5975
5985 5995 5999 6115 6130 6625
7440 and page 51

Triplex Engineering Co. Ltd.,

181 Oneida Dr.,
Pointe Claire 730, Quebec.

Telephone: (514) 695-9872

President: M. Pohoryles

Contact: P. Braun, General Manager

Triplex, as a quality controlable proven source for precision machining of custom metal products, continues to be an assured source of supply for components and assemblies in such diverse fields as:

- Ammunition — components for, flares and fuses
- Aircraft — rolled thread, engine studs
- Automotive — hydraulic brake system components
- Communications — metal components for systems such as described under Radio Engineering products
- Electro-mechanical — ignition controls and assemblies

1310 1315 1336 1340 1345 1350 1360
1390 5305 5306 5307 5310 5935

Uniroyal Limited,
550 Papineau Avenue,
Montreal 133, Quebec.

Telephone: (514) 522-2111
Telex: 01-2862

President: H. D. Glenn

Contact: Chemicals: W. J. Hogg, Gen. Sales Mgr.
Elmira, Ontario.
Telephone: (519) 669-5466
Telex: 029-5421

All Other Products:

W. H. Dotzenroth, Mgr.
Government Sales,
51 Breithaupt Street,
Kitchener, Ontario.
Telephone: (519) 744-7171
Telex: 029-5430

Uniroyal are manufacturers of all types of rubber and plastics, reclaimed rubber and textile products. They also produce a wide range of organic chemicals used in the rubber and plastics industries and in agriculture. A completely equipped machinery shop, specializing in rubber and other industrial manufacturing machinery and moulds and dies is operated by this company. Research is done in the field of chemicals, rubber, textiles and other related products of interest to the company's operations. There are also complete facilities to develop and engineer rubber and plastic products for both the Military and Industry.

Tire Division — Kitchener, Ontario.

This Division manufactures solid rubber tires and rubber tired wheels and tubes for use on passenger trucks, buses, as well as for farm, industrial and aircraft use.

Rubber Machinery Division — Kitchener, Ontario.
Special rubber working machinery fabrications and other industrial manufacturing machinery and such items as tire moulds, dies, tools, jigs and fixtures, sheet metal duct work and tray truck fabrications are manufactured at this plant.

General Products Division — Kitchener, Ontario.

This division produces such materials as crash pads and vinyl coated fabrics for the automotive industry, sponge rubber underlay, vinyl coated upholstery fabrics, simulated wood moulded products, pneumatic mattresses rubber inflatable boats and life rafts, flexible rubber storage containers for liquid fuels, inflatable dunnage, pollution control oil booms, skimmers and tanks. Textile products include nets, fleeces pile fabrics, bonded fibre/padding, fibreglass, insulation and felt products.

Industrial Products Division — Montreal, Quebec.

Industrial rubber products such as hoses, conveyor and transmission belting, moulded formed rubber and plastic products rubber cov-

ered rolls, electrical insulation tapes, rubber and plastic coated fabrics, sheet stock, rubber matting, expansion joints, tank and tractor rubber track treads, gas masks, boat and dock fenders are manufactured:

Uniroyal Chemical — Montreal, Quebec.

This Division is the reclaim rubber and adhesives department where two-part elastomeric sealants, Latricete for ships' decks and hot poured joint sealers can be obtained.

The Elmira plant produces agricultural, rubber and general chemicals, polyester plastic resins and rigid urethane foam systems.

1015	1020	1560	1660	1730	1940	1945
2040	2050	2090	2510	2530	2540	2590
2610	2620	2630	2640	2805	2810	2815
2910	2915	2930	2935	3030	3456	3465
3615	3620	3895	3910	3920	3990	4220
4240	4710	4720	5330	5340	5410	5420
5430	5640	5970	5985	6515	6810	6840
6850	8010	8030	8040	8140	8465	9320
9330	and page 51					

United Aircraft of Canada Limited,

P.O. Box 10,
Longueuil, Quebec.

Telephone: (514) 677-9411
Telex: 05-267509
TWX: 610-4223872
Cable: UNITED AIR MTL

President: T. E. Stephenson

Contact: K. H. Sullivan, Vice-Pres. Sales

United Aircraft has designed and manufactured the PT6 turbo-prop and turbo-shaft series of aircraft engines, the PT6T Turbo Twin-Pac 'TM' engine, ST6 gas turbine engines for industrial and marine applications, and the JT15D turbo-fan engine.

Union Carbide Canada Limited,
Suite 711, Burnside Building,
151, Slater Street,
Ottawa, Ontario.

Telephone: (613) 235-9272

Contact: E. L. Littlejohn, Mgr., Ottawa Office

- **Consumer Products**

Flashlight, lighting, photoflash, hearing aid, transistor and other electronic batteries; flashlight cases and lanterns; Linde star sapphires and rubies; synthetic crystals; anti-freeze coolants; insect repellent; flashlight and radio panel lamps; protective wrappings, bags and garbage bags.

6135 6230 6850 7240

- **Fibres**

Nylon (Unel); modacrylic fibre (Dynel); fabric and filters (Fiberbond).

8305

- **Gas Products**

Linde oxygen, nitrogen, hydrogen, argon and rare gases; calcium carbide and acetylene; welding, cutting, forming and heat-treating apparatus; coatings service; steel-conditioning machines; rock-piercing and shaping equipment; medical gases, inhalation and suction therapy equipment; distillation trays; cryogenic equipment; proppants; food freezing equipment; in-transit refrigeration systems; molecular sieves; special alloys to resist heat, corrosion and wear. Secondary waste water treatment systems (UNOX).

3426 3431 3433 3439 3449 3655 4110
4130 4240 5350 6515 6630 6635 6640
6680 6830 8120 9135

- **Metals and Carbon**

Metals: Ferro-alloys, alloying metals, pure metals and metal compounds produced from the elements boron, calcium, chromium, columbium, manganese, silicon, tantalum, titanium, tungsten, vanadium and zirconium.

Carbon: Electric arc furnace electrodes; electrolytic cell anodes; furnace linings; electric motor and generator brushes; theatre projector carbons; carbon and graphite products for chemical, electrical, mechanical and metallurgical applications.

4430 4710 5330 5977

- **Plastics:** Phenolic resins and compounds; polyethylenes and co-polymers; epoxy resins; vinyl and polystyrene co-polymer resins and

compounds; polysulfone resins; polyethylene film; industrial shipping bags; flexible packaging; cellulose and fibrous food casings.

- **Chemicals:** Organic chemicals including ethylene oxide, ethanolamines, glycols and glycol ethers; agricultural chemicals, silicone chemicals, resins, oils and elastomers.

5970 6810 6850 8030 8040 8105
8135 9330

United Aircraft of Canada Limited,
P.O. Box 10,
Longueuil, Quebec.

Telephone: (514) 677-9411

Telex: 05-267509

TWX: 610-4223872

Cable: UNITED AIR MTL

President: T. E. Stephenson

Contact: K. H. Sullivan, Vice-Pres. Sales

United Aircraft has designed and manufactured the PT6 turbo-prop and turbo-shaft series of aircraft engines, the PT6T Turbo Twin-Pac 'TM' engine, ST6 gas turbine engines for industrial and marine applications, and the JT15D turbo-fan engine.

The PT6 engine at the beginning of the '70's was powering some 75 per cent of the light twin turbo-prop aircraft of the western world.

The second major engine development, the JT15D turbo-fan engine, went into production in early 1971 after prototypes were flown in 1969. The JT15D is scheduled to be the powerplant of light jet transports of the 1970's, including the Cessna Citation and the Corvette from Aerospatiale in France.

In 1966, the company formed an Industrial & Marine division to market industrial and marine versions of the PT6 series of engines. Non-aeronautical applications of the gas turbine engines manufactured by the company have included turbocars at the Indianapolis 500 and turbo-trains in Canada and the United States. The division is the prime contractor for the propulsion system of four turbine-powered Canadian destroyers, scheduled for service in the 1970's. The company now handles virtually all manufacturing and servicing of Pratt & Whitney aircraft reciprocating engines and they also maintain a helicopter and systems division which assembles helicopters for the Canadian Armed Forces and manufactures components for Sikorsky helicopters.

2810 2835 2840 2995 7610
and pages 51.56 and 144

Universal Die & Tool Mfg. Ltd.,
2125 St. Catherine St. East,
Montreal 133, Quebec.

Telephone: (514) 526-9455

Telex: 01-25575

President: L. LeBrun

Contact: A. Zbikowski, Secretary-Treasurer
& Gen. Mgr.

This firm is a major source of supply for custom machine shop work and have been producing to ordnance tolerances for over twenty-five years. They have designed and produced a family of maintenance and cleaning kits for small arms that have greatly reduced the number of items to be carried.

They have also produced such equipments as rocket launchers; sights air lookout; gas pressure gauges; parts for rifle sub-caliber M20, 75 MM; electrical target devices; portable; decontaminating apparatus and electro mechanical assemblies. In the avionics field they produce aircraft masters and allied tooling, aircraft components, extruded hinges, spars, and they have also produced a high percentage of spar caps for all DC 9 and 10 aircraft.

1005 1015 1095 1290 1560 1680 1730
2510 3465 4230 5340 6920 7340
and pages 398 and 454

Valcartier Industries Inc.,
P.O. Box 790,
Courcelette, Co. Portneuf, Quebec.

Telephone: (418) 844-3711

Contacts: T. F. Duchene, General Manager
J. G. Moore, Mgr., Commercial Division

Small arms ammunition and larger caliber brass and steel cases together with a wide variety of metal parts for all calibres of mortar bombs and rockets are the basic production. A wide range of automotive parts including gas tanks, hub caps, as well as steering gear components, are produced. This firm has also developed and produced a line of small tracked vehicles. Plastic blow moulding and injection moulding facilities and products are also available. A range of plug, taper and inspection caliber gauges together with cutting, forming and metal stamping dies are produced. Amongst other special industrial machinery which has been produced is a rivetting machine for the production of boots and shoes.

1305 1310 1315 1320 1325 1390 1395
2410 2510 2530 3456 3520 5110 5210
5220 8125 9330 and page 330

Varian Associates of Canada Ltd.,
45 River Drive,
Georgetown, Ontario.

Telephone: (416) 877-6901
Telex: 069-7502
TWX: 610-492-2641

President and General Mgr.: B. H. Breckenridge

Contact: G. C. Smith, Marketing Manager

This company specializes in the design and manufacture of microwave tubes and associated equipment such as power supplies and isolators. The principal products manufactured are: low power reflex klystron oscillators with frequencies in the range 8 - 26 GHz, used in doppler navigation systems, police radar, parametric amplifiers, etc.; Millimeter Wave Reflex klystrons and extended interaction oscillators (40 - 220 GHz range) used in high definition radar, microwave spectroscopy, radio astronomy and other research applications; medium power (2 to 8 kW) multi-cavity klystron amplifiers (4 - 8 GHz), used in tropospheric scatter systems; travelling wave tubes (1.7 - 11 GHz) used in line-of-sight telecommunications; and high power magnetrons (2.7 - 3 GHz) used in height-finding radar and linear accelerators.

Engineering functions associated with the design, development, production, quality control and marketing of the company's products are handled by a staff of twelve engineers and eighteen technicians.

5960 and page 51

Volcano Limited,
8635 St. Lawrence Blvd.,
Montreal 351, P.Q.

Telephone: (514) 381-6281
Telex: 01-2856
Cable: VOLCANO

President and Gen. Mgr.: Jacques P. Villeneuve

Contact: Yves A. Larose

This company is engaged in the manufacturing of boilers and boiler room equipment. Firetube boilers from 10 to 600 HP for hot water, low and high pressure steam. Water tube high pressure boilers from 4,536 kg to 34,020 kg (10,000 to 75,000 lbs.) of steam per hour. High temperature water generators up to 125 millions BTU/hr. Thermal liquid heaters up to 85 millions BTU/hr. In addition, boiler room equipment such as de-aerators, condensate units, oil pumping and heating sets and water heaters are produced.

4410 4420 4440 4520

Wabco Equipment Canada Limited,
Adams Avenue,
Paris, Ontario.

Telephone: (519) 442-4434
Telex: 021-81156

General Manager: F. R. Remus

Contact: W. Williams, Sales Manager

This company produces a wide range of graders and trucks for the construction industry and maintains a wide service support organization.

3805 3825 and page 312

Westhill Industries Limited,
9031 Parkway Blvd.,
Ville D'Anjou,
Montreal 437, Quebec.

Telephone: (514) 352-2310

Contact: G. Saulnier, President

This company has been a source of supply to the aircraft industry for over 25 years. Components for landing gear, hydraulic struts and assemblies have been produced for a wide range of aircraft. Bulkheads, ribs, beams, wing fittings, leading edges and arresting hooks have been produced for such aircraft as CF-104, CF-5, CL-11, DC-9 and DC-10.

1560 1650

Westinghouse Canada Limited,
(Electronic Systems Division)
P.O. Box 510,
Hamilton 23, Ontario.

Telephone: (416) 528-8811
Telex: 021-655
TWX: 610-371-0246
Cable: WESTCAN

Manager: J. K. Carman

Contact: E. M. Hepburn

Since the formation of the division in 1951, it has played a major role in the supply of defence

products systems and services to the Canadian Forces as well as to other nations. One of the primary activities of the division is the design, development and production of advanced sonar equipment and systems, and in this same field training devices such as sonar target signal generators are designed and produced. Other marine activities include system design and programme management of integrated ship weapon, navigation and action information systems. Various types and configurations of torpedoes and A/S projectiles have been built. A special shallow water configuration of the MK 44 Torpedo has been developed and produced as well as a modification kit to add the shallow water operational capability to standard MK 44 Torpedoes.

Another major activity involves electronic warfare capabilities. It includes ECM and ECCM weapons and weapons counter-measures, studies of automated EW systems, design and production of EW displays, analysis equipment and antennae. These programmes have added to extensive in-house expertise in systems analysis, digital logic, signal processing and microwave systems.

The division has developed a line of stabilized platforms for mounting a variety of imaging devices such as line cameras, TV cameras, infra-red and laser sensors. These platforms provide a degree of line of sight stability not obtainable by any other technique over a wide range of roll pitch and yaw motions encountered on moving vehicles.

- Real-time information display systems are being developed and produced to provide read-out displays in both digital and graphic form. These systems can accept data from a variety of sources in a variety of codes, store the data and convert it for display on standard TV or special monitors.
- Engineering support services are provided for installation, tuning and testing trials of equipment produced by the division. The engineering staff is active in research and development as well as providing design support in the production of hardware items. Feasibility and research study capabilities are available for all the above areas of activity. Mechanical, design and model building to package electronic and electro-mechanical circuits or devices, with emphasis on human engineering considerations, is an integral part of the design services offered.
- Production facilities and expertise are available to fabricate and machine mechanical parts and components and to assemble, wire and test a wide variety of electrical, electronic and electro-mechanical assemblies and equipment.

5820 5821 5840 5841 5845 5985 5999
6110 6940 and pages 50 51 56 158 and 380

Westinghouse Canada Limited,
(Turbine & Generator Division)
P.O. Box 510,
Hamilton, Ontario.

Telephone: (416) 528-8811
Telex: 021-655
TWX: 610-371-0246
Cable: WESTCAN

Manager: C. A. Kain

Contact: R. C. Hall, Manager, Sales.

Manufacturers of steam turbines and AC turbine generator sets to 25,000 KW; overhaul and repair of steam turbines for propulsion and generation duty. Gas turbines and gas turbine generator sets to 22,000 HP; overhaul and repair of gas turbines. Direct current and alternating current type electric ship propulsion systems. Special constant voltage type AC ship service generators to 1,000 KW. Auxiliary steam turbines for cargo, fire pump, etc. service.

2825 6115

Westinghouse Canada Limited,
(Solid State Devices Department)
P.O. Box 510,
Hamilton, Ontario.

Telephone: (416) 528-8811
Telex: 610-371-0246
Cable: WESTCAN

Manager: W. A. Pieczonka

Contact: R. H. Cairns

Manufacturers of Linear integrated circuits for a variety of applications. A development service is offered to integrated circuits to specific customer requirements.

5999 and page 51

Westinghouse Canada Limited,
(Switchgear and Control Division)
P.O. Box 510,
Hamilton, Ontario.

Telephone: (416) 528-8811
Telex: 021-655
TWX: 610-371-0246
Cable: WESTCAN

Manager: R. W. Lister

Contact: N. W. McGuinness

Manufacturers of an extensive line of Switchgear and Control equipment including components, devices and systems for electric utilities, manufacturing plants, transportation and resources industries.

5925 5945 5950 6110 6120 6130
6150 6625

Will-Hart Ltd.,
1100 Bellamy Rd.,
Scarborough, Ontario.

Telephone: (416) 293-8266
TWX: 610-492-4371

President: Kurt Willadsen

Contact: W. M. Stubbs, Sales Manager

The design and production of edge-lit panels to MIL specifications for both military and commercial is the normal production of Will-Hart. Typical applications are in radar and navigation equipments, weapon control systems or pressure and control units. The company also designs and produces graphic and mimic panels for use in annunciator, telemetering, supervisory and control systems.

5999 and page 51

ILLUSTRATED SECTION

This section of the book portrays the broad and diverse lines of equipment now being designed, developed and produced in Canada. As in past editions we feel that after evaluating these items it will become clear that Canada possesses the engineering capability, the production facilities and laboratory back-up so vital to a modern industrial complex.

This edition has been modified in an attempt to make a broader presentation for you by depicting facilities as well as products and also includes a sketch of the National Research Council which is an in depth back-up to Canadian industry.

AIRCRAFT AND AEROSPACE, PRODUCTS AND SERVICES



DHC-6 TWIN OTTER

The Twin Otter, latest de Havilland Canada STOL aircraft to enter military service, is operating in the following military and police forces:

The Army, Navy and Air forces of Argentina, Canadian Armed Forces, Chilean Air Force, Jamaican Defense Force, Panamanian Air Force, Paraguay Air Force, Peruvian Air Force, Royal Norwegian Air Force, Royal Canadian Mounted Police, Uganda Police Air Wing.

Designed for dependable operation with a minimum of ground support, the Twin Otter brings a new standard of performance to the light transport role. Folding seats permit the 20 passenger cabin to be quickly converted to provide 11 m³ (384 cu. ft.) of cargo space. For casualty evacuation nine litters and five seats can be accommodated.

Available on wheels, skis or floats, this aircraft offers unsurpassed versatility.

As a short-haul airliner the Twin Otter is used on high frequency scheduled services from some of the busiest airports in North America. A combination of outstanding short field performance and adaptability in remote areas, with unprepared runways, has led to wide acceptance around the world. Over 330 Twin Otters are now flying in 36 countries opening new areas and setting new standards of transportation. More than 180 of these are in operation with scheduled carriers. Dependable PT6A-27 engines from United Aircraft of Canada provide power for the STOL performance in this popular transport.

The Twin Otter is certified in the normal category (CAR-3) by the Canadian Ministry of Transport (Aircraft Type Approval A-82) and the United States Federal Aviation Administration (Type Certificate A9-EA). In addition, the Series 300 meets the U.S. Special Federal Aviation Regulation No. 23 which establishes additional airworthiness standards for emergency evacuation, systems design and aircraft operation.

SPECIFICATIONS

Wing span	19.81 m	(65 ft)
Length	15.77 m	(51.8 ft)
Height	5.66 m	(18.6 ft)
Mainwheel track	3.81 m	(12.5 ft)
Wheelbase	4.49 m	(14.8 ft)
Propeller ground clearance	1.37 m	(4.5 ft)

WEIGHTS (LANDPLANE)

Maximum takeoff	5,670 kg	(12,500 lb)
Maximum landing	5,580 kg	(12,300 lb)
Basic (20 seat commuter)	3,076 kg	(6,782 lb)
Fuel capacity — standard	1,112 kg	(2,457 lb)
without wing tank	1,385 kg	(3,057 lb)
Wing loading	14.5 kg/m ²	(29.8 lb/sq ft)

PERFORMANCE AT MAXIMUM WEIGHT (LANDPLANE)

CAR 3 (U.S. FAR PART 23)

STOL CAPABILITY

Takeoff distance (s/I ISA)		
Ground run	262 m (860 ft)	213 m (700 ft)
Distance		
over 50 ft	457 m (1,500 ft)	366 m (1,200 ft)
Landing distance (s/I ISA)		
Ground run	290 m (950 ft)	157 m (515 ft)
Distance		
over 50 ft	591 m (1,940 ft)	320 m (1,050 ft)
SFAR-23 Accel Stop	695 m	(2,280 ft)
Stalling speed (Power off)		
Flaps retracted	137 km/hr EAS	(74 kt)
Flaps extended	108 km/hr EAS	(58 kt)
Rate of Climb (s/I ISA)		
Two engines	488 m/min	(1,600 ft/min)
One engine	103 m/min	(340 ft/min)
Service Ceiling (R/C—100 ft/min ISA)		
Two engines	8,140 m	(26,700 ft)
One engine	3,540 m	(11,600 ft)
Max. Cruise speed		
Sea level	315 km/hr TAS	(170 kt)
1.524 m (5,000 ft)	335 km/hr TAS	(181 kt)
3.048 m (10,000 ft)	337 km/hr TAS	(182 kt)
Payload - range		
(20 seat commuter)		
ISA, 45 min reserve		

RANGE

PAYLOADS

Standard tank		
	185 km (100 nm)	2,005 kg (4,420 lb)
	1,275 km (690 nm)	1,155 kg (2,550 lb)
With wing tanks		
	1,778 km (958 nm)	966 kg (2,131 lb)



DHC-5 "BUFFALO"

The DHC-5 Buffalo has been developed to fill the operational requirement for a STOL (short take-off and landing) aircraft capable of handling short to medium range transport support and of operating from rough, improvised airstrips. The Buffalo was designed from the outset to perform sustained operations in harsh tactical environments.

The design margins built into the Buffalo for the primary STOL task can be used to carry substantially greater payloads on more conventional missions. For high performance in unprepared areas, Assault STOL is used. In the conventional transport role from firm smooth runways, Transport STOL allows an increased operational payload. The interaction of automatic lift-dumping spoilers with the reverse pitch propellers and wheel

brakes ensures a controlled short ground roll regardless of surface condition. Power plants in the Buffalo are General Electric CT64-820-1 propeller turbines each rated at 3060 ESHP. The provision of an extra low pitch stop on the propellers, together with the superior capabilities of the free turbine for quick power acceleration or deceleration provides the thrust control necessary for precise, steep approach to confined landing areas. Outstanding low-speed handling characteristics make this aircraft ideal for accurate air dropping of troops or supplies. The large rear doors and lower ramp facilitate the loading of wheeled vehicles or bulky cargo and permit the delivery of palletized cargo using the LAPES (Low Altitude Parachute Extraction) techniques.

DIMENSIONS

Wing Span	29.26 m	(96 ft)
Length	24.0 m	(79 ft)
Height	8.8 m	(28.8 ft)
Main Track	9.3 m	(30.6 ft)
Wheelbase	8.5 m	(28 ft)
Prop Ground Clearance	1.01 m	(40 in)

WEIGHTS

	ASSAULT STOL		TRANSPORT STOL	
Max T/off	18,598 kg	(41,000 lb)	22,252 kg	(49,200 lb)
Max Land	17,736 kg	(39,100 lb)	21,269 kg	(46,900 lb)
Max Payload	5,675 kg	(12,500 lb)	8,165 kg	(18,000 lb)
Max Fuel	6,150 kg	(13,550 lb)	6,150 kg	(13,550 lb)
Op. Wt. Empty	11,120 kg	(24,500 lb)	11,120 kg	(24,500 lb)
Zero Fuel Wt.	16,800 kg	(37,000 lb)	19,727 kg	(43,500 lb)

PERFORMANCE

T/off Distance to 15 m (50 ft)	368 m	(1,210 ft)	640 m	(2,100 ft)
Land Distance from 15 m (50 ft)	298 m	(980 ft)	640 m	(2,100 ft)
Rate of Climb 2 Eng NRP	634 m/min	(2,080 ft/min)	457 m/min	(1,500 ft/min)
Rate of Climb 1 Eng NRP	148 m/min	(485 ft)	53 m/min	(175 ft/min)
Service Ceiling 2 Eng NRP	9,601 m	(31,500 ft)	7,620 m	(25,000 ft)
Service Ceiling 1 Eng NRP	3,960 m	(13,000 ft)	823 m	(2,700 ft)
Max. Cruise Speed (TAS at 3,048 m (10,000 ft))	815 km	(440 nm)	1,390 km	(750 nm)
Range with Zero Payload (Cruise at 3,48 m (10,000 ft))	3,585 km	(1,940 nm)	3,585 km	(1,940 nm)



DHC-4 "CARIBOU"

The DHC-4 Caribou is now in its fourteenth year of continuous production. This aircraft was the first of the DHC twin engine STOLs and is the last piston-powered DHC design still in production. Well proved by many years of service in some of the world's most difficult terrain the Caribou offers exceptional STOL performance from improvised airstrips.

Over 300 Caribou are now flying with the following services:

- United States Air Force
- Canadian Armed Forces
- Royal Australian Air Force
- Ghana Air Force
- Zambia Air Force
- Kenya Air Force
- Kuwait Air Force
- Tanzania Air Force
- Abu Dhabi Defence Force
- Muscat and Oman
- Guyana Airways
- Federal Republic of the Cameroons
- Uganda Police
- Malaysia Air Force
- Indian Air Force
- Thailand Border Patrol Police
- Spanish Air Force
- United Nations Emergency Force
- Pacific Architects & Engineers, U.S.A.
- Global Associates, U.S.A.
- Ansett MAL, Australia
- Imperial Oil, Canada
- Pan American Petroleum, Canada
- Air Asia, Taiwan
- Rocky Mountain Airways

The Caribou is designed to carry out aerial supply dropping, transportation of men and materials, and casualty evacuation. In troop transport configuration it carries 32 fully equipped combat troops in quickly folding seats. As an air ambulance it can accommodate 22 litters.

Large rear loading doors provide access to the 32.5 m³ (1,150 ft.³) cabin and can be opened in flight for dropping paratroops or supplies. The lower ramp facilitates rapid loading of wheeled vehicles or bulky cargo.

At a maximum weight of 12,928 kg (28,500 lbs.) the Caribou has a payload of 3,910 kg (8,620 lbs.) and requires a take-off ground run of only 220 m (725 ft.). Take-off distance over a 15 m (50 ft.) obstacle is 361 m (1,185 ft.); landing distance 376 m (2,135 ft.).

Powered by dependable Pratt and Whitney R2000

engines each rated at 1,450 bhp the Caribou has a cruising speed of 158 knots.

GENERAL

Gross Weight	12,928 kg	(28,500 lb.)
Basic Weight	7,997 kg	(17,630 lb.)
Wing Span	29.15 m	(95 ft. 7.5 in.)
Overall Length	22.12 m	(72 ft. 7 in.)
Overall Height	9.67 m	(31 ft. 9 in.)
Wing Area	84.7 m ²	(912 ft. ²)
Wing Loading	153 kg/m ²	(31.25 lb./ft. ²)
Wing Aspect Ratio	10.0	10.0

CABIN DIMENSIONS

Length	8.76 m	(28 ft. 9 in.)
Width (max.)	221 cm	(87 in.)
Width (at floor)	186.7 cm	(73.5 in.)
Height (on center line)	190.5 cm	(75 in.)
Cabin Capacity	32.5m ²	(1150 ft. ²)
Max. Floor Loading	976.4 kg/m ²	(200 lb./ft. ²)

DOORS

Loading Doors	Width	186.7 cm	(73.5 in.)
	Height	190.5 cm	(75 in.)
Side Doors (2)	Width	76.2 cm	(30 in.)
	Height	139.7 cm	(55 in.)
Crew Hatch	Width	63.5 cm	(25 in.)
	Height	73.7 cm	(29 in.)



TILT-WING AIRCRAFT (CL-84)

The CL-84 is being developed as a highly versatile vehicle with the potential of fulfilling a wide variety of roles that otherwise require the use of both fixed and rotary-wing aircraft. Its military applications are expected to comprise combat support, personnel and cargo transport, reconnaissance, search and rescue, helicopter escort, and communications, from both land bases and aircraft carriers.

Performance flexibility of this order is made possible by the novel "tilt-wing" design of the CL-84 which allows the aircraft to take off vertically and hover like a helicopter, yet fly forward like an airplane at speeds up to 350 mph (563 km/hr). With the wing tilted between the vertical and horizontal, the CL-84 has impressive performance and manoeuvrability at very low speeds and outstanding short take-off and landing (STOL) capabilities.

Although this aircraft is designed for vertical, STOL, and fixed-wing flight, the pilot's primary cockpit controls consist of the standard aeroplane rudder pedals, stick, and single throttle (power lever) which incorporates the wing-tilt switch. (There is no requirement for a collective pitch lever). Because of this simplicity, an experienced pilot will be able to devote virtually his full attention to his operational task rather than to flying the aircraft.

Commercial developments of the Canadair CL-84 would substantially reduce total travel time for passenger transportation between city-centers 100 to 500 miles (161 to 805 km) apart. Also, because such aircraft can operate independent of normal runways, they have considerable potential for survey, exploration and general transport work in undeveloped areas.

Evaluation models for the Canadian Armed Forces are now in production at Canadair.

CF-5/NF-5 — TACTICAL SUPPORT FIGHTER

A total of 220 CF-5/NF-5 tactical fighter aircraft have been delivered to the Canadian Armed Forces and the Royal Netherlands Air Force. The Canadian (CF-5) and Netherlands (NF-5) versions are similar in most respects and were developed from the Northrop F.5. Production at Canadair's Montreal plant is under a license arrangement through the Canadian Government with the Northrop Corporation.

CF-5/NF-5s incorporate many improvements over the basic F-5 model including a stepped-up performance resulting from the increased power available from the General Electric J.85-15 engines. Each engine produces 4,300 lb. (1950 kg) thrust for an engine weight of only 615 lb. (279 kg). The NF-5 is equipped with manoeuvring flaps which provide outstanding handling qualities at high speeds and the CF-5 has an alternative camera equipped nose section as a rapid change item. These are examples of the more important improvements.

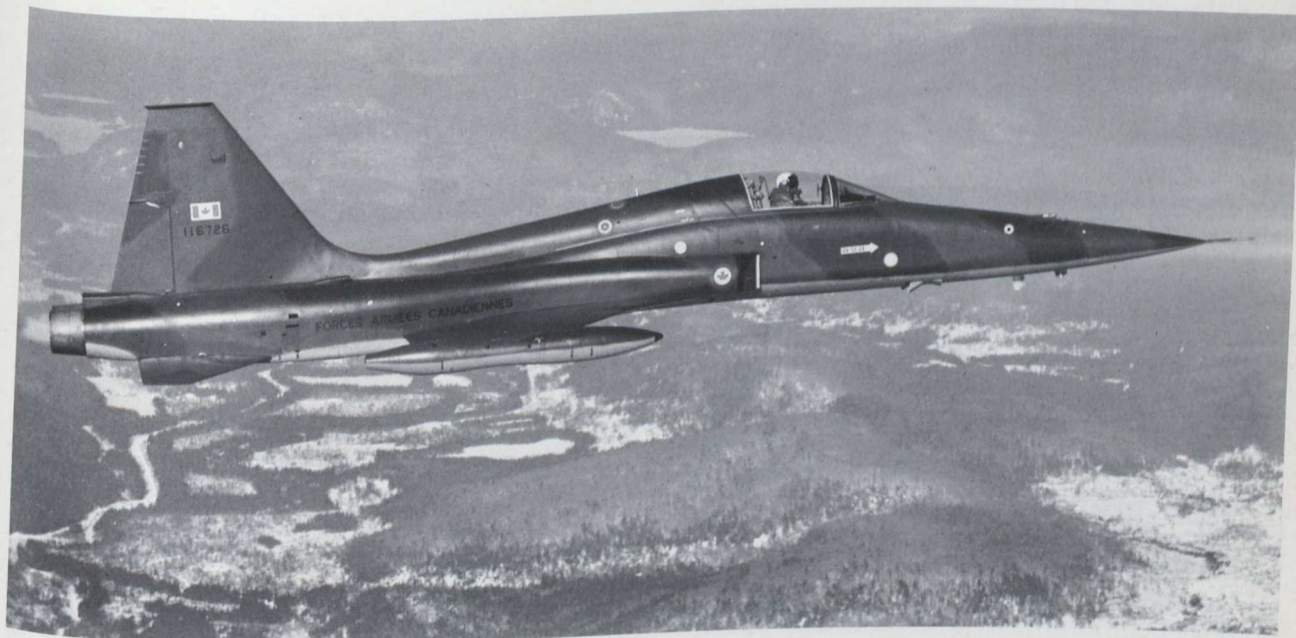
The F-5 was designed for tactical support, interdiction and interceptor roles and to these, the CF-5 has added both high and low level photo reconnaissance capabilities and many other important operational features.

The CF-5 combined the capabilities and performance normally associated with larger and more complex aircraft with rugged strength necessary for the low level tactical role and for operating from semi-prepared forward air strips.

With a low operating cost and many ease-of-maintenance and safety features, the CF-5 is a weapon system ideally suited to the constantly changing requirements of an increasingly complex cost and defence environment.



TILT-WING AIRCRAFT (CL-84)



CF-5/NF-5 — TACTICAL SUPPORT FIGHTER

AMPHIBIOUS UTILITY TRANSPORT (CL-215)

The Canadair CL-215 is an amphibious multi-purpose aircraft, designed for a variety of utility roles. Its rugged construction, plus the advantages of operating from both land and water, increases its ability to perform numerous jobs in widely varying environmental conditions.

The first aircraft in the world to be designed for the role of a forest fire fighter, the CL-215s have been fighting fires for two years in France, Spain, the United States and Canada. They have proven to be by far the most effective of all forest protection aircraft, operating in conditions which grounded other aircraft and establishing new records for the number of gallons of water and chemical dropped on fires.

In the CL-215, each of two fuselage tanks has a capacity of three tons (2.7 tonnes) of water or retardant. Each tank consists of an integral portion below the cabin floor, and a glass fibre portion above the floor. The part above the floor is removable for conversion to the general utility role. The tanks are installed at the centre of gravity of the aircraft. Ducts from the top of the tanks to outlets in the sides of the fuselage provide for venting and overflow. Two hydraulically-operated pick-up probes, located behind the hull step, are provided for scooping water while the aircraft is planing on the surface of water.

Using normal techniques, the CL-215 can scoop a six ton (5.5 tonnes) load of water between 50-foot (15 metres) obstacles approximately 5,300 feet (1615 metres) apart in 16 to 20 seconds. These figures assume calm conditions; scooping distances as short as 3,500 feet (1067 metres) are possible under favourable conditions of wind and water.

For loading with chemical fire retardants at a land base, filling adapters for the attachment of hoses are installed in the sides of the fuselage. In addition, in the fire-fighting role, the CL-215 can carry up to 15 fire-fighting personnel and their equipment which it can offload at the fire scene before starting bombing operations.

In addition to fighting fires the CL-215 can perform other tasks such as:

- Aerial inventory of forests and lands
- Oil pollution location, identification and dispersion
- Sampling of water sources
- Fisheries conservation
- Flying hospital
- Emergency evacuation from remote locations

AN/USD-501 AIRBORNE SURVEILLANCE DRONE SYSTEM

The AN/USD-501 Drone system, designed and produced by Canadair Ltd., is an airborne surveillance system for use at divisional level in forward battle areas. The system consists of reusable drones, launchers, ground support equipment and unit level as well as base workshop test equipment. This system now in quantity production has been evaluated and accepted by the armies of Canada, Great Britain, Federal Republic of Germany and Italy. The system is completely self-supporting in the field. The drone is small, lightweight and flies at speeds below the speed of sound and is highly survivable in the non-permissive air and ECM environment of the modern day battlefield with its attendant highly sophisticated weapons systems.

The drone is launched from a zero length launcher using a solid propellant booster which separates shortly thereafter. It flies a pre-programmed course and is passive throughout the penetration portion of the mission. It has a day and night capability for reconnaissance using a photographic sensor designed by Carl Zeiss of W. Germany and an infra-red line scan sensor designed by Hawker Siddeley Dynamics of U.K. The sustainer engine is a small turbo jet using standard jet fuel.



AMPHIBIOUS UTILITY TRANSPORT (CL-215)



AN/USD-501 AIRBORNE SURVEILLANCE
DRONE SYSTEM

FLIGHT SIMULATORS

The CAE Flight Simulation Facility with a six degree of freedom motion base and a six degree of freedom visual system is a versatile research and development tool which can be used in the performance of a wide variety of engineering and training tasks related to V/STOL and conventional aircraft. A high degree of flexibility and ample capacity in the interface, digital computer, peripheral equipment and power provide excellent capability for activities such as:

FLIGHT CONTROL

- Control system development
- Automatic flight control; system optimization, integration, software validation
- Airborne system hardware, interface and real-time operation with analog and digital systems
- Evaluation of handling qualities
- Studies on redundancy techniques

TRAINING AND FAMILIARIZATION

- Pilot familiarization and training
- Evaluation of simulation techniques for training

NAVIGATION AND GUIDANCE

- Navigation
- Terminal guidance and control

HUMAN ENGINEERING

- Pilot performance
- Crew station layout
- Crew task loading
- Display developments
- New concepts

The facility has ample capacity to simulate accurately aircraft dynamics, engine dynamics, 6 degree of freedom motion and visual cues and in addition carry out engineering investigations in other areas.

Provision can be made to couple digital and/or analog equipments to the facility and operate in real-time with the simulator.

The computing complex consists of an XDS Sigma 3 computer (40K, 16 bit memory) connected to an XDS Sigma 5 computer (for test programs, peripherals) and to a hybrid interface (to interface with the flight compartment, motion base, visual system, etc.).



BLACK BRANT RESEARCH ROCKETS

The Black Brant family of research rockets is capable of carrying a wide range of scientific payloads to altitudes from 100 to 1,050 km (61 to 650 sm). Four solid propellant motors are used singly and in pairs to make up seven different vehicles.

Bristol Aerospace, responsible for the development of these rockets, has participated in their launching from such varied ranges as the Pacific Missile Range, Eglin Air Force Base, the NASA Wallops Island Range, the Churchill Research Range (Canada), ES Range (Sweden), Natal (Brazil), and Andoya (Norway).

The principal characteristics of the Black Brant rockets are as follows:

BLACK BRANT IIIA — Performance — 40 kg to 185 km (88 lb. to 115 sm)

- Single stage
- 9KS11000 motor — thrust 4,900 kg (10,800 lb.)
- Payload diameter 250 mm (10 in.) and maximum length 2,540 mm (100 in.)
- Three stabilizing fins
- Rail launch

BLACK BRANT IIIB — Performance — 51 kg to 235 km (112 lb. to 146 sm)

- Single stage
- 12KS10000 motor — thrust 4,460 kg (9,825 sm)
- Payload diameter 250 mm (10 in.) and maximum length 3,500 mm (138 in.)
- Three stabilizing fins
- Rail launch

BLACK BRANT IVA — Performance — 38 kg to 925 km (84 lb. to 575 sm)

- Two stages
- First stage — 15KS25000 motor — thrust 11,500 kg (25,200 lb.)
- Second stage — 9KS11000 motor — thrust 4,900 kg (10,800 lb.)
- Payload diameter 250 mm (10 in.) and maximum length 3,500 mm (138 in.)
- Three stabilizing fins
- Rail launch

BLACK BRANT IVB — Performance — 38 kg to 1,060 km (84 lb. to 660 sm)

- Two stages
- First stage — 15KS25000 motor — thrust 11,500 kg (25,200 lb.)
- Second stage — 12KS10000 motor — thrust 4,460 kg (9,825 lb.)

- Payload diameter 250 mm (10 in.) and maximum length 3,500 mm (138 in.)
- Three stabilizing fins
- Rail launch

BLACK BRANT VA — Performance — 140 kg to 181 km (308 lb. to 112 sm)

- Single stage
- 15KS25000 motor — thrust 11,500 kg (25,200 lb.)
- Payload diameter 431 mm (17 in.) and maximum length 4,000 mm (157 in.)
- Three stabilizing fins
- Rail or tower launch

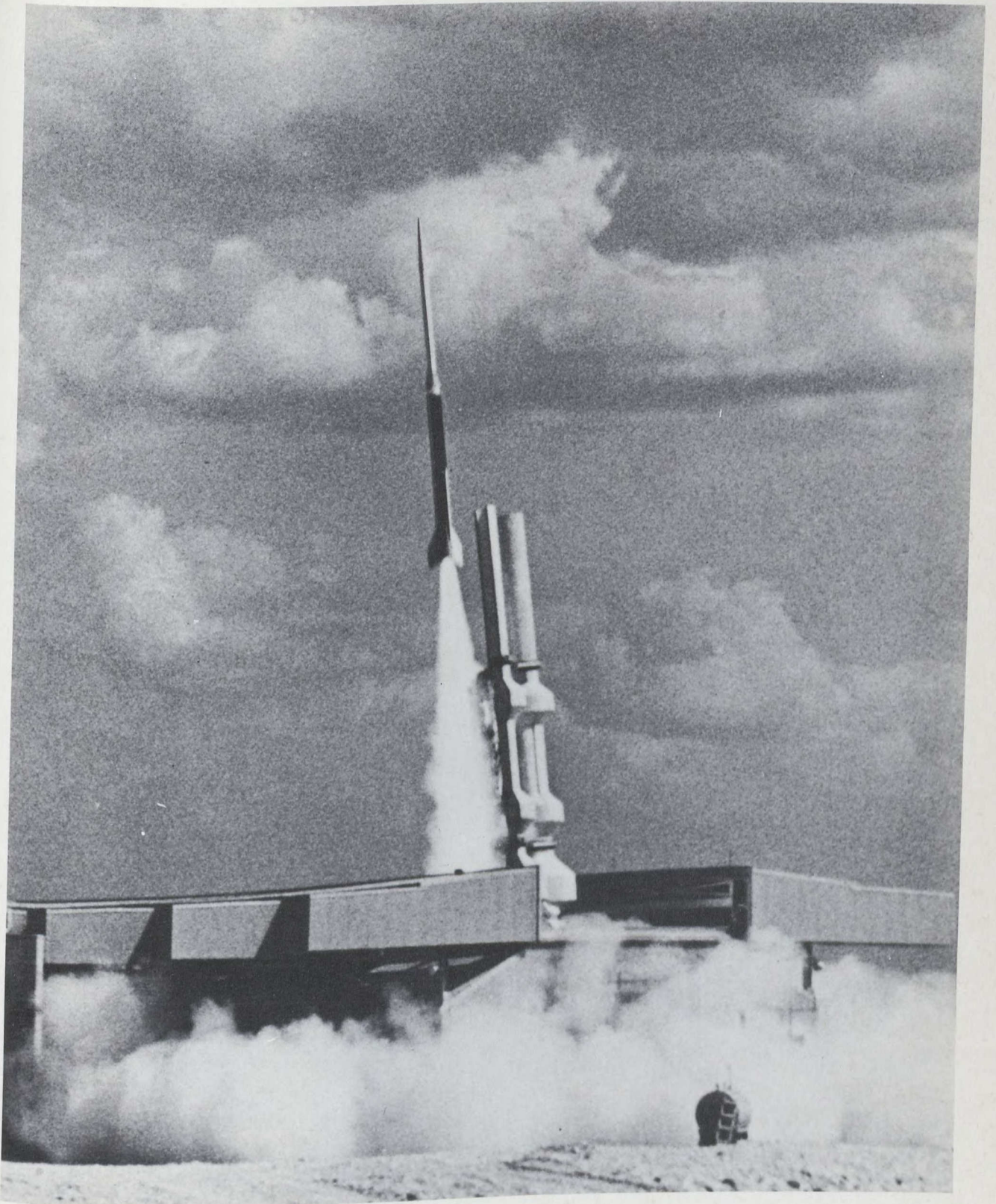
BLACK BRANT VB — Performance — 140 kg to 375 km (308 lb. to 233 sm)

- Single stage
- 26KS20000 motor — thrust 7,750 kg (17,025 lb.)
- Payload diameter 431 mm (17 in.) and maximum length 4,700 mm (185 in.)
- Three stabilizing fins
- Rail or tower launch

BLACK BRANT VC — Performance — 140 kg to 352 km (308 lb. to 218 sm)

- Single stage
- 26KS20000 motor — thrust 7,750 kg (17,025 lb.)
- Payload diameter 431 mm (17 in.) and maximum length 4,700 mm (185 in.)
- Four stabilizing fins
- Rail or tower launch

As well as the Black Brant rockets, Bristol manufactures a complete range of telemetry instruments, equipment for measuring flight characteristics, payload fairings, recovery systems and payload racks and housings. Bristol also has the personnel and equipment to manufacture, integrate, and test scientific payloads.



GAS TURBINE ENGINES

The PT-6 engine, produced by United Aircraft of Canada, formerly Canadian Pratt & Whitney, is now powering some 33 different aircraft types around the world and is seeing use in some 47 other applications including such diversified roles as snow blowers, prime power for small marine craft and as generators for public utility stand-by power plants. This same company is now the only source of supply for genuine Pratt & Whitney parts for reciprocating engines.

THE JT15D ENGINE

The U.A.C.L. JT15D turboprop engine was designed and developed by United Aircraft of Canada as a powerplant for executive and light jet transports of the 1970s. The JT15D-1 is a turboprop engine with 998 kg thrust (2,200 lbs.). The latest advances in aero engine technology

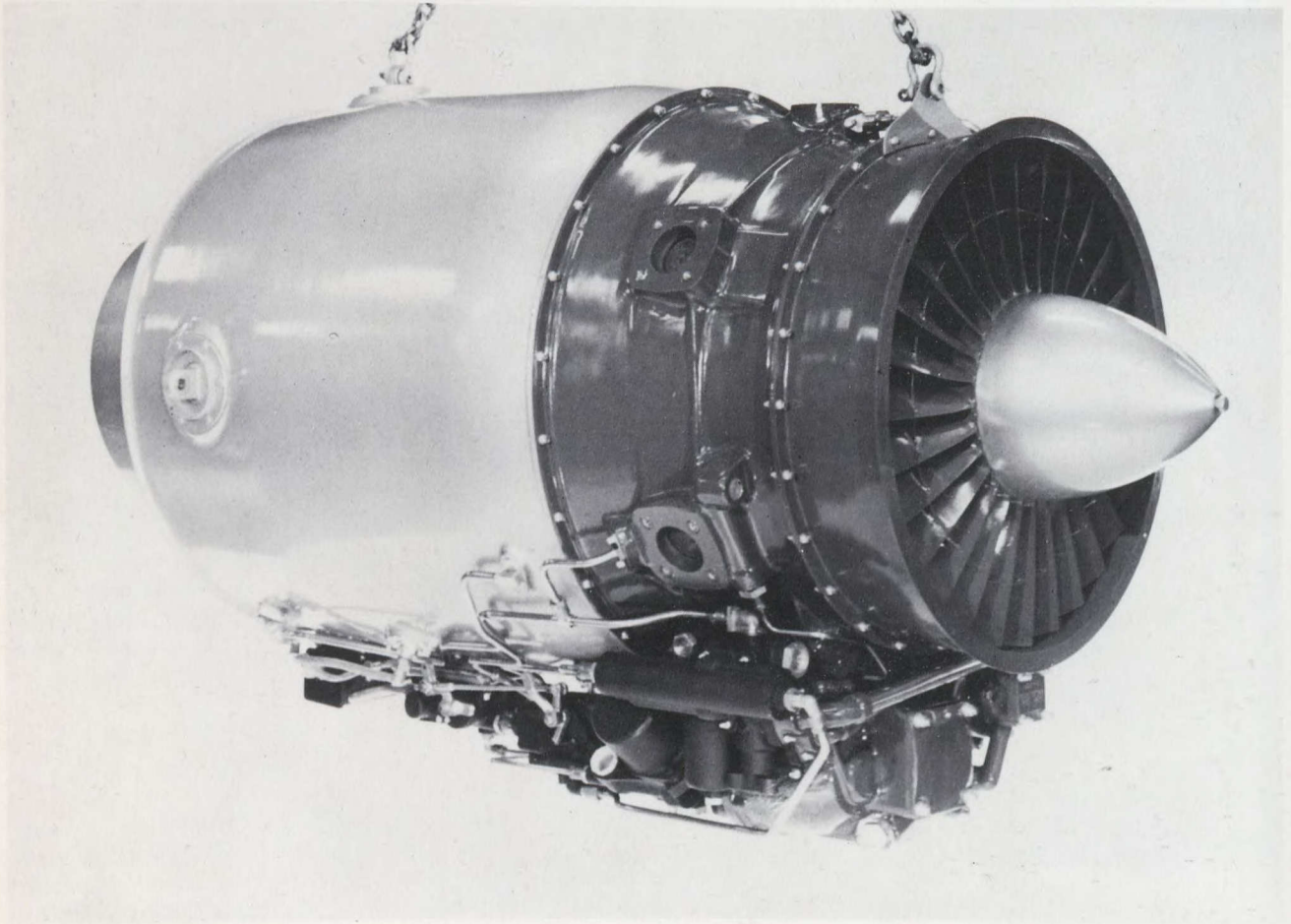
were used to make the JT15D a simple engine. It has only one fan stage, a single compressor stage, and three turbine stages. It produces 998 kg (2,200 lbs.) of take-off thrust in a package only 68 cm (27 in.) in diameter, 152 cm (60 in.) long and weighing only 228 kg (504 lbs.). It is quiet and relatively smoke free.

The JT15D engine has performance and economic features which will find application in multi-engined short-haul transports and small military trainer aircraft.

Delivery of the first production engines in March 1971 followed an intensive development cycle.

The first engines powered the Cessna Citation, a six-to-eight place jet which flies at 644 km/hr (400 MPH) with a range of more than 1,609 km (1,000 miles).

The engines also power the Corvette, a business jet from Aerospatiale in France.



THE PT6 ENGINE

The PT6, a lightweight, free turbine engine 157 cm (62 in.) in length and less than 136 kg (300 lbs.) in weight has been developed through more than 50,000 hours of test cell running at United Aircraft of Canada.

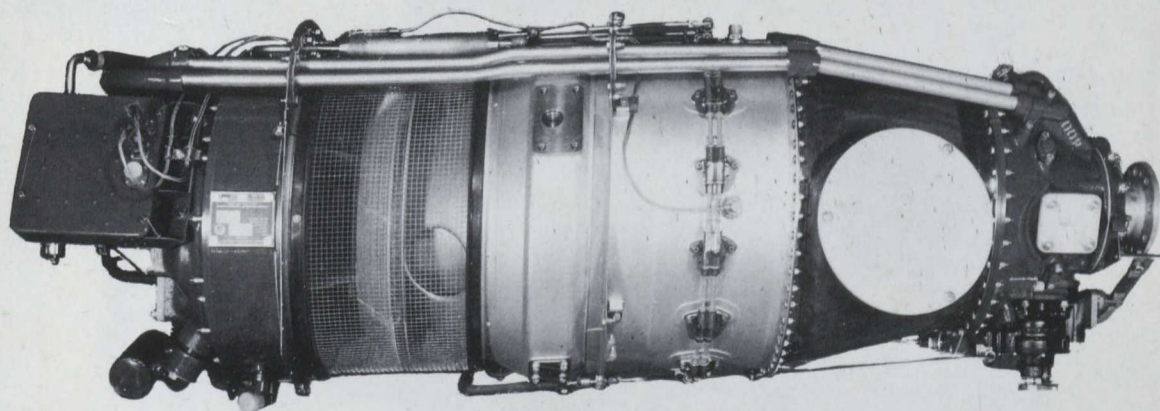
Within the same package, the engine has been developed from 450 hp to 1,200 hp.

The engine has been proved in extremes of heat and cold. In 1970, a PT6-powered plant set an unofficial speed record for propellor-driven aircraft. The Beech 99 that captured three top trophies in the England to Australia air race also cut 32 hours off the old record of air time for prop-aircraft between London and Sydney.

The PT6 engine powers more than 500 aircraft in the Beechcraft King Air series. The King Air B90, the King Air 100, the new King Air C90, as well as the Beech 99 commuter airliners all are powered by the PT6A-20 or the PT6A-27 versions of the U.A.C.L. engine.

Another large user of the PT6 powerplants is de Havilland Aircraft of Canada. The 300th DHC-6 Twin Otter, all powered with PT6s, was delivered in mid-1971.

Also by mid-1971, the PT6 engine powered more than 1,500 aircraft flying in 74 countries. The aircraft were owned by more than 600 operators.



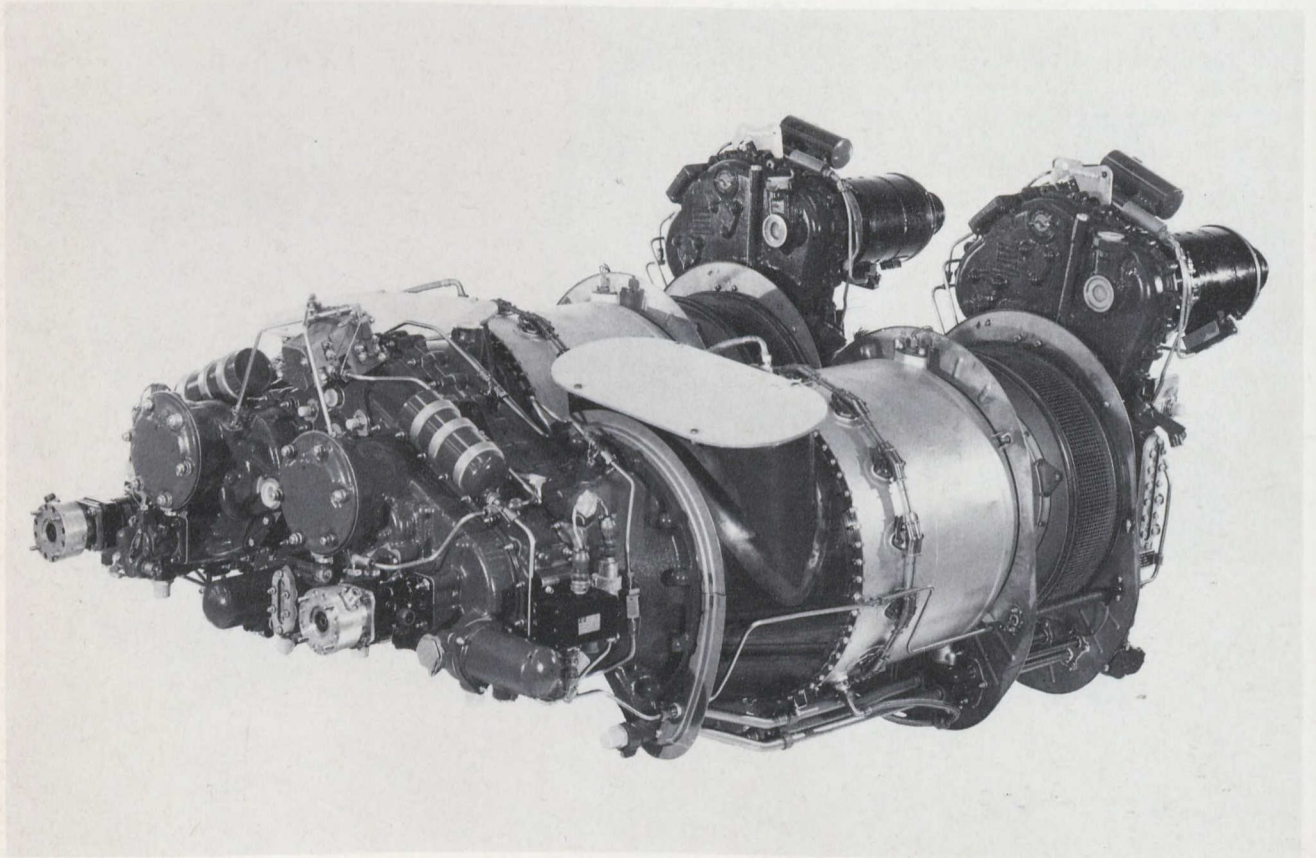
THE PT6 TWIN-PAC™ ENGINE

The PT6 Twin-Pac™ is so called because two PT6 gas turbine engines are coupled through a combining gearbox to drive a single output shaft, producing 1,800 shaft horsepower.

Since its development by United Aircraft of Canada Limited, the Twin-Pac engine has found several applications in helicopters. It is the powerplant for the Bell Two Twelve, the 15-place commercial helicopter which was certified in October 1970 and six months later the Sikorsky S-58T, powered by the same engine was certified for commercial operation.

A military version of the powerplant (the T400) is used in helicopters of the Canadian and United States Armed Forces.

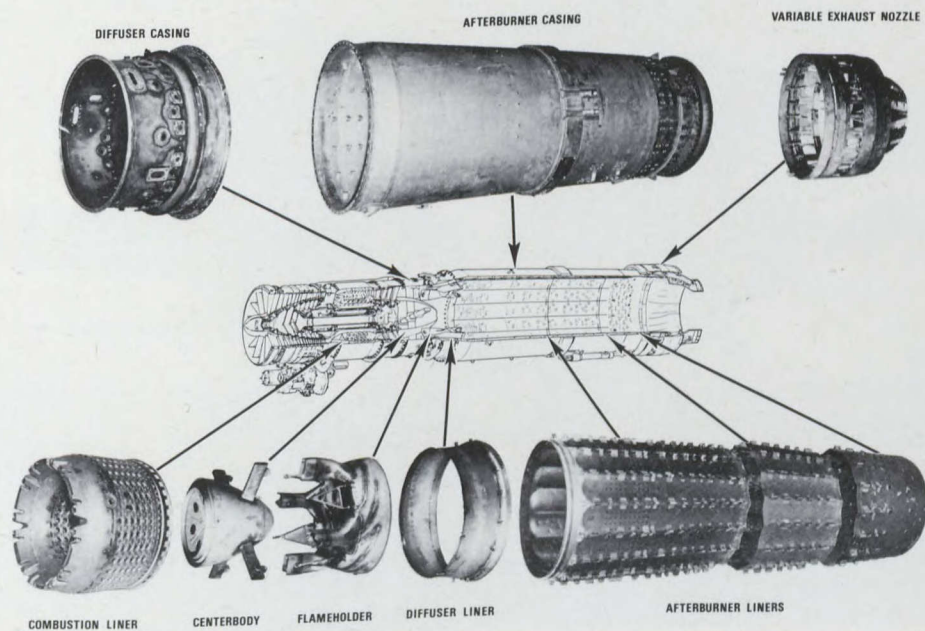
The introduction of the PT6 Twin has greatly improved helicopter reliability by improving high altitude and hot day performances.



GAS TURBINE ENGINE COMPONENTS AND ASSEMBLIES

The fabrication of complex precision gas turbine engine components and assemblies is one of the major lines of specialization at the Bristol Aerospace plant in Winnipeg. This facility has been supplying components of the types illustrated in the adjoining photograph to the leading aero-engine companies in North America for many years, and is fully equipped with a range of the most modern machine tools required for production to the close tolerances demanded in this field. Most of the items produced are in the "hot" section of the engines, from the combustion chamber to the exit nozzle, these being the components requiring special alloys capable of withstanding continuous exposure to elevated temperatures. Many of the materials used in these applications require special forming, machining, welding and heat treatment techniques, for which the Winnipeg facilities are well equipped. Government approved quality control laboratories equipped with the latest range of metallurgical inspection and test equipment support the production programs and ensure adherence to the strictest standards imposed by military and commercial specifications. The Bristol plant includes extensive tool design building and proving facilities, enabling new engine programs to be handled from the prototype stage through to quantity production. In recent years the economies which can accrue to engine operators through repair and overhaul of "hot"

end components and assemblies compared with the cost of the extensive replacement programs previously considered necessary, have led to substantial growth of R and O work for these items. This work is of a specialized nature, by virtue of the materials and techniques involved, and the Winnipeg facility is engaged in domestic and export R & O programmes for both components and assemblies, including complete engine afterburners.



"JATO" AIRCRAFT ROCKET ENGINE 15KS1000 MK 6, MOD 1

This rugged JATO motor is designed to provide instant stand-by power for any take-off, flight, landing, or emergency conditions when short duration thrust may be required. Limitations of gross weight, payload, and range of any aircraft imposed by factors such as runway length, air temperature and runway elevation may be greatly reduced by installation of instant rocket power. The 15KS1000 JATO motor is used for jet assisted take-off on a wide variety of military and civil aircraft, ranging from large bombers, transport aircraft and modern fighters to commercial airliners. The 15KS1000 JATO is now specified for operational use by Canada, U.S.A. and NATO as well as other nations of the free world. More than 100,000 15KS1000 rocket motors have been operated in test and service without malfunction of any kind.

OPERATING RANGE

Storage and operating temperature should be maintained between -53.9°C to $+60^{\circ}\text{C}$ (-65°F to $+140^{\circ}\text{F}$) with an altitude limit of 10,668 m (35,000 ft.).

The JATO unit may be stored for four years maximum from the date stencilled on the motor chamber.

OPERATING LIFE

The JATO motor is designed to be carried on the aircraft ready for use for a period of 750 hours of flight time or 18 months, whichever occurs first. Motors approaching the above limitations should be used for training or administration. This maintains pilot proficiency and eliminates the need for on the ground disposal.

These motors are designed and produced by Bristol Aerospace (1968) Ltd.



AIRCRAFT FUEL CONTROLS

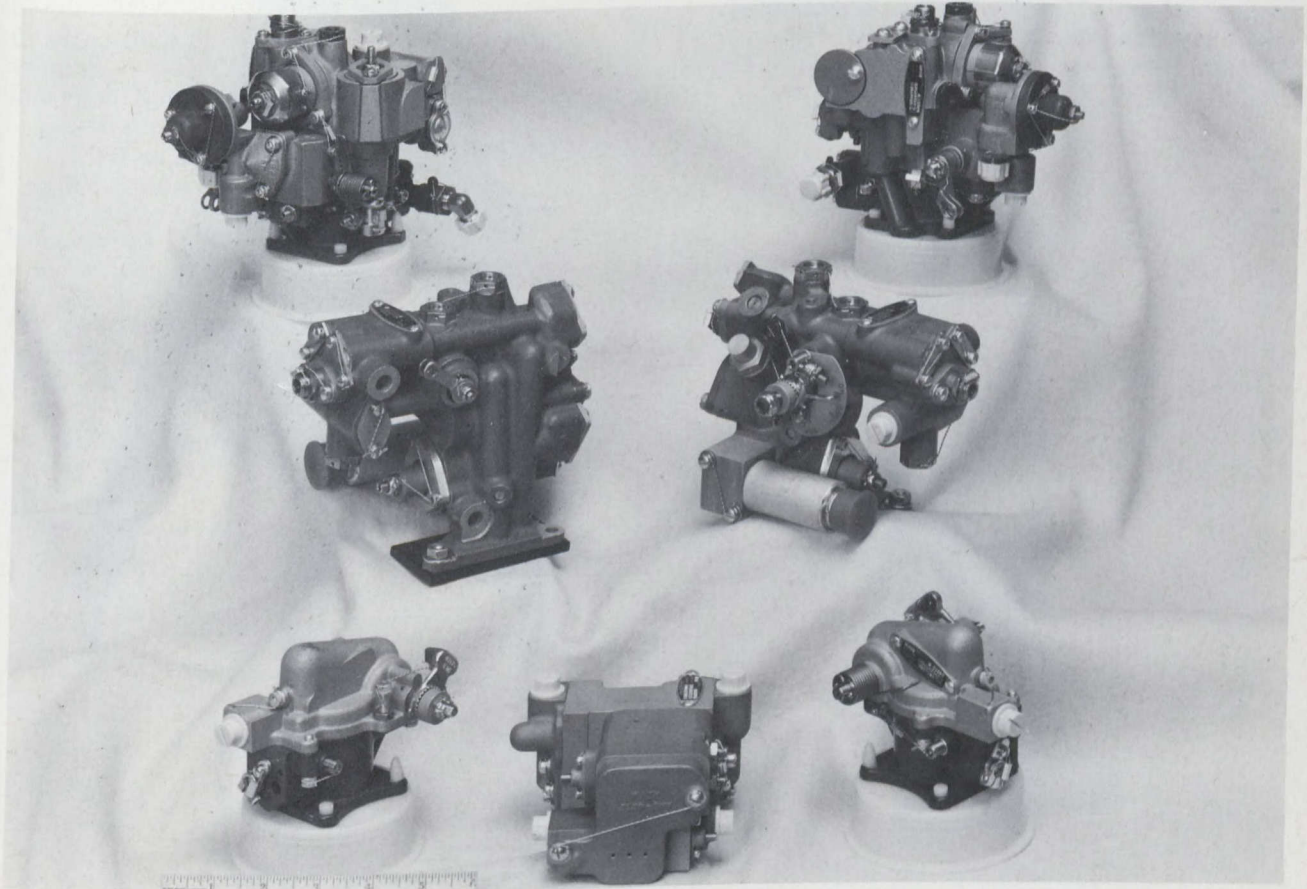
Aviation Electric Ltd. is Canada's leading supplier of Fuel Control Systems for gas turbine engines for both Military and commercial aircraft. Activities include research, development, manufacturing, sales, service and overhaul.

The quality control system meets the requirements of Canadian Government Specification DND 1015 and those of MIL-Q 9858 in the United States.

The company has been engaged in the production of fuel controls and associated fuel metering equipment since the early 1950's, commencing with the manufacture of Bendix type TJS series controls for F-86 and CF-100 aircraft.

More recent programs have included manufacture under licence of highly sophisticated fuel controls for General Electric J79 and J85 series engines. United Aircraft of Canada Ltd. utilizes Aviation Electric designed and manufactured fuel controls for all requirements of prop. shaft and fan engines.

Fuel Control System for United Aircraft PT6-T3 & T400 Twin-Pac helicopter engines. The complete system incorporates these 7 units.



HELICOPTER LANDING GEAR — UH-2

The wheeled main landing gear used on the Navy model UH-2 Helicopter was designed, developed and produced by Dowty Equipment of Canada Limited for Kaman Aircraft Corporation, Bloomfield, Connecticut.

Constructed predominantly of aluminum alloy, anodized, with a link and axle member machined from one steel forging, the gear is fully retractable. Compact, yet readily serviced, the gear is attached to aircraft pick-ups at the main 'Y' member extremities and at the drag strut swivel.

Extension and retraction is accomplished by means of a hydraulic actuator housed within the bore of the main member. An internal claw-type lock within the actuator locks the gear upon full extension; an uplatch affixed to the aircraft fuselage contains the gear in its retracted position. A spring-box is incorporated to assist normal extension of the gear and to ensure emergency full extension. Operational shocks imposed on the gear are absorbed by a Dowty 'Liquid Spring' shock absorber mounted between the link and axle member and the main 'Y' member.

Aircraft towing and tie-down eyes are embodied. Salient characteristics: Weight approx. 42 kg (92.51 lb.); Temperature range -18°C to $+71.1^{\circ}\text{C}$ (-65°F + 160°F); Fluid MIL-H-5606.



FLAP ACTUATOR/CONTROL

Designed and manufactured by Dowty Equipment of Canada for the operation and control of the De Havilland Caribou wing flaps, this unit comprises a double-acting hydraulic actuator and a spool type control valve with an interconnecting mechanism to cancel the selected flow path when the desired actuator traverse has been reached. Other elements embodied include an internal lock which sustains the actuator in its close state, an inlet filter and check valve, a rotary shut-off valve and a pressure relief valve.

Control is normally effected through push-pull linkage from the cockpit control to the external lever of the actuator. Upon selection of the desired degree of traverse, hydraulic pressure to the locked actuator causes the lock to disengage and permit piston movement. A spiralled rod connected to the rotary shutoff valve is rotated by the moving piston until the flow of pressure fluid is stopped. In this condition the actuator piston travel is also stopped. Return fluid flows through a drilling down the centre of the spiralled rod and to return line via the control valve.

Characteristics of this mode:

Weight 9 kg (20 lb.)

Maximum output force

- Retraction
1,047 kg at 210 kg/cm² (2,310 lb. at 3,000 in.²)
- Extension
3,456 kg at 210 kg/cm² (7,620 lb. at 3,000 in.²)

No-load operating time

- Extension 20/25 sec.
- Retraction 35/40 sec.

Input power requirement

1,360 kg (3,000 in.² working pressure)

Shaft stroke

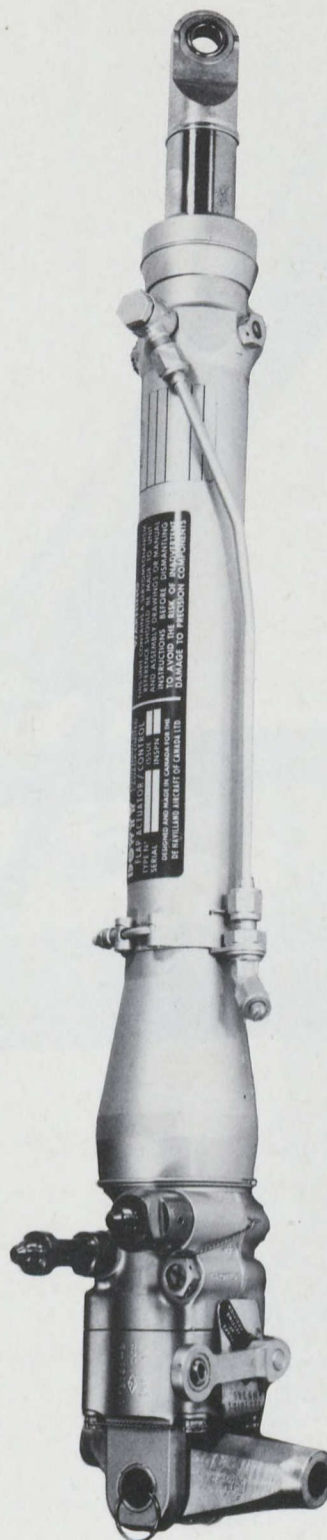
31.2 cm maximum (12.29 in.)

Temperature range

—18°C to +71.1°C (—65°F to +160°F)

Fluid

Hydraulic oil to Specification MIL-H-5606

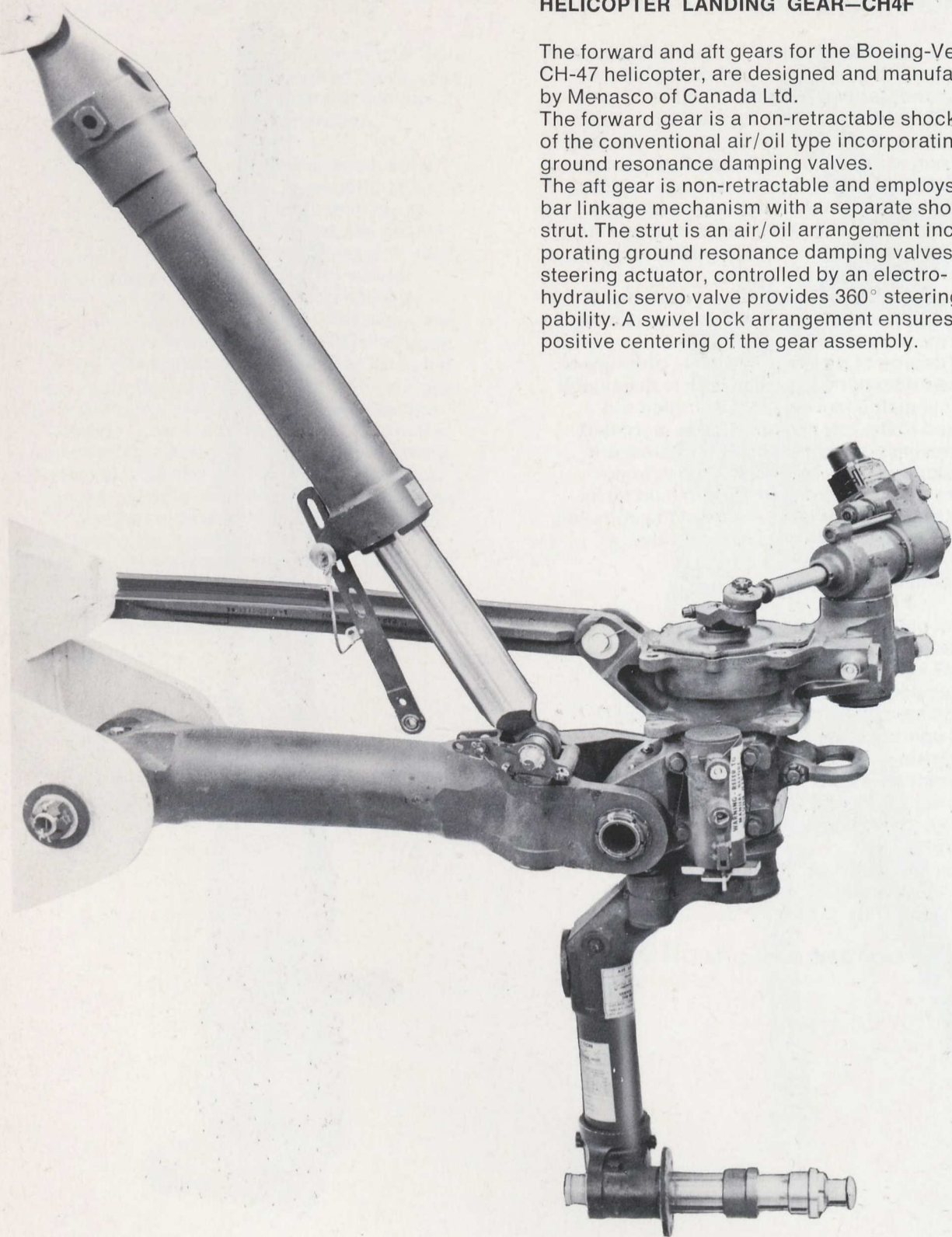


HELICOPTER LANDING GEAR—CH4F

The forward and aft gears for the Boeing-Vertol CH-47 helicopter, are designed and manufactured by Menasco of Canada Ltd.

The forward gear is a non-retractable shock strut of the conventional air/oil type incorporating ground resonance damping valves.

The aft gear is non-retractable and employs a four bar linkage mechanism with a separate shock strut. The strut is an air/oil arrangement incorporating ground resonance damping valves. A steering actuator, controlled by an electrohydraulic servo valve provides 360° steering capability. A swivel lock arrangement ensures positive centering of the gear assembly.



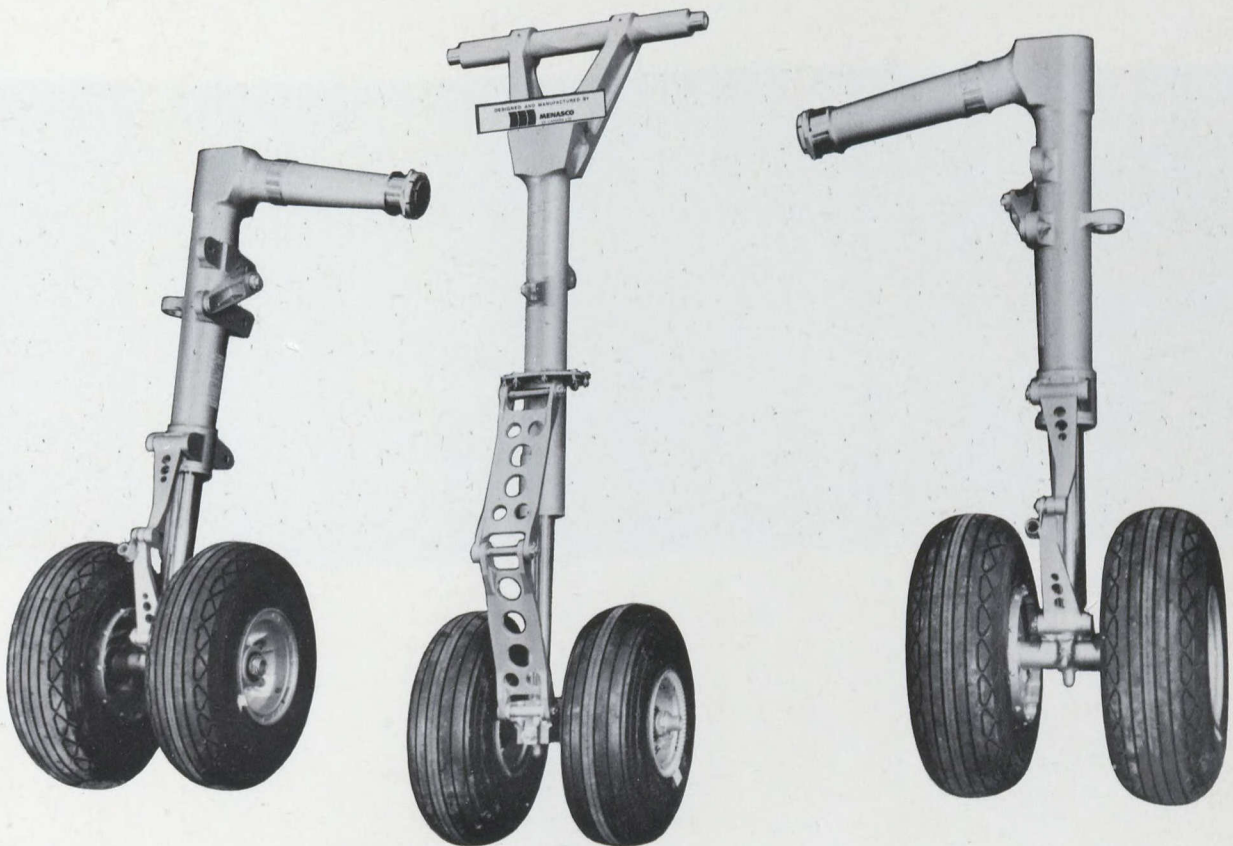
AIRCRAFT LANDING GEAR—CL-84

The CL-84 main and nose landing gears are designed and manufactured by Menasco of Canada Ltd.

The shock struts are of the conventional air/oil type. The nose gear has provisions for castoring through 360° and is fitted with a shimmy damper to ensure adequate damping during taxiing and take off.

The nose gear assembly consists of the shock strut, drag strut and steering actuator. The shock strut is a two stage oleo-pneumatic device and it is designed for rough field operation and provides a stable platform during loading operations.

The drag strut is a double acting hydraulic actuator incorporating an integral locking device in the extended and retracted positions. The drag strut functions as a retraction actuator for raising and lowering the gear and also provides a mechanical uplock and downlock for the gear assembly. Normal operation of the drag strut is achieved using the hydraulic system pressure and emergency provisions are incorporated in the unit to permit the gear to be unlocked, lowered and locked in the down position in the event of system failure.



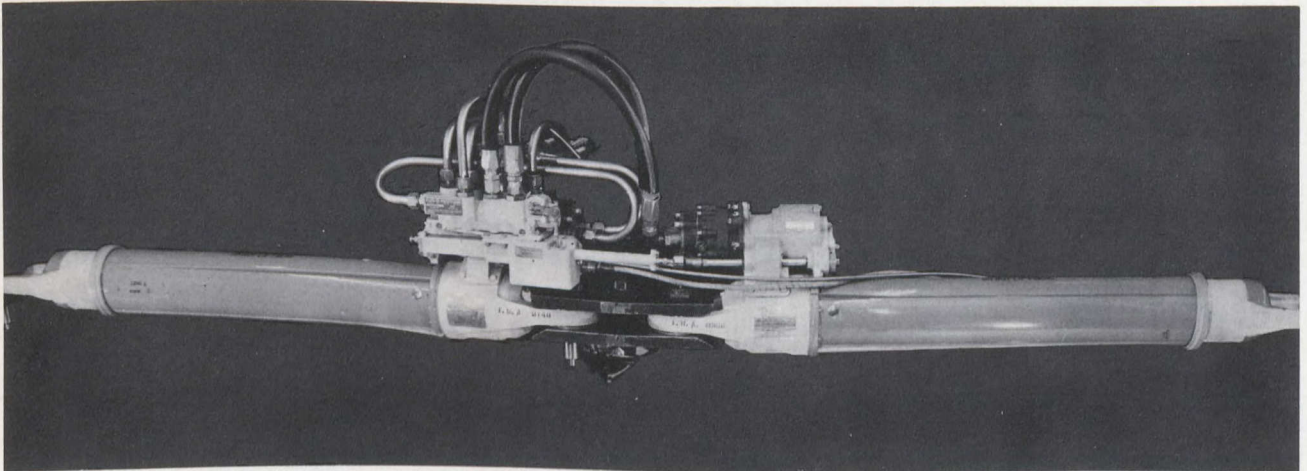
ACTUATION SYSTEMS FOR VARIABLE GEOMETRY AEROPLANES

Menasco's experience in the design, development, manufacture and qualification of actuation systems for variable geometry airplanes commenced with the design and production of the Wing Tilt Actuator and the Flap Actuator for the XC 142. In addition has designed the Wing Tilt Actuator for the Canadair CL 84 Dynavert. Where the actuators are of the Ball Screw type. Further, the design, development and manufacture of the Wing Sweep Actuation System for the F-111 Airplane has established Menasco as a leader in this field.

In the F-111 the system consists of a control mechanism, two ACME screw actuators each having an hydraulic motor and reduction gear box. The actuator gear boxes are connected by a synchronizing shaft which permits either motor to drive both actuators. The pilot operates the Wing Sweep system by a pistol grip type sliding lever which supplies inputs to the position control mechanism and controls the actuator position. The structural load carrying members of the actuator, which transmit a 260 ton barricade load,

are constructed of D6AC steel heated to a minimum of 15,400 kg/cm² (220,000 psi.). The gears, of particular geometry, are also manufactured in D6AC and have nitrided teeth.

Actuator back lash is limited to 0.5 mm (.02 in.) inclusive of the teflon impregnated cotton fabric lined nut. The operating load is approximately 22,675 kg (50,000 lb.) and each hydraulic motor supplies 38 H.P. The actuator has a stroke of 78.7 cm (31 in.) and a fully extended length of 221 cm (87 in.).

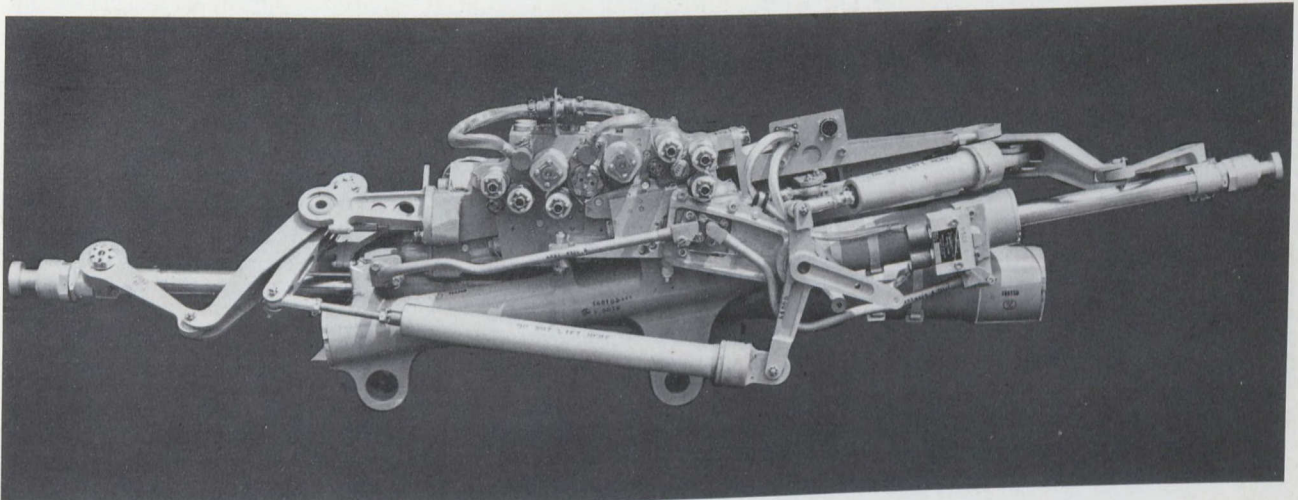


SPOILER ACTUATION SYSTEMS

The Lockheed C141 has one Menasco Spoiler Actuator system in each wing.

In response to pilot and aileron inputs during flight and landing gear touch down input, the system actuates inboard and outboard spoiler panels. Each system accepts manual and electrical signals, the position control being a mechanical loop. The system has two tandem cylinders of 14,965 kg (33,000 lb.) output capacity and a control manifold. The system performs the under-mentioned functions.

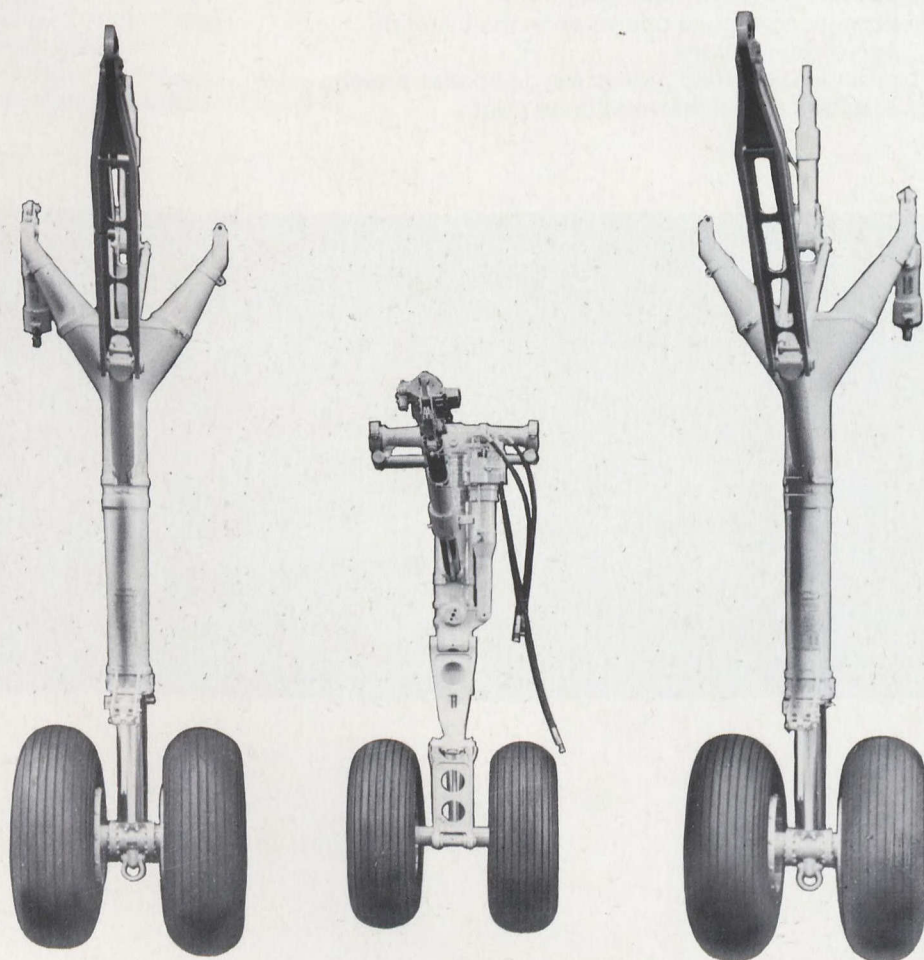
- 1) actuator speed control
- 2) synchronization of inboard and outboard spoilers
- 3) synchronization of wing to wing spoiler operation
- 4) automatic spoiler closure in the event of wing to wing assymetry
- 5) permits pilot hydraulic selection
- 6) permits continued operation in the event of servo valve failure
- 7) provides overload protection on spoiler panels
- 8) provides signal information to pilot



DHC-4 MAIN AND NOSE LANDING GEARS

The main and nose landing gear for the DHC-4 are designed and manufactured by Menasco of Canada Ltd.

The main gear assembly comprises the shock strut, drag strut, shortening mechanism, and retraction actuator. The shock strut is designed for rough field operation and provides a stable platform during loading operations. The strut is a two stage oleo-pneumatic arrangement with an overload relief device which prevents high transient loads being transmitted to the wing. The entire shock strut assembly is housed in a capsule tube which slides inside the outer housing thus enabling the gear to be shortened during the retraction cycle. The drag strut is a structural member and has provisions for connecting the stabilizer rods to the shortening mechanism.



DHC-5 MAIN AND NOSE LANDING GEARS

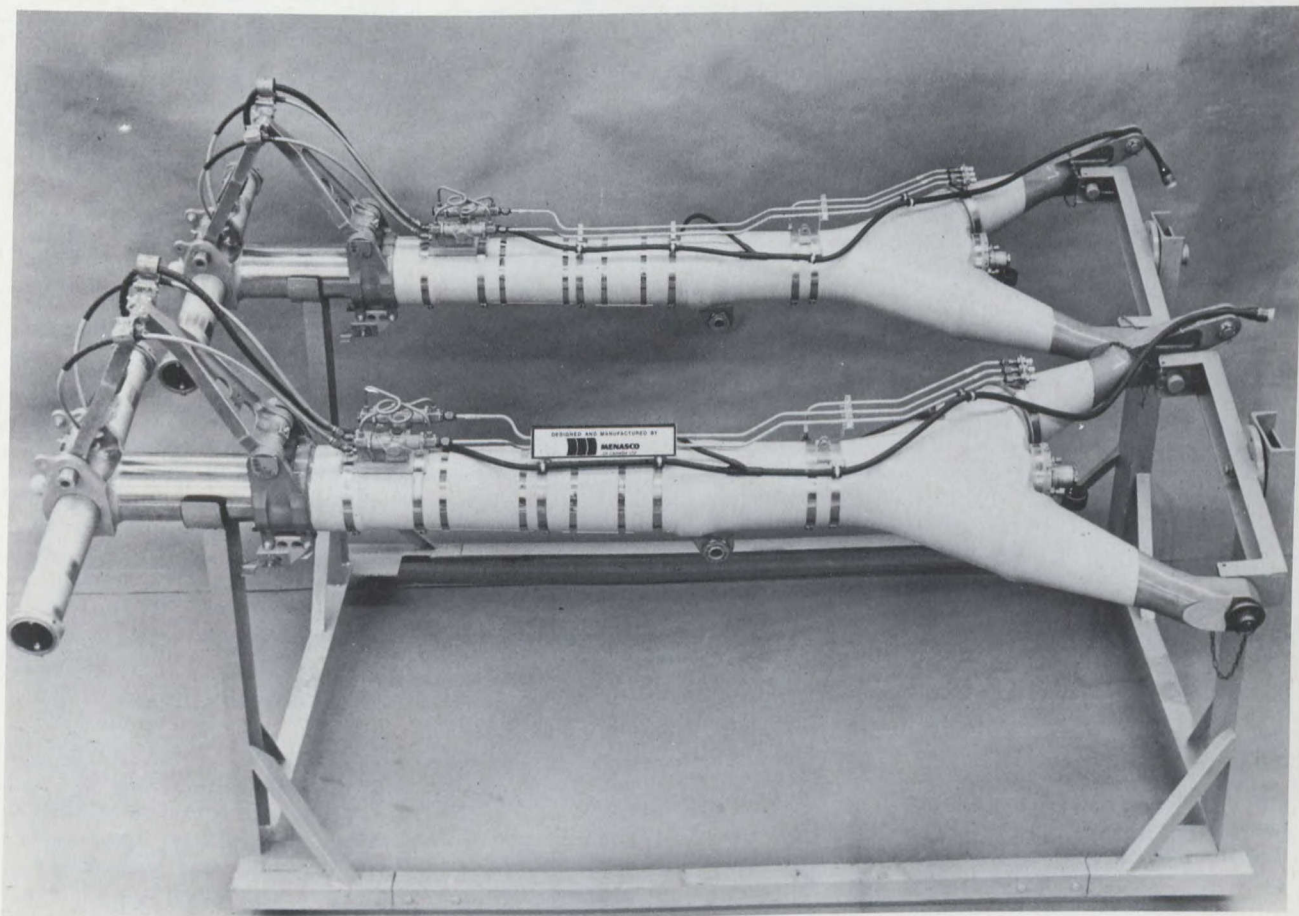
The nose and main landing gears for the DHC-5 are designed and manufactured by Menasco of Canada Ltd.

The main gear assembly represents an advance in STOL rough field operational capability, the design concept having been proven in the DHC-4. The general arrangement of the gear is similar to the DHC-4 except that there is no shortening function. The basic gear comprises the shock strut, drag strut and retraction actuator.

The shock strut is a two stage oleo-pneumatic arrangement with an improved overload relief device. The drag strut is a self-cracking strut incorporating an in-line mechanical locking device. An integral spring-biased hydraulic actuator provides the means for unlocking and cracking the strut and also ensures the positive locking of the gear in the down position. A double acting hydraulic actuator with snubbers at each end of the stroke raises and lowers the gear.

The nose gear assembly comprises the shock strut, and steering actuator.

The shock strut is a two stage oleo-pneumatic device designed for rough field operation and provides a stable platform during loading operations. The drag strut is a double acting hydraulic actuator incorporating an internal locking device in the extended and retracted positions. The drag strut functions as a retraction actuator for raising and lowering the gear and also provides a mechanical uplock and downlock. Normal operation of the drag strut is achieved by the use of system pressure and emergency provisions are incorporated in the unit to permit the gear to be unlocked, lowered and locked in the down position in the event of system failure. The steering actuator is a balanced area linear actuator which operates a bell-crank arrangement to provide the necessary torque to steer the nose gear. The steering actuator has a steering valve, back pressure reservoir and shimmy damper valves.



AIRFIELD LIGHTING POWER SUPPLY SYSTEMS FOR TEMPORARY AIRFIELDS, HELIPORTS, STOL AND PERMANENT BASE AIRFIELDS

Westinghouse Canada Limited has designed, developed, manufactured and placed into operation airfield lighting power supply systems for mobile, transportable and permanent base installations for the Department of National Defence of Canada.

Each of these types of lighting power supply systems is designed to operate from two alternate sources of supply i.e. commercial power source or diesel-generator stand-by source. In the case of the mobile and transportable systems the diesel-generator can also be used as a continuous power source. The output of each system provides regulated constant current power to high intensity series-lighting circuits used on approach, runway, centre line and taxi-way as well as non-regulated power for less essential services. The regulators, first of their kind developed in Canada, are high performance, fast response, solid state thyristor type with three to five brightness levels to provide selection to suit airfield visibility conditions.

Each type of the airfield lighting power supply systems is arranged for automatic transfer from commercial power supply to diesel-generator supply in the event of power failure of the commercial source and for automatic return to commercial power. The lighting supply systems are designed as non-attended regulating stations which can be operated remotely from the control tower or other remote locations. Local control is also provided at the station for emergency operation, test, inspection and maintenance.

OUTDOOR (TRANSPORTABLE) REGULATOR STATION FOR HELIPORTS

The type OTRS outdoor transportable regulator station provides regulated power for approach, landing and taxiway lighting and primary or stand-by power supply for military based heliports. The design is adaptable for use on STOL airports and for isolated airports where the cost of construction of permanent buildings is prohibitive.

The regulator station includes a heavy-duty Deutz air-cooled diesel generating set type F6L-912, 50 KW 120/240 volt single phase 60 Hertz, two Westinghouse solid state constant current type RSS-10H regulators 10KW, 6.6 amps five levels of brightness, 12 Westinghouse type MGL 5 KV 6.6 amps runway selector relays, 600

volt incoming power transformer, distribution panel, diesel engine control, starting batteries, battery charger and fuel tank all supplied as a factory assembled unit. The station can be supplied for 50 Hertz operation if required.

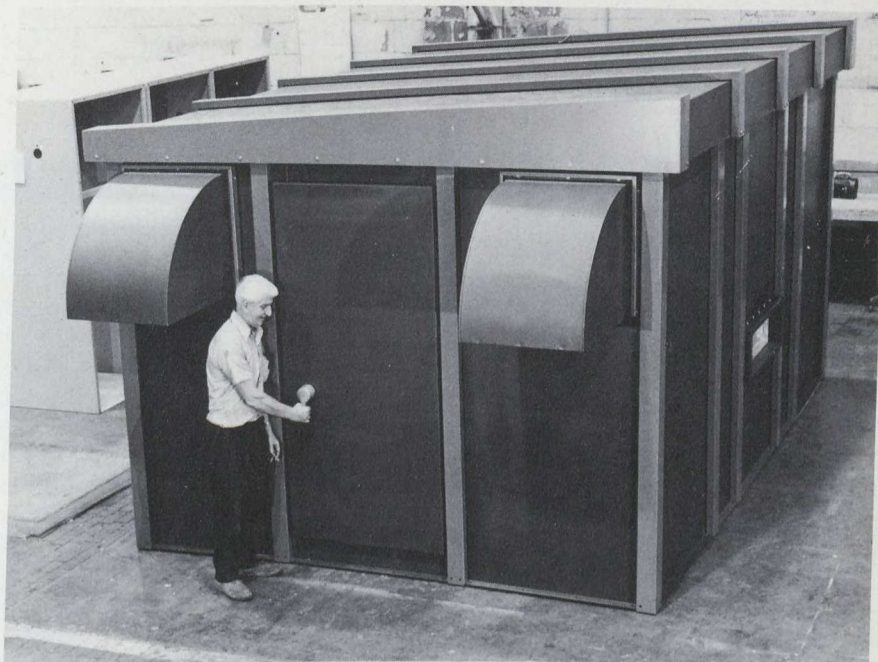
The complete regulating station approx. 289 cm wide, 274 cm high (over base to apex of single sloped roof), 437 cm (114 x 108 x 172 in.) long is supported on a common base equipped with lifting lugs to facilitate transportation and installation.

The regulator station enclosure is constructed of heavy gauge steel double flanged with gasketed doors to ensure resistance to weather. The enclosure is bonderized, primed and the exterior is given two finish coats of outdoor equipment paint to seal against corrosion. The interior walls are insulated with polyurethane foam thermal board and the underside of the roof is sprayed with compound to prevent condensation. Thermostatically controlled heaters come into operation when the temperature falls below 10°C (50°F). Motor-operated louvres provide for diesel cooling air flow. A thermostatically controlled exhaust fan is provided to prevent the interior temperature from becoming excessive.

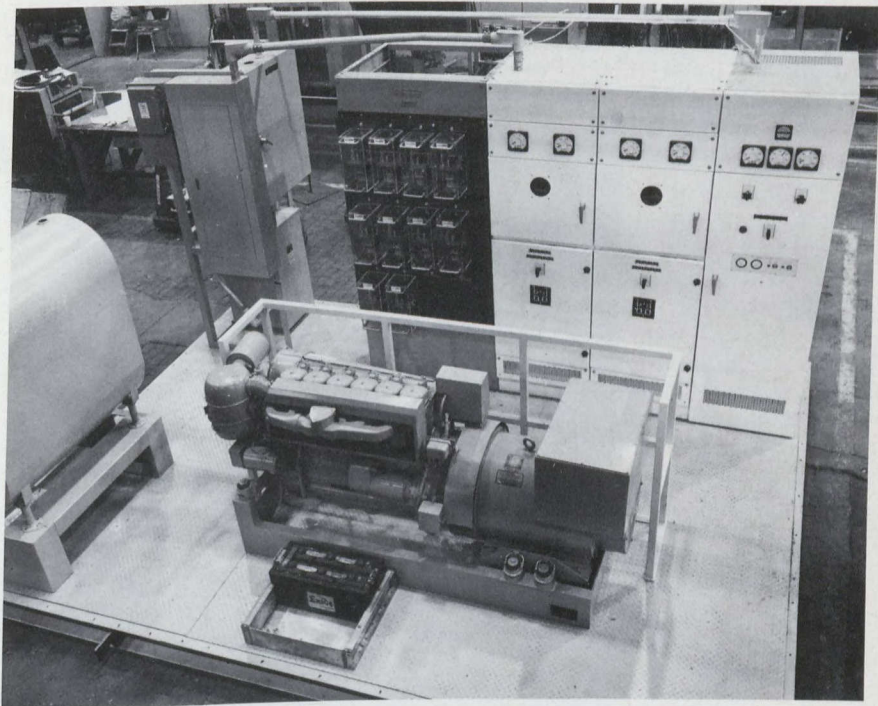
Generous service aisles and adequate work space are provided within the station for manual operation, test, inspection and maintenance. Interior lighting and convenience outlets 115 volts 60 Hertz are provided. The station is equipped with interior emergency lights and outdoor obstruction lights.

The diesel generator is rated for continuous service and can thus serve either as a prime power supply or as an automatic stand-by power supply. The direct air-cooled diesel engine suitable for service under all climatic extremes eliminates any danger of coolant boiling or freezing. The special engine governor maintains the output frequency constant between no load and full load. The generator is of the brushless type with static type automatic voltage regulator. The generating set is mounted on its own steel bases via shock absorbers.

The Westinghouse RSS-10H constant current regulators are dry type solid state with semiconductor devices in the power and control circuits require very little maintenance. Five stages of brightness levels can be selected. Two levels can be pre-selected by means of toggle switches



Type UTTH Regulator Station in process of manufacture.



Interior view of the Outdoor Transportable Regulator station without enclosure in process of manufacture.

before the regulator is switched into service making seven levels of brightness available i.e. 6.6 amps, 5.5 amps or 5.2 amps, 4.8 amps or 4.1 amps, 3.4 amps and 2.8 amps. All brightness levels are field adjustable.

An important feature of the Westinghouse solid state regulators as in the case of the mobile unit is the capability of the regulators to limit the let-through fault current and load switching current from any load to short circuit to $\frac{1}{2}$ cycle or less. The I²t heating effect of the fault current or load switching current is held well below the thermal rating of the lamps to ensure maximum protection and lamp life. When switching the regulator on the current is allowed to build up gradually to rated value in approx. 30 cycles to reduce the thermal stress on cold filaments.

The essential elements of the regulator are mounted on a lift-off hinged door which can be replaced with another regulator door assembly of the same rating by one man in less than 3 minutes thus minimizing "down-time". The component parts on the regulator door are readily accessible for inspection and servicing in location. The printed circuit boards incorporated in the door are "plug-in" type which are readily accessible for test or adjustment. The interface

control relays are sealed "plug-in" type. Each regulator has means for remote and local control. The station is provided with fully automatic diesel starting and shut-down controls, including protective safety shut-downs. The complete regulator station is movable as a complete unit and is capable of being transported and installed as a fully co-ordinated assembly. To place into service, it is necessary only to complete the in-coming and out-going connections. The station is built on a self-supporting base and does not require a concrete pad for installation. The design is such that it can be transported by road, rail or air.

MOBILE LIGHTING POWER SUPPLY FOR AIRFIELDS

The Type 'B' mobile lighting power supply provides power and control for visual guidance for arrival and departure of all types of aircraft including STOL, Helicopters and VTOL aircraft under visibility conditions of 91.4 m and 1.6 km (300 ft. and 1 mile) providing sufficient navigational equipment is available to allow for procedure turn and approach.



Type "B" Mobile Airfield Lighting Power Supply

The trailer unit weighs approximately 2,721 kg (6,000 lb.) and measures 172.7 cm high and 145.5 cm wide and 355.7 cm long over the towing bar and can be airlifted to any landing strip. The unit is capable of operation under all weather conditions from 40°C to 65.5°C (-40°F to 150°F) and is capable of continuous operation as a power source. The fuel tank has a capacity for 364 litres (80 gals.) of fuel, sufficient for approximately 48 hours of full load operation. The lubricating oil tank capacity is adequate for 30 days continuous service. The mobile unit is capable of supplying in addition to the 15 KW regulated lighting load, prime auxiliary power or stand-by power up to 10 KW at 240/120 volt 50 or 60 Hertz for operation of radio, navigational aids, control tower, first line aircraft maintenance or other services.

The mobile power supply includes a heavy-duty DEUTZ air-cooled diesel generating set type F3L912, 25 KW 240 Volt 50 or 60 Hertz operation, two Westinghouse solid state constant current regulators type RSS 7.5 KW 6.6 amps with 3 pre-selected brightness levels, six type MGL 5 KV 6.6 amps runway selector relays, Westinghouse Robonic* automatic transfer panel, remote-local regulator control, engine start panel, batteries, battery charger, fuel tank and a combustion heater for extreme cold weather starting.

The air-cooled DEUTZ diesel has an output of 51.5 HP at 60 Hertz and of 44 HP at 50 Hertz operation, which provides a margin for higher ambient temperatures and site elevation of 28% at 60 Hertz and 10% at 50 Hertz beyond the actual equipment power requirement of 25 KW. The special DEUTZ engine governor maintains permanent speed droop — and, therefore, output frequency — between no load and full load at 0% with 60 Hertz and 1-2% with 50 Hertz operation. The diesel engine is equipped with a heavy duty air filter with cyclon type pre-filter for very dusty locations. Fuel filters are of the change-over type, permitting continuous operation during filter element replacement. A water separator is fitted. Both full-flow and by-pass type lubricating oil filters are provided.

While equipped with a starting aid, a gasoline operated combustion heater requiring battery power for ignition only, and not for operation, is provided to ensure starting under extremely cold temperatures. Special care has been taken to

keep the starting batteries fully charged. A small portable gasoline-powered battery charging set is carried as part of the unit. The battery charger can be plugged directly into a 115 volt 50 or 60 Hertz power supply when available. When the diesel is operating its own battery charging generator takes over.

Where external normal power supply is available (115/230 volts, single phase, either 50 or 60 Hertz) the units diesel generating set will function as an emergency power source, starting automatically when normal power fails. The engine control system provides for three cranking cycles as well as automatic shut-down in the event of low lubricating oil pressure or excessive cylinder head temperature.

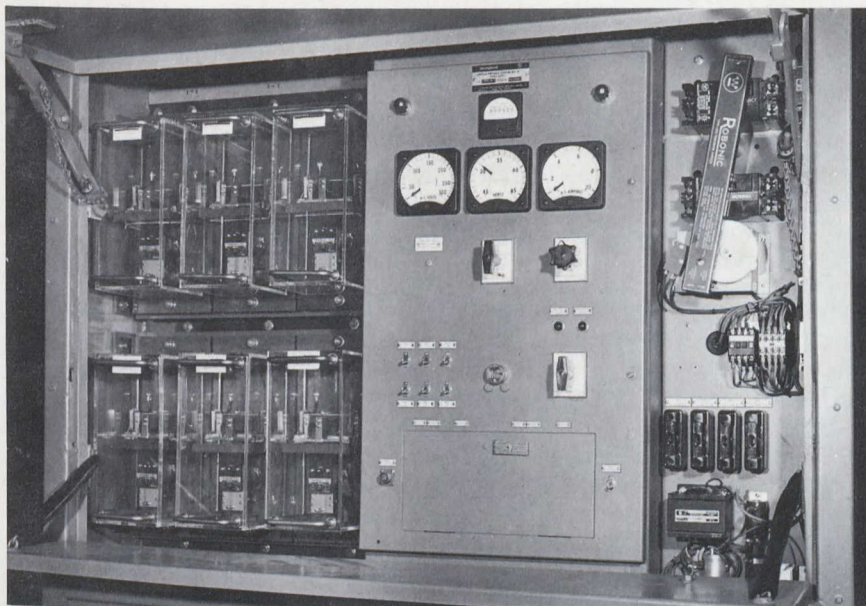
The runway lighting regulators are dry type, solid-state, high accuracy units capable of maintaining constant current output ± 0.1 amps over the complete range of loads from short circuit to full load for all brightness levels. Three brightness levels 2.8 amps, 4.1 amps are provided for remote or local selections to suit visibility requirements. The Westinghouse RSS 7.5 solid state regulator features an inherently fast control circuit response and limits the let-through fault currents and load-switching currents from any load to short circuit to $\frac{1}{2}$ cycle or less. The I^2t heating effect of the fault current or switching current is kept well below the thermal rating of the lamps ensuring maximum lamp protection and lamp life. When the solid state regulator is switched on, the current is allowed to build up gradually over approximately 30 cycles to reduce thermal stress on cold filaments.

While only two regulators are provided on the mobile unit, the use and versatility of the regulators is extended by the six specially designed Westinghouse type MGL high voltage relays. These relays have make-before-break contacts enabling each of the regulators to be connected to three different runway circuits. The six runway circuits can be operated simultaneously or switched independently of one another. Remote operation up to 152 m (500 ft.) from the unit is provided by means of a remote control pushbutton station for starting and stopping the diesel generator set and for operation of the lights.

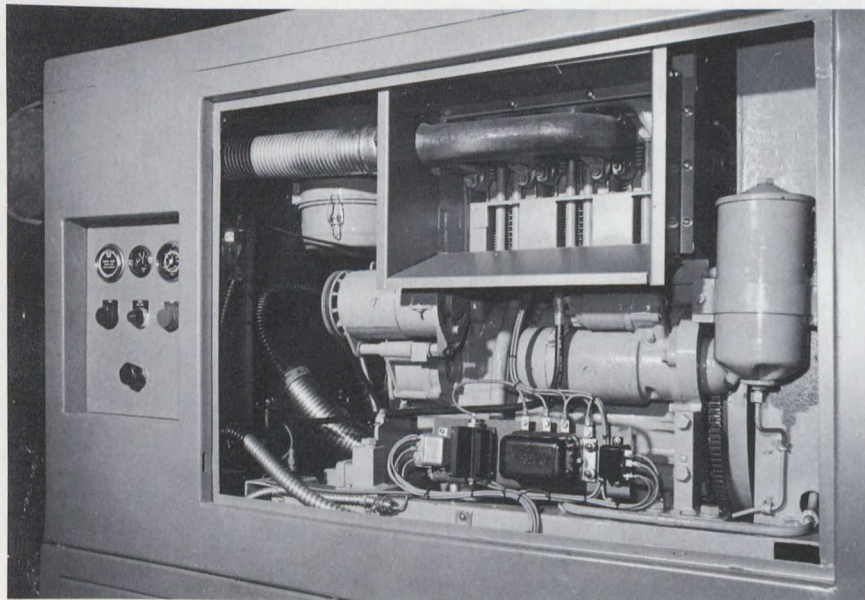
It is expected that the type 'B' Portable System of the type supplied to the Department of National

Defence Canada including all lights, fixtures and cables could be installed by 12 men with 2 jeeps in 12 hours when the installation includes 2,438 m (8,000 ft.) of runway, two approaches, taxiway lighting and possibly some obstruction lighting. The mobile power supply is ideal for small airports in remote locations or temporary airfields for military or civilian operations.

Rear view of Mobile Unit showing the Type RSS-7.5P constant current solid state regulators, Transfer Panel and Type MGL Runway Selector Relays.



Type OTRS Outdoor (Transportable) Regulator Station for Heliports supplied to the Department of National Defence.



PERMANENT AIR BASE INDOOR REGULATOR INSTALLATIONS

For permanent air base installations which have runways 2,438 m (8,000 ft.) or greater and which have requirements for high intensity lighting for approach, runway and taxiway lighting systems for category I and category II operations Westinghouse Canada Limited has developed the type RSS high performance solid state constant current regulator with five pre-selected brightness levels field adjustable for operation from a 60 Hertz or 50 Hertz single phase supply.

The design is modular, flexible and adaptable to a wide range of inputs i.e. from 240 volts to 2,400 volts and for outputs up to 30 KW at 6.6 amps and 60 KW at 20.0 amps.

An airport installation of the type provided to the Department of National Defence Canada typically incorporates a line-up of free-standing switchgear cubicles all single phase units, connected to a common 416 OY/2,400 volt 3 phase 60 Hertz supply. A diesel generating set with same voltage and frequency is provided with a fully automatic start-up control and transfer in the event of failure of the main power supply. In the switchgear line-up a number of cubicles are type RSS solid state constant current regulators single phase; other cubicles contain high voltage non-regulated lighting supplies for less essential circuits. In addition the station service power supply and regulator controls including interface with the control tower are all co-ordinated for most effective and compatible operation.

The most essential sub-system and one requiring a high degree of reliability is the constant current regulator.

DESCRIPTION

Co-ordinated assembly containing 2,400 volt, 60 Hertz, 4-conductor bus section, 2,400 volt switch and fuses, and a solid-state constant-current regulator. The regulator proper includes an incoming transformer, a set of power thyristors with their solid-state feedback control circuit and an output transformer.

CONSTRUCTION

The co-ordinated assembly is housed in a free-standing metal-clad enclosure 61 cm wide x 79 cm deep x 203 cm high (24 x 31.25 x 80 in). Steel partitions divide the enclosure into separate compartments for the various H.V. and L.V. circuit

components. The essential solid-state devices of the regulator are mounted on a rapidly removable door. This door can be lifted off its hinges and replaced with any other regulator door of same rating by one person in less than 3 minutes.

RATINGS

Input:

2,400 \pm 10%, 60 Hz, 1-phase, 24 KVA

Output:

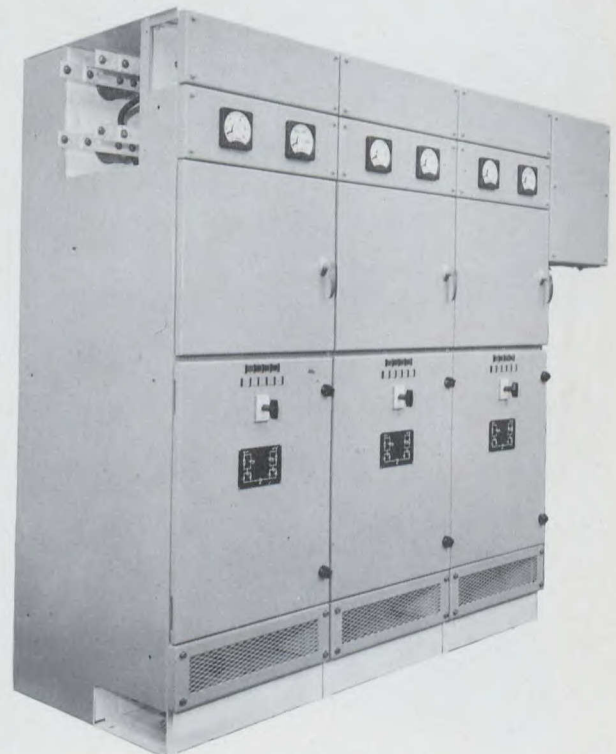
20 KW, 1-phase, continuous at constant current of 6.6 amps, with 5 selectable brightness levels.

Accuracy:

Constant current output \pm 0.1 amps rms for input voltage \pm 10% and for all brightness levels.

Response:

Let-through current limited to $\frac{1}{2}$ cycle on switching output from any load to short-circuit. Rated output at highest brightness level attained in 0.5 second from instant of regulator switch-on.



Group of 3 Type RSS-20 Solid State constant current regulators being prepared for shipment.

Efficiency:

In excess of 96% at full and $\frac{3}{4}$ load at 5.2 and 6.6 amps output levels.

Power Factor:

In excess of 0.8 at full and $\frac{3}{4}$ resistive load, at 5.2 and 6.6 amps output level, at rated voltage.

OPERATION

Operation of regulator at constant current corresponding to 5 brightness levels — adjustable (typical 6.6A, 5.2A, 4.1A, 3.4A, 2.8A).

- (a) by "LOCAL" control using selector switch mounted on regulator door.
- (b) by "REMOTE" control using contacts of 5 interface relays whose coils are energized from remote control and supply location. The remote control supply may be 120 volt, 60 HZ, or other (typical interface relay current 11 milliamp.).

PROTECTION

Over-current trip-adjustable (typical setting 7.2 amps).

Over-voltage trip-adjustable (typical setting 3,700 volts).

Automatic regulator lock-out after 4 consecutive over-current trip-reclose cycles, and after single over-voltage trip pulse.

SUPERVISION

Lights indicating the following:

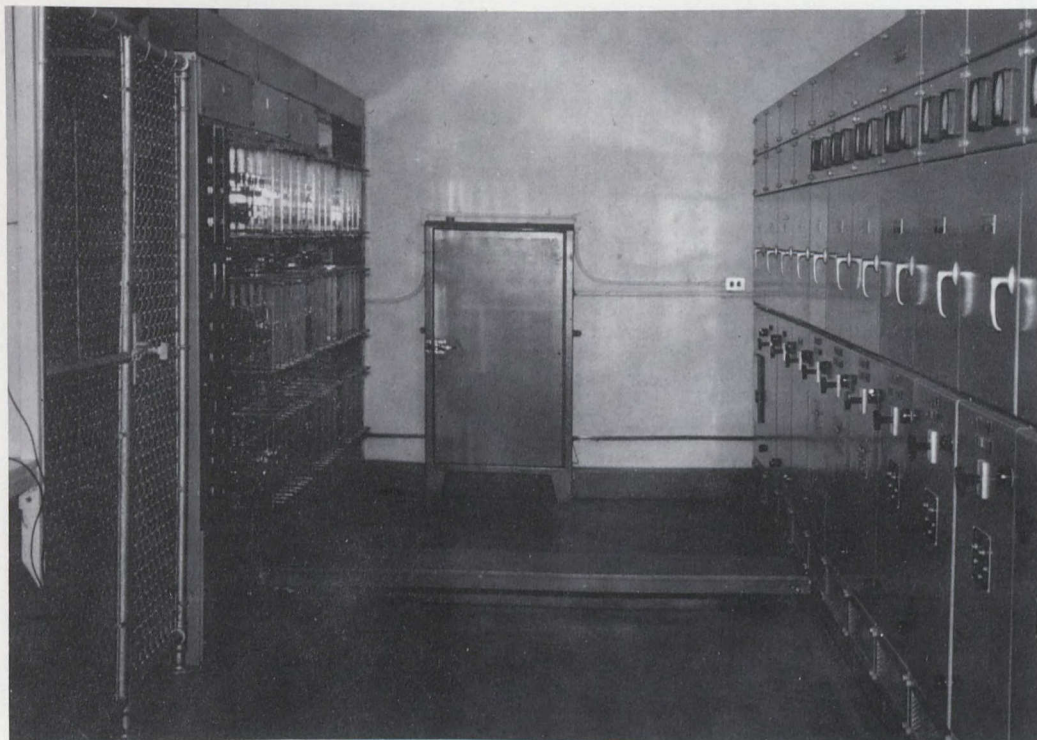
- (i) Regulator is in operation.
- (ii) Regulator tripped on over-voltage.
- (iii) Regulator tripped on over-current.

Optional.

- (iv) Regulator operating position brightness level 1, 2, 3, 4 and 5.

Ammeter for load circuit current.

Voltmeter for output terminal voltage.



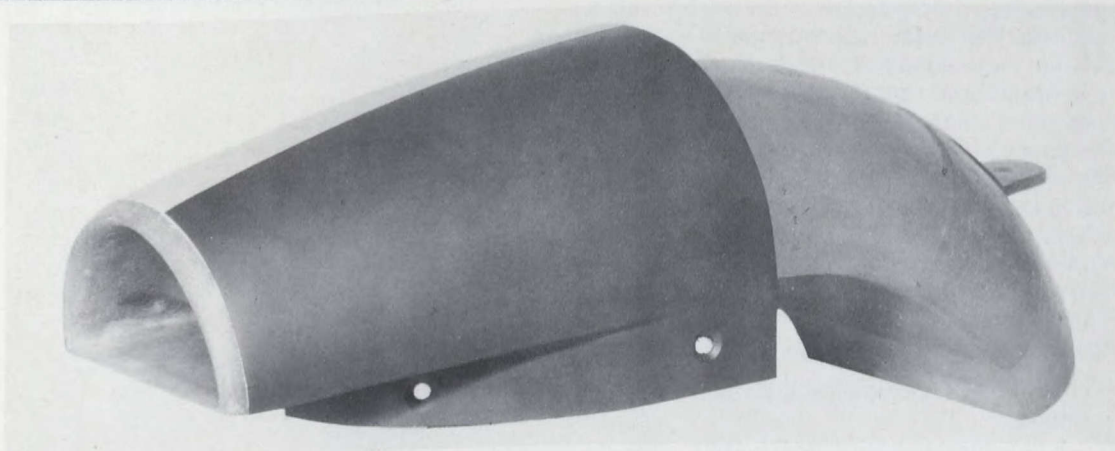
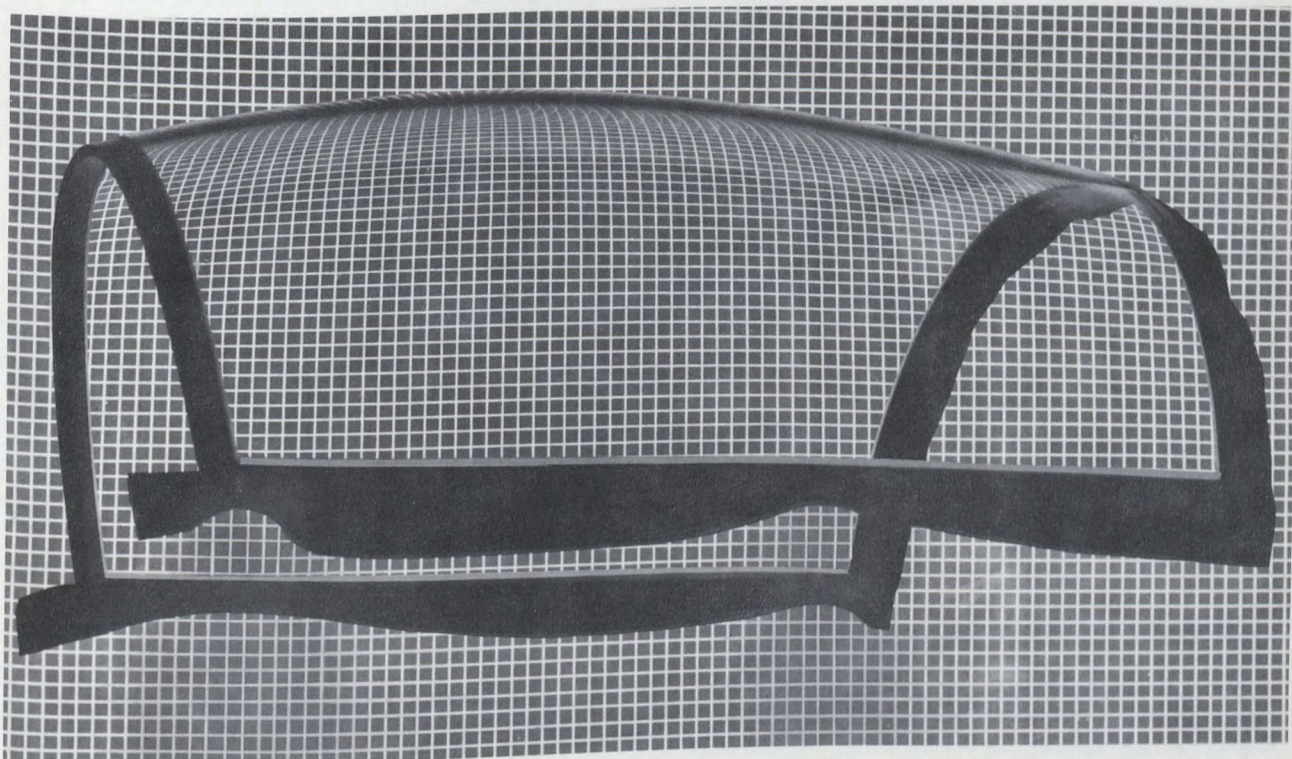
Type RSS-29 Solid State constant current regulators for High Intensity Airfield Lighting. In the photograph on this page is a sample of the operation at Canadian Forces Base, Trenton, Ontario.

ACRYLIC AND PLASTIC LAMINATED SECTIONS

Plastal Manufacturing are specialists in thermoforming acrylic and other sheet thermoplastics. Canopies have been produced for the F-86, F-84, F-104 and T-33 aircraft and for several helicopters. The photograph shows a F-104 canopy, partly finished, being inspected against an optical grid test board in the quality control section. Rigorous optical specifications are maintained in acrylic material up to 50.8 mm (2 in.) in thickness.

Plastal Manufacturing supplies Canadair Ltd. with several reinforced plastic parts incorporated in the CL-89 Reconnaissance Drone. This outboard duct for the engine air intake system is an assembly of precision laminated components and is typical of the wide range of high quality aircraft components manufactured for Canadair and other aerospace customers.

F-104 Acrylic Canopy



Outboard Duct for CL-89

CRASH POSITION INDICATOR (CPI)

The Leigh CPI consists of an aerodynamically designed airfoil system that includes a radio transmitter with self-contained power supply, a mounting tray with an automatic release unit, plus a manual cockpit release capability.

On release, the airfoil will initially fly in a controlled trajectory away from the aircraft and, depending on its design, will descend either in a tumbling or rotating manner at a greatly reduced speed. The airfoil is constructed to be shockproof and waterproof, enabling it to land on the roughest terrain without damage to its contents, and to float indefinitely on water.

The beacon starts transmitting an emergency signal immediately upon ejection from the aircraft and continues to emit a swept-tone signal on 243 MHz for at least 48 hours on land or water. The signal can be detected by aircraft with standard communication equipment at ranges up to 129 km (80 miles) and more.

The CPI offers the maximum possible chance of survival as the beacon is deployed automatically when a crash occurs or can be deployed manually. These CPI systems can be adapted to a variety of aircraft including helicopters.

The Leigh airfoil is designed to have specific aerodynamic properties. Survivability of the airfoil is achieved by ejecting it into the airstream immediately upon the sensing of a crash. Crash sensor switches are located in the aircraft nose and wing-tips and in the undercarriage area. When an aircraft strikes the ground, it buckles at a rate dependent upon speed and the aircraft structure. The rear structure retains its forward velocity for a period long enough to maintain the airflow required to ensure a good airfoil departure. During normal operation, the airfoil is carried in a passive state, mounted in or on the aircraft's fuselage. The airfoil's aerodynamic properties of lift and drag cause the airfoil, once deployed, to fly in an arc and rapidly slow to terminal velocity to achieve a safe landing.

The Leigh airfoil delivery system known as the AN/URT-26(V), consists of various configurations, and is designed to meet USAF standards in exhibit SEAG 66-9.

Within the space and weight provisions of the flush mounted system, a Flight Data Recorder (FDR) can be installed.

Pylon Mounted Systems have been installed on:

- USAF C-124, DeHavilland Beaver and Twin Otters.

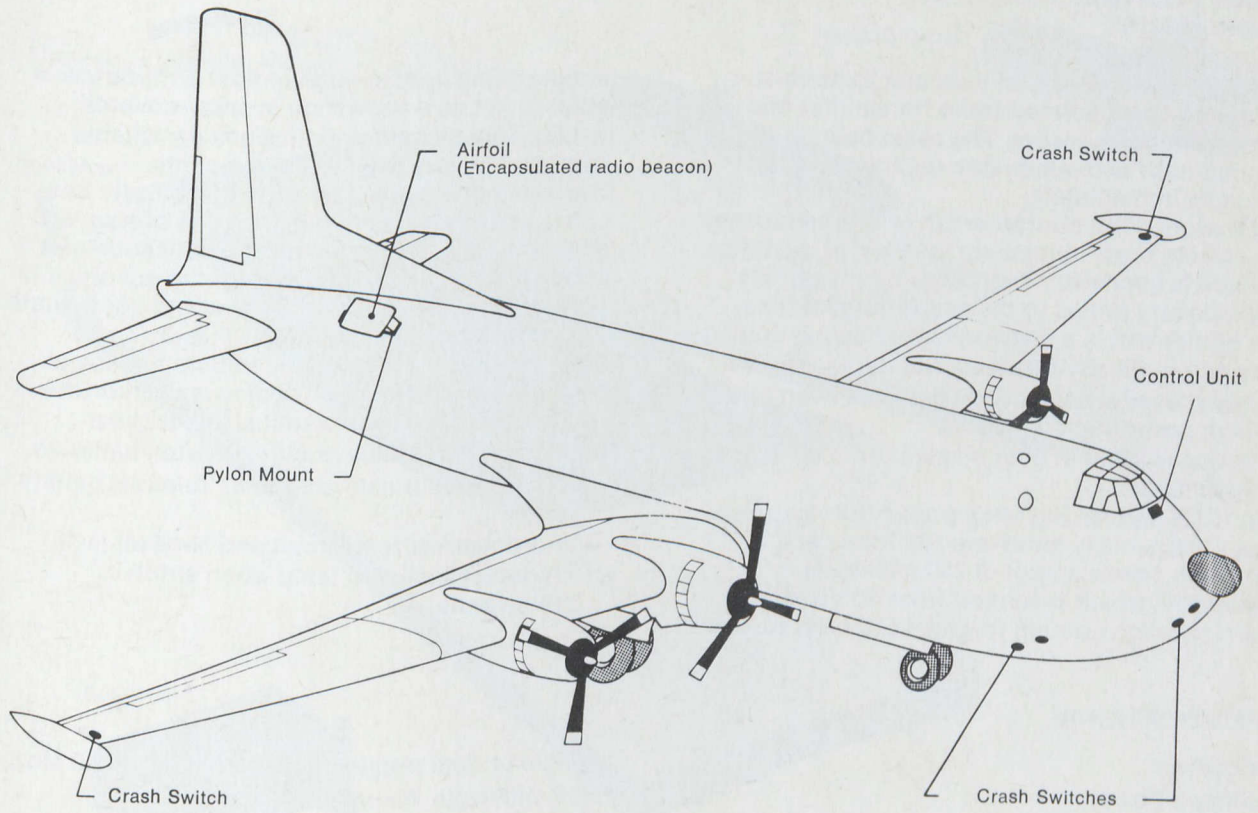
Flush Mounted Systems are in use or are designated for:

- USAF C/RC/WC-135, VC-137, HC-130H, C-130 A/B/D and E, C-141A, Lockheed C-5A, Douglas C-9A.
- Canadian Forces CC-106 (Yukon), CF-104, CC-137, CC-130 Buffalo and Falcons.
- USN P-3 A/B/C, C-2, E-2, S-3A.
- West German Air Force, F-104G.

The airfoil is mounted as far aft as possible to ensure the maximum probability of survival. Should the aircraft crash, sensors detect the crash early enough to release the airfoil. The airflow over the airfoil then allows it to generate lift and fly away from the crash site on a predetermined trajectory. The airfoil's velocity is reduced by a factor of two for each 20° of arc travelled, and safe landing speed is approximately 24.3 m.p.s. (80 f.p.s.) at sea level. (This is approximately twice the airfoil's terminal velocity.)

AN AIRFOIL BEACON CAN BE INSTALLED:

- pylon mounted externally on fuselage,
- flush mounted on tail surfaces,
- flush mounted on fuselage.



Typical Installation of an Externally Mounted
Crash Position Indicator

CRASH POSITION INDICATOR — PYLON MOUNT

The Leigh Crash Position Indicator System consists of an encapsulated radio transmitter and crash detection sensors. The radio beacon is automatically activated upon deployment and transmits immediately.

In the event of an aircraft crash or forced landing in a remote area, immediate location of the crash position is necessary in order to direct search and recovery forces to the scene without delay. The equipment is a distress radio beacon that:

1. is automatically released and deployed.
2. has proved it can survive crashes, even of high performance aircraft.
3. is economical in both installation and maintenance.

The 121.5 and/or 243 MHz transmitter then operates continuously for at least 48 hours at a minimum power output of 250 milliwatts. The airfoil, which is formed from polyurethane foam, is tough enough to withstand hard surface

landings, and light enough to float 85% out of water or act as a snowshoe in snow-covered terrain. These characteristics ensure reliable operation in very severe environments.

The deployment and operation of the radio beacon is entirely automatic in the case of a severe accident. However, when an accident such as a controlled forced landing or ditching occurs, it is possible that the crash sensors would not actuate the release mechanism. Under these circumstances, it may be desired to initiate release of the airfoil by the manual 'deploy' switch on the control unit. The control unit also supplies:

1. A regulated trickle charge to airfoil batteries.
2. A regulated trickle charge to 'release' battery pack.
3. A transmitter test circuit and headset jack.
4. A deploy indicator lamp when airfoil is released.

SPECIFICATIONS

Frequency	Single or dual frequency 121.5 and/or 243.0 Mhz.
Radiated Power	250 milliwatts minimum
Modulation	Sweeping audio 300 to 1600 Hz, repetition rate 3 per second
Operation	Automatic — continuous or manual on/off
Radiation Pattern	Omni-directional
Typical Ranges*	50 nautical miles
Transmitting Life	2 days
Temperature Range (limited by batteries)	—40° C to +56° C (—40° F to +132° F)
Altitude	Up to 42,672 m (140,000 ft.)
Weight (system)	4.5 kg (10 lb.) typical average
Dimensions (beacon only)	40.6 cm dia. x 10 cm thick (16 in. x 4 in.)

*Detection range is limited by (a) terrain at beacon site, (b) efficiency of search receiver, (c) altitude of search aircraft.

Much greater ranges than those quoted will be obtained if beacon is floating in mid-ocean.



Crash Position Indicator System Components

HELICOPTER CRASH POSITION INDICATOR

In the event of a helicopter crash, immediate location of the crash position is necessary in order to provide prompt assistance to survivors and to reduce the hazards of the rescue operation. The Leigh Helicopter Crash Position Indicator fulfills this requirement with efficiency and complete dependability.

This distress beacon —

- (i) is automatically released and activated.
- (ii) has proved that it can survive crashes, even of high-performance aircraft.
- (iii) is economical in both installation and maintenance.

BASIC OPERATION

The equipment consists of an encapsulated radio beacon and crash detection sensors. The radio beacon is automatically actuated upon release and transmits immediately.

Encapsulation of the radio beacon ensures safe deployment of the equipment. In addition, the shock-absorbing qualities of the capsule material completely protect the beacon from destruction in the event of a hard surface landing. The buoyancy of the capsule allows the beacon to float indefinitely.

SPECIFICATIONS

Frequency
Radiated Power
Modulation

Operation
Radiation Pattern
Typical Ranges*
Transmitting Life
Temperature Range
(limited by batteries)
Altitude
Weight (system)
Dimensions (beacon only)

THE RADIO BEACON

Solid-state continuous-wave beacons are crystal controlled for the 121.5— or 243.0— megahertz distress bands, and are tone modulated by a sweeping audio signal. This technique of modulation makes the radiated signal easy to identify against the background of constant frequency interference which is always present in aircraft. The existing Leigh radio beacons provide a signal directable at distances exceeding 50 miles when standard search equipment is used. Also the beacon, when operating in an ambient temperature of -40° to $+132^{\circ}$ F, will operate for durations in excess of 48 hours. Other carrier frequencies are available in the 121.5-mc to 243.0-mc band.

Longer operating life can be provided to meet particular application requirements.

All Leigh Crash Position Indicator systems utilize parallel plate antennas wholly enclosed in the airfoil. The Beacon's nickel-cadmium type batteries are maintained at full charge by a low trickle current from the aircraft battery.

MANUAL DEPLOYMENT

In the event of a controlled forced landing, impact force may not be sufficient to break the frangible switches and deploy the beacon. In this event, activation of the transmitter may be accomplished by using the EMERGENCY TRANSMIT switch on the Cockpit Control Unit, or the beacon may be removed manually from its mount.

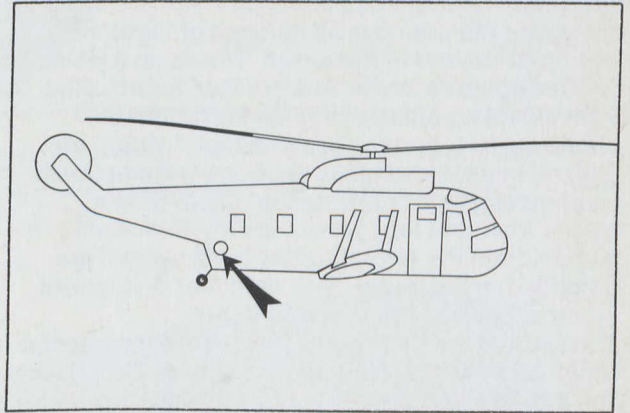
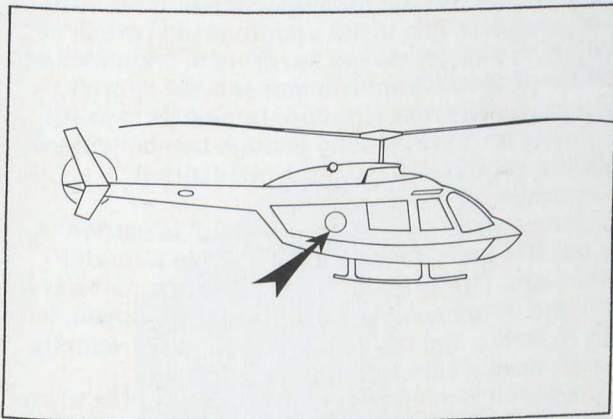
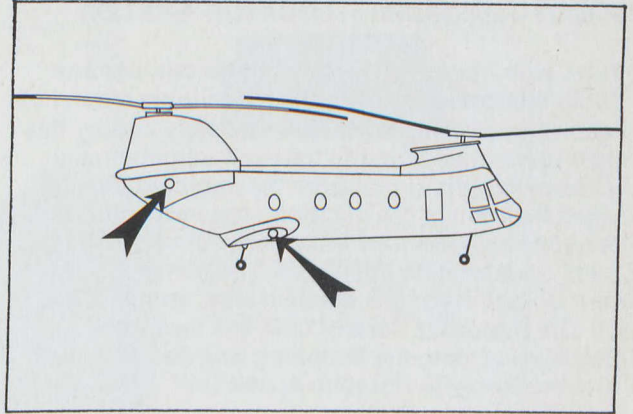
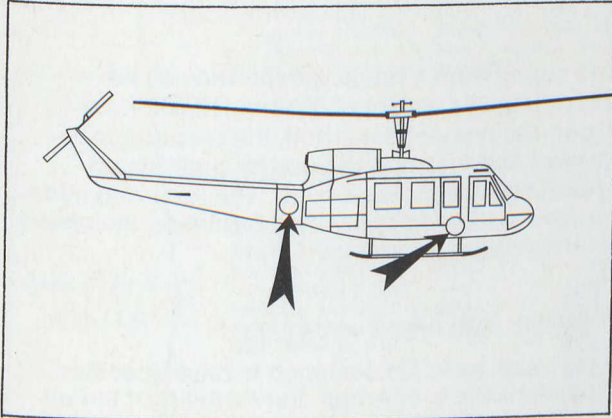
Single or dual frequency 121.5 and/or 243 MHz
250 milliwatts minimum
Sweeping audio 300 to 1600 Hz, repetition rate 3 per second
"Automatic" — continuous or manual on-off
Omni-directional
50 nautical miles
2 days

 -40° C to $+56^{\circ}$ C (-40° F to $+132^{\circ}$ F)
Up to 42,673 m (140,000 ft.)
9.5 kg (21 lb.)
50.8 cm sq. by 1.4 cm (20 in. sq. x 4.5 in.)

*Detection range is limited by (a) terrain at beacon site, (b) efficiency of search receiver, (c) altitude of search aircraft.

Much greater ranges than those quoted will be obtained if beacon is floating in mid-ocean.

Illustrations Indicate Positioning Flexibility of the Leigh Helicopter CPI Recorder/Locator System



FLIGHT RECORDER – LOCATOR SYSTEM

The Leigh Instruments Flight Recorder/Locator System is designed to provide a reliable means of recording aircraft flight data, to safely deploy this data upon impact and to transmit automatically a radio distress signal from the accident location. Upon location of the accident, the recorded data may easily be removed from the airfoil and played back to determine the cause. The complete system is light in weight, small in size, and consists of: The Recorder Control Unit, the Recorder Electronics Unit, the Mounting and Release Unit and the Recorder Beacon Airfoil Unit.

RECORDER SYSTEM

A small re-cycling magnetic tape recorder which preserves the previous 30 minutes of flight information is located in the airfoil. This is an 8 track, bi-directional recorder that accepts information from a data acquisition unit and aircraft interphone system. Four tracks (3 audio, 1 data), are utilized in each direction. A sensor automatically sequences the recorder to the adjacent four tracks when the tape reverses direction. Audio signals from the aircraft interphone system are amplified in the audio/data amplifier unit before being applied to the recorder heads.

The Data Acquisition Unit (DAU), gathers selected flight data from aircraft instruments and special transducers and processes this information into a digital form (PCM) suitable for recording. The DAU contains solid state signal conditioners, multiplexing, analog to digital converters, encoders, timing and control circuits to process up to 128 channels (9 bit words) of flight data. The DAU varies in size and channel capacity according to the number and variety of parameters to be sampled. 32, 64 and 128 samples per second systems are currently available.

A Receiver Control Unit in the flight deck allows crew members to monitor system status and voice recording quality.

LOCATOR SYSTEM

The airfoil contains a distress beacon consisting of a transmitter, antenna and nickel-cadmium batteries. These are encapsulated in polyurethane foam. When the airfoil is separated from the aircraft, the transmitter is activated immediately and radiates a 250 milliwatt, omni-directional signal on 121.5 and/or 243 megahertz. The batteries will supply power for a minimum of 48 hours under the most severe environmental conditions. Search and recovery forces using standard search radio equipment, are able to home in on

the signal from a range greater than 80 km (50 miles) at a height of 3048 m (10,000 ft.). Upon recovery of the airfoil, the recorder is removed and returned to base for analysis on ground playback equipment. The recorded information is used to assist in determining the cause of the crash or accident.

AIRFOIL DELIVERY SYSTEM

The Leigh airfoil is designed to have specific aerodynamic properties. Survivability of the airfoil is achieved by ejecting it into the airstream immediately upon the sensing of a crash. Crash sensor switches are located in the aircraft nose and wing-tips and in the undercarriage area. When an aircraft strikes the ground, it buckles at a rate dependent upon speed and the aircraft structure. The rear structure retains its forward velocity for a period long enough to maintain the airflow required to ensure a good airfoil departure.

During normal operation, the airfoil is carried in a passive state, mounted in or on the aircraft's fuselage. The airfoil's aerodynamic properties of lift and drag cause the airfoil, once deployed, to fly in an arc and rapidly slow to terminal velocity to achieve a safe landing.

The airfoil is mounted as far aft as possible to ensure the maximum probability of survival. Should the aircraft crash, sensors detect the crash early enough to release the airfoil. The airflow over the airfoil then allows it to generate lift and fly away from the crash site on a predetermined trajectory. The airfoil's velocity is reduced by a factor of two for each 20° of arc travelled, and safe landing speed is approximately 24.3 m.p.s. (80 f.p.s.) at sea level. (This is approximately twice the airfoil's terminal velocity).

FEATURES

- Combines radio distress beacon, voice recorder and accident data recorder.
- Exceptionally high survivability.
- Ejection and survival proven beyond Mach 2.0.
- Channel capacity up to 256.
- Up to 3 voice channels.
- Radio beacon range over 50 miles, operates longer than 48 hours, performance to -40°C.
- Floats on water.

AIRCRAFT
INPUTS

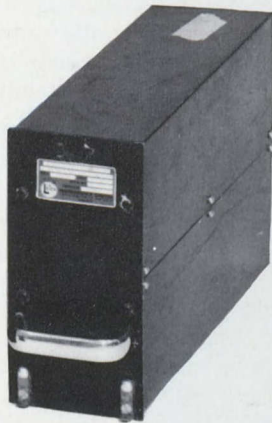
RECORDER CONTROL UNIT. Features Voice playback for system checking. Beacon monitor. Battery charging test. Release for controlled forced landing. Size 47.6mm (1 7/8 in) Dzus rack mounted.

SIGNAL CONDITIONER UNIT. Features. Plug-in module construction. Contains time-of-flight clock modules available for wide range of transducer inputs. Size, short 3/8 ATR.

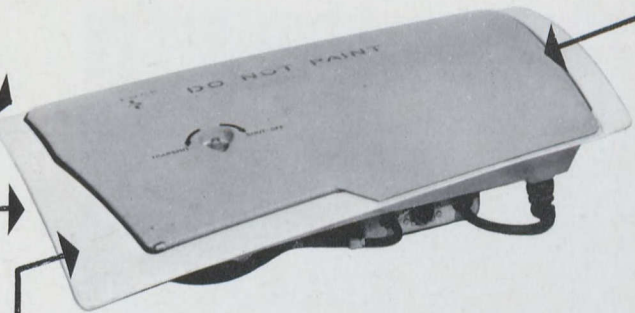


RECORDER ELECTRONICS UNIT. Features. Fully solid state plug-in printed circuit cards. Contains signal conditioner circuits and PCM encoder. Size, Short 3/8 ATR.

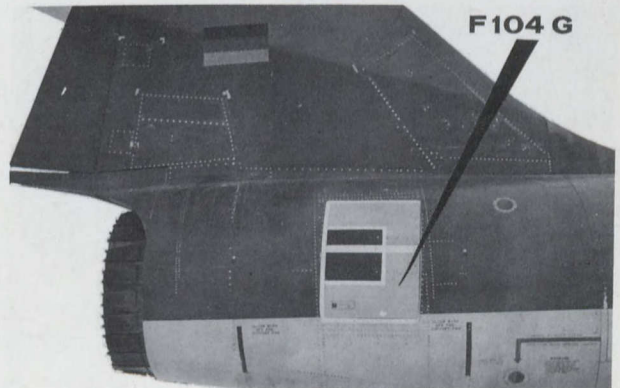
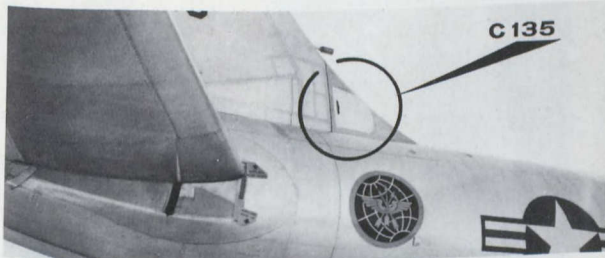
RECORDER BEACON AIRFOIL. Features. Contains both Beacon and Recorder. Aerodynamically designed for best lift and drag characteristics. Polyurethane foam with tough outer fibreglass skin absorbs landing shock. Fire protected. Size, approximately 50.8 x 50.8 x 11.4 cm (20 x 20 x 4.5 in) depends on aircraft.



VOICE INPUTS



MOUNTING AND RELEASE UNIT. Features. Installation flush with aircraft skin. Fibreglass construction. Size, approximately 55.8 x 55.8 x 13.9 cm (20 x 20 x 5.5 in) (depends on aircraft).



SYSTEM SPECIFICATION

RECORDER

Channel Capacity	up to 256
Sampling Period	1.0 seconds (standard)
Voice Channels	1 to 3 optional
Tape Speed	46 mm.p.s. (17 $\frac{1}{8}$ i.p.s.)
Recording Time	last 30 minutes continuous record-erase

BEACON

Frequency	243.0 MHZ (standard) and/or 121.5 MHZ optional crystal controlled to .003%
Radiated Power	250 milliwatts minimum
Modulation	sweeping audio 300 to 1,000 cps. repetition rate 2 per second
Antenna	parallel plate, molded in airfoil
Radiation Pattern	omnidirectional
Typical Range	80.4 km (50 sm)
Temperature Range (limited by batteries)	-40°C to +55°C (-40°F to +132°F)

SYSTEM

Weight	22.6 kg (50 lbs.) (Typical)
Installed Weight	45.8 kg (110 lbs.) for typical large aircraft, 64 channels, including all transducers
Power Consumption	50 VA, 115V, 400 cps 20 watts, 21 VDC
Environment	MIL-E-5400, class 2
Fire Protection (airfoil, beacon and tape cassette)	1,100°C for 1.5 minutes

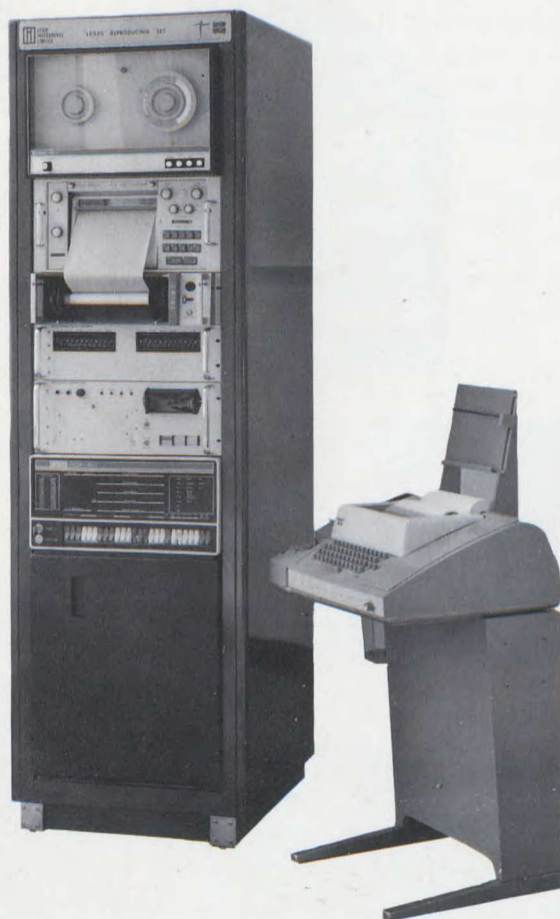
DATA PLAYBACK UNIT

THE DATA PLAYBACK UNIT (DPU) is used for the computer-controlled reduction of recorded data to analog and digital presentation. By this means, recorded tapes from Accident and Maintenance recorders can be played back as hard copy. The unit can be configured to play back voice recordings as well as analog and digital data. The DPU can be used to play back tapes from any of the various Leigh recorders in service. Data playback can be performed in real time or with a 33:1 speedup.

The DPU can be equipped with a Reformatter which transfers data onto a second magnetic tape in compatible format for computer analysis.

Power supply is normally 115V, 60Hz, but operation from other voltages or frequencies can be provided if specified.

Units of this type are in service with the U.S. Navy, Canadian Armed Forces, the West German Air Force and Air Canada. An installation is also maintained at Leigh Instruments.



FLIGHT RECORDER TAPE DECK

The RTD-2 developed and produced by Leigh Instruments was designed for use with their own flight recorder and locator systems but may also be used with virtually any other system as the recording element.

The RTD-2 records data in computer compatible format on IBM standard 7-inch tape reels. Front loading cassette simplifies tape exchange; the ½ ATR long enclosure (ARINC 404) is designed for avionics rack installation.

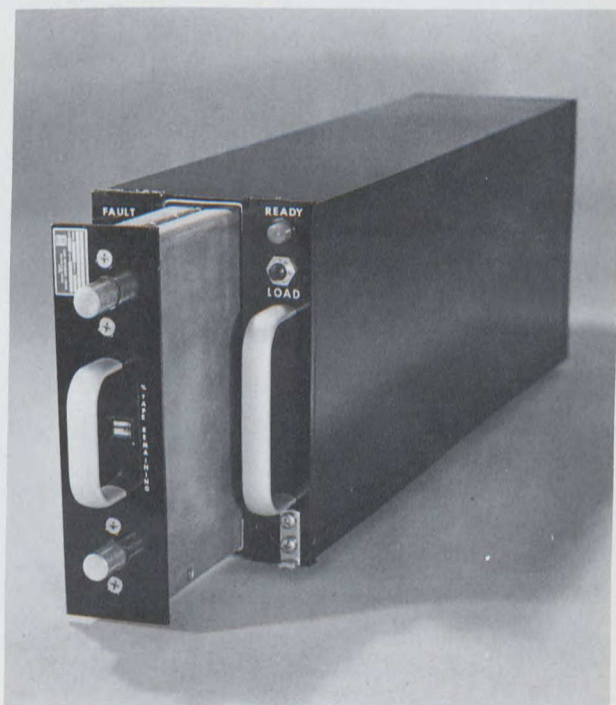
Modular electronics packaging permits a variety of interface and application options such as:

- Parallel recorder
- Buffered incremental recorder
- Input serial to parallel conversion
- Automatic character and block formatting
- Complete data acquisition system

The recorder is available in 7 or 9 track configurations at 556 or 800 character per inch, and provides the necessary tape formatting electronics for generating vertical parity, inter-record gaps with the appropriate cyclic redundancy and longitudinal check characters, and file gaps with file mark character.

SPECIFICATIONS

Recording Rate	
Asynchronous	0 to 300 characters/second
Synchronous	Up to 600 characters/second
Density	556 or 800 characters/inch
Tracks	7 or 9 (6 or 8 plus parity (internal))
Compatibility	IBM 2400 Compatible or equivalent
Reel Size	17.7 cm (7 in) IBM standard
Reel Capacity	183 m (600 ft) of computer grade magnetic tape
Size	½ ATR Long (ARINC 404)
Weight	9 kg (20 lb)
Power	115 AC, 400 Hz 100 VA
Environment	RTCA DO-138
Error Rate	less than 1×10^7 bits



WATER ACTIVATED AIR-SEA RESCUE BEACONS

The RESCU/99 Emergency Radio Beacon is designed and manufactured by Garrett Manufacturing Limited to fulfill ICAO requirements for beacons on all commercial overwater flights.

The Beacon is lightweight, compact, fully automatic device intended primarily for use at sea in conjunction with life-rafts. Operation is initiated automatically upon immersion in water. The radiated power is nominally 350 milliwatts average on either or both of the two output frequencies: civil emergency frequency 121.5 MHz and Military emergency frequency 243 MHz. Each channel is amplitude-modulated using chopped-carrier modulation. The modulation sweeps downward in frequency over the range 1,500 to 600 Hz at a rate of approximately 2½ sweeps per second.

A water-activated magnesium-silver chloride battery provides power to operate the Beacon. The battery is totally dry and inert until activated by immersion in water. While normally intended for use in sea-water, the battery can also be activated by fresh water and by other aqueous liquids. The operating life is in excess of 48 hours.

The transmitter and associated circuitry are fully solid state, with all components operating at conservative ratings. A hermetically-sealed cover encloses all electronic circuitry.

The Beacon can be packed in a stowed life-raft or may be bulkhead-mounted. For the latter application, a bulkhead-mounting bracket is provided.

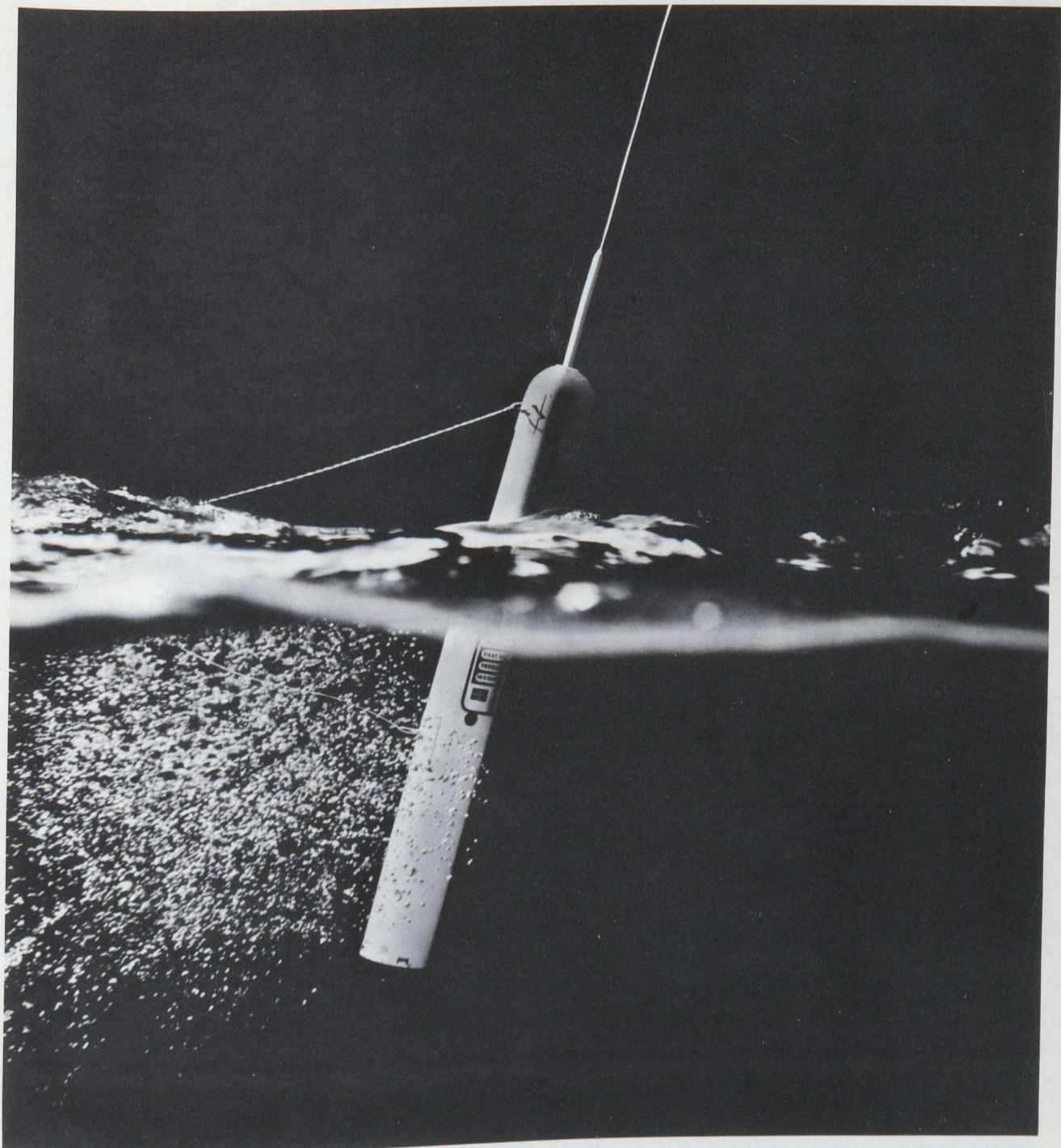
SPECIFICATIONS

Frequency:	121.5 MHz and/or 243 MHz, 0.005% tolerance.
RF Output:	121.5 MHz — 350 milliwatts average power. 243 MHz — 350 milliwatts average power.
Modulation:	Modulation in accordance with ICAO recommendations (100% swept tone modulation over 900 Hz range within the range 1,500 to 600 Hz; Sweep rate 2 to 3 Hz).
Dimensions:	Length (Stowed) 56.5 cm (22.25 in) Length (Operating, with Antenna erected) 98.4 cm (38.75 in) Diameter 6.9 cm (2.75 in) Weight 1.6 kg (3.5 lb)
Operating Life:	48 hours
Storage Life:	Indefinite
Range:	Over 322 km (200 sm) at jet altitudes.

Compliance requirements formulated for these Beacons by the U.S. Federal Aviation Agency and Federal Communications Commission as well as by the Canadian Department of Transport have been met by the RESCU/99. With this status achieved the equipment has now been adopted by more than fifty airlines such as: Air Canada, Pan American, TWA, Lufthansa, SAS, Air France and by such aircraft manufacturers as Boeing and Douglas.

Garrett has developed a new emergency locator transmitter which is qualified to the new U.S. F.A.A. Specification TSO C91. It meets the requirements of an automatic fixed, automatic portable and personnel type unit. The detail specification of this unit is as follows.

— Model	RESCU/88
— Size	43 x 61 x 216 mm (1.7 x 2.4 x 8.5 in.)
— Weight	0.73 Kg (1.6 lb)
— Output	100 m.w. at -20°C (-4°F) for 48 hours
— Portable Antenna	Included
— Fixed Antenna and Co-axial Cable	Included
— Mounting Brackets	Included
— Automatic Activation by G switch	at 5G.
— Optional Cockpit Operation by connector	provided.
— Optional Nicad Batteries and Control Charger	available.
— Uses removable magnesium battery pack with replacement interval of two years (full shelf life four years).	



AUTOMATIC DOWNED AIRCRAFT LOCATORS

Garrett Manufacturing Limited have developed a downed aircraft beacon consisting of three principal components: a main case containing the transmitter and batteries, and two antenna assemblies containing the antennas and matching networks. The antenna assemblies are connected to the main case by coaxial cables. When the aircraft impacts with the ground the beacon is automatically turned on and commences transmission of a signal which can be received at a range of up to 332 km (200 miles).

Operating Frequencies — The beacon uses the military emergency frequency of 243 MHz and the civil of 121.5 MHz thus providing a common media of cooperation for both military and civil flying.

Power Output — The power output of a VHF beacon need only be sufficient so that the range is horizon-limited rather than power-limited; no significant advantage is gained by exceeding this level therefore average power output of 225 milliwatts is adequate to meet this condition. In this beacon, high level of approximately 300 milliwatts is used to allow for random orientation of the antenna system and power output is provided at each of the two output frequencies.

Modulation — The signal is 100% amplitude modulated by an audio tone sweeping downward over the range 1600 to 600 Hz at a rate 2.5 sweeps per second. The modulating waveform is essentially square wave.

Antenna System — Dual opposed antennas are used, fed into anti-phase. In normal operation, the available power on both frequencies is divided equally between the two antennas. If one antenna is broken off, at least half of the available power is fed to the remaining antenna. A DC path is provided between the antenna rods and the airframe to prevent static build-up.

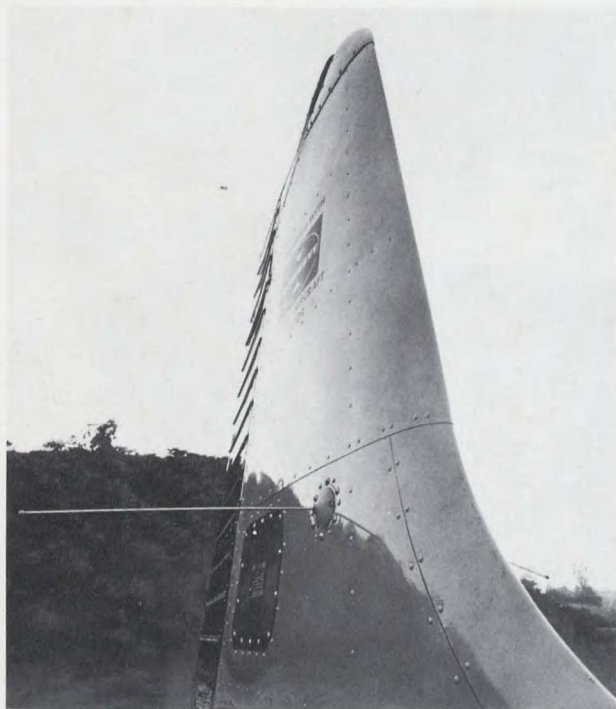
Power Supply — The beacon operates from a source of nominal 12 volts D.C. This source normally consists of eight size D manganese-alkaline cells. As an optional alternative at low temperatures, provision is made for the use of 8 size D sealed nickel-cadmium cells. It is possible to float charge these cells in flight.

Operating Life — The operating life of the beacon to the half-power point is nominally 48 hours after one year from the installation of fresh batteries. A somewhat reduced operating life is permissible at extremely low temperatures, but not less than 24 hours at -40°C using rechargeable batteries.

Switching — The beacon is provided with both automatic and manual switching. An automatic inertia switch operates and remains operating after being subjected to a steady-state rearward

acceleration of 4.5G or to a transient acceleration equivalent to a sudden velocity change of 91.4 cm per sec. (3 ft.). A manual ON-OFF switch normally located in the cockpit of the aircraft, with a shield to guard against accidental operation, may be wired in parallel with the inertia switch. A second manual switch, to permit the inertia switch to be reset, is provided in a position accessible from the exterior of the aircraft.

Compatibility or mounting problems should be discussed with Garrett whose experience in this field and with this equipment covers many aircraft types and operating situations.



AIRPORT VISIBILITY EQUIPMENT

"With respect to all-weather landing, the significance of visibility measurement has considerably increased in the past few years. Accurately and quantitatively to know the state of the free atmosphere on the ground, and on the glide path of the landing aircraft, will be an indispensable requirement."

Marsland Engineering Limited is a leading manufacturer and designer of automatic systems and sensors to various world-wide authorities.

Illustrated is a typical Ministry of Transport — Meteorological Branch MARS weather station for monitoring purposes. The foreground shows a Transmissometer and Ceilometer manufactured to M.O.T. specifications by Marsland.

In addition to supplying equipments for meteorological monitoring, Marsland systems are used extensively by airports throughout the world. Uses include general traffic (rivers, ports, highways, etc.), scientific purposes, and pollution measurement.

Typical equipment and systems are:

- Automatic Weather Stations to monitor cloud height and cover, transmissivity of the atmosphere, altitude, barometric pressure, wind speed, wind direction, temperature, rainfall and dewpoint.

These systems may be designed for remote locations with automatic data transmission equipment.

- Ceilometers (rotating beam type) to provide a means of measuring cloud height by means of triangulation along a known base line. This system consists of a projector, a detector and an indicator or recorder.
- Transmissometer, an electro-mechanical system which continuously measures atmospheric visibility (transmissivity) along a fixed base-line.
- Runway Visual Range Computer accepts visibility readings and converts this information into an accurate three figure digital R.V.R.
- RVR/Transmissometer is a complete visibility system with a continuous automatic up-date which provides local operating minima for airport control personnel.
- Wind Speed and Direction Systems to provide continuous and accurate information.
- Digital Altimeter Display System (D.A.D.S.) for airport altimeter indications to ensure accurate update readings, by barometric pressure converted to inches-of-mercury, four figure digital readout.



PROJECTED MAP SYSTEM

The AN/ASN-99 Projected Map System is a pictorial navigation system in quantity production for the U.S. Navy and U.S. Air Force Corsair II A-7 programme. The system provides a dynamic display of aircraft present position, and features operating modes for look-ahead, north or track map orientation, plus rapid selection of film data. Map scales and area coverage can be changed to meet customer requirements. The AN/ASN-99 stores the equivalent of 27.8 m² (300 ft.²) of paper charts. A typical area coverage at 1:500,000 and 1:2,000,000 scales, combined on one film, would be approximately 1200 n. miles x 1200 n. miles. The two-box system comprises a projected map display (PMD) and an Electronics Assembly Unit (EAU). The PMD contains the film strip of the coverage area, film drives and feedback sensors, optical elements, map display screen, operating controls and peripheral display of compass rose, miles-to-go and bearing-to-destination, ground track, and steering error.

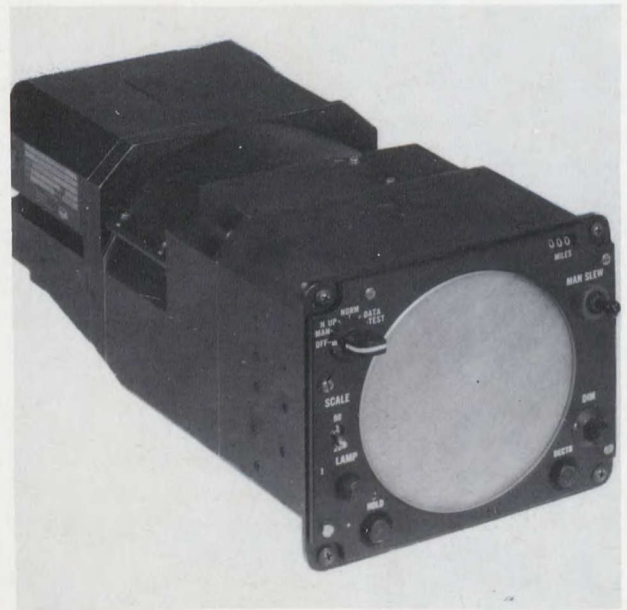
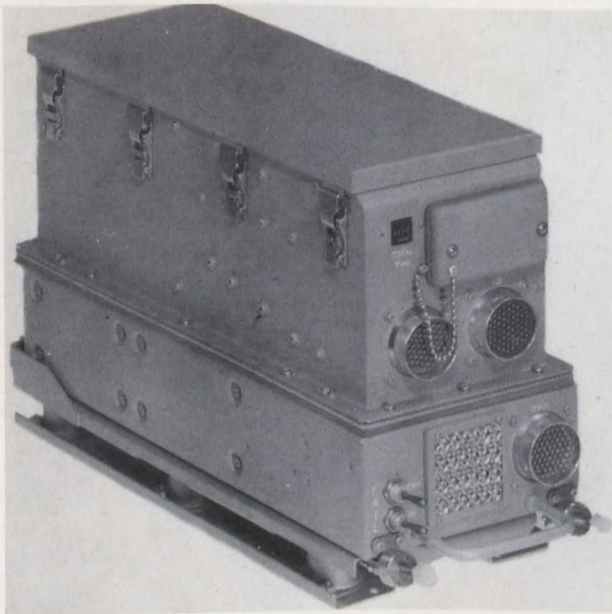
The EAU contains circuitry for receiving and processing the digital bit-serial, word-serial input command from a general purpose digital naviga-

tion computer. The EAU provides closed-loop servo positioning signals to the PMD for each display parameter.

The display is easily read in 10,000 foot candles ambient lighting. The ASN-99 is fully qualified to MIL-E-5400 and MIL-I-6181. The system reliability of 1000 hours MTBF has been demonstrated to MIL STD 781, Test Plan 3.

For aircraft without a central digital navigation computer, the PMS-5 Projected Map System is applicable. The PMS-5 can accept all navigation sensor velocity signals in analog or digital form. This three box system comprises a PMD, an EAU, and a Navigation Display Unit (NDU).

The NDU displays aircraft present position numerics in latitude and longitude to the nearest tenth of a minute, variation to tenth of a degree and wind degrees and knots. A grid position display is optionally available. The NDU stores up to ten destinations and is fully reprogrammable during flight. The PMS-5's smaller size and ease of operation make it ideal for helicopter or medium sized single seat aircraft. This is another example of Computing Devices navigational equipment.



COMBINED DISPLAY

Computing Devices' Combined Display System (CDS) combines a projected map image with cathode ray tube video and projected servoed reticles. The technique employed for combination of the three images is the projection of the optical images through the transparent rear port of a CRT, with the map optics being on axis and unfolded.

The CDS images can be viewed in bright sunlight, individually or in any combination. The most simple mode provides a basic navigation or HSI display representing aircraft track, range and bearing to destination, and track to steer. These projected reticles are available in all modes. In the map plus symbol (M+S) mode, CRT symbols are superimposed on the map and navigation images. The positioning of the CRT symbols is

under the control of a central computer. Distinctive symbol shapes may represent navigation waypoints, targets or aiming points, threat warning locations, sensor reconnaissance signals, defended areas, etc. When the sub-mode TV is selected, the map and navigation symbols are switched off and the CRT provides a television roster scan display. Typical applications of this mode include LLLTV, Missile Guidance, FLIR and radar video from a scan counter.

Optionally, the CDS can be fitted with a CRT having a long persistence phosphor screen to display raw radar video either alone or in combination with the map display. To eliminate the necessity for a viewing hood in areas of high ambient light, contrast enhancement techniques have been employed.



POSITION AND HOMING INDICATOR (PHI)

The PHI is a light-weight, low-cost navigation computer and display system primarily designed for single seat fighter and trainer aircraft. Nearly 5000 PHI systems have been sold to fourteen air forces, mainly in NATO countries. Most recently it has been fitted to the Mirage V and the J-35 Draaken.

The current production series is the PHI-5C which accepts Doppler and/or Air Data sensor signals. The outstanding feature of the PHI is the small flight plan data storage package called the Station Storage Unit (SSU). It is roughly the size of a cigarette package, and stores twelve destinations. The SSU plugs into the Control Unit and can easily be replaced in flight by the pilot. By rotating the Station Selector knob on the Control Unit the

pilot obtains automatic steering data to any of the twelve destinations. The steering data is presented on the Indicator (IND) as bearing, distance and heading to steer. Simple control sequences allow the pilot to quickly correct the system for dead reckoning errors.

This equipment, while it was first produced some thirteen years ago, is still considered as being most applicable to to-day's requirements. The basic designs by Computing Devices and the application of state-of-the-art production techniques continue to offer a sound and proven navigation aid.

Repair and overhaul facilities are available in Europe and North America.

This system is another example of the proven navigational equipments developed and produced by Computing Devices of Canada.



AN/ARA-59 UHF DIRECTION FINDER GROUP

The AN/ARA-59 is a solid state, high-performance ADF system designed to replace the AN/ARA-25 and ARA-50 in search and rescue aircraft. Greater capability is offered by the independent guard receiver on 243 MHz, a broadband UHF preamplifier and antenna switching relay. The system will ADF on 243 without use of the aircraft's main RT unit hence ADF bearing is not lost during transmissions. The preamplifier boosts the UHF receiver's sensitivity or makes up for losses in coax cable.

The antenna is electronically rotated using diode switching techniques to eliminate mechanical parts from the antenna. Condensation and water leakage problems are avoided through sealing the antenna completely.

SPECIFICATIONS:

Frequency Range: 225 - 400 MHz

Altitude: 21,336 m (70,000 ft.)

Temperature: -54°C to $+70^{\circ}\text{C}$

Preamplifier: Frequency - 225 - 400 MHz

Gain: 20 db

Noise Figure: 6 db max

Aux 243 MHz Receiver - Sensitivity: 1 uv for
10 db S+N/N

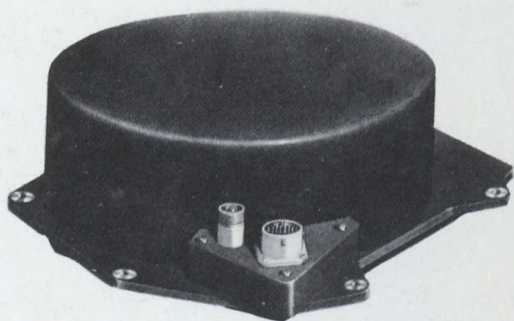
Audio output: 50 milliwatts

Antenna	Control
9.39 cm (3.7 in.)	3.81 cm (1.5 in.)
26.77 cm (10.54 in.)	14.6 cm (5.75 in.)
26.77 cm (10.54 in.)	10.54 cm (4.15 in.)

4.3 kg (9.5 lbs)

.544 kg (1.2 lbs)

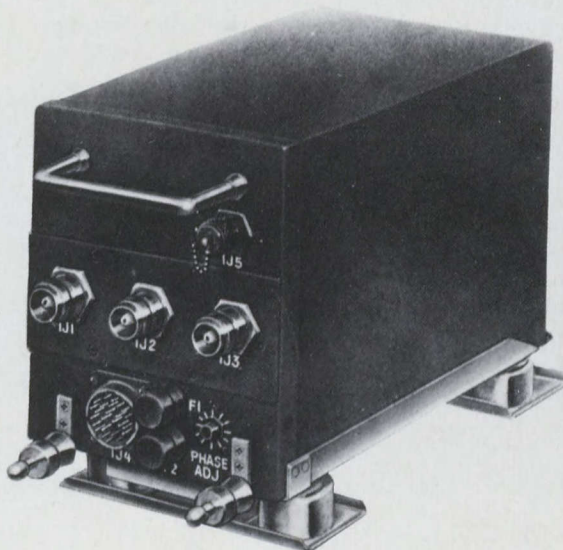
The AN/ARA-59 has been developed under a USAF/WPAFB contract by Collins Radio Company of Canada Ltd.
The antenna fits the ARA-50 antenna mounting.



ANTENNA



CONTROL



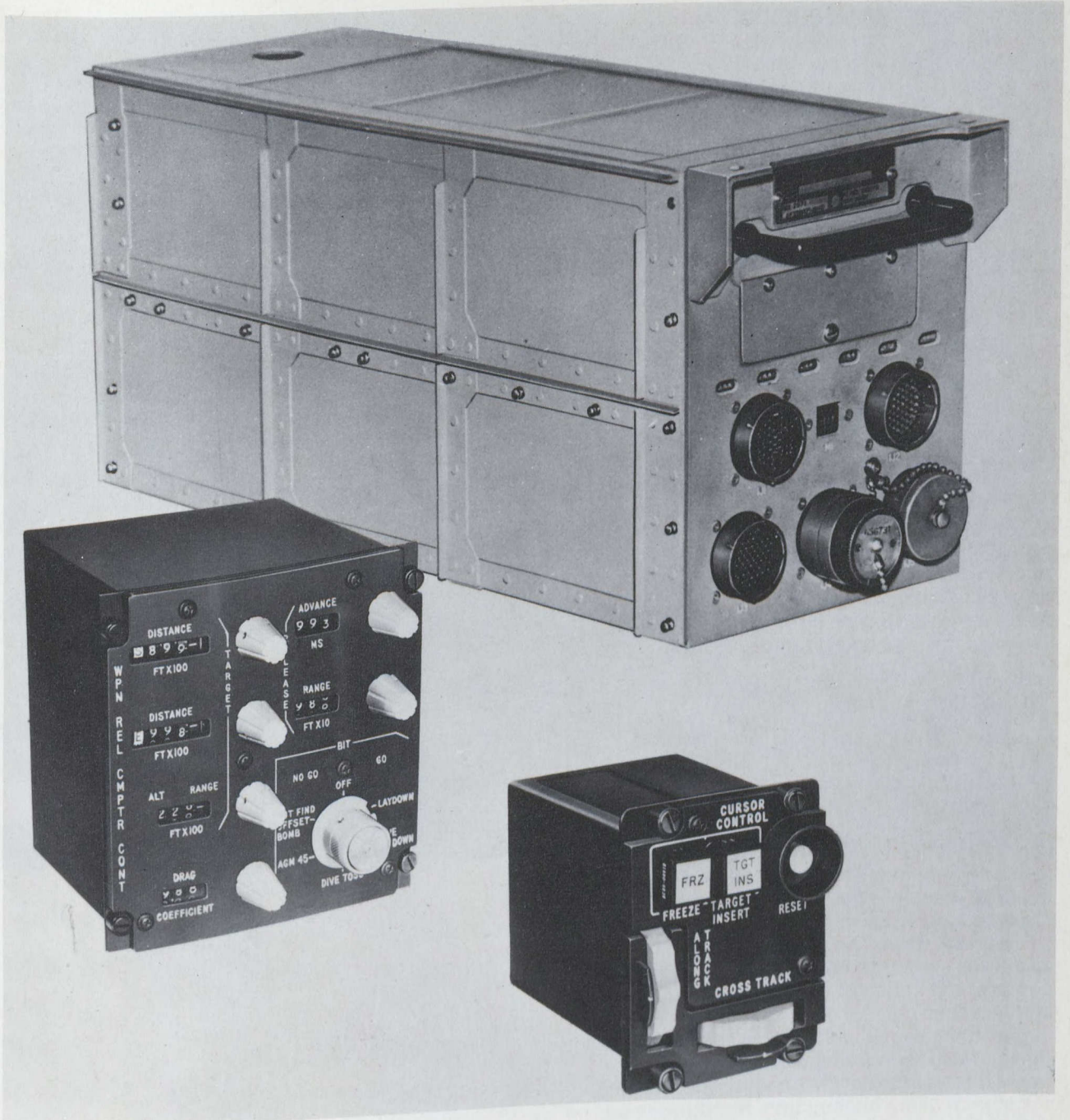
AMPLIFIER

WEAPON RELEASE COMPUTER SET (AN/ASQ-91)

Manufactured in Canada by Litton Systems (Canada) Limited, the AN/ASQ-91 Weapon Release Computer Set is an analog weapon's delivery system designed to enhance the combat effectiveness of the McDonnell F-4D/E aircraft. Compatibility of the weapons release computer set with the LN-12A Inertial Navigation Set used in the F-4C aircraft may be achieved through substitution of the LN-12D Output Signal Distribution Unit. The weapons release computer set provides range calculations and automatic weapons release signals for the laydown, dive-laydown, dive-toss and off-set bombing modes of operation. Steering signals and range-to-target information are supplied for use in the target-finding and off-set bombing modes. Manoeuvre commands and the release signal are provided for successful delivery of the AGM-45 missile. Either low-drag or high-drag bombs may be used through proper adjustment of the weapons release computer control panel drag coefficient control. Maximum use of F-4D/E aircraft inertial navigation set output signals and electronic components and mode-sharing of weapons release computer set components has achieved substantial reductions in size, weight, and cost of the equipment.

The Litton computer set consists of:

- The Ballistic Computer unit which contains all of the analog circuitry required to solve the bombing problem for each mode of computer set operation;
 - The Cursor Control Panel which incorporates two thumbwheel controls for adjusting the position of the long-track and cross-track cursors on the radar screen during the target finding and off-set bombing modes;
 - The Weapons Release Computer Control Panel which contains controls and switches for mode selection, built-in test operation, and insertion of various range, altitude, time and ballistic information.
-



MOBILE AUTOMATIC TEST SET

Developed by the engineering division of Litton Systems (Canada) Limited, the Mobile Automatic Test Set (MATS) is Litton's approach to a rapid maintenance capability employing minimum skill levels for inertial navigation systems at squadron and base shop level. The MATS performs a complete and automatic checkout of inertial navigation systems in aircraft on the flight-line or in the base test laboratory with a minimum of skill and judgement required from the operator. In addition to establishing the serviceability or unavailability of the system under test, the MATS provides precise information on the nature, location and remedy of a fault, to the extent of isolating a particular module or sub-assembly.

In addition to eliminating unnecessary removals of the guidance system, the MATS makes actual flights checks unnecessary after a malfunction has been corrected by doing a pre-flight confidence check itself.

In the MATS, emphasis has been placed on the convenient grouping of operating controls and displays and on the accessibility of components for easy maintenance. The Test Set is mounted on a chassis having an air-bag suspension to reduce shock loads and is fitted with a tow bar and brakes to assist moving with a tractor. Controls and displays are protected from rain by a hinged shield that can be clamped at any desired angle. The MATS uses a programmed tape in conjunction with a photo block reader to perform automatic tests. The tape test programmes used by Litton MATS can be used for any portion of the inertial navigation system without modification. It is not necessary to change tapes for various types of tests. Additional spare tapes can be punched in the field using inexpensive equipment. Programme modification, if required, can be performed with ease. The unit uses relay matrices to select the signals to be tested, their tolerances, and the fault indicator readout instructions. The signal is then compared to an internal reference signal. If the signal is not within specified limits the automatic programme is inhibited and the fault indicator readout is energized to indicate the source of the malfunction. A programmed self-test is included to enable the operator to test the MATS immediately, thereby verifying the integrity of the MATS. Litton MATS vehicles are currently in use with the RCAF, RNLA, RDAF and USN.

Litton Canada has produced over 1000 major units of Aerospace Ground Equipment in addition to MATS. This covers manual and automatic test equipment for flight line, base service lab, depot, and factory applications.

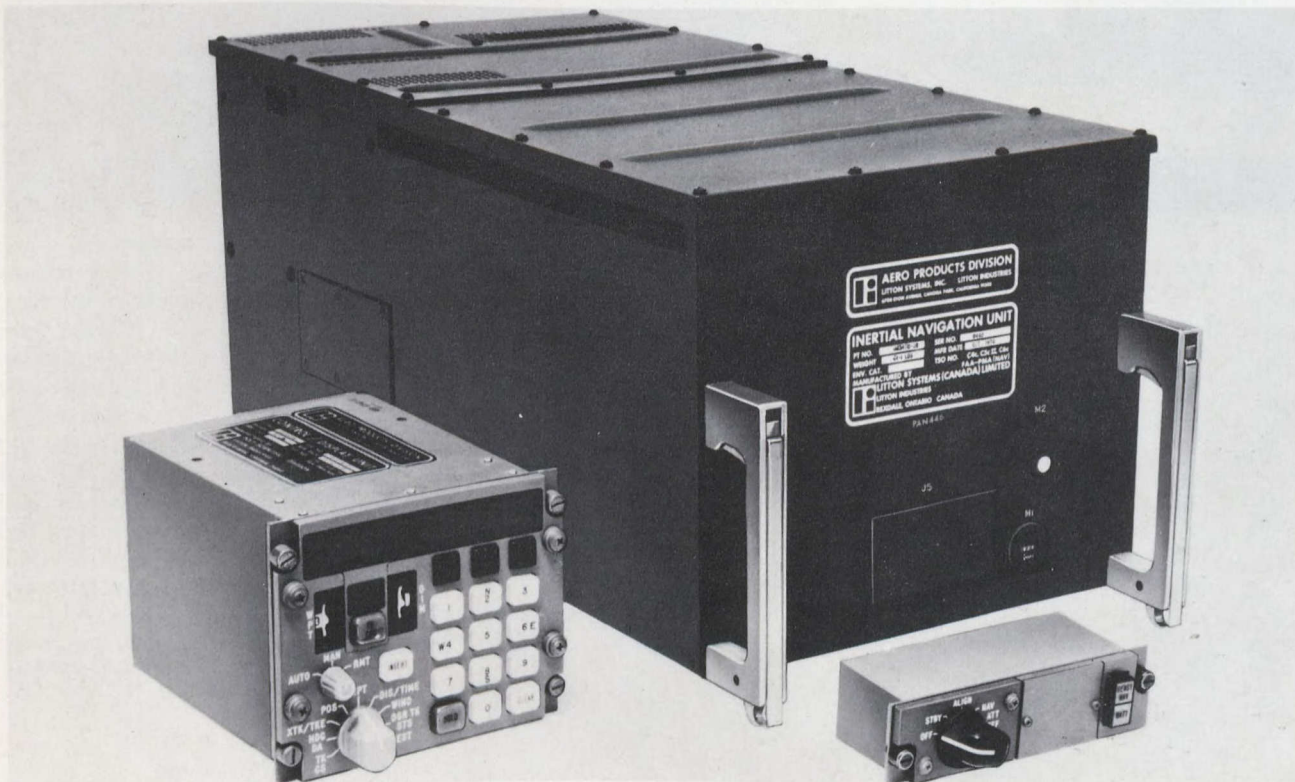


LTN-51 SYSTEM

Developed and produced by Litton Systems (Canada) Limited the LTN-51 provides a compact, lightweight, inertial navigation system designed to fulfill the navigation requirements of modern commercial airliners. The system operates by sensing aircraft accelerations from a gyro-stabilized, 4-gimbal, all-attitude platform. Output functions of the system include accurate present-position (lat/long.) information; course-line computation; steering commands, and angular pitch, roll, and heading information. The navigation and guidance computations are performed by a micro-electronic, general-purpose digital computer. The computer steering commands are referenced to great-circle routes between the desired waypoint coordinates. Unrestricted world-wide navigation is provided by a wander-azimuth technique, which eliminates the ambiguities normally associated with navigation in the polar regions. Accurate initial alignment, without the use of external references, is accomplished within a 15-minute reaction time.

The system form, functions, and outputs are consistent with ARINC-561-2 characteristic and will integrate directly with present aircraft equipment and instrumentation.

	Amplifier
Height	14.92 cm (5.875 in.)
Width	12.47 cm (4.91 in.)
Depth	26.35 cm (10.375 in.)
Weight:	3.62 kg (8.0 lbs)
Power Input	
27.5 Volts DC	600 ma
26 Volts AC	400 Hz, 10 VA



AFTS-23 DIGITAL PRESSURE MONITOR AND AFTS-24 DIGITAL PRESSURE CONTROLLER

The AFTS-23 Digital Pressure Monitor designed and produced by Garrett, has been introduced to provide direct six digit pressure readout in standard units, to facilitate calibration of pressure sources, and instruments. The Monitor is compact, easily carried and suitable for either bench or rack use. It is insensitive to environmental conditions normally encountered by this type of instrument. The unit has exceptional accuracy and repeatability specifications, and is ideally suited for use as a transfer standard over its range of operation. The Pressure Monitor is solid state in design, and employs custom digital circuitry for converting the digital output from the solid state sensor to pressure information suitable for display.

The absolute sensor employed in the Pressure Monitor, is one of a generation of new digitally oriented devices. The sensor output is directly compatible with the rest of the digital system, and thus interface errors are effectively minimized. The rugged solid state construction of the sensor, provides distinct advantages over earlier mechanical, analog oriented types. The sensor is not position sensitive, and exhibits negligible hysteresis. It also features a fast settling time, and

has no wearing parts requiring periodic maintenance, or which introduce alignment errors. Extremely high temperature stability is achieved by employing a material for the sensing element whose elasticity variation with temperature is balanced by its dimensional changes. This material, known commercially as Ni-Span-C, is used for tuning fork manufacture.

The Digital Pressure Monitor, is an extremely versatile piece of equipment which can be used as a basic building block in test systems which require the provision of very precise pressure stimuli into pneumatic units being tested. This function may be obtained when it is teamed with the AFTS-24 Digital Pressure Controller described in subsequent paragraphs. It may also be used with another monitor to provide differential pressure measurements or it may be provided in a configuration which allows it to accept inputs from two pressure sources and read-out the differential. It can be supplied calibrated to operate on most pressure mediums, air nitrogen, oxygen etc. Its digital read-out display can be supplied in anyone of many measurement units — inches of mercury, pounds per square inch, millibar, feet or knots.



PROGRAMMABLE PNEUMATIC SIGNAL GENERATORS

This Programmable Pneumatic Signal Generator has been designed for Aerospatiale Toulouse, by Garrett for use with Automatic Test Equipment Complexes (ATEC) which have been supplied to the leading airlines of the world. It is also used by Aerospatiale themselves on the Concorde programme.

It is designed to simulate flight parameters associated with supersonic Aircraft. In the automatic mode parallel binary digital information provided by an external central data processor is converted through a digital to analog converter into analog voltages which operate closed loop pneumatic servo systems. These, in turn, provide pneumatic outputs suitable for input into an aircraft air data sensing system. The simulated outputs available are static pressure (Ps) and total pressure (Pt). Various ramp can be programmed into either channel up to a maximum of 6,096 mpm (20,000 fpm) and 200 knots/min. Both channels can also be programmed to provide a sinusoidal output signal about a fixed pressure up to a maximum of 10 Hz.

As well as being capable of operating from remote automatic programme commands, the unit may be manually programmed by the use of the digital switches and over controls provided on the front face of the unit.

SPECIFICATIONS

Power Supply 115 V, 1 phase, 400 c.p.s.
1000 VA approx.

Operating Temperature $25^{\circ}\text{C} \pm 5^{\circ}$

No. of Channels 2

ALTITUDE CHANNEL (Ps)

Input

- (a) Automatic 14 bit binary
- (b) Manual 14 bit binary selector switches

Output

- (a) Type Pneumatic (Ps)
-304 m to +25,603 m
(-1,000 to +84,000 ft.)
- (b) Range Programmeable in 3.04 m
(10 ft.) increments.
- (c) Sensitivity 0.003 ins. Hg.
- (d) Repeatability 0.003 ins. Hg.
- (e) Regulation 0.0015 ins. Hg.

- (f) Accuracy ± 5.48 m (18 ft.) or $\pm 0.15\%$ whichever is greater to 18,288 m (60,000 ft.) increasing linearly to 45.7, (150 ft.) at 25.603 m (84,000 ft.).
- (g) Ramp Rates 762 mpm (2,500 fpm)
1,524 mpm (5,000 fpm)
3,048 mpm (10,000 fpm)
6,096 mpm (20,000 fpm)
- (h) Manual Sinusoidal Modulation 0 to 10 Hz ± 0.003 ins. Hg. to ± 0.9 ins. Hg.
- (i) Programmable Sinusoidal Modulation 0.1 Hz at amplitude of ± 0.1 ins. Hg.
1.0 Hz at amplitude of ± 0.22 ins. Hg.
2.0 Hz at amplitude of ± 0.01 ins. Hg.
5.0 Hz at amplitude of ± 0.005 ins. Hg.
- (j) Working Volume/Load 819 cm³ (50 in³)

AIRSPPEED CHANNEL (Pt)

Input

- (a) Automatic 10 bit binary
- (b) Manual 10 bit binary selector switches

Output

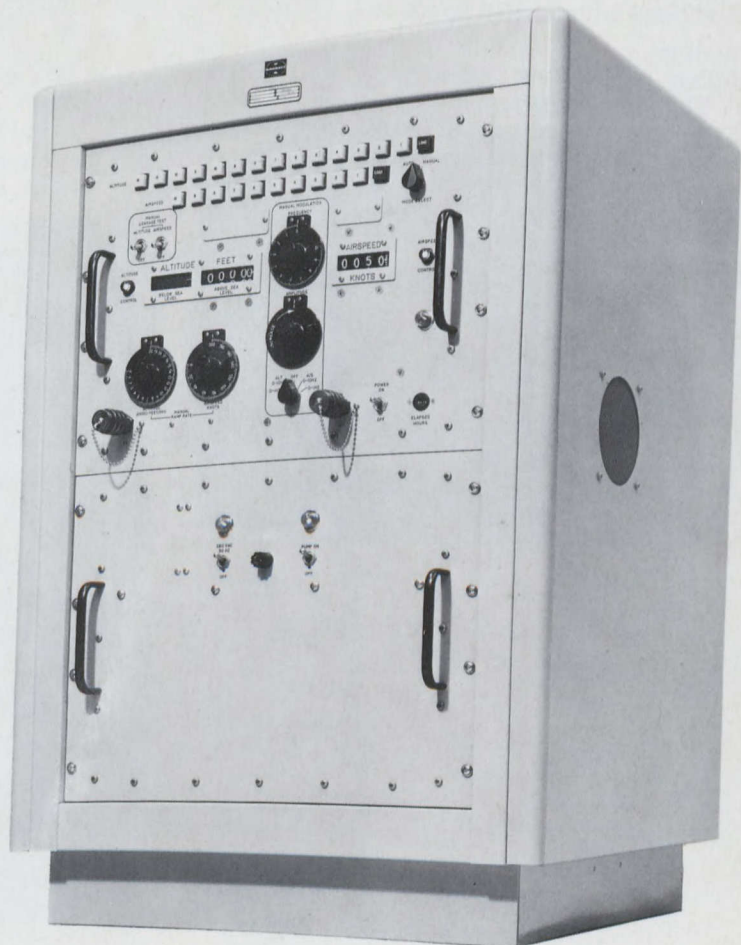
- (a) Type Pneumatic (Pt)
- (b) Range 50 knots to 1,000 knots (4 to 2,500 mb). Programmeable in 1 knot increments.
- (c) Sensitivity 0.003 ins. Hg.
- (d) Repeatability 0.009 ins. Hg.
- (e) Regulation 0.003 ins. Hg.
- (f) Accuracy 2.0 knots at 50 knots decreasing to 0.75 knots at 150 knots. Linear at 0.75 knots to 1,000 knots.
- (g) Ramp Rates 25 knots/min
50 knots/min
100 knots/min
200 knots/min
- (h) Manual Sinusoidal Modulation 0-10 Hz, 0.003 ins. Hg. to 0.9 ins. Hg.

- (i) Pro-grammable Sinusoidal Modulation 0.1 Hz at amplitude of ± 0.9 ins. Hg.
 1.0 Hz at amplitude of ± 0.5 ins. Hg.
 2.0 Hz at amplitude of ± 0.1 ins. Hg.
 5.0 Hz at amplitude of 0.040 ins. Hg.
- (j) Working Volume/Load 819 cm³ (50 in³)

A/11 PNEUMATIC SIGNAL GENERATOR

The A/11 Pneumatic Signal Generator is designed to provide pressure and vacuum signals suitable for checking out aircraft systems such as pitot-

static flight instruments, mach trim, autopilot, engine pressure ratio transducers, etc. It has an airspeed range from 50 to 650 knots and an altitude range of 30.5 m to 15,240 m (100 ft. to 50,000 ft.). Airspeed and altitudes are controlled through independent channels preventing undesirable interaction when either one requires a new setting. Every possible safety is included in the unit such as negative Qc protection, positive Qc protection, absolute pressure relief, rate of climb limited to 1,827 m (5,000 ft.) per minute or as specified, fail safe if power failure occurs protecting aircraft system from sudden pressure change. The unit is lightweight, 15.9 kg (35 lb.) and in addition to aircraft checks, it can be used for bench checks of flight instruments or components requiring accurate pressure/vacuum inputs.



APPLICATION:

Satisfies the pneumatic requirements of all commercial aircraft presently in service (Boeing 707, 720, 727; Douglas DC-8, DC-9) — Simulates the flight envelopes of all new commercial aircraft — Exceeds the tolerance requirements and flight envelopes for AIMS (Altitude Reporting System) Types 1 and 11 (Type III requirements are covered by the Garrett Manufacturing Limited TTU-205B/E) — Exceeds the test requirement of F.A.A. Regulation F.A.R. 91.70 Part 43, Appendix E (Static Pressure Systems and Altimeter Instruments).

SPECIFICATIONS:**Size:**

Without lid 36.8 x 52 x 17.8 cm
(14½ x 20½ x 7 in.)
with lid 36.8 x 52 x 24 cm (14½ x 20½ x 9½ in.)

Weight:

Complete with lid 15.9 kg (35 lb.)

Readouts:

Altitude: -305 to +15,240 m
(-1,000 to +50,000 ft.)
Airspeed: 50 to 650 knots (I.A.S.)
Rate of climb: 0 to +1,828 mpm (6,000 fpm)

Readability:

Altitude: 1.52 m (5 ft.)
Airspeed: ½ knot

Sensitivity:

Better than 0.001 in. Hg.A over entire altitude and airspeed range

Accuracy:

Altitude: ±7.6 m (25 ft.) at sea level
to ±21.3 m (70 ft.) at 15,240 m (50,000 ft.)
Airspeed: ±2 kots over entire range

Flush Static Port Vacuum Adaptors:

Vacuum Source 5.0 in. Hg.A
(minimum)

Power Requirements:

115 V, 400 cps, single phase, 250 VA approx.

Environmental Conditions:

Designed to comply with all applicable sections of MIL-T-21200D. No warm up time required.



PRESSURE-TEMPERATURE TEST SET — TTU-205B/E

This test set is a Flight Line and Maintenance Depot Level Portable Pneumatic Test Set capable of testing the new Altitude Reporting System Computers (AIMS) now being introduced in military and commercial aircraft. The set is now in production at Garrett Manufacturing Limited where such equipments have been developed and produced to meet the needs of ever increasing complex aircraft systems and has been delivered in quantity to the U.S.A.F. and U.S. Navy. It is designed to meet the requirements of the U.S.A.F. designation TTU-205B/E, MIL-T-38191D and it provides: plus or minus 5.5 m (18 ft.) accuracy at sea level; .15 percent accuracy to 18,288 m (60,000 ft.); .2 percent accuracy from 18,288 to 24,384 m (60,000 ft. to 80,000 ft.); plus or minus 2 knots accuracy at 50 knots increasing to plus or minus 1.5 knots from 100 to 1,000 knots; controllable altitude slew rates from 0 to 10,668 mpm (35,000 fpm) altitude; controllable airspeed slew rate from 0 to 250 knots. This unit is an improved version of the earlier TTU-205/E Test Set, MIL-T-38191A which is fully qualified and is also in service with the U.S.A.F. for checkout of flight instruments on aircraft such as F111, F4, C141 and CF5. All these units provide direct digital readout of altitude and airspeed without correction cards to the accuracies stated.

APPLICATIONS:

Checkout of flight instruments on the flight line — Leakage test of aircraft flight instrument pneumatic system — Checkout of the Central Air Data Computer on the flight line — Pneumatic excitation of auto pilot and navigational system on the flight line — Calibration and service of Central Air Data Computer on the bench — Pneumatic supply (airspeed and altitude for aircraft automatic systems test units).

SPECIFICATION — TTU-205B/E

Altitude Range
305 to 24,384 m (−1,000 to 80,000 ft.).

Altitude Accuracy
4.57 m (±15 ft.) or .15% of indicated altitude to 18,288 m (60,000 ft.) increasing linearly to 49 m (160 ft.) at 24,384 m (80,000 ft.).

Altitude Slew Rate
Ramp controllable 0 to 10,166 gm (35,000 fpm).
Accuracy ±3%.

Airspeed Range
50 to 1,000 knots.

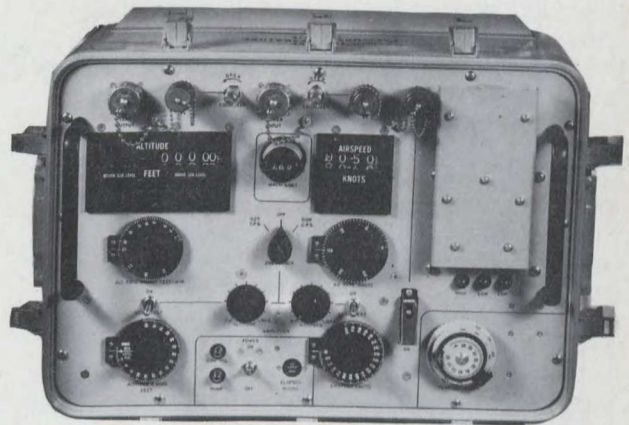
Airspeed Accuracy
±2 knots to 50 knots ±1.5 knots at 100 to 1,000 knots.

Airspeed Slew Rate
Airspeed ramp 0 to 350 knots per minute controllable. Accuracy ±3%.

Modulation
Modulation 0.05 and 0.25 cps. either or both Ps and Pt.

Total Temperature
30 to 130 ohms. Accuracy ±0.1%.

Mach Limit
.8 to 3.0 mach.



ALTIMETERS

The same experience which has given Leigh Instruments a respected place in aerospace recording systems has now been applied to barostatic type altimeters which meet, and as in the case of the following four instruments, in many cases exceed the requirements of MIL-A-81403. Type AAU 21/A and Type AAU 21/A 2 Component. These two altimeters incorporate state-of-the-art technology in three areas of prime importance: accuracy — reliability — continuous altitude recording.

These instruments are driven by a fully temperature compensated altitude mechanism featuring Leigh's patented dual opposing capsule elements. This design principle has been proven, through exhaustive testing, to be a major improvement in altimetry design. The capsule elements respond to variations in pressure altitude to provide a high torque drive to the low friction counter-drum-pointer display and the encoder with minimized hysteresis and after-effect.

By drawing upon Leigh's background in solid state technology, the conventional servo loop or synchro drive has thereby been eliminated. In its place a direct drive optical encoder is used, vastly improving both accuracy and reliability, while allowing a reduction of package size.

In operation, the encoder is actuated by the pneumatic mechanism, the signal is converted to standard digital ICAO code and continuously transmitted to the transponder. This data is referenced to a barometric pressure of 29.92 in. Hg. The baroset can be manually set to the standard range of 28.10 to 31.00 in. Hg. independent of the transmitted data. Should an aircraft power failure occur, transmission to ATC is interrupted so no erroneous data can be generated, a "Code-Off" flag will appear and the instrument will continue to function as a precise altimeter. They have also incorporated an "On-Off" switch on the altimeter which, on command, the pilot can manually operate. This switch interrupts the altitude signal to ATC, but leaves the identity code and the brackets.

While incorporating the above features, the company still offers the shortest case length currently available where the indicating and reporting functions are carried in the same case and this length is a maximum of 13.9 cm (5.5 in.). A standard four digit baroset adjustment, dual red and white lighting and a vibrator are also provided.

SPECIFICATIONS

Range: -304 to +15,240 m (-1,000 to +50,000 ft.)
Range:

-304 m to +15,240 m (-1,000 ft. to +50,000 ft.)

Accuracy, altimeter:

At sea level ±9.14 m (±30 ft.)
At 3,048 m (10,000 ft.) ±18.2 m (±60 ft.)
At 9,144 m (30,000 ft.) ±35 m (±115 ft.)
At 13,716 m (45,000 ft.) ±56.3 m (±185 ft.)

Encoded Output:

±12 m (±40 ft.) of displayed altitude.

Converter:

Output: Standard ICAO code.

Resolution: 30.4 m (100 ft.) increments.

AAU 21/A

Weight 1.36 kg (3 lb.)

AAU 21/A Two Component

Weight, total of
two components 1.58 kg (3.5 lb.)

MTBF:

Altimeter 1,000 hours
Converter 2,000 hours

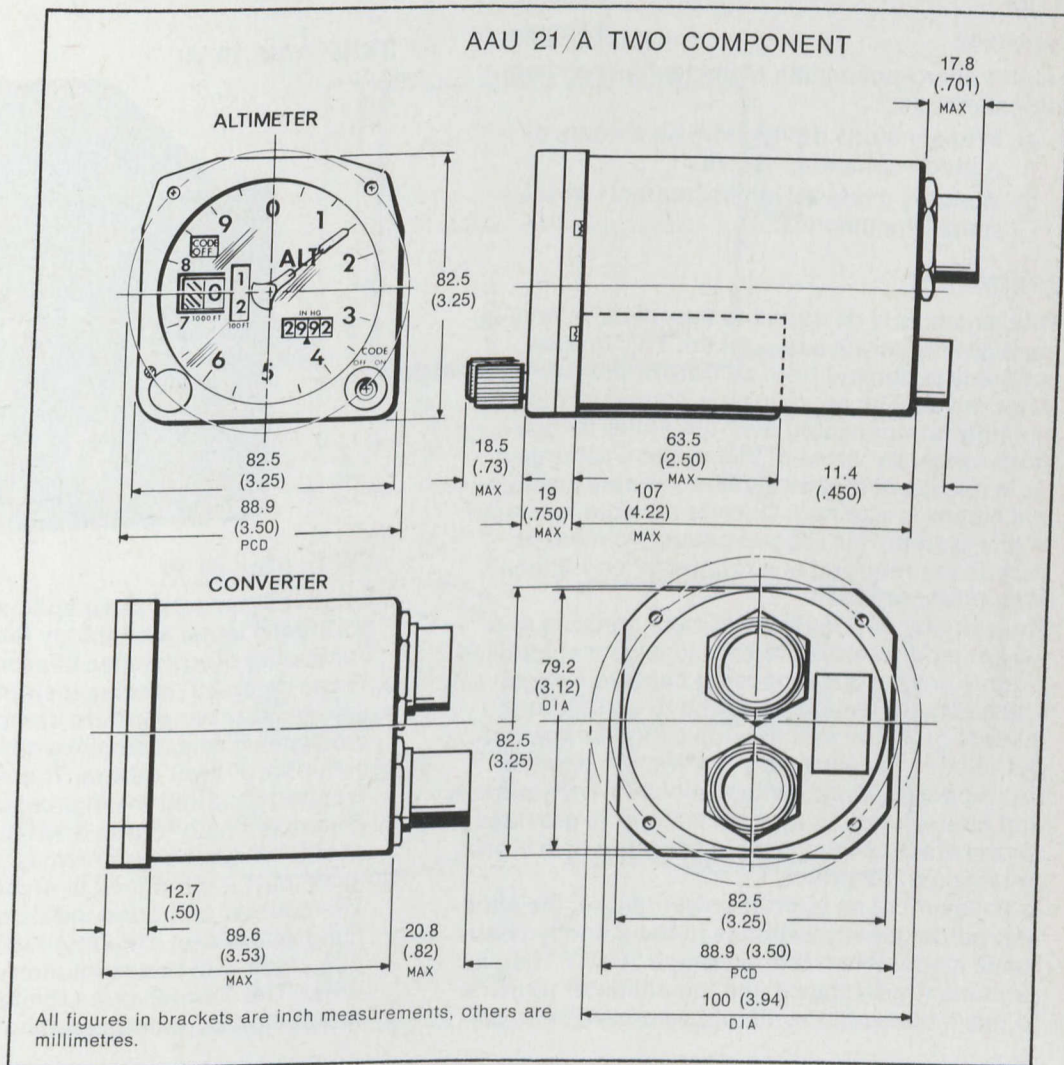
Longevity:

Altimeter 3,000 hours
Converter 6,000 hours

In February 1972 the company commenced production on approximately 3,000 units of the AAU-24/A for the United States Navy with a strong likelihood of a large continuing increase.

AAU 21/A

All basic dimensions for the AAU 21/A are the same as for the AAU 21/A Two Component other than for the behind-the-instrument panel length of the AAU 21/A is 139.7 mm (5.50 in.) as both the Altimeter and the Converter are in the same case.



TYPE AAU 19/A

SPECIFICATIONS

Military Specification DOD (AIMS) 64-101

Range:

-304 m to +24,384 m (-1,000 ft. to +80,000 ft.)

Accuracy:

Servo Mode ± 609 m (± 20 ft.)

Standby (Pneumatic) Mode:

At sea level ± 9.14 m (± 30 ft.)At 3,048 m (10,000 ft.)... ± 24.3 m (± 80 ft.)At 9,144 m (30,000 ft.)... ± 54.8 m (± 180 ft.)At 15,240 m (50,000 ft.) ± 85.3 m (± 280 ft.)At 21,336 m (70,000 ft.) ± 365.7 m ($\pm 1,200$ ft.)

Weight 1.8 kg (4 lb.)

MTBF 1,000 hours

Longevity 3,000 hours

Leigh's servo-pneumatic altimeter has two operational modes:

- a) Primary mode driven from an air data or altitude computer (Servo)
- b) Standby mode driven by internal capsule units (Pneumatic).

OPERATION

This altimeter is designed to operate primarily in the highly accurate servo mode. This greater accuracy is derived from air data or altitude computer drives. The servo loop is completely stable and fully compensated over the entire temperature range. By virtue of this system, accuracy far in excess of that available by purely mechanical means is attained. Despite the sophistication of this system, it is rugged enough to meet or exceed the required environmental conditions without degradation.

The standby or pneumatic system consists of a fully compensated altitude mechanism employing Leigh's unique dual opposing capsule design. The capsule elements respond to variations in altitude pressure and provide a high torque output drive to the extremely low friction counter-drum-pointer display with a minimum of hysteresis and after-effect. An internal vibrator is provided for the standby mode and is operated by a highly reliable multi-vibrator.

In the event of an aircraft power failure, the altimeter automatically switches to the standby pneumatic mode. When this occurs, a "STBY" flag is prominently displayed and the altimeter remains in this mode until the disruptive condition is cor-

rected. Servoed operation can then be restored by manually operating the reset knob.

In general, the Leigh servo-pneumatic altimeter provides the most accurate and easily read display currently available. The standard counter rotation is bottom adding and a barometric setting knob with a four digit counter type display is included. This counter can be manually set for the standard barometric pressure range of 28.10 In. Hg. to 31.00 In. Hg. In addition, high efficiency anti-reflective (HEA) double wedge lighting is provided with 5 volt red or white light operation. Among the options available are a reduction in behind-panel length, display format and the number of graduations.

TYPE AAU 19/A



TYPE AAU 24/A

Leigh Instruments' pneumatic altimeters incorporate the latest technology that has evolved from continuing programmes of product improvement. These compact, precise instruments feature a unique, fully temperature compensated altitude mechanism which employs dual opposing capsule elements of their design. These capsule elements respond to variations in pressure altitude and generate a high torque drive to the low friction counter-drum-pointer display. After-effect and hysteresis are reduced to an absolute minimum. The counter and drum indicate thousands and hundreds of feet. One revolution of the pointer coincides with one revolution of the hundreds drum. The counter-drum rotation is bottom adding. A standard barometric setting knob with a four

digit counter type display is provided. This baro-set can be set manually for the normal range of 28.10 In. Hg. to 31.00 In. Hg. High efficiency, anti-reflective (HEA) double wedge lighting with 5 volt red or white light operation is an integral feature of this indicator, as is a vibrator for further reduction of small friction errors.

This altimeter is designed to meet or exceed the requirements of U.S. Navy specifications MIL-A-81494. In application this instrument can serve as either a primary altimeter on low performance aircraft or as a standby altimeter, used in conjunction with the altitude reporting AAU-21. The same would apply to high performance aircraft where the AAU-24 can be used in combination with the high accuracy, servo driven AAU-19.

SPECIFICATIONS:

Military Specification MIL-A-81494 (USN)
Range:

-304 m to +15,240 m (-1,000 ft. to +50,000 ft.)

Accuracy:

At sea level ± 9.14 m (± 30 ft.)

At 304 m (1,000 ft.) ± 19.8 m (± 65 ft.)

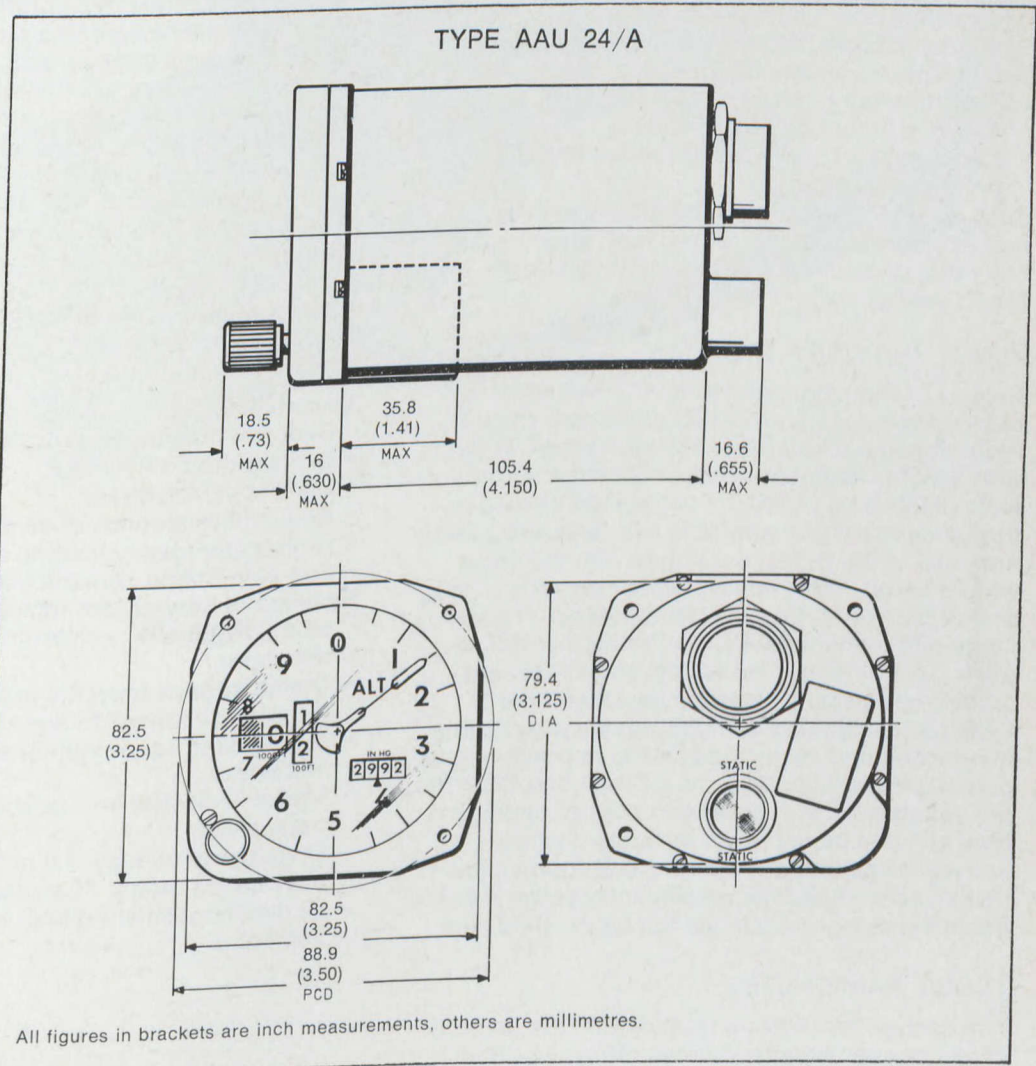
At 9,144 m (30,000 ft.) ± 34 m (± 115 ft.)

At 11,582 m (38,000 ft.) ± 42.6 m (± 140 ft.)

Weight 1.13 kg (2.5 lb.)

MTBF 1,000 hours

Longevity 3,000 hours



PARACHUTE SYSTEMS

That air safety is so often equated with Irvin Air Chute is largely through the company's continual advances in state-of-the-art so as to meet the demands of continually advancing performance. Two of these areas are described below.

IRVIN "ZERO-ZERO" PARACHUTE SYSTEM

Irvin has developed a modification kit which can be installed within any existing back type parachute to provide radical reductions in time loss following ejection. Primary and unique advantages are:

- Low cost due to utilization of existing parachute components.

Three methods of actuation for extreme reliability:

- automatic drogue gun deployment
- automatic pilot chute deployment
- manual actuation with pilot chute deployment

Safety features which include:

- ballistic arming lanyard
- "remove before flight" safety pin
- disconnect on projectile to reduce in flight entanglements

Zero speed — zero altitude capability with a rocket ejection seat. Increased high speed capability due to controlled deployment by stretch fabric quarter bag.

AERIAL DELIVERY SYSTEMS

Results of trials on Irvin model CCP-64 when compared to U.S. type G-12D parachute show a reduction in packed parachute volume of 25%, with weight reduction in the same order. Drop tests of 997.9 kg (2,200 lb.) cargo load show performance results comparable with those obtained from use of the G-12D parachute with the same weight cargo. The trials included comparison test of U.S. type G-11, 30.4 m (100 ft.) diameter parachute and Irvin model CCP-100 which is 19.5 m (64 ft.) in diameter. Test results show that satisfactory performance was achieved with the CCP-100 design and demonstrated a time saving in handling and re-packing due to improvement of packing technique. Both the CCP-64 and CCP-100 are suitable for skirt reefing to control opening time and can be deployed in clusters where heavier cargo loads are involved. Enquiries are invited as many additional advantages are inherent in the design which can not be detailed here.

TROOP PARACHUTES

The economics of troop training and the mobility of forces over wide land areas present a difficult

logistics/cost problem for Defence Forces throughout the Free World. Irvin has over a period of time developed and introduced into service an improved troop parachute which is comparable to U.S. type T-10, 10.6 m (35 ft.) parachute. The Irvin CT-1 and CR-1 (Reserve) parachutes offer a number of advantages, chiefly the promise of up to 200 in-service canopy deployment bag components due to the use of advanced materials and fabrication techniques which contribute to reduced maintenance and longer life.

'VARIABLE POROSITY RIBBON' DECELERATION PARACHUTE

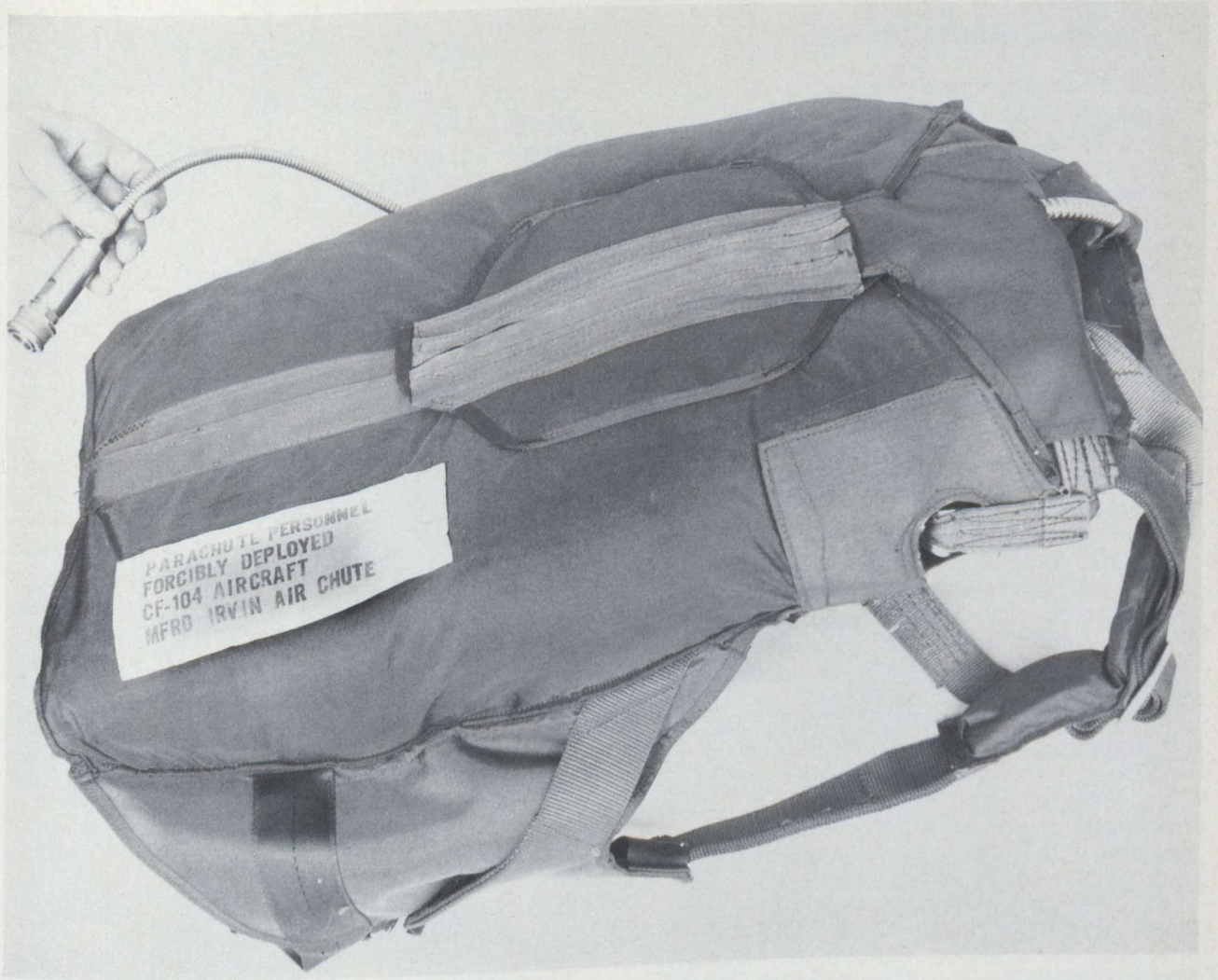
The Irvin Variable Porosity ribbon parachute is a further development of the standard ribbon type, and is adaptable to any aircraft deceleration system presently employing standard (FIST) ribbon, Ring Slot, Cruciform or other deceleration parachutes. The amount of air allowed to flow through a ribbon type parachute canopy is controlled by the spacing of the concentric (horizontal) ribbons. In the Irvin Variable Porosity canopy, the ribbon spacing decreases progressively from the skirt to the vent while ribbon strengths are also adjusted to suit the particular application. Distribution of the ribbons in this manner increases the efficiency and strength towards the crown of the canopy, which is the primary source of drag.

Advantages:

- Reduced maintenance costs
- Greater drag efficiency
- Lower opening shock
- Reduced probability of damage
- Higher emergency landing speed
- Fail-safe ribbon construction

Systems In Service Use Include:

- Model ID-86-101-: — Northrop F-5 aircraft decelerator
 - Diameter of canopy: 4.4 m (14.55 ft.)
 - Service life rating: 75 streams
 - Deployment speed rating: emergency max. 190 knots
- Model ID-86-102-: — Lockheed F-104 aircraft decelerator
 - Diameter of canopy: 4.9 m (16.2 ft.)
 - Service life rating: 75 streams
 - Deployment speed rating: emergency max. 200 knots



TRANSPORTABLE & MOBILE AIR TRAFFIC CONTROL TOWERS

Air Vision Industries have designed developed and produced a line of air traffic control towers which will meet the requirements of military or civil control problems. With over seven years of experience in this new field the extensive experience of the staff is admirably suited to meeting custom demands for specific operational requirements.

The basic enclosure embodies sound structural design, electrical services and/or air-conditioning. Telecommunication equipment (HF, VHF, UHF) and meteorological equipment can be factory-installed and tested on site.

The mobile and air-transportable types are primarily for military or interim civil use; they are light-weight and designed for all-weather conditions on a world-wide basis. Up to three ATC Operators can be accommodated for the control of aircraft in both VFR and IFR conditions. Solid state communication equipment which fulfills ground/air needs for minimum and maximum enroute altitudes is normally provided. In addition standard signalling facilities for visual advisories to aircraft in the operational area are provided for traffic control under VFR conditions. The operators' consoles are designed for use with Airfield Lighting, Navaids, Precision Approach Radar and Acquisition Radar. In accordance with its mobile role, ease of transport to the site and rapid preparation for service are inherent features provided by its self-contained design. The permanent and semi-permanent (modular) towers are pentagonal structures which are intended to be mounted on existing architectural features or modular bases. The configurations and specifications are based on U.S.A. and Canadian requirements. Various floor areas are available to meet varying traffic levels and operational modes while catering to visibility requirements and operator convenience and comfort including noise levels. Roof structures are designed to double glazed sloping windows are used in all towers to provide heat and sound insulation and to prevent disturbing specular reflections. The structure is sufficiently rigid to prevent excessive stress on the glass panes during transit or exposure to wind. Rigid insulation is used in the walls.

Instruction and maintenance services are available if required.

GENERAL SPECIFICATIONS

MOBILE UNIT

Length 4.57 m (15 ft)

Width 2.43 m (8 ft)

Height, exterior 2.43 (8 ft)

Ceiling 2.05 m (6.75 ft)

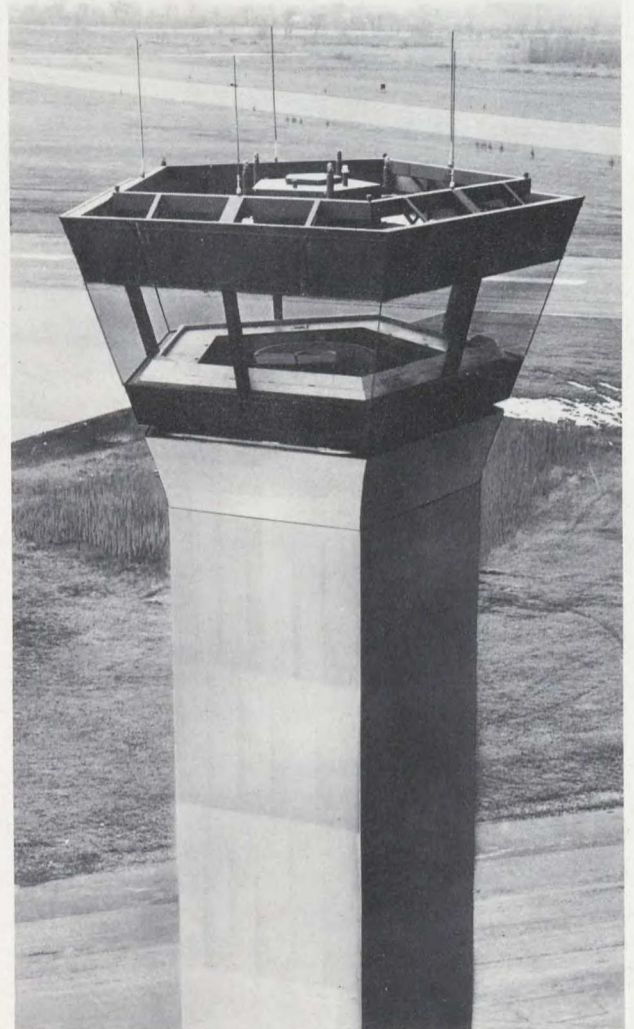
Weight 2721 kg (6,000 lb)

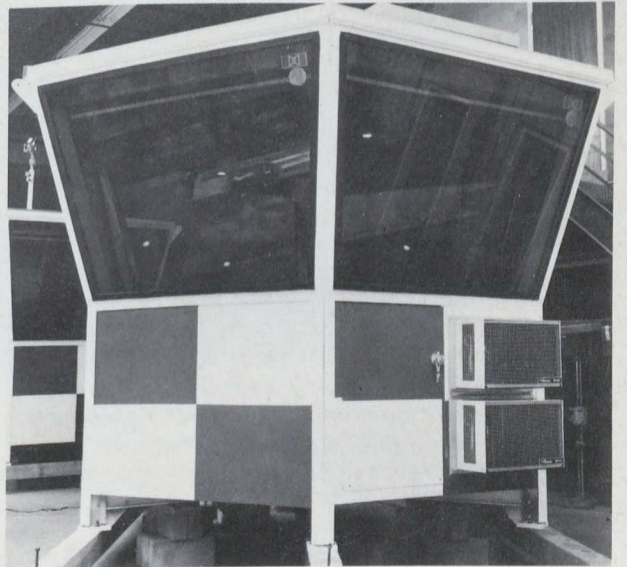
PERMANENT UNITS

23.2 32.5 & 41.8m²

250 350 & 450 ft²

Weight will depend upon the electronics installed.





AIRBORNE AVIONICS SYSTEMS

The Avionics Division of the Canadian Marconi Company specializes in the design, manufacture, and support of Airborne Avionics Systems for all categories of professional aircraft users — Airlines, Military and Business and Commercial Aviation.

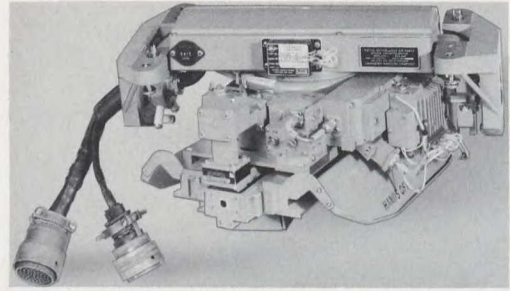
Through originating the application of a novel technique in doppler radar design at CMC during the fifties, it became possible to manufacture airborne navigation devices not previously practicable. As a result the Avionics activity at CMC proceeded to become one of the world's leading suppliers of doppler navigation sensors and computers in the sixties.

The activity has spearheaded the complete spectrum of doppler navigation system growth over three generations, encompassing tubes, transistors and micro-circuitry as well as the latest techniques in stripline microwave antenna design and gun diode RF sources. Systems representative of all generations are in production supporting the navigational requirements of all types of airborne vehicles. To meet the demands of the seventies, design and development activities started in the late sixties have given rise to a number of other Canadian Marconi Avionics (CMA) products. In addition to doppler radars the Avionics Division is now in a position to offer radar altimeters, special purpose analog and digital computers, airborne automatic Omega nav. systems, area navigation (RNAV) systems, solid state flight deck instrument displays and aircraft weight and balance devices. Another area of activity is satellite navigation.

A number of typical products are shown on the adjacent pages.

THE CMA-712 NAVIGATION SYSTEM is a highly versatile, lightweight and reliable airborne integrated avionics package specifically designed for medium and high performance aircraft.

The system provides a comprehensive self contained navigational capability. Using beam intersection techniques ground speed and drift angle are measured continuously and accurately regardless of weather conditions and the terrain over which the aircraft is flying. Using this data, with heading information from the compass system, the navigation computer provides guidance signals for automatic flight control systems, and position information in digital or analogue form.

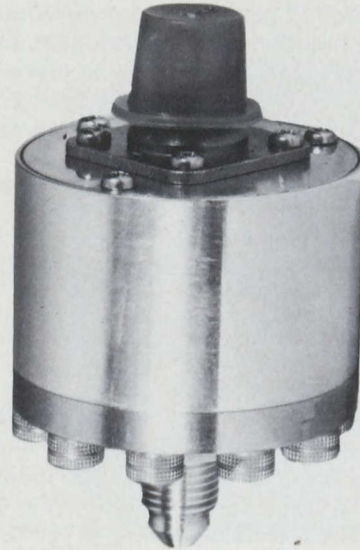


THE CMA-721 AIRCRAFT INTEGRAL WEIGHT AND BALANCE SYSTEM is comprised of two basic elements:

A set of Pressure Sensors, one connected to each landing gear oleo.

A Computer-Display Unit, usually mounted in the cockpit.

The compact Pressure Sensor (less than 49 cm³ (3 in.³)) utilizes a rugged capacitance bridge sensing element with no moving parts and negligible hysteresis. The broad compensated temperature range and hermetically sealed construction assures accuracy in extreme environments. Each sensor is equipped with independent scale factor and zero adjustments, so that all sensors are directly interchangeable. The Computer-Display Unit employs a simple pulse counting computation technique to provide digital outputs of total weight and center of gravity. A selector switch is used to identify the displayed parameter and to initiate self test of the computer-display unit. Continuous monitoring of maximum gross weight, and minimum nose weight (tipping point) limits provides signals for warning lights, or additional aural warning if required. All parameters pertaining to an individual aircraft installation are programmed by means of precision resistors mounted inside the aircraft type adaptor, thus making the standardized computer-display unit interchangeable between all aircraft types.

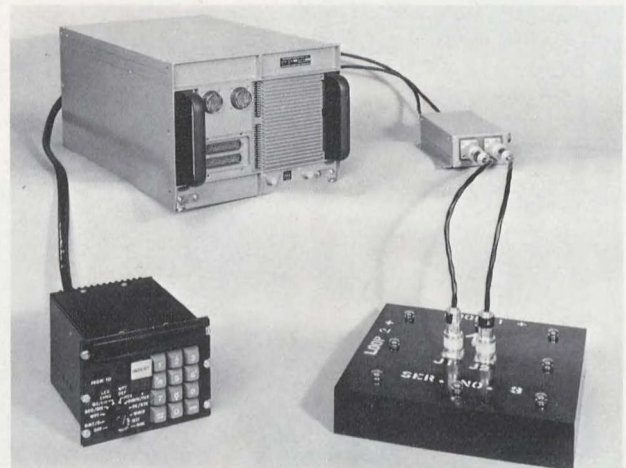
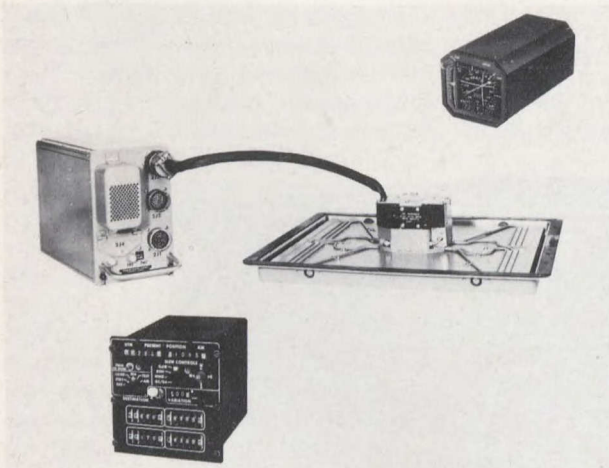


THE CMA-717 DOPPLER NAVIGATION SYSTEM is the latest in a long line of successful developments spanning 20 years and is designed with state-of-the-art techniques for high reliability at low cost. The CMA-717 produces a continuous output of present position, course and distance to destination. The low cost and small size make the CMA-717 most suitable for helicopter applications, where the unique antenna design makes installation possible without major airframe modification. The only cutout required in the aircraft skin is an ARINC altimeter sized hole, 13.97 cm (5.5 in.) in diameter.

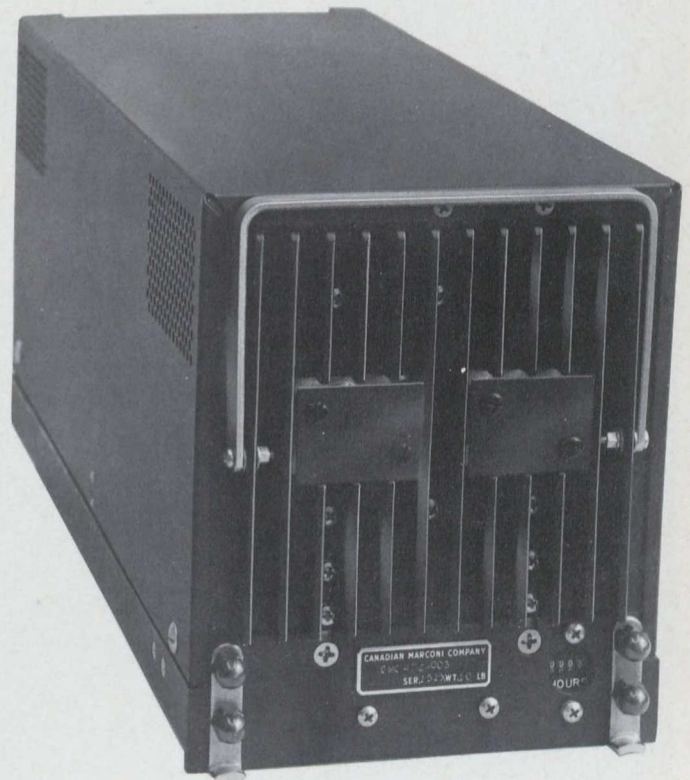
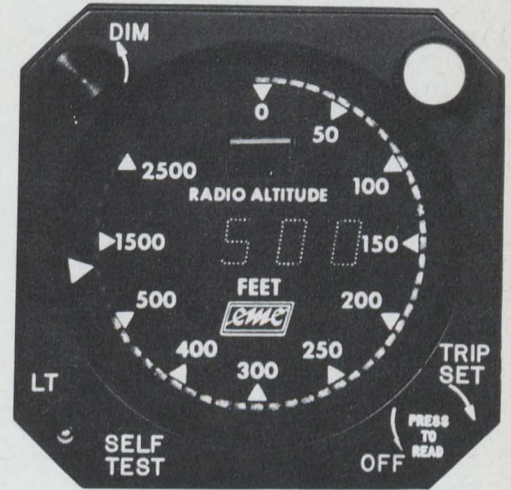
Low-cost features include a single time-shared I.F. channel and a digital frequency tracker. Extensive use is made of proven multi-source, MSI circuit elements and the R.F. Head uses CMC-designed microwave integrated circuit components. The non-stabilized antenna is vibration isolated for extreme reliability and the radiating structure combines two printed wire, planar arrays with an integral radome. Proven FM/CW operation provides immunity from near reflections (e.g. swinging loads, heavy rain, surface spray). A simple Gunn diode transmitter is used.

THE CMA-719 AIRBORNE OMEGA RECEIVER is a fully automatic navigation system comprising a Receiver Computer Unit, Control Indicator and Antenna Coupler Unit. The complete system weighs only 19.5 kg (43 lb.) (excluding VLF antenna) and, in conjunction with a rate aid and heading reference, affords the user a global navigation capability at a fraction of the cost of other contemporary navigation systems. System accuracies are presently of the order of 1 nm CEP demonstrated.

The Omega navigation system, operating in the 10-14 kHz VLF band, was developed by the U.S. Navy to take advantage of the low attenuation rate and stable phase velocity of very-low frequency signals. With ranges of 9,655-12,875 km (6,000-8,000 miles), 8 transmitters will cover the earth by 1973/74. At present, 4 transmitters are operating at reduced power, to cover the Northern half of the Western Hemisphere. Continuous coverage will be provided for military and civilian users, with no user charges.



The Canadian Marconi RADAR ALTIMETER, CMA 709, is accurate to ARINC 552A specifications over an altitude range of -20 to 2500 ft. Use of a Gunn oscillator as a source of RF power, plus the use of digital techniques and microcircuits result in a weight of 10 lbs. and a size of one-half ATR Short for the receiver-transmitter. The twin antennas are complete with integral radomes, and their installation location is flexible within broad limits. The system is designed to allow fault diagnosis to a replaceable module level without removal from the aircraft. The pseudo-random code modulation technique allows two systems to be installed and operated simultaneously without the use of interface equipments. Dual simultaneous operation is a requirement of category III landing systems. The indicator uses fibre optics techniques to provide a continuously illuminated analogue indication in addition to a digital indication of the altitude, eliminating the need for a pointer.

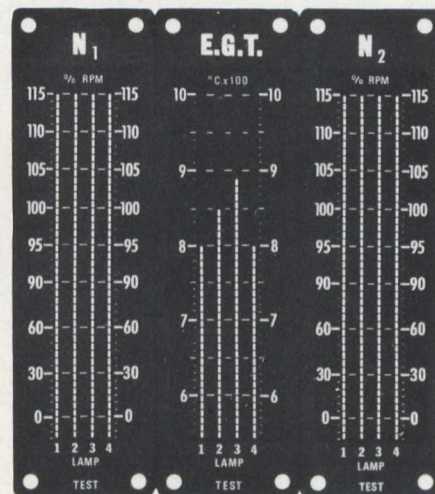
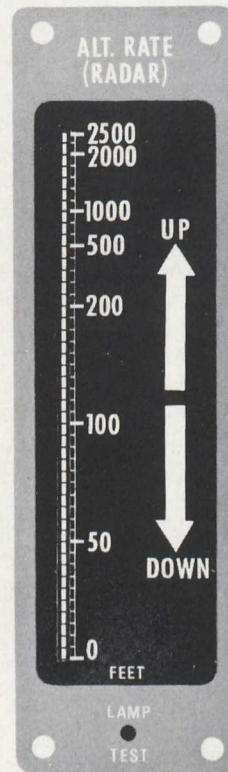


FLIGHT INSTRUMENTATION DISPLAYS

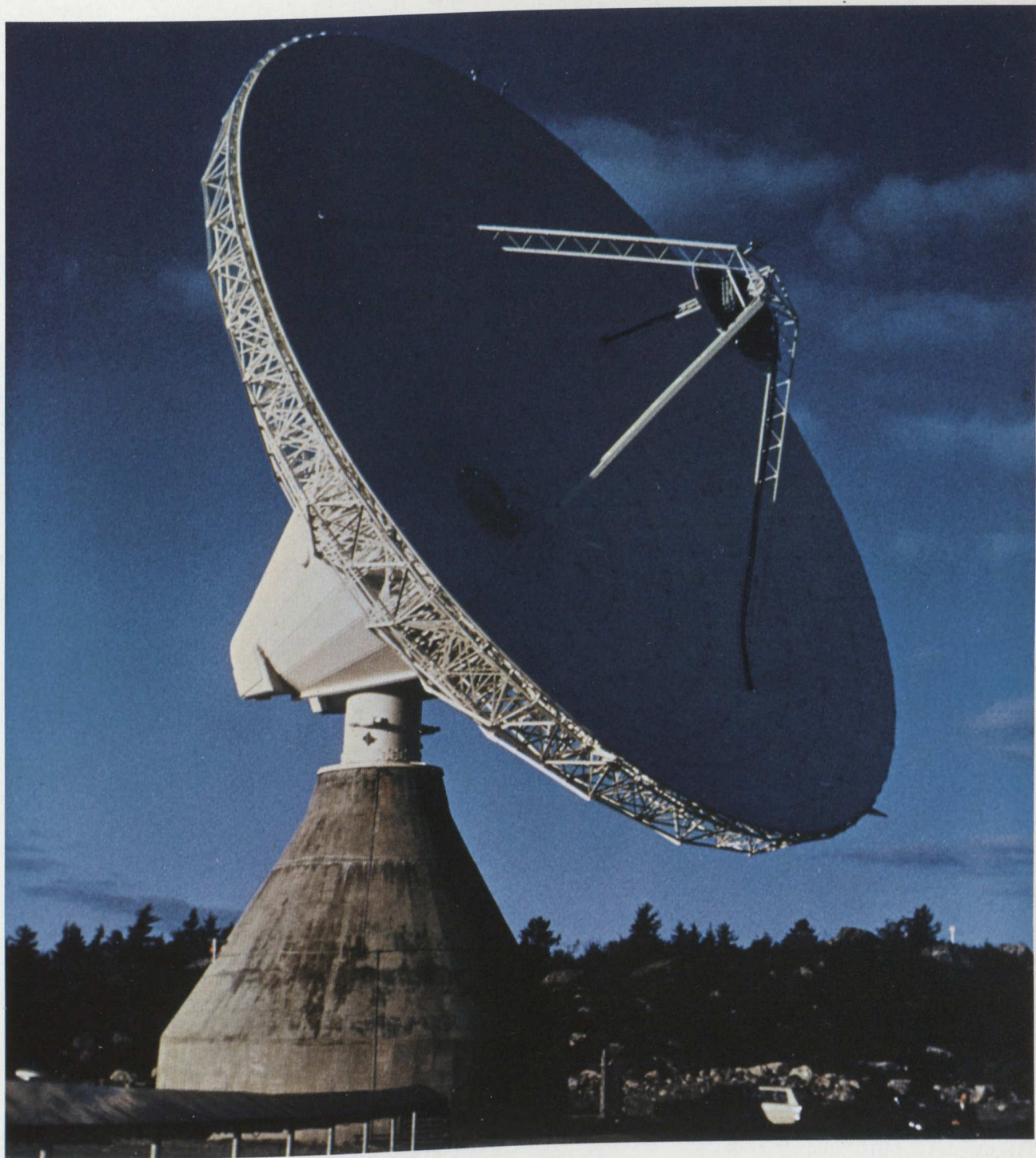
Conventional instruments have many faults but in particular they are mechanically complex, inflexible in presentation format, can be misread, and occupy more space than is readily available on the average flight instrument panel. In looking into the flight display requirements for the next decade, CMC have produced a completely new concept in instrumentation, the pointer-less, all electronic display. Wherever possible digital readouts are combined with analog presentations to give improved accuracy, with trend assessment, and redundancy.

By eliminating all moving parts, scale variations to suit individual requirements can be made available at a cost never before possible.

Up to 30% of instrument panel space can be saved by using CMC vertical scale displays.



COMMUNICATIONS, ELECTRONIC EQUIPMENTS AND COMPONENTS



AEROSPACE PROGRAMMES AND SATELLITE SUB-SYSTEMS

RCA Limited has maintained a Canadian Industry leadership in the design and fabrication of unmanned spacecraft since 1961. This experience has been achieved through participation with the Canadian Government on equipment and services for scientific satellites and, in addition, performing basic and applied research studies on a wide variety of topics related to satellite design and application.

These programmes have resulted in the establishment of a skilled team of engineers experienced in all aspects of satellite design, along with the special facilities, equipment and services required for the manufacture and test of space hardware.

The design, fabrication and test of reliable systems range from complete spacecraft to space-qualified electronic sub-systems. Initial satellite work commenced when NASA approved RCA Limited for the development and supply of telemetry transmitters for Alouette I, Canada's first satellite, and for two major NASA scientific satellites, Explorer XX and Pegasus. With the transition from government laboratories to industry of the engineering capabilities in scientific satellites, RCA Limited was awarded the manufacturing contract of the Alouette II, launched in November, 1965.

Since that time, RCA has undertaken full assumption of prime contractor and design responsibilities for the successive Canadian scientific satellites, the ISIS "A" and ISIS "B". This has included the power supplies, antennae, telemetry and command, communications, attitude determination and control sub-systems. The ISIS "A" spacecraft was launched in January 1969 and the ISIS "B" followed with launching in March 1971, both spacecraft still performing successful missions. RCA Limited has also designed and built complete hardware and software systems for automatic control and checkout of satellites.

As management contractor for the two ISIS programs, RCA Limited has designed, in the course of its work on ionospheric satellites, a series of equipments which can find applications, with slight modifications, in other international space programs. The aerospace business is such that each spacecraft requires its own "custom" equipment; however, the equipment is usually slightly modified versions of a few generic types.

Units and equipments developed by RCA Limited, and which could be used in other space projects, include:

1. F.M. Telemetry Transmitters:
4 watts R.F. output at 136 MHz with true F.M. modulation, d.c. to 50 KHz and d.c. to r.f. power efficiency of close to 50% and weighing 0.45 kg (1 lb).
2. P.M. Telemetry Transmitters:
2 watts or 4 watts output at 136 MHz and weight of 0.58 kg (1.25 lb).
3. Tracking Beacon Transmitters:
100 millivolts r.f. output at 136 MHz and weighing 0.18 kg (4 lb).
4. F.M. and P.M. Telemetry Transmitters:
4 watts r.f. output at 400 MHz and of 0.68 kg (1.51 lb).
5. Pulse Code Modulation Encoders for encoding analog, serial and parallel digital.
6. Digital and Signals Analog Commutators.
Combinations of Items 5 and 6 could be used to sample (time division multiplex) a large number of digital or analog signals and convert to a single pulse code modulated output.
7. DC to DC Converters:
high reliability converters with conversion efficiencies up to 80% at 25 watts output and weighing 0.68 kg (1.51 lb).
8. Magnetometers
Electronics unit for 3-axis fluxgate.
Sensitivity: 5 volts for 200 Gamma F.S.
Linearity: 2 per cent
Resolution: 20 multivolts

SUB-SYSTEM DESIGN CAPABILITY

Spacecraft Power

- Batteries

- Converters

- Conditioning and Protection Circuitry

Telemetry, Tracking, Command

- Transmitters

- Encoders

- Multiplexers

- Decoders

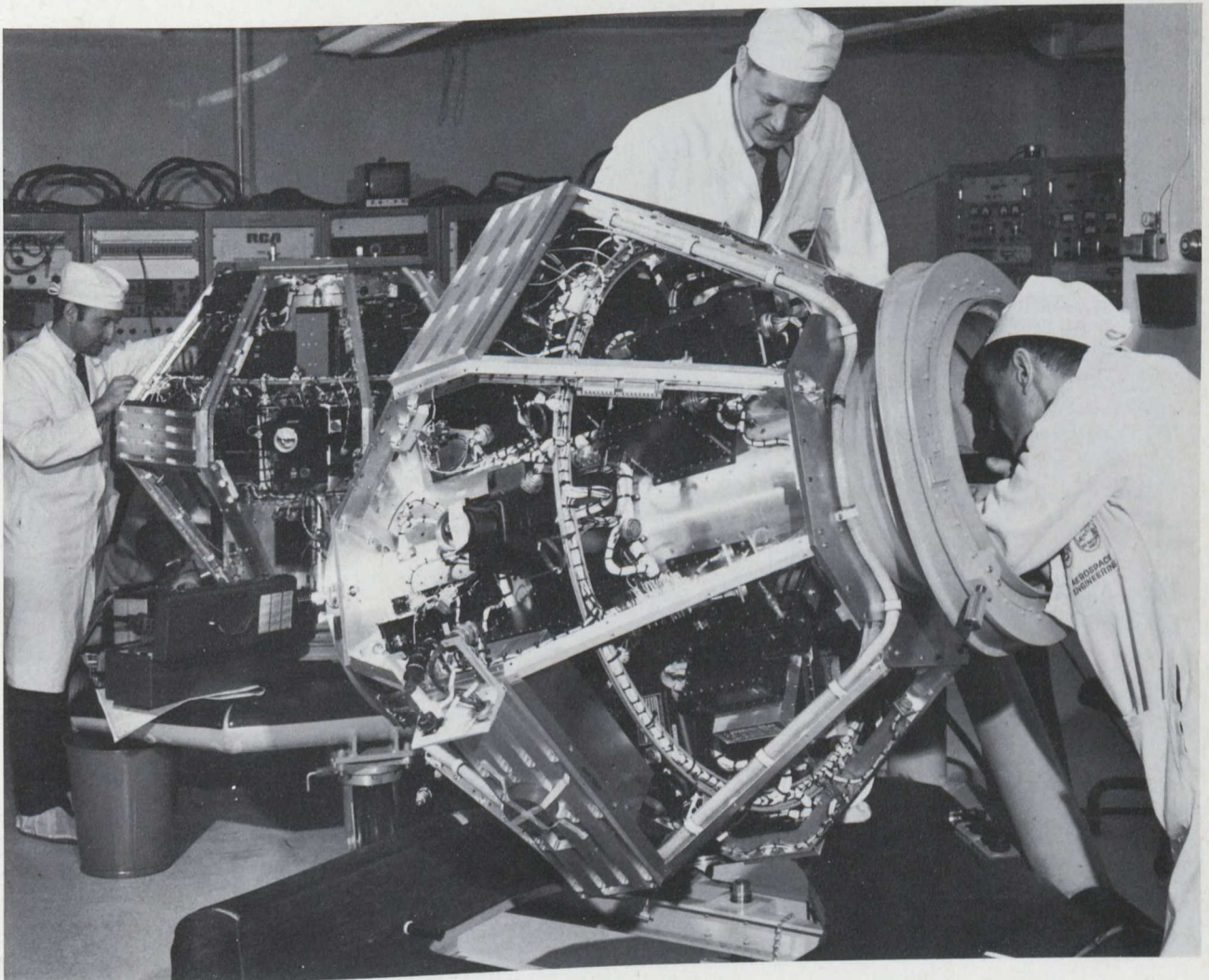
- Receivers

Transponders

Antennae

Attitude Determination and Control

Ground Checkout Equipment



SATELLITE EARTH STATIONS

Canada's only contractor of commercial satellite earth stations for operation with the Intelsat global system is RCA Limited. This company has performed prime contractor responsibility for 8 large terminals with steerable antennas of approximately 30 meter (32.8 yds.) diameter and additionally has furnished the feed and/or ground communications sub-systems for 12 other stations.

The year 1971 saw a major enlargement of RCA Limited skills in earth station technology upon its receipt of the award of over $\frac{3}{4}$ of the value of stations for the Canadian Domestic Satellite System — the world's first domestic system using geo-stationary satellites. The skill extension is primarily represented by the company's design of low cost terminals with fixed-position antennas of 8.4 meter (9.18 yds.) diameter and uncooled low noise receivers, all packaged for rapid erection in remote locations. All electronics are mounted in a compact air-conditioned trailer located adjacent to the antenna. The RCA domestic type satellite terminals feature unattended operation with requirements for periodic routine maintenance. RCA global type earth stations employ 30 meter (32.8 yds.) wheel-and-track antenna and feature double conversion in the communication paths and in the tracking downconverter, an all-electronic servo system with solid state motor controller, a high efficiency multi-mode feed system, and 500 MHz instantaneous for 4 GHz reception.

RCA Limited performs earth station programs on a turnkey basis, if required, involving supply of buildings, emergency power, access road and microwave link to the rearward based International Message Center.



RECEIVER/TRANSMITTER CONTROL GROUP AN/SRA-504(V)

RCA Limited designed and produced the variable configuration radio remote operate system used in the Royal Canadian Navy DDH-280 and AOR-509 classes of ship. The equipment provides access to the shipboard exterior communications system from remote operating positions.

The basic system is intended for use with up to 20 transmit/receive radio circuits, with the central control console supervisor allocating any 10 of the 20 radio circuits as channels for use at all remote operator positions (up to a maximum of 40 positions). The console supervisor can also allocate any one of the 20 radio circuits to each of 5 positions located in the same general operating space as the central console. The control console is the focal point of the system and gives continuous indication of the status of all channels:—

- Channel available for allocation
- Channel allocated
- Busy indication (transmit condition).

Simple operating controls permit the console supervisor to change channel allocations in a matter of seconds.

Each remote operator position has facilities to select any one of the 10 allocated radio channels, operates with handset, headset or loudspeaker and has complete channel status indication. Any number of operators may connect to the same circuit allowing any position to operate or monitor any of the 10 allocated radio channels.

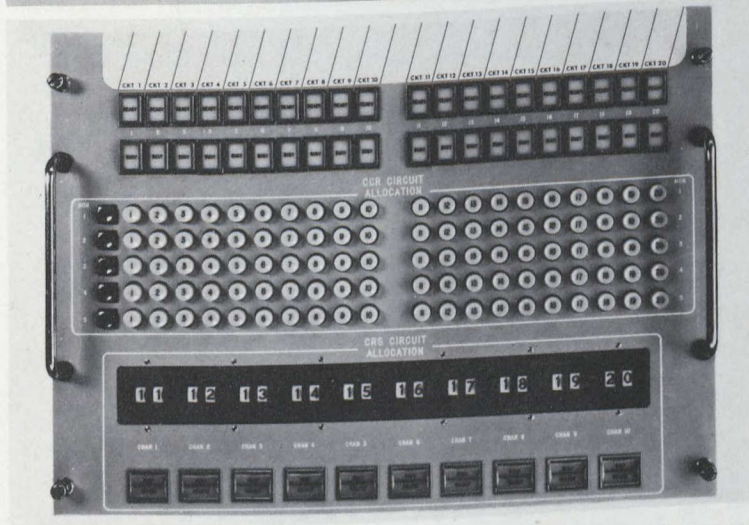
Interface adapters are available for certain specific communication equipment operating in the MF, HF, VHF/UHF bands. Any communication equipment may be connected to the radio remote operate system using suitable interface equipment if required.

Excellent intelligibility is afforded by the use of low-distortion audio equipment with level control maintained automatically by compression amplifiers. Additional flexibility is provided by various patching facilities. Reliability is enhanced by the provision of back-up facilities. Maintainability is straightforward in this equipment which is provided with easy access to all units and modules. Although this system has been designed for the environment of shipboard use, it is well suited as a control system for a ground communication centre.

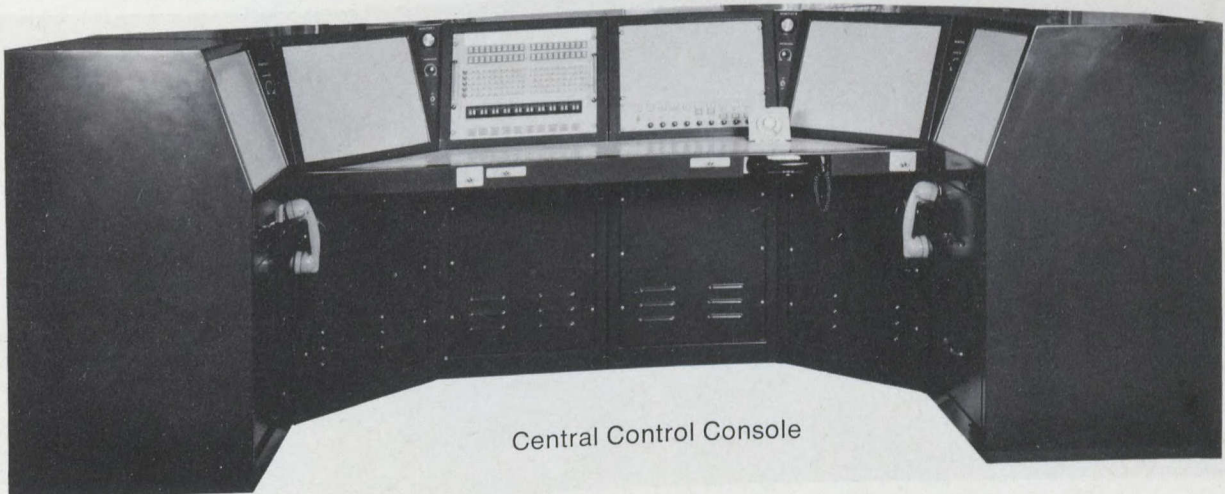
RCA Limited have developed and produced a range of communication equipment for defence applications and supplied (and are still supplying) system design assistance. An example of this is the supply of technical support staff to the Canadian Armed Forces in their DDH-280 class shipbuilding program.



Remote Operate Position



Control Indicator
(part of central control console)



Central Control Console

HIGH POWER LOW FREQUENCY SYSTEMS

The experience of RCA Limited in the design, construction and installation of LF systems for the Department of National Defence extends over the past 30 years. This activity covers all of the equipments required in such systems, i.e. transmitter, antenna, ground system, antenna tuning unit and hut, and transmission lines.

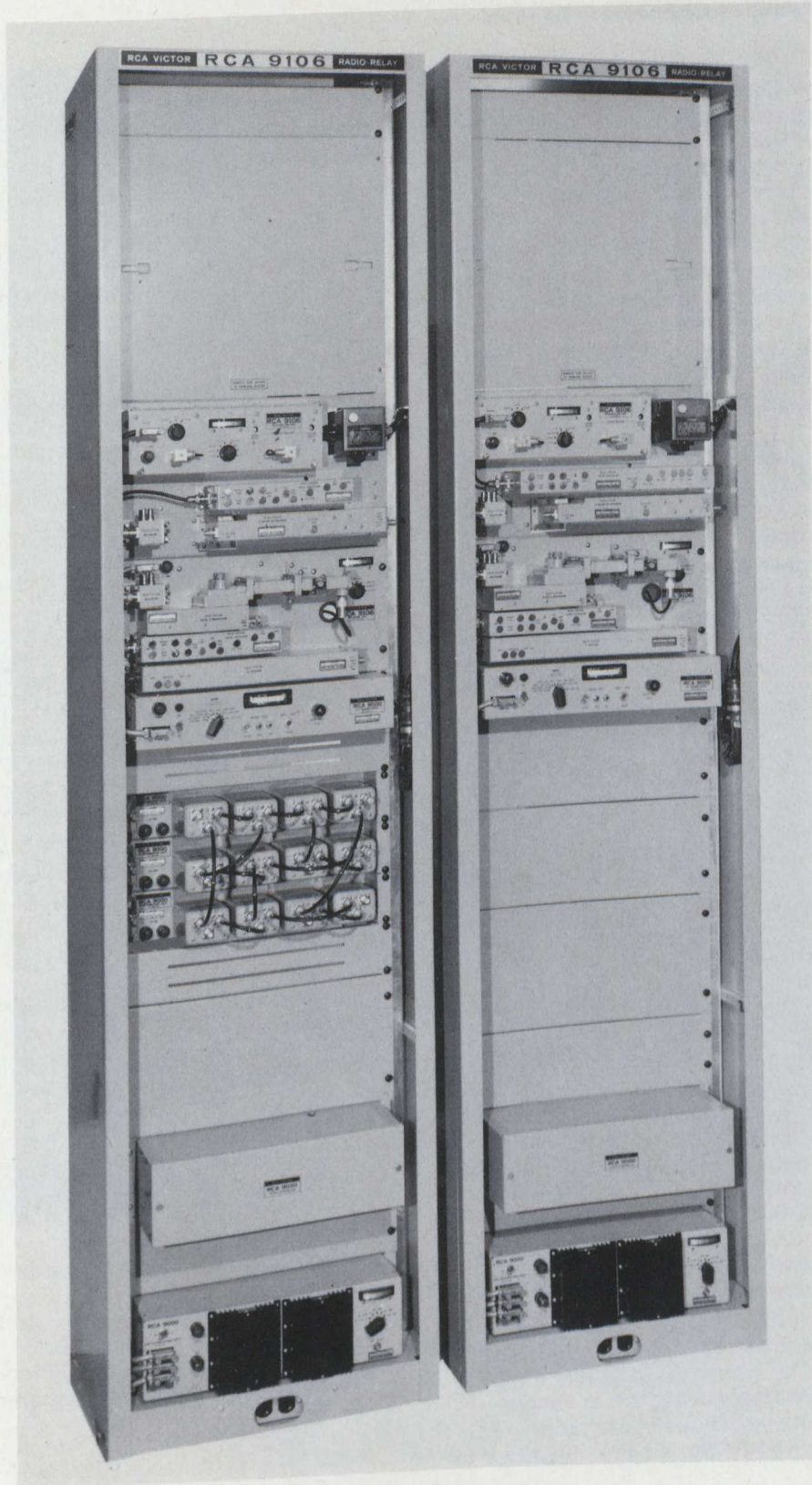
Systems built to date cover power levels from 10 to 250 KW in the 30 - 300 KHz band. Almost all of the equipments supplied are still in operation, regardless of when they were delivered, and highly reliable performance has been demonstrated.

The equipments supplied have been used both for FSK and CW operation. Diplexing equipment to handle two transmitters on one antenna has also been supplied.

MICROWAVE RADIO RELAY

RCA Limited, Montreal, in the microwave radio relay business since 1944, is the microwave skill center for the world-wide RCA Corporation. A full family of RCA wideband microwave systems for operation in the 2, 4, 6 and 7 GHz bands provides CCIR performance particularly suitable for common carrier applications and special military systems. The RCA microwave systems feature full solid state circuitry, low power consumption and ease of maintenance by replacement of plug-in modules. 1800 channel, CCIR performance has been attained on installed systems at 4 and 6 GHz. A measure of world-wide acceptance of RCA microwave radio relay systems is attested by over 55,000 Km (34,177 sm) of installed systems in 18 countries, the majority being made in the last 10 years. Major users have been NATO, CN-CP Telecommunications, Bell Canada, AT & T, Western Union, and PTT organizations in Iran, Turkey, Pakistan, India, Mexico, Colombia, Chile, Brazil, Australia and Israel. Three of the RCA systems each have a total system length of over 5,000 Km (3,107 sm).

RCA furnishes turnkey systems, if required, including multiplex, power, towers, buildings and access roads in response to user agency specifications. RCA also furnishes sub-systems such as modems, baseband equipment, transmit and receive units, space diversity combiners etc.



MICROWAVE COMMUNICATIONS SYSTEM MCS 6900

Canadian Marconi Company's MCS 6900 Microwave Communications System, a completely integrated multiplex/radio equipment, is designed to provide voice and data communications in all normal communications bands between 2 to 12 GHz. The MCS 6900 will carry up to 120 voice-channels or 7.72Mb/s of data. The multiplex techniques used are closely allied with the concepts of simplicity and reliability entertained by today's military communications planners.

Using Pulse Code Modulation (PCM), information is coded into a stream of binary digits (bits) which frequency-modulates the r-f carrier at the transmitter.

The MCS 6900 is of modular configuration which again follows the latest trends in system design. PCM allows the use of simple "on-off" circuitry which is ideally suited to the modular concept.

The MCS 6900 makes extensive use of large scale integrated circuitry in a number of simple basic building blocks. This approach enhances the system from the points-of-view of flexibility of use, simplicity of maintenance, and speed and ease of repair. A basic 24 voice-channel system can be easily expanded to 120 channels simply by adding further plug-in channel units.

Traffic capacities of the system are particularly noteworthy. The MCS 6900/A, the basic system, has 24 voice-channels and can carry up to 1.544Mb/s of digital data; the MCS 6900/B has 48 voice-channels and can carry up to 3.088Mb/s of data; the MCS 6900/C has 120 voice-channels and a capacity of 7.720Mb/s of data.

Preventive maintenance is minimal and repair is effected by simply replacing the faulty module indicated by the comprehensive fault alarm system. Up to 256 functions in groups of up to 16 per station are provided in the system; all field replaceable common equipment modules generate up to 64 local alarms per station. Replaced modules can be returned to Depot for repair, or may be discarded altogether since the modules are designed on the throw-away principle. A major feature of the MCS 6900 is that the system does not contain any circuitry which requires critical and sensitive adjustments. As a result the test equipment requirements are minimal.

The r-f sensitive circuits of the MCS 6900 are mounted adjacent to the parabolic dish antenna at the masthead. The r-f head consists of a weatherproof outdoor assembly designed to accommodate temperature variations in the range -55° C to $+55^{\circ}$ C. Received r-f signals are converted to

i-f before going to the radio ground equipment in the main equipment rack via a down cable assembly, which carries only video frequencies and the r-f head dc power supplies. No wave-guide is used.

Every MCS 6900 receiver in a system demodulates and regenerates the received signal. This ensures essentially distortion-free performance regardless of system length. Idle channel noise is 23dBmC and signal/distortion is: 25 dB, +3 to -40 dBmC.

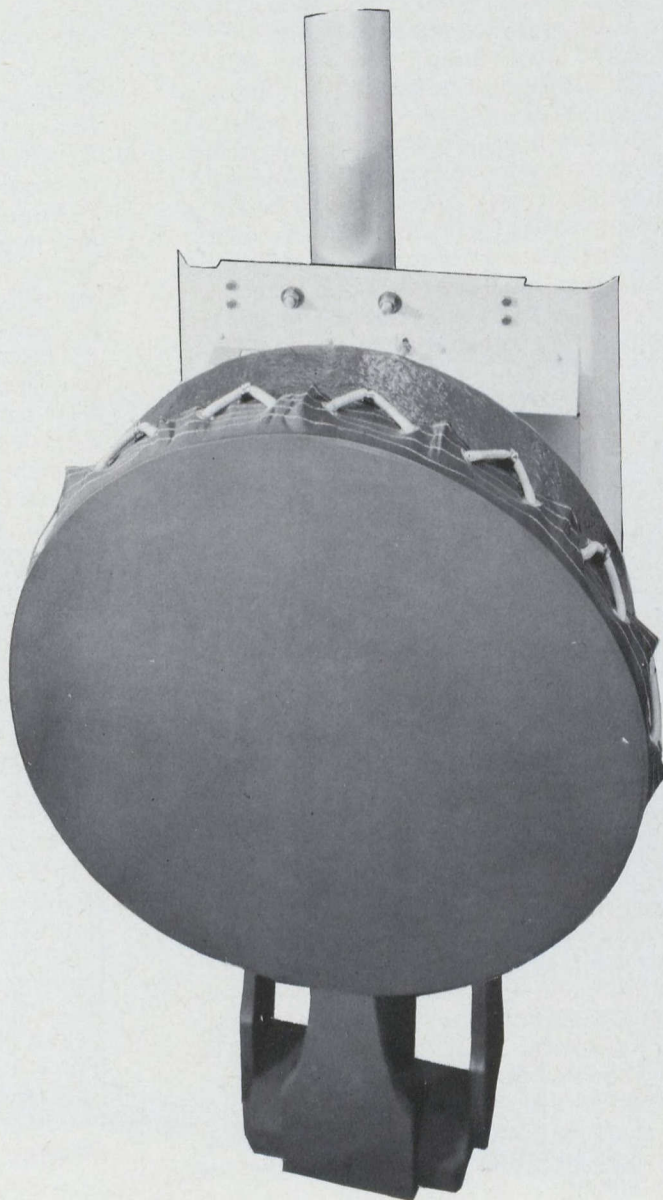
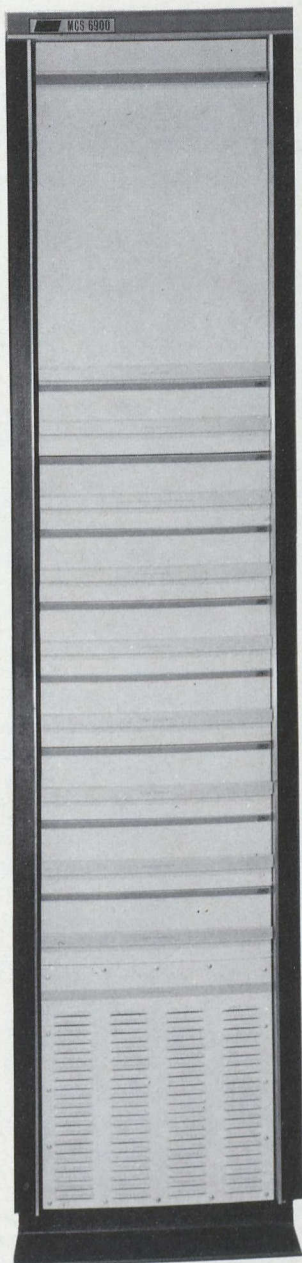
Path protection is provided by either: i) frequency or space diversity; or ii) hot standby, automatically selected, redundant systems where all common (i.e. carrying more than 12 voice-channels or one data group) equipment is duplicated.

All equipment, other than the r-f unit, for a full diversity 48 voice-channel terminal can be mounted in a single 48.26 cm (19 in) EIA rack, 2.13 m high (72 in) high.

The mechanical and electrical integration of the multiplex and radio portions of the communications system is a radical change in microwave system design philosophy, since it is not necessary to use separate, external analogue-digital and digital-analogue converters and modems, thus reducing system costs considerably. The MCS 6900 operates from 110/120/220/240V ac primary power and has a standby battery bank.

In summary the advantages of the MCS 6900 are:

- economical drop-and-insert of single channels because of the digital techniques employed.
- signal regeneration at repeaters reduces system noise penalties.
- system performance is not affected by relaxed feeder and antenna design criteria.
- with the r-f sensitive components immediately adjacent to the antenna no waveguide is necessary.
- superior data/voice mix when compared with fdm systems.
- wide data speed ranges without changing data channel equipment and without expensive A/D — D/A modems.
- operational redundancy of all common equipment.
- built-in fault detection and alarm.
- simple modular replacement.
- no critical or sensitive adjustments.
- minimal test equipment requirements.



RADIO RELAY EQUIPMENT, GRC-103

The GRC-103, designed and manufactured by Canadian Marconi Company, is a lightweight, mobile, tactical radio relay equipment designed for the rapid establishment of high quality radio relay circuits in military forward area communications systems. It is intended for use with pulse code modulation (PCM) or frequency division multiplex (FDM) equipment and is suitable for transmitting a wide variety of traffic including telephone, telegraph, teletype, facsimile and data.

The equipment operates in the 76 to 1850 MHz frequency range providing more than 4500 r-f channels in five separate frequency bands: Band 0 (76 to 170 MHz); Band 1 (220 to 405 MHz); Band 2 (395 to 705 MHz); Band 3 (695 to 1000 MHz); Band 4 (1350 to 1850 MHz). Any of the r-f channels can be rapidly selected by means of simple front panel controls. The GRC-103 represents the most advanced radio relay equipment in its class and is notable for its compact size, high reliability, and ease of operation and maintenance. The two main units, the transmitter and receiver, operate from 115 or 230 V ac, 47 to 420 Hz, or 24 V dc; each is man-transportable. These units measure 21.6 x 44.2 x 30.4 cm (8.5 x 17.38 x 12 in.) and weigh about 29.5 kg (65 lb.). Three ancillary units are available to provide order wire, alarm extension and group multiplexing facilities.

The equipment is fully solid state with the exception of the r-f power amplifier stages; a solid state power amplifier is available for Band 0. Transmission and reception are performed on a common, directional antenna system mounted on a lightweight, portable mast assembly; a corner reflector or parabolic antenna is used for Bands 1 to 4 and a log periodic antenna for Band 0. All units of the equipment are designed for continuous operation and fully meet military environmental and qualitative specifications for this class of equipment.

The GRC-103 provides a truly flexible communications system. The radio set will carry either 6, 12 or 24 channels PCM or 4, 12 or 24 channels FDM. Simple plug-in passive filter networks permit alteration of the baseband response to allow for either greater traffic loading or alternative forms of traffic.

In practical field applications the wide operating frequency range of the GRC-103 is of considerable advantage. The five-band frequency coverage is achieved by using five separate, interchangeable plug-in r-f heads for both transmitter and receiver, thus permitting a high level of flexibility in tactical frequency planning.

An entire radio/multiplex telephone terminal consisting of the GRC-103 and associated multiplex, telephone and power-generating equipment can be readily mounted in a quarter-ton jeep and trailer. The equipment is air-transportable and is suitable for airborne-delivery or assault-landings in tactical vehicles.

Advanced design techniques ensure high reliability under field operating conditions. The mean-time-between failure for the GRC-103 is 1200 hours.

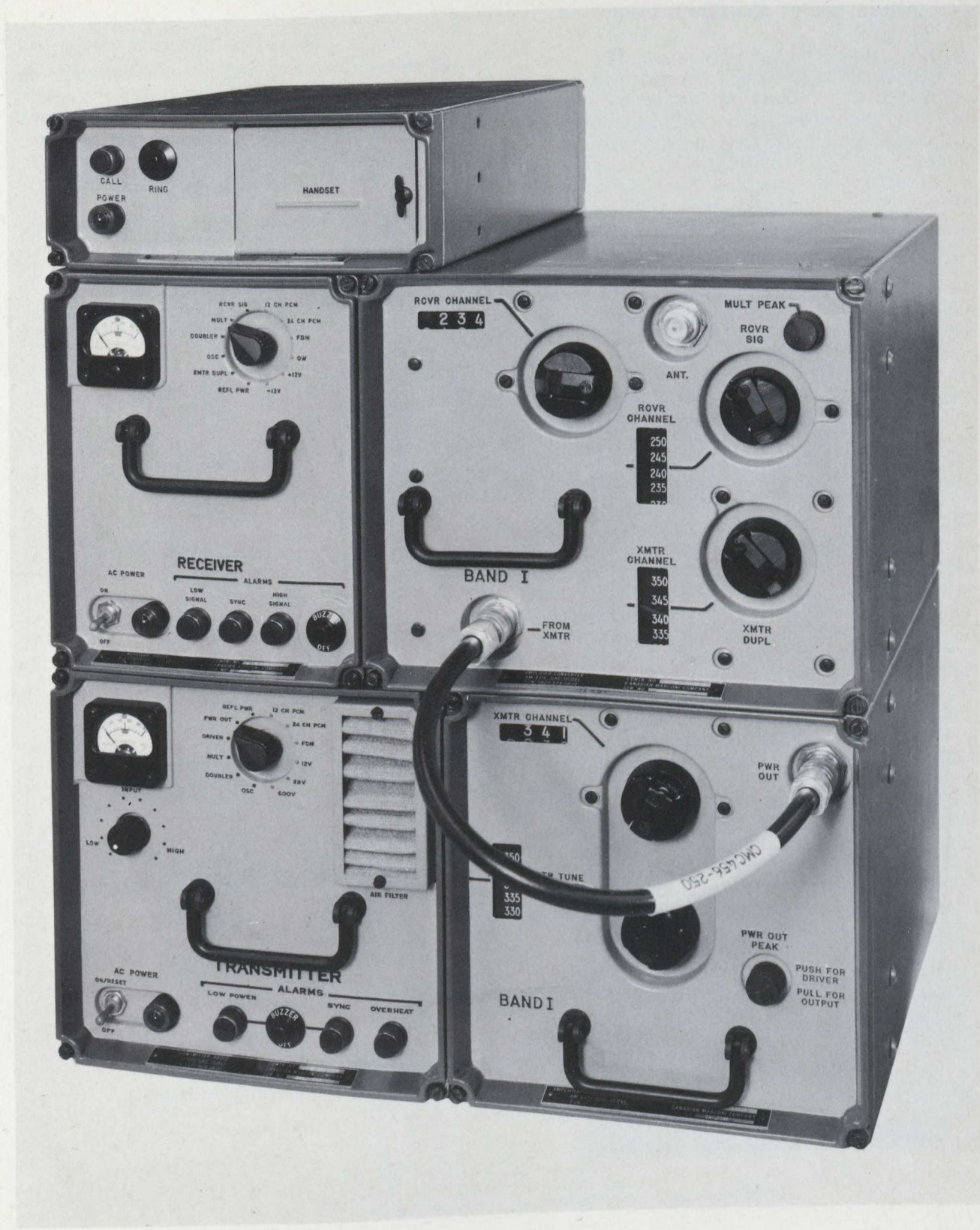
Channel changes on the GRC-103 are made by adjusting the tuning controls until the appropriate channel numbers appear in the adjacent display windows. Two peaking controls are provided for fine tuning. A single operator after minimal instruction, can perform the entire tuning procedure in less than 30 seconds.

The equipment can be fully field-operational in less than 25 minutes. The operating frequency band can be changed in less than 5 minutes by replacing the transmitter and receiver plug-in r-f heads and by making simple alterations to the antenna.

Excellent performance is achieved over line-of-sight paths in excess of 80.46 km (50 miles). The GRC-103 has sufficient reserve power to operate efficiently over routes containing substantial obstructions, an important factor in the application of tactical radio relay systems in the field. Field maintenance of the GRC-103 is accomplished by replacement of plug-in modules and sub-assemblies which are made readily accessible by sliding the major units out of their cases. Built-in test facilities ensure 98 percent repairability within one hour of malfunction.

A 24-channel combiner, the MX-103 provides combining facilities for signals from two 12-channel PCM multiplexers to the GRC-103. The MX-103, operating from its own power supply, combines two groups of 12 channels into a composite PCM signal. The unit also receives, separates, and restores the two groups to their original form. Alternatively, the MX-103 will reduce the bandwidth of a single 12-channel PCM signal for transmission over a radio system designed for 6-channel PCM. The MX-103 uses 4-level (quaternary) coding and measures 8.3 x 44.2 x 30.4 cm (3.25 x 17.38 x 12 in.).

This equipment is now in use with the armed forces of Norway, United States, New Zealand, Singapore and Canada.



MICROWAVE RADIO SYSTEMS TYPE 71F2

Lenkurt's completely solid state type 71F2 Microwave Radio offers a reliable, low cost, light-route microwave link for transmission of up to 300 single side band suppressed carrier (SSBSC) multiplex channels in the 1.7 - 2.3 GHz frequency band.

Compact, modular construction and conservative component ratings have been combined to ensure that economical, high performance 71F2 systems may be engineered and installed in minimum time. Numerous standard system configurations are offered, including variations of unprotected, hot-standby, frequency diversity, space diversity and quadruple diversity. System maintenance is simplified by built-in metering, easy access to important circuit points plus modular construction for rapid replacement.

71F2 systems operating frequencies are available to meet CCIR, D.O.C. and FCC standard plans. System pilots of 607 or 1499 kHz are available, with optional 2 or 3 watt RF power output. A power source of -24 V (basic), or -48 V or 115/230 V ac is required. The ambient temperature range is +10°C to +40°C for specified performance, with an overall operating range of -40°C to +60°C.

Versatile: The various system configurations are available to carry 24, 50, 120 or 300 channel loads in addition to order wire and system supervisory information. Complete or partial baseband drop and insert is provided at repeaters.

Reliable: More than 2,500 sets now in operation around the world have established an enviable reliability record.

Low System Costs: High power outputs combined with low receiver noise figures permit smaller antennas, coaxial feeder lines and less expensive towers to be employed.

Compact: A complete 71F2 transmitter/receiver occupies only 31 cm (12.25 in.) (7 mounting spaces) on a standard nineteen inch relay rack. A frequency diversity terminal complete with baseband auxiliary equipment, order wire and antenna connector panel utilizes 27 mounting spaces.

Simplified Maintenance: Long Mean Time Between Failures (MTBF) and Short Mean Time To Repair (MTTR) result from a completely solid state design, conservatively rated and packaged in fully shielded modules. Individual modules and complete transmitter or receiver assemblies may be replaced quickly and easily in the RF tight cabinet.

Low Power Consumption: For areas where prime power is limited, low power drain versions are available. These assemblies offer a nominal 2 watt transmitter with crystal ovens disconnected. For example, an unprotected assembly requires 40 watts and a hot-standby assembly requires 60 watts.

Test Set: For complete system alignment an optional test set is available. The 81030 Test Set simplifies 71F2 field adjustments and reduces the number of standard instruments required.

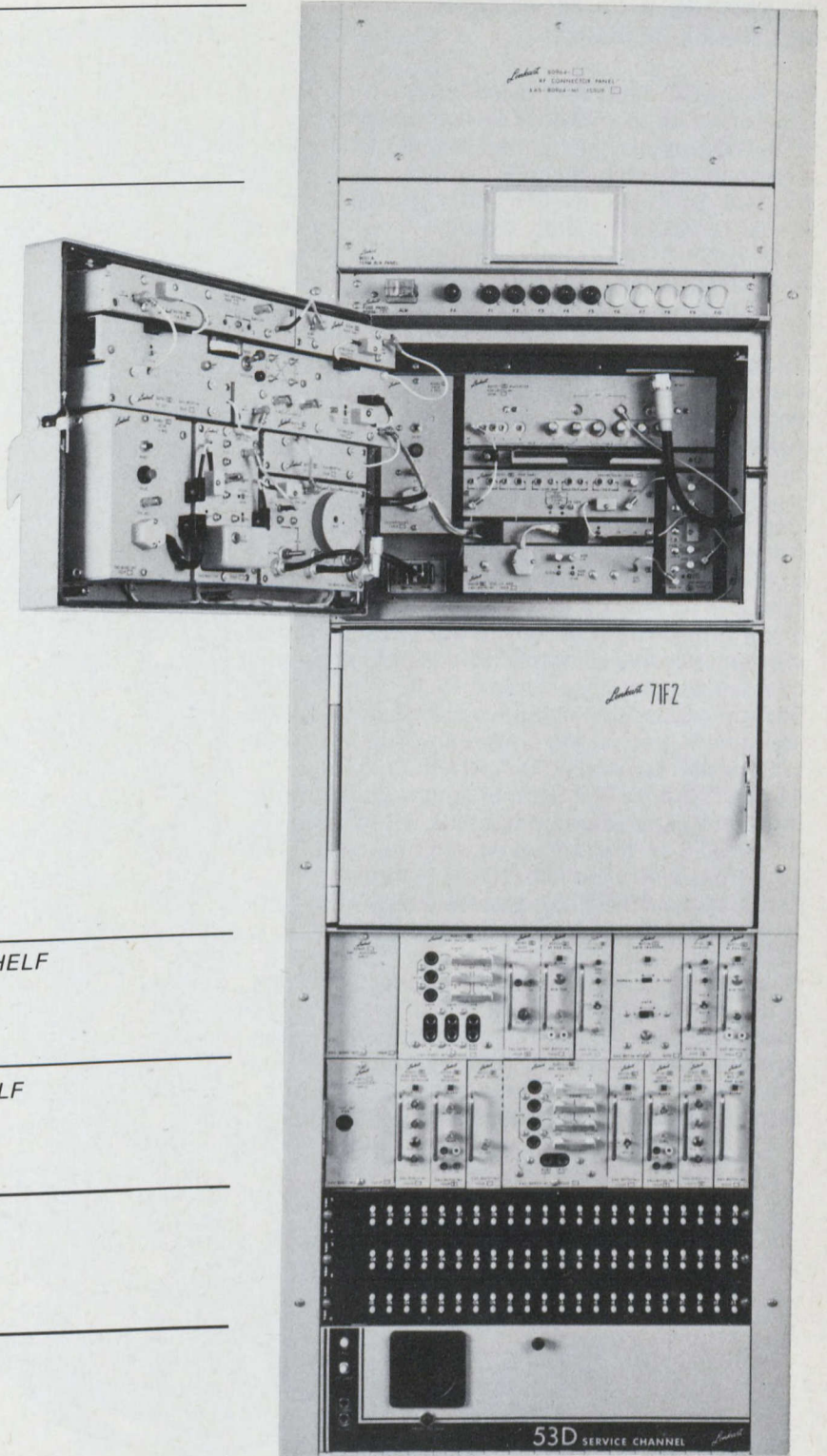
Constructed for rugged field portability, the Test Set is powered from the baseband auxiliary shelf.

RF CONNECTOR PANEL
(4 spaces)

TERMINAL BLOCK
(2 spaces)

FUSE PANEL
(1 space)

DIVERSITY RADIO
(14 spaces)



TRANSMIT AUXILIARY SHELF
(3 spaces)

RECEIVE AUXILIARY SHELF
(3 spaces)

SUPERVISORY DISPLAY
(3 spaces)

ORDER WIRE SHELF
(3 spaces)

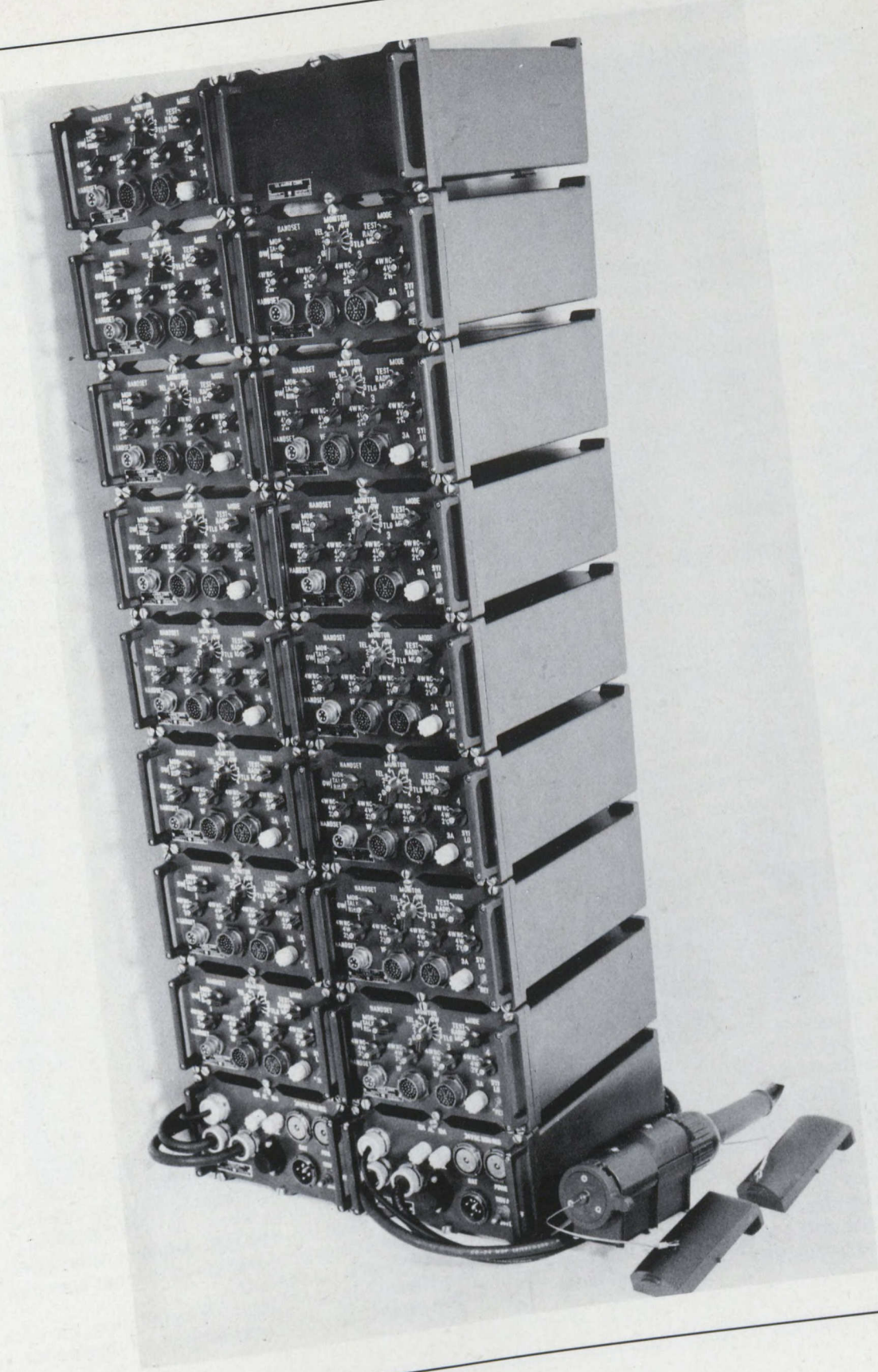
Typical 71F2 Diversity Terminal with Order Wire and Supervisory Display

**TELEPHONE AND TELEGRAPH
MULTIPLEX TERMINAL**

The AN/GCC-14(V) Multiplex Terminal provides a capacity of up to 15 3-KHZ telephone channels, 60 4-KHZ telephone channels and 60 full duplex telegraph channels on an FDM basis over AN/TRC-24, C-50, AN/GRC-50, AN/TRC-97 or AN/GRC-103 Radio Sets. It consists principally of up to 15 TH-81/GCC 1 plus 4 plus 4 channel terminals with stacking and power supply equipment. A fully-equipped terminal requires 133.35 cm (52.5 in.) of mounting space on a standard 48.2 cm (19 in.) rack. Each telephone channel is equipped with 20/1600 Hz ringing circuit, compandor, hybrid circuit, and loop switch. Each 1 plus 4 plus 4 channel sub-group is equipped with carrier supply, power supply, and automatic transmission regulator. Any sub-group can be replaced mechanically and electrically by a broad-band modem for digital signals. At repeater points in a radio-relay system, any number of sub-groups from one up may be dropped and inserted in either or both directions. Any sub-group terminal may be operated remotely from the main terminal over a 4-wire radio or cable circuit.

Several modulation schemes are available in this equipment. In one, the lower sub-groups are compatible with the AN/VCC-1, AN/VCC-2 and AN/VCC-3 Terminal Sets. In another, the lowest three sub-groups are compatible with the AN/GCC-5 or -6 Multiplexers, and the next three sub-groups with the AN/GCC-6 Multiplexer. Multiplex terminals can also be supplied in conformity with the technical requirements set up for DCA, CCITT, and NATO Systems."

Radio Engineering Products have designed and produced terminals such as these for a variety of custom requirements and your particular demands may be referred to them with the assurance that it will be met within the parameters of internationally accepted tolerances and specifications.



VLF-VHF DIRECTION FINDER

General Precision Industries has designed a series of radio direction finding equipment which combines the following capabilities in one set:

- Complete coverage of 10 kHz through 180 MHz.
- Instant visual indication of bearing and sense.
- Spectrum surveillance with built-in sweep.
- Panoramic bearing display of a band of signals distinguished in frequency by the colour of trace.
- Intelligence monitor tuned to any selected frequency while surveying the DF band with sweep.
- Positive identification of the bearing trace corresponding to the monitored signal.
- Vertical or horizontal polarization (above 30 MHz).

Novel operational features include:

- Computer coordinated controls which save operator's time and lengthen his effective operating time.
- Automatic tuning, local or remote, by frequency synthesizer.
- Fast access to tuning with search-through facility.
- Interception of signals of any type of modulation, including SSB.
- Balanced AGC, operative over the full dynamic range.
- Centre-frequency tuning by colour of trace or by beats.
- Anti-parallax; daylight viewing filter.
- Stable phase and gain match — no need to re-balance before taking a reading.

These direction finders operate on the principle of resolving the electromagnetic field at the antenna location into a set of orthogonal vectors which are then amplified and applied to the plates of a cathode ray tube so as to trace a bearing line indicating the azimuth of arrival of the signal.

Two antennas are used: one for the LF through HF ranges and one for VHF. The LF/HF antenna derives the DF vectors from a pair of multi-turn, switched loops while the sense is obtained from a set of balanced dipoles. The VHF antenna comprises 16 separate monopole elements which can be arranged as crossed-Adcock and parallel dipole arrays in both the horizontal and the vertical plane of polarization.

The DF signal vectors are amplified by two identical receiver channels which are accurately matched in phase and gain under all conditions of tuning and signal strength. A third channel, matched in phase only and equipped with a separate AGC, serves to amplify the omni-directional

sense signal which is applied to the grid of the c.r.t. to blank out the unwanted half of the bearing trace.

In addition to the instantaneous single-signal DF mode, the receiver can be operated in a panoramic mode (amplitude/frequency display), or in a wide-band sweep mode, allowing the operator to see simultaneously the bearings and frequencies of all the signals present within the search band. This "3-D" display is made possible by using colour modulation as the frequency parameter.

A phantom omni-directional audio output is available at all times for intelligence interception purposes. This monitor channel can be tuned to any of the signals within the sweep band without disrupting the panoramic bearing display.

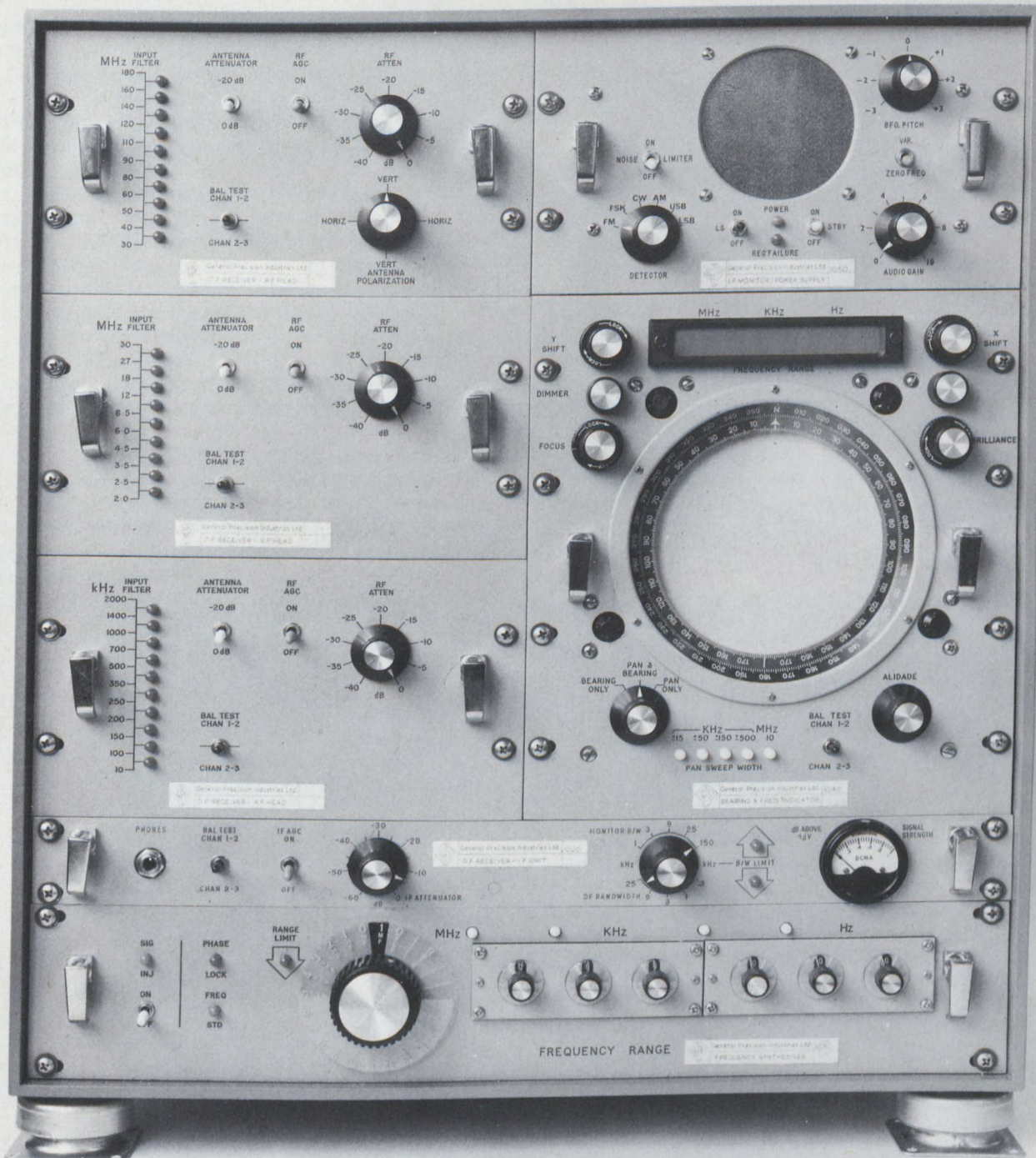
Digital, automatic tuning is derived from a phase-locked frequency synthesizer fitted with an oven-stabilized frequency standard. The synthesizer is designed for fast access manual tuning, using decade reed switches which are gear-interlocked to count up or down automatically. The tuning frequency is indicated directly by the decade knobs and in addition there is a projection-type luminous readout which can be duplicated in a remote location.

The receiver is of modular construction, employing field effect transistors and integrated circuits. Military style components and workmanship are used throughout. A built-in test generator provides a signal at the receiver frequency which can be injected at the antenna for the purpose of checking the system, trouble-shooting and aligning. A series of commutation networks permit rapid interchange of the channels to facilitate the alignment of phase and gain balance, unit by unit. No instruments, other than a VOM, are required for routine maintenance. Failure alarm lights are provided for the synthesizer phase lock and for all the voltage-regulated lines of the power supply.

APPLICATIONS:

A radio direction finder measures the velocity vector of the electro-magnetic field as seen at the antenna site, hence successful radio DF depends to a great extent on the location of the antenna. Two versions of the new GPI series of radio direction finders have been designed to meet specific environmental conditions.

The Model 100, for shipboard installation, provides an instrumental accuracy of ± 1 degree for

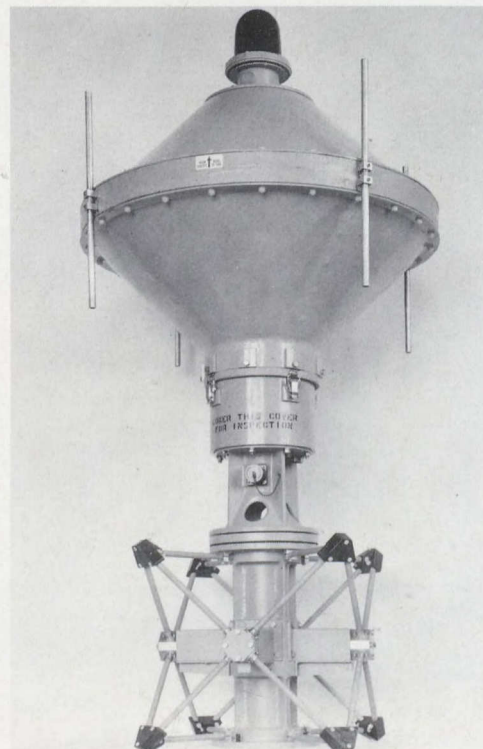
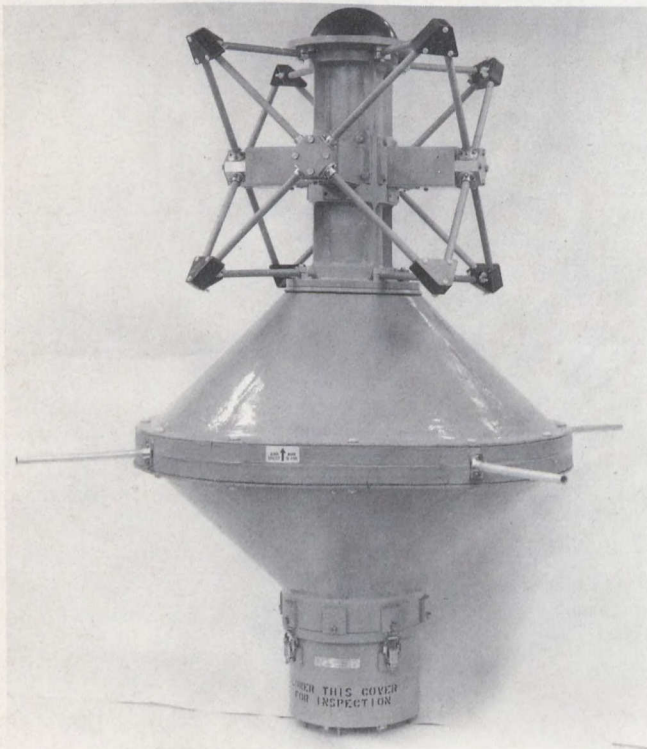


ground propagated waves. Additional bearing errors caused by re-radiation from the ship's superstructure can be eliminated by calibration, the repeatability of reading the bearing being of the same order as the instrumental accuracy.

The Model 100 Shipboard Direction Finder is intended to replace older HF/DF sets, extending operational range and usefulness. With the new concept of combining monitoring, intercept and DF, smaller vessels can now be provided with a comprehensive electronic surveillance capability at a relatively low cost.

The Model 109, designed for vehicular installation, utilizes the same receiver as the Model 100. The instrumental accuracy is ± 1 for ground-propagated waves, and additional bearing errors caused by re-radiation from surrounding buildings, towers or overhead lines, can be partially cancelled by averaging several bearings taken from different positions. Full coordinates of the signal source can be obtained by triangulation from at least two mobile DF stations.

The Model 109 Mobile Direction Finder is particularly suited for close range monitoring of radio traffic and location of signal source. As with the Model 100, an economical yet comprehensive electronic surveillance capability can now be provided in mobile stations operated by a crew of two.



DATA TRANSMISSION SETS

Lenkurt type 26C Data Modems are used for data transmission in a voice band using standard multiplex or carrier telephone facilities. The 26C-81201 Data Modem provides transmission of serial binary data (non-return to zero format) at 2400 and/or 1200 bits per second over C1 conditioned circuits.

The 26C Data Set uses proven frequency shift keying techniques for modulation of the data stream. At 2400 bits per second the Lenkurt(C) Duobinary process is used, for bit comparison of the data stream, thus providing accurate data transmission comparable to that at 1200 b/s. Typical bit error rates are 1×10^{-5} for a line signal noise ratio of 10.5 dB at 1200 b/s; 13 dB at 2400 b/s. A bonus feature of the 26C Duobinary technique is automatic error detection at the receive end of the circuit.

The 26C meets the CCITT V24 specification for data interfacing as well as EIA RS 232C and MIL-STD-188B specifications.

Optional features provide 230 V ac operation and compliance with the British G.P.O. specifications on line output levels.

Other features offered include:

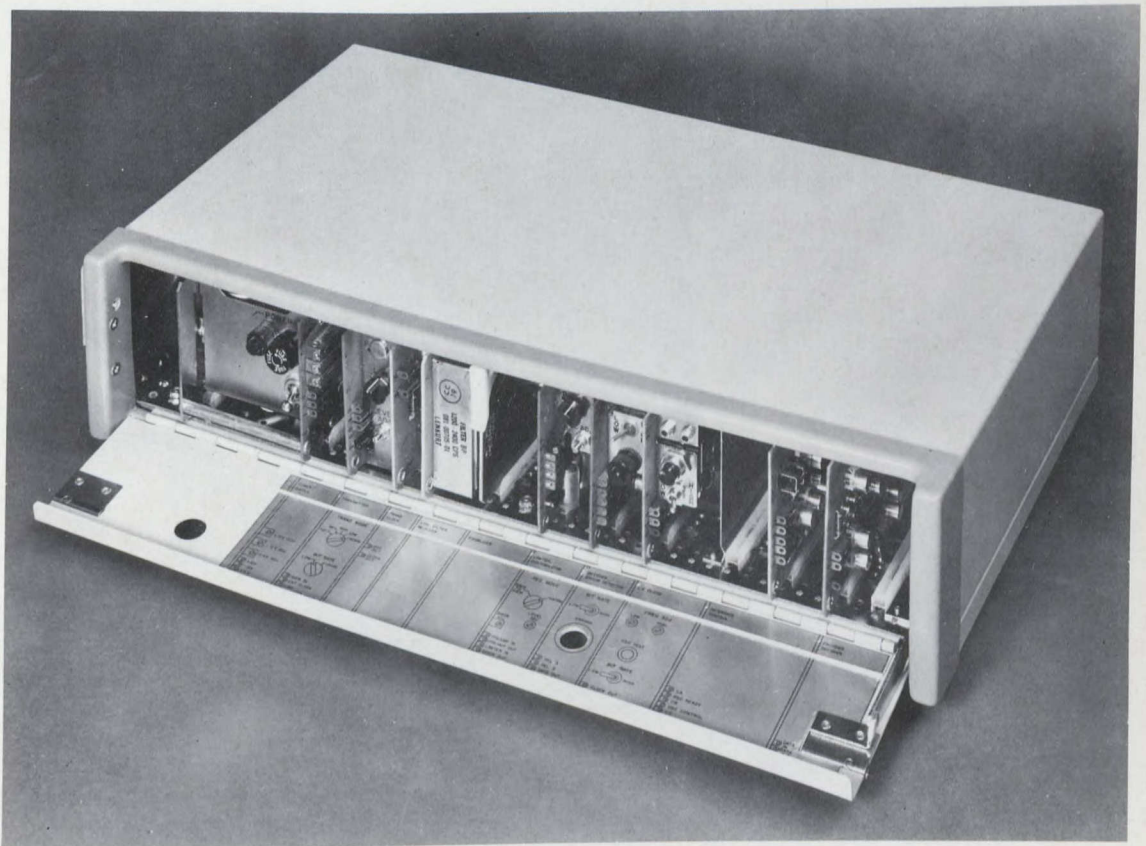
- Manual equalization for improved data accuracy over leased line facilities.
- Compromise equalization allowing accurate data set operation over dial-up telephone networks, at 1200 and 2400 b/s.
- R.F.I. shielding where sets are exposed to noise interference from radiation, typically at radar sites.
- Fully protected power supplies with alarm options.
- In built test pattern generator.
- Continuous receiver clock synchronization.

The 26C can also be provided for synchronous operation up to 1800 bits per second.

Typical circuit applications are:

- Full duplex point-to-point.
- Half duplex multi-point polled networks on a party line basis.
- Simplex arrangements between computers and other business machines.

Turn around time can be as low as 2 milliseconds in polled networks.



TELETYPEWRITERS

Data communications by teletypewriter has become a necessity in this day of speed, accuracy and reliability. Marsland Engineering Limited manufactures this equipment for major communication networks, data processing and automation supervisory control systems.

DESCRIPTION:

The Automatic Send-Receive (ASR) models are the most versatile, and should be considered for even the most simple communication network. The ASR Model utilizes tape perforator and reader in conjunction with the page printer. The perforator and reader may be engaged or disengaged at will. Messages for transmission may be originated by either manual operation of the keyboard or the reading of a previously prepared tape. Tapes may be prepared for data originating locally, or remotely. In all operating modes a printed copy is produced.

The Keyboard Send-Receive (KSR) models provide facilities for the origination of messages for transmission by the manual operation of the keyboard. The page printer will provide a record of these locally generated data, as well as a hard copy of remotely generated data.

The Receive Only (RO) models are equipped with a page printer only, for receiving messages. With the exception of a call sign no data can be transmitted. Optional tape perforator is available. Marsland Engineering Teleprinters are available with several standard options consisting of:

- A) Call Control Unit which will permit local and on line models and direct dialing of remote stations.
- B) A three (3) Row Keyboard uses letter/figure shift combination providing standard requirements at economical cost. The 3-row keyboard may be used with Tape Punch and Tape Reader systems. Supplied as standard on Marsland 32 Series Models.
- C) The Tape Punch produces perforated tape for later transmission, data storage and elimination of repetitive typing.
A Tape Reader is used in conjunction with punched tape. Reads and transmits data from fully perforated and chadless tape.
- D) The four (4) Row Keyboard is standard for Model 33 and available for Model 32. Used in international communications and as an operational refinement for all transmissions. This model utilizes a letter/figure shift with automatic key locking. A parity keyboard feature is available.

- E) Optional features composed of an automatic answer-back, automatic reader and punch control, sprocket feed platen, automatic carriage return and line feed and a low paper alarm are also available.
Special features such as keyboards in language other than English are provided upon request.

SPECIFICATIONS:

Speed:	Characters per Second	{	6 6.6 7.5 10	Words per Minute	{	60 66 75 100
	Model 32 —		45 Baud 49.5 " 56.3 " 75 "			
	Model 33 —		66 Baud 74 " 82.5 " 110 "			
Code:	32 Series —		5-level with 7.5 unit transmission pattern.			
	33 Series —		8-level with 11 unit transmission pattern (ASC11 Code).			
Tape:	32 Series —		11/16" wide, 10 code combinations per inch.			
	33 Series —		1" wide, 10 code combinations per inch.			
Printer:			• Friction-driven platen • 8½" wide paper • 10 characters/inch (72 characters /line standard) • Vertical spacing at 3 or 6 lines/ inch, single or double spacing.			
Power:			115 volts, 60 Hertz, single phase: synchronous motor. 50 Hertz opera- tion is available on special request.			



TRANSCEIVERS

These Transceivers by Canadian Marconi provide reliable communications for short distance operators with a minimum of sophistication.

The CP34 is a portable HF-SSB Transceiver with capability of up to 36 simplex or 9 semi-duplex channels. Designed for arctic and tropic environments as a rugged portable for remote-location field communications, it can also be used in a vehicle as a mobile unit. The high impact plastic case with aluminum cast panel is sealed and weatherproof. The entire unit complete with 9 "D" size flashlight batteries weighs only 6.6 kg (14.5 lb.). The CP34 is compatible with other SSB equipment and a full range of options and accessories are available for it.

TRANSCEIVER, DT-56

Frequency Range:
138 - 174 MHz.

rf Channels:
Up to 6 transmit and receive combinations.

Duty Cycle:
Receiver 100%, Transmitter 100%.

rf Power Output:
30 watts.

Power Input:
Transmit 13.6V - 5.8A
Receive 13.8V - 0.1A

Dimensions:	H	W	D
Radio Unit:	7.62 cm (3.00 in.)	26.80 cm (10.55 in.)	24.13 cm (9.5 in.) (less control head)
Loudspeaker:	6.68 cm (2.63 in.)	16.84 cm (6.63 in.)	6.68 cm (2.63 in.)
Control Head:	7.62 cm (3.00 in.)	13.67 cm (5.38 in.)	5.72 cm (2.25 in.)

Weight:
Radio Unit: 3.54 kg (7.8 lb.) (incl. control head).
Speaker: 1.27 kg (2.8 lb.)

Voltage Regulation:
Solid-state regulator supplies constant voltage to all circuits.

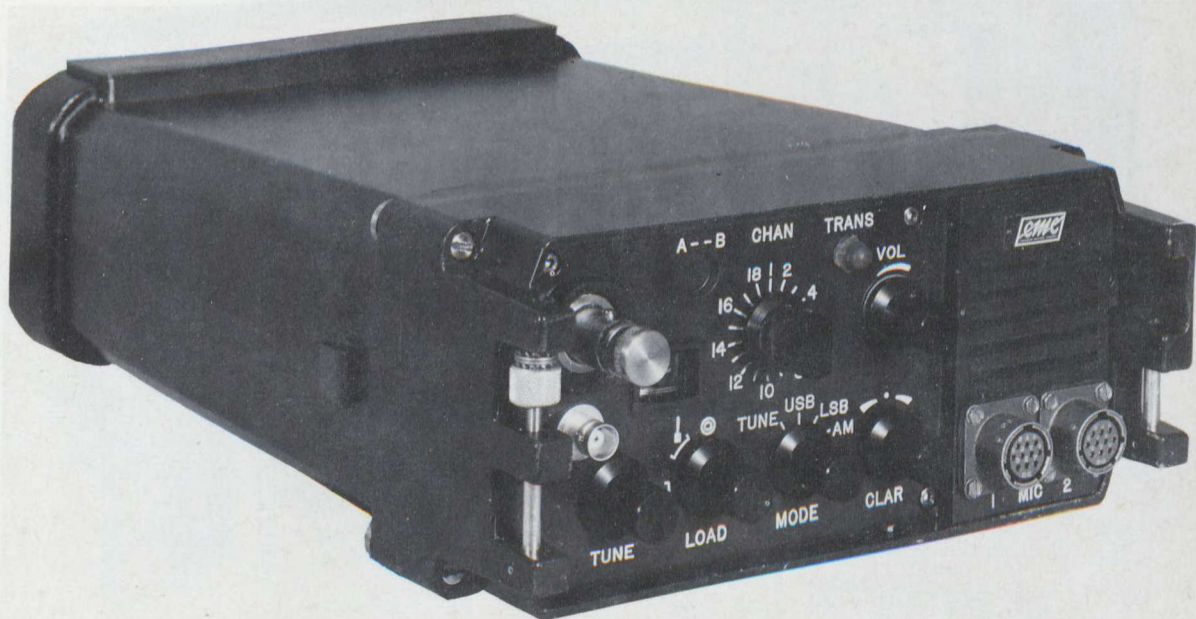
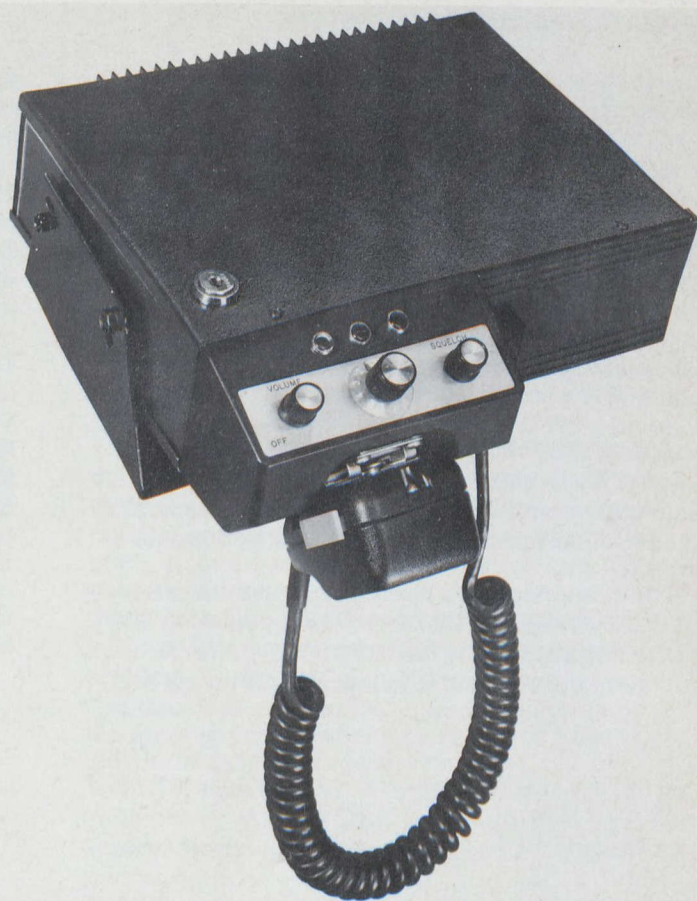
VSWR Protection:
Prevents damage to transistors when antenna is broken or shorted.

Microphone:
High Impact Cyclocac housing, element protected against shock and vibration.

Receiver:
Solid-state single conversion superheterodyne.

Sensitivity:
.35 μ V for 12 dB SINAD.

Audio Output:
2.0 watts at 16 ohms with less than 5% distortion.



20 WATT VHF-AM TRANSMITTER

The CGE Type ETC-72-A VHF Transmitter is an amplitude-modulated, single-channel unit intended for use as a ground-based transmitter in aviation voice-communication systems. One transmitter is required for each frequency to be used in the system.

The transmitter is designed for Class C operation in the 118 to 136 MHz vhf range with an output power variable from 0 to 25 watts. Overall modulated carrier envelope distortion does not exceed 10 percent over the audio passband and good communications-quality speech with a minimum of bandwidth is assured by limiting the passband to 300 to 2750 Hz. Provision is made for the operation of the transmitter from a remote location using 600-ohm telephone lines. Local or remote operation is selected by means of a front panel switch.

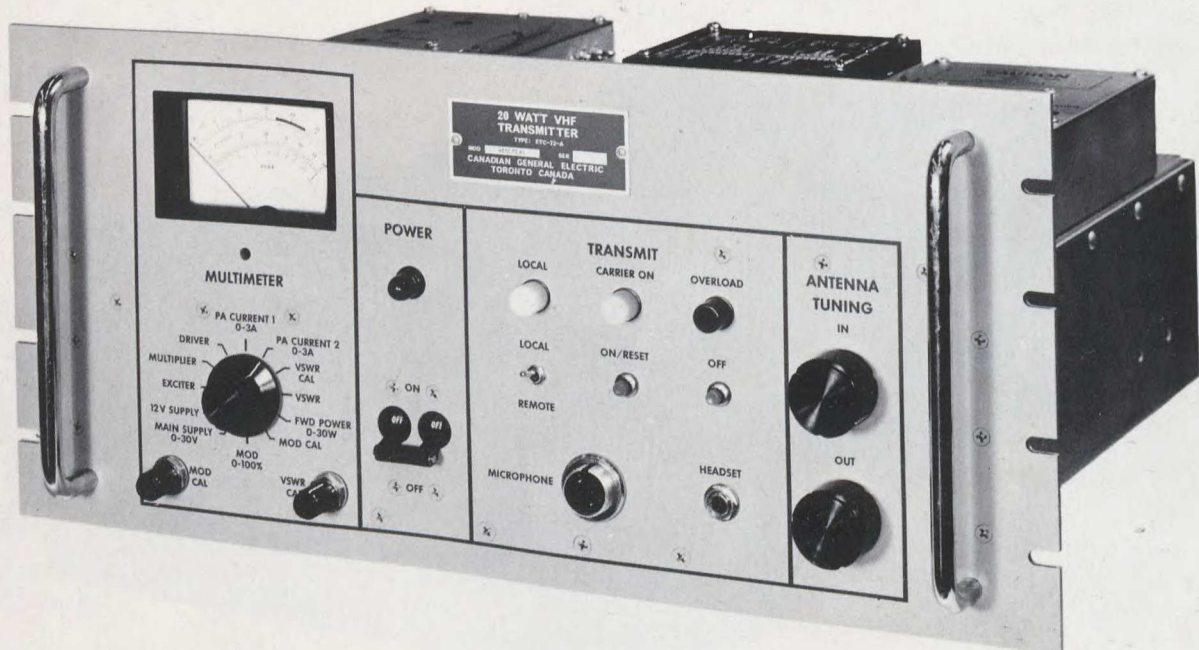
All third and higher order intermodulation products are at least 27 dB below the modulation level at the output, and the harmonic and spurious radiation output level is at least 70 dB below the

carrier output level. This makes possible the operation of a number of transmitters on a common antenna system without serious interference from cross-modulation products.

The transmitter contains a harmonic filter, a reflectometer, an antenna tuning unit and built-in metering circuitry to measure power supply voltages, multiplier and driver outputs, power amplifier currents, power output, VSWR and percent modulation.

The transmitter is designed to allow sufficient convection cooling so that a minimum of five units can be mounted in one standard 48.26 cm (19 in.) enclosed rack without forced air cooling. Additional transmitters may be mounted in the same cabinet if forced air cooling is provided, or if the operating ambient is less than 40°C.

The CGE Type ETC-72-A VHF-AM Transmitter may be used in conjunction with the CGE Type ERC-70-A Receiver to form a completed ground based communication system.



VHF-AM RECEIVER

The CGE Type ERC-70-A Receiver is designed for use as a ground-based unit for the reception of amplitude-modulated signals in aeronautical voice-communication systems. The unit is completely solid state and uses monolithic integrated circuits extensively for increased reliability. Diode-protected dual-gate MOSFET transistors are utilized in the RF amplifier and mixer stages for optimum cross-modulation performance and noise figure.

The receiver operate on a single pre-set channel within the frequency range 118 to 136 MHz. The single-conversion superheterodyne circuit employs a crystal filter for selectivity. A crystal-controlled oscillator provides a frequency stability of $\pm 0.0005\%$ over the temperature range from -10°C to $+55^{\circ}\text{C}$. Designed for reliable unattended operation, the receiver may be used with the companion ETC-72-A solid-state 20-watt transmitter or can be operated as part of existing VHF communication systems employing 50-kHz receiver channel spacing. Receivers for 25-kHz spacing may also be provided on special order. Total harmonic distortion over the 300 to 3000 Hz audio passband does not exceed 10% when receiving a 30% modulated signal, or 15% when receiving a 90% modulated signal.

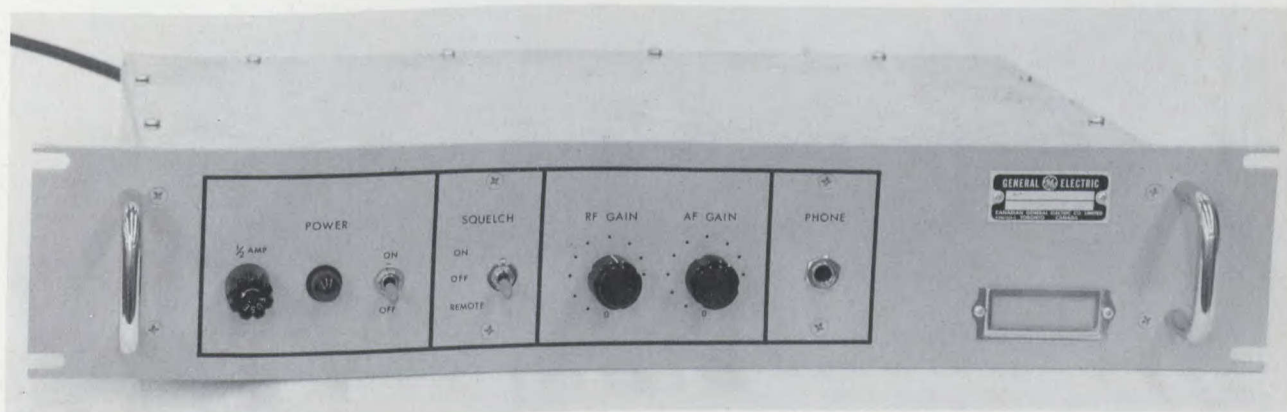
A three-section front end helicoil resonator filter is used to minimize overloading, desensitization, cross modulation, mixing and other undesirable

conditions which can be caused by strong adjacent channel signals. The RF, oscillator and mixer assemblies are contained in a copper-plated aluminum casting for maximum shielding and rigidity. The IF amplifier, audio, AGC and squelch functions employ integrated circuits.

A RF gain control is provided to permit adjustment of receiver sensitivity for low-noise operation. Squelch and noise limiting functions have been included and a muting feature is available as an option. The self-contained power supply will operate from 117/230 vac, 50/60 Hz, 28 vdc or 12 vdc supplies.

The mechanical construction and component layout affords relative ease in maintenance. Rack mounting slides enable all tuning and routine maintenance operations to be carried out from the front of the equipment rack or cabinet. The use of a MIL-type quick-disconnect connector provides a quick receiver interchangeability feature. A centralized multi-pin metering socket is provided for ease of alignment and servicing. A wide range of optional features additional to the standard receiver can be provided to suit individual customer requirements.

The CGE type ERC-70-A Receiver may be used in conjunction with the CGE Type ETC-72-A VHF-AM Transmitter to form a complete ground based communication system.



SPECTRUM AND FREQUENCY MONITORING RECEIVER

The Monitoring Receiver, Model 102 designed by General Precision Industries, is intended for spectrum surveillance in the VLF through VHF bands. By combining the functions of spectrum analysis, interception and monitoring of signals and the accurate measurement of frequency, it is now possible for one operator to handle a much larger sector of radio traffic. This is facilitated by automatic coordination of controls, by careful attention to human engineering and by the provision of a recorder data interface.

The receiver can be used in fixed, mobile or ship-board stations, in conjunction with a variety of uni- or omni-directional antennas in accordance with the available site. For very crowded bands, the Model 102-A can be provided which is fitted with a bearing position indicator driven by a synchro system to show the position of a rotatable antenna. A switch for the antenna motor drive is located on the same panel. Special directional antennas can be supplied with a sharp null pattern to cut out interference from the unwanted direction.

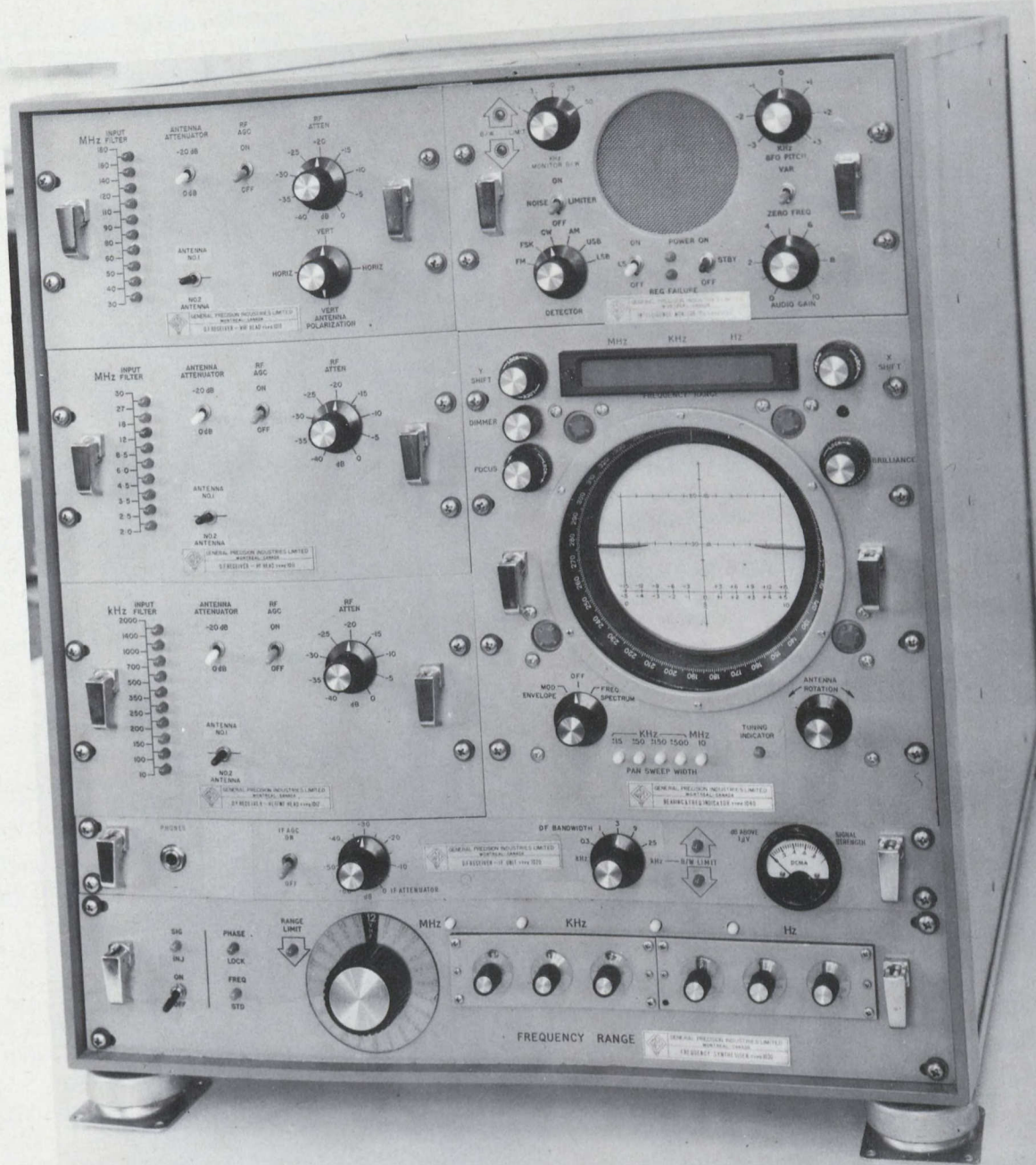
The set provides the following features:

- Complete coverage of 10 kHz through 180 MHz.
- Panoramic spectrum surveillance with built-in sweep.
- Intelligence monitor tuned to any selected frequency while surveying the band with sweep.
- Positive identification of the signal trace corresponding to the monitoring frequency.
- Sweep expansion to examine spectrum signatures in frequency and time domains.
- Control and metering of antenna rotation (Model 102-A only).

Digital, automatic tuning, local or remote, is derived from a phase-locked frequency synthesizer fitted with an oven-stabilized frequency standard. The tuning frequency is indicated by a projection-type luminous readout which can be duplicated in a remote location.

A broadband tuning indicator for search purposes is provided by the peaking of the signal strength meter and by the signal identification brightening pulse. As the signal enters the IF band, a special indicator lamp begins to glow, its brightness increasing towards the centre of the band. At the centre the lamp begins to flash at a rate corresponding to the frequency detuning.

The receiver is of modular construction, employing field effect transistors and integrated circuits. Military style components and workmanship are used throughout. Failure alarm lights are provided for the synthesizer phase lock and for all voltage-regulated lines of the power supply.



UHF TRANSCEIVER AN/PRC-66

The AN/PRC-66 is a small portable transceiver that provides AM communication on any one of 3500 channels in the frequency range from 225.00 to 399.95 MHz. It offers considerable improvement in weight, size, performance and reliability over any equipment of its type in use today. It can be handheld during use, or operated as a packset, vehicular or airborne unit.

Special design emphasis has been placed on mechanical simplicity, electrical shielding and proper heat transfer.

The radio is modularized for easy maintenance. Each of the functional modules plug into a main chassis, which also forms part of the external case.

Low power consumption and high efficiency have resulted in maximum battery life. Either re-chargeable nickel cadmium or throw-away alkaline cell batteries are available.

Accessories include the flexible fixed length antenna which can be tilted in any direction to provide vertical polarization, H250 handset, back mounted carrying harness and transit case. Battery charger and module fixtures are also available for easy maintenance.

SPECIFICATIONS

Frequency Range	225.00-399.95MHz Guard channel 243.0 (optional)
Channels	3500 spaced 50 kHz
Tx Power Output	2 watts average
Transmit Fidelity	Narrow band ± 6 db, 300 to 2700 Hz
Rx Sensitivity	Wideband ± 3 db, 300 to 23000 Hz
Rx Selectivity	3 uv for S+N/N of 10 db 3 db, 60 kHz minimum 60 db 120 kHz maximum
Audio Output	10 milliwatts, 500 ohm load
Audio Fidelity	2700 Hz Wideband ± 3 db, 300 to 23000 Hz Narrow band ± 6 db, 300 to
Squelch	Carrier squelch adjustable
Sidetone	Detected RF 10 milliwatts
Size	22.68 cm x 12.7 cm exclud- ing knobs x 4.13 cm (9 in. x 5 in. x 1 5/8 in.)
Weight	2.49 kg excluding battery (5.5 lbs.)

The AN/PRC-66 has been developed under Rome Air Development Centre USAF by Collins Radio Company of Canada Limited and is now in production for Military requirements.



PUBLIC ADDRESS SYSTEM

The AN/SIH-503 Public Address/Alarm System has been designed and engineered by Marsland Engineering Limited for the Canadian Armed Forces for use aboard class of destroyer, the DDH-280.

This equipment permits operators, via microphone, to call crew living and working areas, exposed areas of the ship (weather decks) and/or combinations of these areas. An emergency mode is selectable to direct announcements to all areas and over-ride any other remote operators. An alarm push-button may be located near selected stations to supply a 1,000 Hz tone to all areas of the ship.

The basic system is composed of two units: A main console of amplifiers, power supplies and signal routing circuits, and a control unit.

The Control Unit consists of a 60 db audio pre-amplifier and control circuitry.

The main console contains two power supplies, voltage sensors, control circuitry and six identical audio frequency amplifiers. Both power supplies are identical; one being used, the other on stand-by. The voltage sensor monitors the output voltages, and if they become out of tolerance it

causes the stand-by power supply to be switched in place of the main supply. The control circuitry enables a flexible sound distribution in any of the modes of operation. The audio frequency amplifiers each contain two power supplies, a gain reduction circuit which reduces signal levels to suppress noise; a variable gain circuit which provides a constant output over +23 db to -10 db signal input variation, as well as a squelch control; and a fixed gain voltage and power amplifier providing 50 watts output at 70 volts. Four of these amplifiers distribute announcements to crew's living and working areas, one is used for distribution to the officers living areas and the sixth is used for distribution to the exposed areas of the ship.

TEST SET:

A Servicing Accessory Unit is available to facilitate bench testing of the system. All individual units may be tested as a system by this unit which incorporates input/output cabling, dummy loads and monitoring terminals.

ELECTRICAL CHARACTERISTICS:

UNIT.	FREQUENCY.	INPUT.	OUTPUT.	NOTES.
Dynamic Microphone	300-3,500 Hz.	Sound pressure of 10 dynes/cm ² at 1,000 Hz.	Not less than -60 db across output impedance of 220 ohm at 1,000 Hz.	Odb = 1mw/10 dynes/cm ²
Pre-amplifier & audio freq. amp.	100-5,000 Hz.	0.78 mv across input terminals at 1,000 Hz -10 db +23 db.	50 Watts @ 70V at 1,000 Hz.	Gain control approx. 1/3 rotation
Oscillator	1,000 Hz.		Adjustable to 10 vrms at output	
Power Supply	60 Hz ±5 Hz.	115 volts ±10%	+20, -26, +15, -15, +120V.	
Input Power Required	60 Hz ±5 Hz.	115 volts 8 amps		M355A Complete

MESSAGE HEADER FORMATTER 101

Automatic switching inherent in the United States' Department of Defence AUTODIN teletype communication system requires that all messages be preceded by a header as prescribed in JANAP 128/ACP 127 operating procedure. For reliable transmission a standard header format is necessary. Errors, or departures from a standard format cause message rejection, resulting in costly time delays and occasionally lost messages. These problems are eliminated by removing the human error factor. Message Header Formatter MHF-101, designed and produced by Computing Devices of Canada, achieves this aim and simultaneously improves operating speed, reliability and security. By semi-automating the process of header preparation, the operator's function is reduced to pressing a limited number of keys, and during the operating procedure, he is continuously cued as to when his intervention is required. Error checking circuits guarantee the insertion of complete heading information by alerting the operator to missing or illogical data. Time, date, and message number are updated automatically; provision is made for inserting non-programmed data. The MHF may also be teamed with teletypewriter or CRT and/or an OCR type device to yield a modern, versatile message preparation centre.



PHI-TRAN FOR DATA ACQUISITION

PHI-tran, produced by Computing Devices, was developed to meet the need for fully automatic environmental data acquisition and reporting from remote unmanned locations on land or water. This equipment consists of a centrally located Master Station data-coupled with from one to ten remote monitoring stations. Each remote station is capable of reporting data from up to 12 sensors. Master interrogation of the remote stations is on a programmed fully automatic basis. A manual satellite "select" and "interrogate" facility is also included. The received data is printed out at the Master Station on an alpha-numeric printer, e.g. teletype and/or a computer-compatible output can be provided. Remote stations can be land-based PHI-tran/100 or buoy-mounted PHI-tran/200 series. Data links can be via radio, landline, or acoustic coupler (used with standard telephone subscriber lines) as required.

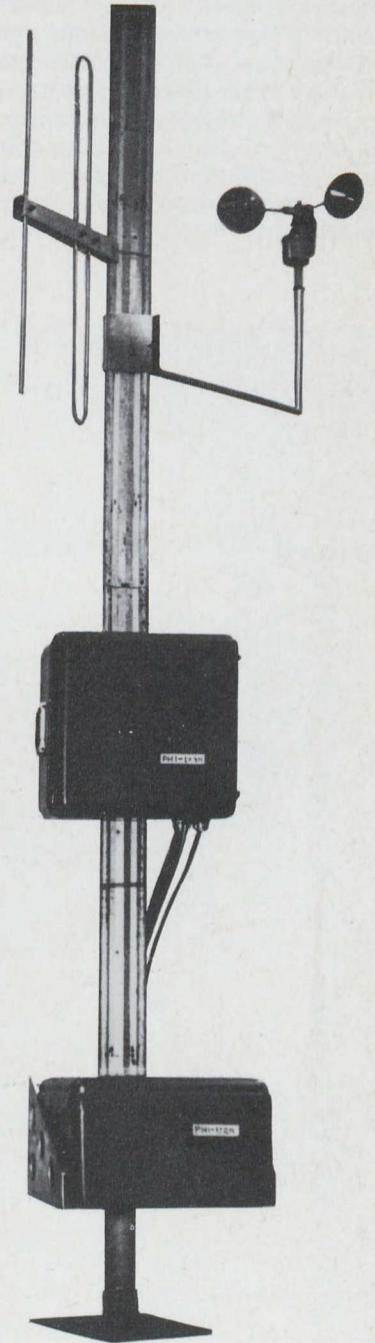
The system is presently in operation with the Canadian Forest Protection Service. Reporting over an H.F. single side band data link this system provides fire-weather data to the forest protection office on a 24-hour automatic or on demand basis. The sensors being monitored for this application are Wind Speed, Relative Humidity, Air Temperature and Precipitation.

Soon to be used for providing hydro dam operations personnel with hydro-met data (meteorological and water table), PHI-tran can be applied for other programmes relating to Climatology, e.g. Micro-Climature studies in relation to plant species or geological location.

Use of solid-state technology throughout assures high system reliability, at economical cost.



MASTER UNIT

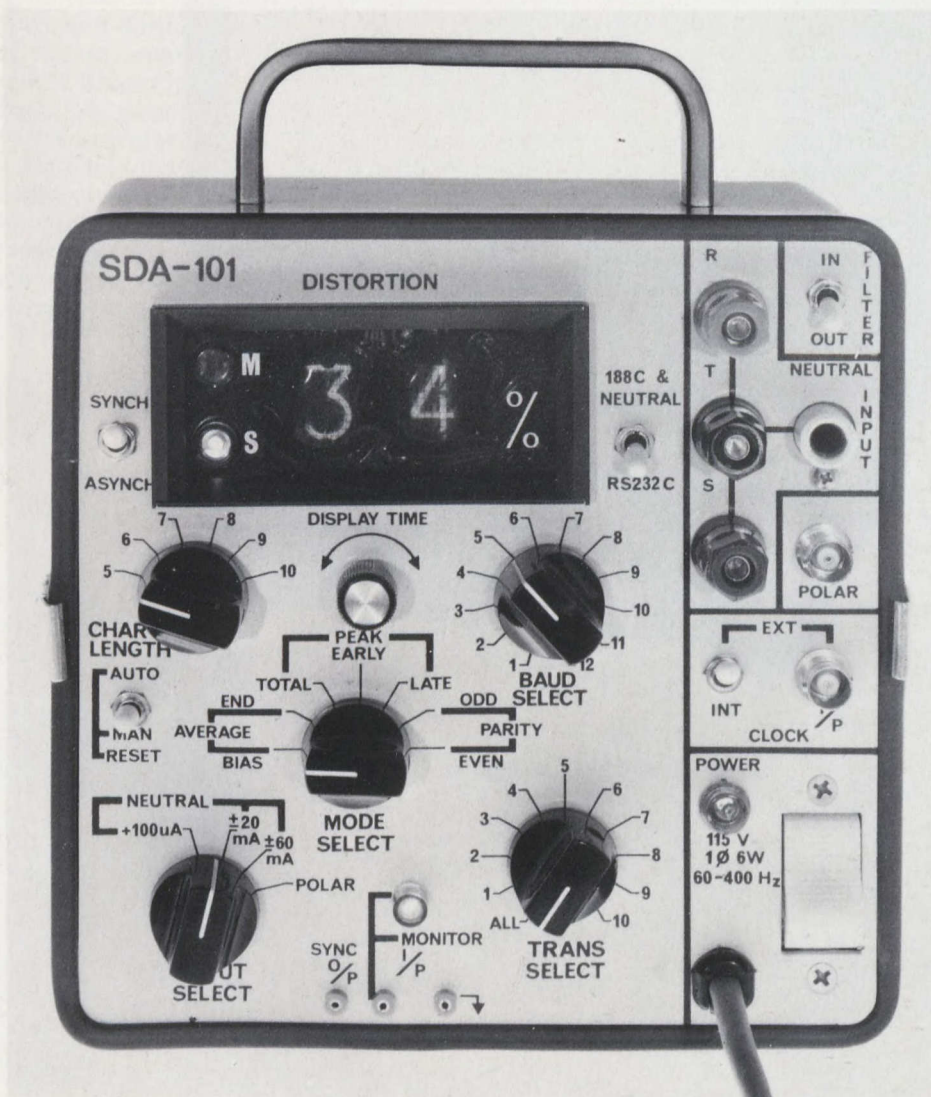


REMOTE MONITORING STATION

SIGNAL DISTORTION ANALYZER

The SDA-101 Signal Distortion Analyzer designed and produced by Computing Devices is a precision instrument designed for test centre and field use for measuring distortion on all or individually selected transitions within a character. Bias and end distortion as well as total peak, early peak, and late peak are displayed on the easy-to-read two-digit NIXIE display. The use of early peak and late peak distortion measurements enables the operator to determine the amount of fortuitous or cyclic distortion in the signal. Parity error detection and bit error are displayed using the NIXIE tube readout.

The twelve input speeds are selectable from 37.5 to 9600 and accuracy is better than 0.1%. Other speeds are available on request. Unit accuracy is better than 0.75% for all speeds for both average and peak measurements. Code lengths are selectable from 5 to 10 elements excluding start and stop codes. Test points are at the input signal, sync output, clock and signal ground. The unit, which is 17.7 x 17.7 x 17.7 cm (7 x 7 x 7 in), can be either rack mounted or packaged in a rugged portable carrying case. Weight is approximately 2.49 kg (5.5 lb).



TEST MESSAGE GENERATOR

The Test Message Generator TMG-300 was designed by Computing Devices of Canada for testing telegraph and data transmission facilities and associated equipment. This rugged test instrument is completely portable and may be used either in communication centres or at field installations. The TMG-300 generates a 64-character Fox message or selectable characters repetitive message in either 5-level Baudot or 8-level ASC11 code.

A selection of 12 crystal-controlled speeds is available from 37.5 to 9600 Baud with an accuracy of 0.2%. Other speeds are available on request. Provision is also made for an external clock input. Output may be continuous or stepped. In stepped

mode, a panel-mounted pushbutton permits output of either the Fox message or selected character message one character at a time. Output distortion is less than 0.1%. For test purposes controlled distortion can be introduced from 0 to 45% in 5% steps to include mark bias, space bias, switched bias, mark end and space end. Optionally a 511 bit pseudo random word generator (C.C.I.T.T.) is also available with this instrument.

Measurements of the equipment are 17.7 x 17.7 x 17.7 cm (7 x 7 x 7 in), and weight is 2.63 kg (5.8 lb). Power requirements are 115V/230V, 50 to 400 Hz and 6W.



PRINTED CIRCUIT BOARDS AND EDGE LIGHTED PANELS

The boards and panels depicted here are quite representative of the design and production capabilities of O. & W. Electronics. The pictures themselves, however, do not demonstrate the accuracies and reliability for which this company is noted.

PRINTED CIRCUIT BOARDS

Both rigid and flexible circuits are manufactured for military and commercial requirements. Copper clad material including single and 2-sided paper based phenolics, glass epoxies, glass melamines, flexible mylars, kaptons and teflons are all used and are fabricated with or without plated-through holes. A wide variety of finishes are available and include flux cote, solder resist, tin lead, nickel gold, tin nickel, silver and rhodium etc.

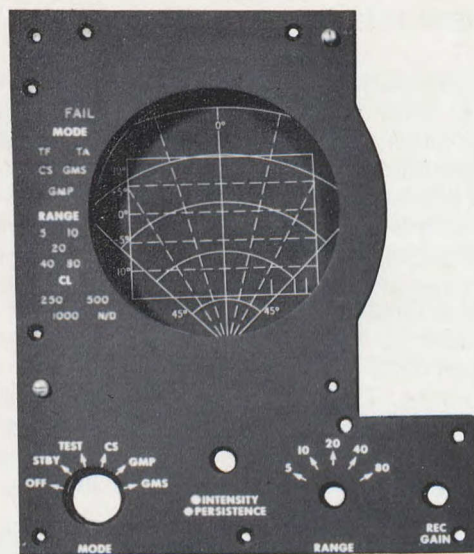
These boards are manufactured in accordance with MIL 55110. Included in 'in house' facility related to manufacture of circuit boards are full photographic capability, N/C drilling and machining complete test labs and full laminating capabilities up to 1.2 x 1.2 m (4 x 4 ft.).

EDGE LIGHTED PANELS

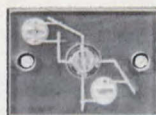
Designed and produced to customer requirements utilizing the photo engraving process to extremely close tolerances (graduations and markings to .0025 mm (.001 in.) and angular tolerances to 5' of arc.

Edge lighted panels are designed and produced to MIL 7788D and related specifications. Edge lighted panels manufactured by O. & W. Electronics may be found in a number of military aircraft which includes F-4, F-5, F-14, Caribou, Buffalo and others.

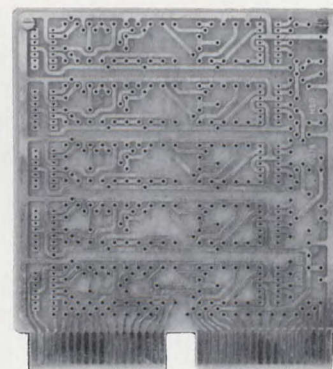
The same facility produces a wide range of special dials, scales and display modules. 'In house' facilities include complete light measurement laboratory and engineering and engineering assistance in design and layout.



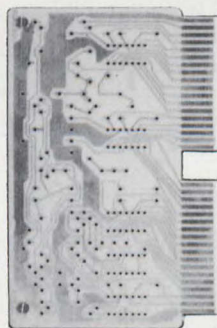
Planned Position Indicator



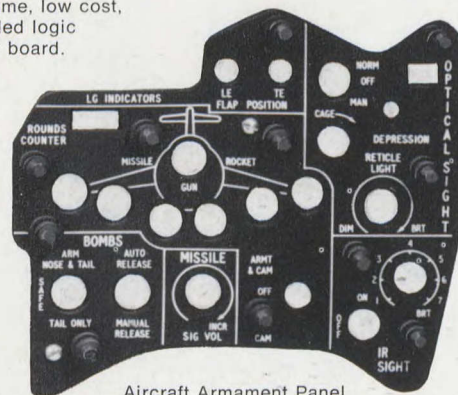
Embedded Wiring.



Double sided and plated holes for computer use.



High volume, low cost, single sided logic computer board.



Aircraft Armament Panel

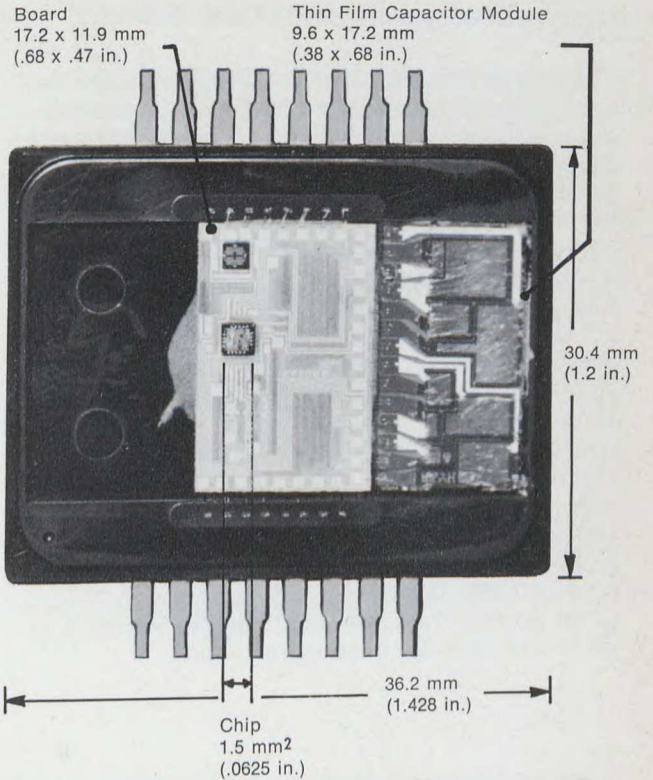
MICRO - ELECTRONICS

Exacting standards of production, extensive research, development and manufacturing facilities, and a reliable distribution and customer service network are the basic business parameters of Microsystems International Limited.

Since entering the semi-conductor market on a world-wide basis almost two years ago, Microsystems International has consistently supplied high reliability micro-electronic components and sub-systems for a variety of sophisticated electronic applications.

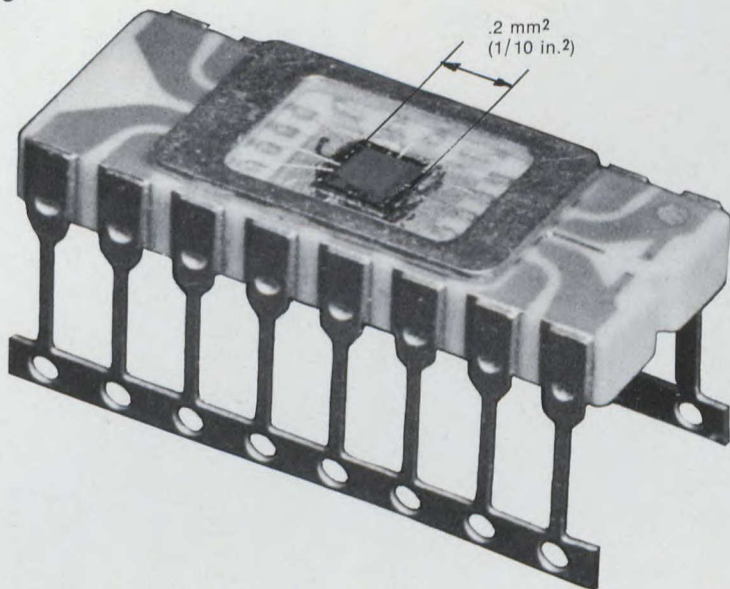
The company, a subsidiary of the Northern Electric Company, has a 27,870 m² (300,000 ft.²) facility located at Ottawa. A combination of sound financial backing and sophisticated plant facilities, gives Microsystems International wide resources for the successful completion of demanding projects of a short, medium or long-term nature — to standard, custom or military specifications. The company's personnel, recruited from around the world, are chosen from among the best in their respective fields.

Microsystems International has process lines utilizing a full range of state-of-the-art technologies for MOS-LSI silicon-gate products, thin and thick film multi-chip hybrid microcircuits, bipolar linears and discretes. In-house facilities permit the design, development and manufacture of microelectronic components and subsystems from raw materials through to packaged goods. The company's capability also includes computer-aided-design (CAD), glass and metal mask-making and reliability assurance testing.



ME 8900 Series: dual tone generators featuring high stability and wide operating voltage ranges. Used in push button telephones, multi-frequency signalling and data communications.

MF1101A silicon-gate MOS LSI fully decoded random access 256-bit memory consists of normally-off P-channel MOS devices integrated on a monolithic array. Low-threshold silicon-gate technology allows the design and production of higher performance MOS circuits and provides a higher functional density on a monolithic chip than conventional MOS technologies.



MICRO-ELECTRONIC SITUATION DISPLAY

A key element in its advanced Tactical Data Systems, Litton Systems (Canada) Limited manufacture micro-electronic Situation Display Consoles (SDC). These Displays are designed for use in any tactical role where an efficient man-machine interface is necessary to release the operators from routine tasks and allow them to concentrate on decision-making functions.

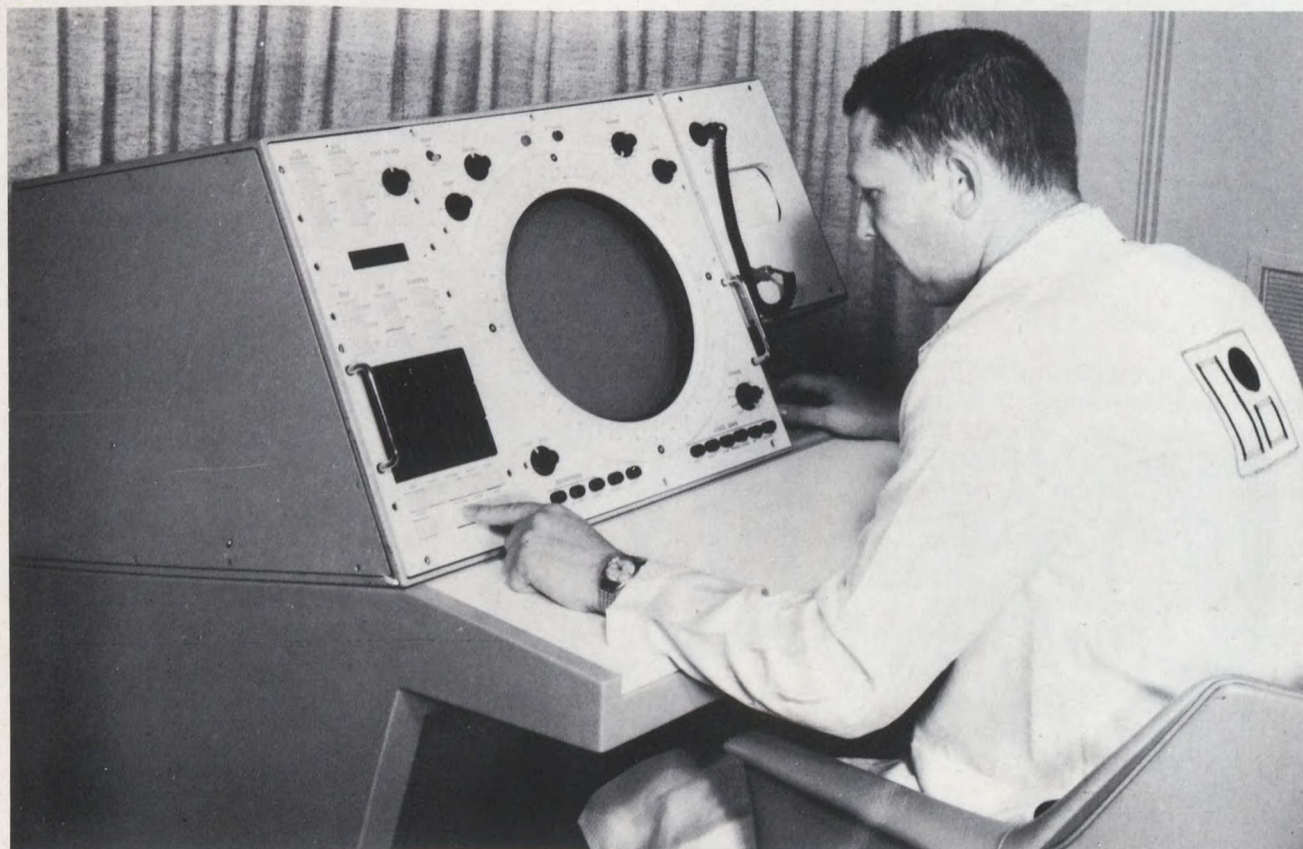
They offer a combination of programmable control flexibility radar/symbolic display, modular design and state-of-the-art micro-electronic construction. The Litton SDC can present radar or sonar video data and provides the operator with various techniques for computer data storage and retrieval. A small CRT Data Information Display provides auxiliary alpha-numeric data and a voice communications panel allows the operator to talk to other operators for switching and patching functions. Because it functions under program control, the Litton SDC has the flexibility to meet a wide range of specified tasks.

The front panel of the Litton Situation Display Console consists of three basic sections:

1. Operational Keyset — contains keyset matrix for data entry, operational task pushbuttons, symbol-select pushbuttons, and alert readouts.
2. Situation Information Display — contains a 30.48 cm (12 in.) PPI for displaying tactical and surveillance information (track data, video reports, etc.), and various CRT controls.
3. Digital Information Display — contains a 12.7 cm (5 in.) CRT for displaying and entering into the computer, alphanumeric data of an operational nature; light pen and track ball for data entry and call-up.

The versatility and adaptability of the Litton Digital Display is exemplified by:

1. The number and variety of operating modes and target categories available to the operator.
2. The flexibility achieved through provision of 5 multi-function operational task buttons and 15 momentary action function switches in the keyset matrix. As many as 360 unique actions can be performed by the operator with the multi-function capability.



GRAPHIC TO DIGITAL CONVERTER

The 'Gradicon' is a precision digitizer, capable of converting graphic information into a form suitable for use by computers, numerically controlled tape machines, and other data processing, storage, or handling equipment.

It can be used to analyze, in terms of X and Y coordinates, maps, production drawings, artwork, surveys, photographs, or any other similar graphic material. With the addition of a Z-axis coordinate it also provides three dimensional profiles.

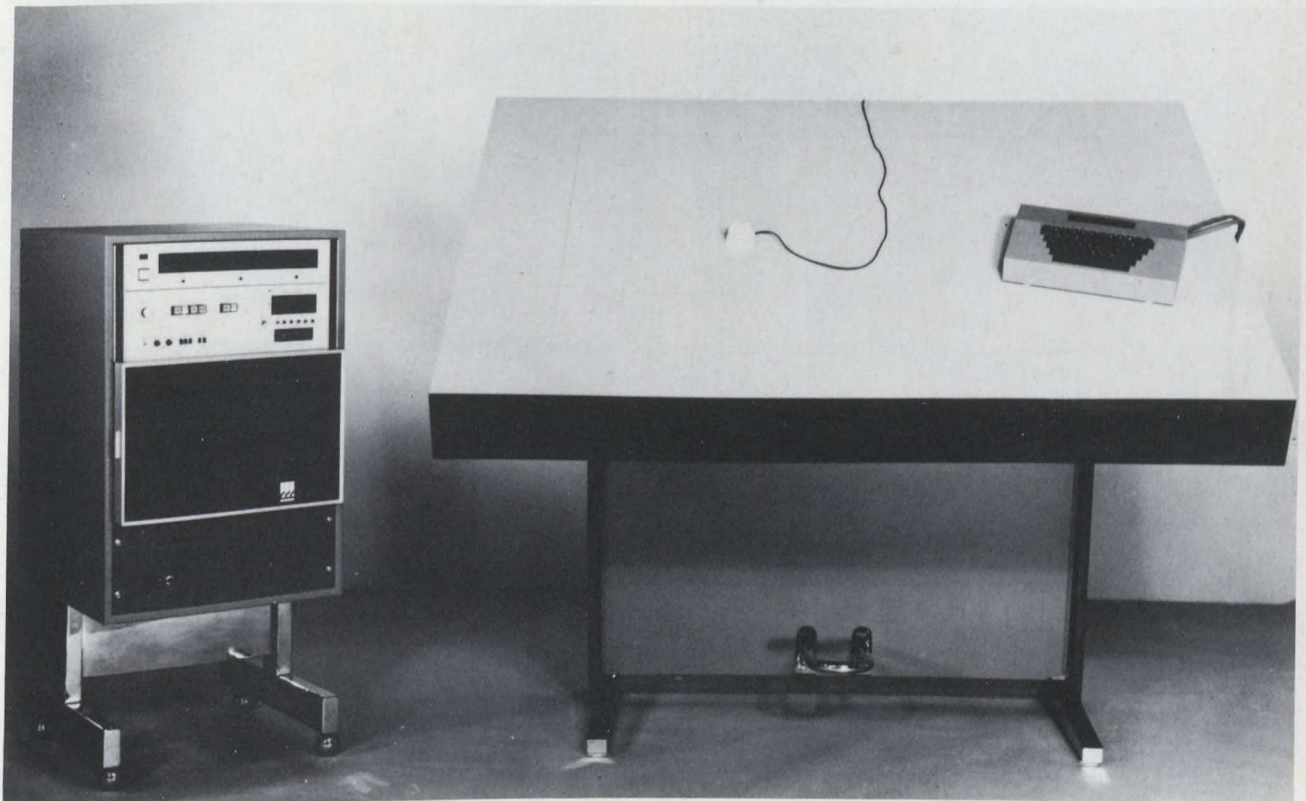
The system consists of three basic units: a digitizing surface or table; a readout conversion console; and an optional output device. A modular electronic concept is employed, permitting printed circuit boards to be added as additional functions are required. The Gradicon can also be supplied with an integral mini-computer for on-line data processing.

Operation is simple. The user moves a light-weight electrically coupled cursor across the graphic material. Four modes of operation are provided: *TIME* — the coordinates are recorded as a function of time (variable) while the cursor or foot switch is operated: *POINT* — the coordinates

are recorded each time the cursor or foot switch is operated; *INCREMENTAL* — the coordinates are recorded as a function of pre-selected cursor travel; *GRID* — the coordinates are recorded and related to pre-selected grid pattern, thus eliminating subject positional error in many applications.

The cursor senses a signal generated by a coil located under the surface of the digitizing table. This coil is attached to an ultra reliable mechanical gantry and follows the cursor as it moves at speeds up to 30 inches per second. This is accomplished by an electro-mechanical closed-loop servo system with two servomotors which move the generating coil in the X and Y axes as required.

The electromechanical servo system was chosen as the most reliable, versatile, accurate, and best suited system for the application.



The digitizing surface is completely obstruction free, since the positioning servo system is located beneath the table surface. This feature increases digitizing speed, flexibility and ensures that 'point of origin' is never lost.

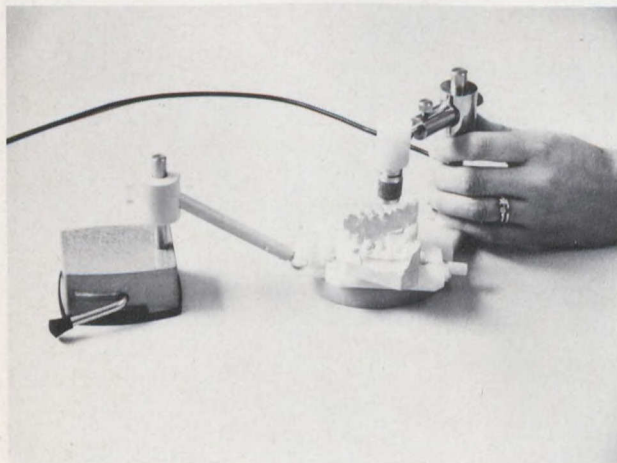
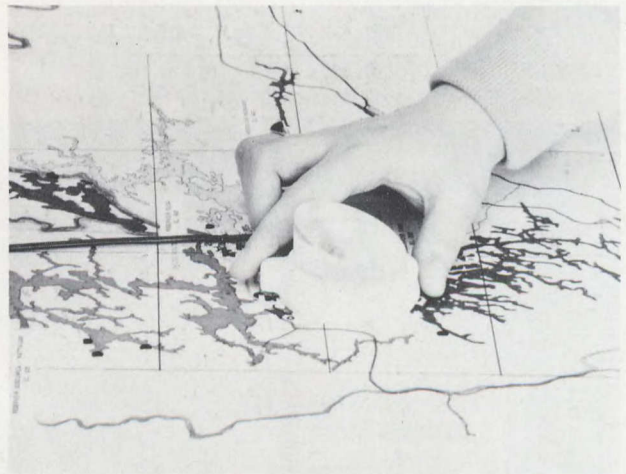
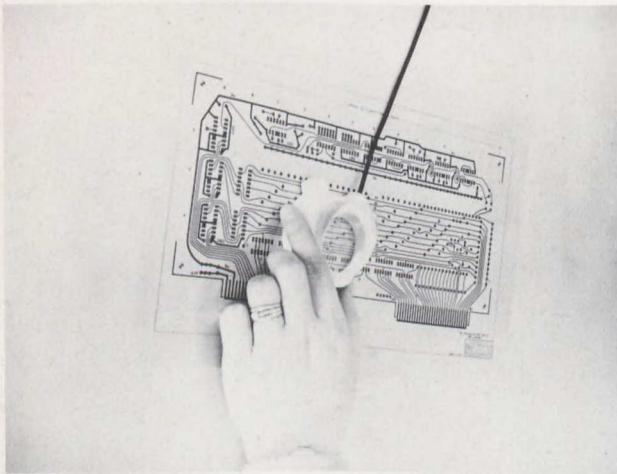
Various cursors are available. The optional 'Gratilite'* optical cursor projects a graticule through the graphic material from below, assuring exact location of the point to be digitized.

The Gratilite* features finger tip selection of six graticules and in addition six illuminated colours for contrast optimization. Other cursors are available for use with opaque material, images from overhead projectors, three dimensional objects and other graphic sources.

**Patent Pending*

The X and Y coordinates are displayed at all times on a visual digital display. This readout also contains space to accommodate an optional Z-axis readout, for use when a three-axis profile is required. By using separate Z-axis encoder monitoring devices, real time data can be recorded.

A 20-key keyboard is supplied with the basic system to enable the operator to identify coordinate values with respect to the specimen being digitized, or as to extraneous data used in computer programming and location. Alpha-numeric or typewriter keyboards are also available as input devices.

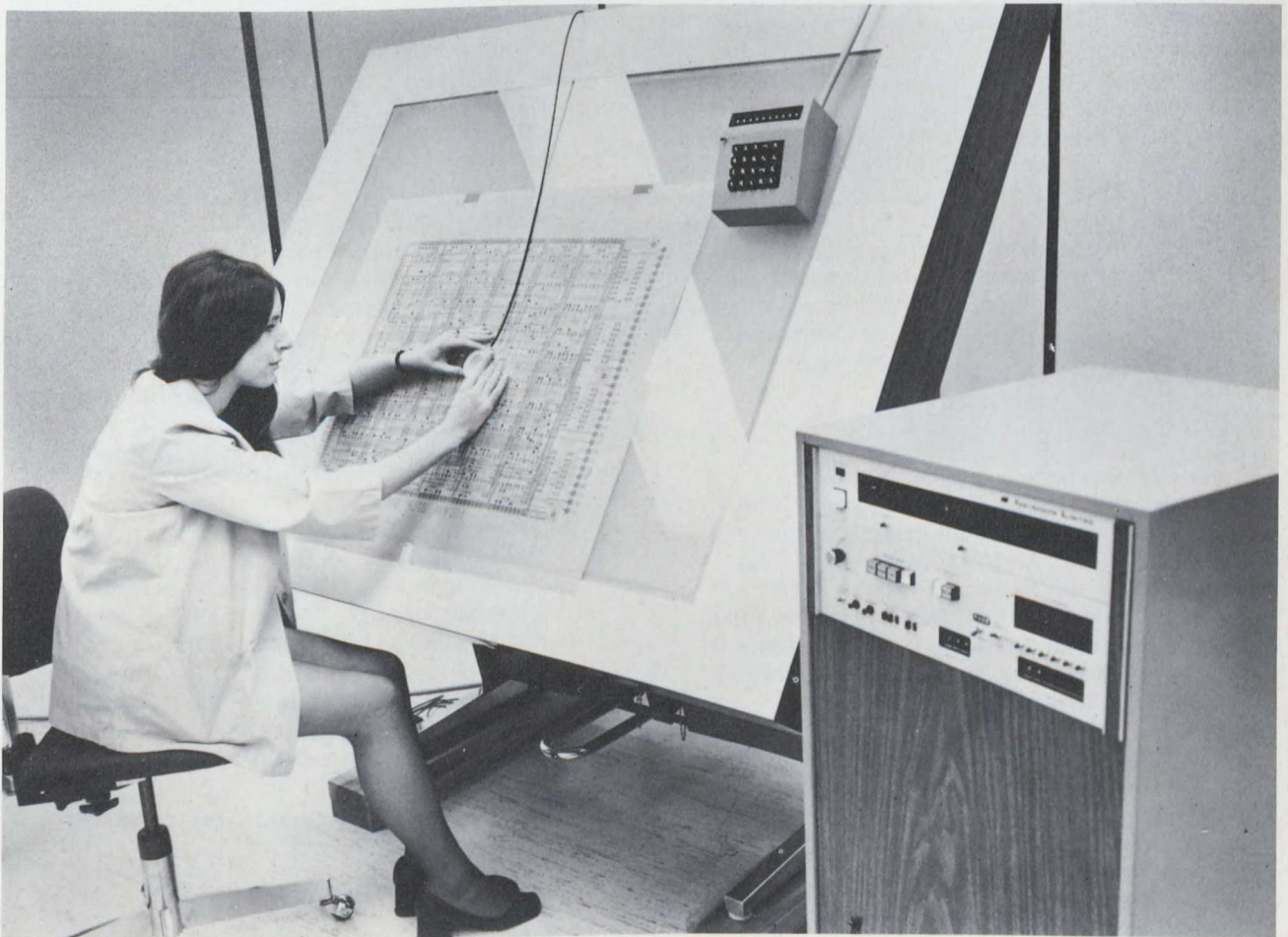


The Gradicon has a resolution of 0.01 mm (0.001 in) and an accuracy of better than ± 0.1 mm (± 0.004 in). The output is suitably coded for all the major forms of recording. Extreme versatility of program format is provided through a program patch cord arrangement and the removable patch panel provides the ability to change format rapidly from one setting to another.

- SHIPBUILDING: Computer Aided; Stress Studies / Tolerance Studies / Hull Studies / Scaling
- AIRCRAFT: N/C Machine Tape Production; Computer Aided: Tolerance Studies / Stress Studies / Weight Studies Scaling / Airfoil Design / Human Engineering Studies

- ELECTRONICS: Computer Aided; Circuit Design / Wire Routing: Printed Circuit Artwork: Integrated Circuit Artwork
- CARTOGRAPHIC: Computer Aided; Categorizing / Sorting / Overlaying / Scaling
- METEOROLOGICAL, HYDROLOGICAL: Analysis of temperature, rainfall, river level, solar radiation and other records: Analysis of radio-sonde traces
- MEDICAL: Analysis of EEG, ECG, EKG and X-Ray plates. Dental Analysis and storage.
- PHYSICS, GEOPHYSICS, ASTRONOMY: Analysis of all types of chart recording including radiation, seismograms, magnetometer, strain gauge recordings, telemetry records, star spectograms
- MACHINING: N/C Machine Tape Production Computer Aided; Tolerance Studies / Stress Studies

This equipment was designed, developed and produced by Instronics Ltd.



TOUCH SENSITIVE DIGITIZER

The Touch Sensitive Digitizer is a major Canadian innovation which offers direct interface between the public and computers, and opens up a whole new field of applications.

The unit is an X — Y position encoder, or digitizer, which senses the location of a finger, pencil, or other object on a piece of glass ranging in sizes up to 50.8 cm x 50.8 cm (20 in x 20 in) and providing a direct digital output of the co-ordinates to a computer plus a visual read-out. In some respects, the digitizer's function can be considered as similar to existing systems, such as the light pen, however the Touch Sensitive unit goes beyond anything known to date and at favourable costs.

Two of the most important features of the new unit are:

- 1) The digitizing area is a piece of glass. There are no embedded wires or any other active components in the glass.
- 2) The probe is completely non-active and may be a finger, pencil, or other similar type of pointer.

The use of glass as the digitizing surface means that it can be placed in front of, or on top of any material to be digitized, including a CRT display, maps, drawing, or photographs. The information to be digitized can also be projected directly on the screen area.

Because the total area of direct contact is non-active, the digitizer can be safely used in applications involving the general public or unskilled personnel. It is also free from the ambient noise interference common to sound wave generating elements.

HOW IT WORKS

A number of piezoelectric transducers are located along two sides of the glass digitizing area. The transducers are alternately connected to a transmit circuit and a receive circuit. The time lapse between transmission of a 4 MHz pulse modulated elastic surface wave, and the reception of a reflected pulse from any object on the glass, provides a highly accurate indication of the distance to the object or probe on the glass.

Two digital counters are employed, one providing the X co-ordinate and the other the Y co-ordinate. The counters provide a binary or BCD output for computer use, and based on a surface velocity of the 4 MHz signal of 3170 m/sec, could be arranged to provide a reading directly in inches or metric units.

The transducers are fired in groups of six, with a scanning time of 1 m/sec for each group. As two complete scans with identical co-ordinate measurements are required, to assure elimination of any false readings, the total scanning time for each point is 24 m/sec.

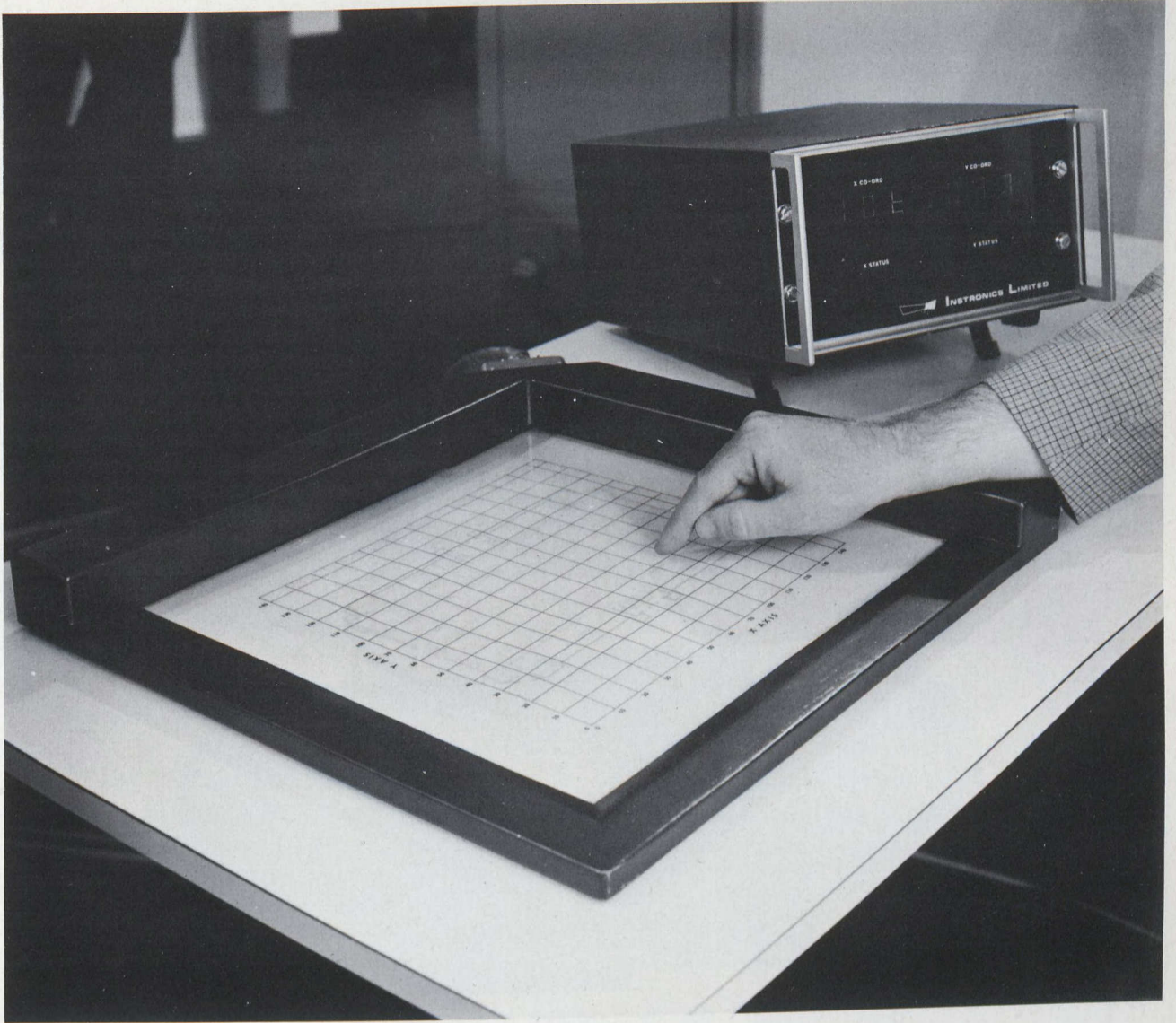
The sensitivity of the digitizer is limited only by the molecular contact of the probe on the glass. Contact is aided by moisture, so that natural moisture makes the finger an excellent probe. The transducers and rf diode multiplex switches are housed in a metal frame around the perimeter of the digitizing glass surface. The transmit and receive circuits, counters, and computer interface board are housed in a separate cabinet, although the configuration can be altered to suit particular applications.

APPLICATIONS

Applications for the Touch Sensitive digitizer are numerous; here are a few examples:

- 1) Using a projection set-up in a process control computer installation, a completely interactive system can be designed. The control panel could be projected by the computer system onto the digitizing screen, permitting the operator to simply touch the image of the desired control. The computer could then effect the control procedure and project readings of operating conditions until the operator points to a particular reading or condition that he wants to alter or control.
- 2) A totally keyless typewriter, teletypewriter, or similar machine could be produced by placing a drawing of the keyboard under the glass plate. Merely touching the glass surface would activate the computer circuit for the nearest key.
- 3) When placed in front of a CRT display the possibilities are almost limitless. One of the areas now under serious consideration is in air traffic control. The air traffic controller only has to touch the screen in front of his radar display to indicate the location of a particular aircraft to the computer which in turn will automatically track the aircraft or a variety of other pre-programmed requirements.

This equipment was designed, developed and produced by Instronics Ltd.



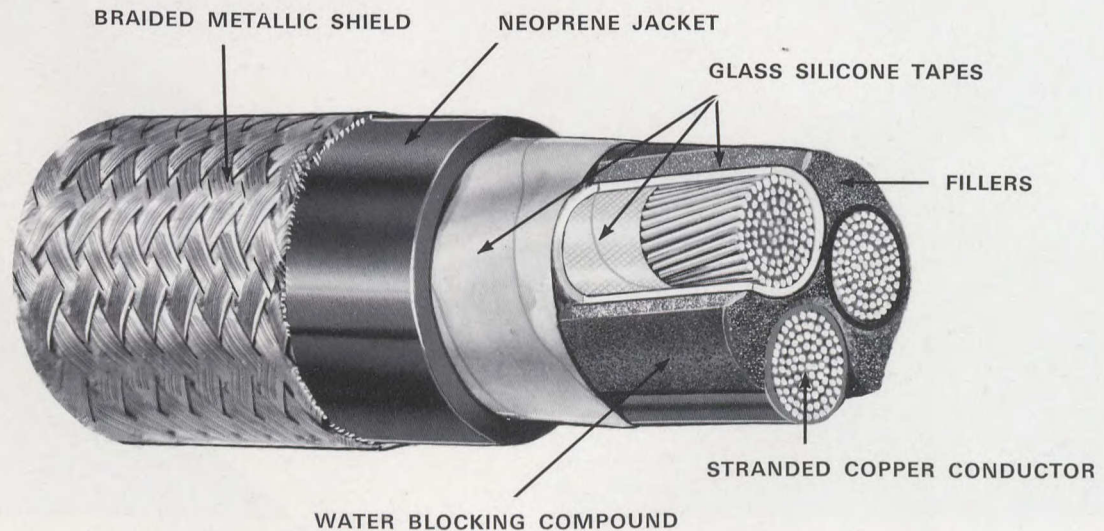
COMMUNICATION AND POWER TRANSMISSION CABLE

The geography and population of Canada demands that we are in the position to communicate with each other, readily and inexpensively, and this we do through our vast, sophisticated communication networks. We also enjoy one of the world's highest living standards made possible by an abundance of hydro-electrical power and the means to make it readily available. Both fields and their reliability is based on the cables which serve them and here Canada Wire and Cable Company has been serving our needs since 1911. While serving world-markets they also operate subsidiary companies in New Zealand, Mexico, Columbia, Venezuela and the Dominican Republic.

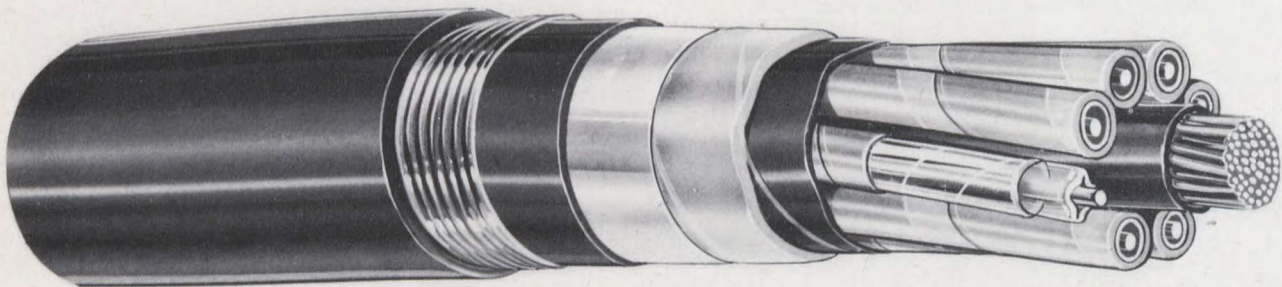
The defence contributions of Canada Wire and Cable Company have been many and continuous

and the lead enjoyed by Canada in VDS and other oceanographic areas, is, in part, based on the ability of this firm to meet the increasing requirements of these demanding fields.

The technical staff of Canada Wire is continually investigating new materials, designs and concepts to improve the utilization of their products in today's sophisticated market, ranging from 735 KV ACSR transmission circuits to the finest of magnet wires. Their engineers maintain constant contact with their customers, making technical recommendations, ensuring that the customers obtain the utmost in technical service and where necessary providing supervisory service for arduous cable installations.



Shipboard Cable



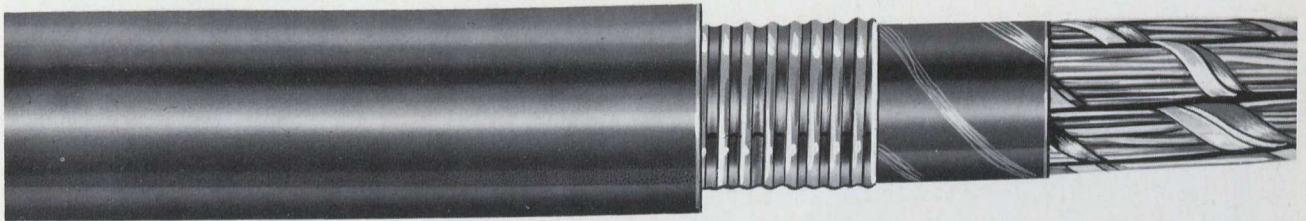
Composite Coaxial Balloon Type Cable

Diameter 165 mm (6½ in.)
Thickness 101.6 mm (4 in.)



Diameter 156 mm (6¼ in.)
Thickness 61 mm (2⅜ in.)

Ultra-Light Field Telephone Cable
¼ and ½ mile dispensers



Telephone Cable Pic Aleph
100 pair #19 AWG-19-T-83

SIGNAL PROCESSING APPLIED RESEARCH PROGRAMME

Since late 1962, the Canadian General Electric Company has been engaged in a continuing program of applied research in the field of signal processing. This effort is jointly funded by the Company and the Defence Research Board of the Department of National Defence of Canada.

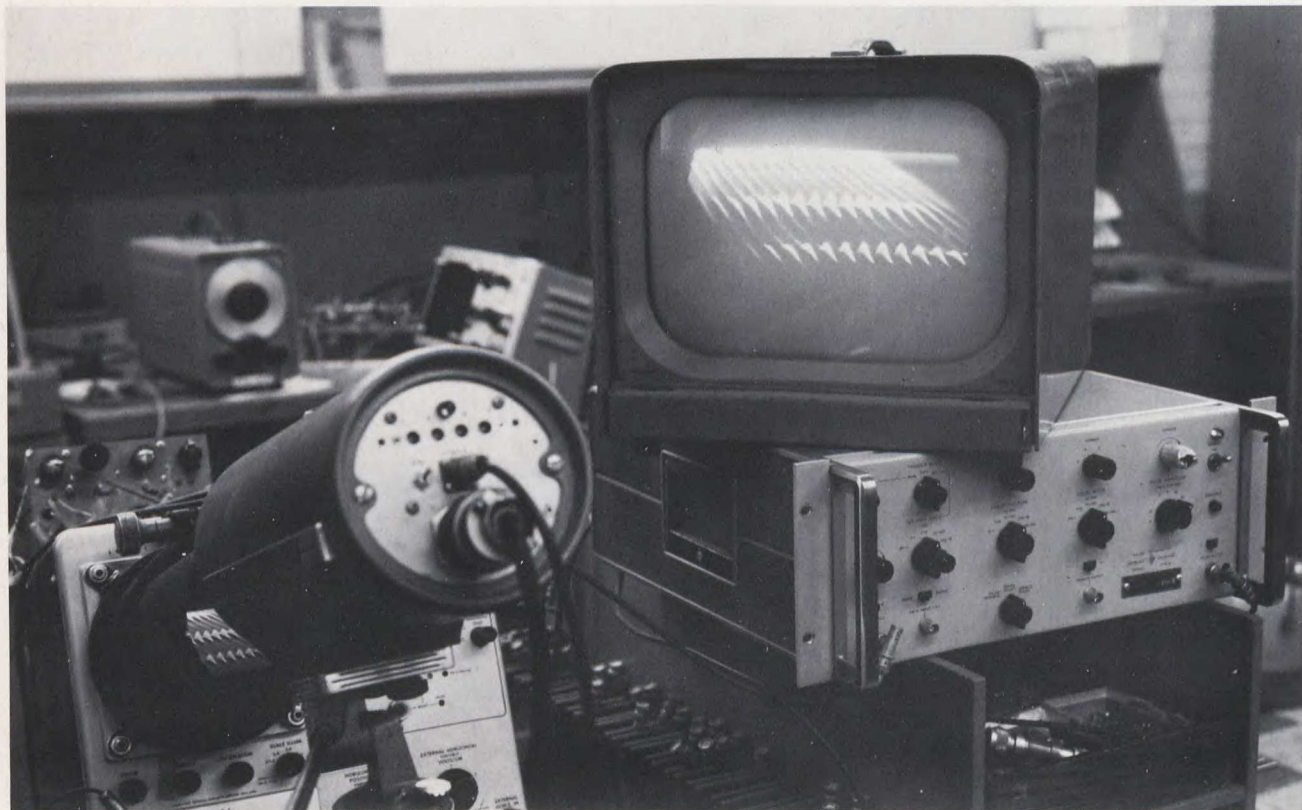
The objective of the programme is to undertake studies aimed at improving the detection and resolution capabilities of target locating systems operating in non-ideal environments that occur in space, atmospheric and undersea media. This involves extensive investigation into analytic, technological, and system aspects of signal processing applied to specific problem areas encountered by radar, sonar, and communications equipments.

With the aid of a programmable electronic matched filter and a perspective display device both of which were developed by the techniques group at Canadian General Electric, the characteristics of a large number of coded waveforms have been portrayed and catalogued. This effort has produced significant contributions to waveform design some of which are referenced in a

recently published text book on signal processing. Current laboratory studies are aimed at expanding the information capacity of correlator devices through the exploitation of digital matched filters and the development of improved real time optical processing techniques.

A portion of the applied research activities has been devoted to a field demonstration of the effectiveness of pulse compression when used to enhance target location in a range-extended clutter background. This test programme involved the physical coupling of the experimental matched filter with an operational surveillance radar in the Air Defence network, and subjecting the modified system to a series of flight trials. The results obtained in this exercise are in close agreement with those predicted by theory.

Future programme activities will be devoted to further demonstrations of effectiveness aimed at similar problem areas in other defence electronic systems. This will be carried out in parallel with the aforementioned laboratory investigations into advanced digital and optical signal processing techniques.



MARINE EQUIPMENTS AND DESIGN



REPLENISHMENT AT SEA (RAS)

Naval deployments today demand that support ships be capable of speedy replenishment of operational units including liquids, solids, spares of all types and personnel, in a "one-stop" operation. Only a systematic approach could meet this requirement and the answer was found in the award of a contract to Saint John Shipbuilding, after competitive tender, covering two Operational Support Ships, the *HMCS Preserver* and the *HMCS Protecteur*.

These two ships, unlike many other faced with similar problems around the world, are not converted tankers on a make-do basis but rather are purpose designed vessels capable of the modern replenishment demands of a fleet under-way.

THE TRANSFER SYSTEMS

To maintain this steady flow of replenishment to one or more ships the ammunition and other dry cargo is carried in two separate holds of three decks each.

Each hold is served by its own high-speed automatic elevator and four electric fork lifts are included in the ship's equipment. A fork lift truck down below loads an elevator with pallets of ammunition or other cargo. The elevator rises swiftly to the main deck level, where another fork lift removes the pallets and carries them to one or more of the Solids Transfer Stations. While the Solids Transfer Stations are sending the requirements to the ship or ships being replenished — operating at a speed of 366 meters (1,200 ft.) per minute — the elevator has descended for another load and the cargo movement continues non-stop. The two elevators can operate simultaneously. Refuelling and personnel transfer are concurrent operations. Four dual-duty liquids or solids replenishment stations are fitted. Each replenishment station has its own control console on deck with a clear view of the whole operation. Each station consists of one leg of a goal post with fueling hoses and also a travelling block for solids. The winches are as follows: highline winch and two control winches for the purpose of controlling loads during solid and hose during liquid replenishment.

The Solids Transfer System is capable of speeds up to 366 meters (1,200 ft.) per minute with accelerations of 4.88 meters (16 ft.) per second. Automatic slowing down and stopping devices are fitted to the system. The Traveller moves backwards and forwards across the highline under

control of the inhaul and outhaul winches, with tension in both inhaul and outhaul cables at all times.

The Liquids Transfer System — Liquids are transferred between ships by means of 17.7 cm (7 in.) interior diameter hoses supported by hose saddles and controlled by the saddle winches. Almost any type of hose end connection may be used, but the preferable type for fast, clean fueling is the probe and receiver. The probe and receiver method connects the replenishment hose automatically. The receiver is fitted into a position below the highline in the receiving ship. Immediately after the highline is secure and tension is applied, the probe from the replenishment ship is allowed to travel along the highline at a predetermined velocity to mate with the receiver. The mating process simultaneously locks the two components together and opens the valve in the probe. With other previous fueling vessels, the preparation to fuel was a long, arduous procedure with men exposed on deck in the cold, dangerous environment. In the *Protecteur* and the *Preserver*, with their enclosed cargo deck, the men are in a safe environment. The heavy labour of opening and closing tank valves has been done away with nearly all tank valves being hydraulically operated. Crossovers and drop valves are hydraulically operated, as are all tank-stripping valves. These valves are operated from the two consoles with mimic display — i.e. JP-5, AVGAS, Diesel forward and Main Cargo System aft. These consoles are situated in two control rooms from which the valves and cargo pumps are controlled and the tank capacities shown. In an emergency, the deck valves may be rapidly closed from a third control room overlooking the whole of the fueling deck.

THE PROPULSION UNIT

A total of five heat balance studies were made for various conditions, and it was during this work that the bleed steam system was evolved. On previous steam turbine ships of this type, full bleed conditions were obtained only at or near full power. However, the replenishment ship was found from service experience to spend a large portion of its life at sea at a much lower power. Therefore a system was designed with automatically operated changeover and control valves using selectable turbine bleed points to give required bleed conditions and efficient feed heating from 12,500 to 21,000 shp.

The boilers supply steam at 42 kg/cm² (600 lb.) per square inch and a controlled temperature of 463°C (865°F) at the superheater outlet. Each boiler has a capacity of 48,535 kg (107,000 lb.) per hour and as such is conservatively sized for actual steam requirements, as are all boiler auxiliaries, such as forced draft fans, etc. The steam from the boilers is supplied to a 21,000 shaft horsepower two-cylinder cross-compound turbine, coupled to a double reduction gear of the articulated double helical type, with external thrustblock driving a single line shaft system.

BOILER AND COMBUSTION CONTROL SYSTEMS

The main boilers are controlled and flashed up from the Machinery Control Room and there is a duplicated set of controls in the aft end of the Boiler Room. The automatic light-up and accurate boiler controls do away with the need for firemen on the boiler flat. The boiler operator seated at this console in the Machinery Control Room has control of both boilers and associated auxiliaries, including remote start and stop of steam turbine driven feed pumps and soot-blower controls.



MACHINERY CONTROL ROOM

The Machinery Control Room is separate from the Engine Room and is airconditioned. The concept of this important space is that the main propulsion plant and its associated auxiliaries can be run and monitored remotely from the Machinery Control Room. This concept is different from previous supply ships because of careful design and more advanced technology. It provides a sit-down operation without the fatigue induced by conventional hot engine and boiler room conditions. Also, the whole operation of running the machinery plant takes fewer personnel.

As well as the single-handle control of the turbines, the operator has control of all essential pumps. From his console he can select main or standby units and start or stop them. In addition, he has visual indication of all essential pressures and temperatures, including cylinder temperatures on diesels, salinometer monitoring of feed system, monitoring of essential steam-driven alternator information, etc. The single-handle control of the turbines, either from the Bridge or the Machinery Control Room, works as follows: the Bridge dials the required revolutions per minute. The pneumatic control system

positions the valves to give that speed, comparing the required and actual revolutions and trimming the valve positions until the ordered and actual revolutions are equal. Many safeguards are built into this system to ensure that any speed ordered will not endanger either the boiler or the turbines. Also, a damped throttle response is incorporated into the system to prevent the propeller racing in rough weather. The main switchboard with mimic display of breaker positions and main BUS is located in the Machinery Control Room, as are the motor control centre and various distribution panels. The emergency alternator has its own switchboard forward, but can be paralleled from the Machinery Control Room. This alternator is set to start automatically on loss of power or low voltage, and will be on line 15 seconds after power failure. Or it can be used as a ship service generator in harbour conditions.

DAMAGE CONTROL

The Damage Control Systems are visual displays utilizing three dimensional incident boards which include all the normal hazard presentations plus Nuclear, Biological and Chemical threats.

BASIC DATA

Length Over-All	171.96 m (564 ft. 2 in.)
Breadth Moulded	23.16 m (76 ft.)
Draught	9.14 m (30 ft.)
Displacement 9.14 m (30 ft.) Draught	22,334 metric tons (21,980 long tons)
Deadweight 9.14 m (30 ft.) Draught	13,819 metric tons (13,600 long tons)
Speed	21 knots
Shaft Horsepower	21,292 metric hp at 112 rpm (21,000 at 112 rpm)

THESE SUPPORT SHIPS CAN SUPPLY

Furnace Fuel Oil	13,006 metric tons at 95% (12,800 long tons at 95%)
Diesel Oil	589 metric tons (580 long tons)
AVGAS JP-5	523 metric tons (515 long tons)
Refrigerated Provisions	396 meters ³ (14,000 ft. ³)
Ammunition	1,650 meters ³ (58,300 ft. ³)
Arms, Food, Spares, Stores	822 meters ³ (29,400 ft. ³)
Trucks and Jeeps	1,415 meters ³ (50,000 ft. ³)
Fresh Water	203 metric tons (200 tons)
Replacement Helicopters	Three

HYDROGRAPHIC AND OCEANOGRAPHIC SURVEY VESSEL

The *CCGS Hudson*, built by Saint John Shipbuilding for the Canadian government was the first vessel to circumnavigate North and South America on a single voyage. This 66,000 km (41,000 miles) voyage carried out in 11 months ranks well among the major oceanographic studies carried out over the past 50 years. Her Maierform hull is 89.6 m (294 ft.) in length and has diesel electric power driving twin screws giving a 24,000 km (15,000 miles) range through heavy ice conditions or tropical waters for deep sea oceanography.

In addition to a normal complement of 86 persons the vessel carries the following auxiliary equipment:

- 2 — Helicopters
- 2 — 12 m (40 ft.) survey launches
- 1 — 9.4 m (31 ft.) survey launch
- 1 — 9.1 m (30 ft.) landing barge
- 5 — 6 m (20 ft.) dories



NAVAL SHIP DESIGN AND CONSTRUCTION

Canadian industry and the Canadian Armed Forces — Maritime, have a recognized capability for the design and construction of ships of the frigate and destroyer types (2,000-5,000 tons). This capability is demonstrated by the "St. Laurent" and "Annapolis" class destroyer now in Canadian Naval service. The latest Canadian ships under construction are the "DDH-280" class. An illustration of this class is on the facing page.

The DDH-280 class was primarily designed as an anti-submarine weapon system, but it has a flexible capability. The design allows the ship to perform effectively in area search, force or convoy protection, air defence, and amphibious support roles. The ships are as modern in concept and design as any contemporary destroyer and suited to provide a 20 to 25 year life for the vessels.

Hull particulars are —

Overall Length 130 m (426 ft.).

Midship Beam 15.2 m (50 ft.).

Deep Draught 4.4 m (14.5 ft.).

Displacement 4100 tons.

The propulsion system utilizes all gas turbine machinery (COGOG). The main propulsion machinery is a two-shaft arrangement of geared gas turbines, 50,000 total maximum shaft horsepower. Each shaft set consists of a main gas turbine of 25,000 SHP and a cruise turbine of 3,700 SHP, arranged side-by-side, driving a controllable pitch propeller through a common gearbox and clutches. The engines can be controlled from the Bridge or Machinery Control Room.

The remainder of the machinery and power plant design represent advanced engineering and are chosen for maximum performance, durability, and ease of maintenance.

The combat system suit, including sensors, weapons, electronic counter-measures, communications, and command and control systems is highly integrated and automated representing a completely new system taking advantage of the most advanced technical knowledge and fighting concepts. Use of digital computers for this system "core" has provided considerable flexibility for further up-dating in the early 1980's. The integrated weapons package consists of search and attack sonars, both hull mounted and variable depth; dual helicopter weapon system ("Sea King" — CHSS-2); point defence missile system; 12.7 cm (5 in.) surface guns; anti-

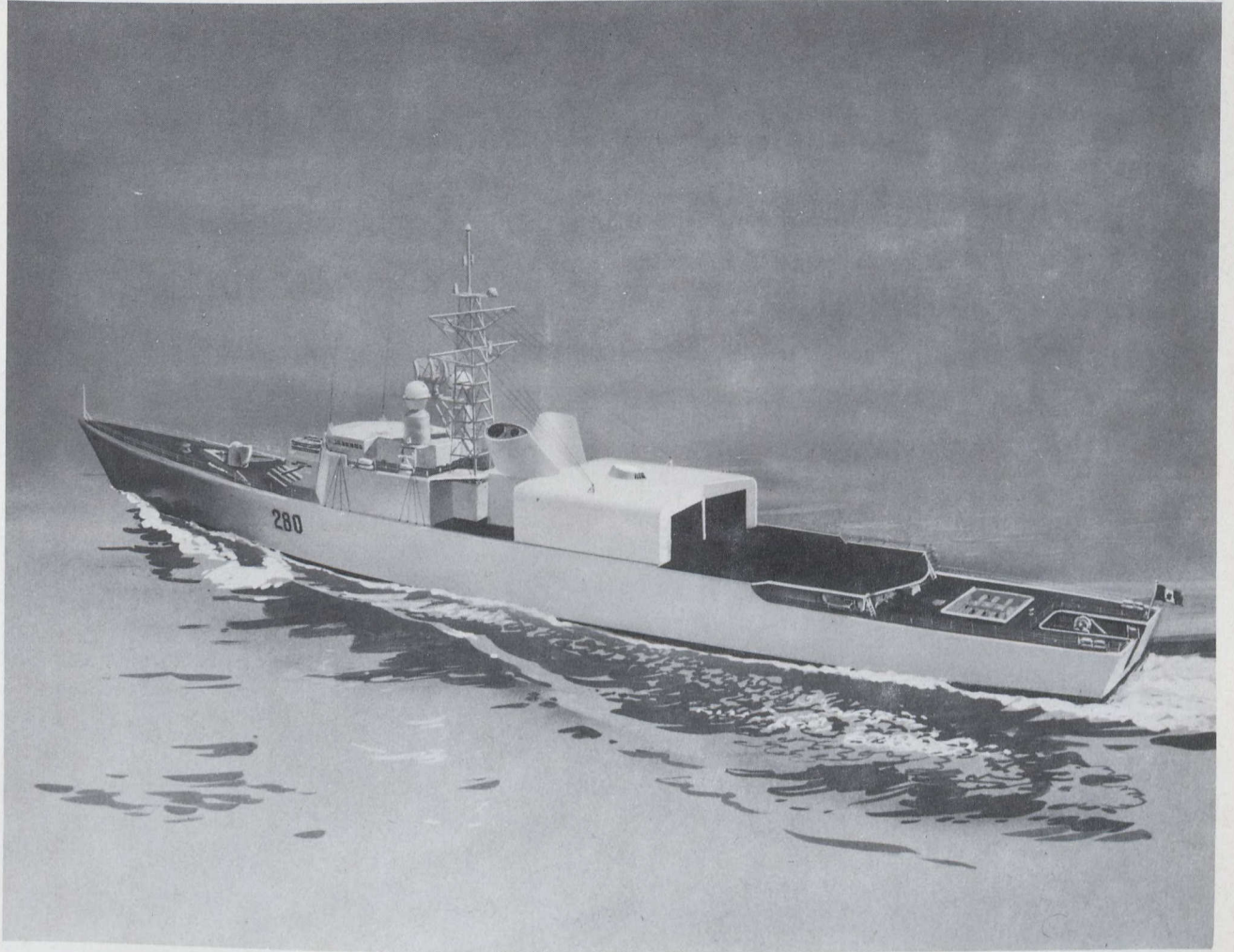
submarine mortar mountings; and anti-submarine torpedoes.

The prime contractors for the DDH-280 ships are Marine Industries Limited, and Davie Shipbuilding Limited. The gas turbine propulsion system is supplied by United Aircraft of Canada. Command and Control System, by Litton Systems (Canada) Ltd.; Sonars by Westinghouse Canada Ltd.; Helicopter hauldown and securing device by Dominion Aluminum Fabricators.

Other Canadian shipyards and sub-contractors are providing specialized systems and hardware items. (Many of these items are individually described in this book).

The DDH-280 class ships are an example of the Canadian capability for the design and construction of modern naval vessels suited to the variety of roles required in ships by smaller navies.

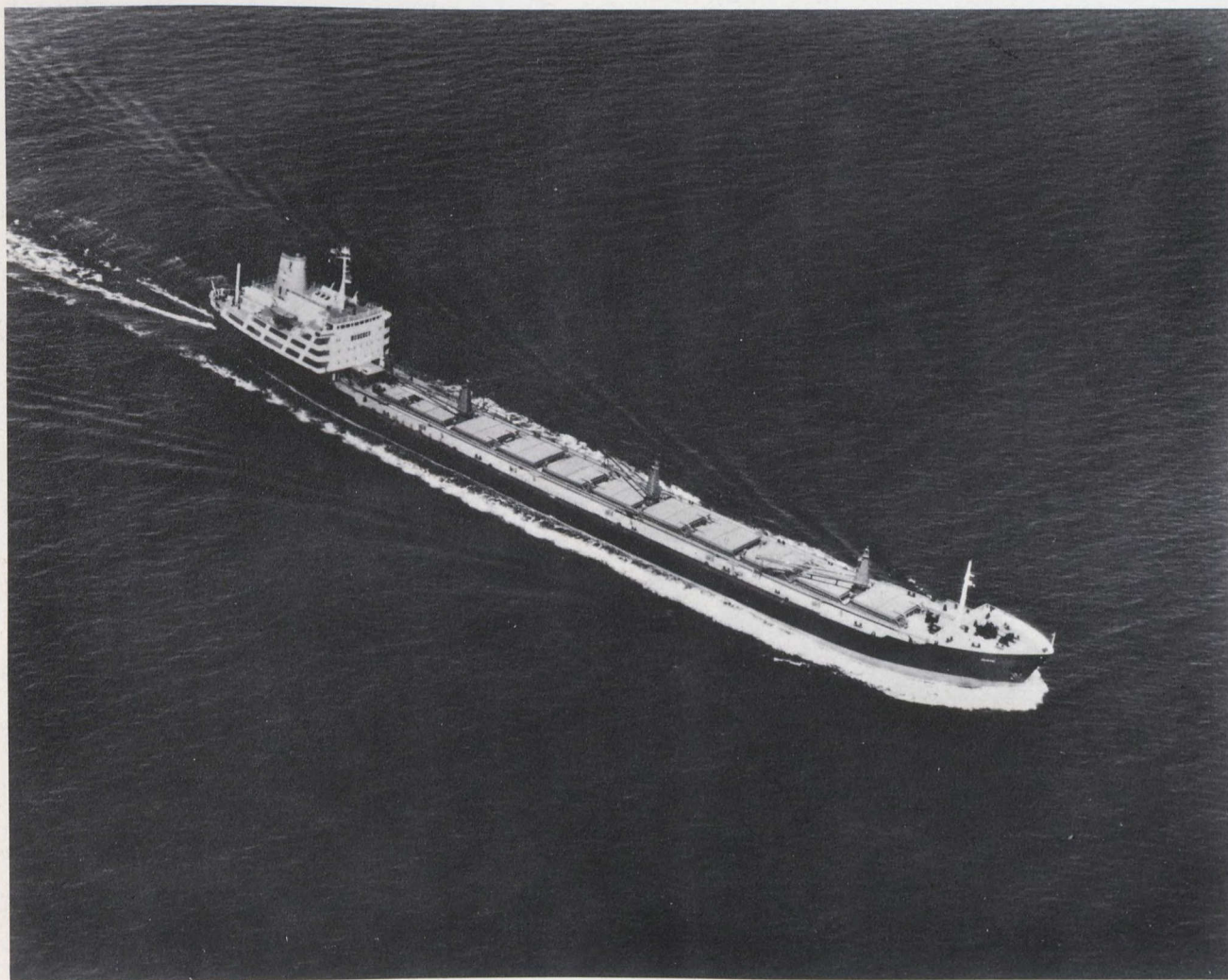
As well as destroyers, a series of composite supply and replenishment ships, patrol and other miscellaneous naval vessels made in Canada are now in operational service. The Canadian shipbuilding industry is experienced and prepared to respond to naval ship systems and hardware requirements in the international market.



BULK CARRIERS

This 30,000 ton, single screw ocean-going oil/ore carrier with a length of 210 m (690 ft.) was built in Saint John Shipbuilding & Dry Dock Co. Ltd. At the time of construction she was the largest of her kind built to navigate in ice and still meet Lloyd's Register.

At the present time the yard is building three 30,000 clean product carriers for ESSO International Incorporated.



FERRY SERVICES

Commencing operation in June, 1971, Canadian Pacific Railways new 10,270 metric tons (10,108 G.R.T.) passenger/vehicle ferry *Princess of Acadia*, now makes a twice daily return trip between St. John, N.B. and Digby, N.S., a one-way distance of forty miles and was designed for three complete trips per day should traffic demand it.

The rapid turn-around period in such an area as the Bay of Fundy which experiences the greatest fluctuations in tidal waters, is largely due to a great deal of original design and adapting of proven methods to new fields. The bow visor and stern doors, permitting straight-through traffic together with an automated turn control system ensuring that the 1,168 metric tons (1,150 long tons) of vehicles and 650 passengers are loaded or discharged with a minimum of motion and time. The twin screws aided by a bow thrusts unit, are driven by 4 GM diesels each producing 2,875 bhp., are so clutched through single output gear boxes that the propellor can still be driven in the event of an engine failure.

Passenger comfort, for both temperature and sea state conditions, has been catered to while the vehicle deck, employing the power available to the bow thruster unit, can maintain a temperature of 7°C (45°F) for an outside ambient temperature of -31°C (-20°F).



HYDROFOIL DEVELOPMENT

Canadian Industry has demonstrated its capability in the design, development and construction of hydrofoil vessels in the successful completion of *HMCS Bras d'Or* test program. This craft was developed to a Canadian Armed Forces specification which called for an ocean-going hydrofoil ASW weapons system. The vessel met and exceeded design predictions in all-weather North Atlantic trials, attaining speeds up to 63 knots. High rate turns were made at all speeds; hullborne, the ship could be stopped and turned in two lengths. Foilborne trials at over 40 knots were made in 3.04 m - 4. m (10 - 15 ft.) waves, hullborne trials were made in 6.09 m (20 ft.) seas with better seakeeping than conventional destroyers. The ship was designed to tow variable depth sonar at high speed and to carry search and homing torpedoes. While the experimental ship was based upon an anti-submarine warfare role, it is readily adaptable to other roles such as that of missile carrier.

It has a canard, trim stabilized surface-piercing foil system with 90% of lift supplied by the aft foil. It requires a minimum of electronic controls because of its inherent stability. Surface-piercing foils provide excellent displacement sea-keeping because of greater damping, as well as a broader foilborne speed range.

The size of this experimental vessel was optimized with the propulsion system for maximum endurance over a wide speed range. It has food storage capacity for 14 day missions with the ability to refuel and revictual at sea. Seamanship, navigation and habitability have been demonstrated in a 14 day 4,000 km (2,500 miles) mission.

LEADING PARTICULARS OF THE EXPERIMENTAL VESSEL ARE:

Dimensions:

Length	46 m (150 ft.)
Hull breadth	6.6 m (21.5 ft.)
Main foil span	20 m (66 ft.)
Draft (Hullborne)	7.7 m (23.5 ft.)
Draft (60 knots)	2.3 m (7.5 ft.)

Speed:

Max. Foilborne	60 knots (actual 63 knots)
Rough water	50 knots
Hullborne design speed	12 knots

Range:

Foilborne	Several hundred miles
Hullborne	More than 3,200 km (2,000 miles) in head seas towing sonar

Accommodation:

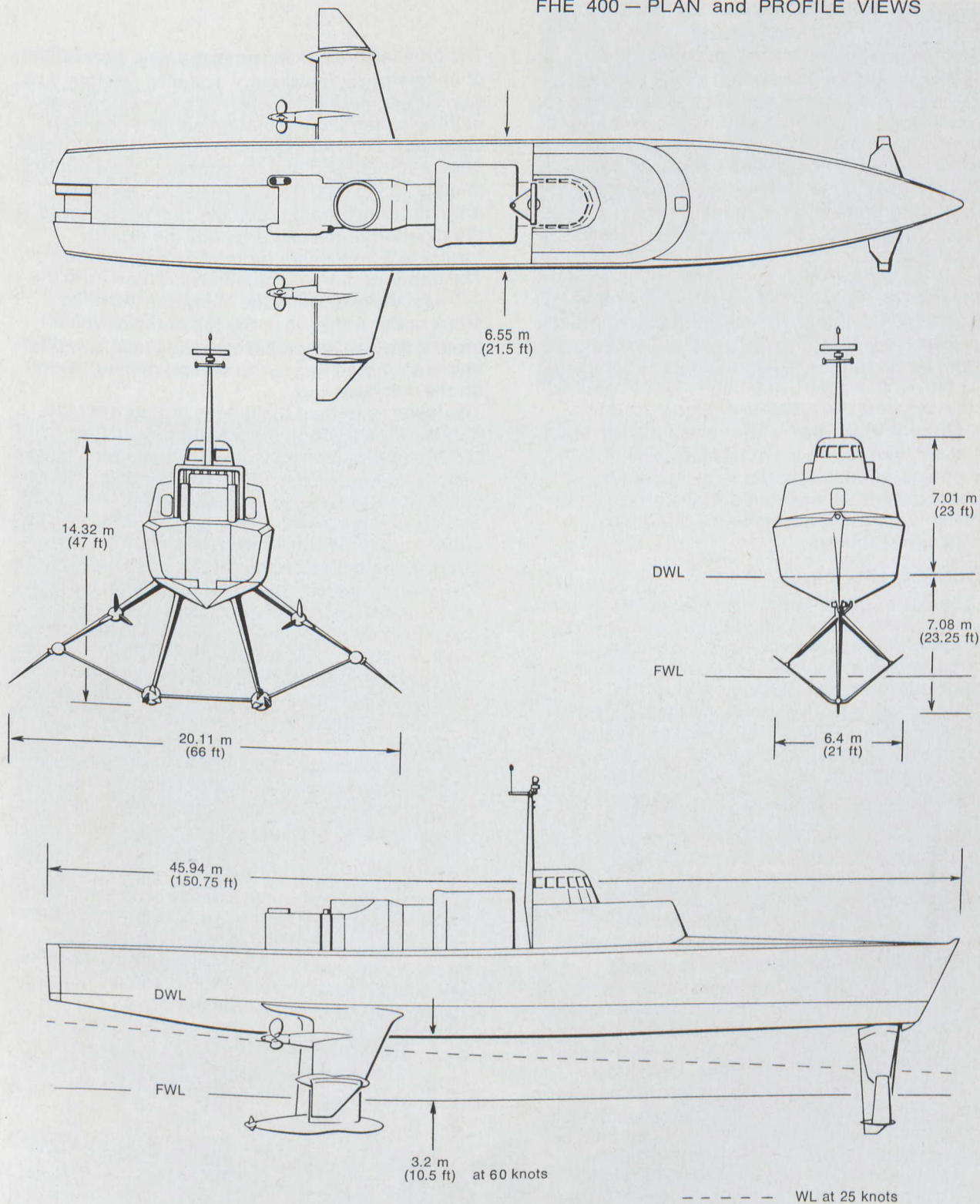
20 - 25 (officers and men)

Foilborne and displacement power is applied from a bridge comparable to an aircraft cockpit, with throttles, and dual bow foil steering controls with a heading hold function. Anhedral tip foils are rotated from the bridge either automatically or manually to coordinate turns and augment roll stability at intermediate speeds. The ship has been operated successfully in rough water without stability augmentation.

The design study, development, construction and testing *Bras d'Or* was carried out by de Havilland Aircraft of Canada, Toronto, as design agent and prime contractor. The major subcontract was hull construction by Marine Industries, Sorel, P.Q., where the ship was assembled and fitted out. Systems management for the complete propulsion system, including vibration testing, was carried out by United Aircraft of Canada, Longueuil, Quebec.

The fighting equipment was provided by Westinghouse Canada of Hamilton, Ontario, to a CAF requirement which included the towed sonar body designed by the Canadian Defence Research Board (DREA Halifax). The lightweight VDS handling gear was designed and built by Fleet Manufacturing, Fort Erie, Ontario. Like the ship, the fighting equipment comprising VDS and handling gear, computer-based action information system, four triple torpedo tubes and communications, are compact, lightweight designs. The Canadian hydrofoil industry, as defined above, is capable of designing, developing and producing complete hydrofoil vessels, parts or subsystems thereof, as a result of its participation in the *Bras d'Or* program.

FHE 400 — PLAN and PROFILE VIEWS



UNDERWAY REPLENISHMENT OF SHIPS

Garrett has developed and produced for the Canadian Navy a unique system which allows the safe transfer of heavy equipment between ships at sea, without interfering with their operational readiness. Conventional methods using in-haul/out-haul techniques have long been used but these methods are very restricted due to problems of co-ordinating three independent winches (in-haul, out-haul and highline) in anything other than calm seas.

The Garrett concept shown in the upper picture employs a Self-Propelled Vehicle (SPV) operating on a tensioned highline between the supply vessel and a receiving ship. Drive is by an electric motor carried on the vehicle which is controlled from the supply ship via a trailing cable. Self-Propelled Vehicle systems are capable of being used for either liquids or solids transfer and it is envisaged that to achieve optimum cost/effectiveness, equipment will be integrated to the extent of having each station capable of transferring either solids or liquids. Various systems offered by Garrett are as follows:

(a) SINGLE HIGHLINE

Utilizes a conventional highline winch and ram tensioner with the highline dead-ended on the receiving ship. A combination latch, shock absorber and vehicle freewheeling actuator is incorporated on the supply ship. This device limits the shock during docking to 5 g, holds the vehicle, and freewheels the drive in order that the highline may respond to the ship's motion with vehicle stopped.

(b) DOUBLE HIGHLINE

Again utilizes the standard highline winch and ram tensioner but with the line passed to the receiving vessel through a flounder plate and sheave and back to the supply vessel where it is dead-ended. In this configuration, the vehicle drive is operated on the lower dead-ended line whilst the top line is passed through an extra idler sheave in the top of the vehicle so that the vehicle is supported by both lines. Thus for a given payload it is possible to use lower line tensions than required by the single highline system. Use of the doubled highline imparts greater stability to the vehicle traveling on the line. The docking arrangement is reversed with this method in that the latch assembly is situated on the receiving vessel. Again maximum shock of 5 g is seen by the payload during docking.

The artist's concept shown is the next generation of underway replenishment systems. Designed by Garrett engineers the powered tri-drum consists of three winch drums rotating about a common shaft axis. The two interconnected highline drums, one for in-haul and one for out-haul, store approximately 183 m (600 ft.) of wire each. The third drum is connected through the ram tensioner to the highline winch and provides the driving torque to compensate for relative ship motion.

The upper or out-haul highline is routed from the out-haul drum through the supply ship sliding block under a sheave at the top of the traveller around the sheave on the receiving ship kingpost and is anchored fast to the bottom of the traveller on the outboard side.

The lower or in-haul highline is routed from the in-haul drum through the supply ship sliding block and is anchored fast to the traveller on the inboard side. Transfer of the traveller is achieved by the powered contra rotation of the in-haul/out-haul drums in the appropriate directions. The power is derived from a system of motors and gears mounted inside the drums.

The gearing system permits relative ship motion to be super-imposed on transfer motion and be compensated by the aforementioned highline winch torque.

During the In-haul/Out-haul operation positional control is maintained at the extremes of travel by activation of a two position mode switch. The supply ship mode is selected while the traveller is in the proximity of the supply ship and the receiving ship mode in the proximity of the receiving ship. The function of these modes is generally as follows.

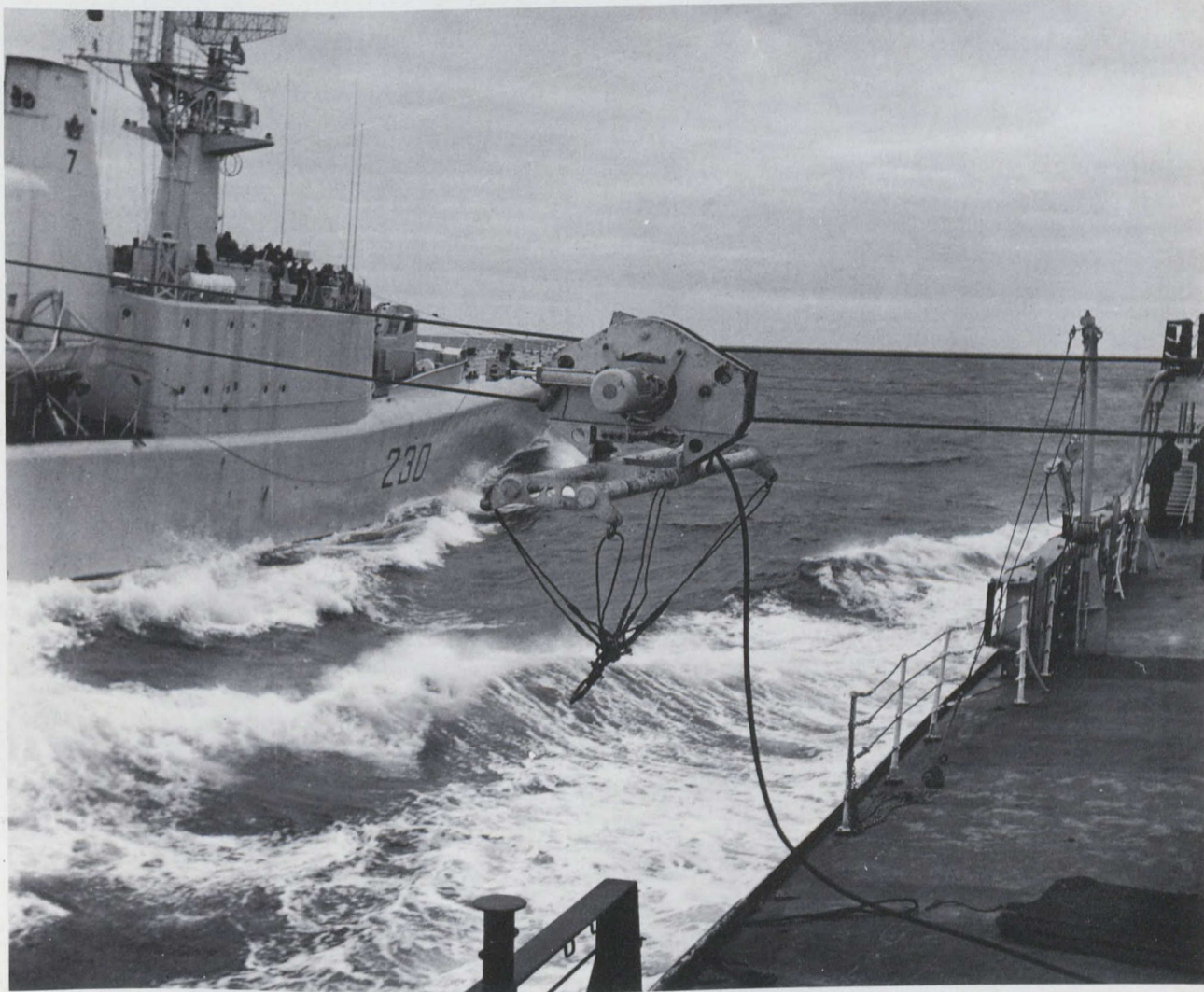
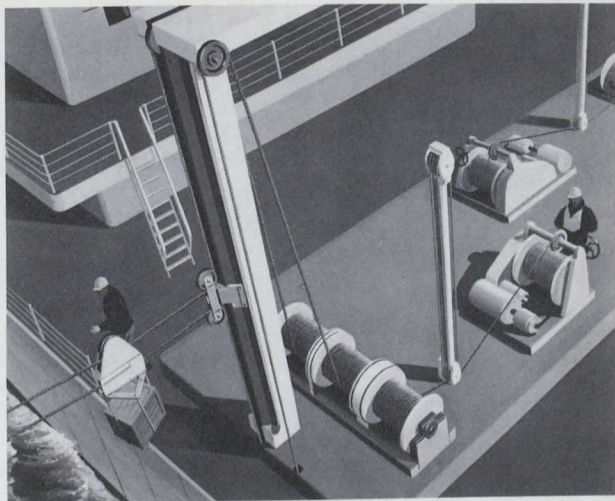
SUPPLY SHIP MODE

All random excursions or relative ship's motions are accommodated by the out-haul line only therefore, all relative position changes are between the receiving point and the traveller. The distance between the supply point is fixed and is changed only by activation of the transfer drive.

RECEIVING SHIP MODE

Excursions are accommodated equally by the in-haul and the out-haul drums therefore, all relative position changes are between the supply point and the traveller. The distance between the receiving point and the traveller is fixed and is changed only by activation of the transfer drive. The obvious benefits of this system are:

1. All power drives and their controls are deck mounted on the supply ship.
2. There is shockless entry of the traveller at either end of its travel.
3. The horsepower required by the transfer drive is extremely low.



UNDERWAY REPLENISHMENT SYSTEM

John T. Hepburn, Limited, designed and manufactured various items of deck machinery for the Canadian Armed Forces Operational Support Ships *Protecteur* and *Preserver*, including anchor windlasses, capstans, deck cranes, stores and ammunition elevators and, highly important to the prime function of the ships, the Underway Replenishment Systems.

These ships provide operational support to anti-submarine vessels on operational patrol at sea by replenishing the fleet with petroleum products, ammunition, stores, provisions and replacement helicopters. Each will have the ability to transport and transfer at sea, fuel and lubricating oil in excess of 12,000 tons.

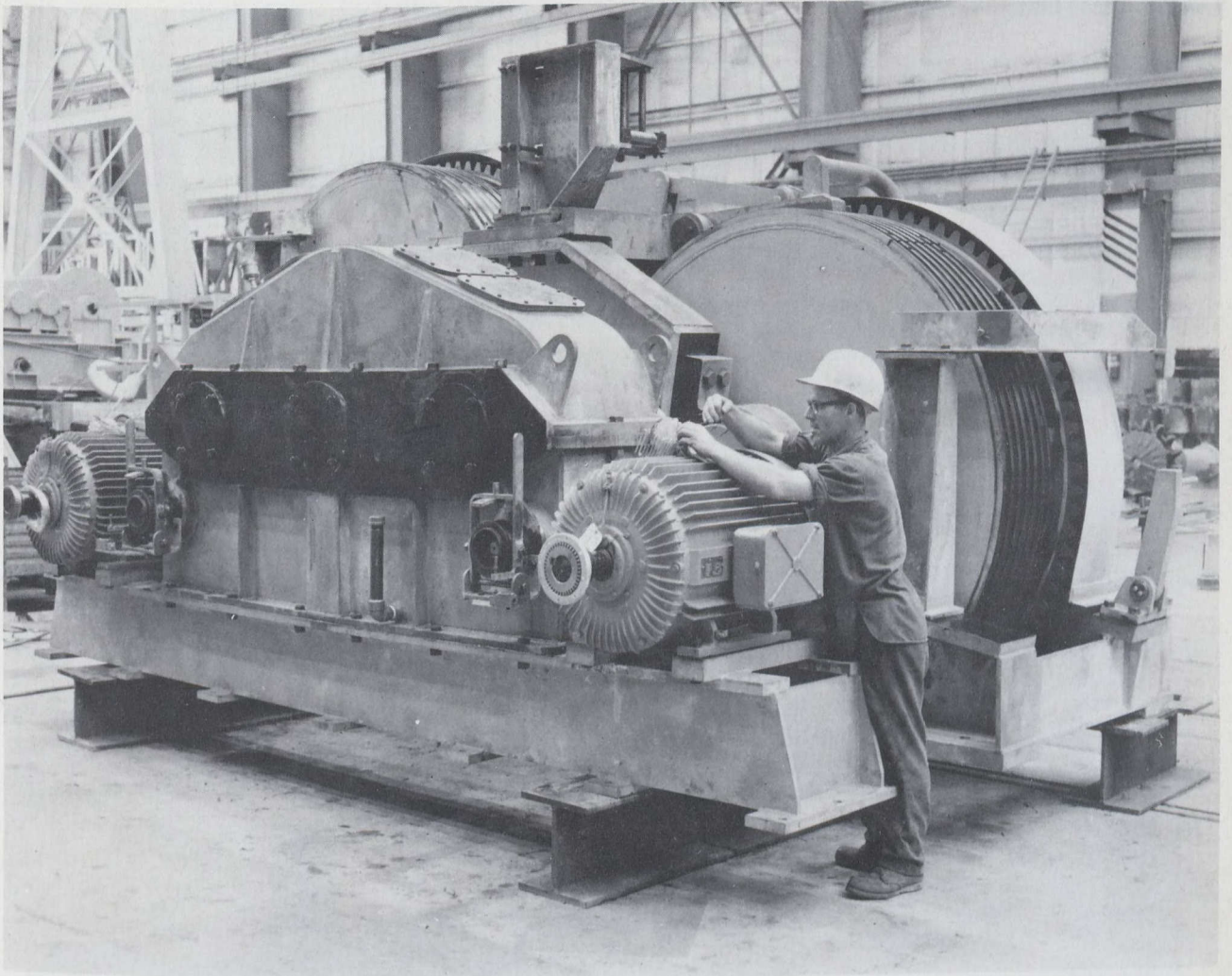
Four Hepburn Replenishment Stations are fitted on board each ship. Each station has a dual capacity and can be used for either solids or fuel. During cargo (solids) transfer, the load is transported by a traveller riding on a tensioned highline connected between the two ships and controlled by a "Highline" winch and a ram tensioner or rope storage device in the supplying ship. Two winches, also in the supplying ship, are used to move the traveller and load back and forth between the ships. During liquids transfer the highline is used to support a hose on several "saddles", the positions of which are controlled by the same winches which are used for inhaul and outhaul during solids transfer.

Underway Replenishment Systems of various types and configurations are available from John T. Hepburn, Limited.

OCEANOGRAPHIC WINCH

H.M.C.S. *Quest* provides a 2,080-ton ocean going facility for the Defence Research Board's Naval Research Establishment, Dartmouth, N.S. The vessel's primary function is to carry out oceanographic research in relation to anti-submarine warfare. At the same time she will contribute significantly to general scientific knowledge of the waters adjacent to Canada's East coast. To facilitate acoustic research the hull is constructed to minimize water noise and machinery is resiliently mounted to reduce hull vibration and underwater noise to a minimum. Line pull of the winch is 22,680 kg (50,000 lb.) at 42.6 mpm (140 fpm) which requires approximately 375 HP to hoist and regenerates approximately 570 HP in the lowering mode. 4,572 m (15,000 ft.) of 38.1 mm (1.5 in.) diameter wire rope is stored on an 27.94 cm (11 in.) diameter storage spool and the wire rope is driven by two 17.78 cm (7 in.) diameter traction drums. The entire system weighs approximately 149,668 kg (330,000 lb.). The winch drive is both constant tension and horsepower limited. A variable tension also exists between the traction drums and storage spool, to take care of the rope inertia and speed at the storage spool when 15 tons of rope is wound on or off.

John T. Hepburn, Limited is well geared for the design and manufacture of complete systems or components in the fields of underway replenishment, shipboard handling, boat handling, deck machinery, cranes and elevators and other specialized medium to heavy equipment.



WINCH SYSTEMS

Swann winches have been designed and produced to meet a wide variety of marine requirements and are in service in many parts of the world. As might be expected with such a firm the normal range of towing anchor, cargo and utility winches, capstans and windlasses are produced while continuing design work has added to their varieties and specialties which cater to modern fishing techniques.

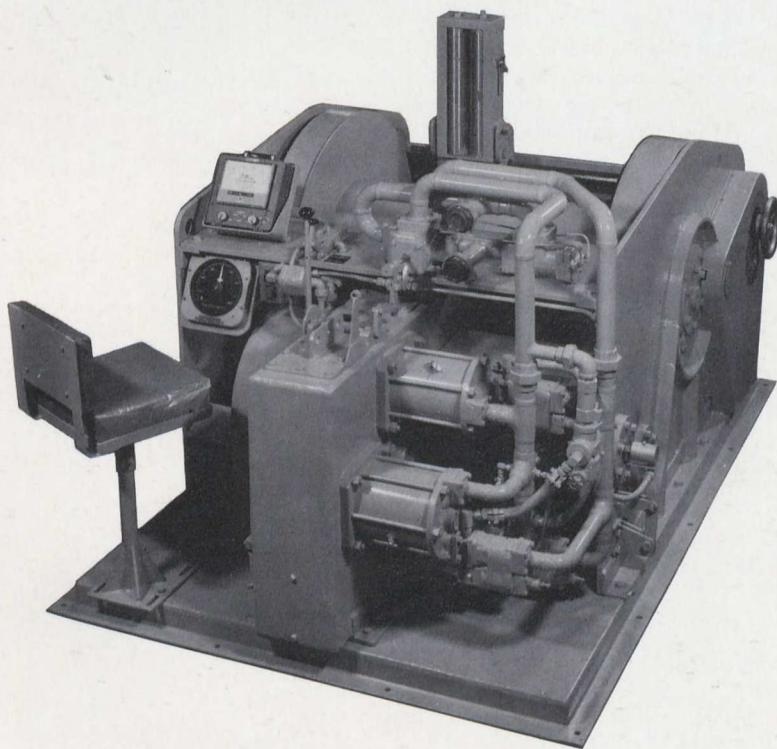
Probably the most interesting aspect of marine activity to-day is to be found in the survey and bathythermograph fields and it is in these areas that the depicted equipments belong.

OH 4624 CORING WINCH

Wire Size	mm	6.35	9.52	12.7	19.0	22.2	25.4
	in.	1/4	3/8	1/2	3/4	7/8	1
Drum Capacity	m	18,288	8,229	4,572	2,042	1,524	1,158
	ft.	60,000	27,000	15,000	6,700	5,000	3,800

Mid-Drum Line Pull:	LOW SPEED, HIGH PULL		HIGH SPEED, LOW PULL	
Mid-Drum Line Speed:	5,443 kg	(12,000 lb.)	1,814 kg	(4,000 lb.)
Oil Required:	61 mpm	(200 fpm)	191 mpm	(625 fpm)
	477 lit. pm at 105 kg/cm ²		(105 gpm at 1,500 in. ²)	

Input: 100 H.P.

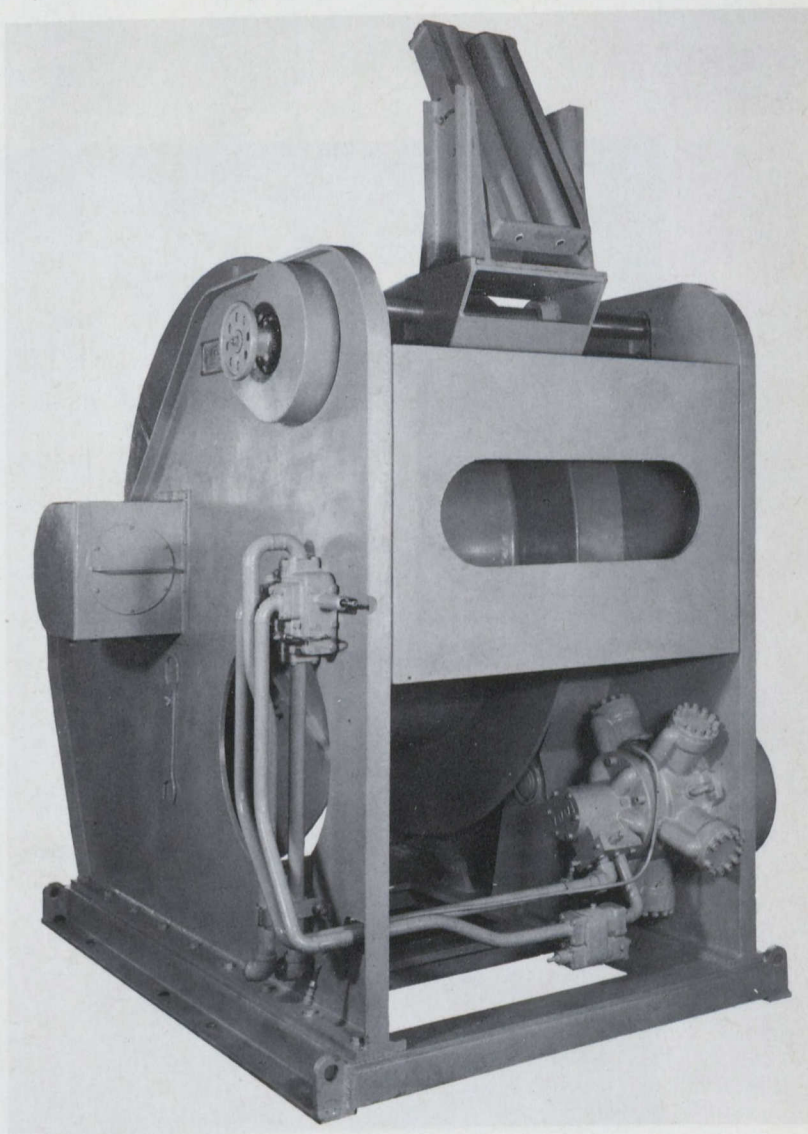


OH 8860 TELEVISION CAMERA WINCH

Wire Size	38 mm	1½ in.
Drum Capacity	792 m	2,600 ft.
Mid-Drum Line Pull:	4,763 kg	(10,500 lb.)
Mid-Drum Line Speed:	53.34 mpm	(175 fpm)
Oil Required:	341 lit. pm at 105 kg/cm ²	(75 gpm at 1,500 in. ²)

Input: 70 H.P.

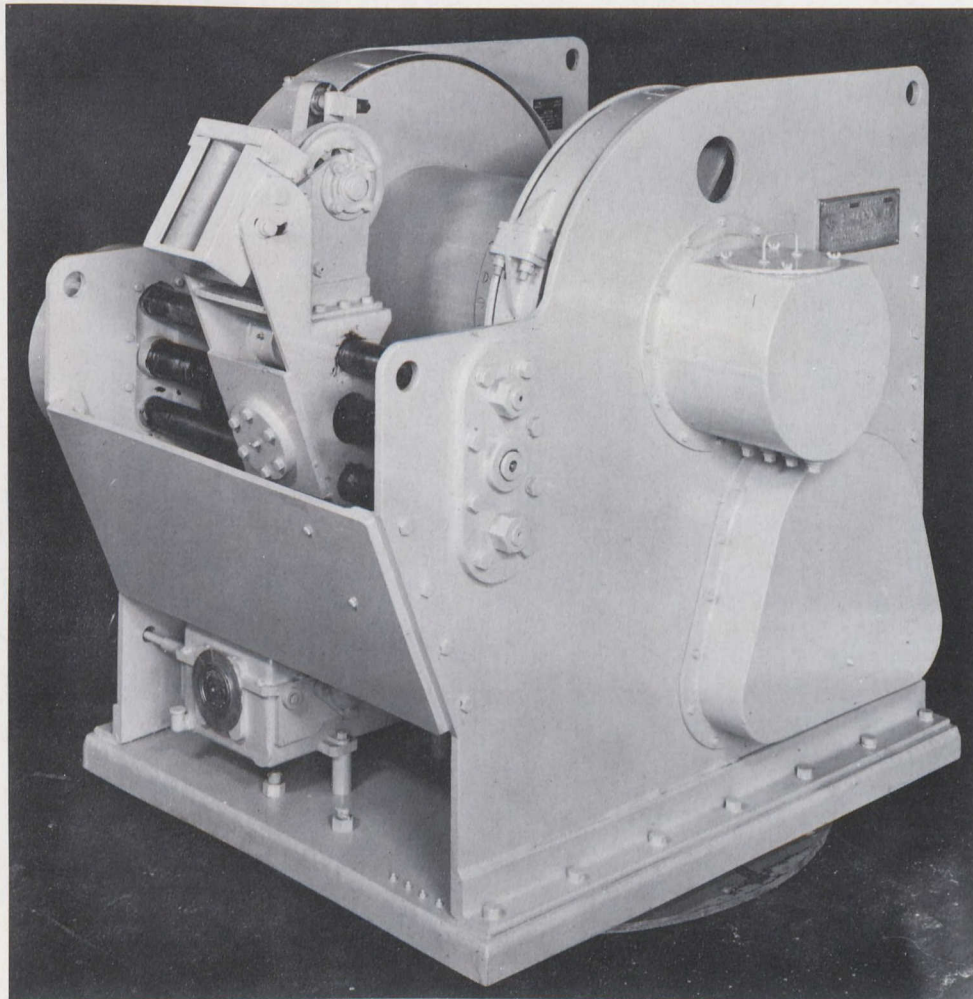
The large diameter barrel of this winch enables the television cable to be wrapped on without exceeding the cable's minimum bending radius, thus any sharp kinking is avoided. The winch features automatic spooling, slip rings, electric counter system and remote control operation.



OH 3618-2 OCEANOGRAPHIC TRAWL WINCH

Wire Size	mm	6.35	7.94	9.52	12.7	15.8	19.
	in.	1/4	5/16	3/8	1/2	5/8	3/4
Drum Capacity	m	6,096	4,115	3,048	1,524	1,066	762
	ft.	20,000	13,500	10,000	5,000	3,500	2,500

MODEL 50	LOW SPEED, HIGH PULL	HIGH SPEED, LOW PULL
Mid-Drum Line Pull:	2,268 kg (5,000 lb.)	1,134 kg (2,500 lb.)
Mid-Drum Line Speed:	68.6 mpm (225 fpm)	137 mpm (450 fpm)
MODEL 60	LOW SPEED, HIGH PULL	HIGH SPEED, LOW PULL
Mid-Drum Line Pull:	2,722 kg (6,000 lb.)	1,361 kg (3,000 lb.)
Mid-Drum Line Speed:	56.4 mpm (185 fpm)	97.5 mpm (310 fpm)
MODEL 80	LOW SPEED, HIGH PULL	HIGH SPEED, LOW PULL
Mid-Drum Line Pull:	3,629 kg (8,000 lb.)	1,810 kg (4,000 lb.)
Mid-Drum Line Speed:	45.7 mpm (150 fpm)	91.4 mpm (300 fpm)
Oil Required:	341 lit. pm at 84 kg/cm ²	(75 gpm at 1,200 in. ²)
Input: 50 H.P.		



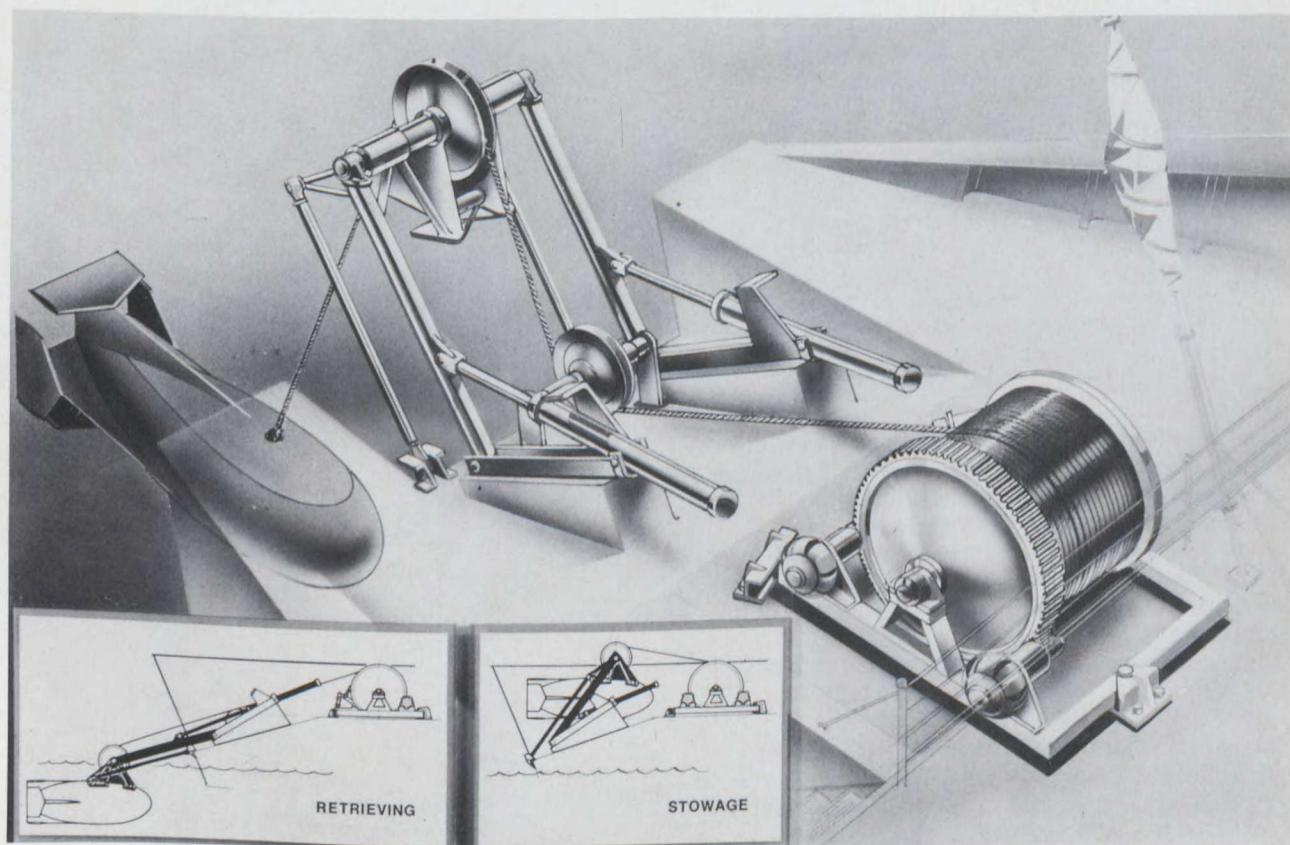
LAUNCHING AND RETRIEVING SYSTEMS — V.D.S.

With the advent of Variable Depth Sonar one of the problems to be solved was the development and production of launching and recovery gear which could handle the weights and strains involved without damage to the towed body. Fleet Manufacturing has designed and produced such systems which are associated with the AN/SQA-502 V.D.S. hoist mechanism. This equipment is capable of launching and retrieving a towed body weighing 6,350 kg (14,000 lb.) in air with State 5 sea conditions.

The cable drum system is unique in its design in that it eliminates the use of electrical slip rings and is powered by an electric/hydraulic 75 horsepower motor. The pivoting oscillating design utilizes a central pinion which ensures that the Fleet-designed faired cable pays in or out at right angles to the drum without kinks or strains.

SPECIFICATIONS:

Towed Body Weight (in air)	63,50 kg (14,000 lb.)
Towed Cable Length	304 m (1,000 ft.)
Drag Max.	13,154 kg (29,000 lb.)
Speed Max.	25 knots
Winding Capacity	13,608 kg (30,000 lb.)
Winding Rate	38 m.p.m. (125 F.P.M.)
Brake Capacity	31,752 kg (70,000 lb.)
Tow Cable Tension Max.	
Allowable	31,752 kg (70,000 lb.)
Recover Speed up to	22 knots
Shock Resistance to Spec.	NVHS 1-0-3
Cable Shock Absorber	Included
Space Requirement	
Length	10.36 m (34 ft.)
Width	3.65 m (12 ft.)
Weight	
Winch	8,028 kg (17,700 lb.)
Boom Assembly	5,216 kg (11,500 lb.)
Accessories	5,987 kg (13,200 lb.)
Power Equipment	75 H.P.



DEEP SEA TOWING

Garrett engineers have designed reliable high capacity towing systems for the towing and salvage industries and oceanographic research agencies.

In its popular configuration the system consists of three basic schemes; a winch drive mounted on the weather deck, a diesel drive mounted below deck and a control console in the wheelhouse.

The diesel engine, transmission, torque converter and air holding brake are connected to the winch by a shaft drive or multiple chain which pass through the deck in a heavy trunk.

The deck mounted winch consists of an integrally welded structure into which is fitted a unique arrangement of fairlead, fleeting shaft, level wind and main drum assembly all of which are capable of withstanding the breaking strength of 5.7 cm (2.25 in.) wire rope. The drum has a capacity of 792 m (2,600 ft.) of 5.7 cm (2.25 in.) — 6 x 37 wire rope with 3.8 cm (1.5 in.) free flange. The drum clutch (set for 21 metric tons, 200,000 lb.) is a planetary type mounted on the low speed shaft with control at the winch and in the wheelhouse.

A gypsy head, dogging device and footage counter are also fitted to the drum assembly. The gypsy head is suitable for 25.4 cm (10 in.) manila rope with a breaking strength of 30.4 metric tons (77,000 lb.).

The Towing Machine is operated from the winch console. While these controls operate the winch, they also control the diesel drive located below deck and are divided into two main groups — one group for the pneumatic controls and the other for the electric.

The main control functions are regulated pneumatically by three levers on the winch console. The first is the direction-throttle lever, the second is the shift control (low or high) and the third lever controls air supply to the winch drum clutch brake for motivation of the drum. The electrical control covers startup, shutdown, running, diesel air brakes and electrical monitoring.

Cable payout is indicated both on the winch console and in the pilot house by a selsyn system driven from the winch. The lifting lever to engage the drum dogging device is a manual adjustment at the winch.

Maximum line pull of 68 metric tons (150,000 lb.) is at 6.7 m (22 ft.) per minute, while light line speed is 30.5 m (100 ft.) per minute.

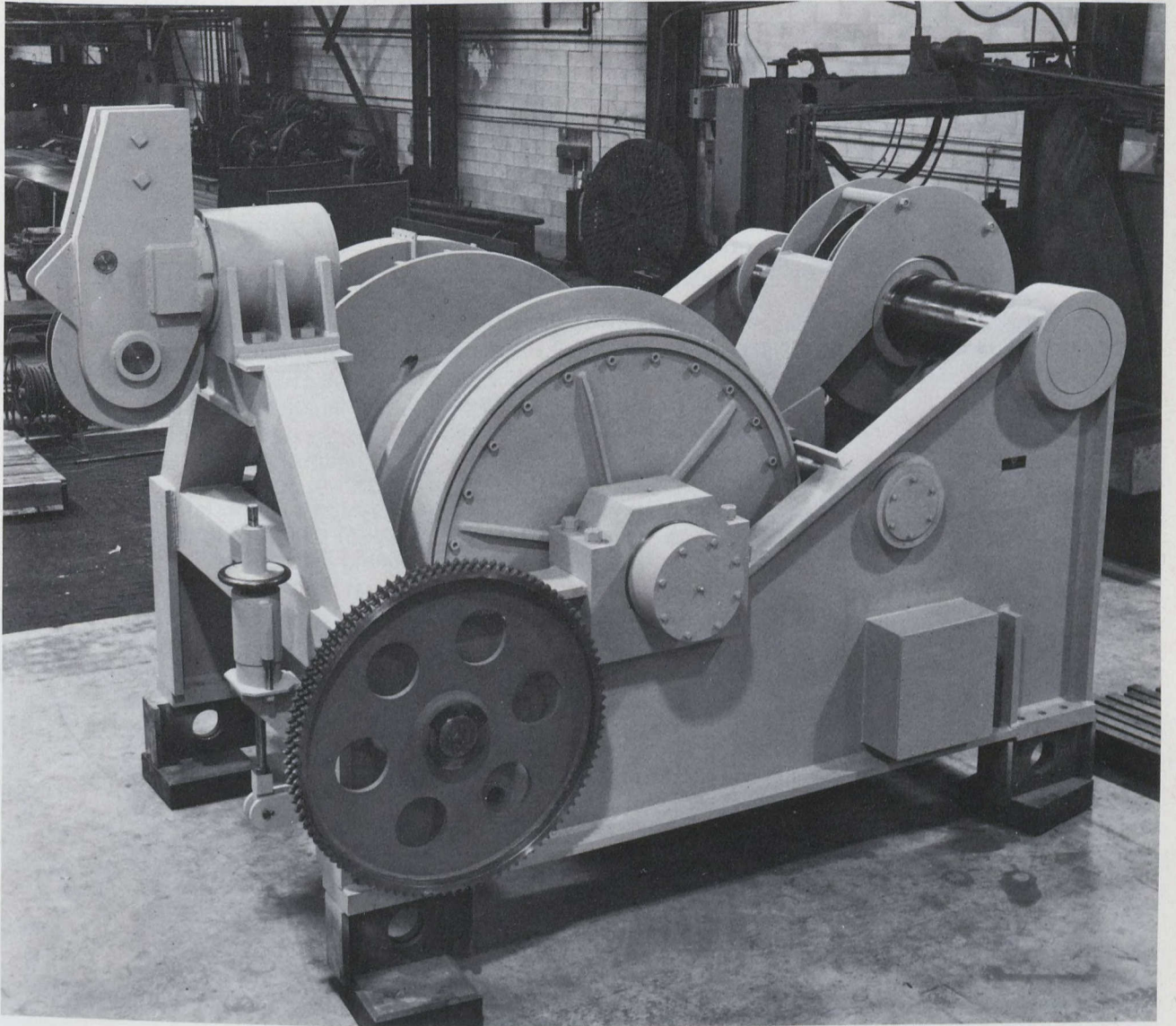
The winch which is approximately 4.3 m long, 3 m wide and 2.7 m high (14 x 10 x 9 ft.) weighs 22.7 metric tons (50,000 lb.) The drive system

including transmission and converter weighs 3.6 metric tons (8,000 lb.).

The deck mounted winch is of fabricated steel construction with the exception of the warping end and main ring gear which are cast. Self-Aligning anti-friction bearings are used throughout and the entire system meets the requirements of the various regulatory bodies. Other configurations could include a split traction winch, storage reel drive for deep submergence vehicle towing along with vehicle capture devices, onboard handling, power limiting, regenerative or dynamic lowing, constant depth and positional control. Drive schemes may be electric AC-DC, hydraulic or diesel.

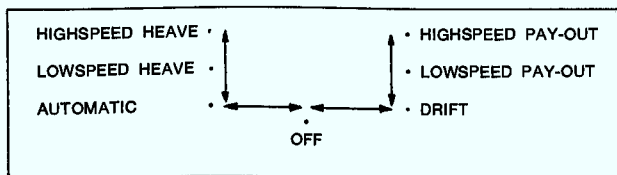
To offer a complete systems capability Garrett also design:

- ANCHOR WINDLASSES
- CAPSTANS
- CARGO WINCHES
- CARGO HANDLING SYSTEMS
- DECK CRANES



DECK MACHINERY

Garrett have recently introduced a new line of Live Motor Electric Mooring Winches. These machines with their built-in electrical tension sensing supersede the former dead motor drive with mechanical tension sensing. The mooring winches enable ships to stop and manoeuvre in canal locks and loading berths and also to stand off at seaway mooring stations. The mooring is performed quickly and automatically leaving the personnel free for other functions. Each winch is controlled by two deck water tight master control switches, one on the port side and one starboard. These switches have seven positions for:



The AUTOMATIC, DRIFT and OFF positions are self maintaining; the HEAVE positions spring return to AUTOMATIC and PAY-OUT positions spring return to DRIFT. A tension selector switch located on the winch can be arranged for any number of tension settings between two and five. When the Automatic position is selected the winch will haul in at low speed, 19.8 m (65 ft.) per minute, until the selected tension has been reached. At this point the rotor winding control circuit will cause the motor to stall continuously while delivering the torque required to maintain the selected tension. The motor brake will remain released and the motor may PAY-OUT or HEAVE to maintain the tension.

If the winch is used to check the forward motion of the ship, the line will be pulled off the drum under the selected tension up to a predetermined over-speed at which point, the voltage-sensing relay in the motor secondary circuit actuates to shift the winch into high gear by energizing the clutch and releasing the ring gear brake in the planetary gear change assembly. The motor speed drops to $\frac{1}{4}$ speed for the same line speed. Because of the higher gear ratio and lower mechanical advantage, the motor will now only apply a counter-torque corresponding to $\frac{1}{4}$ the selected line pull.

When the manual position is selected the tension selector and monitoring systems are rendered inoperable.

- (i) In high speed pay-out, the line speed is 83 mpm (275 fpm) at zero tension.
- (ii) In high speed heave, the line speed is 79 mpm (260 fpm) at approximately 25% of rated tension.
- (iii) In low speed pay-out, the line speed is 21 mpm (69 fpm) at zero tension.
- (iv) In low speed heave the line speed is 20 mpm (65 fpm) at the rated tension.
- (v) If the winch is used for checking, the performance will be the same as in the "AUTO" position.
- (vi) In the OFF position, the motor is de-energized and all brakes are applied.

The winch is powered by a force ventilated drip-proof electric motor which is enclosed in a water tight housing on the winch. There is single phasing protection on the motor secondary for all tension settings in the automatic mode.

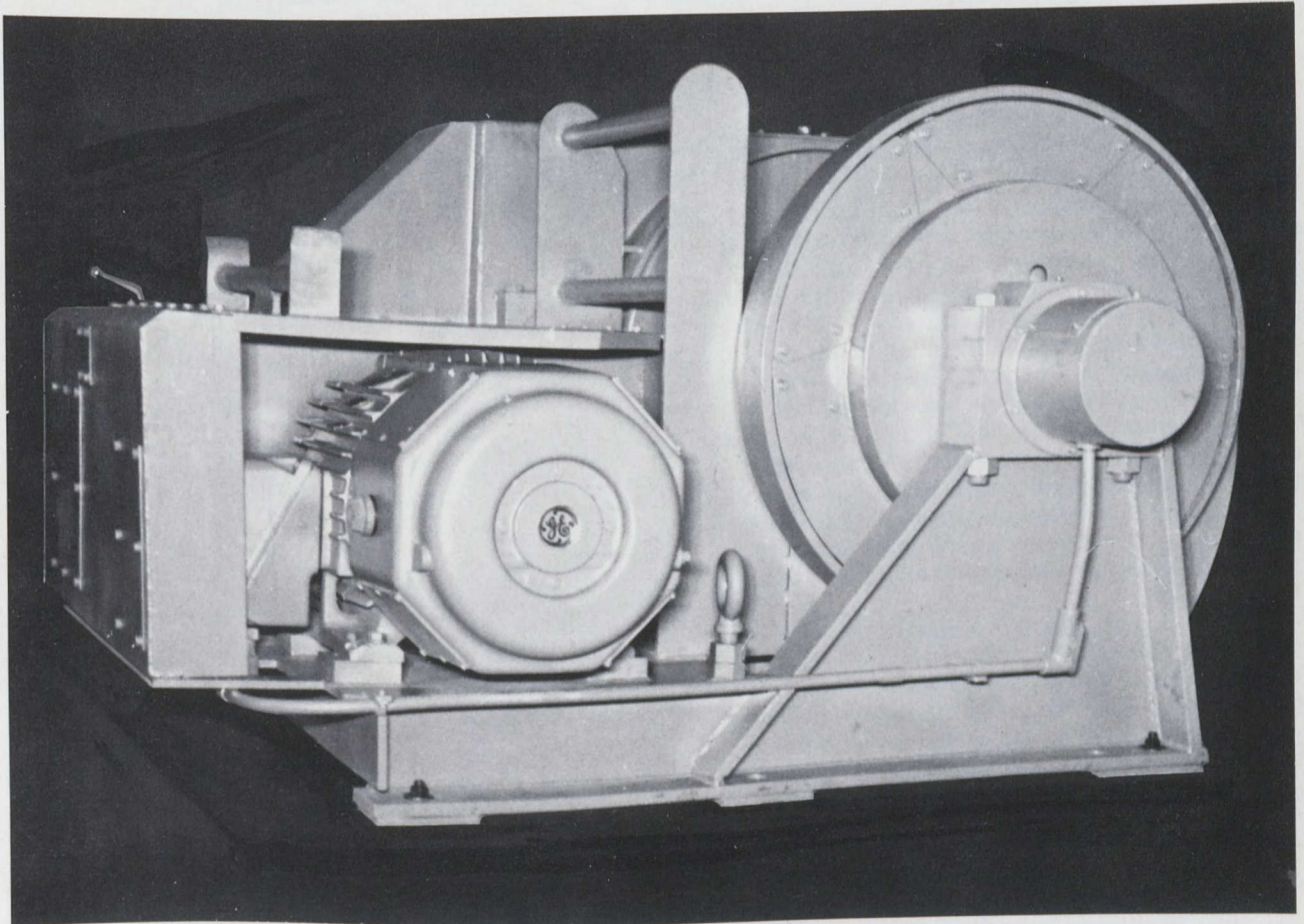
External Magnetic Overload protection is provided by a rod and tube type rate of rise temperature detector embedded in the stator winding. A red warning light on the master switch will warn of overheating at any time but the motor will not be tripped out while checking the ship as during this mode protection of the motor may compromise ship safety. The separate motor driven blower circuit has inlets and outlets in the main motor casing with water tight covers. Protection is incorporated into this circuit to prevent energizing the winch unless both covers are open.

Other major components of the winch include a double planetary gear set with a brake/clutch speed change arrangement. The ratios in this gear set are approximately 85 to 1 with the brake on and the clutch off and approximately $21\frac{1}{4}$ to 1 with the brake off and the clutch on. A fail safe disc brake spring applied pneumatically released is capable of a brake holding force up to 150% of rated tension. A motor mounted disc brake is also spring applied and pneumatically released and this brake is rated at 200% of the full load motor torque.

An optional feature on these machines is a Warping Head and Drum Clutch Assembly. This consists of a cast iron warping head with hardened whelps, a positive engagement clutch for the main drum and a ratchet and pawl to dog the drum while the warping head is in use.

The size range of the Garrett Mooring Winches is as follows:

MODEL	RATED DUTY		LIGHT LINE	MOTOR
	TENSION	SPEED	SPEED	H.P.
M 20-10	3,048 kg 10,000 lb.	19.8 mpm	79.2 mpm	20
M 40-20	6,096 kg 20,000 lb.	(65 fpm)	(260 fpm)	40
M 60-30	9,144 kg 30,000 lb.	"	"	60
M 80-40	12,192 kg 40,000 lb.	"	"	80
M 100-50	15,240 kg 50,000 lb.	"	"	100
M 120-60	18,288 kg 60,000 lb.	"	"	120



SHIPBOARD HELICOPTER HANDLING SYSTEM

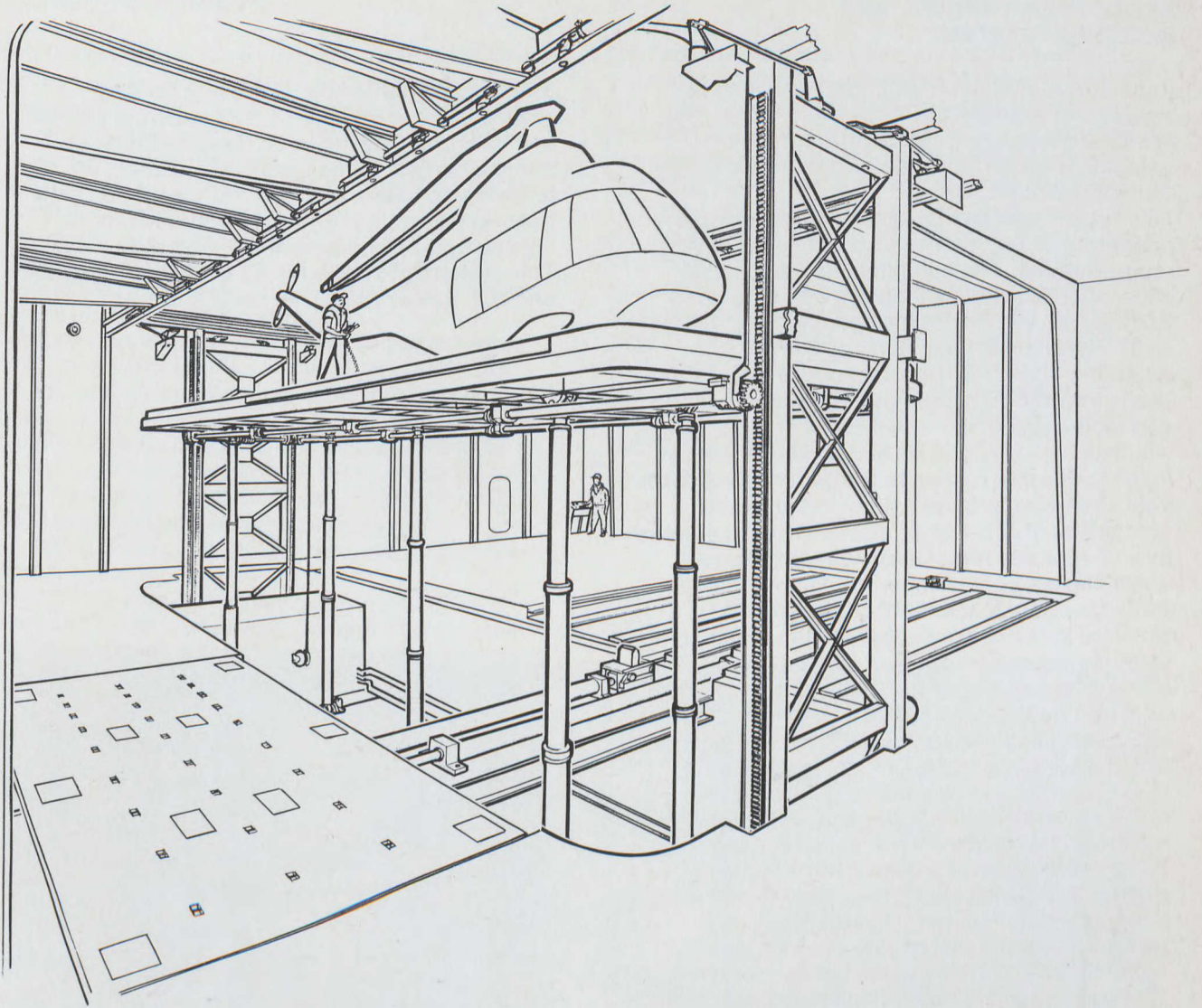
This unique shipboard helicopter handling system was designed and manufactured by John T. Hepburn for the C.C.G.S. *Louis S. Saint Laurent*, the most powerful conventionally powered icebreaker in the world. Designed for ocean-going icebreaking service in the Arctic, the ship's helicopters are handled between the hangar deck, which is below deck and the flight deck which is of course a weather deck.

The system comprises a main platform, 5.18 m wide and 16 m long (17 x 52.5 ft.), which travels a vertical distance of 5.48 m (18 ft.) between the two deck levels. Each helicopter sits on a tie-down pad 5.18 m wide and 9.1 m long (17 x 30 ft.) which rolls athwartships from its stowed position in the hangar onto the main platform. When either pad is in position on the main platform, this platform starts to elevate. The initial travel of the platform locks the pad to the platform and lifts it clear of its traversing mechanism. As the main platform reaches the flight deck, it is automatically locked in position and a pneumatic seal is inflated. The locks, which are equally spaced all around the periphery of the platform, make up the structural integrity between the platform and the surrounding deck. This enables the point load of a helicopter landing to be absorbed anywhere on the entire platform area. When the main platform is locked at the flight deck level and the seal is inflated, it becomes the permanent, watertight flush deck hatch. There is also an auxiliary static seal which will help maintain watertight integrity, should there be a rupture of the pneumatic seal. In addition to a dual pump hydraulic system, there is also a separately piped power unit to close the hatch in case of emergency. A rack and pinion equalizer system ensures a smooth, jam-free action of the main platform. Platform-thrust loads are absorbed by rollers running on tracks and this, combined with the pivot mounting of the main rams, prevents the latter being subjected to any bending loads.

As may be readily seen, this type of handling system can be adapted to many different hangar configurations. It is also ideally suited to the incorporation of a helicopter hauldown as the rapid securing device could be mounted permanently in the tie-down pads and the hauldown gear could be located in the well with the main lift rams. With this scheme it is not necessary to have a separate traversing mechanism or arresting buffers.

In an effort to simplify the installation of this system for the shipbuilder, everything was assembled in pre-tested sub-assemblies such as end frames with integral tracks, pad traversing mechanism, platform locks and hydraulic power units.

John T. Hepburn, Limited is well geared for the design and manufacture of complete systems or components in the fields of underway replenishment, shipboard handling, boat handling, deck machinery, cranes and elevators, and other specialized medium to heavy equipment.



This drawing depicts a system similar to that installed in the *C.C.G.S. Louis S. St. Laurent*.

HELICOPTER LANDING AND SECURING SYSTEM

Dominion Aluminum Fabricators who also designed and produce the Telescopic Hangar for shipboard use now produce this companion equipment which has been proven in use by the Canadian Armed Forces.

This system was designed to enable helicopters to operate at sea from small flight decks in very rough weather. The equipment is designed to allow operations of helicopters weighing up to 0,072 kg (20,000 lb.) from ships rolling as much as 31°, pitching 8°, and heaving 6 m (20 ft.). A landing operation is carried out as follows: A line is lowered from the hovering helicopter and connected to the haul down cable end fitting, which is then winched up and locked in a probe in the helicopter bottom fuselage. The haul down cable is reeved around a drum in the winch compartment of the ship, and this drum, powered by a hydrostatic transmission, is operated to winch the helicopter under a selected and controlled tension, to the flight deck. Tension selected at the control console will remain constant regardless of ship motion. At a "null" period in the ship's motion the helicopter will be drawn smoothly down to the flight deck. This constant tension feature is achieved through the use of a servo system which compares cable tension, measured by a load cell, with a command signal or tension selection at the control console. The resultant error signal is used to control the output of a variable displacement pump, causing the haul down cable to be reeled in or out and to maintain the required cable tension. Rate of descent can be controlled by increasing or decreasing the tension selected. As soon as the helicopter has landed, the Rapid Securing Device, known colloquially as the "Beartrap", is actuated. The securing device is a steel structure about 1.8m² (6 ft².) and 20.3 cm (8 in.) high, which contains two mutually opposed parallel Arresting Beams. These beams are remotely closed and opened from the control console by the securing device hydraulic system. In the closed position, both beams lock together and secure the helicopter probe protruding from the bottom fuselage. When the beams have locked together on the probe, and the helicopter tail probe is lowered, the helicopter is restrained on deck against motion in all directions. The operation is completed by straightening the helicopter on deck by traversing the securing device aft, with the helicopter attached. A tail guiding winch system can be installed which

assists in straightening the helicopter under severe weather conditions. The securing device and helicopter may then be traversed forward into the hangar. In the installation shown, use of a "swinging bellmouth" permits a common haul down system to be used with independent traversing systems for port and starboard hangars. This system is in use with the Canadian, Japanese and U.S. navies as well as the U.S. Coast Guard.



TELESCOPIC HANGARS

With the Dominion Aluminum patented telescopic helicopter hangar, it is possible to house and service the aircraft in the same area as that used for landing. Extended, it is a hangar — retracted, it frees its own deck space for take-off and landing, making it possible for the smallest ships to provide hangar facilities.

The hangar operates on the principle of a telescope, and is installed on the flight deck. Coaxial sections constructed of arched aluminum frames and sheeting retract within each other to expose the flight deck for use. The structure forms an inverted "U" in cross section and with the use of high-strength low-weight aluminum, minimizes the ship's top weight. The hangar usually employs one fixed section forward and one or more fixed sections aft that extend out over the flight deck. The forward fixed section is the largest and contains the power supply, operating control panel, heating units, and maintenance gear.

The moving sections travel on steel tracks recessed in the flight deck. Retraction and exten-

sion are accomplished by electric drives with provision for manual operation in the event of power failure. Electric brakes automatically engage the track when not operating to prevent hangar movement caused by the ship's motion. The hangars have now been designed in sizes ranging from 3.6 m wide by 7.6 m long and 3.6 m high (12 ft. x 25 ft. x 12 ft.) to 24 m wide by 91 m long and 18 m high (80 ft. x 300 ft. x 60 ft.). Special lighting, heating, ventilating and fire-fighting equipment has been developed as an integral part of the DAF telescopic hangar system. Over 80 of the hangars are now at sea with the Canadian, United States, Indian, Iranian and Italian navies as well as with the Canadian and U.S. Coast Guards.



STABILIZED HORIZON BAR

Helicopter operations in conjunction with a ship, particularly flight deck landings, present no great problem when the conditions are clear and calm, since:—

- a) The ship is visible, and an accurate approach may be made in the desired direction;
- b) The deck is reasonably stable, giving the pilot a horizontal datum with which to align the aircraft.

Under rough sea conditions the ship may roll severely, hampering the pilot's attitude judgement. This is especially true when the roll characteristic is erratic and further confused by pitch and heave motions. The pilot now finds it necessary to refer to the natural horizon or to consult his flight instruments, to maintain level flight and synchronize his approach with the appropriate phase of the ship's movement. In either case, his external visual scan pattern is extended or interrupted, increasing the chance of error.

When the natural horizon is obscured by darkness or limited visibility, the pilot's judgement is further confused; the task of synchronizing the aircraft approach with shipboard operations then becomes increasingly difficult, resulting in a potentially disastrous situation. It was to meet these conditions that Garrett Manufacturing commenced development on the equipment which has, to a very great degree, reduced pilot strain under such conditions.

The function of an artificial horizon, in the conditions described above, is to provide the helicopter pilot with an accurate visual datum by which to establish his attitude during initial approach and in the final stage of landing. In addition the system provides a distinctive pattern for positional control, enabling the pilot to line up accurately for a stern approach. All phases of flight in the vicinity of the ship are thus facilitated, with consequent time saving and increased safety.

The exterior installation consists of two stabilized horizon bars, mounted fore and aft on the hangar deck top, facing aft. The bars are distinctively coloured for daylight recognition, and are illuminated for dark conditions.

The design specification conditions for the bar installation are as follows:—

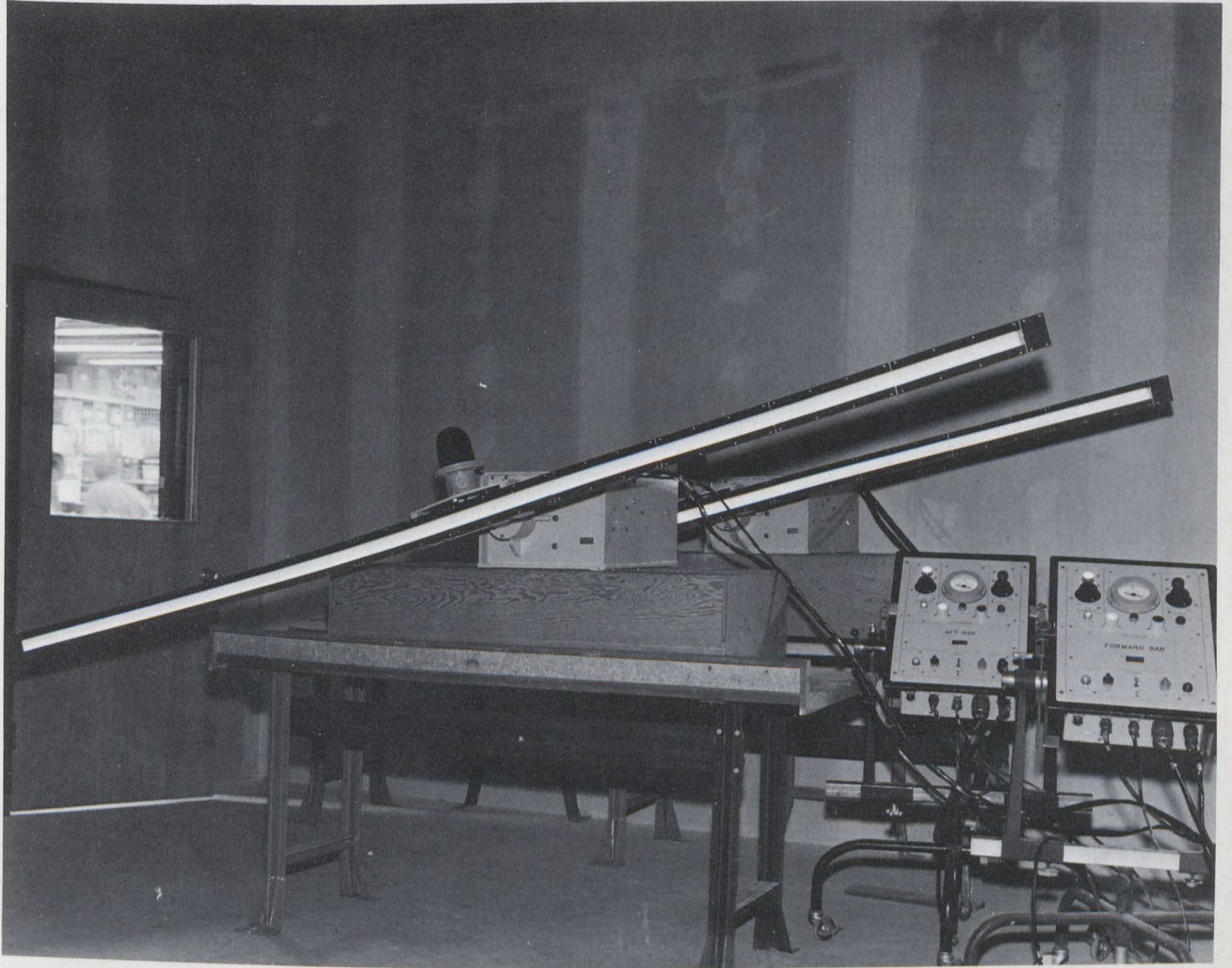
OPERATIVE MODE

Vertical wind	70 knots*
Ice Build-up	22 kg/m ² (4.5 lb./ft. ²)
Bar Amplitude	±30°
Bar Frequency	0.125 cycles/sec.
Accuracy	±1°

The bar itself is 3 m (10 ft.) long and is mounted to the shaft at its mid point. The bar is recessed on its after face to house the electroluminescent tape, which is clamped in position behind a Plexiglass window. A machined terminal block fastened to one end of the bar houses the electrical connections to the tape, and provides environmental protection to the end of this. A bracket located on top of the bar at its centre provides the warning mounting. The bar is dynamically balanced to compensate for the above fixtures where they cause an asymmetrical force.

Viewed from the air, the system appears as two horizontal lines which clearly delineate a horizontal plane adjacent to the landing area, acting as a range, position and attitude reference during all phases of the landing procedure. The following basic parameters are satisfied by the system:—

- a) Provision of an accurate horizon datum, visible over a wide field, with a range of 152 m to 304 m (500 to 1000 yds.) under most visibility conditions, for a ship's roll of up to 30 degrees.
- b) Optimum reliability through the use of independent controls for each bar. Maximum flexibility of operation is also afforded in this manner.
- c) Simplicity of operation and minimum maintenance and spares requirements, by standardization of parts whenever possible.
- d) Safety interlocks and warnings to prevent the transmission of false information. The bars automatically lock parallel to the deck when not operating and under fault conditions.



SONAR EQUIPMENTS

Since its formation in 1951, the Electronic Systems Division of Westinghouse Canada Limited has been a major supplier of sonar to the Canadian Maritime Forces. The Company's activities in the A/S sonar field extend from the design concept phase, including original research and development work (on signal processing techniques in particular), through product development, production and factory acceptance testing. Engineering Services have also been provided to the Canadian Maritime Forces during installation, tuning testing trials of A/S Sonar Systems. Three current ASW Sonars and a special ship sensing sonar are described below. All these sonars would be supplied as complete systems, including all mechanical handling equipment, by Westinghouse who would act as Prime Contractor and System Manager.

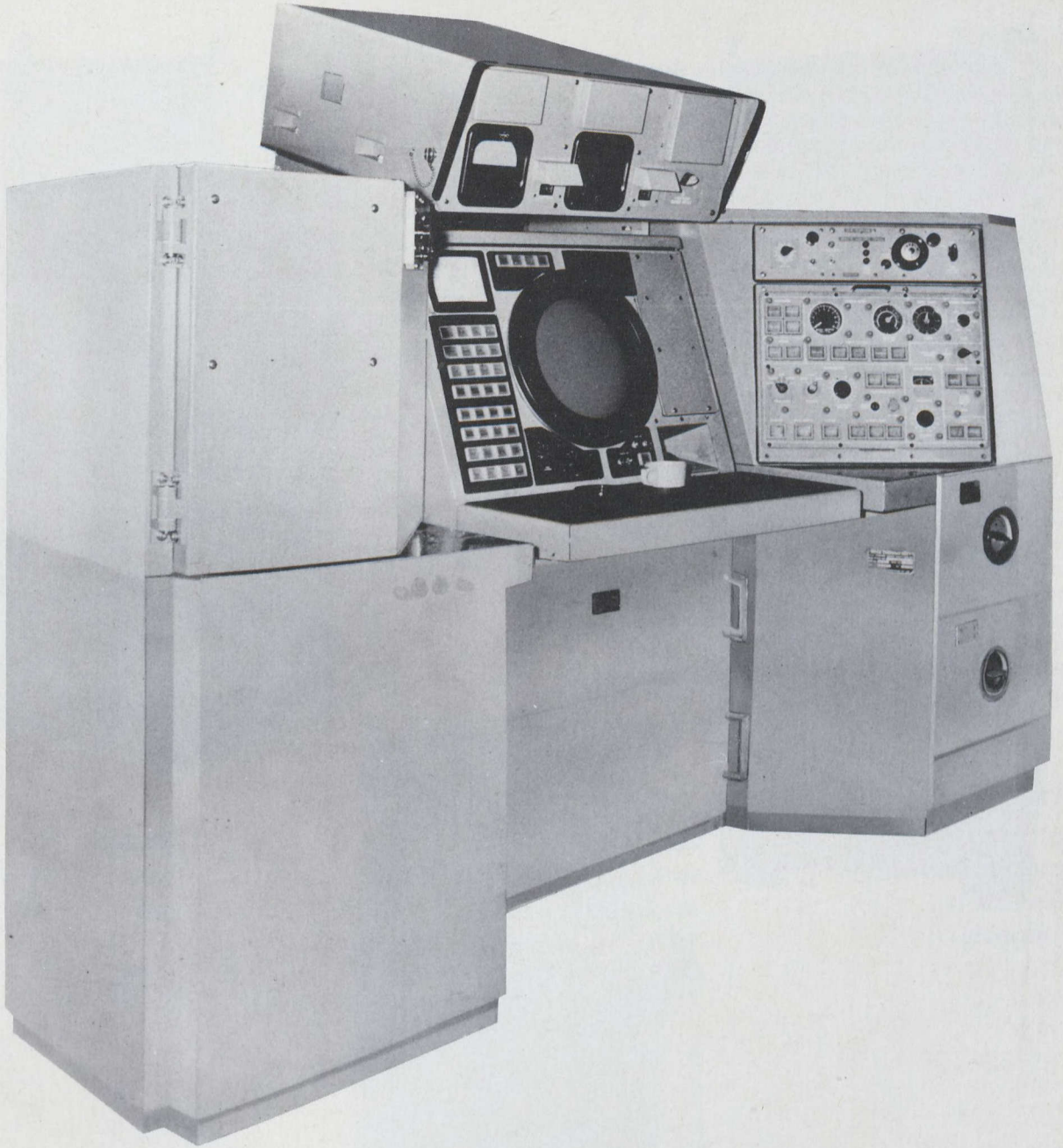
AN/SQS-505

The AN/SQS-505 Sonar was developed for use by the Canadian Maritime Forces as their search attack sonar system for the period 1970 - 1980. It is a medium sized omni-directional sonar suitable for use with ships of 1500 tons and up. On Canadian naval ships it is fitted with both a hull-mounted transducer and a variable depth towed transducer (VDS). Although especially designed for use with a computer, it is equally suitable for manual application.

The electronics are completely solid state (except for CRT display). Test equipment is integrated into the system to permit semi-automatic routine testing or trouble-shooting. Faults can be identified (by non-technical personnel or operators) down to the level of a replaceable circuit card or module component. The AN/SQS-505 is a fully qualified military sonar. The Service Test Model has been in service since 1966. The initial production units have successfully completed environmental testing, including both shock and vibration to military standards.

PHYSICAL SUMMARY [AN/SQS-505 Fixed Hull-Mounted Version]

SYSTEM COMPONENT	VOLUME	WEIGHT
Electronics Cabinets (9)	8495 dm ³ (300 ft. ³)	2630 kg (5800 lbs.)
Transducer (1)	1415.8 dm ³ (50 ft. ³)	2268 kg (5000 lbs.)
Dome (1)	4.11 m L x 1.37 m W x 1.67 m H (13.5 ft. x 4.5 ft. x 5.5 ft.)	997.9 kg (2200 lbs.)



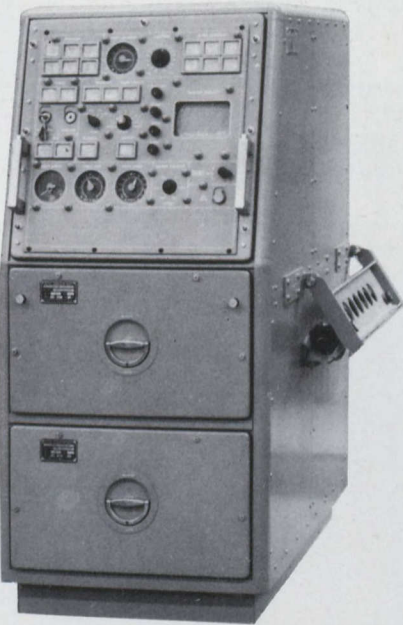
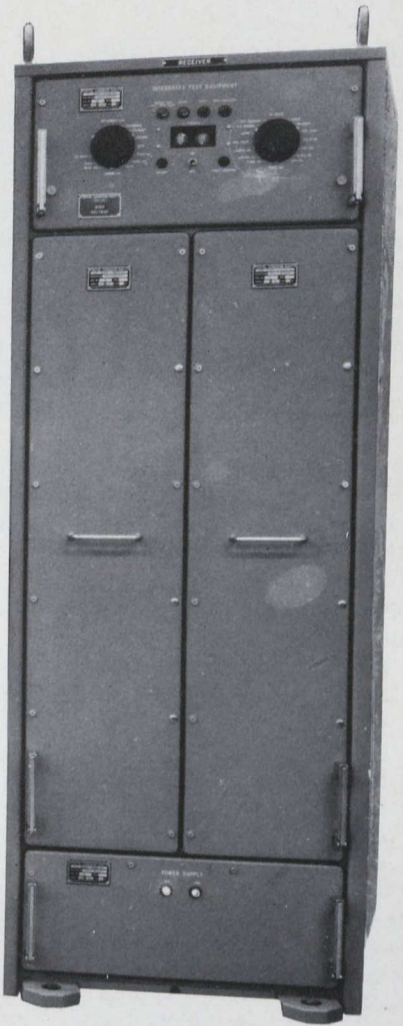
AN/SQS-507

As part of the overall responsibility as Systems Managers for the vessel's fighting equipment, Westinghouse Canada Limited designed and produced a compact Variable Depth Sonar system for the Canadian Maritime Forces Hydrofoil (Bras d'Or). It is a modern omni-directional sonar built to military specifications. In its original configuration, it is intended for integration with the hydrofoil vessel's Action Information System, and utilizes displays and a digital computer common to this system. However, an alternate Control Indicator Group is available to permit use of the AN/SQS-507 without the full Action Information System.

The electronics are suitable for use with a hull-mounted transducer, but in the special hydrofoil application, a Variable Depth Sonar type of transducer sub-system was built, using a special towed body capable of speeds in excess of 40 knots. As in the AN/SQS-505, the AN/SQS-507 sonar electronics are completely solid state, and each cabinet has its own integrated test equipment permitting semi-automatic checking of all systems' functions. Faults are isolated to the level of a replaceable printed circuit card of component module.

PHYSICAL SUMMARY

SYSTEM COMPONENT	VOLUME	WEIGHT
Electronics Cabinets (7)	5946.5 dm ³ (210 ft. ³)	2449.4 kg (5400 lbs.)
Transducer (1)	311.4 dm ³ (11 ft. ³)	340 kg (750 lbs.)
Towed Body (1)	3.9 m L x .6 m W x 2.13 m H (13 ft. L x 2 ft. W x 7 ft. H)	1678.3 kg In Air (3700 lbs.)



SONAR SHIP DETECTOR

SERIES HS-1000 SONARS

The Electronic Systems Division of Westinghouse Canada has designed and is producing a truly lightweight sonar for any ship of 100 tons or over. The HS-1000 series of sonars incorporates features usually found only in large ships sonar equipments. They provide for the first time in a single electronics cabinet a search and attack sonar capable of interfacing with an Anti-Submarine Weapon Fire Control or Data System. The HS-1000 Transducer can be either hull-mounted or installed in a Variable Depth Towed Body (VDS). The same electronics cabinet is applicable in either case.

The operator's console provides a 30.48 cm (12 in.) PPI, ball tab control of the multiplexed continuous range/bearing cursor, and a display that can be stabilized relative to either a north reference or ship's head.

Sonar transmission is omni-directional, with three selectable operational modes:—

- PRN (Pseudo Random Noise) for improved detection against low speed targets in reverberation-limited conditions.
- CW with reverberation notch filter, for improved detection capabilities against moving targets.
- Alternating PRN/CW, to ensure optimum processing and maximum detection potential in search

The electronics are completely solid state, with heat dissipation approximately 2 KW.

The average power demand on the ship's supply is only 2 KW with instantaneous peaks below 4 KW.

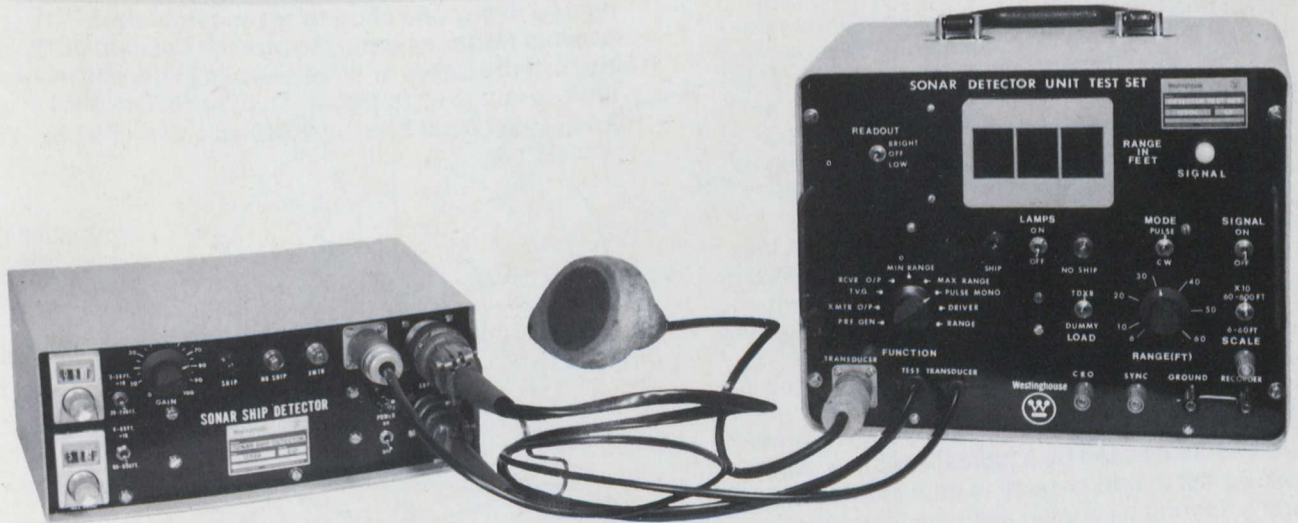
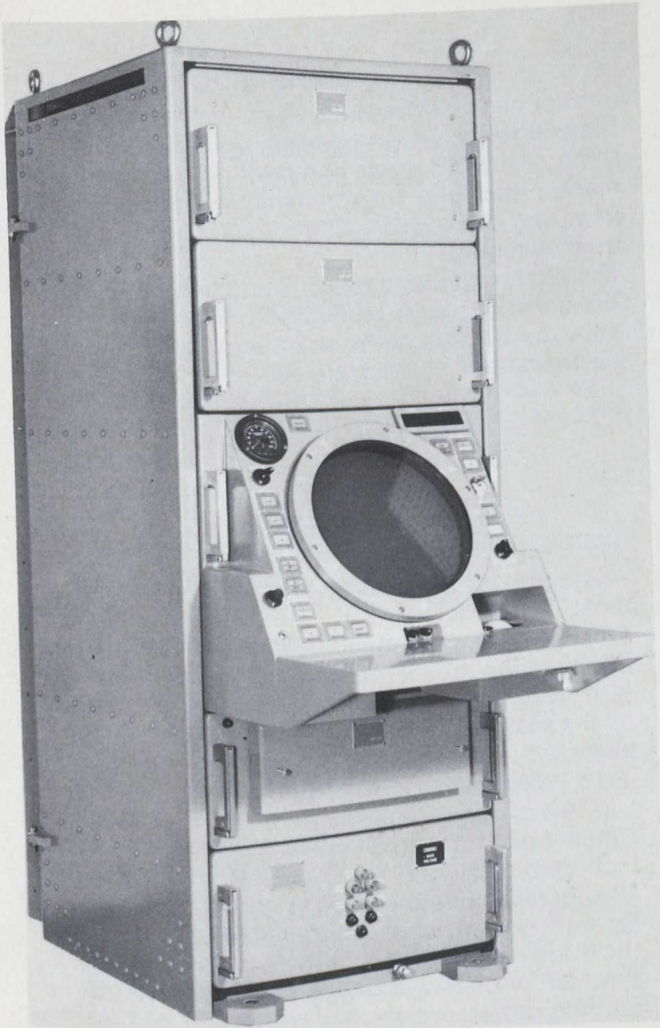
Integrated test equipment, and a memory range A-Scan display are two of the several optional features available in the HS-100 series sonar.

To meet a requirement of the Canadian St. Lawrence Seaway Authority, to detect and monitor the passage of ships through certain sections of the Seaway System, Westinghouse designed a Sonar Ship Detector. As a result of the range gating and widely adjustable sensitivity designed into this unit, it has the capability of being able to detect and monitor the large shipping vessels, while ignoring small pleasure boats, floating debris etc.

Although specifically designed for a domestic application, this principle has a defence use in monitoring surface vessels or submarines passing through a harbour entrance.

PHYSICAL SUMMARY

SYSTEM COMPONENT	VOLUME	WEIGHT
Electronics Cabinet (1)	182.88 cm H x 63.5 cm W x 132.08 cm D (72 x 25 x 52 in.)	453.6 kg (1000 lbs.)
Transducer (1)	60.96 cm H x 68.58 cm Dia. (24 x 27 in.)	272 kg (600 lbs.)



MINESWEEPER AND OCEANOGRAPHIC PLOTTER (M541A)

The X-Y plotter, model M451A, has been specially designed to plot the track of a minesweeper, sweeping a minefield. Range and bearing data, relating own-ship position to a moored marker buoy or other fixed reference point, are fed from a radar PPI to the plotter in which the own-ship projector follows the true geographic track of own-ship relative to the fixed reference. The initial position on the plot is established by setting in the marker-buoy co-ordinates on a phantom grid of 254 cm by 254 cm (100 inches x 100 inches). The plotter is also fitted with two target plotting projectors, Model M157, and target data selectors to permit selection of any two of up to seven sources of target data. In addition to the minesweeping operation, described herein, the equipment is ideally suited for use as a mapping aid in oceanography and in off-shore mineral exploration.

The plotter can be fitted with selected plotting scales, up to two additional target plotting projectors or other features to meet a wide variety of customer requirements.

Marsland Engineering, as well as being one of the finest custom machine shops in Canada, also possess a strong engineering group who have produced this equipment and others of equal complexity.

EQUIPMENT:

The M451A plotter is structurally the same as the MK NC2 plotter with the plotting surface on top and the main controls along the front or south side. The structure is largely composed of non-magnetic materials to minimize the degaussing requirements of the minesweeping vessel. The principal magnetic items in the plotter are the cores of transformer and rotary devices. The plotting surface is of frosted plexiglas on top of a sub-surface of tempered plate glass. The plotting surface dimensions are 76.2 cm by 114.3 cm (30 by 45 inches) and the limits of the own-ship projector motion are 58.4 cm by 83.8 cm (23 x 33 inches). Two lamp dimmers, for own-ship projector and plotting surface back-lighting, are located on the back or north side of the plotting table beside the stowage cabinet for graticules and rules.

The principles of operation of the M451A plotter are best illustrated by a typical exercise. After setting out a marker buoy (with a radar target) and selecting a suitable scale on the plotter, the operator sets in suitable co-ordinates for the

marker buoy on the plotter by means of dials on the control panel. An operator on the radar PPI sets the PPI range and bearing cursors on the marker buoy blip, thus transmitting range (R yards) and bearing (B degrees) of the buoy from own-ship.

The plotter converts range R and bearing B into X-Y co-ordinates of distance from the marker buoy to own-ship at the selected scale. The co-ordinate conversions are:

$$X = \frac{R}{S} \cos (B + 180^\circ) \text{ inches}$$

$$Y = \frac{R}{S} \sin (B + 180^\circ) \text{ inches}$$

where R is in yards, and S is scale in yards per inch.

The X-Y co-ordinates of buoy to own-ship are added to the preset marker buoy co-ordinates (X_m , Y_m) to give the present own-ship position on the plot. Own-ship's plot position (X_o , Y_o) is given by:

$$X_o = X_m + X \text{ inches}$$

$$Y_o = Y_m + Y \text{ inches}$$

Datum point for the 254 cm by 254 cm (100 x 100 inch) grid is located at 127 cm (50 in.) west and 127 cm (50 in.) south of the centre of the plot.

By marking own-ship position at regular intervals, the track of own-ship is plotted.

The M451A plotter is also fitted with two target plotting projectors, each of which may be connected to any one of up to seven target data sensors (radar or sonar) to plot the position or track of obstacles or other vessels in the immediate area (up to 18,288 m range at 1828 m per 2.54 scale (20,000 yds. at 2,000 yds. per inch scale).

SPECIFICATIONS:

Dimension:

129.8 cm long by 100.9 cm wide by 100.3 cm deep (51 $\frac{1}{8}$ in. x 39 $\frac{3}{4}$ in. x 39 $\frac{1}{2}$ in.).

Weight:

401 kg (886 lbs.).

Mounting:

Deck-mounted on Barry C4300-T10 shock-mounts.

Power Requirements:

120 volts 400 hertz 1 phase 2.5 amperes max.

120 volts 60 hertz 1 phase 1.5 amperes max.

Power Dissipation:

420 Watts.

Accuracy — Own-Ship:

1% of full scale, all scale ranges, up to a speed of twenty knots.

Targets:

1% up to 1 inch/second range rate, and 25°/second bearing rate.

Slewing Rates:

Slow: 6.3 mm per second (.25 in. per sec.).

(minimum)

Fast: North-South: 142 mm per second (5.6 in. per sec.). East-West: 83.8 mm per second (3.3 in. per sec.).

Input Requirements:

Marker-buoy range (R): 1.14 volts per 1,000 yards (400 hertz voltage).

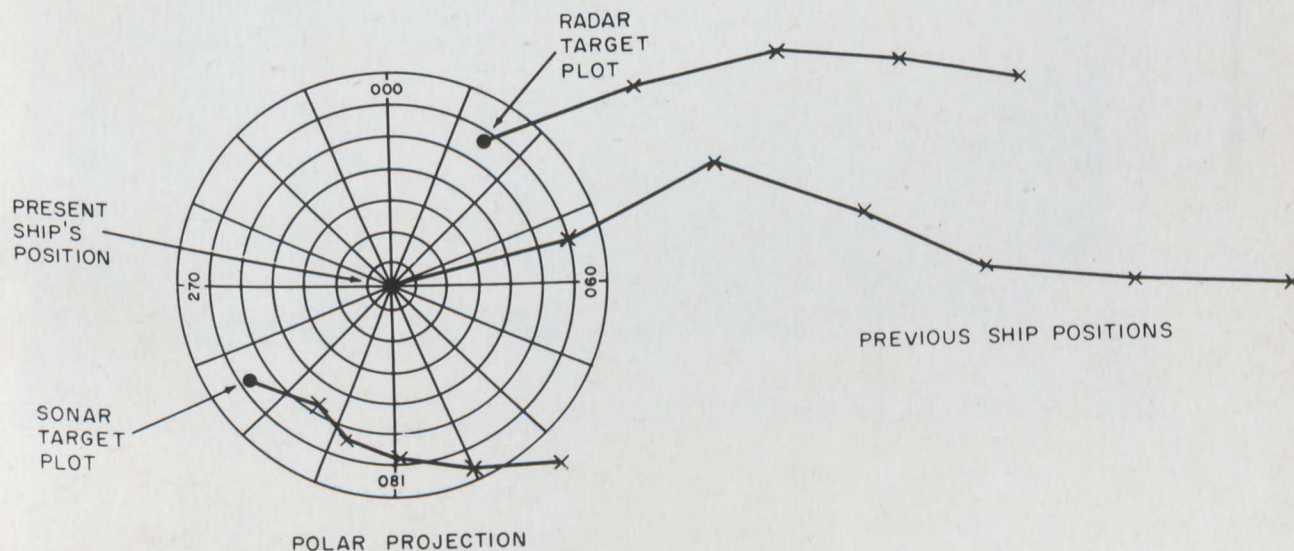
Marker-buoy bearing (B): 115 volts

400 hertz 3 wire synchro.

Target Range (R_t): 6.0 volts per 1,000 yards (400 hertz).

Target Bearing (B_t): 115 volts
400 hertz 3 wire synchro.

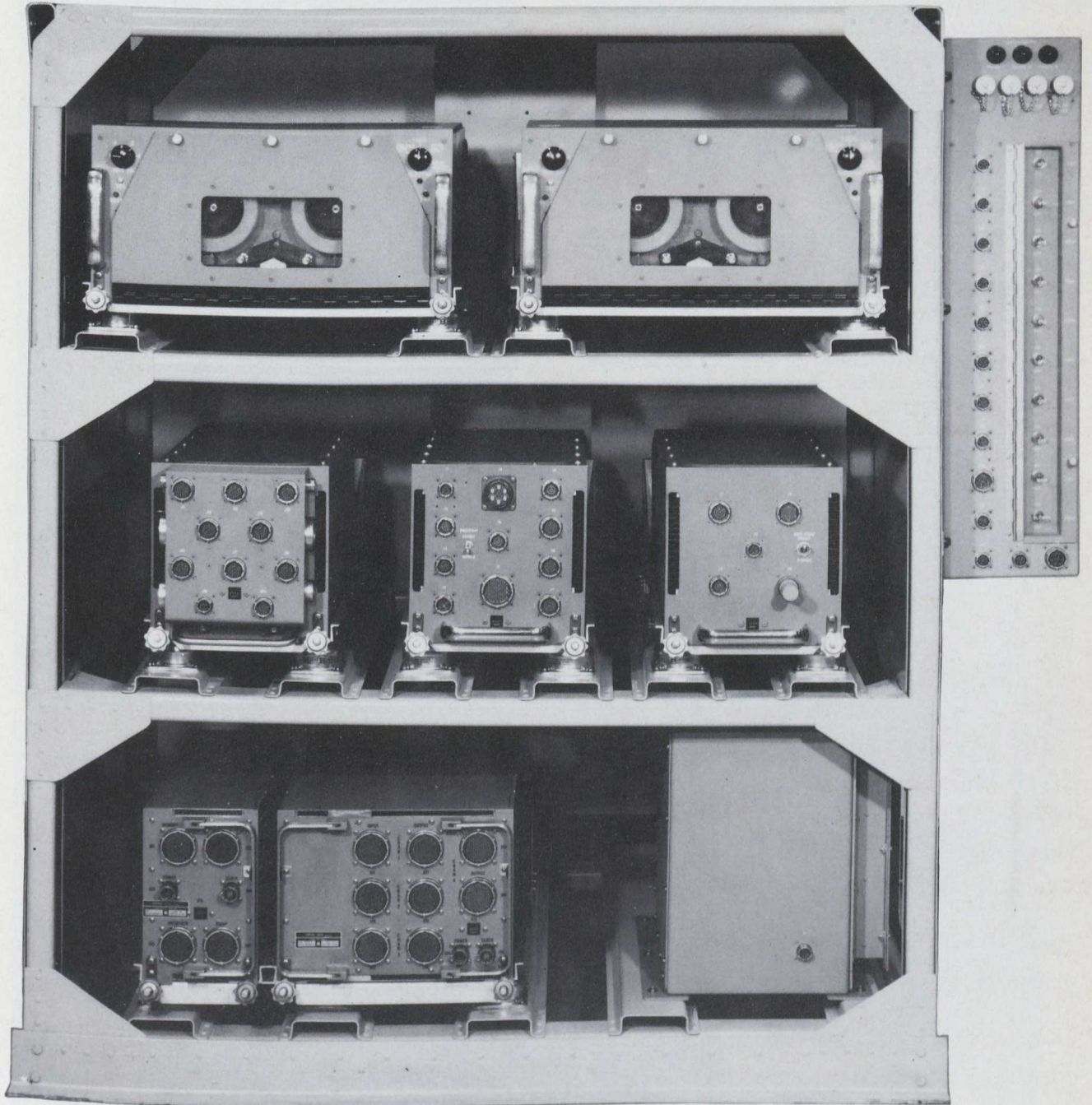
This equipment can also be produced so as to present a metric display.



ALPHA COMPUTER SYSTEM (ASW)

A function of a long range Anti-Submarine (ASW) patrol aircraft is to detect and locate submarine targets using acoustic and non-acoustic sensors. Computing Devices, through co-operative Canada/US Navy cost sharing programmes, has developed special computer processes and systems that substantially improve the capability of ASW sensors. These systems are a flexible suit of computing hardware consisting of the Control Data ALPHA computer and memory connected to an independent input/output processor and mass storage digital magnetic tapes.

The ALPHA system was chosen from a large number of competitive machines because of its unique capabilities in the fields of analysis, pattern recognition and statistical decision making. Its advanced technology include MSI circuitry, thin film and core memory and one microsecond cycle time. In addition to these features, its rugged military design (MIL E 5400 class 1AX) enables it to be effectively employed in the prohibitive ASW environment. The high reliability of the digital magnetic tape system has demonstrated this effectiveness over six years of operational use. The ASW Forces have placed great emphasis on the sensor decision-making function of the ASW aircraft and thus this ALPHA computer system is "dedicated" to sensor data processing. An ALPHA Fast Fourier Transform (FFT) spectrum analyzer has been interfaced with this computer system to further improve its capability as a Signal Processing System. This approach can be fitted to become the advanced OMNI and directional Sensor Data Processing system for any ASW patrol platform.



SONOBUOYS

For more than seventeen years Sparton of Canada, Limited has been producing sonobuoys for the Canadian and United States markets. With the co-operation and assistance of the Department of National Defence the company has been able to achieve an increase in reliability from about 50% to more than 96% and at the same time reduce the price by a factor of 3. The AN/SSQ517 illustrated is the buoy currently in use by the Canadian Maritime Forces and is in quantity production.

In addition to their primary role in Anti-Submarine Warfare, modifications of the standard sonobuoy have proven very useful in underwater geological survey operations and are being marketed for that purpose.

Sparton of Canada, Limited has complete facilities for the development of all types of sonobuoys, military and non-military, Active and Passive, including a completely instrumental test tank and other equipment such as wave machines to simulate ocean operating conditions.

SPECIFICATIONS

Dimensions:	Length: Shipboard launch	86.36 cm (34 in.)
	Airborne launch	91.44 cm (36 in.)
	Diameter:	12.38 cm (4.875 in.)
	Weight:	5.78 kg to 8.61 kg (12.75 to 19 lb.) Depending on operating life.
Frequency:	RF — 162.25 — 17,125 in 31 channels Acoustic — 10 Hz — 20 KHz as required	
RF Power:	1 Watt min.	
Modulation:	FM	
Operating Life:	30 mins to 14 Hrs as required selectable if required	
Storage Life:	Indefinite — 5 years nominal	
Range RF:	241 km (150 miles) (dependent on receiver altitude)	
Hydrophone:	Line Array or Omni	
Launching:	Ship, Helicopter, Fixed Wing Aircraft	



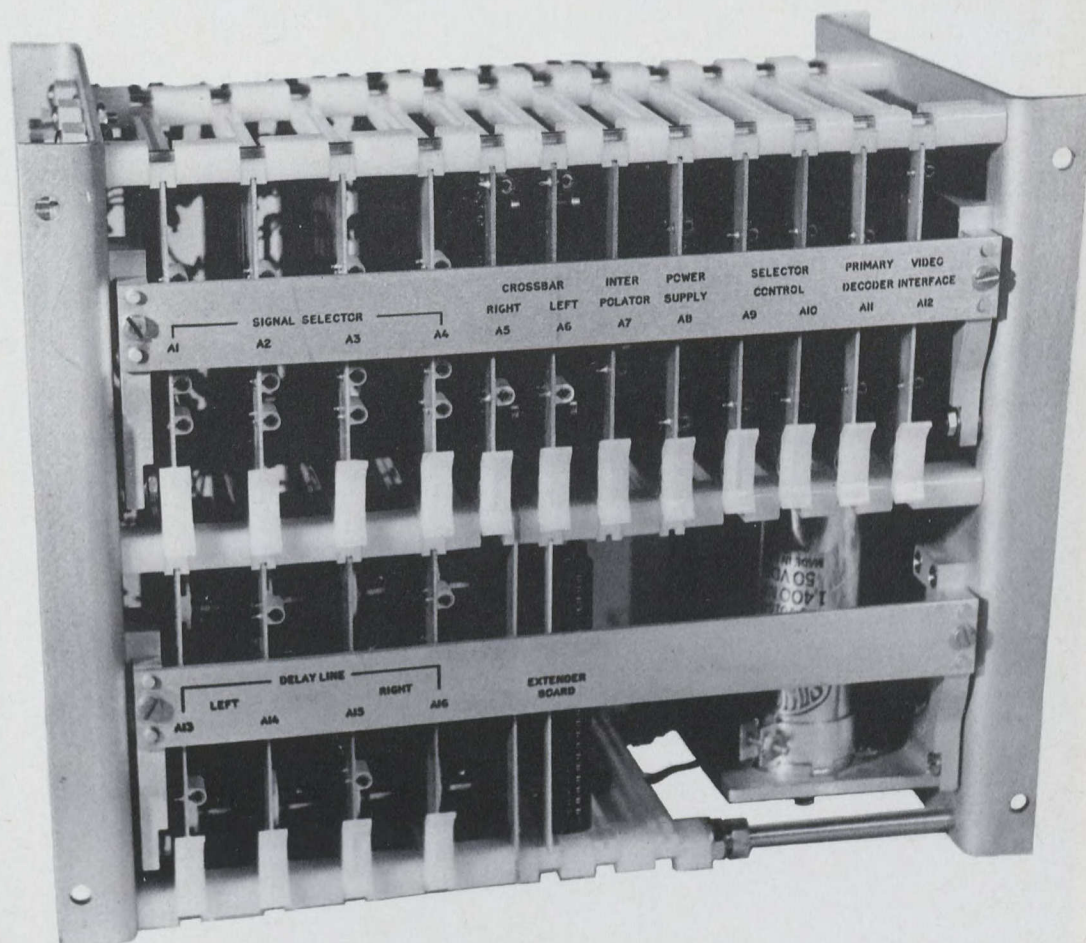
SOLID STATE ELECTRONIC TRANSDUCER SCANNER

The C-TECH Ltd. Electronic Scanner is a solid state electronic replacement for the mechanically rotated scanning switches used in most Anti-Submarine Warfare scanning sonar sets currently in use in the Canadian, United States and other Allied navies.

The electronic circuits of the electronic scanner duplicate all of the functions and meet all of the technical performance and interface requirements of the mechanical scanning switch. The electronic scanner has no adjustments or controls; its circuits are protected against abnormally high preamplifier output voltages. The Mean Time Between Failure rate of the electronic scanner is well in excess of 5,000 hours.

The electronic scanner operation can be checked with the applicable sonar test set. The testing procedure allows a fault to be localized to a printed wiring assembly. Repairs are effected by the replacement of the defective board. Installation of the scanner can be carried out by ship or shore based personnel and can be accomplished in less than four hours.

The electronic circuits, including solid state sweep generator are arranged on eighteen printed wiring assemblies; several of which are common. These boards plug into a card file to form a single assembly whose overall dimensions are 33 cm (13 in.) wide by 28 cm (11 in.) high by 23 cm (9 in.) deep. The total weight of the equipment is 6.8 kg (15 lb.).



TRANSISTORIZED MARINE RADAR — LN-66

Continuing development by Canadian Marconi in the light marine radar field has seen increased power, increased range and improved range resolution without attendant increases in cost or over-sophistication.

This equipment consists of three separate interconnected units:

1. The Antenna (with associated drive unit). (Marconi antennas are computer-designed slotted waveguide arrays for maximum precision. Three antennas provide a suitable choice for all conditions.)
2. The Transmitter/Receiver Unit.
3. The Display Unit.

1. Antennas.

FIXED RADOME — Suitable for even the smallest craft. Houses the antenna only, with no electronics. Not affected by wind drag or ice loading and cannot foul lines or cause personal injury. Gives constant rotation speed with minimum current drain.

ROTATING ANTENNAS — Two lightweight models, one 1.22 m (4 ft.) the other 2.44 m (8 ft.) are designed for the larger vessels and provide improved angular discrimination. No exterior electronics which make adjustments and maintenance difficult or which deteriorate from weather and spray. Fixed coil display keeps antenna synchronized with display without "switch on" adjustment.



2. THE TRANSMITTER/RECEIVER UNIT — Has been designed to meet the exacting needs of either river, coastal or seagoing vessels, navigating in crowded or constricted waterways as well as in open water. Dual pulse lengths, with automatic switching give maximum efficiency at all ranges. A manual pulse override permits high-definition visual indication of buoys, channel markers, other craft and the shore line for precise short-range navigation. It is transistorized to the highest state-of-the-art to give the combination of compactness, reliability and low power requirements. Even the power supply is transistorized — no moving parts to maintain or replace. Peak power output of 10 kW.

3. THE DISPLAY UNIT — Plug-in circuit boards which can be removed and replaced without the need for a soldering iron make it easy to service, should this become necessary. Fold-out trays and swing panel assemblies reduce down-time to an absolute minimum. The 25.4 cm (10 in.) cathode ray tube utilizes a P33 phosphor giving long persistence and good contrast. An edge-lit panel provides uniform illumination of all switch and control positions.

SPECIFICATIONS

1. ANTENNAS —

FIXED RADOME

Horizontal Beamwidth

Side Lobe Suppression

Rated Wind Load

Weight

	4' SWG	8' SWG
Horizontal Beamwidth	2.5°	0.85°
Side Lobe Suppression	Better than 24 dB.	Better than 28 dB.
Rated Wind Load	80 knots	80 knots
Weight	22.7 kg (50 lb.)	35.6 kg (78.5 lb.)

2. TRANSMITTER/RECEIVER —

Peak Power Output

Frequency

Pulse Width

Pulse Repetition Frequency

IF Bandwidth

IF Center

Noise Figure

Weight

Peak Power Output	10 kW.
Frequency	9345 to 9405 MHz.
Pulse Width	0.05 and 0.5 microseconds.
Pulse Repetition Frequency	2500 and 1250 pulses per second.
IF Bandwidth	14 MHz.
IF Center	45 MHz.
Noise Figure	11 dB overall.
Weight	20.4 kg (45 lb.)

3. DISPLAY —

25.4 cm (10 in.) Display Tube

Fixed Coil

Range discrimination

Range Accuracy

Bearing accuracy

Ranges

Weight

P33 Phosphor

18.2 m (20 yds.) or better

±1% of indicated range or 20 yds. whichever is greater.

1.22 m (4 ft.) antenna ±1%

1.44 m (8 ft.) antenna ±0.9%

0.4, 2.4, 5, 9.6, 19.3 and 58 km.

¼, 1½, 3, 6, 12 and 36 miles

22.7 kg (50 lb.)

TEMPERATURE, DEPTH AND SALINITY SYSTEMS

These oceanographic data collection systems provide unparalleled convenience, speed, and accuracy in the accumulation of data profiles of ocean temperature and salinity as a function of depth. A single, compact, lightweight probe, lowered overside by a light winch and cable, and dropped at a rate of up to 3.04 m (10 ft.) per sec., transmits continuous analog data from its three high-precision transducers to a small panel-mounted solid-state control console on deck. The three signal voltages, representing depth (pressure), temperature, and salinity, are high-level (2 or 3 volts) linear functions of the measured parameters, immune to denigration by noise pickup and thermoelectric effects.

The outputs of the console amplifiers are designed for direct drive of X-Y potentiometric recorders or data logging after appropriate conditioning. Panel controls provide selection of four output scale sensitivities for each function, and 10-step zero-suppression controls permit an additional choice of recording levels, enabling the operator to obtain an optimum presentation of observation range and resolution.

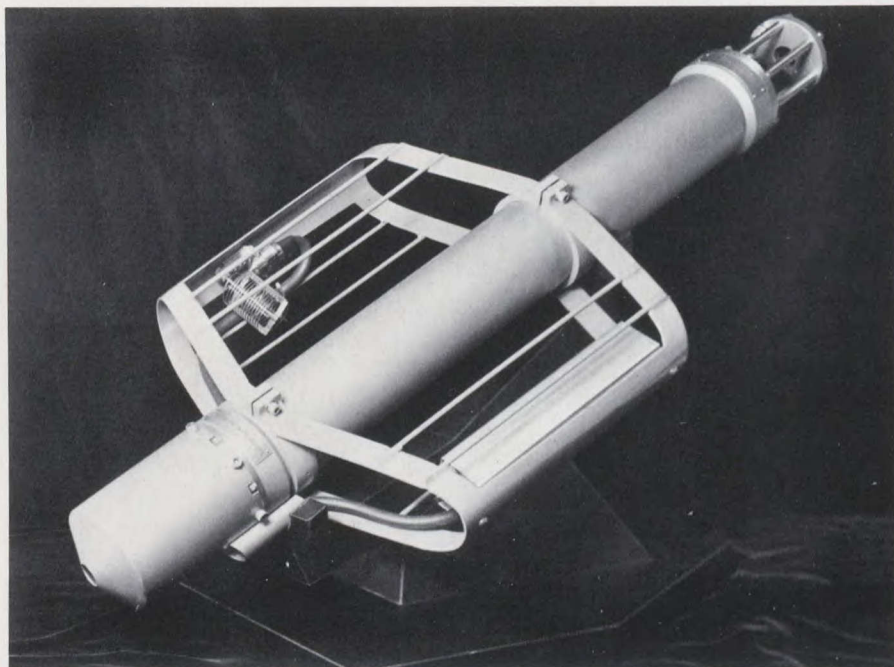
The use of interchangeable plug-in components (including sensors), which can be independently calibrated, makes the entire system extremely simple and easy to use. User calibration is confined to ice-point checks of the thermometer,

35PPT reading of the salinometer, and surface pressure setting.

The instrument is readily convertible from narrow range conductivity (full span from 28 to 40 parts per thousands) with accuracy of ± 0.04 PPT, to wide range (full range from deep ocean, to 40PPT down to tap water, to 50PPM) with accuracies of ± 0.06 PPT at 35PPT and ± 1 PPM at 100 PPM. Conductivity in the narrow range model is automatically temperature compensated to give a direct analog of salinity.

In addition to conventional vertical profiling the system is readily packaged in towing bodies for high speed horizontal or combined profiles. Conversion to a minimum diameter 104.7mm (4 $\frac{1}{8}$ in.) configuration for Arctic through-the-ice profiling can be achieved in minutes.

The Series 8100 systems evolved from collaboration between Guildline instruments and the National Research Council at Ottawa. This collaboration has resulted in a number of significant advances in the production of electrical and temperature measuring instruments and standards of the highest accuracy and resolution. Guildline's potentiometers and bridges, voltage and resistances standards, and related equipment are in use by standards and research laboratories around the world, and where the ultimate in performance is required.



OUTBOARD MOTORS

Outboard Marine Corporation of Canada Ltd. manufactures outboard motors under the brand names Johnson and Evinrude, with a horsepower range of 2 to 125 HP. Many countries including Great Britain, have utilized these products for military purposes, particularly in the 18, 20, 25 and 40 HP models. They have also been used extensively by the Canadian military forces. All models feature compact design and simplified construction for ease of maintenance. Models ranging from 50 to 125 HP have a capacitor discharge ignition system for longer spark plug life. Optional propellers are available to suit any use. For military applications, olive drab finishes are available. These various military uses include the building of pontoon bridges, powering barges and landing craft, and providing portable power for military inflatable boats. Johnson and Evinrude outboard motors are distributed world-wide. There exists an availability of parts, service, and product knowledge for these units in nearly every part of the world.



MARINE DESIGN & DRAUGHTING

In 1949, Canadian Vickers Ltd., Montreal, was tasked, by what is now known as the Dept. of Supply & Services, with the setting up, manning and operation of a centralized Drawing Office with its primary purpose being the production of Working Drawings for the Royal Canadian Navy. This office was to be known as the Naval Central Drawing Office (N.C.D.O.).

As Warship technical know-how was built up, N.C.D.O. became more involved in the Contract Design aspect of each Programme and, to-date, Contract Design and/or Working Drawings have been processed for virtually every naval major new construction and/or conversion programme. These include:—

NEW CONSTRUCTION

<i>St. Laurent Class</i>	<i>G.P. Frigate Class</i>
<i>Restigouche Class</i>	<i>Vancouver Class</i>
<i>Mackenzie Class</i>	<i>Provider O.S.S.</i>
<i>Annapolis Class</i>	<i>Diving Tender</i>
<i>Iroquois Class</i>	<i>Deperming Barge</i>

CONVERSIONS

<i>St. Laurent Class</i>	<i>Bangor Class</i>
<i>Restigouche Class</i>	<i>Bonaventure Class</i>
<i>Ocean escorts Class</i>	

As an operational arm of the Royal Canadian Navy, this office was involved in numerous other associated activities, some of the more basic functions being:—

Specification & Ship Standards Drawings; Market Research, Assessment of Quotations, Requisitioning and Leayard Demands; C.P.M. Networks; Weight Control, Corrosion Control and Drawing Quality Control & Assurance Programmes; Master Composite Drawings; small scale Models and full size Mock-ups; etc.

From the foregoing functions, special emphasis should be placed on the control aspect of Master Composite Drawings and the small scale model of the Main Machinery Space. These two virtually control the spatial arrangement of the ship especially from the point of view of piping, ventilation and electrical systems with none of these systems becoming the final working drawing until they have been "proven" on the control document.

With the cessation of shipbuilding operations, in Montreal, by Canadian Vickers Limited in October, 1969, a new organization has been built on the joint foundation of the existing Naval

Central Drawing Office and the Marine Technical Drawing Offices of Canadian Vickers Limited with the expertise formerly available only to the Canadian Government and to the commercial customers of Canadian Vickers Limited respectively, now open to all Canadian and foreign marine interests.

This new organization is now known as the "MARINE SERVICES & SYSTEMS", a Division of Canadian Vickers Limited, Montreal.

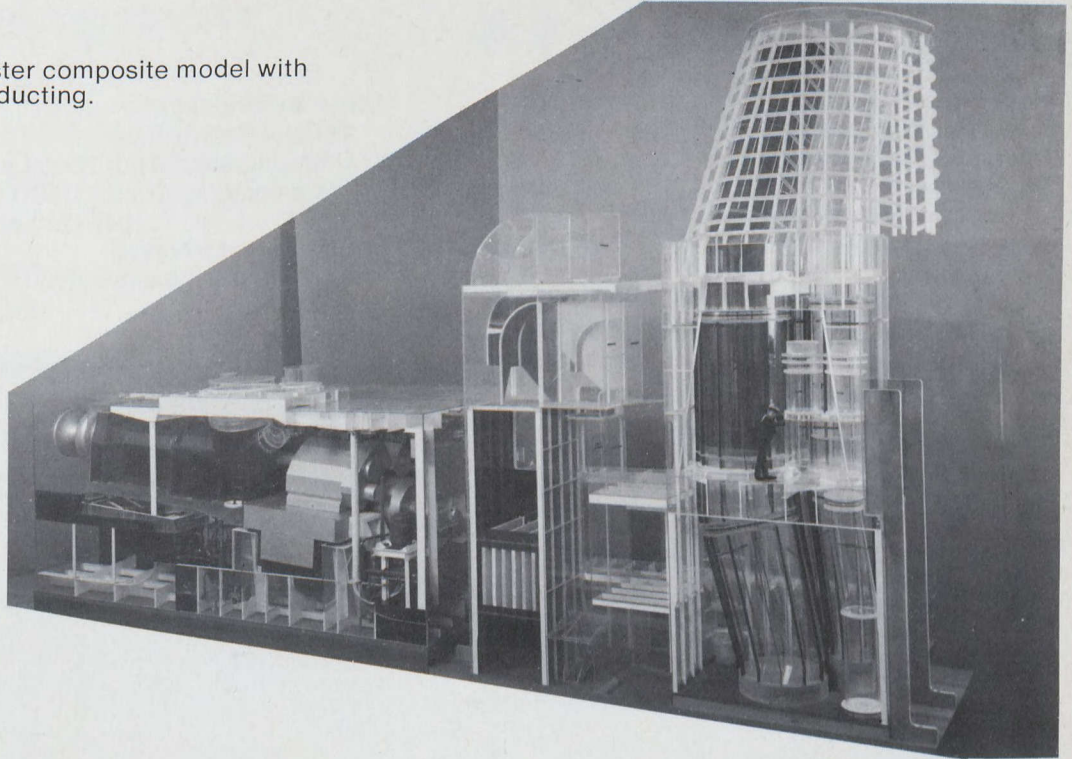
By this combining of forces, expertise in the commercial marine fields has been retained, with vast experience in the following types of vessels:—

Cable Laying	Icebreakers
Car/Passenger Ferries	Lakers Bulk Cargo
Container	Passenger/Cargo
Dredges	Tender/Buoy
Floating Docks	Trawlers
Hydrographic Survey	Tugs

The services offered by "Marine Services & Systems" are the conceptual and basic design, the production of working drawings and associated documentation, specifications, models and mock-ups, quality control and assurance, weight control, corrosion consultant service, in fact, just about everything associated with Naval and/or commercial marine shipbuilding.

The versatility of this organization can also be demonstrated in its contribution to the world fishing industry. Since 1969, the organization has designed outstanding all-weather shrimp and fish trawlers, purse-seiners-combination boats such as the (a) *Supershrimper*, (b) *Amazon Delta Trawler* and (c) *Northland Delta Trawler*. Most of these are equipped with the Canadian Vickers Multi-Rig Trawling Method, which, through simplification, has upgraded trawling considerably when fishing with one, two or three nets. Marine Services & Systems also has direct access, within the Canadian Vickers Organization, to the design and drawing office expertise of the Industrial Division should any workload involve areas of non-marine work.

DDH 280 main master composite model with intake and uptake ducting.



General view of the drafting office.



VHF/UHF ANTENNA GROUP AN/SRA-505

The VHF/UHF antenna group is a proven design equipment used on board DDE/DDH class ships to permit simultaneous transmission and reception of signals in the combined VHF/UHF range. The equipment consists of an antenna assembly, two antenna couplers (diplexers) and an antenna patch panel.

The antenna assembly comprises two independent antennas located colinearly, one on top of the other, each covering both the VHF and UHF frequency bands.

The two antennas together with associated cabling and ancillary fittings are enclosed in a fibreglass radiation-transparent structural member with a ladder providing access to attachment fittings for externally mounted antennas (antennas not supplied). The mast is a self-supporting structure.

Main advantages of this antenna group:

- Eliminates the need for individual VHF and UHF antennas

- Construction meets all shipboard environment conditions

- Minimizes intermodulation products

- Mounting facilities for other antennas at the mid-section, space for a DF antenna at the top and fittings for obstruction lights.

RCA Limited can adapt this flexible design to meet the requirements of other classes of ships.

Basic specification:

- Vertical Polarization

- Omni-directional horizontal pattern

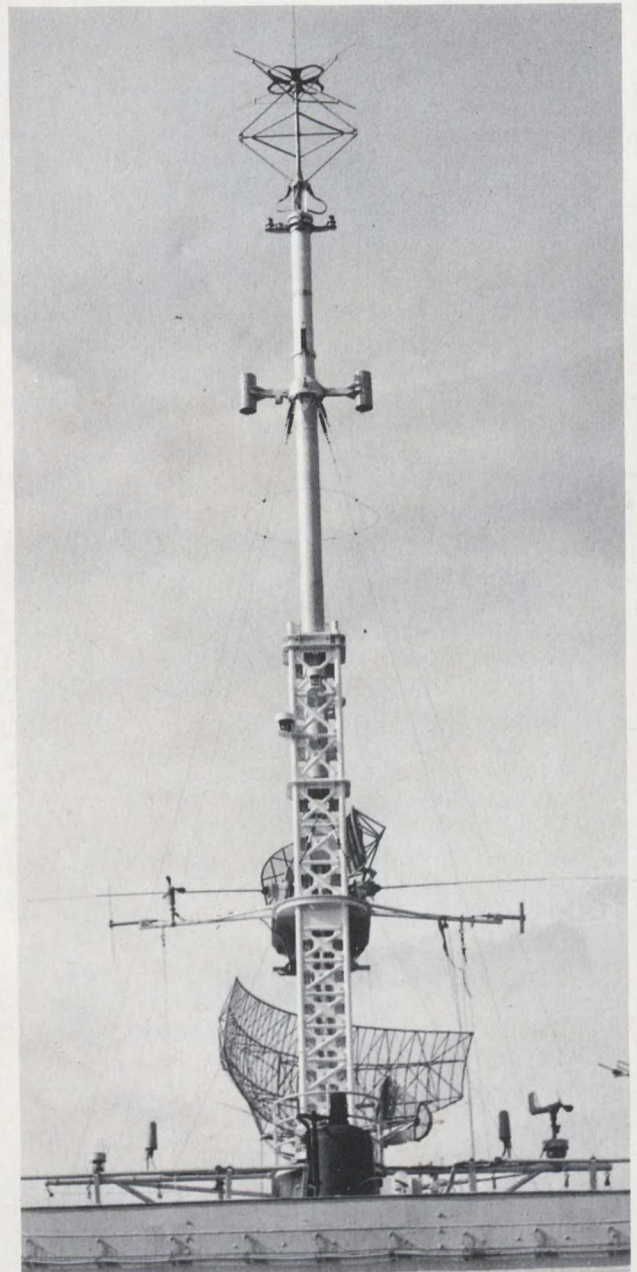
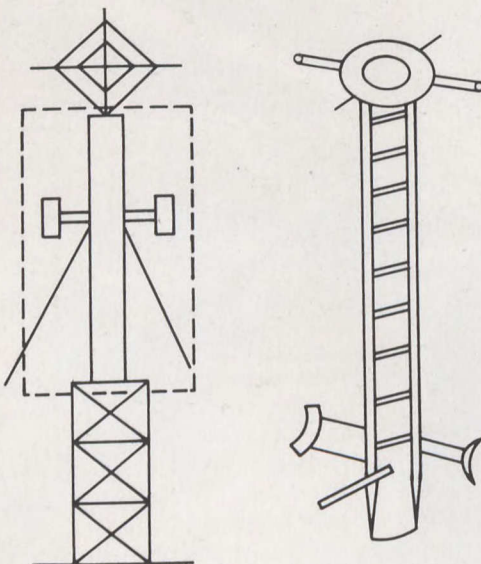
- Frequency range VHF (156-173 MHz)

- UHF (225-400 MHz)

- Impedance 50 ohms

- Power handling capacity VHF 100W

- UHF 2000W



WHEELED AND TRACKED VEHICLES



OFF-HIGHWAY VEHICLES — FLEXTRAC NODWELL

One of the generally accepted by extremely high costs of the new construction of military encampments or of any site is the moving in and out of the primer equipment required to transport materials, construction equipment or the work force. Such costs often preclude the desired end or seriously curtail the degree of achievement planned and in some cases will force abandonment of the complete project.

The off-highway series of tracked and wheeled vehicles designed and produced Flextrac Nodwell have offered construction and exploration crews the advantages of equipments designed for a cross-country role, not adapted, at lower basic costs, with the additional advantage of further on-site use following the initial stages.

The following pages will detail a cross section of the vehicles available from this company whose pioneering equipments in this field have seen service in such diverse fields as Antarctic expeditions and Hawaiian sugar cane fields.

MODEL FN-WT 100

This newer member with its high speed off-highway capability is now in service in the Canadian north, where dependability and operating costs are the criteria.

Weight of vehicle
5,443 kg (12,000 lb.).

Payload
4,536 kg (10,000 lb.).

Ground pressure
135 kg/cm² (51 lb./in.²) at 0 in. penetration.

Frame
Steel, articulated centre pivot, on front axle bearing trunnion allowing frame oscillation.

Engine
Ford Industrial Gasoline V8 5.4 l (330 in.³), 150 BHP 12V electric starter, generator and voltage regulators, centrifugal flyball governor, dry type air cleaner, standard fuel and oil filters, mechanical fuel pump.

Gear train
New process transmission — 435L — four (4) speeds forward, one reverse, synchromesh gears 30.5 cm (12 in.) heavy clutch (12 speeds forward and three speeds reverse with the use of the transfer case).

Electrical system
12 volt w/53 amp-hour battery.

Overall width
302 cm (119 in.).

Overall length
610 cm (240 in.). Wheel base 305 cm (120 in.).

Overall height
To top of canopy — 287 cm (113 in.).

Ground clearance
64 cm (25 in.) at axle: 76 cm (30 in.) at pivot point.

Ground speed
to 65 km/hr (40 mph).

Winch
5,443 kg (12,000 lb.) capacity, 38 m (125 ft.), 9.5 mm (3/8 in.) cable, hook and fairleads.



FN-WT 100



FN 110

MODEL FN 110

The illustration below shows a Seismic field drilling unit being carried by this versatile vehicle which is considered to be the work horse in the middleweight field.

Weight of vehicle	8,240 kg (18,200 lb.)
Payload	5,440 kg (12,000 lb.)
Ground pressure — unloaded	0.106 kg/cm ² (1.51 in. ²)
— loaded	0.177 kg/cm ² (2.52 in. ²)
Overall width — tracks on	302 cm (119 in.)
Overall height	287 cm (113 in.)
Overall length	640 cm (252 in.)
Ground clearance — loaded	41 cm (16 in.)
Fording depth	112 cm (48 in.)
Climbing ability — grade	60%
Sidehill ability — grade	40%

Power train:

Engine — Ford 391 C.I.D. V-8 Industrial gasoline

Transmission — Spicer 5652 — 5-speed forward, 1 reverse

Clutch — 36.5 cm (14 in.) hydraulic controls

Final drive — controlled planetary differential in oil bath 4.5:1 reduction
— outer planetaries 3.6:1 reduction

MODEL FN 360

The 360 edges into the field of the heavyweight carriers and its use is as diversified as your requirement.

Weight of vehicle	14,500 kg (32,000 lb.)
Ground pressure — unloaded	0.126 kg/cm ² (1.80 in. ²)
— loaded	0.268 kg/cm ² (3.82 in. ²)
Overall width — tracks on	368 cm (145 in.)
Overall height	296 cm (116½ in.)
Overall length	860 cm (338 in.)
Ground clearance — loaded	58.5 cm (23 in. approximately)
Climbing ability	60% grade
Sidehill ability	40% grade

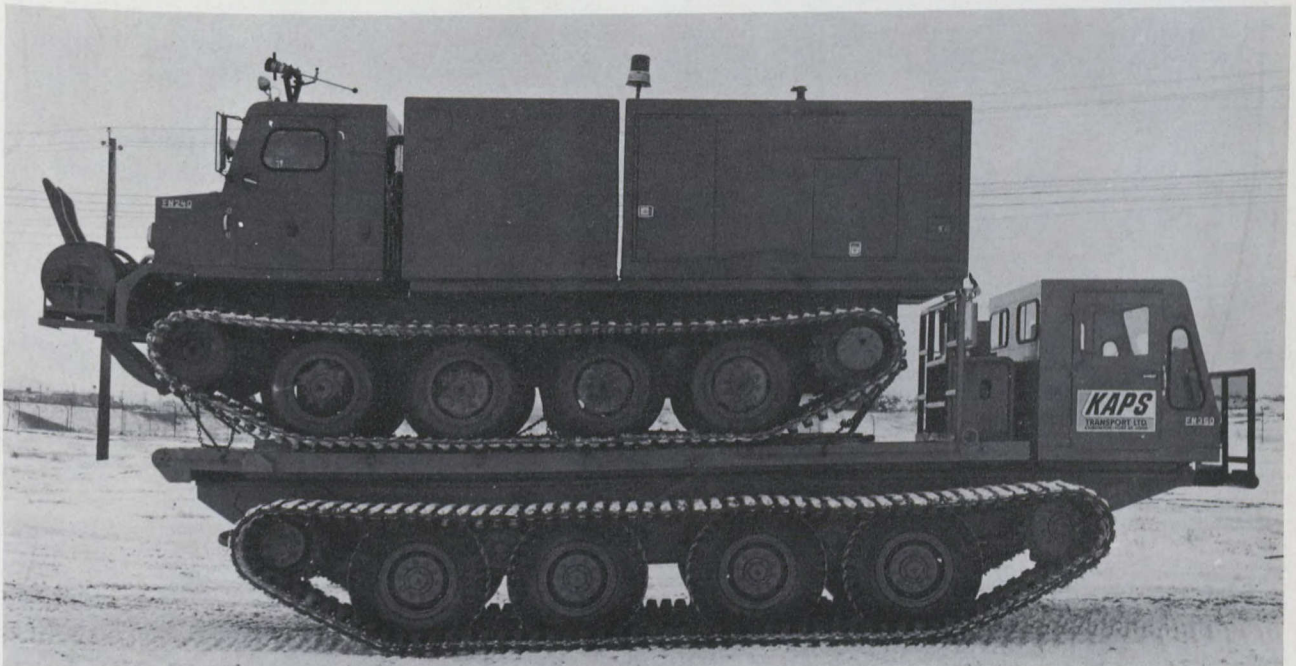
Power train:

Engine — Ford 534 C.I.D. V-8 Industrial gasoline or diesel

Transmission — Fuller 5CW65AT — 5-speed forward, 1 reverse

Final drive — controlled planetary differential in oil bath 2.62:1 reduction
— outer planetaries, 3.6:1 reduction

Clutch — 36.5 cm (14 in.)



FN 360

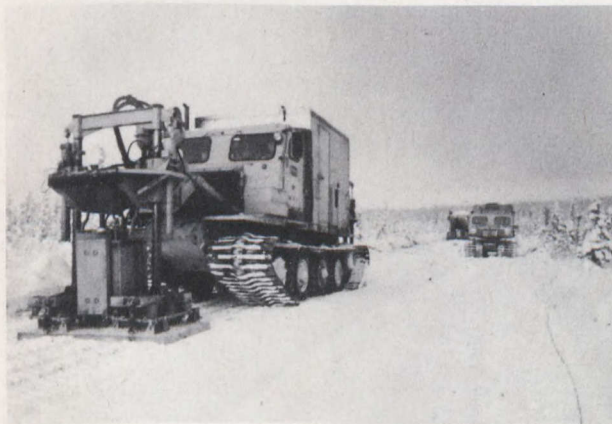


FN 10

MODEL FN 600

This vehicle with its 10.67 m (35 ft.) useable bed, trailer supported, will handle the majority of the bulk work in any area and yet travel the most trying terrain.

Weight of vehicle	37,650 kg (83,000 lb.)
Payload	27,215 kg (60,000 lb.)
Ground pressure — unloaded	0.148 kg/cm ² (2.1 in. ²)
— loaded	0.254 kg/cm ² (3.62 in. ²)
Overall width — tracks on	404 cm (159 in.)
Overall height	353 cm (139 in.)
Overall length	15.39 cm (50.5 ft.)
Fording depth	116.8 cm (46 in.)
Climbing ability — grade	60%
Sidehill ability — grade	30%



FN 240

MODEL 720/34

This model, as one custom choice, provides an exceedingly fine base for a tracked fire/crash vehicle and not limited to road use.

Weight of vehicle	8,560 kg (19,000 lb.)
Payload	9,500 kg (21,000 lb.)
Ground pressure — unloaded	.20 kg/cm ² (2.9 in. ²)
— loaded	.43 kg/cm ² (6.1 in. ²)
Max. overall width — tracks on	259 cm (102 in.)
Overall height	274 cm (108 in.)
Overall length	662 cm (260 in.)
Climbing ability — grade	60%
Sidehill ability — grade	40%

Power train:

Engine — Ford 534 C.I.D. V-8 Gasoline

Transmission — Allison Mt-42 automatic 6-speed
forward, 1 reverse with fluid torque convertor

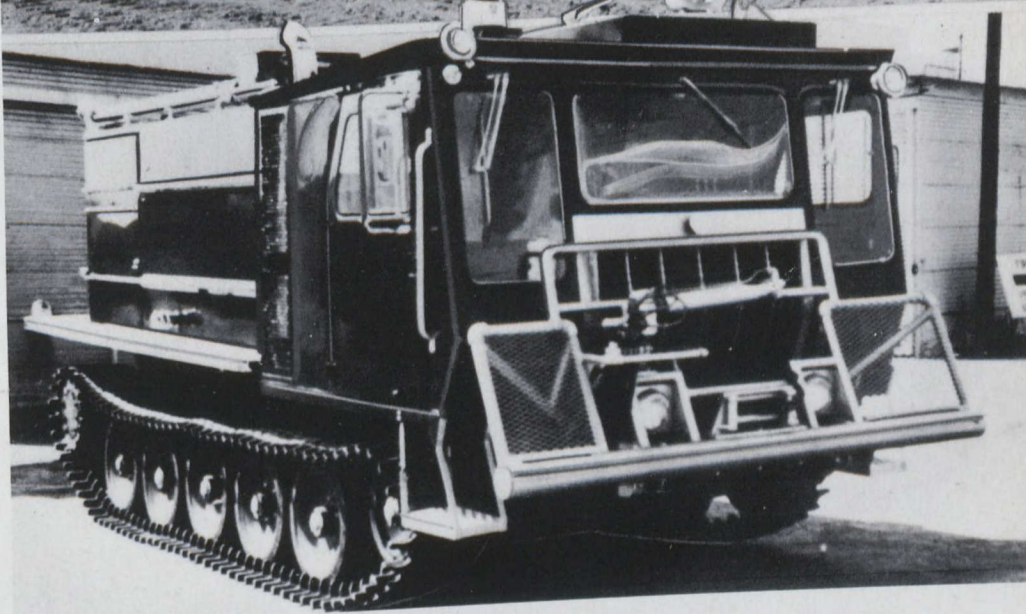
Final drive — controlled planetary differential in
oil bath 2.77:1 reduction.

— outer planetaries 3.36:1

FN 600



720/34



OFF-HIGHWAY VEHICLES — FOREMOST

The Foremost range of full-tracked carrier has experienced success in many countries where off-highway conditions of muskeg, snow, mud or broken terrain preclude the use of conventional vehicles. Along with being used as a transporter of equipment and personnel, these versatile units double as specially-designed self-contained camp units, being able to make living in isolated or remote areas more pleasant, yet retain high mobility.

The "four track" design offers a greater payload capacity without sacrificing a low ground bearing pressure. This increased track area, along with full power two-point steering, allows for unequalled maneuverability under extreme condi-

tions. Full power to all four tracks at all times enables the operator to steer without any power loss when negotiating a steep incline. The Husky 8 offers 10.36 m (34 ft.) of useable deck length and handles up to 40.8 metric tons (45 tons) of payload with relative ease.

Two tracked units are also available for light duty work where payloads range from .45 to 7.25 metric tons (.5 to 8 tons). These units double as ideal personnel carriers or survey vehicles. Non-powered tracked trailers complement the powered vehicle line.

Brief specifications of some of the larger units are as follows:

YUKON



DAWSON 5



DESCRIPTION	TWO TRACK		FOUR TRACK		
	YUKON	DAWSON 5	DAWSON 6	DAWSON 7	HUSKY 8
Deck size	2.43 m x 3.8 m (8 ft. x 12.5 ft.)	2.43 m x 5.48 m (8 ft. x 18 ft.)	2.43 m x 6.1 m (8 ft. x 20 ft.)	2.43 m x 7.01 m (8 ft. x 23 ft.)	2.74 m x 10.36 m (9 ft. x 34 ft.)
Overall length	3.7 m (12 ft. 2 in.)	8.63 m (28 ft. 4 in.)	8.93 m (29 ft. 4 in.)	9.85 m (32 ft. 4 in.)	13.71 m (45 ft.)
Overall height	2.64 m (8 ft. 8.5 in.)	3 m (10 ft. 2 in.)	3 m (10 ft. 2 in.)	3 m (10 ft. 2 in.)	4.06 m (13 ft. 4 in.)
Basic weight	8,074 kg (17,800 lb.)	12,700 kg (28,000 lb.)	13,835 kg (30,500 lb.)	15,650 kg (34,500 lb.)	38,329 kg (84,500 lb.)
Track area at 6 in. Pen.	7.15 m ² (77 ft. ²)	11.39 m ² (122.66 ft. ²)	13.74 m ² (148 ft. ²)	16.37 kg/cm ² (176.3 ft. ²)	22.45 m ² (241.7 ft. ²)
Ground pressure	.111 kg/cm ² (1.59 lb./in. ²)	.111 kg/cm ² (1.59 lb./in. ²)	.1 kg/cm ² (1.43 lb./in. ²)	.0952 kg/cm ² (1.36 lb./in. ²)	.17 kg/cm ² (2.43 lb./in. ²)
Capacity	5.4 to 7.25 metric tons (6-8 tons)	7.25 to 9.97 metric tons (8-11 tons)	9 to 11.8 metric tons (10-13 tons)	10.88 to 13.6 metric tons (12-15 tons)	27.2 to 40.8 metric tons (30-45 tons)
Gradeability (forward)	50%	60%	60%	60%	60%
Gradeability side	50%	50%	50%	50%	50%



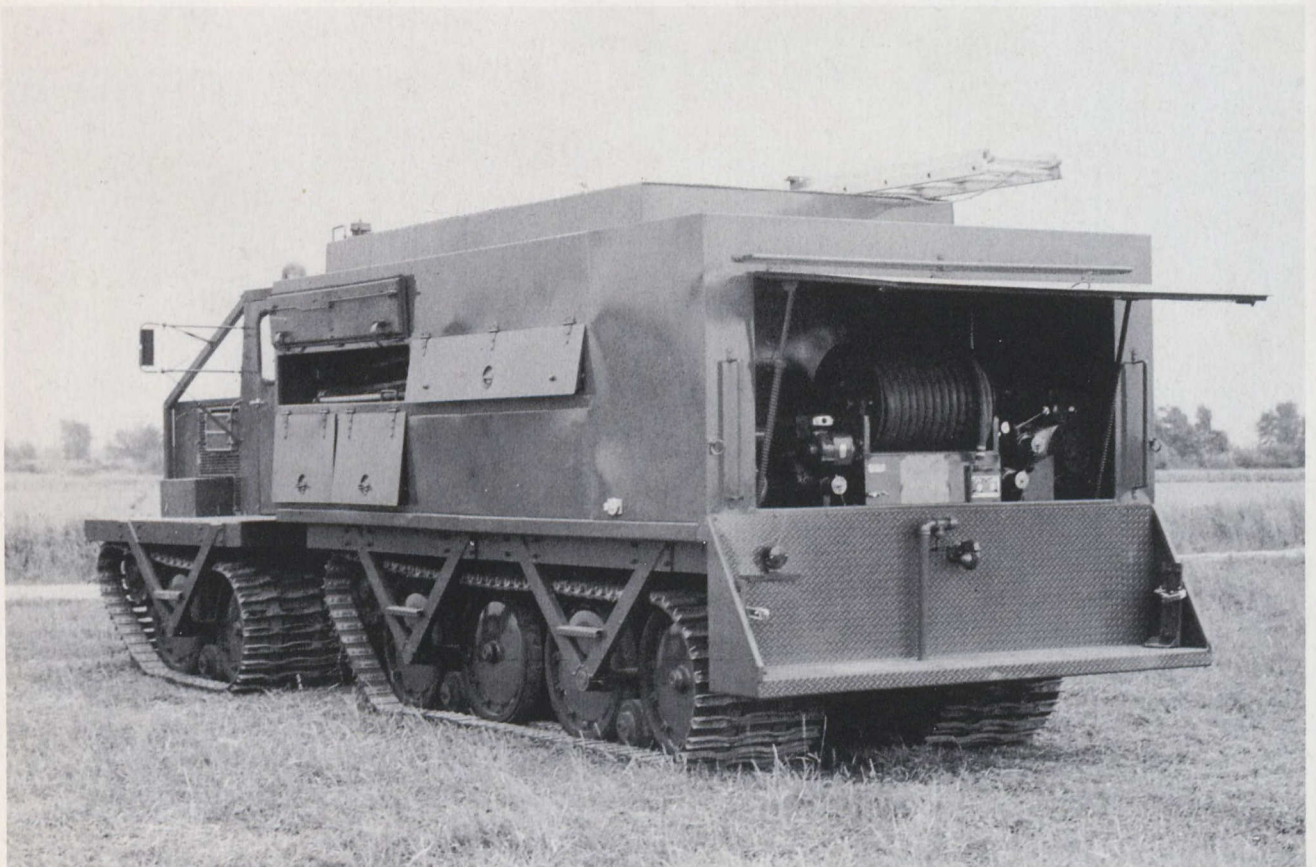
HUSKY 8

**LOAD CARRIERS, CONSTRUCTION —
MAINTENANCE — SAFETY, VEHICLES**

The construction and maintenance of a military camp or training area invariably implies high capital expenditures with equally high overheads. Both of these fields may be reduced through a judicious selection of Bombardier vehicles.

THE "TERRAIN MASTER"

The "Terrain Master" at 8,845 kg (19,500 lb.) is diesel powered and capable of the heaviest bush work. The mean ground pressure, loaded is .3 kg/cm² (4.4 lb./in.²) and it has a fording depth of 101 cm (40 in.).



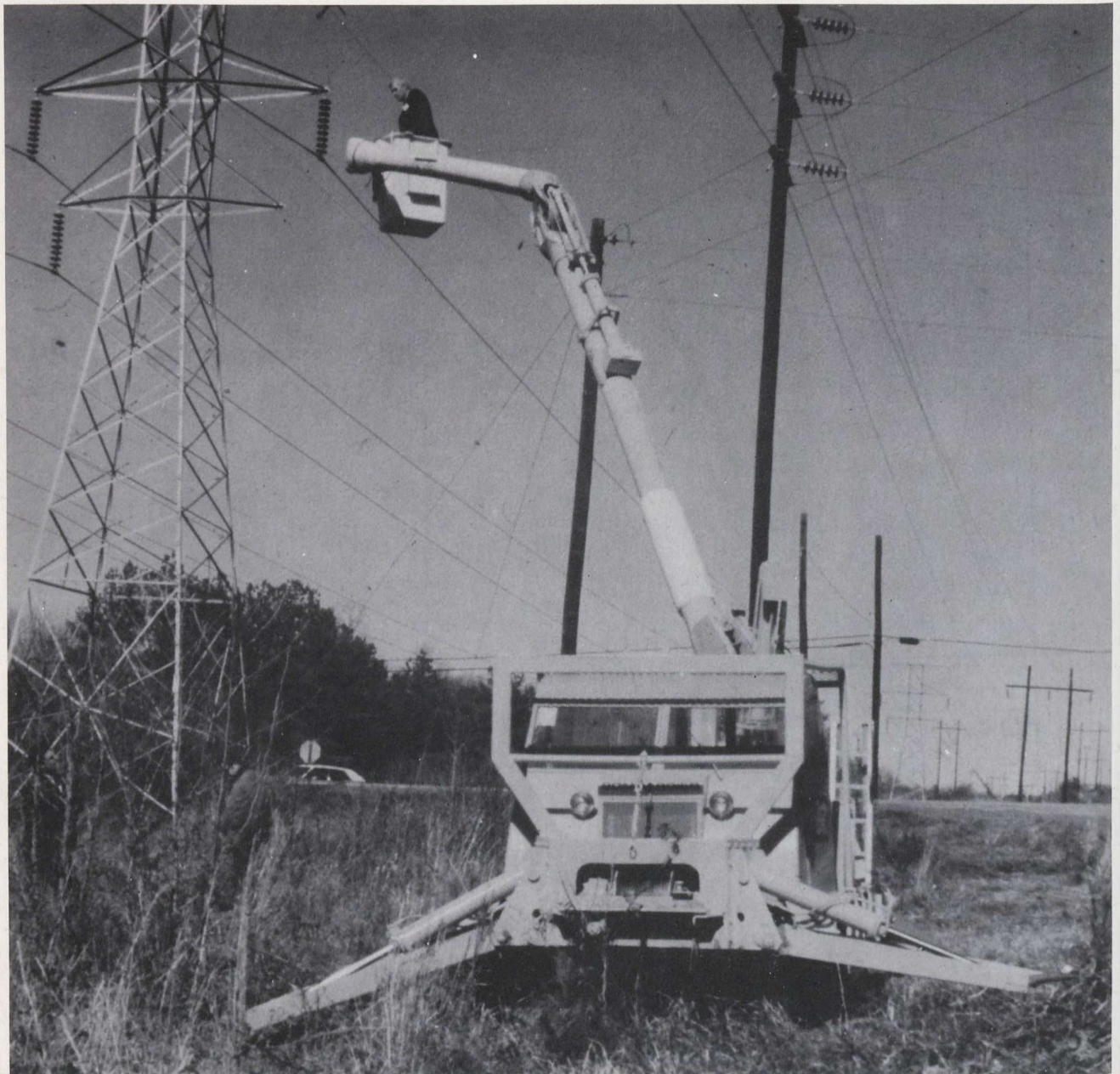
THE SV SERIES, 200, 250 AND 300

The SV series, 200, 250 and 300 are versatile vehicles with a basic 2-man cab and rear deck which can be converted to troop transport, ambulance, command headquarters or a local carrier.



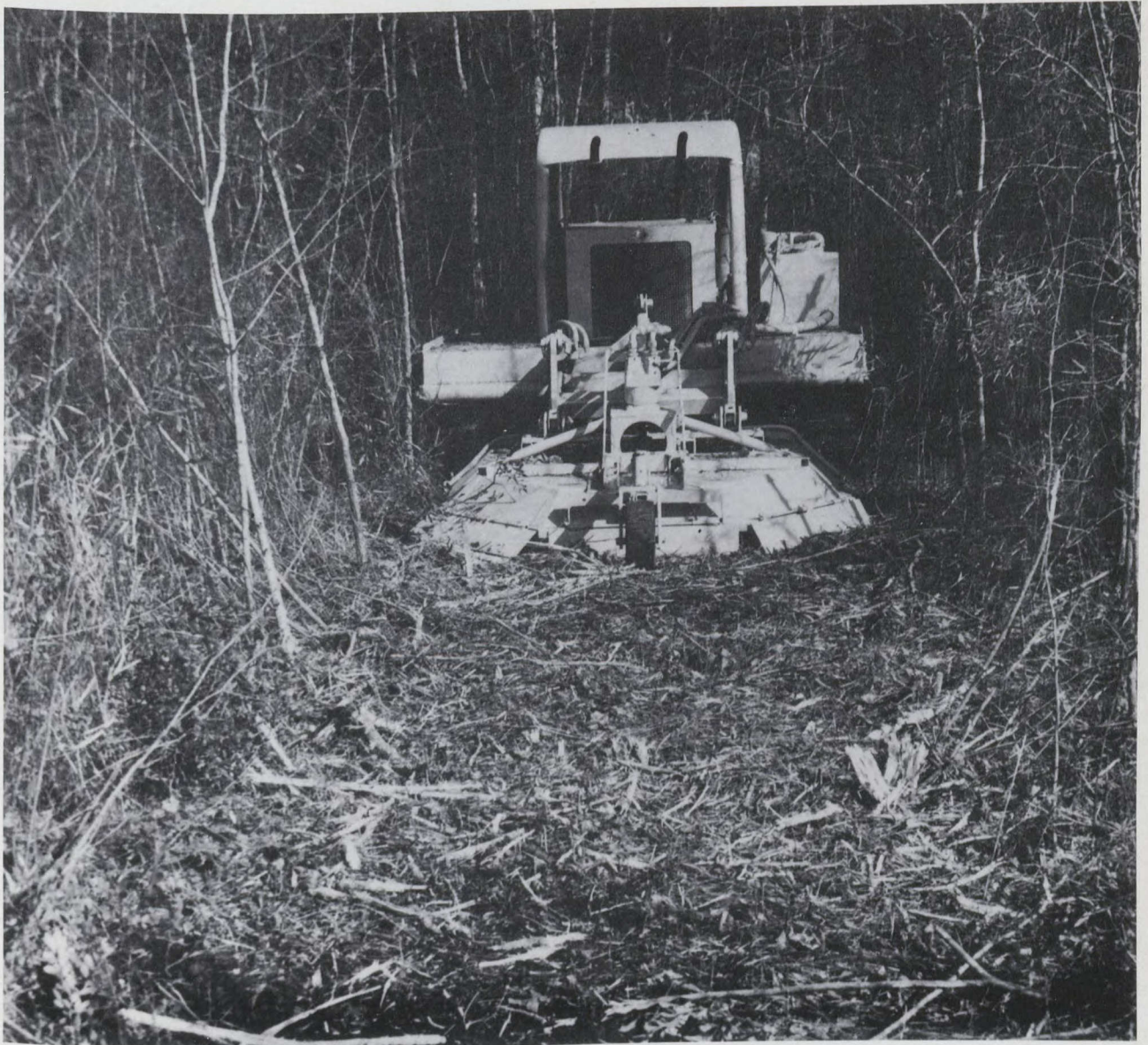
THE MUSKEG CARRIER

The Muskeg Carrier, a larger vehicle, 2,900 kg (6,400 lb.) with a 2,720 kg (6,000 lb.) payload, is even more versatile, carrying and powering drilling rigs, cable laying, firefighting with its own water supply or carrying a "Giraffe" with a reach of 21.3 m (70 ft.)



THE J-5

The J-5 shown here is driving a hydraulically-powered piece of equipment called a "Bush-Hog" which can clear bush with trees up to 10 cm (4 in.) at the rate of 1.6 to 19 km/hr (1 to 12 mph) depending on the terrain and weight of bush. This same vehicle is ideal for transporting men and equipment to work areas and can easily fulfill the requirements of a fire/rescue vehicle for construction sites or airports.



EARTH MOVING EQUIPMENT

The line of graders and Rear-dump truck, produced by WABCO Equipment Canada and described here not only complement the construction equipments in this section but offer to the user field-proven equipments with world-wide acceptance and service. They have seen use in many parts of the world such as North America, South America, Africa, Asia and the West Indies. The graders range from 11,340 kg (25,000 lb.) with 125 HP to the new 888 at 18,597 kg (41,000 lb.) with 256 HP. A wide selection of accessories is available to make these graders very diversified equipments where capital costs are written off over a multiplicity of fields.

888B MOTOR GRADER

Weights w/standard equip., no accessories

Total	18,597 kg (41,000 lb.)
Front	5,579 kg (12,300 lb.)
Rear	13,018 kg (28,700 lb.)

Engine, Diesel, rubber mounted	GM8V-71
Horsepower, maximum	256
net	230
RPM (variable by Gov. Control)	2,000
Number of cylinders	8
Bore	108 m (4¼ in.)
Stroke	127 m (5 in.)
Displacement, inches ³	9.3 L (568 in. ³)

Transmission and Torque Converter

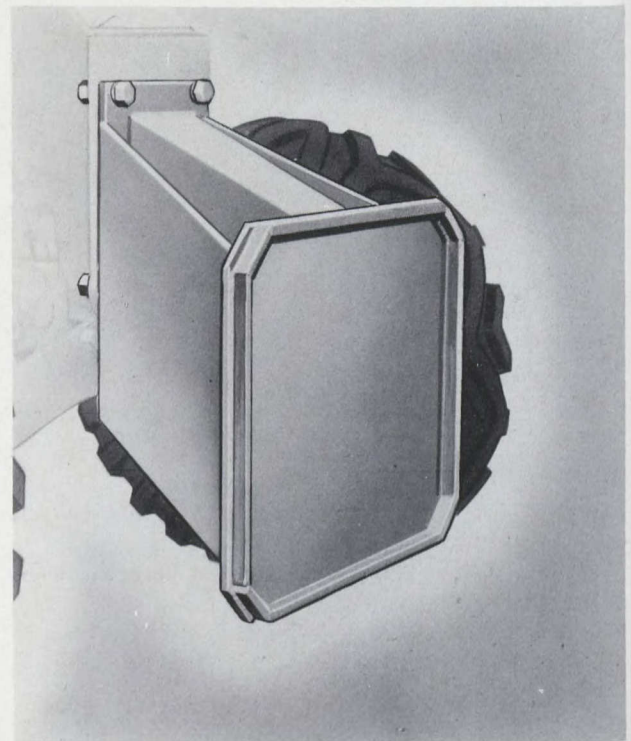
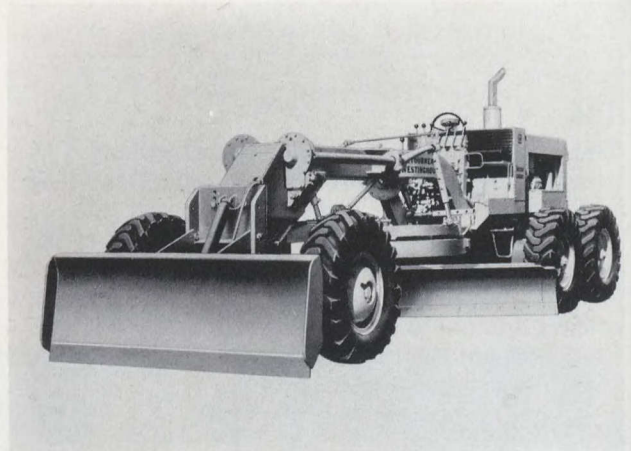
Transmission type	Power shift clutch and constant mesh
Transmission shift	Shifts from forward to reverse without clutching
Torque converter	40.64 cm (16 in.), single stage
Torque multiplication ratio	2.78 to 1

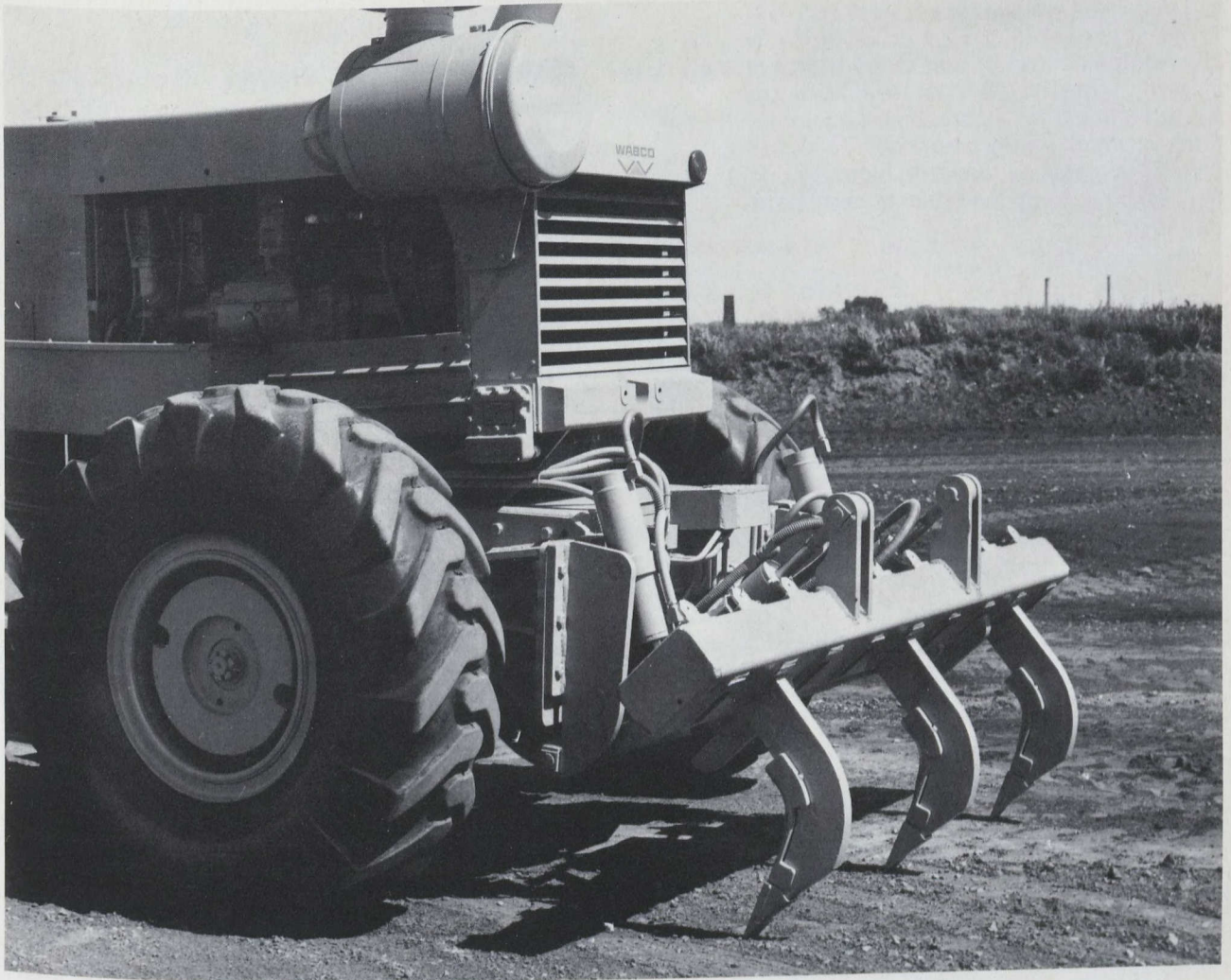
Overall Measurements

Length	8.84 m (29 ft.)
Width	2.77 m (9 ft. 1 in.)
Height, with cab	3.27 m (10 ft. 9 in.)
Height, without cab	2.44 m (8 ft.)
Wheelbase	6.37 m (20 ft. 11 in.)
Bladebase	2.94 m (9 ft. 7¾ in.)
Tread, front	2.20 m (86⅝ in.)
Tread, rear	2.23 m (88 in.)
Distance between centres of tandem wheels	1.68 m (66 in.)
Turning radius	13.7 m (45 ft.)

Blade Working Range

Lift for ground clearance	45.72 cm (18 in.)
Bank cutting angle, maximum degrees	90°
Side shift with control, moldboard centred	99.06 cm (39 in.) R and L
Shoulder reach	233.68 cm (92 in.) R and L





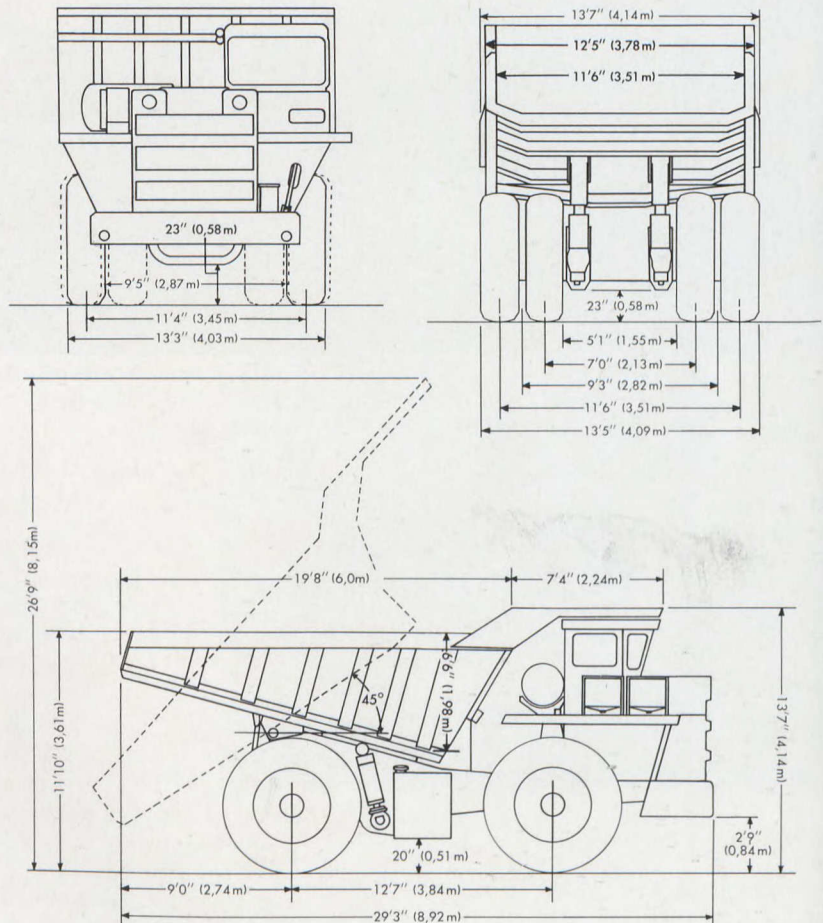
The Haulpak series of rear dump trucks range from 31.75 m tons (35 tons) to 45.36 m tons (50 tons) and offer a companion equipment to the graders which jointly have been used on such diverse projects as runways, highway construction, encampments and dam construction.

Weights

Chassis with Hoists, empty	25,329 kg (55,840 lb.)
Body, empty	8,845 kg (19,500 lb.)
Net Weight, No Load	34,174 kg (75,340 lb.)
Pay Load	45,360 kg (100,000 lb.)
Gross Weight	79,534 kg (175,340 lb.)
Weight Distribution:	
Front Axle, empty	16,405 kg (36,166 lb.)
Rear Axle, empty	17,769 kg (39,174 lb.)
Front Axle, loaded	23,066 kg (50,850 lb.)
Rear Axle, loaded	56,469 kg (124,490 lb.)

CUMMINS VT-1710-C ENGINE

Engine, Diesel	Cummins VT-1710-C
Number of Cylinders	12
Operating Cycle	4 Stroke
Rated Brake HP	635 @ 2100 RPM
Flywheel HP	600 @ 2100 RPM
Rating Baseline	up to 3.353 m (11,000 ft.) Altitude @ 37.8°C (100°F.)
Maximum Torque	241.5 kgm (1,750 ft./lb.)
Bore	139.7 mm (5.5 in.)
Stroke	152.4 mm (6 in.)
Displacement	28.02 L (1,710 in. ³)
Transmission	Allison CLBT-6061 with Torqmatic Brake
Power Shift type	Torque Converter, lock-up type Allison TC-680
Electric Shift Control	Allison



Service Capacities

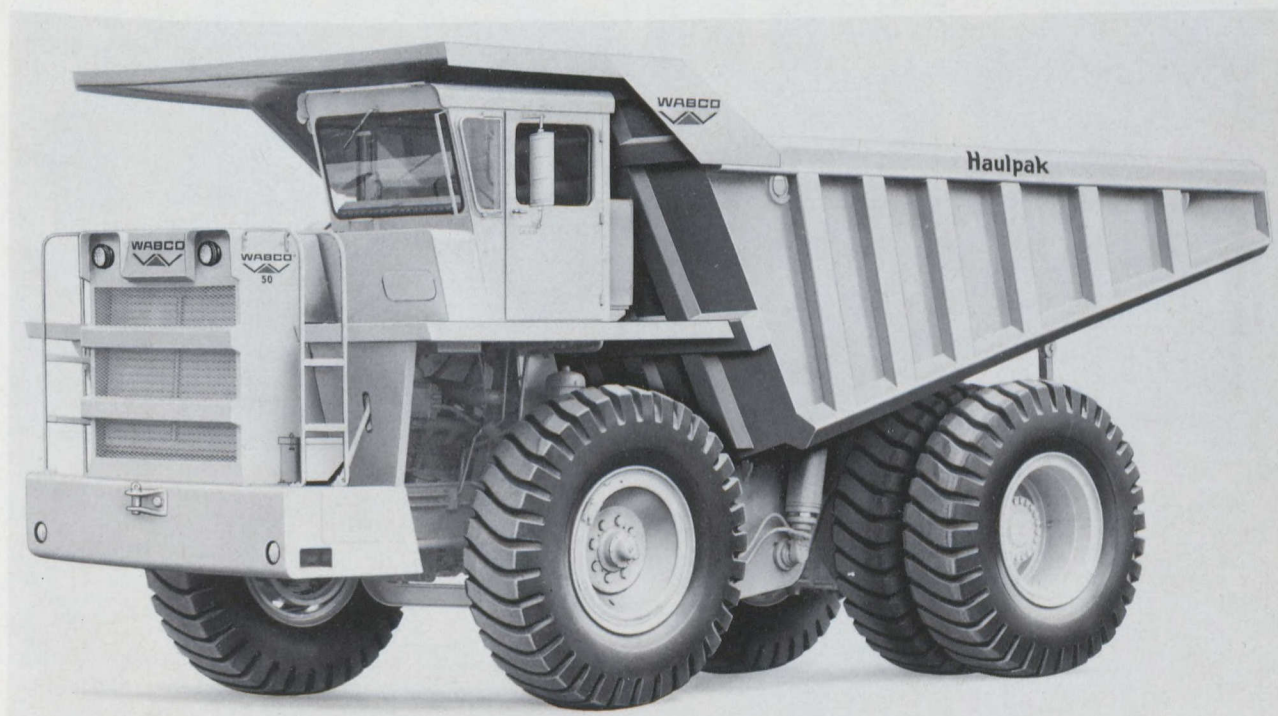
	(U.S. Standard)
Cooling System	42 L (159 gal.)
Crankcase	18 L (68 gal.)
Hydraulic System	60 L (227 gal.)
Transmission and Torque Converter	16 L (61 gal.)
Final Drive	29 L (110 gal.)

GM 16V-71N ENGINE

Engine, Diesel	GM 16V-71N
Number of Cylinders	16
Operating Cycle	2 Stroke
Rated Brake HP	635 @ 2100 RPM
Flywheel HP	600 @ 2100 RPM
Rating Baseline	Sea Level @ 15.5°C (60°F.)
Maximum Torque	238.4 kgm (1,728 ft./lb.)
Bore	108 mm (4.25 in.)
Stroke	127 mm (5 in.)
Displacement	18.6 L (1,134.8 in. ³)
Transmission	
Power Shift type	Allison CLBT-6061 with Torqmatic Brake
Torque Converter, lock-up type	Allison TC-680
Electric Shift Control	Allison

Service Capacities

	(U.S. Standard)
Cooling System	42 L (159 gal.)
Crankcase	2.5 L (81 gal.)
Hydraulic System	60 L (227 gal.)
Transmission and Torque Converter	16 L (61 gal.)
Final Drive	29 L (110 gal.)



OVER-BURDEN DRILLING EQUIPMENT

In recent years Becker Drills Ltd. have added considerably to the "state of the art" in field drilling under adverse conditions whether it be ore sampling, geological studies, construction techniques or the setting of anchors for transmission towers. Two basic models are available:

The Becker Hammer Drill which is most effective in unconsolidated formations; and the Becker CSR (Centre Sampling Rotary) Drill which is better suited to the drilling of clays and fractured formations.

The Becker Hammer drill has a depth capability of 76 m to 91 m (250 to 300 ft.) in overburdens, depending on pipe size and air compressor capacity. On reaching such depths an auxiliary hydraulic rotary attachment may be swung into position and rotary drilling carried on in bedrock, through the inner pipe, to hole depths of 153 m (500 ft.).

CSR Drills are available with depth capabilities to 304 m (1,000 ft.) and are particularly effective in clays and fractured formations.

Both types of drills offer sample recoveries approaching 100% and economies over conventional coring operations, particularly in formations where coring is difficult. A growing acceptance of chip sampling using reverse circulation for exploration undertakings is apparent.

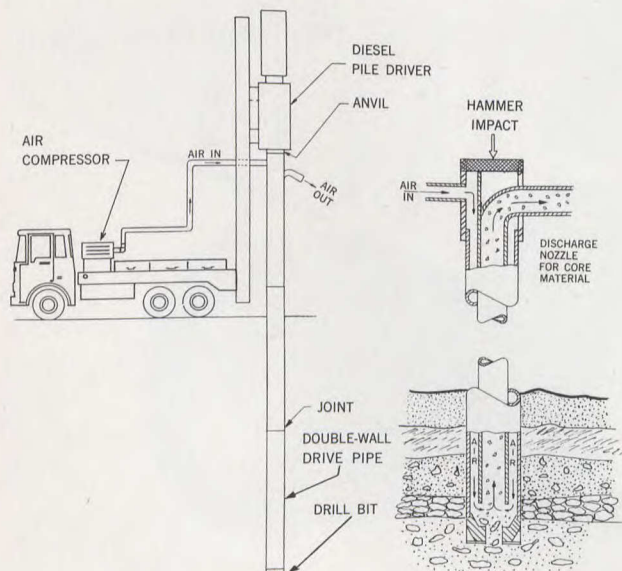
In addition to operations in Canada and the U.S.A., Becker Drills are proving effective in Pakistan, New Caledonia, Indonesia, Thailand, Philippines, and Colombia.

BECKER HAMMER DRILL

The most noteworthy character of the equipment is the method by which sand, gravel and boulder formations can be penetrated rapidly and efficiently, giving immediate, accurate analysis of the formation encountered. With this patented method a double wall drive pipe is driven by a diesel-operated pile hammer. Air or water, under pressure, is forced down the annulus of the drive pipe and upwards in the inner pipe. The material cut by the drill bit is rapidly transported to the surface through the inside pipe by the drilling fluid. The discharged materials can be accumulated in suitable containers as they emerge from a cyclone and samples bagged at specified intervals for analysis of the drilled formation. As the centre of the drive pipe is always clear and the bit always remains on the bottom of the hole, Pentrometer, Shelby or Split-Spoon tests for undisturbed samples, can be taken at any desired interval. Upon reaching bedrock, a hydraulic driven rotary attachment can be swung into position, and the drive pipe then acts as the overburden casing and conventional drilling methods may proceed for the penetration of bedrock. Chip sampling with air and tricone bits can be achieved very economically as the difficulty of penetrating the overburden has been overcome.

Designed for drilling in gravel, sand and boulder formations, this rugged unit achieves penetration rates up to 30.4 m (100 ft.) per hour and provides a continuous sample. For sampling, close to 100% recovery can be achieved.

Air is generally used as the drilling fluid. However, water or a combination of air and water can be used when desired. Because the drive pipe is clear at all times and the bit is hollow centered, casing or explosives can be set before the drive pipe is withdrawn.







BECKER CSR — 250 DRILL

The CSR series operates on the same double wall principle as the Hammer Drill.

The CSR double wall drill pipe is flush jointed, permitting the bore hole to be cut with a minimum of clearance. This eliminates loss of drilling fluid between the drill pipe and bore hole, thus forcing the drilling fluid and the sample up the centre of the double wall drill pipe. With this reverse circulation method of forcing the geological samples to the surface through the centre of the double wall drill pipe, rather than through the annulus between the drill pipe O.D. and the bore hole (conventional method), sample contamination by caving formations or particles eroded from the wall of the hole is eliminated. The loss of samples or sludge into voids and fissures is also avoided. This drill is particularly well suited for remote and hard-to-get-at areas because of its size, weight and versatility. Without modifications to the drill unit, it can be easily mounted on skids, truck or tracks.

DIMENSIONS FOR SKID-MOUNTED UNIT:

Gross weight	4,536 kg	(10,000 lb.)
Length: mast	7 m	(23 ft.)
deck	3.35 m	(11 ft.)
Width	1.82 m	(6 ft.)

Tallest point of mast in transport position	1.98 m	(6.5 ft.)
--	--------	-----------

DWD Pipe Size and Rated Depth Capacities:

8.89 cm (3.5 in.) OD pipe to	91.44 m (300 ft.)
11.43 cm (4.5 in.) OD pipe to	60.96 m (200 ft.)
13.97 cm (5.5 in.) OD pipe to	95.7 m (150 ft.)

Power Source

Diesel engine at 1800 RPM — 74BHP

Air Compressor

8,352 dm³ (295 ft.³) per min at 3.5 kg/cm²
(50 lb./in.²)

Power Swivel

Hydraulic — Torque 26.22 kgm at 7 kg/cm²
(190 ft./lb. at 100 lb. in.²)

Other CSR models have rated depths of 152 m (500 ft.) and 304 m (1000 ft.) with 8.89 cm (3.5 in.) pipe.

Becker Drills Ltd. do not offer a contracting service outside of Canada and the continental U.S.A. The equipment is available on the basis of outright purchase, or by leasing in instances where the size of the drilling project may not justify purchase. Well qualified driller-instructors are offered for the training of clients' operators in the operation and maintenance of these unique drills.

GENERAL SPECIFICATIONS FOR TRUCK MOUNT

Gross Weight	19,051 kg	(42,000 lb.)
Length	7.92 m	(26 ft.)
Width	2.43 m	(8 ft.)
Tallest point of mast in operating position	7.62 m	(25 ft.)
Tallest point of mast in transport position	3.2 m	(10.5 ft.)
Weight of ram only	798 kg	(1,760 lb.)
Strokes per minute		(90-95)
Energy rating	1,106 kgm	8,000 ft./lb. per blow)
Standard drive pipe diameters	13.97 cm OD x 8.35 cm ID	(5.5 in. x 3.25 in.)
	15.24 cm OD x 9.5 cm ID	(6 in. x 3.75 in.)
	16.82 cm OD x 11.26 cm ID	(6.6 in. x 4 in.)
Penetration depths with standard casing up to	76.2 m	(250 ft.)
Penetration depths with hydraulic rotary up to	152.4 m	(500 ft.)
Controls	All hydraulic	
Drive	Truck engine	
Pulling cylinder capacity	90.7 metric tons	(100 T)

MATERIAL HANDLING EQUIPMENT — TRAVELLING CRANES

The travelling cranes engineered and produced by Dahmer Steel have proven themselves in developing dock and port areas where heavy capital equipment is not available. At the same time their use in any military establishment will lend efficiency to the most difficult of operations, whether stockpiling or assisting in power plant replacements in vehicles, aircraft or marine craft.

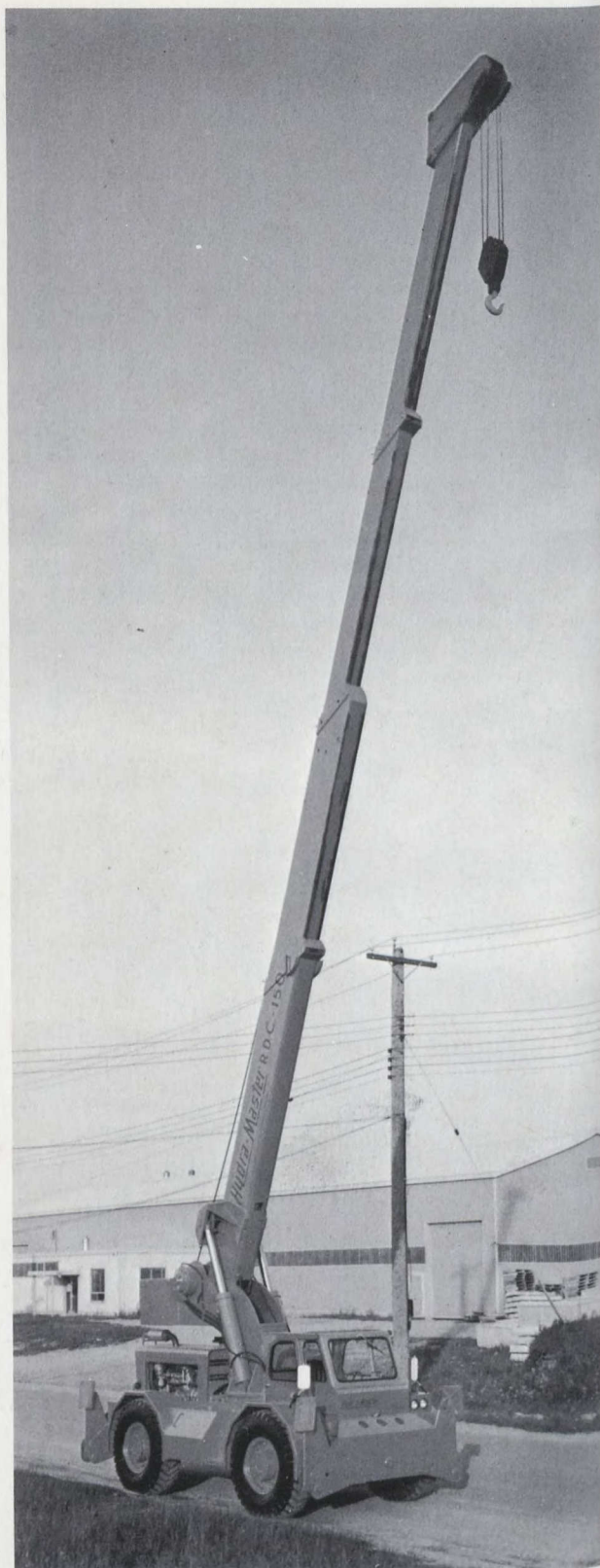
HYDRA-MASTER MODEL RDC 150
13,600 kg (30,000 lb.)

The Hydra-Master series ranges in capacity from 6,800 kg to 13,000 kg (15,000 to 30,000 lb.) in four models, and all carry the same features which assure the user of stated performance beyond the normally expected limits of safety. Some of these features include:

- An extra large, hermetically sealed slewing ring where the upper and lower bearing race ways effectively transfer movement and thrust loads into smooth, low friction rolling action.
- The orbital steering feature, a standard wheel and a single three position control lever, gives all three types of steering — front wheel — four wheel co-ordinated and four wheel crab, left or right.
- The hydraulic system has a built-in power reserve which serves every function — boom — turntable — and winch line, all at maximum rated speeds.

DIMENSIONS

Wheel Base	2.89 m (114 in.)
Overall Length	8.45 m (27.6 ft.)
Overall Height (Boom Horizontal)	3.29 m (10.8 ft.)
Overall Width (Outriggers Raised)	2.43 m (96 in.)
Frame length less outriggers	
Outrigger spread, width center to center of pads	3.84 m (12.6 ft.)
Outrigger spread, length center to center of pads	5.18 m (17 ft.)
Ground clearance under axle differential housing	38.10 cm (15 in.)



MOBILE BOOMS

MODEL BHC — 2036D 9072 kg (20,000 lb.)
at 91.44 cm (36 in.)

The "Cranemobile" series offers four standard models with a hydraulic boom in capacities from 4536 kg to 18144 kg (10,000 to 40,000 lb.).

The same models are also available without the hydraulic drive on the boom.

Wherever a truck can go the Dahmer Crane Mobile can be driven — loaded or empty — and can winch itself with its own power across ground where no conventional wheeled vehicle could travel. Dual wheels, mounted with definite camber on rigid spindles, give great buoyancy on soft ground or snow. The crane reaches and picks like a human arm. Full capacity loads can be lifted by booming up without manual adjustment of the anchor pin. With the boom horizontal and the telescope extended, reach is 4.53 m (15 ft.) from the front of the crane to the hook. Hydraulic control of the tower provides for positioning the boom from near ground level to a hook height of 8.23 m (27 ft.) and while boom is horizontal the crane can easily be operated under an 11 foot ceiling. By adjustment of the anchor pin, the tower can be collapsed sufficiently to pass under a 3.04 m (10 ft.) doorway and with this adjustment the boom may be operated hydraulically from horizontal to a maximum hook height of approximately 8.23 m (27 ft.). For operating with loads through low doorways and other hard-to-get-at places the crane has great versatility.

DUAL HYDRAULIC SYSTEM

Separate hydraulic systems are used for the steering and lifting mechanisms thereby providing for maximum efficiency of operation. Independent hydraulic steering permits finger-tip control at all times. Full power is obtained for tower, boom and cable operation from the direct connected hydraulic system.

PLANETARY DRIVE

A tremendous increase in tractive power with greatly reduced torque load on axles, hubs, differential, drive line, transmission, clutch and motor is accomplished with the planetary drive. To handle heavy loads easily over any type of terrain under the most adverse conditions is now possible with the steady even flow of full power by the planetary drive.

Length	less boom	5.18 m (204 in.)
Height	boom horizontal	3.04 m (120 in.)
Width	front	2.43 m (96 in.)
	rear	1.67 m (65 in.)
Wheel Base		4.11 m (163 in.)
Clearance	under chassis	38 cm (15 in.)
	under axle	30 cm (12 in.)
Weight	gross	9,979 kg (22,000 lb.)
	less counterweight	6,804 kg (15,000 lb.)
Engine	Ford Industrial 4.9 litre (300 in. ³) 132 HP, 12 volt, alternator.	
Transmission	Warner T9L2 4 speeds forward and 4 reverse.	



EXCAVATORS

Koehring-Waterous, offers a complete range of Excavators, both hydraulic and cable with capacities from $.38\text{m}^3$ (.5 yd.³) to 1.9m^3 (2.5 yd.³). Illustrated is the Koehring Model 466, one yard Hydraulic Backhoe, featuring shear ball mounting, independent hydraulic swing and traction, cushioned hydraulic cylinders and air over hydraulic controls.



HYDRAULIC CRANES

Cranes are marketed under the name Koehring, Bantam and Lorain with capacities from $9\frac{1}{2}$ to 150 ton. Hydraulic cranes are self-propelled or truck mounted and cable cranes are crawler or truck mounted. Illustrated in the Bantam Model S-626, self-propelled 15 ton hydraulic crane featuring the operator's cab revolving with the boom, 18.28 m (60 ft.) telescoping boom, three-way power steering and hydraulic outriggers.



BUSH CLEARANCE AND LOGGING EQUIPMENT

The clearance of an area for a military encampment or training base can add greatly to the capital cost of the overall establishment unless the clearance is carried out as a planned operation using professional equipment. Such equipment is available from Koehring-Waterous who manufacture the Koehring Harvester, the Koehring Feller Skidder and Log Loaders. The Harvester is a fully mechanical small tree harvester which fells, de-limbs, tops and forwards a payload of 23.9 m³ (6.6 cords) pulpwood to the roadside. The Skidder fells and skids full trees to roadside and is mounted on the same vehicle as the Harvester which is centre frame articulated, with four wheel hydrostatic drive and 37.5 x 39 in. low pressure tires. Log loaders are cable or hydraulic, mounted on tractor type crawlers or self-propelled rubber

with capacities up to 65 tons at 3.65 m (12 ft. radius). Illustrated is the Model 666 hydraulic log loader with a capacity of 11½ tons at 7.6 m (25 ft.) and featuring shear ball mounting, independent hydraulic swing and traction cushioned cylinders.

The Harvester and the Feller Skidder is offered as a general purpose, off-road vehicle, with a capacity of 31,752 kg (70,000 lb.). The machine is centre frame articulated, oscillates at the centre joint, four wheel hydrostatic drive and is mounted on 37.5 x 39 in. low pressure tires. The Harvester and the Feller Skidder is offered as a general purpose, off-road vehicle, with a capacity of 31,752 kg (70,000 lb.). The machine is centre frame articulated, oscillates at the centre joint, four wheel hydrostatic drive and is mounted on 37.5 x 39 in. low pressure tires.



POLLUTION CONTROL AND SANITARY LANDFILL EQUIPMENT

Designed and manufactured specifically for sanitary landfill operation by Bomag (Canada) Limited, the Buffalo-Bomag K301 features a modified version of the patented Pakall wheel used exclusively on the line of high-speed Bomag earth compactors.

The K301 wheel, which can be ballasted, utilizes the same continuous rows of tapered segments but with longer replaceable apex caps for better traction and to provide the required demolition, spreading and compaction of solid waste materials.

The machine has a total of 80° articulated steering and an inside turning radius of 2.73 m (9 ft.), less than half its length. Total frame oscillation of 30° provides complete wheel-to-ground contact for maximum stability at all times. Other features include a completely enclosed cab with entry from either side; an adjustable suspension-type seat for operator comfort; conveniently located operator controls; and such safety equipment as a heavy wire mesh windshield guard, engine, radiator and muffler guards, as well as complete undercarriage guards. Air conditioning and fire protection systems are optional.

General Data

Weight:

Shipping weight with blade and cab (no ballast) 14,660 kg (32,320 lb.)

Overall Dimensions:

Length 610 cm (240 in.) Width 335 cm (132 in.) Wheel base 330 cm (118 in.)

Height with cab 333 cm (131 in.)

Compaction Wheels:

Front — 122 cm (48 in.) dia. Drum x 162.6 cm (64 in.) outside dia. x 96.5 cm (38 in.) wide

Rear — 122 cm (48 in.) dia. Drum x 162.6 cm (64 in.) outside dia. x 76.2 cm (30 in.) wide

Speeds

Four forward and four back.

Maximum: 1st 5.07 km/h (3.15 mph) 2nd 10.78 km/h (6.7 mph)

3rd 18.67 km/h (11.6 mph) 4th 33.63 km/h (20.9 mph)

Hydraulic System:

Hydraulic steering with mechanical compensator.

Two 10.2 cm (4 in.) double-acting hydraulic steering cylinders and one 10.2 cm (4 in.) spreader blade cylinder. 50 3.15 lit/sec (50GPM) gear-type pump has relief valve setting at 105 kg/cm² (1,500 in.²).

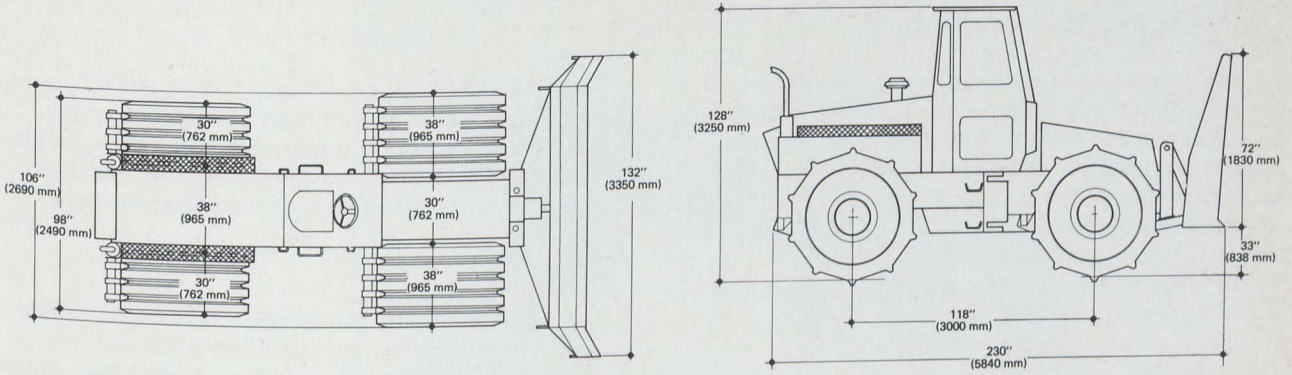
Engine:

MAKE	MODEL	BORE AND STROKE	DISPLACEMENT	RATED HORSE POWER
Cummins	V-504C	11.75 x 9.53 cm (4 $\frac{5}{8}$ x 3 $\frac{3}{4}$ in.)	8,260 cm ³ (504 in. ³)	158 at 2600 RPM

TRASH SPREADER BLADE — "U" TYPE:

Width 335 cm (132 in.). Height 183 cm (72 in.).

Adjustment 14 cm (5.6 in.) below ground level to 83.8 cm (33 in.) above.



BOMBARDIER LIGHTWEIGHT SNOW VEHICLES —

Bombardier are probably better known on an international basis for their snowmobile "Ski-Doo" line which is providing winter entertainment in most temperate countries around the world. Not so well known is the day-by-day work roles of these dependable machines. The following pages will outline the basic uses of the various machines in the series and provide general data on each type.

THE "ELAN"

This machine comes with either a 250 cc standard engine or 250 cc electric starting engine. Presently being used by the nursing staff of the Canadian Department of Health and Welfare it has been proven successful as a light, manoeuvrable machine.

THE "OLYMPIQUE"

This series comes in 300 cc; 335 cc; 399 cc; of which the latter two can be equipped with electric starts. Currently in use by the Royal Canadian Mounted Police in the Northwest Territories of Canada replacing the use of dog teams. These machines have proven their reliability in the extreme cold.

THE "T'NT"

This is the fastest of the series and is ideally suited to courier service of high speed patrols.

THE "SKANDIC"

The Skandic has found wide acceptance in Norway, Denmark and Finland. Used as a utility vehicle by the Laplanders as well as for herding reindeer the machine has more than demonstrated its low temperature characteristics and reliable operation with a minimum of maintenance.

THE "VALMONT"

Known as the workhorse of the family. These vehicles are equipped with a single front ski and move on twin 15" endless rubber tracks. In service with British Antarctic Survey Groups in Antarctica; Federal and Provincial Ministries in Canada; Federal and State Departments in the United States; these machines are used in a multiplicity of occupations from Pole Line Inspection to general transportation. Vehicles are equipped with 440 cc standard; 440 cc electric and reverse; 640 cc electric and reverse engines.

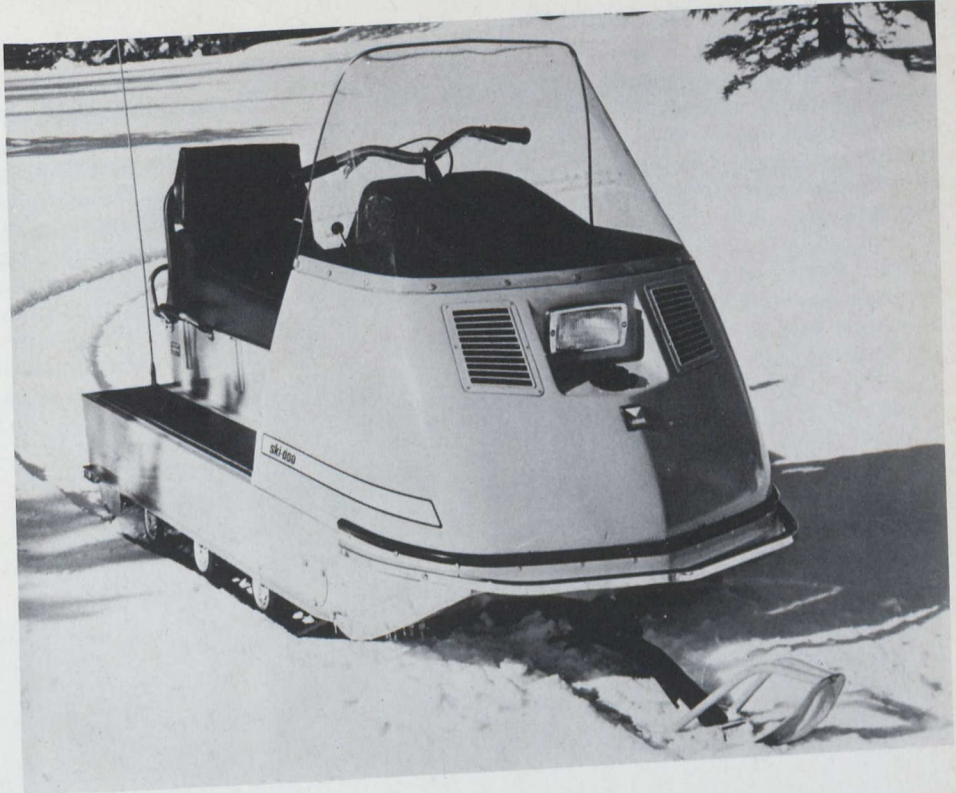
THE "ALPINE"

A twin tracked unit with high flotation characteristics which lends ready acceptance by rescue groups particularly where a toboggan stretcher is towed. It is also used by hydro linesmen and ranchers.

THE "NORDIC"

Currently in use by the Quebec Provincial Police Department and numerous other Federal, Provincial and Municipal Police Authorities, these machines have proven their adaptability as winter patrol vehicles. Equipped with 440 cc; 440 cc electric and 640 cc electric reverse engines, they are mounted on 18" wide endless rubber tracks.

THE "VALMONT"



THE "ALPINE"
left
THE "NORDIC"
right



LIGHTWEIGHT SNOW VEHICLES —

Outboard Marine Corporation of Canada Ltd. manufactures a complete line of snowmobiles under the Johnson and Evinrude brand names. They are the only fully integrated snowmobile manufacturers in Canada who manufacture their own engines within Canada.

A complete line of personal-transportation vehicles is offered, in both wide-track 52 cm (20.5 in.) and narrow-track 39 cm (15.4 in.) models, equipped with either moulded rubber, moulded urethane or cleated rubber tracks, and two-cycle Canadian-made engines ranging from 21 to 32 horsepower. Models feature automatic torque-sensing drives, capacitor discharge ignition, neutral lock-out, manual or electric start and disk brakes.

These snowmobiles are already in extensive use for surveying, hydro and telephone line work, forestry, trapping and many other commercial purposes, and have been used extensively in Arctic manoeuvres by the Canadian army. In addition, they have been tested in Scandinavia by the armed forces of the United Kingdom. Distribution of Johnson and Evinrude snowmobiles is world-wide, therefore, the availability of parts, service and product knowledge exists for these units in a great many parts of the world.



TRACKED SNOWPLOWS

The Bombardier SW-48 was designed to clear sidewalks or other close areas. Where speed and a high degree of manoeuvrability is required — powered by a 113 bhp engine and moving on two 36.8 cm (14.5 in.) tracks, the SW-48 will work at snow clearance for an hour on approximately 4.5 lit (1 gal.). With optional rubber treads, damage to sidewalks or proud hangar areas is no longer a problem.

The SW-48 is ideally suited to working in-close around parked aircraft. This same equipment, equipped with a 'Dozor' blade can carry out a variety of jobs such as grading, spreading or back-filling.

The SW-68 is a heavier version, better employed on larger areas, such as vehicle parks, warehousing areas or tarmacs.



LIGHTWEIGHT AMPHIBIOUS TRACKED VEHICLES

Valcartier Industries Inc. has developed this extremely compact and versatile fully tracked high speed carrier that has a payload capacity of 226 kg (500 lb.). Its 3-ply nylon and rubber track construction allows the vehicle to be driven on paved roads as well as on any terrain that it might encounter. The vehicle is only 1.21 m (48 in.) wide by 2.43 m (96 in.) long and with a full payload is easily transportable by light helicopter. Its low ground pressure of .56 kg/cm² (.8 in.²) at G.V.W. of 589 kg (1300 lb.) at 50.8 mm (2 in.) sinkage gives it extreme ability in soft terrain. The gear box has a 2 range of speed operation, coupled with a reverse. Its synchronized

clutch-brake steering arrangement allows a snowmobile type of steering to be used, thus giving the driver complete freedom of action. A quick-attach floatation collar is available to give it completely amphibious properties. This small but versatile vehicle can carry out many tasks, such as small personnel or troop carrier, rescue unit or ambulance, small fire fighter for military or civilian use, patrol unit for the north, etc., etc. Economy of operation, ease of maintenance and inherent simplicity have been designed into the vehicle making it one of the most versatile units in the world today.



MILITARY CLOTHING AND PERSONAL EQUIPMENT



CANADIAN MILITARY CLOTHING

Canadian Combat Clothing was designed to satisfy infantry requirements for world-wide use in both combat and peace keeping roles. While the primary designs were based on temperate climates, secondary capabilities for cold weather and tropical conditions were part of the design criteria. Since its introduction the Canadian Combat Clothing has been used extensively in temperate conditions in Canada and Europe and has been very favourably reported upon after use in the hot/dry and hot/wet conditions experienced in the Middle East and Africa. The cold weather supplement has been found to be very satisfactory in Northwest Europe and the Canadian North.

The success of this equipment is based not only on the application of modern materials and techniques but also on the wide use of the "layer principle" of clothing. To demonstrate this principle an example will be considered: the Combat Coat and Trousers worn in a temperate climate can be augmented by adding the Coat Liner for colder temperate conditions. Still further insulation, thus warmth, is achieved by another layer, the Parka and Windpants. All Canadian Combat Clothing is produced in a green camouflage colour designed to give protection against visual detection. While eleven sizes are available there is also provision for custom requirements beyond this range.

Two types of fabrics are used in combat clothing: Cloth, cotton/nylon twist, 169 gm/m² (5 oz./yd.²). A lightweight cloth primarily intended for the tropical and warmer temperate regions. It does not have a water repellent finish. There are two

reasons for this: first, chemically treated fabrics can not yet provide the degree of protection required for tropical rain areas and second, they inhibit the absorption of perspiration which is a basic function of the uniform. Accordingly, in these areas field rainwear would be used.

Cloth, cotton/nylon twist, 281 gm/m² (8.3 oz./yd.²). Used in the heavier garments and has a "Quar-pel" water repellent finish. This finish is one of the most durable and effective currently available. Canada, although primarily in the temperate climatic zone, can and does offer extremes of temperature and precipitation. These extremes illustrate the problems the designers of Canadian environmental clothing have encountered, and the wide limits of climate under which this clothing is highly effective.

The concept of the use of the Combat Clothing ensemble is illustrated in the following table where the serviceman wears the most appropriate combination for the prevailing weather and climatic conditions.

The varying combinations of this clothing, employing the "layer principle" are considered to be adequate for the ranges -54°C to 52°C (-65°F to 125°F).

	TROPICAL	TEMPERATE	COLD WEATHER
1. Cap, Combat	x	x	
2. Shirt/Coat, Combat	x	x	x
3. Trousers, Lightweight	x	x	
4. Coat, Combat		x	x
5. Trousers, Combat		x	x
6. Cap, Knit (Toque)		x	x
7. Scarf		x	x
8. Sweater, V-Neck		x	x
9. Liner, Coat		x	x
10. Face Mask			x
11. Parka			x
12. Windpants			x
13. Cold weather Cap			
14. Parka and Trousers, Camouflage, White			x
15. Jacket and Trousers, Field Rainwear	x	x	
16. Undershirt and Undershorts, cotton	x	x	
17. Undershirt and Drawers, Extreme cold			x

The equipment described and illustrated here does not constitute the complete range procured for the Canadian Serviceman, nor does the information provided include detailed specifications, and the quality assurance measures governing production. Enquiries regarding additional technical details should be referred to the addresses given in the introduction to this book.

COMBAT CLOTHING

TROPICAL

1. CAP, COMBAT

MATERIAL: Cloth, Cotton/Nylon twist, 281 gm/m² (8.3 oz./yd.²) olive green, "Quarapel" treated.

DESIGN: The cap has a semi-soft brim which can be worn either up or down to give additional weather protection. Ear flaps are provided which fold inside the cap when not in use.

2. SHIRT/COAT, COMBAT

MATERIAL: Cloth, Cotton/Nylon twist, 169 gm/m² (5 oz./yd.²) olive green.

DESIGN: The Hip length shirt has a front button closure with drawcords at waist and bottom hem. Adjustable wrist closures are included. Breast pockets are designed for carriage of small arms magazines; one inside pocket for personal belongings and side cargo pockets for carriage of such items as first aid kits, emergency rations and extra magazines. This dual purpose garment is used as an outer garment under tropical conditions and as an inner garment under other climatic conditions.

3. TROUSERS, LIGHTWEIGHT

MATERIAL: Same as (2).

DESIGN: Designed to be worn with suspenders or to be self-supporting. Two side pockets and two cargo pockets on the side of each thigh and one right hip pocket are provided. The bottoms of the trouser legs have drawcords which allow the trousers to be closed over the boot and also have inner sleeves which fit inside the boot preventing the entry of insects, etc. The seat and knee areas are reinforced with a layer of extra material. The fly zipper, with a two way action, may be opened from the bottom or the top.

16. UNDERSHIRT AND UNDERSHORTS, COTTON

MATERIAL: The V-Neck, short sleeve undershirt is made of a circular knit cotton jersey. The undershorts are made from 135 gm/m² (4 oz./yd.²) cotton broadcloth with elastic waist. Combat underwear is dyed olive green to reduce camouflage problems when the items are drying in the field.

BOOTS, COMBAT, GENERAL SERVICE

TROPICAL/TEMPERATE

15. JACKET AND TROUSERS, FIELD RAINWEAR

MATERIAL: Neoprene Coated Nylon 160 gm/m² (4.75 oz./yd.²) olive green.

DESIGN: The jacket is single breasted with slide

fastener and button front closure. It is provided with a detachable hood with button attachment to the collar. There is a drawcord at the bottom hem. The trousers are slip-on type with a waist drawcord, side openings to the pockets of innerwear, and drawcord ankle closures. The field rainwear is designed to give protection to the soldier in heavy rain when he is involved in relatively static duties. The weight of the jacket and trousers combined is currently 737 gms (26 oz.) while a 312 gms (11 oz.) ensemble is under development.

OVERBOOTS, COMBAT



TEMPERATE

1. CAP, COMBAT
4. COAT, COMBAT

MATERIAL: Cloth, Cotton/Nylon twist, 281 gm/m² (8.3 oz./yd.²) olive green, "Quarpel" treated.

DESIGN: The design is similar to the Shirt/Coat in the arrangement of the pocket system. The front is closed by a slide fastener underneath a button flap for extra weather protection. The collar is faced with corduroy to provide extra warmth and comfort. The slotted type plastic button is used on this garment.

5. TROUSERS, COMBAT

MATERIAL: Same as (4).

DESIGN: Similar to the lightweight trousers (Item 2) except that there are no reinforcing patches. The fly zipper, with a two way action, may be opened from the bottom or the top.

GLOVES, COMBAT

6. CAP, KNIT (TOQUE)

MATERIAL: Worsted spun olive green yarn of 80% wool and 20% nylon.

DESIGN: Close fitting for wearing under the steel helmet to give cold weather protection to the head, forehead and ears. The ear flaps can be rolled up if desired.

This toque is produced by Dorothea Knitting Mills.

7. SCARF

MATERIAL: Open knitted olive green cotton.

DESIGN: The scarf is 183 cm (72 in.) long by 61 cm (24 in.) wide and is designed to provide additional comfort under temperate and cold weather conditions.

8. SWEATER, V-NECK

MATERIAL: Worsted spun olive green yarn 80% wool and 20% nylon.

DESIGN: The V-Neck, long sleeve sweater is provided in small, medium and large sizes.

9. LINER, COAT, COMBAT

MATERIAL: Polyester batting, laminated both sides to nylon taffeta. This material was developed to produce a more effective and lighter insulant.

DESIGN: The liner is provided with buttons for attachment to the combat coat at the front facing, the neck and sleeve cuff. A knitted cuff gives additional comfort at the wrist areas and reduces heat loss.

The model is indicating the Liner with his right hand.



COLD WEATHER**10. FACE MASK**

MATERIAL: White nylon tricot laminated to polyurethane foam. The mouth cup is made from laminated paper.

DESIGN: The mouth cup has a wire reinforcement around the edge which enables it to follow the contour of the nose and cheeks. This design prevents hot exhaled breath from passing upwards towards the eyes thus reducing the problems of condensation on goggles and of the eye lashes freezing. Slits are provided above the ears to allow spectacles to be worn. The excellent fit made possible by the flexibility of the polyurethane foam and the easy breathing characteristics of the mouth cup, give a high degree of protection against frozen skin and lungs where extreme cold and high wind chill factors are common. An adjustable head harness is provided.

11. PARKA

MATERIAL: Cloth, Twill, Nylon Warp, Cotton Weft "Quarpel" treated olive green. The inner-lining is polyester batting laminated to nylon tricot. The hood is trimmed with wolf fur.

DESIGN: The pocket system follows the pattern of the Shirt/Coat. There are drawcords at the waist and bottom hem. The front is closed by a slide fastener and button system similar to the Coat, Combat. The sleeves are closed with a knitted cuff. The hood is capable of being worn over a steel helmet. The front of the fur trimmed hood has a wire reinforcement which enables the front opening to be reduced in size and to stand out from the face to form a highly effective wind shield. Tabs are provided at the front and back for rank identification.

12. WINDPANTS

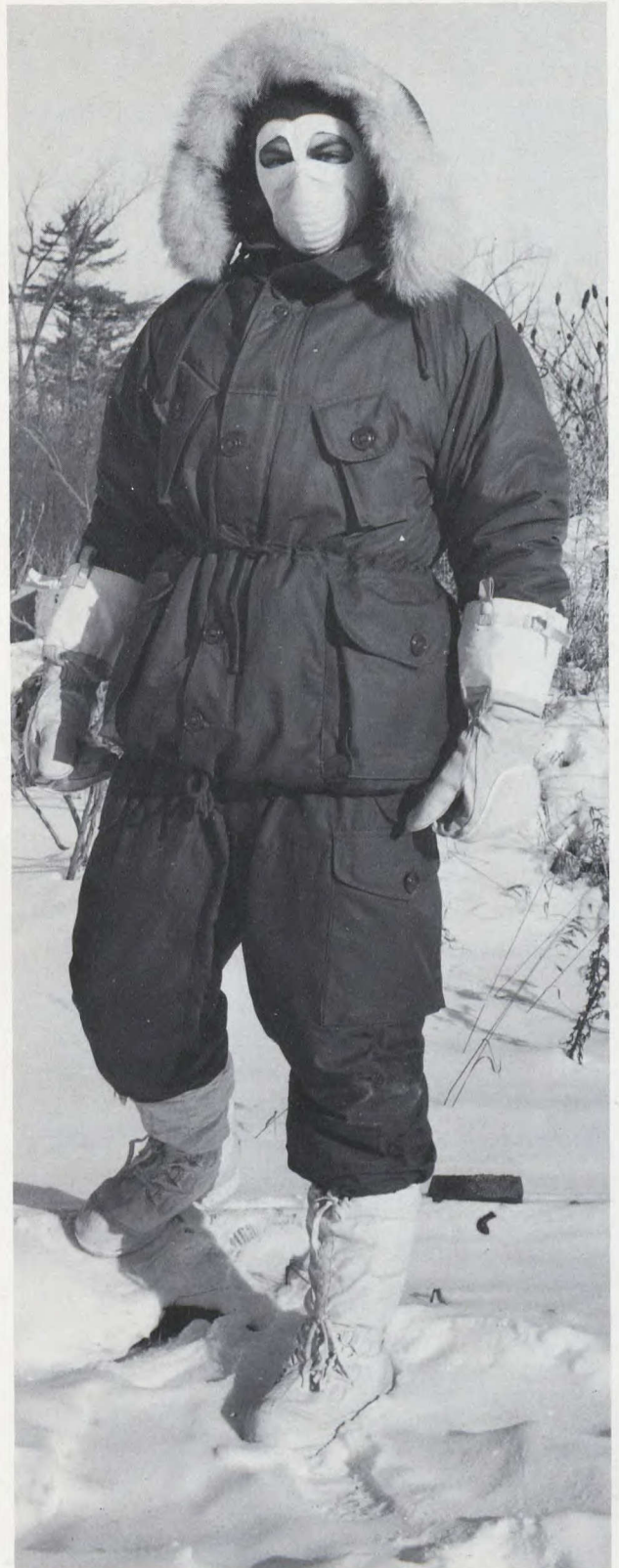
MATERIAL: Cloth, Twill, Nylon Warp, Cotton Weft olive green, "Quarpel" treated.

DESIGN: The trousers are supported by a waist drawcord and can also be closed at the ankles by drawcords. Side openings give entry to the combat trousers worn underneath and two further outside pockets are also provided.

MITTEN SHELLS & INSERTS, WINTER**MUKLUKS**

13. The Cold Weather Cap has a short peak for compatibility with the Parka. It has a pile trimmed ear and neck flap for cold weather protection.

MATERIAL: Polyester/Viscose with acrylic pile trim and cotton batting insulation. Dark Green.



14. PARKA AND TROUSERS, CAMOUFLAGE, WHITE

MATERIAL: Lightweight, White Polyester Twill.

DESIGN: In operations under snow conditions the olive green colour of the parka and windpants does not meet camouflage requirements, therefore, special white camouflage garments are provided. The camouflage parka and trousers are of simple design and completely cover the insulated parka and windpants. The parka has a button front and attached hood. Both garments can be compressed to so little bulk that they can be carried conveniently in the pocket of the insulated parka.

In this illustration the model, with his right hand, is demonstrating the Anti-Contact Glove which provides the dexterity for some operations such as affixing and adjusting this Sniper Sight without the risk of frost damage to his hands.

17. UNDERSHIRT & DRAWERS, EXTREME COLD WEATHER

MATERIAL: Honeycomb knit, carded cotton, olive green or white.

DESIGN: The construction is found highly effective as an insulating layer in that the honeycomb construction provides a layer of still air next to the skin.

SNOWSHOES, TRAIL, MAGNESIUM

GLOVES, ANTI-CONTACT



AIR CREW CLOTHING

The four flying suits, with accessories, described here have been designed to meet all climatic conditions from tropical to frigid with a minimum of sophistication. After a long period of development and user trial they have met all requirements and at the same time provide a neat, military dress for aircrew.

ONE-PIECE TRANSPORT FLYING SUIT

This suit is a one piece coverall with a front slide-fastener closure. There are two button-fastened pockets and two side pockets.

The sleeve cuff is a button closure and Velcro* is used for the waist adjustment. This garment provides an acceptable standard of uniform dress for out-of-aircraft activity.

MATERIAL: 203 gm/m² (6 oz./yd.²). Polyester/Wool. Dark green.

The shoe worn here is the standard Officer's dress shoe.



TWO-PIECE TRANSPORT FLYING SUIT

The Jacket is a simple hip length style with a nylon slide-fastener front closure. The trousers are belt supported and have two hip and two side pockets. This two-piece suit complements the one-piece but is more versatile in that the crew may fly in a "shirt-sleeve" environment when the aircraft type permits. With the jacket on this very practical uniform presents a smart military appearance for all normal use. It uses the same material as the one-piece suit.

The Gloves worn by both the transport models are the hair type sheep leather (South African Cape) which have a tacky finish which provides good gripping characteristics.

The Boot worn here is of ankle height and blucher design manufactured on the Goodyear welt process. Ankle straps are provided to prevent loss during high speed ejection.



COMBAT FLYING SUIT

This one-piece coverall is a purely functional design, with a two-way slide-fastener front closure. Patch pockets with slide-fastener closures are located on each breast, the left sleeve, on the side of each lower leg and two on the left thigh. The waist is adjusted by Velcro* loop and tab. The wrists have a buttoned cuff and the ankles are closed by slide-fasteners. Pencil slots are placed on the lower leg pockets and a map clip on the front left thigh pocket. All closures and fastenings will withstand the stresses of high speed ejection.

MATERIAL: Polyester/Wool 203 gm/m² (6 oz./yd.²). The Intermediate Flying Jacket may be used here depending upon the environment. It has a slide fastener front closure and knitted collar and cuffs. Exterior and interior pockets are provided with the left sleeve having a slide fastener closed pocket with pencil slots located on its outer surface. Velcro* loop and tab is used for waist adjustment.

MATERIAL: Nylon warp, cotton weft twill with polyester batting laminated to nylon twill as insulation. Dark green.



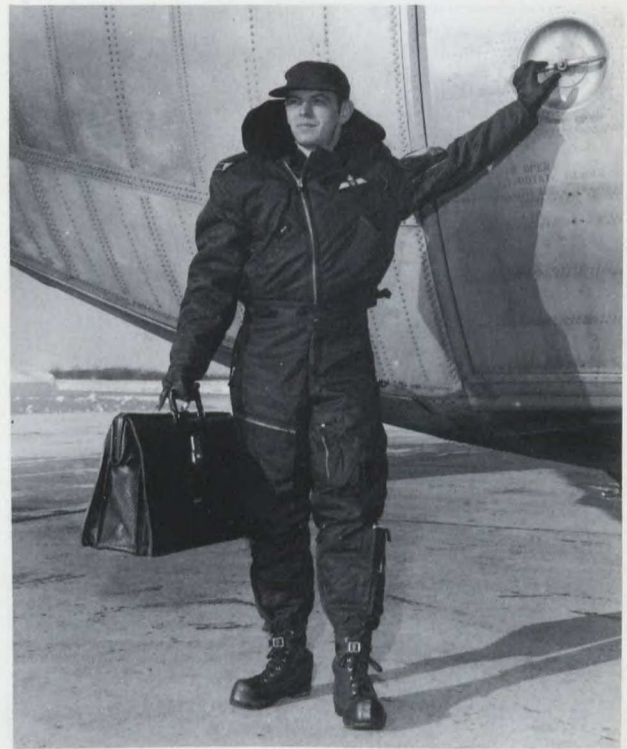
WINTER FLYING SUIT

A two-piece suit consisting of Jacket and Overalls. The jacket has a overlapped slide-fastener front closure and a mouton collar with a hood which is enclosed in the collar when not in use. Diagonal slide-fastener closed pockets are provided on each side together with two inside pockets. Pencil slots are located on the outer side of a slide fastened pocket on the left sleeve. Velcro* loop and tab provided the waist adjustment. The overalls have a high back and front with integral suspenders and Velcro* adjusted. A drop-seat is incorporated. Patch pockets with slide fastener closures are located on both thighs and lower legs. Pencil slots and map clip are provided. The two-way slide fasteners on the legs ease donning and doffing as well as provide ventilation as required.

MATERIAL: Nylon warp, Cotton welt twill, dark green. Insulation is polyester batting laminated to nylon tricot.

The Gloves displayed here are the Winter type with an inner woolen glove worn under the leather glove.

The foot wear system here comprises the Winter Flying Overboot with its own Duffel Sock and again incorporates an ankle strap to prevent loss during high speed ejection.



FLIGHT LINE CLOTHING

BASIC WORKING DRESS

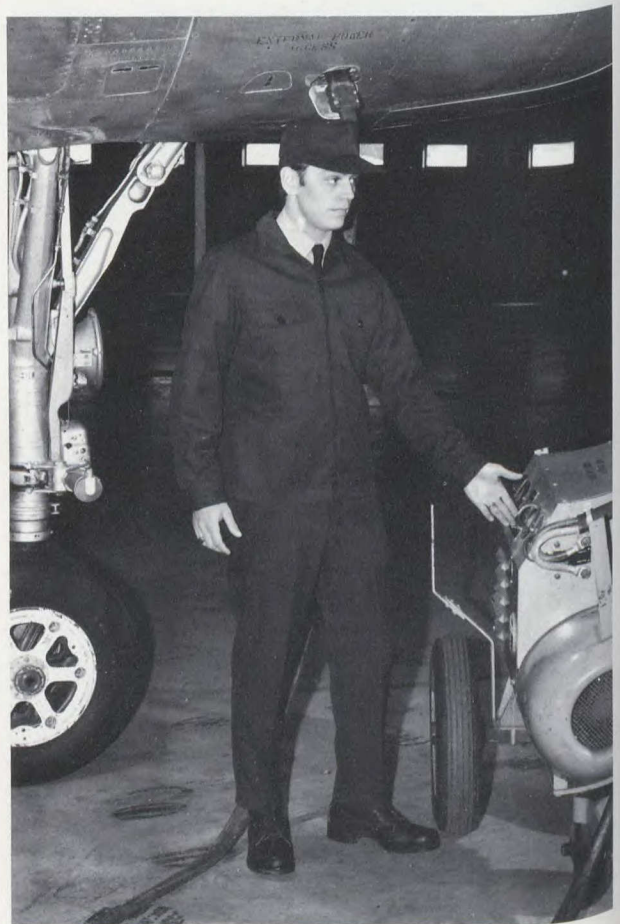
The Basic Working Dress has a Jacket which is hip length with a nylon slide fastener as a front closure. There are two breast pockets and inside pencil/pen pockets. The Trousers are conventional slim fitting design and are belt supported. The peaked Cap (baseball) has an elastic insert at the back to accommodate varying head sizes. The material for the above three items is Polyester/Viscose 302 gm/m² (8.9 oz./yd.²). Dark green in colour.

The Shirt, with two breast pockets, has long sleeves and a collar designed to be worn with or without a tie. The material is Polyester/Cotton, lagoon green at 169 gm/m² (5 oz./yd.²).

CONCEPT OF USE: The Basic Work Dress provides a uniform for working in clean areas as well as for normal movement between those areas. Through application of the layer concept the dress is adaptable to warm weather by removing the Jacket and tie and rolling the sleeves. In cooler weather the same principle applies by adding under or over-garments. The Dress on the following three pages presents such conditions. The Boot displayed here is ankle length and is water repellent as well as being resistant to petroleum products. It is manufactured on the direct moulded sole system of a one piece leather plain-toe vamp with a full bellowed tongue. The Boot is fully lined and has a leather insole.

COVERALLS AND INTERMEDIATE JACKET

The Coverall is readily adaptable to the layer concept and may be worn over underclothes or the whole or part of the Basic Dress and may be further augmented by the Intermediate Jacket. Their use will depend upon the work function and to a degree upon the environment. The Coverall design is an attempt to reduce the problem of foreign objects such as pencils, screws, locking wires, etc. falling from the pockets and becoming jammed in control linkages or possibly being ingested by jet engines, therefore there are no external pockets. The one piece suit has a nylon slide-fastener as a front closure and uses Velcro* closures at the wrist and ankle as well as for a waist adjustment. Two pockets are provided on the inside for personal belongings, check-stamp or pen, etc. and are closed by nylon slide



fasteners. The Coveralls may be colour coded for trade or work area identification.

MATERIAL: Polyester/Viscose 320 gm/m² (8.9 oz./yd.²). Yellow, dark green, or other colours as required.

The Intermediate Jacket which is similar in design to the Basic Working Dress jacket is slightly longer to give added climatic protection to the lower back and is used down to -6°C (20°F).

This Jacket may be worn over the coveralls, replacing the jacket from the basic dress, depending upon environment.

MATERIAL: Nylon warp, Cotton weft with Polyester batting laminated to nylon twill as insulation. Dark green.

The glove worn here is the Anti-Contact Glove to protect against "cold burn" but at the same time it enables the user to manipulate small objects with dexterity. White cotton twill with small raised plastic dots to prevent contact with cold metal.



FOUL WEATHER ENSEMBLE

The Parka and Trousers are designed to be worn over the clothing such as the Basic or Coveralls. The Parka is a pullover type with attached hood which is adjusted by a drawcord and a slide fastener. A large patch pocket is provided across the chest and the sleeve openings are adjusted by Velcro*. An alternate design is available which has a slide front closure covered by a buttoned flap and a drawcord at the bottom hem. In this case the hood is detachable. The Trousers are a pull-on type with elasticized waist and Velcro* closures. All seams are sealed with cement to ensure a waterproof garment.

MATERIAL: 92 gm/m² (2.7 oz./yd.²). Polyurethane Coated Nylon, yellow or dark green. Yellow is used where high visibility is required.

COLD WEATHER ENSEMBLE

For detail see items 10, 11, 12 and 13 on page 336

This equipment is also standard issue to the Army for field rainwear having been field trialled and proven to meet their requirements.



SPECIAL CLOTHING

AFV CREW CLOTHING

Combat Clothing, with its bulky pocketing system so necessary to the infantry soldier, provides endless problems to those who operate in Armoured Fighting Vehicles or other types such as scout cars where space is at a premium. The AFV, studded with control levers and similar projections, can only be operated with assurance and ease when a suit has been designed to meet this closely confined environment. The Canadian Forces now have such a cold weather suit while a temperate climate model is under development.

GENERAL: This clothing was developed for wear in the temperature range -40°C to 0°C (-40°F to 32°F) and has been in service for three years.

MATERIAL: Cloth, Nylon/Cotton Twist, 281 gm/m^2 (8.3 oz./yd.^2) olive green, "Quarapel" treated. The insulating layer is polyester batting laminated to nylon tricot.

DESIGN: A two-piece suit consisting of a jacket and overalls. The overlapping jacket is waist length with a slide-fastener front closing. Knitted wrist cuffs give additional warmth and a hood, which can be rolled to form a collar, is also provided. Pencil slots are located on the left front together with a slide-fastener closed pocket for carriage of small items. Lifting straps for the retrieval of injured crewmen are provided on each shoulder and at the centre back. There are loops at the waist of the jacket for attachment to the overalls.

The overalls are provided with a high front and back for extra insulation and are worn with suspenders. The overalls have slide-fastener closures at the side waist and the trouser legs bottoms which provide ventilation as well as ease of donning and doffing. A drop-seat is incorporated. Cargo pockets are provided on the right and left thigh regions as well as two side pockets for carriage of personal belongings which are closed with Velcro* fastenings.



CHEMICAL WARFARE PROTECTIVE CLOTHING OVERGARMENT

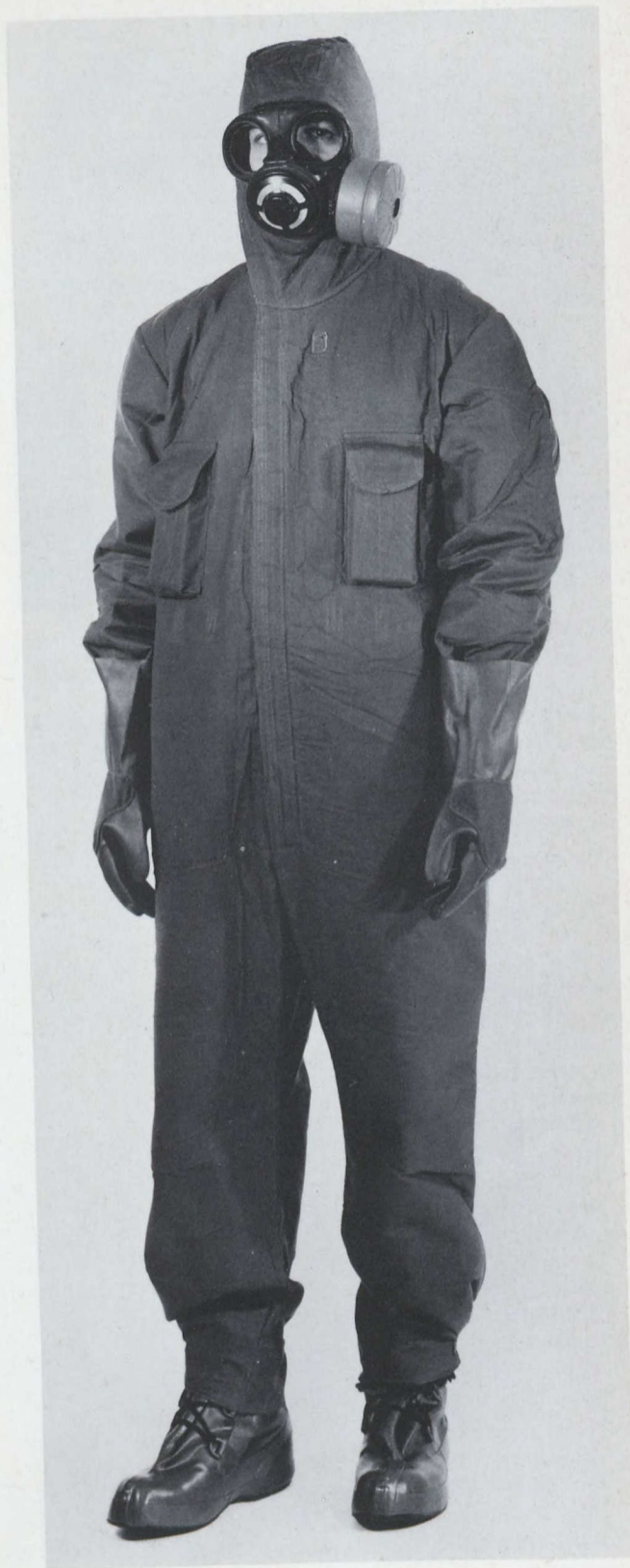
MATERIAL: Shell material is Cloth, Nylon/Cotton Twist, 169 gm/m² (5 oz./yd.²), "Quarapel" treated, olive green. The lining is charcoal-impregnated polyurethane foam, laminated to nylon tricot.

DESIGN: The coverall, with an attached hood, has a slide-fastener and a Velcro* front closure. The wrist and ankle openings are also closed by Velcro*. Elastic webbing stirrups are provided on each leg to ensure that there is a satisfactory overlap of the pant leg and the coverboot. The garment is provided in four sizes and there is a built-in suspender adjustment to cater for height variations within each size. There are two breast pockets for the carriage of small arms magazines. The hood is designed to give a close fit around the Canadian Protective Mask and has been modified on request for other custom applications.

PARKA AND TROUSERS, FOUL WEATHER, NAVAL.

The older garments, which were heavy, bulky and not particularly durable have now been replaced by a lightweight suit. Sea trials have proven that the new design and materials have overcome these shortcomings under extreme wet conditions.

The same equipment described on page 341 under the title "Foul Weather Ensemble" is also utilized by the navy and in fact was originally designed for marine use.



MASK PROTECTIVE, NBCW NO. 2 MK 2/2

The Canadian designed Mask, Protective, NBCW (Nuclear Biological and Chemical Warfare) No. 2 MK 2/2 is designed to provide protection from all known NBCW toxicological agents to the respiratory tract, the face and eyes of combat and support personnel of the Armed Forces. Within the Canadian Armed Forces this mask is the normal issue protective mask, other types of masks being issued are to individuals having specialized roles such as tank-crew and air-crew. The design has evolved from a family of masks dating back to World War II. During this period almost every component of the mask has been modified or completely re-designed and additional sub-assemblies have been added. Each change was extensively tested and has withstood prolonged user evaluation after introduction. The mask in its present design provides a high level of protection against chemical and biological agents and against the ingestion or inhalation of radioactive particles. It combines this protective capability with a high degree of user comfort and acceptability, and gives minimal interference with the functions of the combat soldier.

The mask is completely non-magnetic, the metal components having been re-engineered in non-magnetic materials. This allows accurate use of a compass, even when held close to the face.

This protective mask meets all the operational characteristics established as firm requirements by NATO.

The Face-Piece, which is made of moulded natural rubber, incorporates several salient features which have contributed to the ready acceptance of the equipment by several other nations.

- The FACE-PIECE BLANK is moulded in three sizes: Large, Medium and Small, the rubber is formulated to remain soft and pliable at sub-zero temperatures and yet to remain non-tacky at 53°C (125°F). It has passed cyclic storage tests from -55°C to 70°C (-65°F to 160°F).
- The EYE-PIECE assemblies — The two eye-piece assemblies each consist of a shatter proof flat glass eye-piece 6.35 cm (2.5 in.) in diameter with the appropriate inner and outer rims, washer and clamp assembly to preclude leakage and facilitate replacement. The circular flat eye-pieces give a wide angle of vision due to their position close to the wearer's eyes, allow for the use of optical instruments

(e.g. binoculars or gun sights) and provide distortion free vision across their entire surface. The use of wider curved plastic eye pieces and a single unit "goggle" type eye-piece were investigated and considered to be inferior in operational type situation although they may afford increased peripheral vision.

- The combined OUTLET VALVE AND SPEECH TRANSMITTER assembly C1 fits into the central opening of the face-piece blank. The outlet valve C2 is a circular rubber disc operating against a metal seat. The valve is protected both from the inside and outside by wire mesh screens to prevent the ingress of dirt which could cause valve leakage. Between the outlet valve and the inner screen is a two ply Mylar (polyester film) speech diaphragm. Exhaled air by-passes this diaphragm peripherally.
- The NOSECUP assembly is assembled into the same opening of the face-piece blank as the outlet valve and speech transmitter. This nosecup fitting around the mouth and nose of the wearer, and moulded of natural rubber contains a one-way rubber valve. The purpose of the nosecup assembly is to draw incoming cool dry air over the inside of the eye-piece and to funnel the moist exhaled air directly out of the mask. The one-way valve (and the re-entrant nature of the nosecup to face seal) allows the passage of air from upper portion of face-piece into the nosecup during the inhalation phase of the breathing cycle.

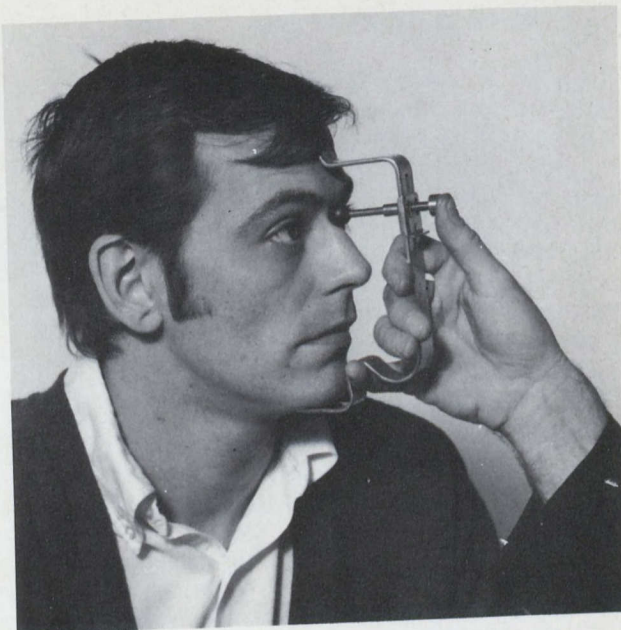
The CANISTER C-1 contains activated charcoal which adsorbs toxic gases, and an integral particulate filter which removes particulates of the size that have been determined to constitute a toxicological threat. Removable rubber plugs are provided for the canister to prevent ingress of moisture when the mask is kept assembled in the carrier. A screw type cap in addition to the rubber plugs is provided when the canister is stored separately.

The CARRIER for the mask is a rugged fabric bag having a quick opening device for fast access to the mask. Attachments allow carriage of the carrier in a number of ways. Pockets on both the inside and outside of the bag hold the eye-piece anti-fogging kit, instruction sheet chemical agent detector paper booklets and other small items issued for detection and protection of the individual.

The approximate weight of the complete mask as worn is 540 gm (19.5 oz.).

SIZING SCALE

The Sizing Scale is a very simple and inexpensive device which makes possible the quick and accurate fitting of Face-Pieces to large numbers of personnel, particularly the civilian population.



HANDWEAR & FOOTWEAR

The service man, to be able to carry out his assigned tasks, depends largely on his ability to use hands effectively and to maintain his personal mobility. Consequently handwear and footwear have been developed to improve manual dexterity under adverse climatic conditions, and to give him maximum foot mobility and comfort. New materials and designs have been used, and new approaches to old problems have been adopted. A good example of these approaches is in the combat boot. While every effort has been made to make the boot waterproof it has been realized that the addition of the combat overboot would not only ensure the waterproof state but also provide further protection from cold, again using the layer principle.

Handwear follows much the same pattern and recognizes the need for cleaning and drying by having removeable liners where required. In all cases excellent dexterity, tactility and gripping characteristics have been provided.

HANDWEAR

TEMPERATE

GLOVES, COMBAT (SHELL AND LINER)

These gloves were designed to complement the temperature combat clothing system and may be worn with or without the removeable liner. They have good tactility and dexterity characteristics. The black horsehide leather shell is of a curved hand and finger design and has an elasticized wrist.

The removeable liner is of seamless knitted construction with tapered fingers and ribbed cuff. It is produced from a shrink-resistant and mothproofed yarn, $\frac{3}{8}$'s worsted count — 58's quality wool, olive green in colour and containing 20% to 25% nylon staple.

SIZES: The shell and liner are provided in Small, Medium, Large and Extra Large.

These gloves were produced by Consumers Glove.

GLOVE, FLYING, WINTER, INNER, WOOLLEN

This item is designed to be worn in combination with Gloves, Leather, Aircrew in cold conditions. The glove is a knitted type with tapered fingers and a ribbed cuff. It is knitted from a shrink-resistant and mothproofed yarn, 2 ends 2/20's worsted count, 64's quality wool, natural colour and containing 10 to 15% of nylon staple.

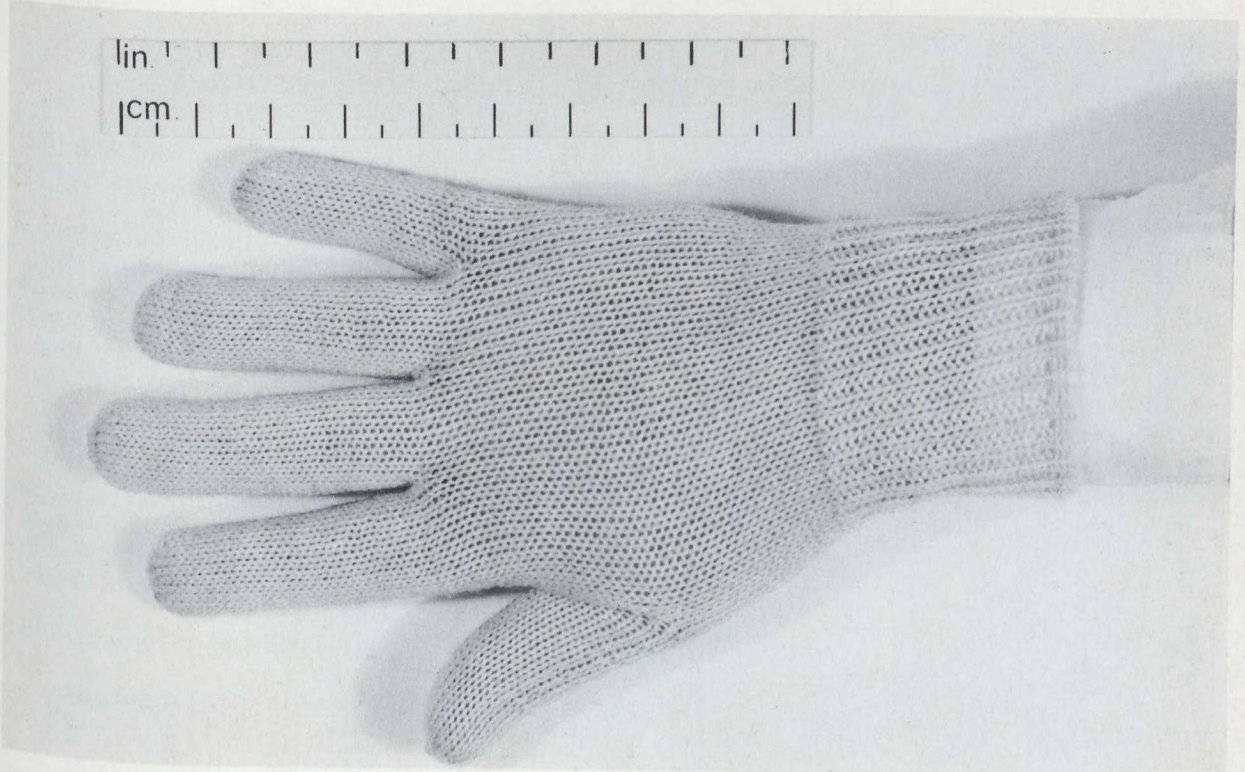
SIZES: The glove is provided in Small, Medium, Large and Extra Large sizes.

GLOVES, LEATHER, AIRCREW

These items are designed to complement the aircrew clothing shown on pages . The glove has an elasticized wrist. The hair type sheep leather (South African Cape) has a tacky finish which provides good gripping characteristics. The glove is "table cut" and all closing operations are full pique (PK) sewn. The item provides excellent dexterity and tactility characteristics. Additional wear life is obtained on the palmar surface of the thumb through the employment of a leather patche.

SIZES: The glove is provided in sizes 8 - 12 inclusive, including half sizes.





Gloves, Flying, Winter, Inner, Woollen



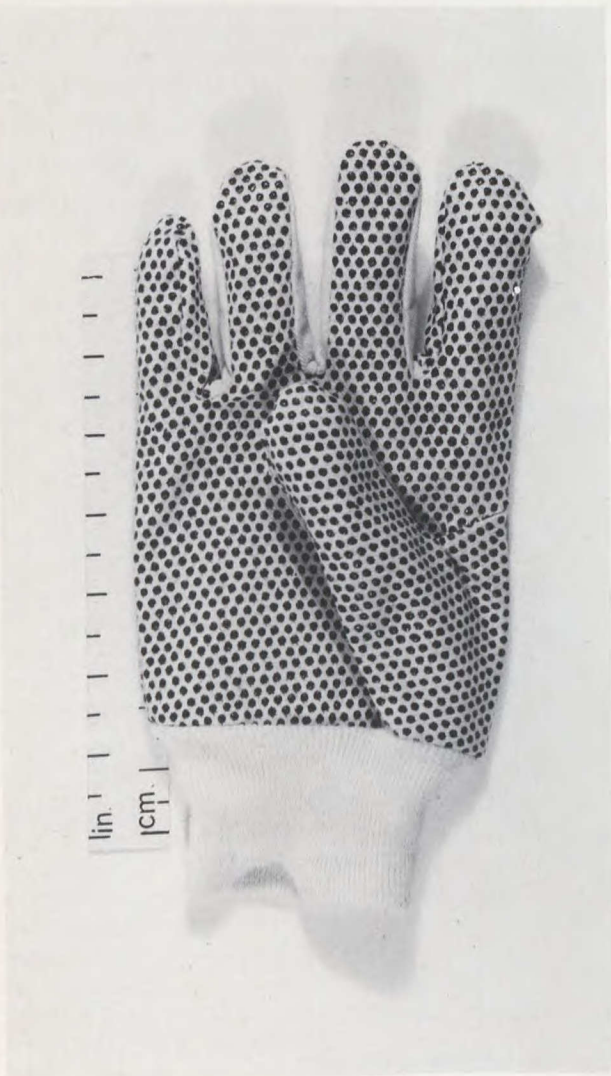
Gloves, Leather, Aircrew

GLOVES, ANTI-CONTACT

This item is designed to complement the extreme cold weather system of handwear. It provides hand protection for a limited time against "cold burn" in extreme cold weather and enables the user to manipulate small objects with dexterity and tactility for short periods of time while re-warming the hands as necessary. The glove is manufactured from a white cotton twill with a white cotton knitted cuff. The surface of the glove has small raised plastic dots attached to it to further prevent contact with cold metal, etc.

SIZES: The glove is provided in Small, Medium, Large and Extra Large.

This glove was produced by Consumers Glove.



COLD WEATHER

MITTEN SHELLS, WINTER, C1, A1
MITTEN INSERTS, WINTER, C1

The mitten shells and mitten inserts are of a curved palm design and provide protection to the hands in extreme cold conditions.

The hand portion of the shell is made from a chrome tanned horsehide leather and the gauntlet cuff is nylon canvas with a cotton canvas interlining. The wrist portion is elasticized and the cuff closure is affected by the use of a webbing strap and quick-release buckle. A wool pile "face warmer" is attached to the back.

The insert is removeable to permit cleaning and drying and is manufactured from a quilted nylon twill backed 10 oz. synthetic nylon batting and lined with wool flannel. The cuff is stiffened with cotton canvas. The insert is held in place in the shell with four stud fasteners positioned at the top of the cuff.

SIZES: The shell and insert are provided in Small, Medium and Large.

The Shells and Inserts were produced by Consumers Glove.

GLOVES, CHEMICAL WARFARE

The gloves are part of the system of protective clothing and they are worn in conjunction with the CW protective garment and CW protective overboots see page 343

The gauntlet type of glove is of a curved finger and palm configuration. It is manufactured from a duo-stretch nylon fabric coated with butyl and overcoated with a polyvinyl chloride material which has good low temperature and gripping characteristics. To assist in the dissipation of hand moisture the dorsal area of the hand portion incorporates a patch manufactured from a combination of cloth, nylon/cotton twist, 169 gm/m² (5 oz./yd.²) "Quarpel" water repellent finish and a nylon tricot, laminated to .02 mm (3/32 in.) charcoal-impregnated foam. The gloves are of an olive drab colour. To provide additional warmth for the hands the Glove, Combat, Liner can be worn inside the gloves. The gauntlet portion of the glove is worn under the sleeve of the CW protective garment.

SIZES: Gloves are provided in Small, Medium and Large.



BOOTS, COMBAT, GENERAL SERVICE

Prior to the introduction of the current combat boot the boot used by the Canadian Army was a legacy from World War II and even before that time. The so-called "ammunition boot" or "general service boot" was heavy and stiff, absorbed water readily and had to be worn with puttees or gaiters. It also increased the logistic burden as it required a boot repair facility in the field to maintain it.

The Combat Boot utilizes a new process of footwear manufacturing — the direct-moulded sole. In this process the uppers are cut from leather and lasted in the normal fashion, a steel shank added and the sole and heel are moulded and vulcanized in one piece onto the uppers. This provides a waterproof seam at the juncture of the uppers and the sole. To further prevent entry of moisture the pattern was designed with a one-piece vamp and thus the only seam entering the juncture of sole and upper is at the back of the boot. Water-repellency is maintained during the life of the boot by the application of silicone compounds; a small can of silicone with an applicator is issued for this purpose.

The sole has a tread pattern to assist traction and the life of the sole is approximately equal to that of the uppers. Canadian Forces experience has indicated that an 18-month field wear-life can be expected and there are many instances of boots still in service after three years of use. Only minor repairs are provided for, such as stitching in the uppers, although this is seldom required because nylon thread is used. Re-soling and heeling are a thing of the past and when the sole is eventually worn out, the boot is replaced. This boot is 20.3 cm (8 in.) high and thus eliminates the need for puttees or gaiters. The Canadian Forces found it to be less expensive than the old GS boot plus puttees/gaiters. It is leather-lined and has a strong leather insole to permit the absorption of foot moisture. Other design features are too numerous to detail but the Mk II version incorporates a speed-lace closure, modification to the pattern to give even greater protection from moisture and improved counter (heel stiffener) materials.

DETAILS

UPPER LEATHER:

Chrome tanned (Mk I)

Chrome/Glutaraldehyde tanned (Mk II)

LINING LEATHER:

Chrome tanned (Mk I)

Chrome/Glutaraldehyde tanned (Mk II)

INSIDE LEATHER:

Chrome retanned bends

SOLE COMPOUND:

70% Butadiene-acrylonitrile/30% pvc

LACES:

Braided "Taslanized" nylon

FINISH:

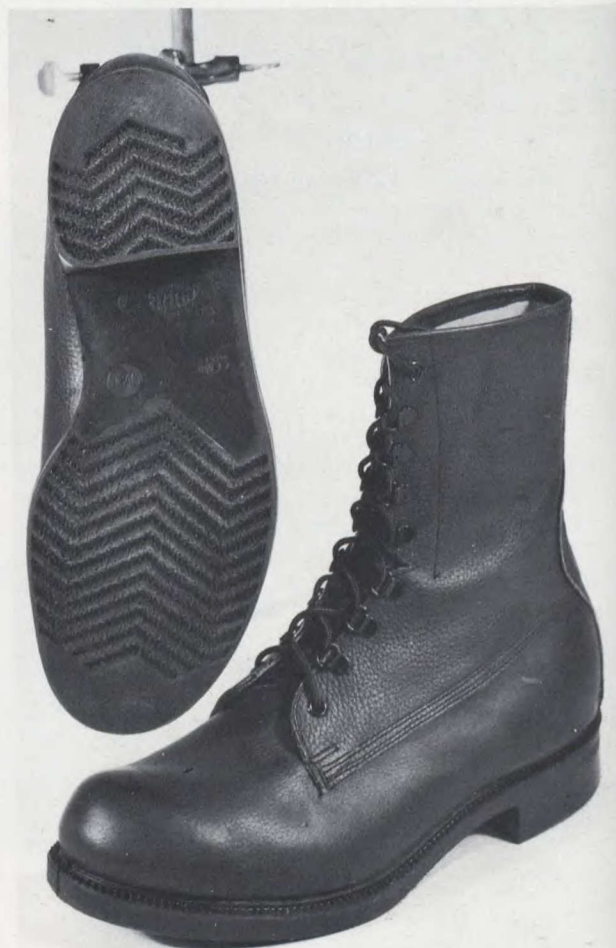
Uppers treated with silicone water-repellent on grain side.

WIDTHS:

D, E & F

SIZES:

4-14 (incl. half sizes)



OVERBOOTS, COMBAT

This black rubber overboot is designed to complement the combat clothing system and is normally worn over the combat boot under cold/wet conditions. The outsole is of a medium-course knurled design and has a high resistance to abrasion. It is completely waterproof and employs a slide-fastener type of closure.

A felt insole encased by a coated nylon tricot cover is used as the insulating medium. An expanded latex foam material is embedded between the gum cover and the lining to provide insulation to the lower part of the boot. To facilitate quick donning and doffing a nylon tricot insole cover and back strip are used internally. All components are cemented and vulcanized under the differential pressure cure system.

SIZES: The overboot is provided in one width and in sizes 5 to 14 inclusive, including half sizes. The height is 28 cm (11 in.).



COLD WEATHER FOOTWEAR SYSTEM

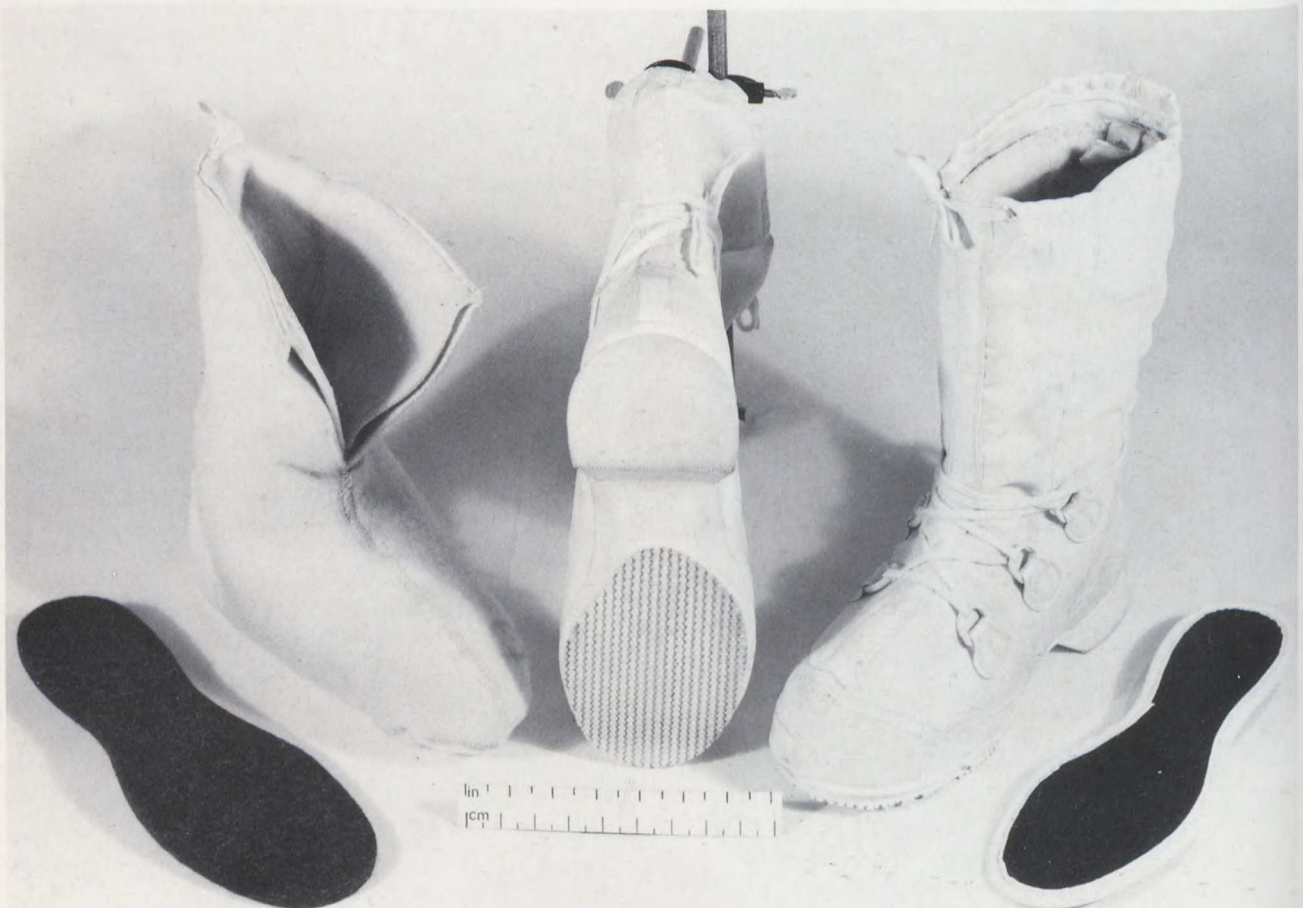
This system comprises the Mukluk, the Duffle Sock and Insoles, with each item being dependant upon the other for effectiveness.

The overall height of the Mukluk ranges from 34.2 cm (13.5 in.) for sizes 4 to 6 to 42 cm (16.5 in.) for sizes 11 and up. The uppers are manufactured from a white polyester fabric 8 $\frac{3}{4}$ oz./sq. yd. The outsole, heel and bottom reinforcing components are manufactured from a white synthetic rubber compound which meets low temperature requirements. Instep closure is effected through the use of 6 "D" rings and nylon laces. The top of the boot is closed by the use of a nylon drawstring. The rubber sole and reinforcing components are vulcanized to the upper under a differential pressure cure system. Full sizes from 4 to 12 inclusive are available in narrow and medium widths.

The Duffle Sock is manufactured from 31 oz./sq. yd. wool/viscose duffle cloth with the heel and toe reinforced with nylon fabric. Two layers of material are used in the construction. All edges of the sock material are blanket stitched and the seam closing is serged. A pull-tab is provided at the back of the sock. Full sizes are available from 4 to 12 inclusive.

The Plastic Insole is manufactured from a polyvinylidene chloride mono-filament material which is woven into a plain weave for the outer and middle layers and a honeycomb weave for the two inner layers. The outer edges of the insole are fused together by heat sealing and then bound with a white bias binding which is stitched in place. Full sizes from 4 to 12 inclusive with narrow and medium widths.

The Felt Insole is cut from 12.7 mm (.5 in.) felt material containing a mixture of 50% wool and 50% cattle hair. Full sizes from 4 to 12 inclusive.



OVERBOOTS, FLYING, WINTER

This boot is of mukluk design and is used with the Cold Weather Flying Suit. The system is similar to the army mukluk except that the height and sole area are reduced for compatibility with flying clothing and aircraft controls. The ankle strap prevents loss of the boot during high-speed ejection.

BOOTS, SERVICE, ANKLE HEIGHT

This item is a part of the air and ground crew clothing system. It is worn in temperate conditions where it provides traction and is resistant to gasoline, oil and other lubricants. The boot is manufactured on the Goodyear welt process and is of a blucher design with a plain toe vamp, outside counter pocket, box toe and a fabric lined vamp. It incorporates a leather insole and a full leather midsole. The outsole and heel are manufactured from a neoprene/cork material. In addition to the eyelet and lace closure system it has a leather strap and buckle closure at the top of the quarters to prevent loss of the boot during high-speed ejection. The uppers are manufactured from a chrome tanned black leather. Reinforced leather fibre counters, steel shanks and polystyrene box toes are also incorporated. SIZES: The boot is provided in sizes 4 to 13 inclusive, including half sizes and in D, E and F widths.



OVERBOOTS, CHEMICAL WARFARE

The overboots are part of the system of the CW protective clothing. They are worn over Boots, Combat and in conjunction with the CW Protective Garment and Gloves.

The overboot is 28 cm (11 in.) in height, made in left and right, to fit over the combat boots. Closure is effected by means of plastic "D" rings and nylon lace. The upper is made from a neoprene/butyl coated duo-stretch nylon fabric. The outsole and upper reinforcing components are made from neoprene rubber. An internal liner,

insole cover and back strip are provided to facilitate quick donning and doffing. After lasting, all components are vulcanized together under a differential pressure cure system.

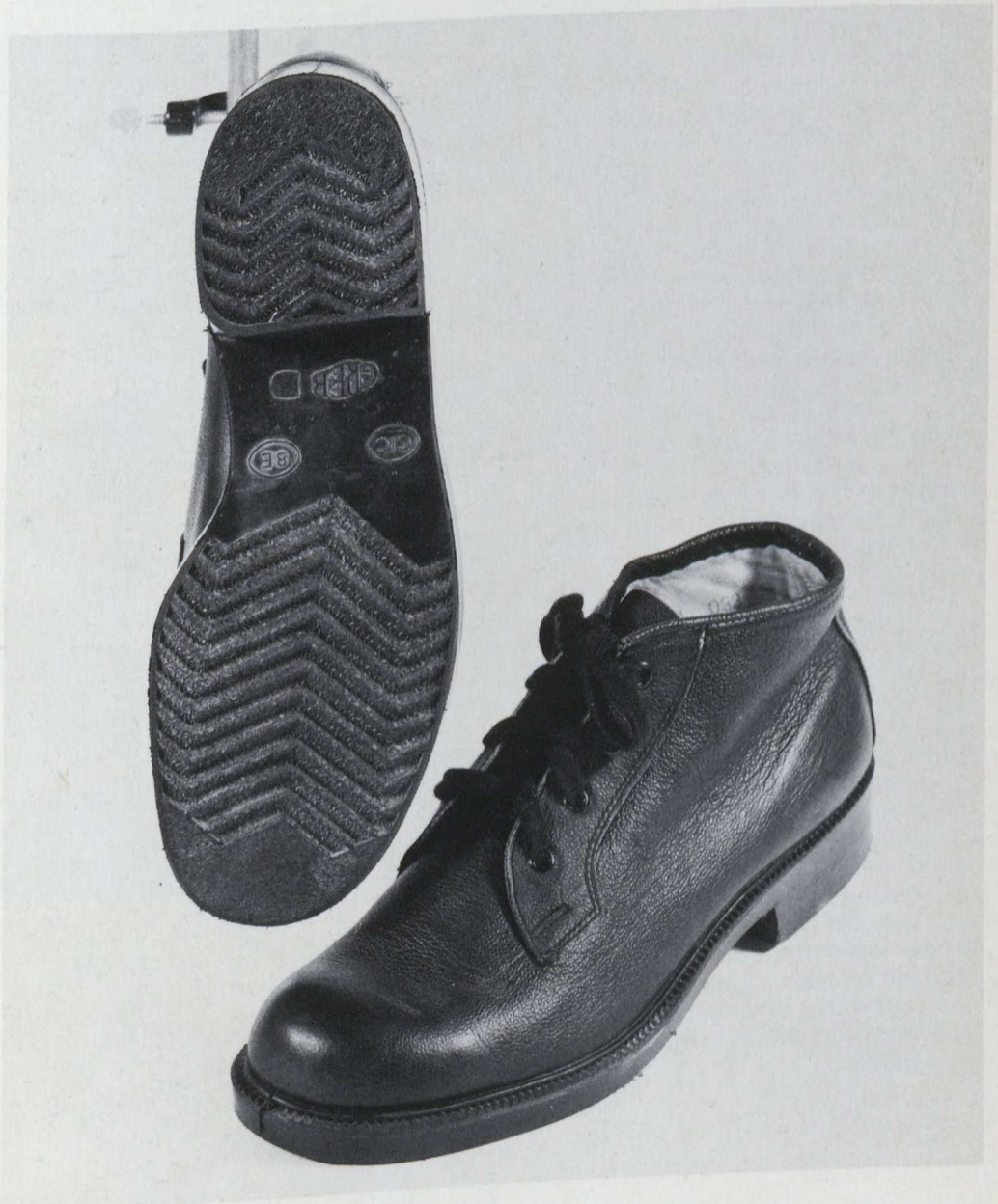
SIZES: The overboot is provided in one width and in sizes 6½, 8, 9½, 11 and 12½.



BOOTS, FLEET

This item is a part of the shipboard crew clothing system, worn in temperate conditions and provides good traction as well as being water repellent and resistant to petroleum products. The boot is manufactured on the Direct Moulded Sole system and is of a one-piece leather plain-toe vamp and quarter design with outside eyelet facings and full bellowed tongue. It is fully lined and has a leather insole.

SIZES: Widths D & F — 5-13 inclusive, full sizes only. Width E — 6-13 inclusive, full and half sizes.



CANADIAN FORCES COMBAT SPECTACLES

The wearing of eye-glasses or spectacles by military personnel has presented problems to almost every military force in the world. The increased general use of spectacles in the past two decades, combined with the greater need for unimpaired vision in an even wider spectrum of military trades and specialities has aggravated this problem. The use of contact lenses, while alleviating the problem to a certain degree, has not eliminated it because some individuals cannot wear them, and in other cases they have proven to be impractical for continuous 24 hour-a-day wear.

Over the past ten years the Canadian Department of National Defence has been engaged in the development of spectacles (specifically, spectacle frames) suitable for wear under all combat conditions, including those requiring the wearing of the non-leaking gas masks.

The frames or chassis are fairly normal in design and are made from German silver. There is a slightly increased clearance between the lenses and the nose (a wider bridge) in order to provide space for the NBCW mask nose-cup.

The temple members are moulded nylon, hinged near the top corners of the lenses and shaped to follow the eye-socket contour downwards to a point where the backward extension will pass over the cheekbone. The cross-section of the temple member is a very shallow 'D' with the shaped side against the wearer's head. The temple member terminates at a fully closed ear loop to which it is attached by a hinged attachment clip.

The spectacles are available in the following six sizes, using the Box system of sizing

48 x 26	46 x 26	44 x 26
48 x 24	46 x 24	44 x 24

The ear loops are available in 3 sizes: 55, 60 and 65 mm and are made of vinyl with a German silver wire within the vinyl tube for a strong supporting connection to the temple straps.

It must be emphasized that evaluation of these spectacle frames must be carried out under professional supervision and fitting of the spectacles should be performed by qualified personnel. Individual prescription lenses would be required for each individual because it has been found that valid trial results can only be obtained using subjects who normally require spectacles.

These combat spectacles have been subjected to exhaustive trials including:

1. field training and battle physical training
2. exercises requiring wearing of gas masks (training agents employed)
3. night driving and firing exercises
4. operational flying wearing helmet and oxygen mask
5. parachuting
6. recreational sports including skiing and scuba diving
7. normal wear for periods up to four months (office and home)

It is recognized that adoption of a completely new type of spectacle frame by a military force is a major decision and is only undertaken after considerable operational and medical evaluation and consideration. Therefore this office will be pleased to provide further information and to establish contact with the appropriate medical authorities in the Canadian Department of National Defence concerning any technical areas.



WEB AND LOAD CARRYING EQUIPMENT

The web equipment adopted by the Canadian Forces and introduced in 1964 was designed in conjunction with the load carrying capabilities of the combat clothing. The system provides for the carriage of personal clothing and equipment, ammunition and rations and caters for various operational conditions. The basic system is a web belt with suspenders to which carriers for specialized equipment can be attached. An independently suspended cargo pack is also provided. The improvements now featured in the Canadian Forces web system were not due to new designs or new materials alone but rather to an amalgum of these facets of product improvement. The introduction of field trialled plastics as well as the proven capabilities of Velcro* closures have permitted these radical advances.

Plastic hardware reduces the weight of all equipments with which it is associated and is permanently camouflaged without losing the durability found in the previous metal hardware. The design of the personal load carrying ensemble has been considerably simplified by reducing the total number of individual pieces and by eliminating time consuming and often ineffective methods of attachment of the components.

In this respect Velcro* hook and pile strip has been used to advantage where it provides proven, secure attachments. The Velcro* strips have been so positioned on the items that they are not affected by mud, snow, etc., nor are they prone to accidental opening.

In this field of basic equipment, realistic and meaningful improvement is difficult and here the rucksack may serve as an example of the advances made. The rucksacks from the commercial market, did not meet service requirements with respect to durability and the particular needs of airborne troops. Once again it was necessary to undertake development on what apparently was old and proven equipment but in the light of modern service use, was not.

Another basic piece of equipment, the water bottle, has seen improvement through the application of new materials. Following World War II the Canadian Army adopted an aluminium water bottle of U.S. design which has proven to be too expensive and its construction did not solve hygienic and bacteriological problems caused by the retention of food particles, etc. During development phases it was realized that the application of plastics to water carriers would result in the necessary improvements and would considerably reduce production costs.

WEBBING

WEB BELT: Constructed from a rot resistant, olive green, cotton webbing, the ends of which are protected by a vinyl impregnation. Adjustment for girth is achieved by Velcro*. A moulded nylon buckle, olive green, provides the closure
see page 373

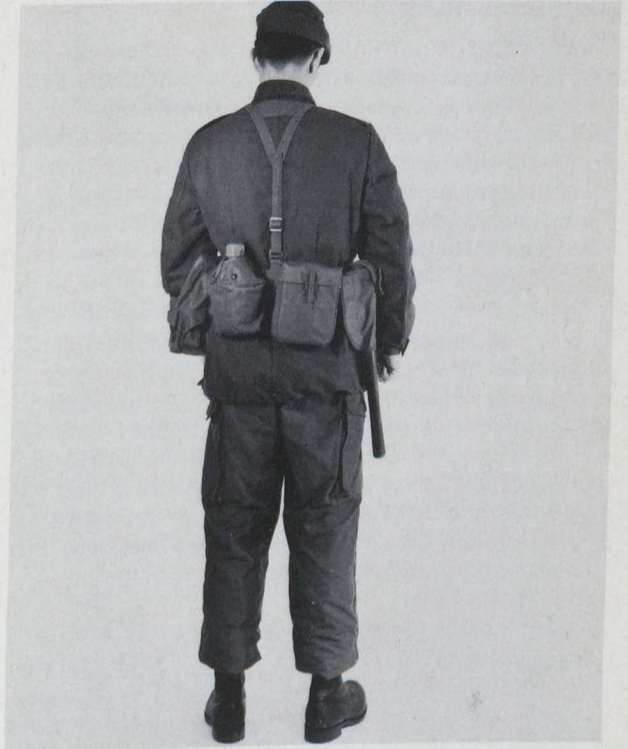
SUSPENDERS: Constructed from a rot resistant, olive green, cotton webbing with an adjustment for height provided by three 25.4 mm (1 in.) centre bar buckles. The suspenders are attached to the belt by means of Velcro* hook and pile closure.

INDIVIDUAL CARRIERS: Individual carriers for the following items are provided: grenades, water bottle, mess tins, entrenching tool, bayonet, NBCW Protective Mask pistol and respirator. All carriers are attached to the belt by means of loops which are closed by Velcro* hook and pile. The carriers can be arranged on the belt to meet varying operational circumstances and to suit individual preference. All items are constructed from vinyl impregnated nylon/cotton canvas and also utilize plastic hardware. Much of this webbing was produced by Textile Industries.

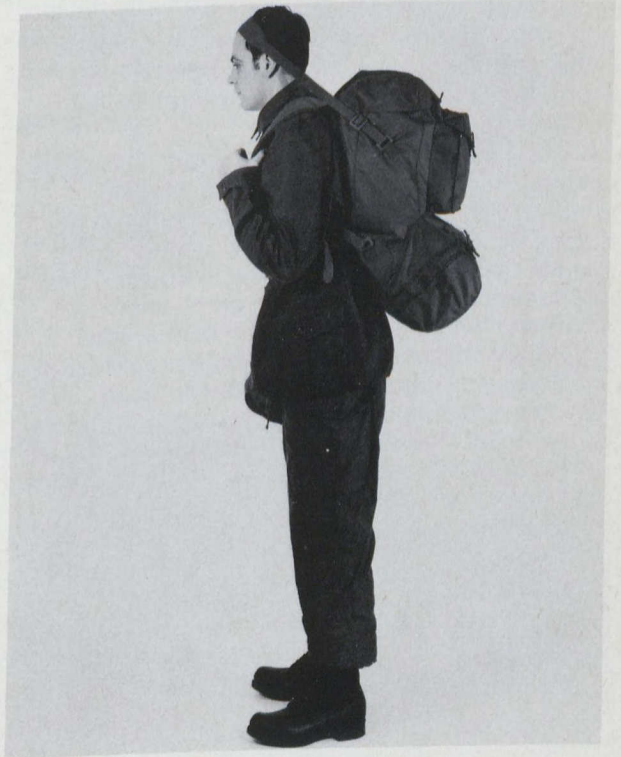
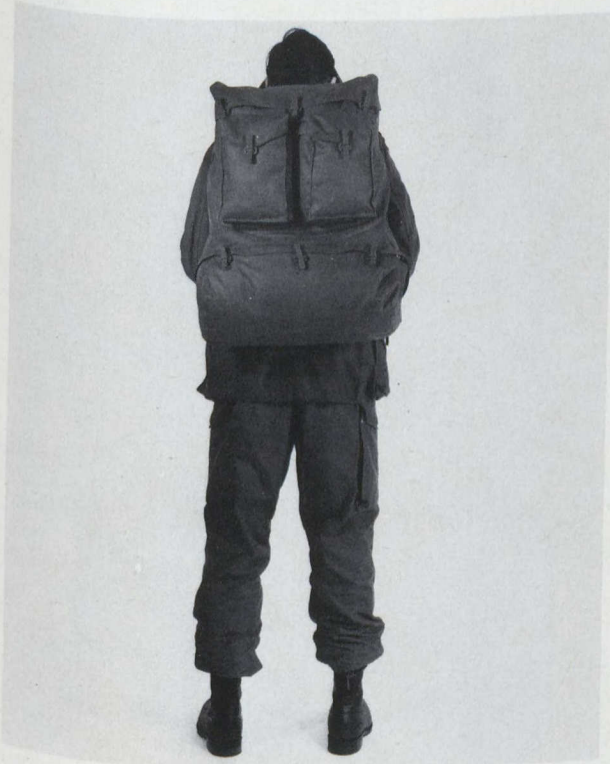
CARGO CARRYING

CARGO PACK: This pack has one large compartment for general storage with two smaller compartments on the outside capable of carrying the mess tins and water bottle. Below this is a compartment for sleeping equipment which is closed by a slide-fastener protected by a flap. This compartment is canted away from the back to reduce bumping and continual contact. Padded shoulder straps are provided and a three-dimensional honey-comb type material is incorporated to give air circulation between the pack and the man's back for improved comfort. A "tumpline" (head strap) is also provided.

MATERIAL: The pack is constructed from vinyl impregnated nylon/cotton canvas and cotton webbing, olive green, and uses plastic hardware.



WEBBING



CARGO CARRYING

UNIVERSAL RUCKSACK, C-2

The rucksack is normally a part of the personal load carrying equipment ensemble and is usually used as the major carrier under extreme cold conditions. Following evaluation of many different models the Canadian Forces Rucksack was adopted consisting of:

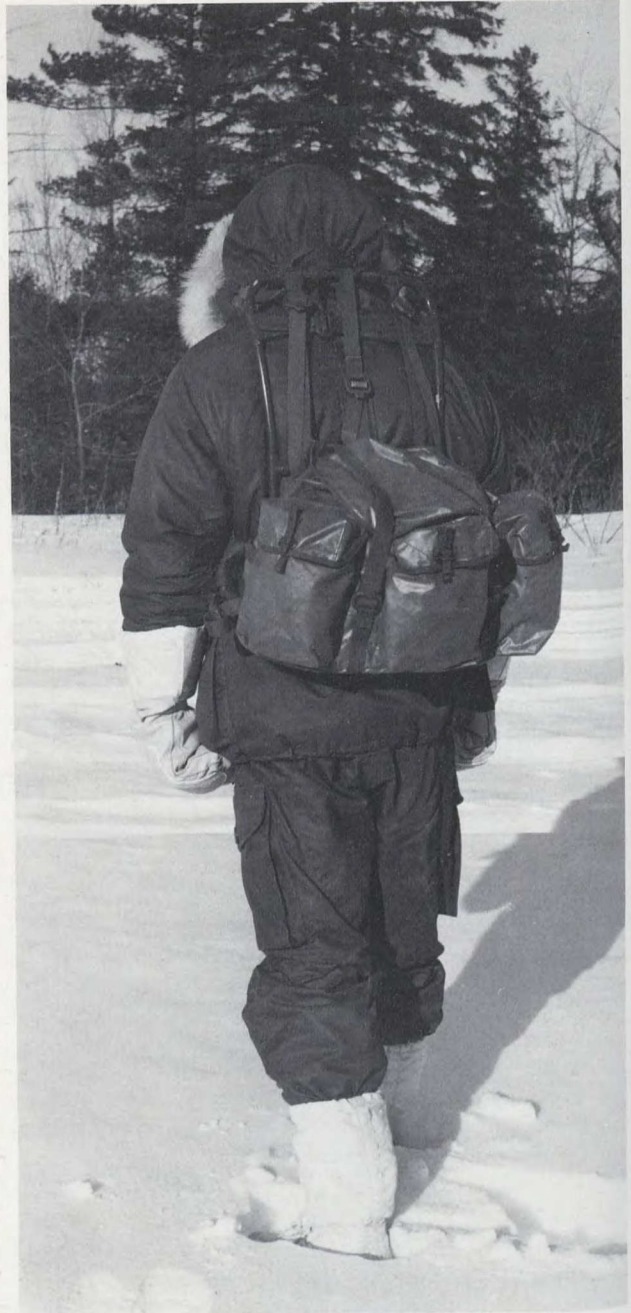
- A tubular frame.
- A neoprene-coated nylon bag.
- A cargo shelf.
- A waist belt with quick release fastening device.

THE FRAME: Holds the load off the wearer's back and allows air to circulate between his body and the load. It consists of aluminum tubing to which a series of strap keepers are welded to hold webbing in place. A strap retainer is welded to the top of the frame to hold the shoulder straps in place and a bracket, welded on the right side of the frame midway between the top and the middle horizontal bars, is used to assist in carrying the rifle.

CARGO SUPPORT SHELF: Fabricated from aluminum alloy and may be attached to the centre or bottom horizontal bars on the frame. It is used to assist in carrying square, rectangular or box-type items such as radios, gasoline cans, water cans and insulated food containers. It has pockets with quick release tabs, back straps and side straps for attachment to the frame, a double eyelet webbing hanger and securing straps on each side for attachment of canteen and mess tin cargoes.

BAG: It is fabricated from a waterproof, neoprene-coated nylon fabric. The straps and shoulder straps are cotton webbing with plastic hardware fittings. All components are olive green.

A white cotton camouflage cover in the form of a large rectangular sheet having grommets attached along the edges and corners which allow the cover to be draped over the rucksack and fastened with cord, is available for use with this equipment. Recent user trials carried out by the Royal Marines indicate that this particular rucksack, which was tested under field conditions with various kits and loads up to 27 kg (60 lb.) in weight, was preferred above all others on trial and has been recommended for worldwide use.



WATER CONTAINERS

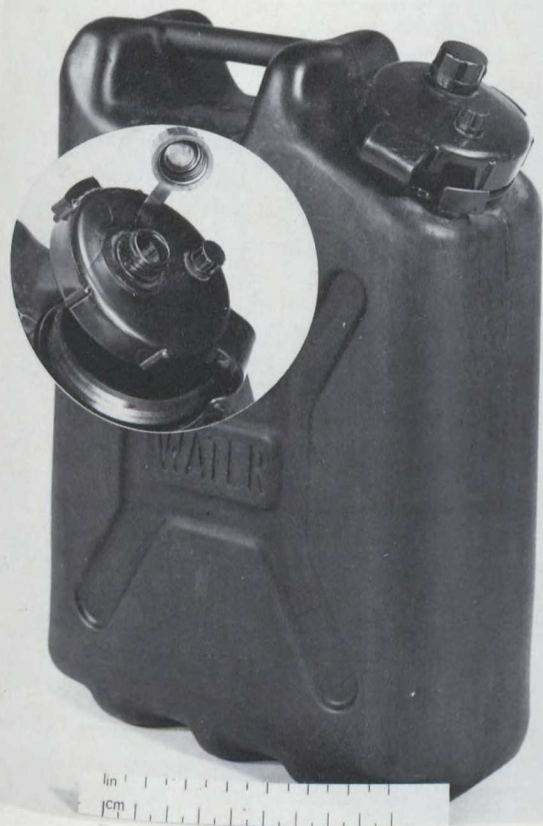
WATER CONTAINER, PLASTIC, 5 GALLON

During various experimental and development trials relative to plastic water containers and fuel containers it was found that non-metallic containers offered decided advantages when applied to bulk water carriers.

The plastic water container developed by the Canadian Forces has the following advantages:

- 50% lighter than the metal item.
- Does not rattle during handling.
- Will not rust.
- Capable of being stacked.
- Requires no maintenance.
- 30 to 40% less expensive.
- More durable and permits freezing of contents without fracture.

The rectangular container has an integral carrying handle and the screw-cap has a tab which locks onto the body in the event, through vibration, the cap should attempt to come loose. The body walls have a minimum thickness of 2.5 mm (.10 in.).



CAP AND STRAP ASSEMBLY: The large cap, strap (with locking tab), pouring spout and breather cap are injection moulded and fabricated from low density polyethylene. The large cap is locked in the tightened position by means of a tab on the cap and strap assembly. Superimposed on the large cap is the small pouring spout, with its cap, as well as the breather cap assembly.

PHYSICAL CHARACTERISTICS:

Height: 48 cm (19 in.)

Length: 33 cm (13 $\frac{1}{8}$ in.)

Width: 17 cm (6 $\frac{7}{16}$ in.)

Capacity: 19 liters (5 Gals. (US))

Weight: (Empty) 2.27 kg (5 lb.)

The item has been adopted by the U.S. Army and Marine Corps.

WATER BOTTLE, PLASTIC

The body of the canteen is blow-moulded in one piece from high density linear polyethylene. The neck of the bottle, which forms a sealing surface against the cap, is flat, smooth and free from nicks and depressions. The neck is threaded with a buttress type thread for a minimum of two full turns and prevents leakage. The wall thickness at any point on the body is not less than 95 mm (.036 in.). The cap and strap are injection moulded of high density polyethylene. The canteen and its cap weighs 120 grams. The olive green camouflage colour is maintained throughout the life of the bottle.

Both the U.S. Army and U.S. Marine Corps have adopted the Canadian water bottle and it is in operational use.



TENTAGE AND SLEEPING EQUIPMENT

To meet operational requirements for accommodation tentage, a study of tentage available in the U.S., Britain, France and West Germany was carried out and the survey report selected a modular concept to be used as the basis for Canadian development. This design concept consists of three main tent frame components which can be elongated by the addition of one or more centre sections in multiples of 2.4 m (8 ft.). This provides tentage accommodation for field and training forces in the following categories:

- (a) Offices, stores, field sleeping, canteens and messes;
- (b) Medical installations;
- (c) Field cooking equipment and weapon servicing and maintenance;
- (d) Light aircraft maintenance shelter.

SLEEPING EQUIPMENT

Field exercises in northern Canada in the winter demonstrated the absolute necessity of providing the best possible sleeping equipment so as to maintain the combat efficiency of troops. Canadian Forces field sleeping gear caters for two environments, temperate and cold weather. The temperate sleeping system consists of a general service sleeping bag and a multi-purpose sheet. The cold weather ensemble consists of an air mattress and a heavier sleeping bag complete with a detachable nylon cover and insulated hood. The cold weather system, with periodic product improvement, has seen satisfactory service for the past 15 years. The temperate system was only currently introduced.

Development is currently in progress for the production of an improved sleeping bag using a novel method of construction which will largely eliminate the problem of insulation migration. Preliminary results indicate that the method is satisfactory and further field testing is being undertaken.

It will be noted that the development program has examined the problem of field sleeping and the relationship of sleeping gear to other items of personal equipment. As a result we have been able to introduce improved insulation materials and replaced such items as the poncho and ground sheet with more effective pieces of equipment.

SLEEPING BAG, COLD WEATHER

The cold weather sleeping bag consists of five components, weighing 5 kg (11.5 lb.) complete.

- a carrying bag
- an outer insulated bag
- an inner insulated bag
- a cotton flannelette liner
- a separate insulated hood

The inner and outer bags are of similar design with channels for the control of the insulation which run longitudinally. The bag has a centre front opening closed by a free-running slide-fastener. The inner and outer bags are fastened together by means of tying tapes and the flannelette liner, which is provided for hygienic reasons, is similarly attached. The bags have a neck drawcord making them snug-fitting at the neck and shoulders. A combination of down and feathers is used as the insulant and a lightweight nylon fabric is used for the shell.

The insulated hood, which has a cowl-like cape fitted with elastic straps to fasten under the arms and a Velcro* front closure, is designed to give warmth to the head. The main advantage to the separate hood is that when the man turns during his sleep the hood turns with him. This design overcomes the problem experienced with other bags having an attached hood where the exhaled breath may be released into the sleeping bag proper thus causing condensation which freezes and reduces insulation.

SLEEPING BAG, GENERAL SERVICE

DESIGN: The bag is of rectangular shape, 203 cm (80 in.) long by 76 cm (30 in.) wide with a centre front slide fastener, 137 cm (54 in.) in length, and has a neck drawstring. The bag rolls up into an attached case which can also be used as a pillow. Conventional bags of this type use quilted insulation; however, this lends to "cold spots" and a relatively inefficient bag. To overcome this problem a novel feature has been developed which allows the insulation to be stabilized without quilting.

The bottom of this bag is made from a waterproof coated fabric thus eliminating the need for a ground sheet. When the bag is used in conjunction with the multi-purpose sheet the user is completely protected from the wet weather.

MATERIAL: Shell material is 80 gm/m² (2.35 oz./yd.²) nylon twill. The insulation is 16 denier resin bonded polyester batting. The bottom is waterproofed with polyurethane-coated nylon.

AIR MATTRESS

The air mattress is provided solely for cold weather sleeping and is primarily designed for insulation value rather than comfort.

DESIGN: The mattress is approximately 183 cm long by 76 cm wide at the shoulders tapering to 51 cm at the foot (92 x 30 x 20 in.). This design facilitates the placing of mattresses in the arctic tent so as to use a minimum floor area. The mattress uses a pillow inflation system. This is a device attached permanently to the head of the mattress and is found to be superior to conventional hand pumps in that less effort is required, it is impossible to lose the inflation device and it prevents the entry of moisture laden air into the mattress. "D" rings are attached to the sides of the mattress to enable it to be secured to the ground or to the bag as necessary.

MATERIAL: Neoprene coated nylon with all seams vulcanized.

It has been the Canadian experience that commercially available air mattresses will not meet the military requirement for durability and low temperature flexibility. This mattress is much stronger than the available commercial types and meets all the low temperature requirements.

This picture illustrates the independant hood system of the Cold Weather Bag. The model is holding the inner/sheet liner, which is removable for washing, in his left hand and in his right he is holding the inner bag. The outer bag is in the foreground.



MULTI-PURPOSE SHEET

This waterproof item provides protection to the sleeping soldier by using it as an improvised bivouac or as a ground sheet. When used as a bivouac it is connected to the general service sleeping bag to provide a "sleep-in ensemble". In addition to these functions, the sheet can also be used for many other purposes examples of which are: a hammock; an improvised litter; a rain-catch; a burial pouch; a sun screen or as overhead foxhole protection.

DESIGN: The sheet is 1.5 x 2.7 (60 x 108 in.). Six eyelets reinforced by nylon webbing are placed on each short edge and a full length separating slide-fastener is attached to the long edge of the sheet. This enables a number of sheets to be rapidly fastened together to form large shelters. The current weight of this item is 794 grams (28 oz.), but development is in progress to reduce this to 340 grams (12 oz.).

MATERIAL: 161 gm/m² (4.75 oz./yd.²) polyurethane-coated nylon.

Three sheets joined to provide tent-like accommodation.



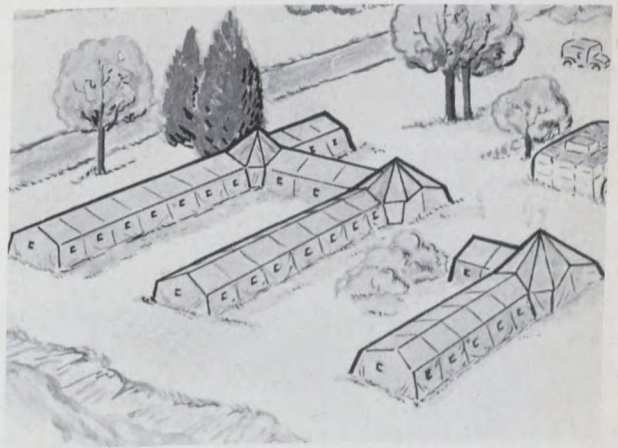
TENTAGE

TENT, MODULAR, FIELD SERVICE

The basic unit of the modular system measures 2.55 m (8.3 ft.) in length, 5.5 m (18 ft.) wide at the base, 4.7 m (15.5 ft.) wide at the eaves, 3 m (9.6 ft.) high at the ridge and 1.7 m (5.6 ft.) high at the side (vertical). It has a self-supporting hinge framework fabricated from aluminum alloy tubing with die cast hinge brackets and fixtures. The framework consists of only two components, hinge ties and longitudinal connectors and can be assembled without special tools. The framework, while offering an unobstructed inside space and interchangeability of components, also eliminates the need for external guy ropes by pegging down on the base of the frame. It is quickly and easily erected and can withstand winds of high velocity. The canvas sections of each unit consist of a roofed covering, which includes windows and a chimney passage, and is attached to the end walls by a series of loops and grommets normally known as "Dutch lacing". The standard end walls consist of a black-out porchway and a plain wall having a split opening to allow entry of large equipment into the tent. To meet other requirements such as a storage tent or a light maintenance shelter, special walls are available to permit the tent to be joined to a vehicle on a semi-permanent basis or to allow the nose of an aircraft into the tent and provide suitable cover from climatic conditions or as an aid to maintenance.

The tents can be extended by one or more units without any difficulty due to the fact that all the side walls and roof sections are identical and match one to the other. The front and rear ends are interchangeable. The canvas sections are fabricated from olive green polyester/cotton core-spun material 406 gm/m² (12 oz./yd.²), water, rot and flame resistance treated.

The white liner is fabricated from a plain weave vinyon (polyvinyl chloride), inherently flame resistant material, weighing approximately 135 gm/m² (4 oz./yd.²).



TENT, LIGHTWEIGHT, ARCTIC, 10-MAN

This tent provides shelter for 10 men and their personal equipment when operating in extreme cold conditions. The outside fabric is an olive green, cotton warp/synthetic fibre filling oxford cloth finished with "Quarpel" water repellent 19 gm/m^2 (5.6 oz./yd.²). The white liner is fabricated from a plain weave vinyon (polyvinyl chloride), inherently flame resistant material weighing 136 gm/m^2 (4 oz./yd.²). It provides insulation for the tent and prevents freezing of the condensate on the inside of the tent. The tent is a 5-sided pyramid supported by a telescopic magnesium pole with a base plate at the centre. A stove pipe opening is located at one side near the eave. The dimensions are as follows:

Length: 3.2 m (10.5 ft.) each side.

Height: 2.6 m (8.5 ft.).

Wall Height: 61 cm (2 ft.).

Door Opening: 1.5 m (5 ft.).

Floor Area: 16.3 m^2 (175 ft.²).

Weight (including poles, base plate, tent pegs, tent & liner) is approx. 32.7 kg (72 lb.).

TENT, LIGHTWEIGHT, ARCTIC, 5-MAN

The configuration is similar to the 10-man tent and uses the same materials. The dimensions are as follows:

Length: 2.5 m (8.1 ft.) each side.

Height: 2.5 m (8.1 ft.) at the peak. 61 cm (2 ft.) at the wall.

Weight: 25.9 kg (57 lb.).

Area: 9.3 m^2 (100 ft.²).

The tent pole, baseplate and pegs are common to both tents.

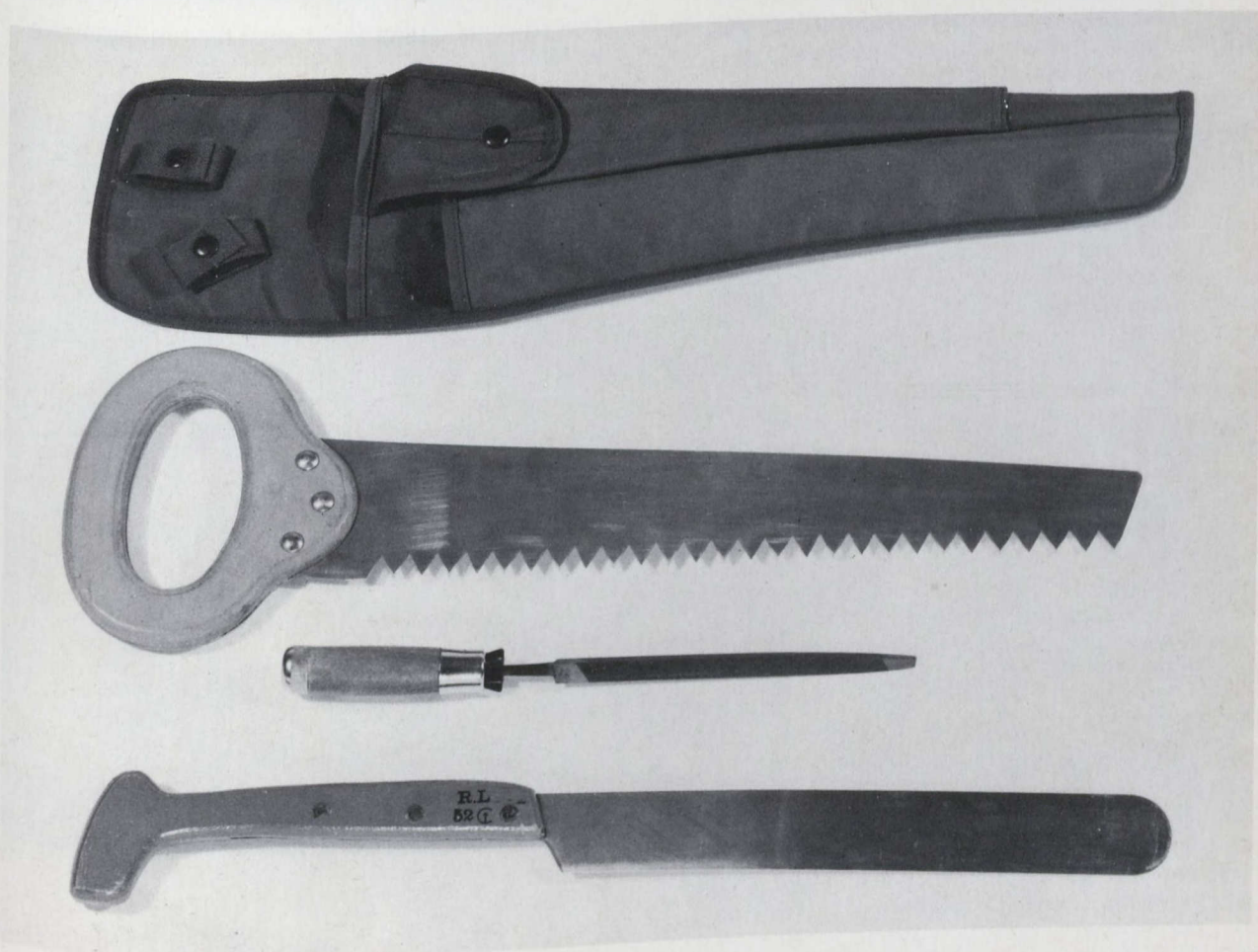


SNOW KIT

These items, adopted by the Canadian Forces, have seen more than twenty years use in the Arctic zones. The Saw and Knife are used to cut hard-packed snow and ice for emergency shelter requirements.

The saw is 61.2 cm (24.5 in.) in length with a stainless steel blade having an exposed length of 45.7 cm (18 in.). The handle which is painted orange for easy identification, is made of wood, oval in shape, has an opening large enough to accommodate arctic mittens.

The knife is 59.7 cm (23.5 in) in length having a stainless steel blade, 34.3 cm (13.5 in.) exposed length and the wooden handle is also painted orange. The file is 35.7 cm (14 in.) in length including wooden handle: effective surface (3 sides) is 17.8 cm (7 in.) long. The carrying case is made of nylon/cotton fabric, vinyl impregnated olive green in colour. The compartments for the saw and knife are reinforced with leather.



OVER-SNOW EQUIPMENT

The basic means of ground transportation in snow covered areas are still the snowshoe, the ski and, where a load carrying capability is required, the toboggan. The origin of these items is in antiquity for the problem is as old as the climatic conditions which bring about their use. The design of the traditional equipment, while simplicity itself, was based on useage by persons and materials indigenous to these regions. The improvement of such time-honoured equipments can only be found in basic approaches and it was here that the Canadian Forces, in their early experimental studies, looked for and found their gains. The two obvious areas were in the application of new materials and in designs which not only took advantage of materials but also recognized the fact that men with no knowledge of snow or operation in it would require extensive training which could not be simulated. The design of the 45 and 90 kg (100 and 200 lb.) capacity toboggans provides for them to be loaded and used as airdrop platforms to facilitate airborne service. Both toboggans are used to transport equipment. The design of the 90 kg (200 lb.) capacity toboggan pays particular attention to the movement of casualties.

45.4 kg (100 lb.) CAPACITY TOBOGGAN

This toboggan is used to transport fuel and tent group equipment for troops operating under extreme cold conditions. It is capable of being para-dropped while loaded to capacity and of being pulled by one man. While it is shaped like a conventional toboggan, it is fabricated from magnesium sheet 2 mm (.081 in.) thick and is 127 cm (50 in.) long and 48 cm (19 in.) wide. The sides are reinforced with a 12.7 mm x 25.4 mm (.5 x 1 in.) extrusion which is welded to the sheet and there are two plastic runners on the bottom of the toboggan. There is a fabric cover with secure latching attachments which protects and stabilizes the load. The design incorporates a feature which permits the joining of the back ends of two toboggans by means of a reinforcement bar and thus provides a longer load-carrying base.

90 kg (200 lb.) CAPACITY TOBOGGAN

This toboggan, which has an extruded magnesium alloy frame covered with a magnesium alloy sheet welded to the frame, is boat-shaped. For lateral stability there are two plastic runners riveted into "U" channel extrusions which are in turn welded to the frame. There is a tubular control device

mounted at the end of the toboggan which is provided with "D" ring attachments for the harness. This toboggan also has a fabric cover with secure strapping features which attaches to the gun-wales of the toboggan.

These toboggans, which are also used extensively by the medical services as a means of transporting casualties to a point where they may be treated or evacuated, may be moved by manpower but the intent is that they are to be used with a prime mover where four or more toboggans in tandem sequence may make up a casualty train. Movement of this toboggan should be considered under the following headings:

- (a) Para-dropped from supply aircraft;
- (b) Moved by manpower over snow;
- (c) Moved in trains by tractor over the snow;
- (d) The tractor and toboggan train as a whole transported by wheeled or tracked load-carrying vehicles to a point where operational snow conditions exist.

The physical characteristics of the toboggan are as follows:

Length: 200 cm (78 in.)

Width — Overall 56 cm (22 in.)

Width — at Runners: 28 cm (11 in.)

Sheet thickness: 3.2 mm (.125 in.)

Steering Handle fully extended: 159 cm (62.5 in.) beyond the length of the toboggan.

Width of Cargo Pack: 66 cm (26.5 in.)

Weight: 18 kg (40 lb.)

CARGO PACK, FABRIC

The covers for both toboggans are fabricated from a nylon canvas, 218 gm/m² (6.4 oz./yd²) and are polyurethane coated on one side.



90 kg (200 lb)



Two 45.4 kg Toboggans being joined to make one larger carrier.

SNOWSHOE, TRAIL, MAGNESIUM

A series of exercises held in the Canadian Arctic after World War II were aimed at delineating areas of development which would produce new equipment for the Canadian Forces. While there was much in favour of the wooden snowshoe it was found that there were two major weaknesses, namely the unacceptable rate of breakage and deterioration in storage.

Early development, which dates back to 1949, considered all existing commercial types and then went on to consider models fabricated from a wide variety of materials ranging from reinforced plastics to light metal extrusions for the frame. With respect to the stringing, nylon covered steel cables, wide nylon and cotton cordage, as well as sheet metal and plastics were considered before the existing equipment was adopted.

The basic frame of the snowshoe consists of a magnesium extrusion resembling the letter "E" in cross-section. This "E" shaped extrusion makes provision for the stringing to be laced around the centre bar of the "E" and considerably reduces string breakage. The extrusion has a high section modulus through the axis and also incorporates a rounded lip around the outside which greatly reduces the possibility of interlocking the two snowshoes while travelling. The stringing or mesh of the snowshoe is nylon covered galvanized aircraft cable which is a standard commercial item. Two sizes of cable are used for varying snow densities and to meet optimum floatation characteristics. Slippage is reduced by gripping strips which are welded to the bottom of the frame.

This snowshoe, which has been adopted by other countries, has proved itself over the years in terms of effectiveness and durability.

The physical characteristics of the snowshoe are as follows:

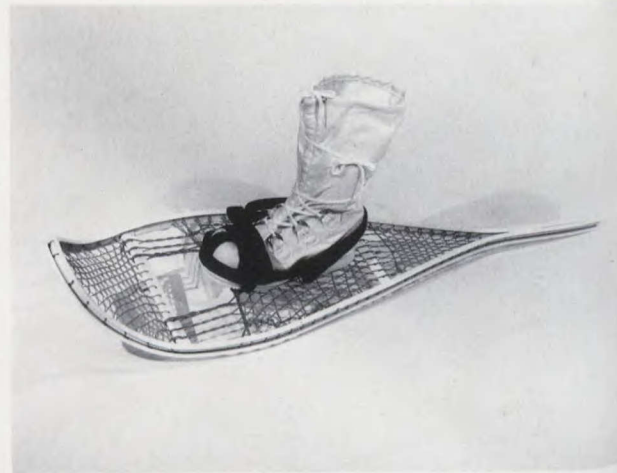
Length: 122 cm (48 in.) Turn-Up Height at Toe:
Width: 30.5 cm (12 in.) Weight Per Pair
1.36 kg (3 lb.) with binding.

This item has been adopted by the U.S. Forces and is in use in the Antarctic by Australia.

SNOWSHOE BINDING

The standard one-piece leather binding used with the conventional wooden snowshoe was found unsuitable because it could not be handled or adjusted when cold weather handwear was worn. The leather also presented a storage problem as it has a tendency to dry out and lose its durability. Early development included a two-piece binding which incorporated a quick-release feature and eliminated exposure of the hand which could result in frost damage. Further trials with this model indicated that the same advantages might be found in a one-piece binding and development was continued along this line until today's acceptable equipment was achieved.

The present equipment is a one-piece binding made from cotton webbing and includes an adjustable toe and heel strap. To prevent the binding from riding too high an arch strap is provided. The binding is made in one size only and there is no difference in the left or right fitting.



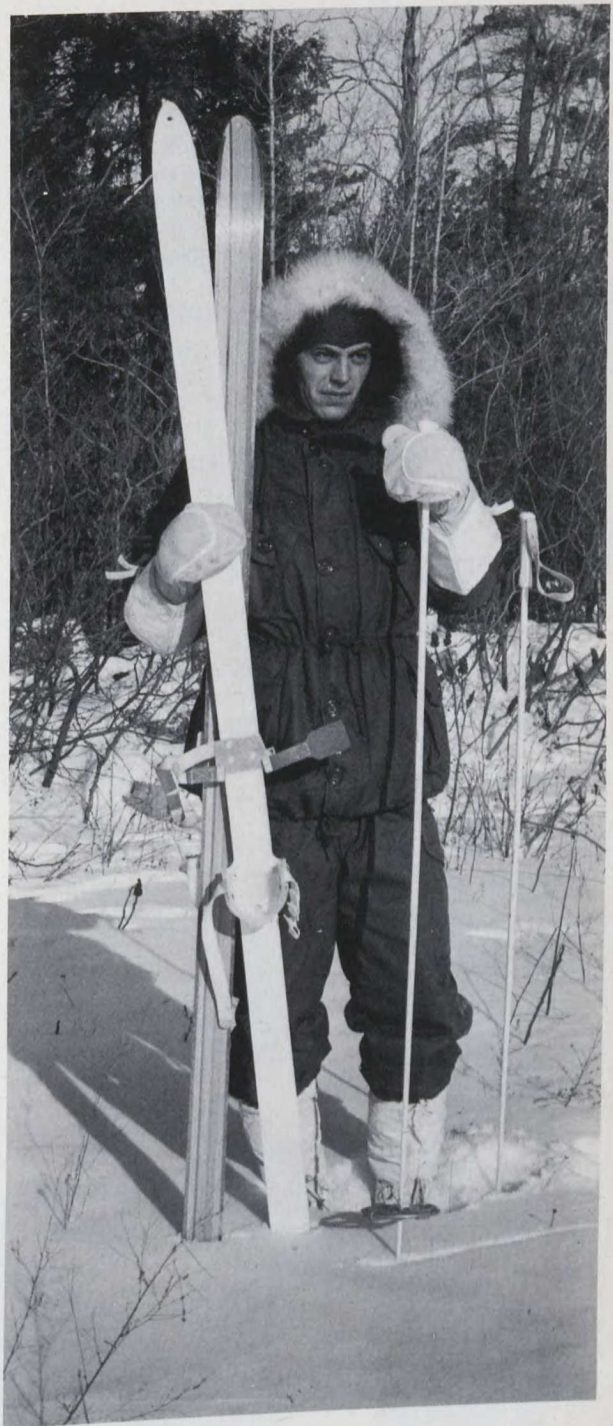
SKIS, POLES & BINDINGS

As a result of service troop trials it was found that available commercial equipment required modification to meet military requirements. The skis did not incorporate the necessary flexibility and the poles also required modification to meet the more rugged service requirements.

The service ski is of the cross-country type of laminated construction with a hickory running surface having steel edges and a gradual upturn at the toe section. It is 2 m (7 ft.) long and approximately 6.4 cm (2.5 in.) wide. The toe section has a chamfered hole to provide for towing services during survival operations. Product improvement is in progress and will incorporate an anti-slip device.

The ski pole has a tapered steel shaft and an aluminum snow ring secured to the ski by a moulded synthetic cross-strap arrangement. Leather wrist straps are provided which accommodate military handwear. The poles come in two sizes, 132 cm and 144 cm (52 and 57 in.) and are zinc plated to meet camouflage requirements. The military characteristics covering the Universal Ski Bindings for the Canadian Forces state that they must be useable with mukluks, insulated boots and combat boots, with or without overboots. The development of such a binding was complicated by the fact that the mukluks, and to a lesser extent, the insulated boots have non-rigid soles and soft toes which do not permit the use of conventional cross-country bindings. This made it necessary to design a binding having its own sole-plate and heel-cup.

The current universal binding has a moulded high-density polyethylene sole-plate to which is riveted a moulded nylon heel-cup. The heel-cup makes provision for a threaded heel strap. The toe-plate is aluminum to which a rubberized strap is riveted. The design of the binding provides for two adjustments which covers a foot size range from 6 to 12 and is mounted on the ski by four wood screws.



SKI MAINTENANCE KIT

The kit consists of a canvas container which houses the various components.

- Two metal ski tips to be used in the event that tips are broken thus allowing the ski to be used until proper replacement can be made.
- Two additional ski pole rings complete with cotterpins and grommets.
- Four sticks of ski wax for varying cross-country conditions.
- A small quantity of steel edges and screws.
- A roll of steel wire for emergency use in the repair of broken equipment.
- Screwdriver.
- Pliers.

The closed dimensions are as follows:

Length: 36 cm (14.5 in.)

Width: 21 cm (8.25 in.)

Thickness: 11 cm (4.5 in.)

Weight: 25 kg (5.5 lb.)



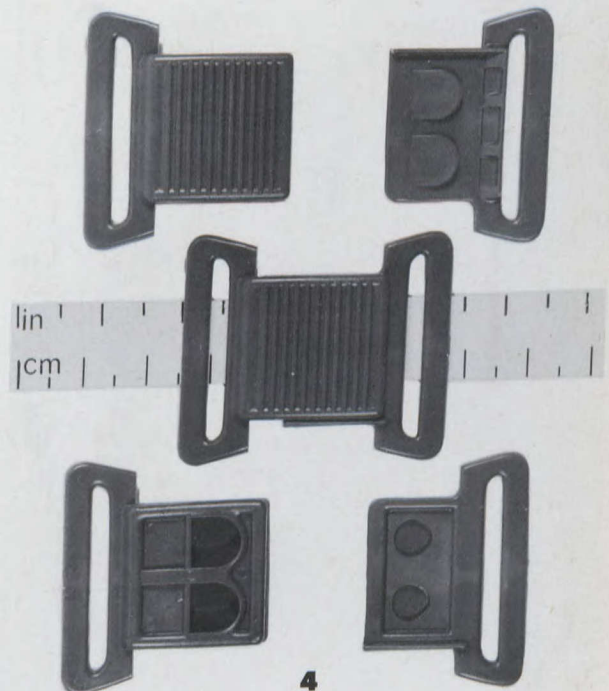
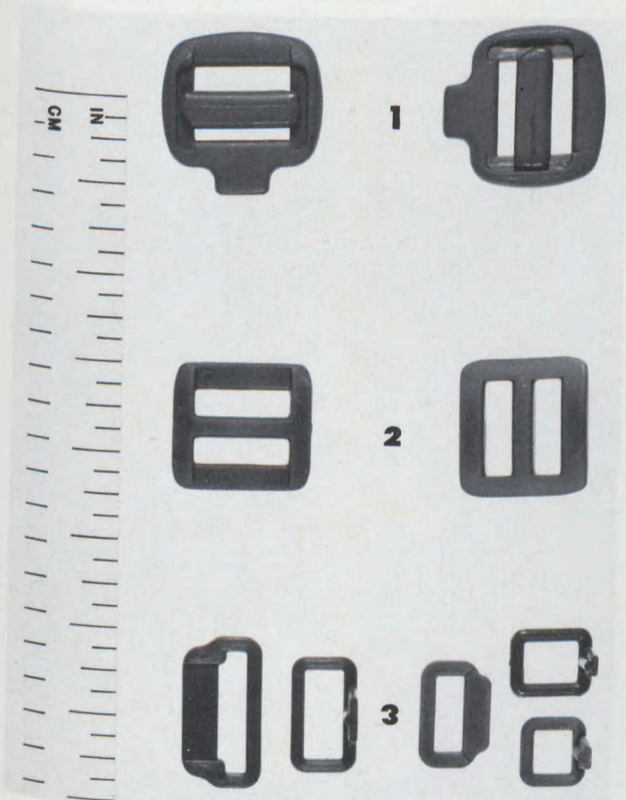
PLASTIC HARDWARE

In the course of investigations to improve service equipment by taking advantage of modern technology, it was realized that the utilization of plastic hardware for web equipment and other applications could present a financial saving of approximately 30% as well as a weight reduction of 66% relative to the time-honoured and costly brass hardware. Further, non-ferrous materials, such as brass, invariably are in short supply in times of emergency whereas the basic plastic materials are produced in large quantities in Canada.

BUCKLES

A buckle is only fully effective when used with the webbing for which it was designed and should not be mis-matched with materials outside of the design parameters.

1. BUCKLE, CENTRE BAR, SLIDE, 2.54 cm (1 in.). This buckle has a centre slide bar which locks the webbing in any given position. It also has a small tapered extension with a small hole to accommodate a thong which may be used to release pressure on the buckle. This buckle must always be used under tension and is employed on tentage and load carrying equipment.
2. BUCKLE, CENTRE BAR, 2.54 cm (1 in.). This buckle has a permanent centre bar and is used as a locking device. It is adjustable and normally used on cover flaps, rifle slings and tentage.
3. HASP AND STAPLE, QUICK-RELEASE. They are used in conjunction with specially made quick-release strap arrangements. Comes in two sizes to accommodate 2.54 cm (1 in.) and 1.2 cm (½ in.) webbing. Effects quick release on flaps on many non-rigid carriers.
4. BELT BUCKLE. This buckle is used in conjunction with 5.7 cm (2.25 in.) waist belts on load carrying equipment. It incorporates a quick-locking and unlocking design feature and can be easily fastened when the belt is loaded with other non-rigid carriers.



“D” RINGS, BUTTONS, ETC.

5. “D” RING. Used in conjunction with an open hook or snap fastener and it accommodates cotton and synthetic webbing; also used for quick lashing purposes. Two sizes are available, 2.54 cm (1 in.) and 1.6 cm (5/8 in.) while a 1 cm (3/8 in.) type is under development.

6. LOOP, 2.54 cm (1 in.) and 5 cm (2 in.) STRAP FASTENER. Used to join two straps or to link non-rigid carriers.

7. OPEN HOOK 2.54 cm (1 in.) AND SNAP HOOK 2.54 cm (1 in.). Used in conjunction with the 2.54 cm (1 in.) “D” Ring for fastening tent flaps, large cargo valises and tarpaulins.

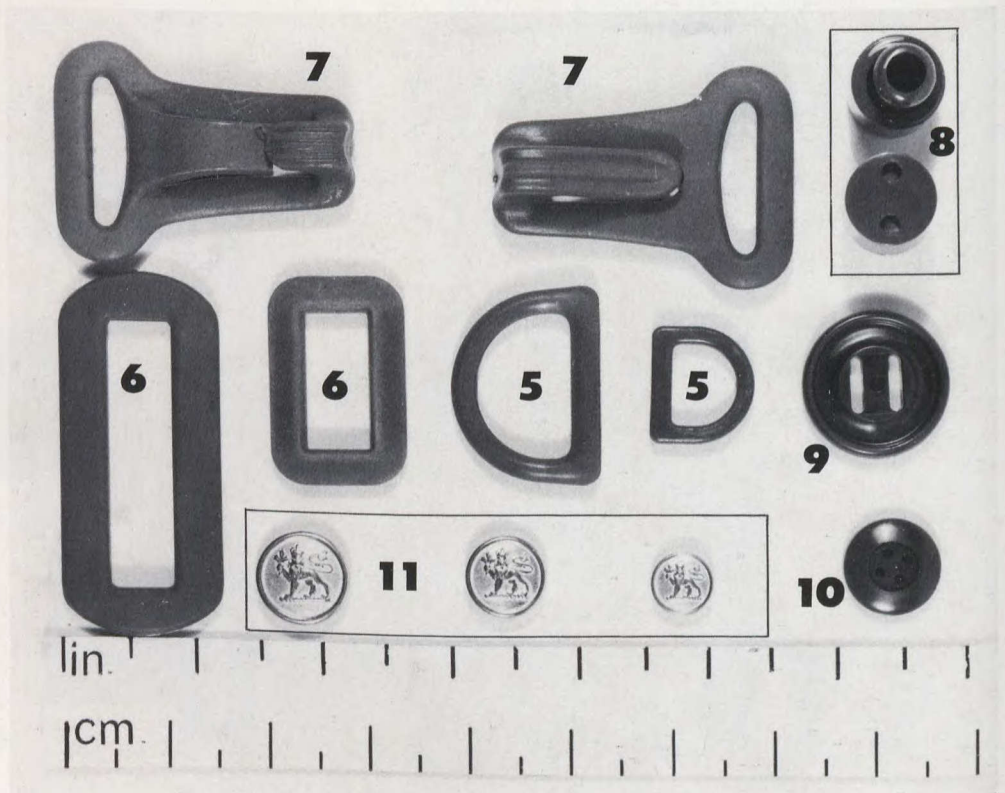
8. CLAMP, 2-CORD. Used for drawstring closures on such items as bags, door openings and parkas.

9. BUTTON, 45 LIGNE (2.9 cm (1 1/8 in.) DIAMETER), BAR TYPE. Has two slots to allow attachment of the button to material by means of tape loops and is used on functional clothing and tentage. The slotted button was developed to overcome the problems experienced with conventional sewn-on buttons. The tape attachment ensures that the buttons will stay attached for the

life of the garment and it provides flexibility of adjustment and location.

10. BUTTON, 30 LIGNE (1.9 cm (3/4 in.) DIAMETER). Has four holes and is sewn in the conventional manner.

11. GOLD PLATED PLASTIC BUTTON WITH INSIGNIA. This button, used on uniforms, is produced in three sizes — 30 ligne 1.9 cm (3/4 in.), 26 ligne 1.6 cm (5/8 in.) and 20 ligne 1.2 cm (1/2 in.). The button illustrated bears the Canadian Forces insignia but they can be made to custom design. It is moulded from phenolic compound with a metal eye shank embedded during the moulding process. The moulded item is then given various metal finishes with the final one being an electro gold plating. This button has overcome the many disadvantages of metal buttons which were susceptible to dents, excessive scratching and loosening of the shank.



OPTICAL AND MECHANICAL FIRE CONTROL



GUN ALIGNMENT AND CONTROL SYSTEM

Recent efforts to improve the effectiveness of field artillery have focussed on increased sophistication in command and control functions at the battery and higher levels, notably through the use of fire control computers and observation post—command post data links. Canadian Armed Forces studies have shown that streamlining of the battery command post-to-gun control function yields a high relative payoff in response time reduction versus development effort. The Gun Alignment and Control System (GACS) being developed for the Canadian Armed Forces by Aviation Electric Limited arises from a new alignment philosophy proposed by the Canadian Forces and tested for feasibility by Defence Research Establishment Valcartier.

GACS is designed to provide the means for rapidly and accurately determining and communicating data required to orient each weapon in a fire unit, to provide a link for command and control of the weapons, and to allow rapid reversion to existing fire control procedures in the case of a malfunction. The system has three major components: a reference unit (RU), gun unit (GU) and command post unit (CPU), the latter two being joined by a Command and Control Link (CCL). The RU provides continuous (once per second) optically-coded orientation information simultaneously for all guns in a fire unit. Each GU receives the optical orientation information from the RU and displays it numerically, or combines it with information received from the CPU to give bearing, elevation and fuze setting in a digital display. The CPU allows manual or computer input of fire control data and provides an operator's display and loop verification to ensure error-free data transmission. The CCL may be either radio or wire line.

METHOD OF ALIGNMENT

The RU, mounted on a standard military tripod, is oriented on grid north by any conventional means (gyro orienter, for example). Once oriented it transmits optically-coded orientation information in the infra-red region by means of an omnidirectional Xenon flasher and a rotating laser diode linked to a shaft encoder. As the laser rotates (1 cycle/second), the Xenon flasher pulses once for every 40 mils of arc and gives a double pulse when the laser beam passes through the south direction.

The infra-red receiver portion of each GU is mounted on the gunsight. It senses the double Xenon pulse and starts a clock (local oscillator) which is "driven" by the periodic single Xenon pulses. Sensing of the laser beam by the IR receiver stops the clock and logic circuits linked to the interpolating oscillator express the elapsed time as a measure of the angle "R" (see figure 1), rounding off to the nearest mil. This angle can be displayed by itself or combined automatically with data transmitted from the CPU to give the angle "S". The layer applies the angle S to the gunsight and lays on the RU to engage the specified target.

ADVANTAGE OF GACS

The system yields a significant improvement in time into action by providing for immediate and simultaneous orientation of all guns in a fire unit. Current procedures require approximately five minutes for a troop of four guns under ideal conditions and can take much longer. With GACS all guns in the range of and inter-visible with the RU can be in action within one minute under a wide range of conditions.

Once-per-second generation of orientation data allows movement of guns on the position while firing and rapid return to action after any gun malfunction.



DEPLOYMENT SEQUENCE

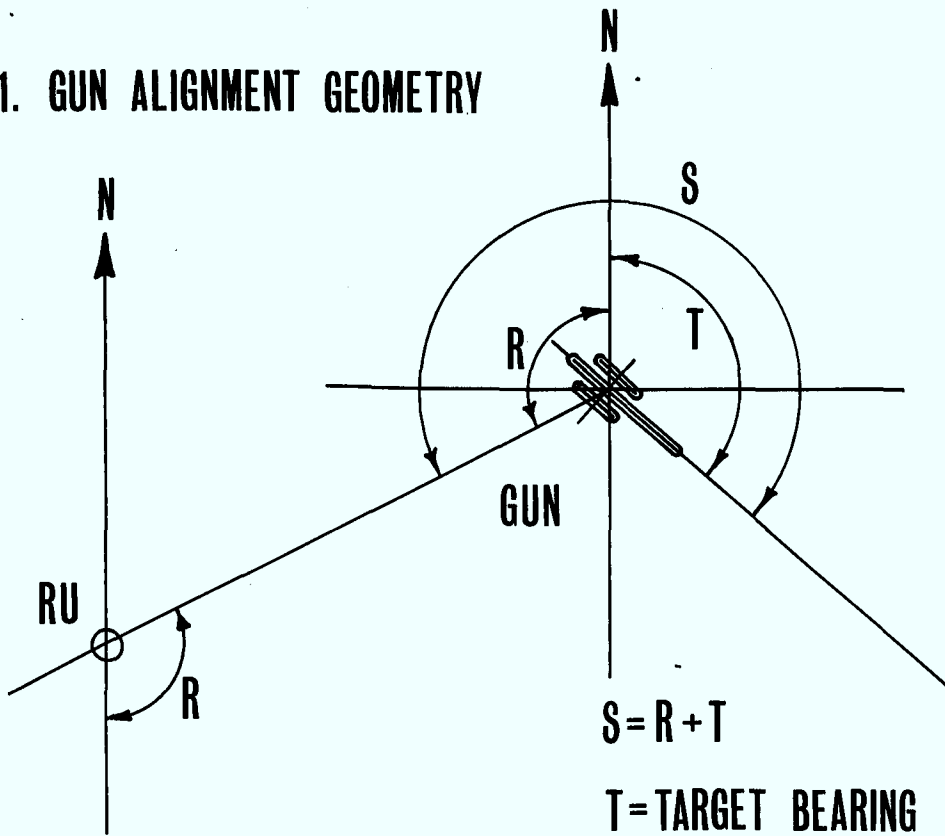
The use of GACS with self-propelled (SP) artillery introduces new degrees of freedom which may revolutionize present concepts of indirect fire support. No longer do accuracy requirements dictate that SPs bind themselves to fixed, surveyed gun platforms to guarantee effective fire. For most targets, where area neutralization is the aim and where the critical factor is the ability to deliver a high volume of accurate fire with a minimum of adjustment, use of GACS will reduce the survey requirements to:

- (1) Accurate azimuthal orientation of the RU.
- (2) Accurate positional fix for troop/battery centre.

Weapons may remain in a hide until a target must be engaged. Upon receipt of a fire mission, the guns drive full-speed onto the position, grouping in a normal troop deployment pattern around a pre-surveyed troop centre marker. Several such markers could be surveyed for firing positions serviced by the same RU. As long as each gun has line-of-sight to the RU, all guns will be parallel on the selected centre-of-arc within seconds.

Meanwhile, target bearing and fuze setting have been transmitted automatically by radio from the CPU. A few executive orders by voice over the radio and rounds are away. Once "End of Mission" is received the guns can withdraw to the hide. For the next target the troop centre might be another of the pre-surveyed markers. These deployment tactics indeed confer full mobility upon the SP and make the guns much less susceptible to enemy air or counter-bombardment activity.

FIGURE 1. GUN ALIGNMENT GEOMETRY



Digital data transmission/verification and visual display of all necessary fire control data speeds control and reduces error.

GACS is designed to be interfaced with current and future fire control computers. By providing automatic transmission of firing data from computer to guns and rapid verification, the GACS command-and-control link makes optimum use of the computer's speed while retaining a high degree of operator control. GACS can also be integrated with an automated laying system. With minimal modification (i.e. provision of mounting devices) GACS is adaptable to any field artillery weapon.

TECHNICAL DATA

GACS is being designed to meet the following specifications:

	RU	GU	CPU	CCL
1. ACCURACY	LR: $\pm .25$ m LS: $\pm .5$ m		As per input	10^{-8} (probability of incorrect verification)
2. INFORMATION RATE	LR: once/sec.			Bearing, fuze length, and elevation sent to up to six guns and verified in three seconds
3. RANGE	500 metres with RU-GU intervisible		N/A	Depends on radio type
4. VERTICAL COVERAGE	± 150 m/ RU-GU		N/A	N/A
5. WARM-UP TIME	20 seconds all units			
6. POWER SUPPLY	Std mil bty (24 hrs.)	Vehicle power supply or std mil bty (24 hrs.)	Vehicle power supply or std mil bty (24 hrs.)	Depends on radio type Nil for wire
7. WEIGHT	Not to exceed 31.7 kg (70 lb.) (with tripod and bty)	Not to exceed 11.3 kg (25 lb.)	Not to exceed 6.8 kg (15 lb.)	Depends upon radio type (N/A for wire)
8. ENCLOSURE	Conforms to MIL-STD 108.			
9. EMPLOYMENT/ ENVIRONMENT	System to be employable with air- dropped, towed, and tracked vehicles and weapons under any environmental conditions.			

TRIALS/TESTING

The system will undergo engineering trials during summer 1972 and user trials during fall/winter 1972.

STABILIZED ELECTRO-OPTICAL MOUNTS

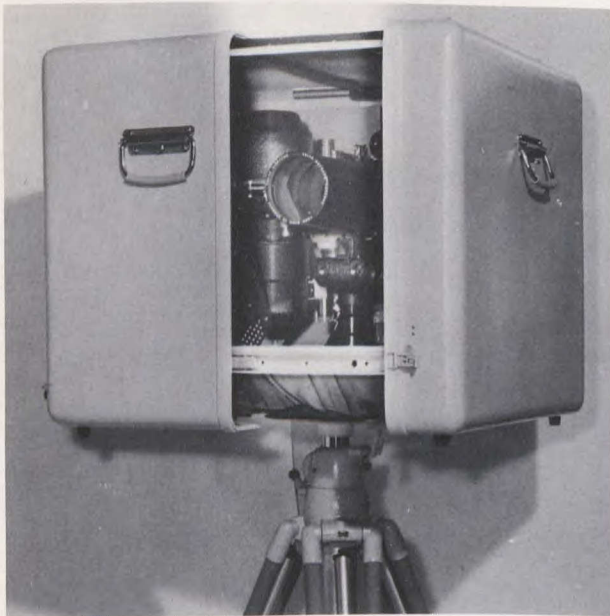
The WESSCAM mount HC100 series, designed, developed and produced by Westinghouse Canada Ltd., applies to a group of stabilized and steered interface systems designed for sensors weighing up to 18.14 kg (40 lb.). These include low light level television sensors, near I.R sensors, conventional optics, etc. In particular the HC101/LM208A WESSCAM mount is a portable self-contained, tripod mounted, interface for a long focal length (up to 1600 mm), high resolution optics for use in a dynamic reconnaissance situation. The enclosure provides protection from the outside environment and seals the instrument and sensor package from wind loads during operation. The enclosure is also used as a transit case in which the optics are housed in a shock resistant environment.

Alternate payloads for the HC101/LM208A include a 35 mm still camera with a 560 mm Leitz lens or a 16 mm movie camera with a 280 mm lens. A 2-10 power sighting telescope is attached for picture composition.

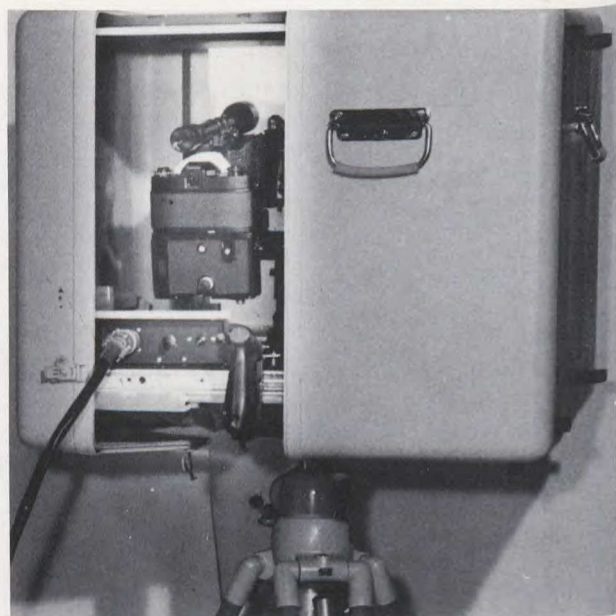
The sensor package is isolated from vehicle angular motions, imparted at any rate of rotation by the vehicle, about the pitch-and-roll axes up to 18° , and up to 360° , at any rate, about the

yaw axes. The line-of-sight is capable of being steered in tilt and yaw rates up to 10° per second but this may be increased to 60° per second. Steering is controlled by either a trigger switch for single pointing functions or a stiff stick with steering rates proportional to the magnitude and direction of the pressure exerted on the stick for tracking functions.

Angular resolution better than 1.0 arc second may be easily achieved at exposure times below one-fifteenths of a second from moving vehicles. The HC32 WESSCAM mount is stabilized and steered interface designed for sensors weighing up to 40.82 kg (90 lb.). The sensors are enclosed in a composite, fibreglass foam plastic sphere 116.84 cm (46 in.) in diameter, which contains a transparent plastic window. The azimuthal position of the housing is slaved to the sensor line-of-sight so that window remains in front of the sensor lens at all times. The transparent window subtends a sufficiently vertical angle to accommodate tilt steering from 15° above the horizontal to 90° below the horizontal and also allows vehicle pitch-and-roll of up to $\pm 20^\circ$ from the horizontal. The dome will rotate freely $\pm 360^\circ$ in pan with continuous movement.



Front View of HC-101 WESSCAM Mount with 560 mm f5.6 lens, 35 mm motor driven still camera payload. The Transit Case is shown open on a heavy duty tripod.



Rear view of the HC-101 showing the Sighting Scope, rear window and Control Handle Grip.

Measured image motion of an optical sensor mounted on a helicopter has been measured at less than 0.1 milliradians per second, with the image of the selected subject unblurred using shutter speeds of one-thirtieth of a second and focal lengths of 250 mm.

The HC32 is ideally suited to interface all types of electro-optical and EW radiator sensors which require precise stabilization and steering functions.



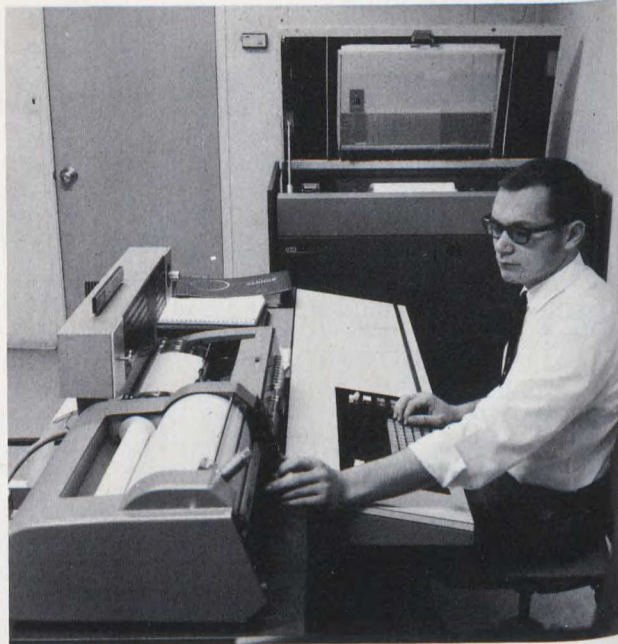
HC-32 WESSCAM Mount fitted to a Jet Bell Ranger.

OPTICAL EQUIPMENTS AND SERVICES

The following pages, in general terms, will outline products and services which have provided the Canadian Forces and many of our allies with some of the finest optical equipment available. For the past twenty years the designs and products of Ernst Leitz Canada have consistently met the most demanding standards set by a variety of users and have still remained competitive on an international basis. The product reputation enjoyed by the firm is not only the result of years of experience but also from a firm foundation in such areas as noted below.

OPTICAL RAY TRACING

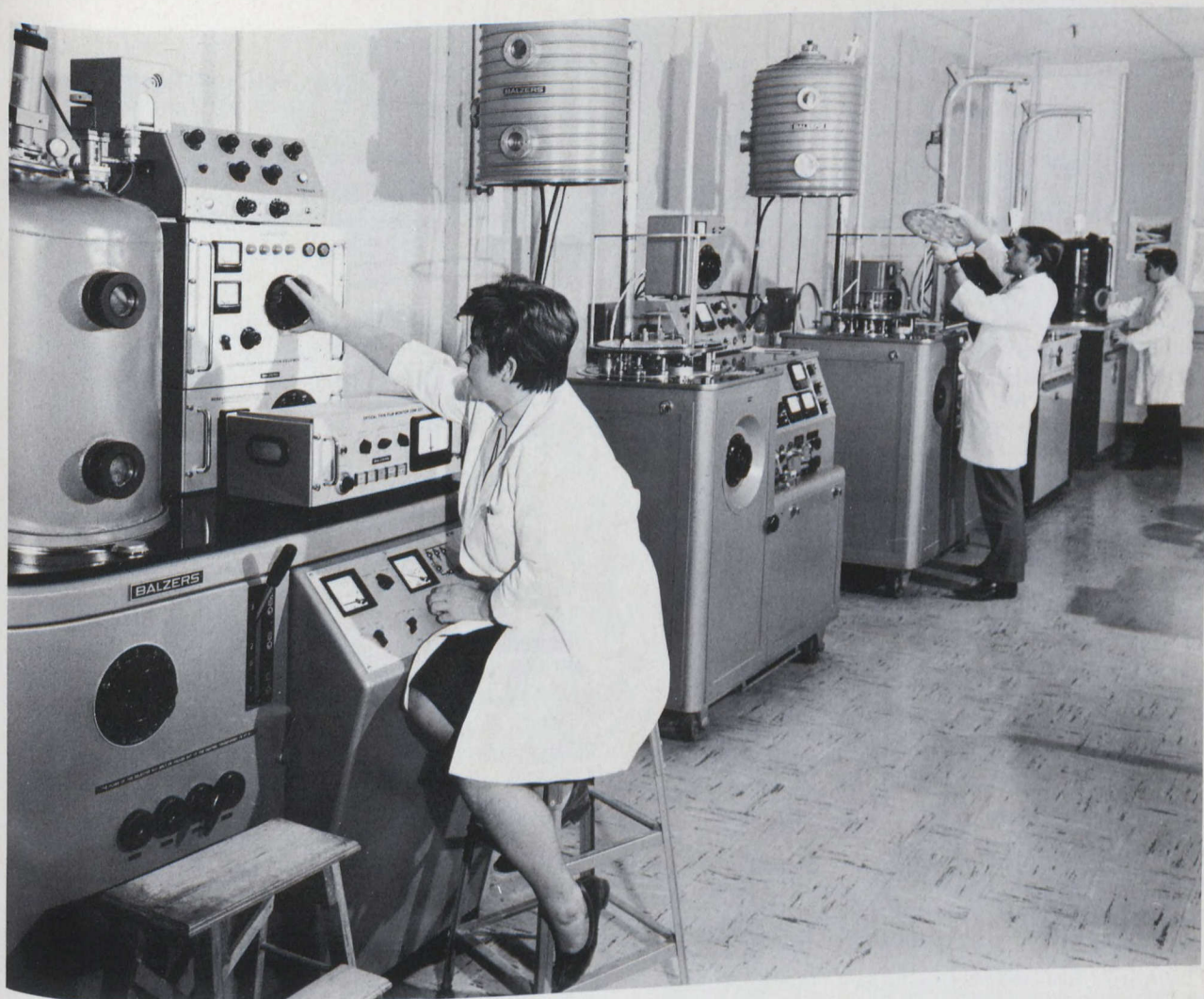
The major function in the development of optical systems is ray tracing. Modern computers have greatly facilitated the work of the designers and this facility also makes use of these modern tools. The picture shows part of the in-house equipment which also permits the designer to automatically plot correction curves as well as lens diagrams. For the design of large and complex systems, the company also employs bigger computers on a time sharing basis.



MODULATION FUNCTION TRANSFER ANALYZER

Ernst Leitz Canada Limited is a company engaged in the development and manufacture of highly sophisticated optical systems. An essential part of the operation is of necessity, quality control. In recent years a new concept of testing optical systems was introduced, which is generally known as Modulation Transfer Function. This company is believed to have been the first in North America to have used this most complete and sophisticated equipment to take such measurements. This equipment is known as the EROS IV model, manufactured by Ealing-Beck and the facility is available on a per diem rental basis.





HIGH VACUUM DEPARTMENT

Almost without exception, optical components require some form of thin film deposition. The work in this department ranges from simple anti-reflection coatings of magnesium fluoride to as many as 50 layers for some types of interference filters. The use of an electron gun permits the evaporation of any known material suitable for thin film depositions.

FIRE CONTROL EQUIPMENTS

The effectiveness of any weapon system can be denominated by the accuracy and simplicity of the fire control element. The reliability of the weaponry may be measured by the ruggedness designed into the precision instrument and the degree of ease associated with maintenance. Availability of the fire control element may be influenced by cost and excessive costs may well preclude the acquisition of an equipment which could take full advantage of the inherent capabilities of the weapon.

Canadian problems in this area were largely solved when Ernst Leitz Canada Ltd. was established in 1952. This firm has provided Canada and the Canadian Forces with a facility equal to any in North America and personnel with production and design backgrounds trained to the exacting standards demanded by their predominant product — the Leica Camera.

While these same comments were made in an earlier edition they still apply changed only by the further dependancy that time lends to a proven source.

Leitz equipments have found acceptance in allied nations around the world in commercial and military fields where both competition and performance requirements present a restricted field. Some of the more basic and interesting products are noted below.

DAY-NIGHT SIGHT

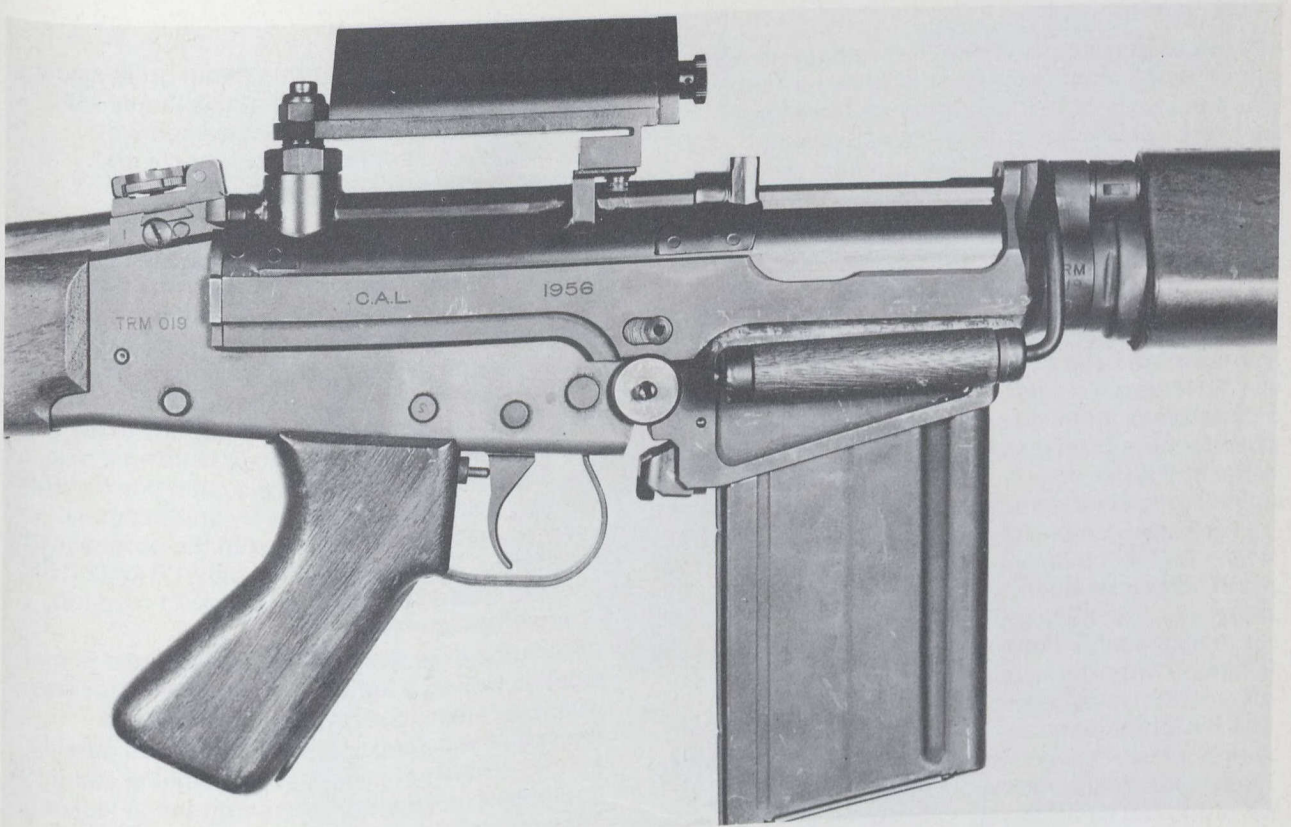
To meet a requirement for an inexpensive Day-Night rifle sight Leitz has developed a light-weight unit power reflecting telescope type of day-night sight that, although short in length and simple in construction, is capable of projecting a reticle to infinity on which to align a target. This is accomplished by providing a real intermediate image of the target on a mirror in which a reticle is located. Night use becomes possible by illuminating this etched reticle with a Trilux light source thereby eliminating batteries. A control is provided for reticle illumination adjustment. This sight is on field trial in Canada, U.K., Sweden, Germany and Denmark.

SNIPER SIGHT

When the Canadian Army adopted the FN Rifle they were left with the choice of accepting existing Sniper Telescopes, as is the usual practice, or providing a Scope which was designed for the rifle and that met the particular ballistics of that rifle. Fortunately they chose the latter course and Ernst Leitz Canada designed, developed and produced a sight which offers many distinct advantages over other known models. The basic design accommodates the FN Rifle or rifles of that type but the scope can be used with any rifle by changing the mount facilities. The Telescope has a length of 203 mm (8 in.) and a tube diameter of 25.4 mm (1 in.) and weighs only .28 kg (10 oz.) including the mount. It has a magnification of 4 and a field of view of 90 mils. The Telescope Mount is fixed to the rear cover of the rifle and employs a unique shock mount device which provides instantaneous mounting or dismounting of the telescope, as the rifle changes roles, yet still maintains its zero. In range the reticle is elevated or depressed by rotating the eyepiece mount and adjustments are in 1/2 mil clicks from 91.4 to 914 m (100-1000 yds.) with an additional reticle movement of 6 mils to allow for zeroing. In deflection the reticle is moved laterally by rotating the objective mount which again is adjustable in 1/2 mil clicks with 6 mils provided for zeroing. The deflection slipping scale is graduated in mils and provides 5 mils left and 5 mils right of center.

The sight optical members are cemented to the ends of a triangular prism which eliminates internal air glass surfaces. This optical system is enclosed in a metal case which incorporates elevation and azimuth adjustments and this case is in turn mounted on the rear cover of the FN rifle. Other adapter mounts can be provided if desired.

During day use the reticle is dark against the bright background but at night it is light against the dark background.



BINOCULARS

Anyone who has been concerned with repair and maintenance of binoculars for Services would doubtlessly agree that due to an inherent long life there tends to be a multitude of types and makes with an ensuing logistic problem for spares and repair techniques. This company has designed a family of light-weight binoculars which is of considerable interest. In the small sizes, 5 x 20 and 6 x 24, a new prismatic erecting system is used which provides equal inter-objective and inter-pupillar distances. This allows the two halves of the main body to be designed to accept identical erecting systems thus permitting modern maintenance methods as well as economical manufacture. Both glasses have the same eye-piece and differ only in the objective lenses therefore special requirements by the user could be very easily satisfied.

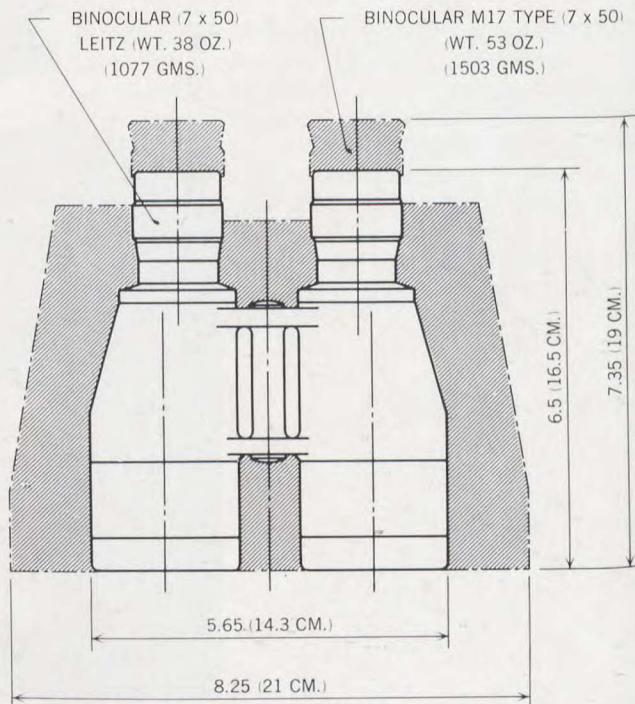
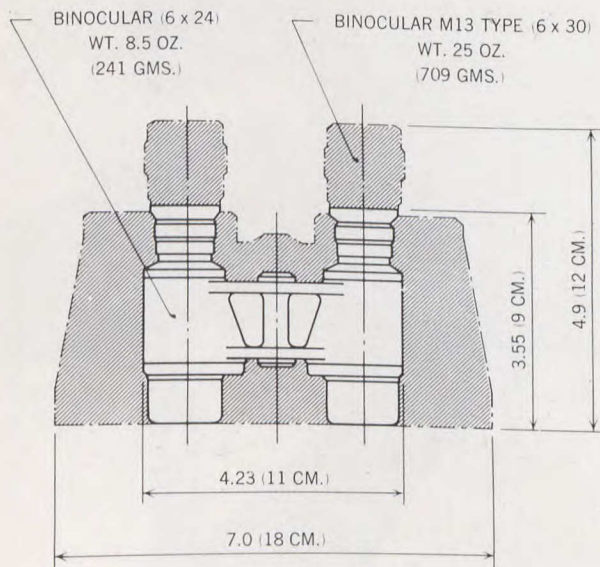
A special binocular, 5 x 35, for observation, from moving vehicles such as aircraft, landing craft, tanks, etc. has been provided with a relatively large exit pupil (7 mm) and low magnification which provides considerable improvement over all present types now available for this purpose. The 7 x 50 has been re-designed into the light-weight class. Design studies have shown that the larger glasses, including the special 5 x 35, can be produced by using one standard main body changing only the eyepieces and objectives

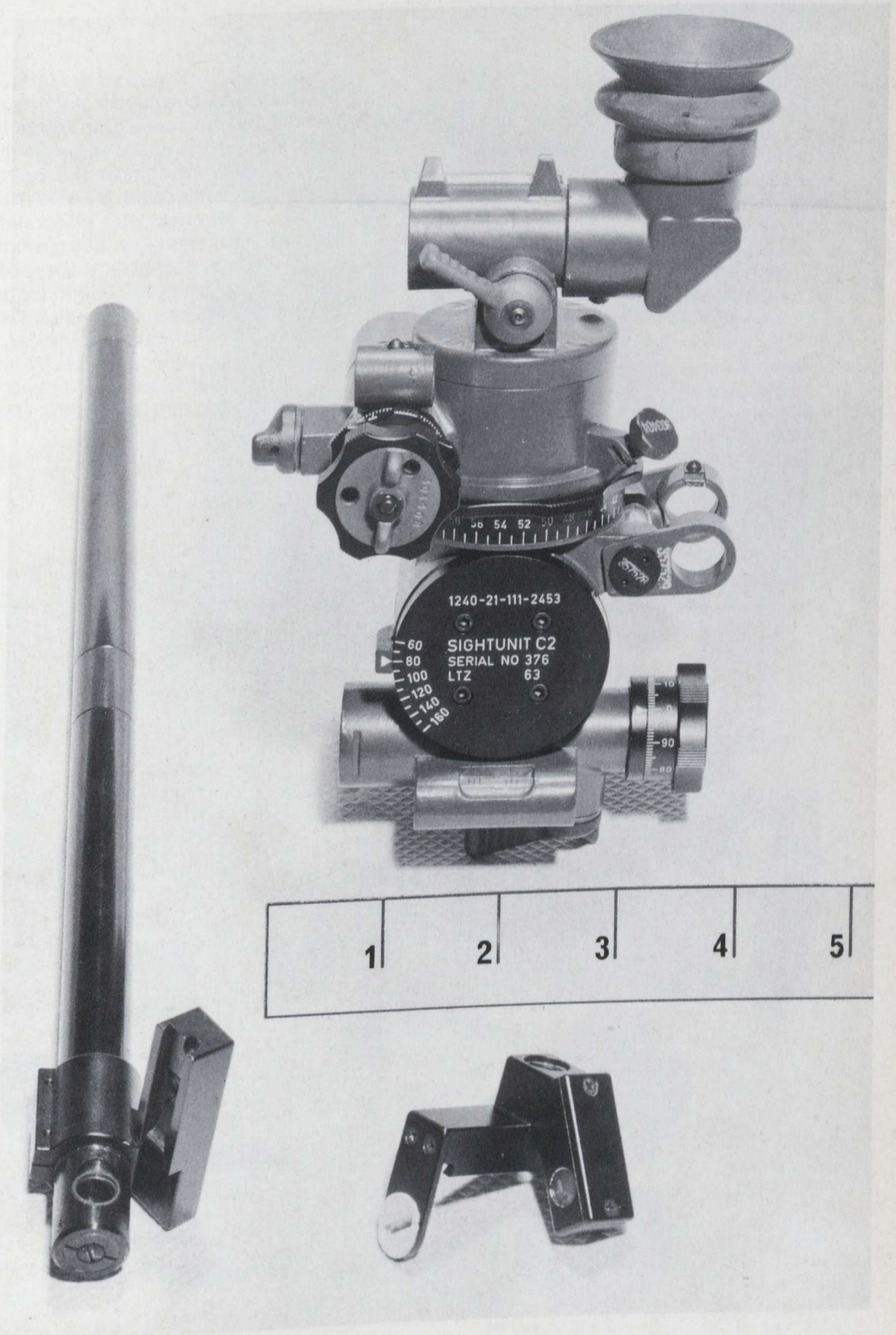
which, of course, would bring about great savings in cost and maintenance. All of this family will meet the standard military requirements of MIL-E-5272A and optical requirements are covered by JAN-G-174 and MIL-O-13830.

SIGHTUNIT C2

Although the Sightunit C2, has now been in service for over 10 years its many users find that it still meets to-day's requirements for a sight which will meet the accuracy demands of the longer ranges and withstand the accompanying heavier shocks imposed on the equipment. All Scales are in mils and the accuracy to lay is true in Azimuth and Elevation to within ± 2 mils. The Sight has been designed so that it is capable of being tested and adjusted by unit personnel to ensure proper alignment with the bore axis of the mortar. The Sight weighs only 1.3 kg (2.8 lb.) and has passed all trials for shock, immersion, drop, temperature, etc.

Ancillaries exist which permit an elevated line of sight as well as a light projection device for use with a paralleloscope when the weapon is employed in a deep pit or APC where an outside aiming post is not possible. This sight is standard equipment in a multitude of countries. A lesser known employment of its designed use is as an indirect-fire sight for heavy M.G's with built-in separate scales.





1	2	3	4	5
---	---	---	---	---

INTERNAL IMMERSION LENSES FOR SUBMERSIBLES

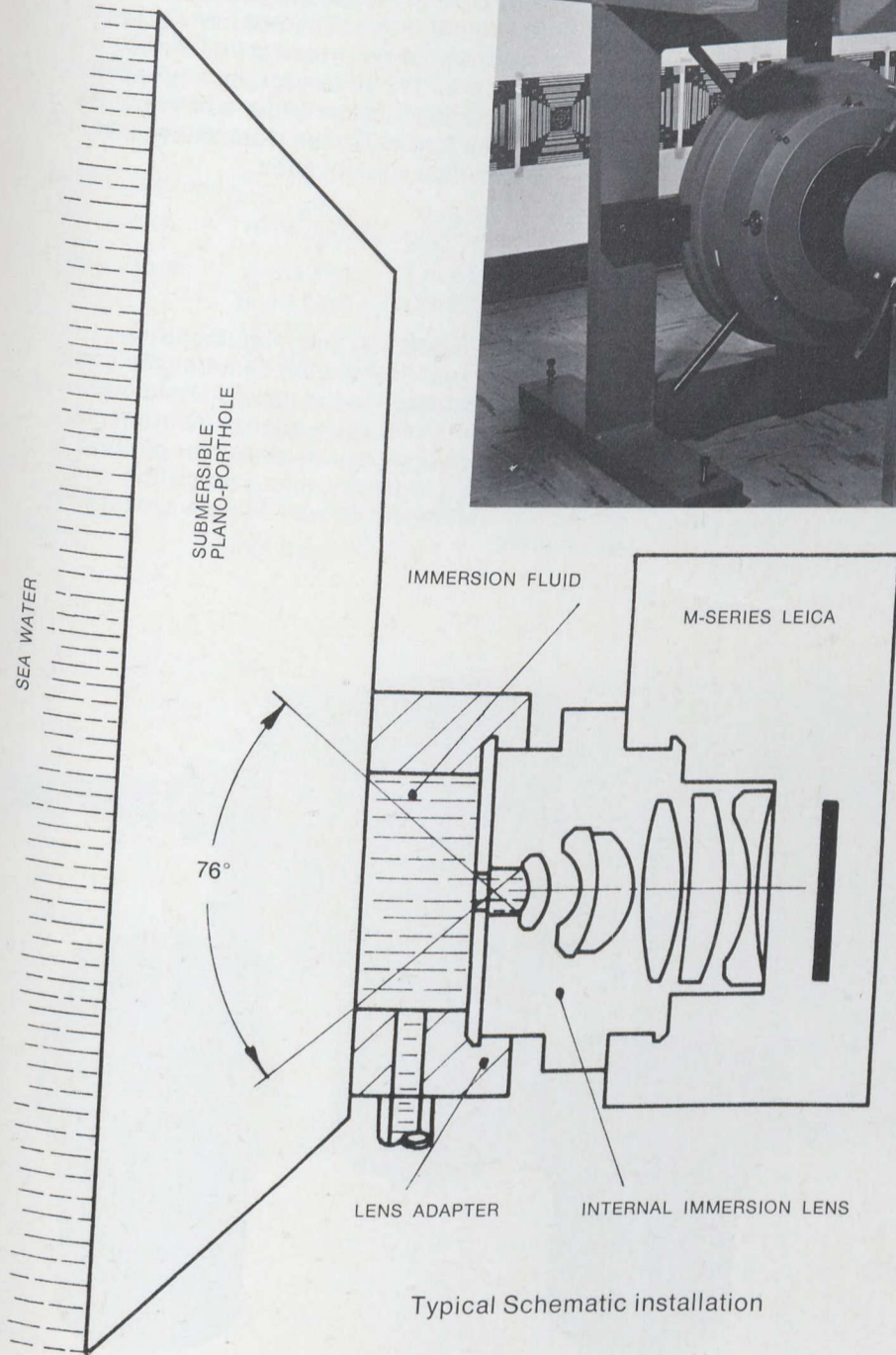
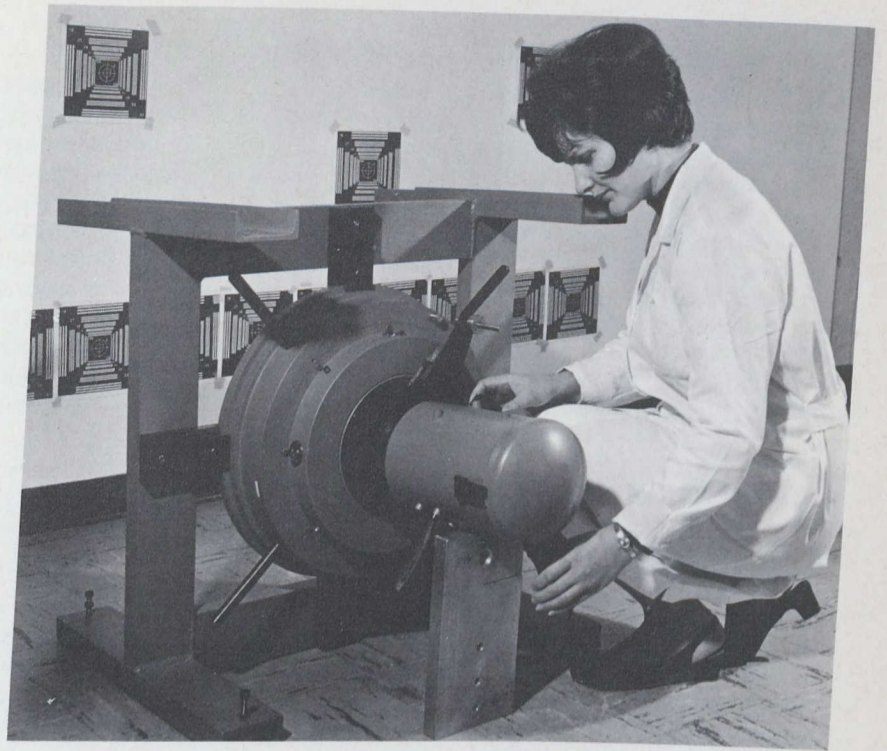
Leitz Canada has developed a family of fully water corrected lenses for various film formats from 16 mm to 70 mm using a front dome which is in direct contact with sea water. This patented system allows the correction of these lenses to the same degree of performance in water as is now obtainable in aerial lenses.

When deep-sea photography is required, cameras are usually mounted on rigs or on the outside of submersibles, which limits the photographic mission by the film capacity of the camera system. It was, therefore, deemed desirable to develop a new water corrected lens system which would permit the use of cameras inside a submersible. The lens shown on this data sheet describes this immersion system.

As wide-angle coverage should not interfere with continuous sampling alarms issued to units and visual observation, a lens system with an external entrance pupil was selected, therefore keeping the lens diameter small and maintaining the

maximum field of view of the operator. To achieve the necessary correction and angular coverage, the lens has been designed as an immersion lens, that is to say, the space between the inner surface of the plano viewing port and the front surface of the lens is filled with a liquid medium of optical properties identical with, or similar to, the outside water environment. Various methods of attaching the lens to the port-hole, either permanently or temporarily, are possible and the user may select his own preference. One method would be to cement a small mounting cylinder against the port-hole and attach the lens by means of a bayonet ring, another would be to use a simple rubber suction cup against the window.





Typical Schematic installation

LENSES FOR AERIAL RECONNAISSANCE CAMERAS & MULTI-SPECTRAL PHOTOGRAPHY.

These lenses were developed and produced by Leitz to meet the requirements of the Canadian Forces, the United States Military Services as well as a number of NATO countries.

Using the knowledge gained from the development of high precision photographic lenses for 35 mm cameras, the company more than 10 years ago started research work on lenses covering larger formats. The company's aerial lenses for the 70 mm format are presently being used in 70 mm cameras installed in all Canadian Defence Force Reconnaissance Aircraft. They are also used in Reconnaissance Aircraft of many NATO countries. The present range of lenses covers the following focal lengths and apertures:

38 mm	(1.5 in.)	f/2.8
45 mm	(1.75 in.)	f/2.8
75 mm	(3 in.)	f/2.8
75 mm	(3 in.)	f/2
75 mm	(3 in.)	f/2 infra-red
75 mm	(3 in.)	f/1.5 infra-red
150 mm	(6 in.)	f/2.8
150 mm	(6 in.)	f/2.8 multi-spectral
150 mm	(6 in.)	f/2.4
300 mm	(12 in.)	f/4
450 mm	(18 in.)	f/4
600 mm	(24 in.)	f/4

This group gives an angular coverage from 7.5° (24 in.) to 90° (1.5 in.). The 600 mm (24 in.) lens is an apochromate and the designer made use of the latest developments of new optical glass. As the lenses are used with filters they are designed for optimum performance in the spectral range of 486.1 m/μ to 656.3 m/μ. The 600 mm (24 in.) however, is also achromatized for 768.2 m/μ. Besides lenses for the 70 mm format a group was also designed and made for cameras having the 4½ in. x 4½ in. format. These lenses have the following technical specification:

150 mm	(6 in.)	f/2.8
300 mm	(12 in.)	f/4
450 mm	(18 in.)	f/4
600 mm	(24 in.)	f/4

In addition to designing and manufacturing lenses for air reconnaissance cameras the company is also engaged in the development and manufacture of optical fire control instruments, infra-red optics and special lenses for plotting tables, CRT photography, micro recording and projection equipment as well as data processing equipment.



The Elcan 1797, a 16 mm camera, has evolved to a dual role while still maintaining its rugged reliability, ease of operation, minimum maintenance requirements and the unvarying accuracy of its performance yet remaining well within the stringent NATO delineated specifications. It was primarily developed to record aircraft instrument readings, flight tests and aerial gunnery. Incorporating a minimum number of assemblies the camera is demonstrating its versatility in almost all branches of motion picture work.

Specifications:—

Film length: 15 m and 30 m (50 ft. and 100 ft.)

Frame Rates: 4, 8 & 16 or
8, 16 & 32 or
16, 32 & 64 or (STANDARD)
25, 50 & 100.

Lenses: f/2.8, 35 mm, colour-corrected anastigmatic.
f/1.4, 25 mm, high speed.

Aperture: f/2.8, 4, 5.6, 8, 11 & 22.

Weight: 1.64 kg (3.61 lb.)

Another version of the basic 1797 is the 16 mm Aerial camera with the wide angle periscope lens. The special periscope lens was designed to provide wide angle photography through a very small camera window. This was essential particularly for high speed aircraft, where aerodynamic and structural considerations permitted only small port holes. The equipment has passed field trials and is presently used by Nato countries for bomb assessment roles. It is likewise suitable, however, for special instrumentation, flight path recording, deck landing recording, flight test photography and other applications where "key-hole" photography is required. The standard camera has speeds of 16, 32 and 64 frames per second but many options from pulsed operation to 100 frames per second are available. The periscope lens can be purchased as a separate unit and will adapt to most available 16mm cameras. Equipped with a f/3.5, 10 mm lens with an angular coverage of 60 the complete camera weighs 1.95 kg (4.3 lb.).

As stated before this is a general outline of the optical facility at Ernst Leitz Canada Limited in which many of our requirements have been met and to which your own particular problems or customs needs may be referred.





The Leica camera, a criteria in the international professional fields of photography, is generally thought of as a civilian standard only. These 1:2.35mm wide-angle lenses which are undergoing inspection are part of a production of 400 Leica systems to meet a foreign military requirement.

NBCW EQUIPMENTS



WJ DRES COLOR PHOTO

PAPER DETECTOR, LIQUID CHEMICAL AGENT

GENERAL DESCRIPTION

The "Paper, Chemical Agent Detector, Liquid, 3-Way" (with adhesive backing) was developed for the Canadian Forces to meet the need for a simple and rapid method of detecting the three major groups of chemical warfare agents which constitute a threat when in liquid form and of differentiating among them. This "3-way Paper" consists of a paper base impregnated with dye-stuffs and coated on one side with an adhesive backing. These sheets are assembled into booklet form, the cover of which gives instructions for use.

The three agent groups detected and differentiated by the detector paper are the "G and V" agents (both nerve agents but differing in many characteristics) and the "H" (mustard) agents.

DETECTION CHARACTERISTICS

Each type of agent dissolves one of the dyes to produce a distinctive stain on the paper. G agents produce colours which vary from yellow to orange. H agents produce a red colour, and V agents produce colours which vary from very dark blue-green to light blue-green. The variations in colours produced depend on the particular G or V agent encountered. The inside of the front cover of the booklet has three panels which show the colours produced by G, H and V agents and bears the legend: "Detects Liquids Only".

The paper will not change colour with water, gasoline, motor oil, grease or anti-freeze. Some decontaminating agents will cause a colour change in the paper to black, but with large drops a brown colour may be seen in the centre of this black spot. This colour change is easily distinguishable from those caused by G, H and V agents.

OPERATIONAL USE

In detecting liquid chemical agents such as falling drops or splash from chemical munitions, the detector paper is exposed on the clothing or on unscreened surfaces. Where an area is suspected of liquid contamination, the paper is pressed or rubbed over the suspected surface such as grass, broad leaves, etc. Following this action, if coloured spots or streaks appear on the paper the troops immediately don their protective masks. The spots or streaks may then be compared with the colour panel provided and the matching colour determines the agent being used.

The detector is sufficiently inexpensive that individual issue is possible.

PHYSICAL CHARACTERISTICS

The chemical agent detector is made from a reasonably strong paper. It has good wet strength and is stable in storage when kept dry and away from sunlight. The paper is loaded with three water insoluble dyes to permit detection of and differentiation between G, H and V agents. Each sheet of paper is perforated to allow easy removal from the booklet. Twelve sheets 6.4 x 10.2 cm (2.5 x 4.0 in.) are assembled into a booklet, the cover of which gives instructions for use and shows the colours produced by the three chemical agent groups.

The paper has an adhesive backing protected by silicone treated Kraft Release Paper. This design allows easy attachment to water repellent treated combat cloth as well as practically any other type of surface with a gloved hand if necessary.

ALTERNATIVES

The detector paper can be procured in larger individual sheets or in different sized booklet form. Adhesive backed paper is available only in a limited range of sizes. Quotations on these alternatives will be produced on request.

* *The colour photo on page 393 shows the controlled explosion of 500 tons of TNT which was constructed in the shape of a sphere. Some of the equipments depicted on the following pages were submitted to over pressures of 1.75 kg/cm² (25 lb in²) at this test in July 1970. Virtually all of these equipments have been submitted to the same proof at other similar explosions.*

6665-21-858-8494

**PAPER
CHEMICAL AGENT DETECTOR,
(3-WAY LIQUID, ADHESIVE BACKED)**

**DETECTS LIQUIDS ONLY
POUR LIQUIDES SEULEMENT**

G:

ORANGE TO LIGHT YELLOW
ORANGE À JAUNE PÂLE

H:

SMALL VARIATIONS OF SHADES OF RED
PETITES VARIATIONS DE NUANCES ROUGES

V:

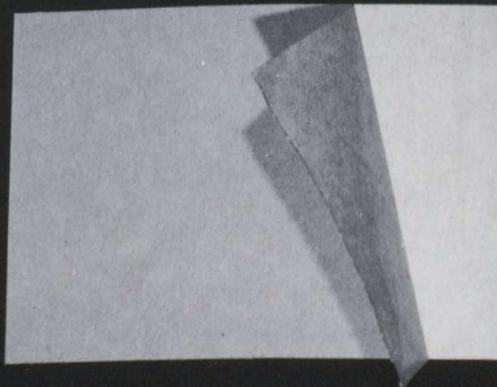
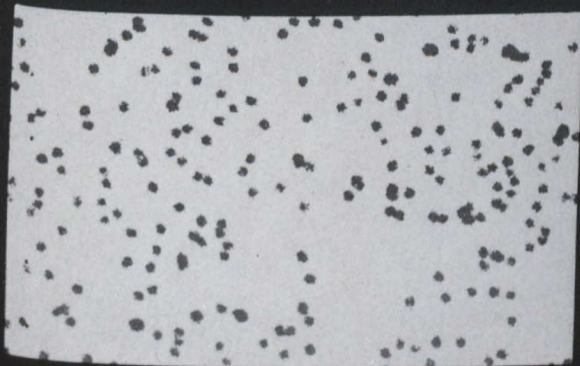
DARK TO LIGHT GREEN
VERT PÂLE OU FONCÉ

INSTRUCTIONS FOR USE OF PAPER

Detach a sheet of detector paper from the book and attach it to clothing or place on a surface so it can be exposed to drops or liquid splash of chemical agents. If coloured spots appear chemical agent is present. Put on protective mask. Compare coloured spot with colours on inside cover to determine type of agent. The paper may also be used to detect liquid contamination by placing the paper in contact with the suspect surface.

L'UTILISATION DU PAPIER-DETECTEUR

Détachez du livret une feuille de papier-détecteur et attachez-la à vos vêtements ou placez-la sur une surface de façon à ce qu'elle soit exposée aux gouttes ou aux éclaboussures liquides de substances chimiques. L'apparition de taches colorées indique la présence d'une substance chimique. Mettez votre masque protecteur. Comparez la couleur de la tache avec celles qui se trouvent à l'intérieur de la couverture, pour déterminer la sorte de substance chimique. Le papier peut être également utilisé pour déterminer s'il y a contamination par un liquide, en mettant le papier en contact avec la surface suspecte.



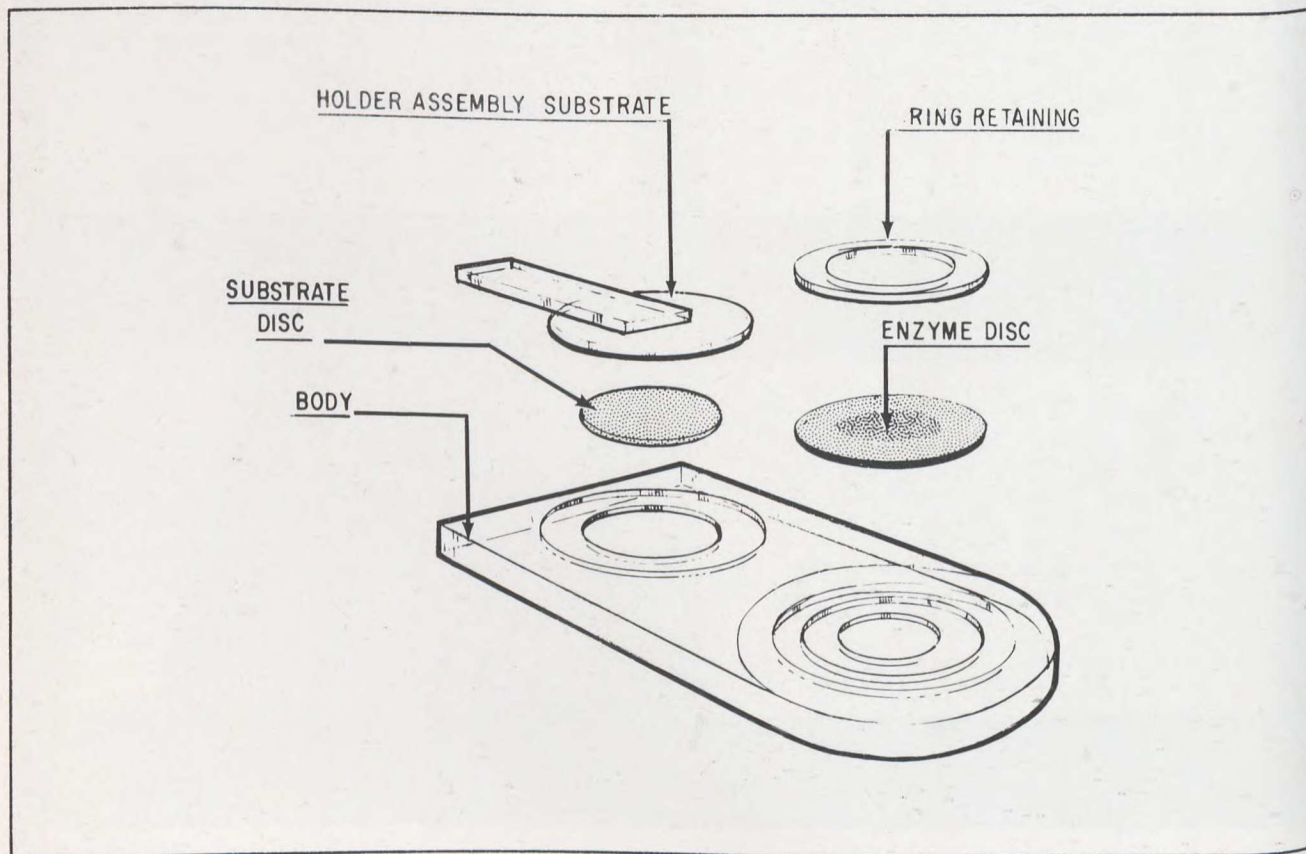
DETECTOR, CHEMICAL AGENT, NERVE VAPOUR

The Canadian Forces have developed and taken into service a simple inexpensive expendable device for the detection of dangerous concentrations of nerve gas vapours which required a minimum of training to use. This detector has no counterpart in NATO.

The simplicity, low cost and small size of this detector allows distribution to the individual soldier. It does not replace complex and expensive continuous sampling alarms issued to units and some sub-units, but in operations its use is complementary to such alarms. Its use is two-fold, to determine if a chemical attack detected by a "gas alarm" system is dangerous in the immediate vicinity of the individual, and to determine when it is safe for an individual to unmask. Basically the chemical reaction is of the fail-safe type. The two reagents must remain reactive to give a "safe" indication, thus damage in storage, contamination or poisoning of the reagents will result in a "positive" or "dangerous" indication.

The detector consists of two main parts comprising a body, containing a bovine acetylcholinesterase-impregnated test paper and a holder containing an indoxyl acetate-impregnated test paper. When the test paper in the body is moistened, exposed to the atmosphere and then pressed into contact with the test paper in the holder, the cholinesterase test paper will turn blue or green in the absence of nerve agent vapour. If nerve agent vapour is present, the colour of the test paper will remain unchanged after contact.

The detector which is 8.9 x 2.9 x 0.65 cm (3.5 x 1.15 x .25 in.) is packaged in an airtight moisture proof foil wrap for protection against environmental conditions until required for use. An instruction sheet and a silica-ger air dryer agent pack are included. These individual units are then packaged in groups of ten in an airtight moisture proof container whose size is 9.5 x 9.5 x 5.1 cm (3.75 x 3.75 x 2 in.).



MITT, DECONTAMINATING, CW AGENT

The decontaminating mitt is designed to meet the requirement for an individual decontamination set and used for the quick removal of liquid agents from the skin or other surfaces.

It is a pouch type mitt enclosing the whole hand and wrist with a thumb opening on each side. The size is sufficiently large so it may be donned when wearing protective gloves. It is made of 135 gm/m² (4 oz./yd.²) broadcloth with a Velcro* fastener at the wrist as closure. Pockets on both faces of the mitt contain 21.3 gm (.75 oz.) each, of the decontaminating powder which is a natural bentonite clay similar to Fuller's Earth. The material of the mitt allows the powder to be dusted onto the skin or other surfaces. The mitt is an expendable item and intended for one decontamination. It is packaged singly in a sealed barrier bag which is made of laminated material.

The packaged mitt weighs 78 gm (2.75 oz.) and measures 21 x 16.5 cm (8.25 x 6.5 in.). Open, the mitt measures 29 x 16.5 cm (11.5 x 6.5 in.).

PROTECTIVE MATERIAL KIT, NBCW, C-2

The Protective Material Kit is issued to units of the Canadian Forces to provide the capability for rapid field fabrication of chemical resistant items such as anti-gas sacks, covers for stocks or equipments which are in the open. In short the uses are virtually endless.

The Kit consists of a roll of flexible, laminated, camouflage coated plastic; rolls of pressure sensitive tape; a cutting knife and a set of instructions for use.

The specifications for production pay particular attention to such areas as delamination, adhesion of the camouflage coating, tear resistance and mustard agent penetration.

Evaluation in the Canadian Forces continues only in so far as roll width and length is concerned.



DECONTAMINATING APPARATUS, PORTABLE

The apparatus is designed to provide sufficient decontamination for vehicles, guns and other military equipments to permit the personnel to complete their assigned task and return to a Decontamination Centre where equipments can be completely decontaminated.

The equipment is quite simple consisting of a steel cylinder 31.75 cm (12.5 in.) high and 10.16 cm (4 in.) in diameter. Empty the unit weighs 1.36 kilo (3 lb.) and when filled with 1.24 kg (2.75 lb.) of Decontamination Agent C-1, weighs slightly under 2.67 kg (6 lb.). The agent is ejected as a spray with a standard nitrogen cartridge supplying the pressure. Being easily recharged spare refills of both the agent and the pressure cartridge can be carried into the field. This equipment is manufactured by Universal Die & Tool Mfg. Ltd. who are also the manufacturers of the Electric Trainfire Target Device, Cleaning Kits for Small Arms as well as many other items in the ordnance field.

DECONTAMINATING AGENT, C-1

This decontaminating agent contains 2/28/70, by weight, of Sodium Hydroxide/Ethylene Glycol Monomethyl Ether/Diethylenetriamine. It may be swabbed or sprayed on contaminated surfaces and is non-corrosive to common metals. The agent is pressurized in 10 mp Quart tins with soldered seams which constituting one refill. Four cans are packed in a corrugated fibreboard container.



RADIATION DETECTION SET, AIRBORNE, AN/ADR-501

Canadian Admiral Corporation Ltd. has been associated with the field of radiac detection for many years and this set as well as the AN/FDR-502(V) has been produced by them.

The Radiation Detection Set, Airborne, AN/ADR-501 provides for the rapid reconnaissance by light aircraft or helicopter of gamma radiation due to contamination on the ground. The set measures and records gamma radiation dose rates over the range of 0.1 to 100 r/hr.

The main components of the set are:

- Detector, Radiac, DT-5004 ()/ADR-501; NSN 6665-21-847-8905.
- Cable Assembly, special purpose, electrical, CX-5131 ()/ADR-501; NSN 6665-21-847-8913.
- Recorder, Radiation RO-5009 ()/ADR-501; NSN 6665-21-847-8953.

Power is supplied from the following self-contained batteries:

- Six Batteries, Dry, 1.3-V, BA 1006/U.
- Two Batteries, Dry, 6.5V, BA 1100/U.
- One Battery, Dry, 1.5-V, BA 30.

The detector radiac is the radiation — sensitive portion of the AN/ADR-501. It converts gamma radiation dose rate to an electrical signal.

The cable assembly connects the detector to the amplifier, provides power to the detector, and carries the electrical signal from the detector to the amplifier.

The radiation dose rate measured at the aircraft is recorded automatically on the recorder strip-chart and related to the radiation level on the ground by a co-relation factor.

The operator marks the time, the position, height, and heading of the aircraft on the recorder strip-chart at the beginning of the flight and periodically during the flight so that the area can be readily identified.

Simulator, Radiation Detection Set, SM-5021/ADR-501; NSN 6930-21-858-7054 is used with the Radiation Detection Set, Airborne, AN/ADR-501 in radiation monitoring training exercises.

LENGTH	HEIGHT
35.5 cm (14 in.)	20.3 cm (8 in.)
WIDTH	WEIGHT
22.8 cm (9 in.)	4.98 kg (11 lb.)



RADIAC SET, REMOTE MONITOR AND ALARM, AN/FDR-502 (V)

This set which greatly extends the operating range of this field has been produced by Canadian Admiral Corporation who have also produced other equipments for the Canadian Forces.

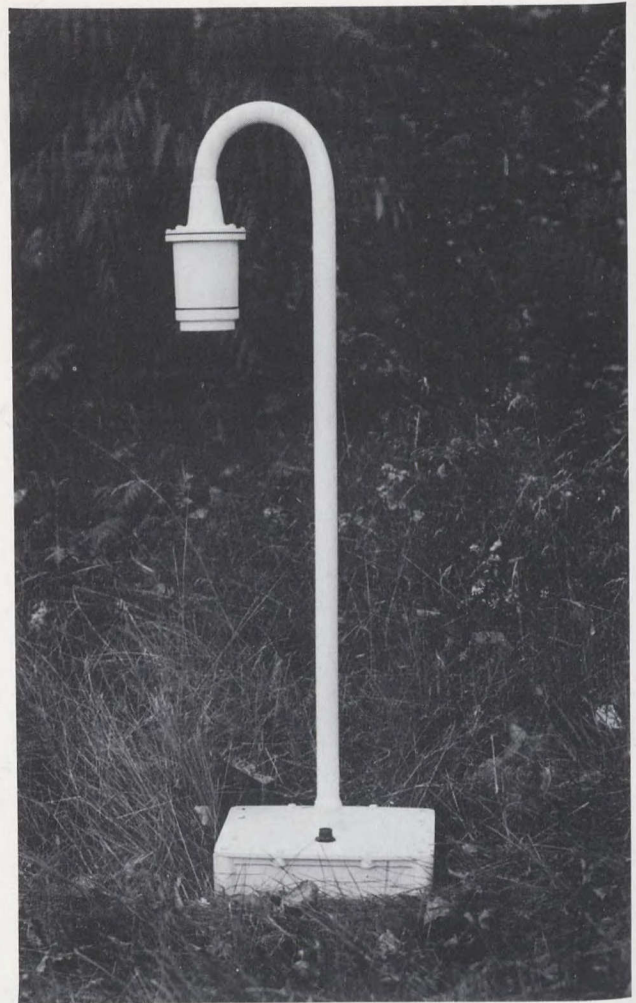
This system is designed for continuous radiation monitoring at fixed, or semi-fixed ground installations and in ships. The equipment consists of a 48.2 cm (19 in.) rack mounted Control Console and several sensor heads connected to the console by means of a shielded eight-conductor electrical cable. As many as ten sensors may be used at distances up to 3,048 m (10,000 ft.). The dose rates are indicated by a digital readout covering a range of 0.1 r/hr. to 5,000 r/hr. with $\pm 20\%$ accuracy, while the audible and visual alarm circuit is preset to a dose rate within 1.0 r/hr. to 100 r/hr. range. The equipment can also be connected to a recording device. A simulator is provided for training operators in the use of the equipment, and for realistic employment of the equipment during field exercises. The operating temperature range for the console is -18°C to 50°C , and for the sensors -45.6°C to 52°C . The storage temperature range is -54°C to 68°C .

Operating Ranges:

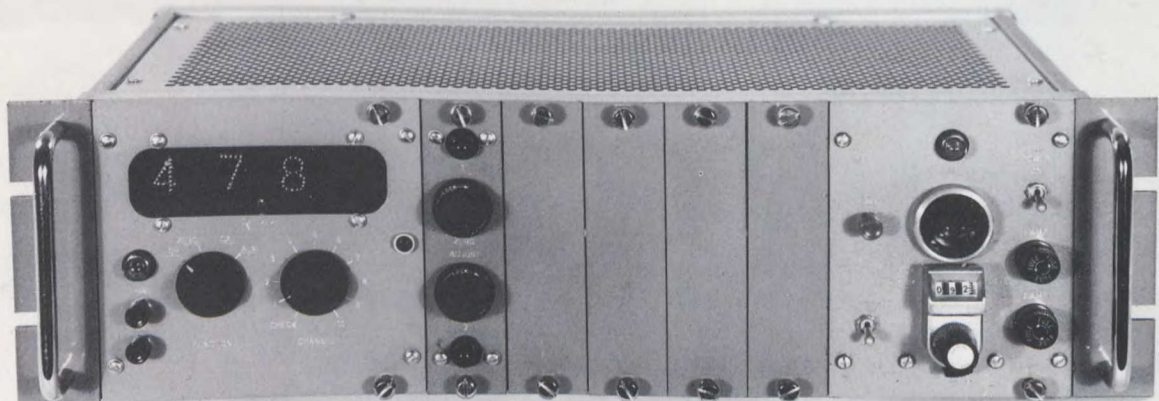
0.1 r/hr. to 5,000 r/hr. — Digital Readout
1.0 r/hr. to 100 r/hr. — Alarm Range

Power Requirements:

115/220 vac, 50-60 hz, 30 va, or
24 vdc, 2.0 amp (stand-by power)



	LENGTH	WIDTH	HEIGHT	WEIGHT
Console	39.3 cm (15.5 in.)	48.2 cm (19 in.)		9.9 kg (22 lb.)
Sensor	15.2 cm (6 in.)	11.3 cm (4.4 in.)	13.3 cm (5.25 in.)	1.04 kg (2¼ lb.)



COMPUTER INDICATOR RADIAC TACTICAL DOSIMETER READER CP-95A/PD

The Radiac Computer Indicator CP-95A/PD is a portable electronic instrument used for computing the total amount of x-ray or gamma-ray dose to which a Radiac Detector DT-60A/PD may have been exposed.

The electronic circuit incorporates a source of ultra-violet light, a photomultiplier tube, a vacuum tube amplifier and an indicating meter calibrated 0-600 roentgens.

The computer indicator is enclosed in a moisture proof painted aluminum case with a carrying handle. The removable cover encloses a compartment for the power cable assembly, instruction book, two spare fuses, two small pin wrenches, and a spanner socket.

Power Requirements: External source,
110-130V AC, 60 cps, single phase.

Power Consumption: 31 Watts.

DIMENSIONS AND WEIGHT

LENGTH

37 cm (14.5 in.)

WIDTH

25.4 cm (10 in.)

HEIGHT

21 cm (8.25 in.)

WEIGHT

10 kg (22 lb.)



QUARTZ FIBRE DOSIMETERS

TACTICAL: Radiacmeter, Tactical Dosimeter, (0-600 r) IM-5013/PD.

RESIDUAL: Radiacmeter, Technical Dosimeter, (0-10 r) IM-5002A/PD.

SPECIAL: Radiacmeter, Technical Dosimeter, (0-500 mr) IM-5006A/PD.

These dosimeters, manufactured by Computing Devices of Canada, are direct reading instruments for measuring up to their maximum range the total dose of gamma radiation to which they are exposed. They consist of a quartz fibre electroscope and an optical system contained in a tube which is similar in appearance to a fountain pen, and are read by looking through them longitudinally at a source of light. They are 11.2 cm (4-13/32 in.) long, 1.4 cm (17/32 in.) in diameter, and weigh 35.0 gms (1¼ oz.). They can be re-zeroed by means of the Charger Radiac Detector PP-5120-PD.

The IM-5013/PD dosimeter is for use by officers and NCOs for measuring prompt and residual gamma radiation as an indicator of the dose received in a local area. The IM-5002A/PD (0-10 r) dosimeter is primarily for use by reconnaissance, monitoring, and decontaminating parties. The IM-5006A/PD (0-500 mr) dosimeter is for use by instructors, and technicians for training and special purposes.

The dosimeters are hermetically sealed instruments with the full range of characteristics of ruggedness and environmental performance for military equipment. They meet the draft operational characteristics given at Appendices 2, 3 and 11 to the Annex to AC/196-WP/59 subject to the following comments:

- They do not measure neutrons;
- Energy response testing has only been carried out between 90 kev and 1.2 mev;
- Saturation occurs at ultra high dose rates (e.g. 10^4 rad per microsecond) of mixed gamma radiation and neutrons;
- The leakage rate is approximately 2 to 3 percent per day of full scale reading;
- An off-scale reading can be artificially created without leaving detectable evidence;
- The scale is in "r" rather than "rad".

Operating Instructions are supplied with each dosimeter.

A continuing programme of testing samples drawn from stock of each type of dosimeter has been initiated to determine the effect of age on performance.

These dosimeters have been adopted for use by the Canadian Forces.

CHARGER, RADIAC DETECTOR, PP5120/PD

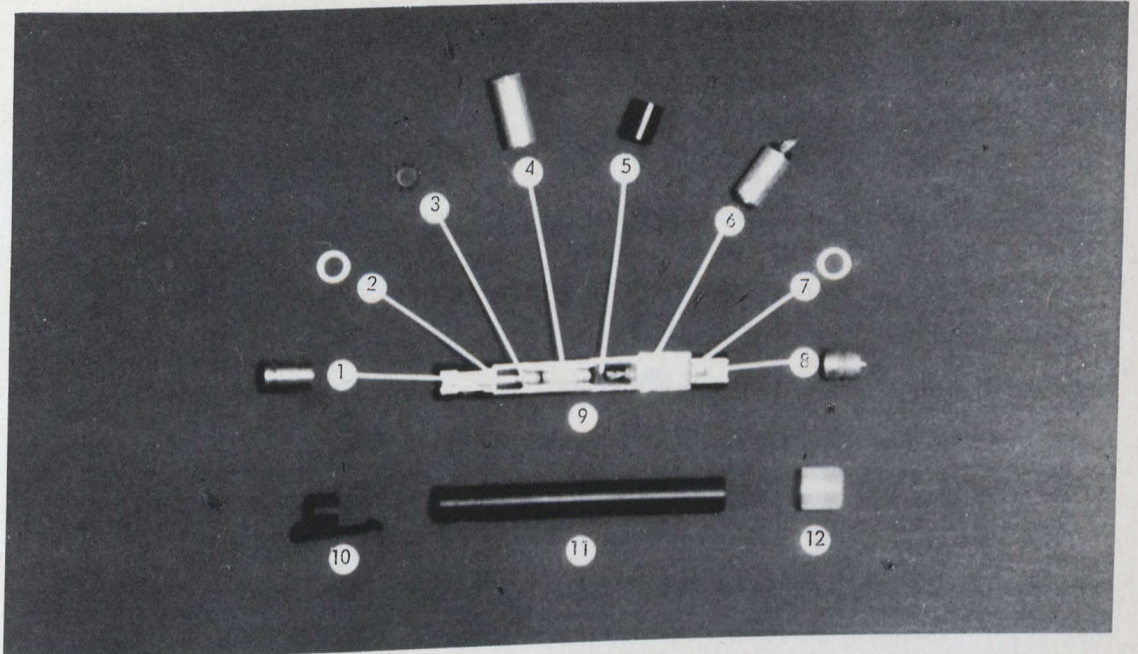
The Charger, Radiac Detector, PP5120/PD is for zeroing the above electrostatic dosimeters. It is basically a lightweight transistorized dc power supply operating from a single "D" cell dry battery. Its size is 11.4 cm x 9.5 cm x 4.8 cm (4.5 in. x 3.75 in. x 1⅞ in.) and it weighs 0.7 kg (1.5 lb.).

The charger possesses the full range of military characteristics of ruggedness and environmental performance. It substantially meets the draft operational characteristics given in AC/196(WP4)D/3.

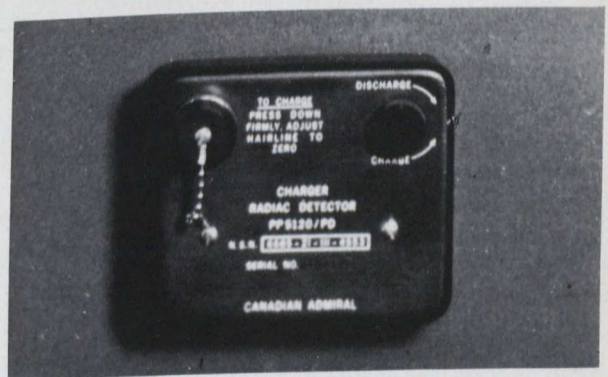
Operating Instructions are included with the charger.

The charger is provided with a fabric carrying case containing a belt loop and shoulder strap to facilitate carriage.

Tests corresponding to operational and technical requirements are included in the specification. This charger has been adopted for use by the Canadian Forces and has been produced by Canadian Admiral Corp. who are most active in the radiac field.



- 1 - EYE PIECE
- 2 - UPPER WASHER
- 3 - STAR WASHER
- 4 - OBJECTIVE LENS
- 5 - CHAMBER
- 6 - CONDENSER, ELECTROMETER
- 7 - LOWER WASHER
- 8 - BELLOWS
- 9 - CUT-AWAY VIEW
- 10 - CLIP
- 11 - BARREL
- 12 - PLASTIC PROTECTOR



RADIACMETER REMOTE MONITORING SINGLE PROBE

The Radiacmeter Remote Monitoring Single Probe IM-5015/TD is designed to detect and monitor gamma radiation in roentgens per hour (r/hr). The monitoring device, or detector, is placed in a protected location and is connected by cable to the exposed detecting element.

The radiacmeter consists of a radiac detecting element, a radiac detecting element mounting bracket, a triaxial cable, a radiac indicator and a wooden carrying case.

The radiac indicator is a battery-operated instrument. It incorporates an electrometer box, a battery power source, a voltage check and operation switches, circuit balance controls and a 0 to 500 r/hr meter. A read line on the meter scale marked VOLT. MIN. denotes the lowest acceptable supply voltage reading. The electrometer box contains a constant current source which provides the zero reference and electrometer tube VI which amplifies the input circuit. Nine mercury cell batteries mounted on a plug-in board provide all the reference and control voltages for the radiacmeter.

The detecting element is a sealed ionization chamber which interconnects with the radiac indicator by means of a 15 or 30.5 m (50 or 100 ft.) triaxial cable.

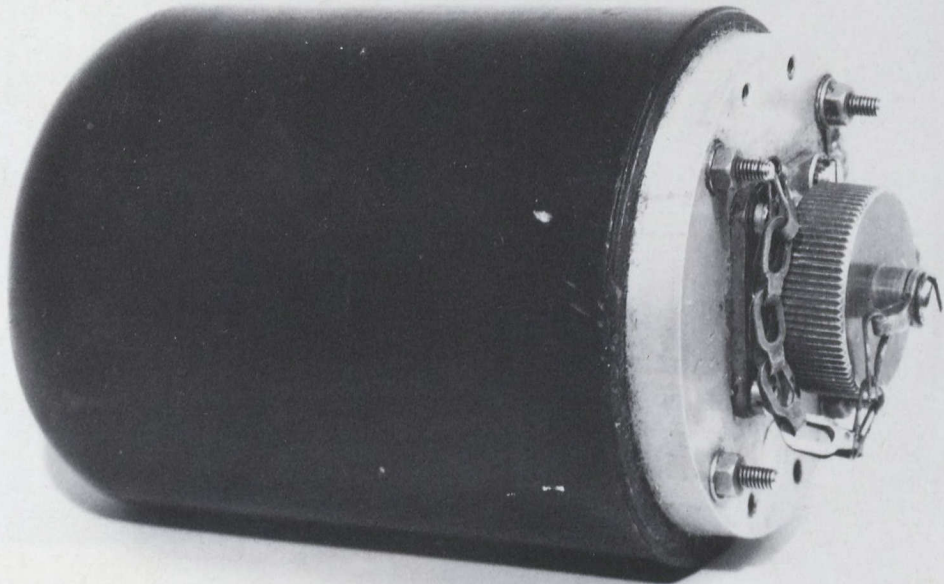
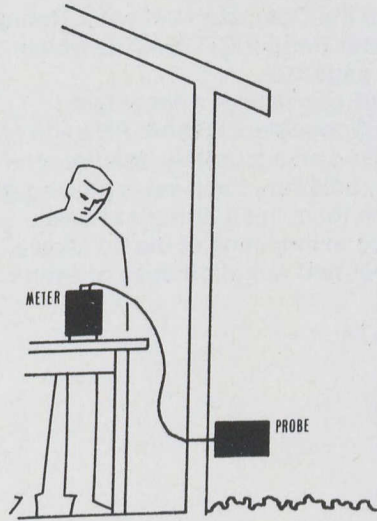
The normal location of the indicator is an underground or basement center. The interconnecting cable passes through a conduit to the detecting element which is mounted 1 m (3 ft.) above the ground and as far away from buildings as the cable will allow. The indicator can be placed horizontally on a table or mounted vertically on a wall. Mounting details are supplied in the carrying case.

The front panel of the indicator houses the meter, the operation panel switch, the voltage check switch and 500 set controls. The two switches are mechanically interlocked so that one cannot be rotated unless the other is set to OFF.

Indicator Radiac:	27 x 18 x 13 cm (10.5 in. h. x 7 in. w. x 5 in. dia.) 3,969 gm (8.75 oz.)
Detecting Element:	15 x 9 cm (6 in. h. x 3.4 in. dia.) 851 gm (1.9 lb.)
Cable Assembly:	15 m (50 in.) 3,118 gm (6.9 lb.)
1-Conductor Twin Shield:	30.5 m (100 ft.) 5,797 gm (13 lb.)
Carrying Case:	61 x 51 x 21 cm (23.9 in. x 20 in. x 8.1 in.) 9 kg (20 lb.)

PHYSICAL AND ELECTRICAL DATA

Range:	0 — 500 R/hr
Accuracy:	± 25% within 3 minutes after switching on equipment
Response Time:	90% of maximum response within 15 seconds after exposure to radiation source.
Energy Dependents:	50 Kev to 2 Mev ± 50%
Battery Operating Life:	1.3 voltage DC mercury cell type BA1391/U (250 hrs.) 6.7 voltage DC mercury cell type TR165R (600 hrs.)
Battery Service Life:	2 years.
Electrometer Tube Type ME1404 or equivalent.	



CALIBRATION SET, RADIAC, AN/UDM-502

The Calibration Set, Radiac, AN/UDM-502 is used to calibrate the Computer-Indicator Radiac Tactical Dosimeter Reader CP-95A/PD which is described on page 402.

The AN/UDM-502 consists of a set of five Tactical Radiac Dosimeters DT60A/PD each of which has received an accurately determined dose of gamma radiation. Each set is packaged in a polyethylene foam lined fibreglass case. A cut-out section in the lining of the lid shows the serial number and radiation dose of each dosimeter.

PHYSICAL DATA:**LENGTH**

25.4 cm (10 in.)

WIDTH

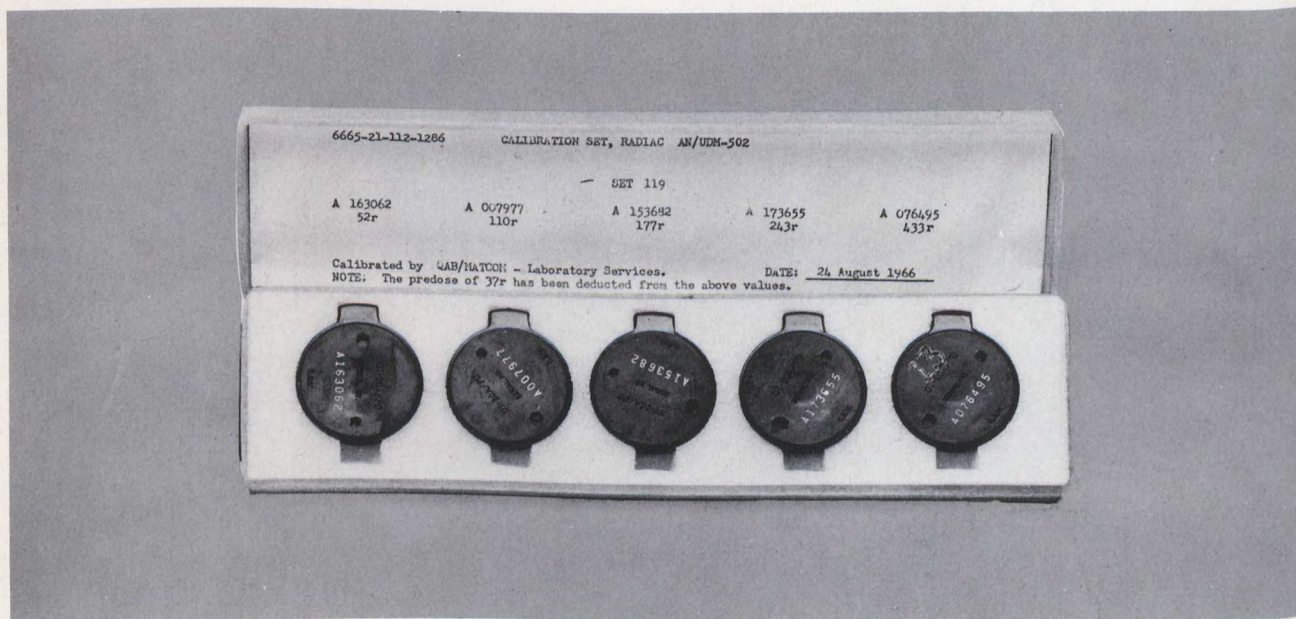
7.62 cm (3 in.)

DEPTH

3.8 cm (1.5 in.)

WEIGHT

340 gms (12 oz.)



CALIBRATOR SET, RADIAC, AN/UDM-501(V)

In exercising the precise control which is required for operations in nuclear/radiac areas, you must possess sound accurate recording instruments with, where needed, reading equipment of zero error accuracy. It becomes obvious that to maintain such stringent controls in field operations that basic calibration sets, standard controlled must become part of the normal equipment of an operational unit. To this end the Canadian Forces have designed and developed the Calibrator set. It is used to check the calibration of radiacmeters after repair and on periodic inspection. The suffix "(V)" in the nomenclature indicates a variable composition of the set since holders are added when new radiacmeters are brought into service.

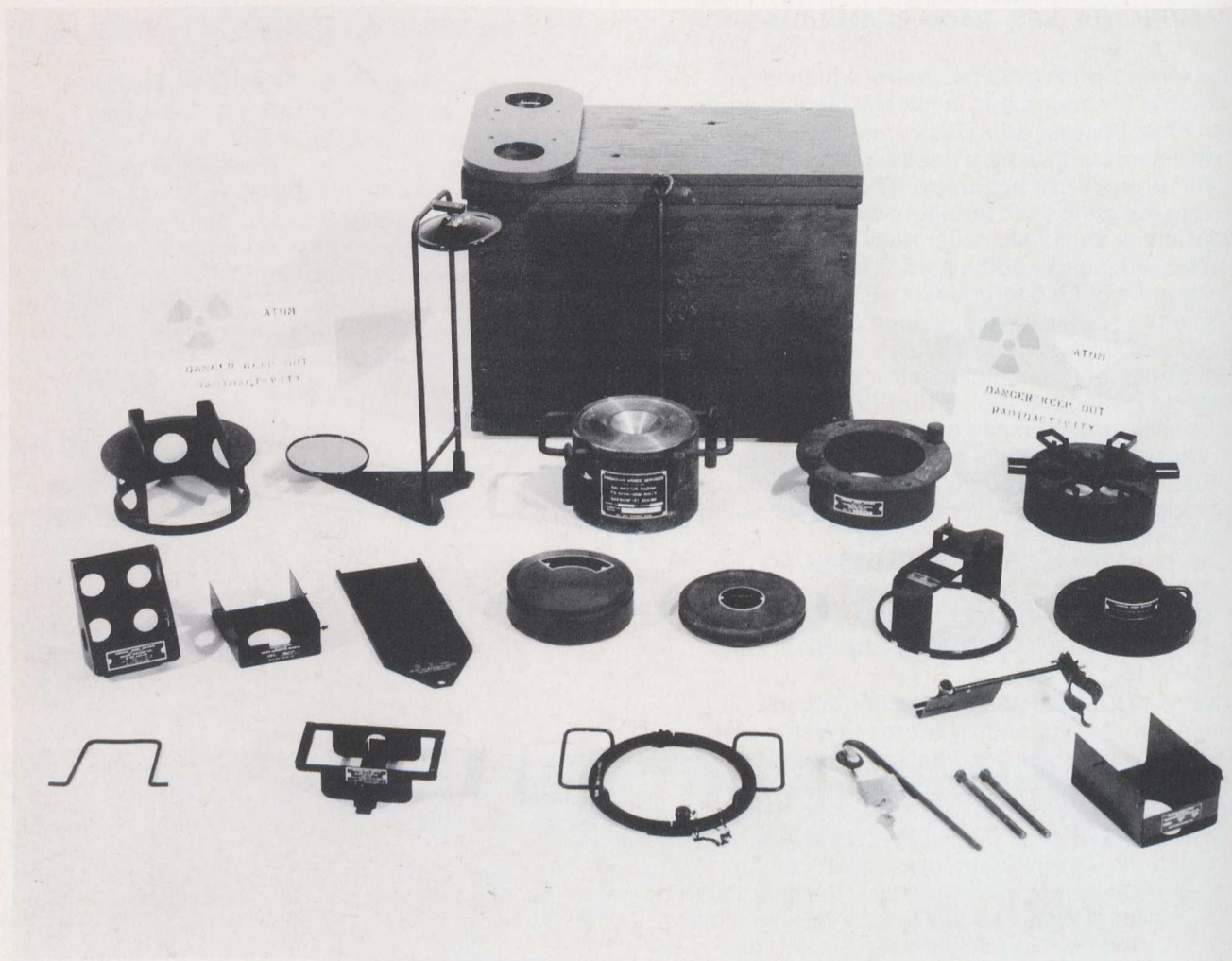
Included in the set are holders for the following radiacmeters:

IM-5016/PD; IM-108A/PD; IM-108B/PD;
 "MINIRAD"; 440 RF;
 CDV 700; AN/PDR-27J; AN/PDR-60;
 IM-5002A/PD; IM-5006A/PD; IM-5013/PD;
 IM-5015/TD.

The AN/UDM-501(V) consists of a 200 mc Caesium 137 radioactive source in a shielded shipping container, two filters, and a cover. The filters and cover when fitted are held in place by a keeper bar locked to a loop on the outer side of the container to keep the calibrator package intact and to comply with the regulations for handling and transporting radioactive materials. A series of holders and jigs for the various radiacmeters, and certain ancillary devices to aid calibration procedures are stored in a steel-framed wooden box suitable for shipment and for use in vehicle or workshop roles.

The set has two radiation warning signs that are stowed in the box when not in use.





SIMULATOR, RADIATION DETECTION SET, SM 5021/ADR-501

The Simulator, Radiation Detection Set, SM-5021/ADR-501 is used with the Radiation Detection Set, Airborne, AN/ADR-501 in radiation monitoring training exercises. The Simulator is a battery-operated, solid state, radio receiver, tunable over the standard AM Broadcast (commercial) band, with a frequency coverage of 550 to 1,650KHz.

The set is carried inside the aircraft and connected to the AN/ADR-501 Radiation Detection Set by a 1.21 m (4 ft.) length of cable. A separate

loop antenna replacing the Detector, Radiac, DT-5004/ADR-501 is mounted externally on the aircraft and connected to the simulator by the standard 15-foot AN/ADR-501 detector cable. Power is supplied from 12 self-contained Burgess type AL-9, 1.5-V, alkaline AA size cells. When the simulator is tuned to a broadcast band AM radio station, the output activates the AN/ADR-501 Recording unit in a manner simulating the receipt of signals from the detector head.

DIMENSIONS AND WEIGHTS

COMPONENT	LENGTH	WIDTH	HEIGHT	WEIGHT
Simulator (incl. batteries)	27.9 cm (11 in.)	17.7 cm (7 in.)	17.14 cm (6.75 in.)	3.5 kg (7.75 lb.)
Antenna		17.14 cm (6.75 in.)	17.7 cm (7 in.)	.9 kg (2 lb.)
Interconnecting Cable	1.2 m (4 ft.)	8.2 mm dia. (.323 in.)		226 gms (8 oz.)



RADIAC TRAINING SET, RST 8500

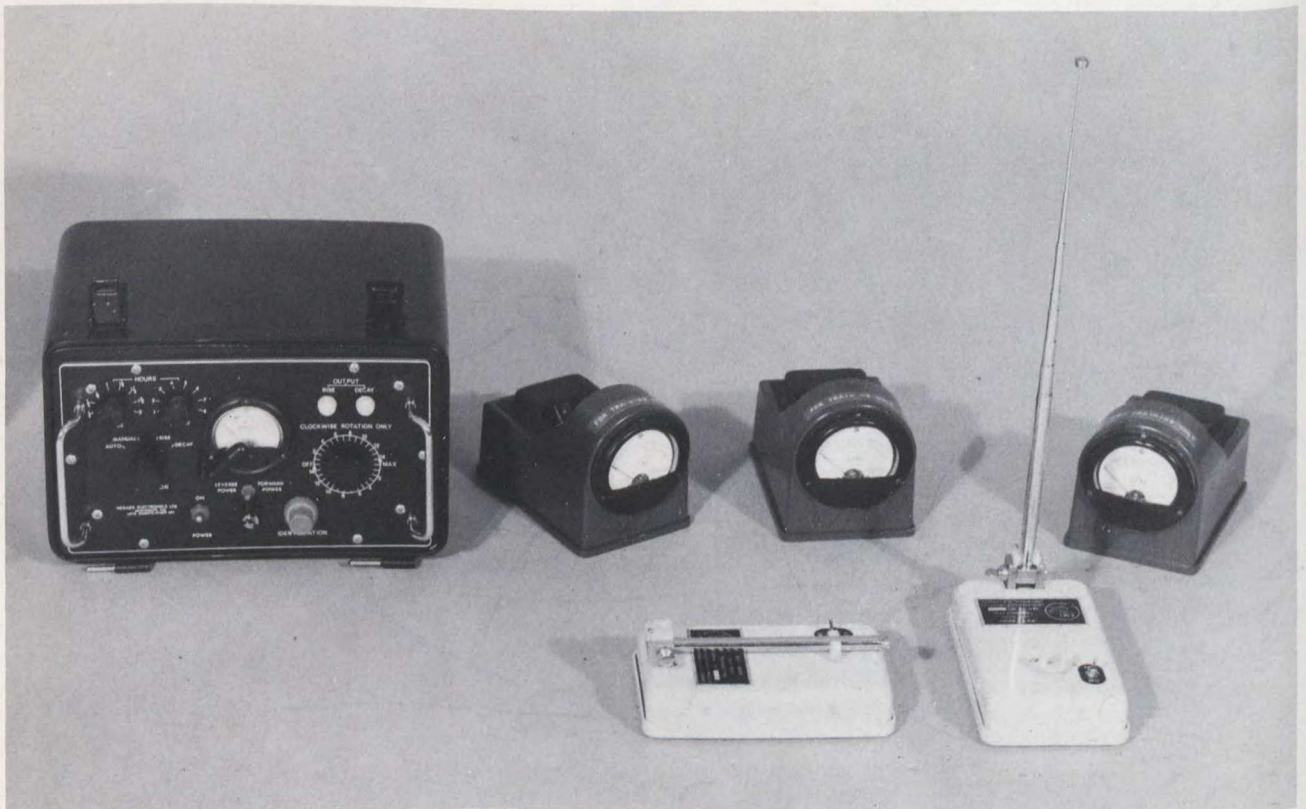
The Simulated Gamma Radiation Training Set, RST 8500 was developed and produced by EMI-Cossar, now Hermes Electronics Limited. This development by Hermes has produced an equipment which replaced the AN/TDQ-T501, which while widely accepted, had been in service for eleven years and required updating to existing technologies.

The RST 8500 is a low power system conceived to meet the fully portable requirements of the CF training program and acceptable in that the receivers (simulators) very closely resemble the standard Canadian high range survey meter, IM-108B/PD.

The RST 8500 comprises a 5 watt main transmitter operating at 29.800MHz. It embodies a pre-selectable rise and decay facility to vary output power over a wide range of rise and decay phases up to 8 hours. The rise and decay operation may also be controlled manually. There is also a coding device for identifying the transmitter whilst operating which will transmit the call sign at full power regardless of the level of power output as controlled by the rise and decay facility. The transmitting antenna

comprises two phased monopoles and the propagated pattern, subject to terrain is an ellipse approximately 16 km x 8 km (10 miles x 5 miles). To simulate hot spots of radiation, two 50 mW transmitters are provided. The simulated survey meters are radio receivers built into standard IM108B/PD cases and duplicate all 108B functions so that regular preoperating drills that apply to the actual Gamma Survey meter may be carried out on the simulator. The small transmitters and the simulators may be powered by standard AA size carbon/zinc or alkaline batteries.

This equipment, troop trialled by the Canadian Forces has been accepted as standard and US Army trials have indicated that it is acceptable as a substitute for their own equipment. Hermes Electronics are also active designers and producers in such fields as oceanographic equipment, pollution monitors and other specialty electronics.



NATIONAL RESEARCH COUNCIL



NATIONAL RESEARCH COUNCIL

After nearly ten years of publication, this book now includes a brief description of a Canadian Government facility, the National Research Council. The decision has been made to include information on NRC from a desire both to introduce the R & D field and to depict the operations of a unique, Crown-owned and directed facility which has been a source of pride to Canada since it was established in 1916. While Canadian research and development endeavours may fall into fields as diversified as aerospace and agriculture, NRC has served one as faithfully as the other, for its terms of reference are as wide as Canada's national requirements and interests. A lesser-known facet of its terms and another reason for this presentation, is an ability and willingness to co-operate with other friendly countries and accredited agencies.

Possibly the best introduction to the Council, would be a resumé of the library's activities. It is no accident that those countries which have achieved greatest success in scientific research and industrial development have, within their borders, access to the world's output of scientific and technical literature. It is equally no accident that NRC, in keeping with its responsibility for promoting scientific and technical research and development in Canada, is also responsible for maintaining the National Science Library of Canada.

The National Science Library, with its collection of well over 800,000 volumes, is not a "library" in the conventional sense of the word. It is an "information transferral" agency which is continually developing new techniques to ensure that Canadian scientists, engineers and industrialists, can obtain with a minimum of delay, the publications or information required in their day to day work. The Library's resources have been developed in close co-operation with other federal libraries to the point where there now exists in Ottawa one of the world's outstanding collections of scientific and technical literature.

Subscriptions to more than 16,500 journals, and purchases of monographs, textbooks, abstracting and indexing services, are supplemented by publications acquired through exchange agreements with scientific and technical societies in all parts of the world. The Library is also a depository for all publications issued by such organizations as the International Atomic Energy Agency, the U.S. Atomic Energy Commission and by the U.S. Clearinghouse for Federal Scientific and Technical Information. Publications from this

latter agency are received in the form of microfiche and total more than 50,000 technical reports per year.

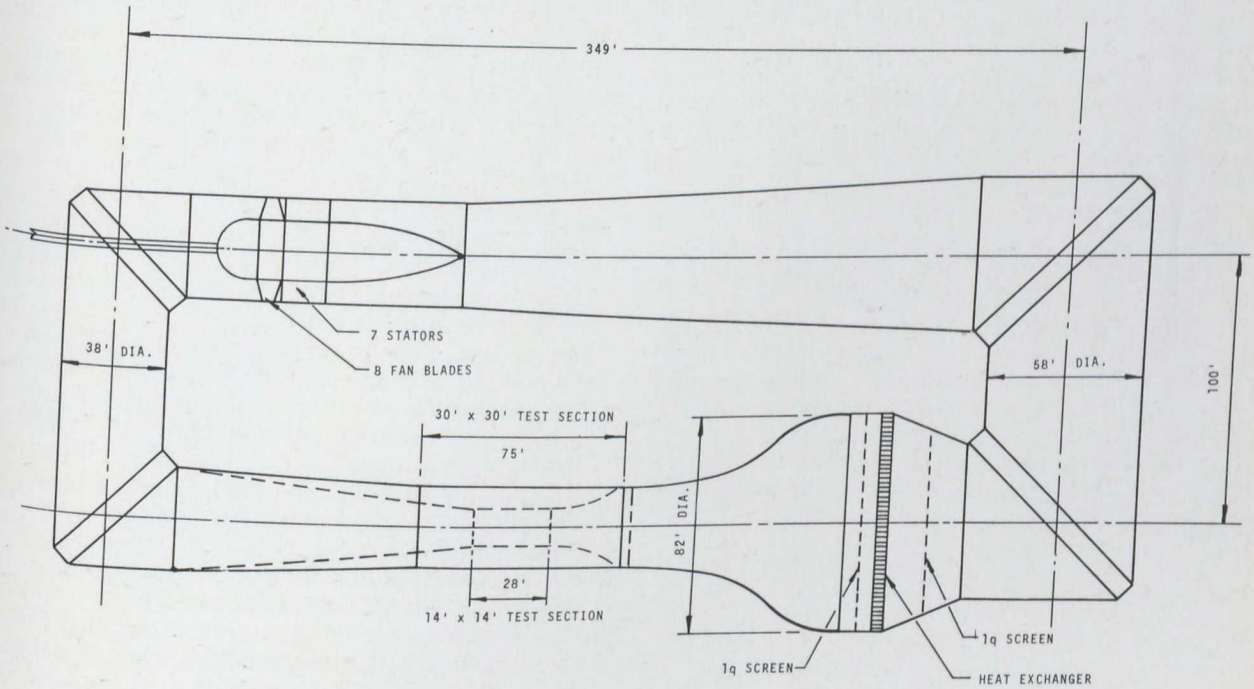
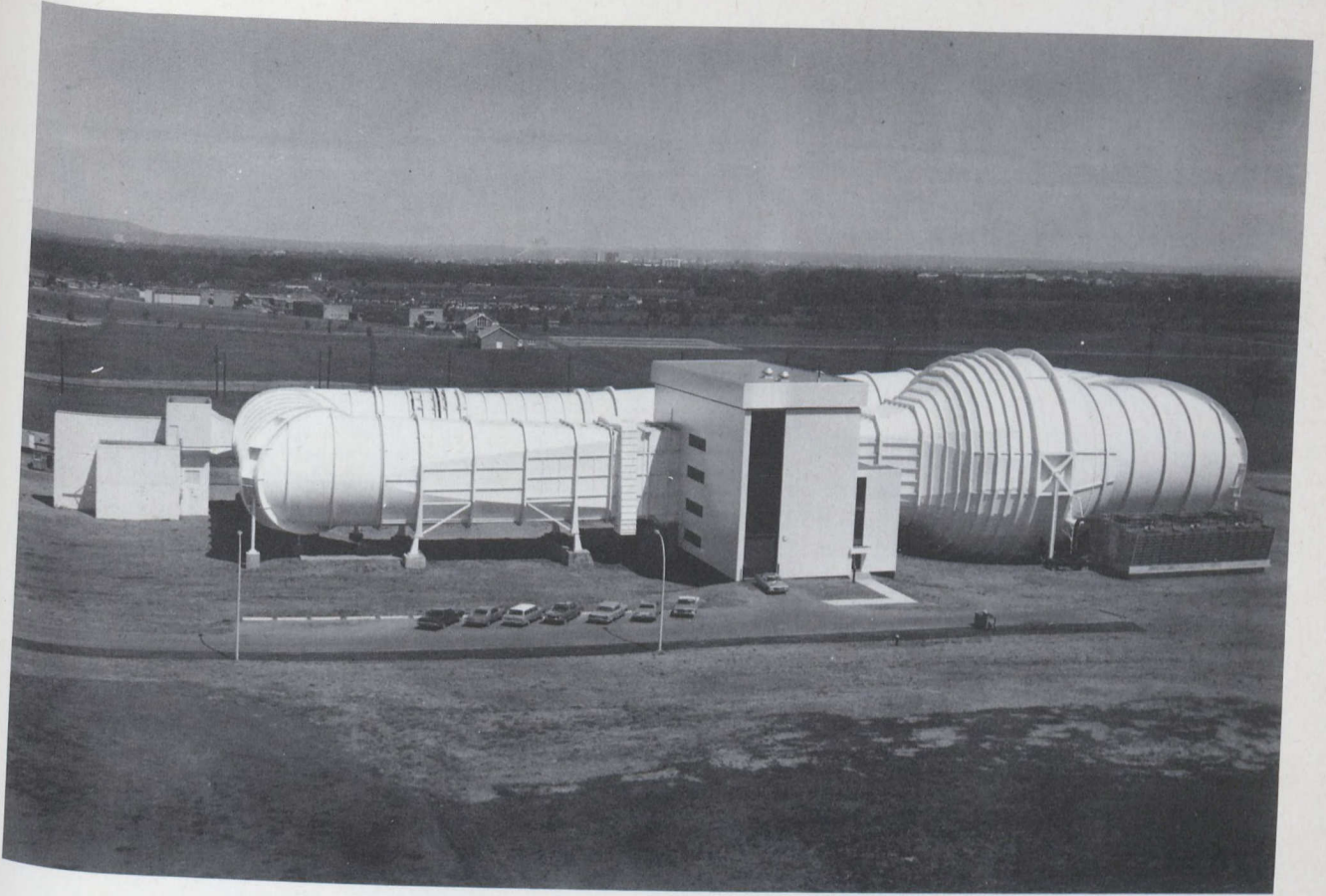
The Library's resources are publicized by means of an annual list of the titles and holdings of journals and periodicals received by the Library; by semi-monthly lists of the Library's latest acquisitions; and by special subject bibliographies, such as lists of Chinese, Japanese, Russian, mathematical or biomedical journals held by the Library. These bibliographies are distributed free of charge to all major libraries in Canada and to other interested organizations.

THE NATIONAL AERONAUTICAL ESTABLISHMENT

The National Aeronautical Establishment is the custodian and operator of all the development wind tunnels in Canada. These tunnels have an aggregate value of about \$20 million, and are capable of research and development work up to Mach 4½ in air and Mach 18 in Helium. The tunnels are committed to the service of Canadian industry, and are available on contract to suppliers and contractors both domestic and foreign. The establishment as a whole is the national centre of expertise in the fields of Aerodynamics, Flight Research, and Aeronautical Structures and Materials. In these subjects it is "on call" in support of Canadian industry, the military services, airline operations, and other government departments and agencies.

In aeronautical structures and materials, the laboratories are particularly active and well-equipped for work on the static and fatigue strength of aircraft structures, for analytical and experimental work in dynamics and aeroelasticity, and for work on the development and performance of advanced high temperature alloys for aircraft engines.

The Flight Research Laboratory is well-equipped with fixed-wing aircraft and helicopters, and is particularly occupied with research work on aircraft performance and handling qualities, in conjunction with various aircraft contractors both domestic and foreign. Its current work program includes the building of a 6-degree of freedom variable stability helicopter, the investigation of atmospheric turbulence and hail suppression, the airborne remote sensing of magnetic phenomena, and a variety of aircraft operational techniques and studies.



Some of the more recent programmes under way are listed below:

LOW SPEED AERODYNAMICS

In most of the larger industrialized countries of the world, the aircraft industry owns and operates its own wind tunnels and other major experimental equipment. In Canada the relatively small size of the individual firms has made it of economic advantage to build all the large wind tunnels now available to industry in the laboratories of the National Research Council in Ottawa.

As a result, a large proportion of the aerodynamic program is devoted to experimental work, done under direct contract with the aerospace industry, and contributing directly to the design and development of new hardware. Every significant aircraft and rocket designed and developed in Canada during the past 20 years has been partially or wholly supported by wind tunnel experiments at N.R.C.'s National Aeronautical Establishment (NAE).

Since about the mid 1950's, the Canadian aircraft industry has made significant advances in the development of vertical or short take-off and landing (V/STOL) aircraft, and as the state of this art has become increasingly competitive and sophisticated, it has been necessary to provide support in a number of areas within the NAE. In 1966 the first contracts were let for the construction of the new 9.4 m (30 ft.) low speed tunnel at the Uplands airport site, and this tunnel began its commissioning and calibration runs toward the end of 1969, with the first experimental work scheduled for the Spring of 1970 on a 5.4 m (18 ft.) span model of a new Canadian STOL aircraft design.

Other in-house V/STOL research that has been completed within the past two years in the Low Speed Aerodynamics Section includes an experimental investigation of the aerodynamic characteristics of the tilt wing VTOL system, a theoretical analysis of the aircraft configuration parameters leading to minimum energy requirements in slow flight, and a research program aimed at minimizing the effects of wind tunnel walls on the measurement of forces and moments on V/STOL models.

HIGH SPEED AERODYNAMICS

The High Speed Aerodynamics Section is centred around the NAE 1.52 m (5 ft.) trisonic blowdown wind tunnel, but also makes limited use of a 12.7 cm (5 in.) supersonic and a 30.4 cm (12 in.) hypersonic gun tunnel for basic research studies. During the review period the large trisonic wind tunnel was used for a variety of aerodynamic investigations for the aerospace industry, defense services and for internal research work. Typical of the tests made for industry were longitudinal stability measurements of flexible rocket vehicle models; a succession of increasingly complex flutter investigations of models of a large tri-jet aircraft (airbus); static lateral and longitudinal stability and hinge moment measurements on rigid and flexible models of a strike fighter aircraft, and trajectory studies of small solid fueled rockets launched from these same wind tunnel models. Most of these investigations have utilised the high Reynolds number capabilities of the 1.52 m (5 ft.) wind tunnel and have been carried out in the high subsonic and transonic speed ranges.

Recently the high Reynolds number transonic performance has been enhanced by the provision of insertable wall sections which reduce the test section area to 1.52 m by 38.1 cm (5 ft. by 1.25 ft.), but enable the wind tunnel to be operated at higher pressures. This unique two-dimensional test facility, which has attracted widespread interest, has been commissioned, calibrated and used by several aerospace companies to develop transonic wing sections. Investigations in this facility are supported by internal research work aimed at the development of theoretical methods of aerofoil design for supercritical transonic conditions. Co-operative experimental and theoretical research programs with the Courant Institute of Mathematic Sciences, New York University and the Convair Division of General Dynamics on "shockless" high lift transonic aerofoils including the effect of jet flap blowing, are also in progress. The research work of the Section has been concerned with three-dimensional boundary layers and flow separation, the computation of three-dimensional inviscid and interacting flow fields, and the design of supercritical transonic aerofoils, mentioned above.

Fundamental studies have been made of the three-dimensional laminar boundary layer, with and without suction and on cones, and also the two-dimensional turbulent boundary layer using finite difference techniques with the turbulent



shear stress described by various mixing length models. Measurements have been made of the laminar and turbulent boundary layer growth, separation and vortex structure about lifting circular cones in subsonic, supersonic and hypersonic flows.

Other experimental research programmes involving three-dimensional viscous flows have included: Magnus force measurements on mortars spinning at high rotational speeds, the separation on long slender ogive-cylinder models and the resulting side forces, the turbulent boundary layer development and separation on a slender ellipsoid of revolution at incidence to a subsonic stream, an investigation of fuselage boundary layer separation caused by side mounted supersonic intakes and a related study of separation caused by the glancing interaction of an oblique shock wave system.

FLIGHT RESEARCH SECTION

Flight research is conducted by the NAE to supplement the work of the other aeronautical laboratories in exploring new avenues for aircraft development, to find solutions to their operational problems and to facilitate their application to new functions.

In the first and second of these categories the emphasis in recent years has been placed upon research on VTOL and STOL aircraft handling qualities, and upon research on atmospheric turbulence. Airborne simulators, evolved using helicopters with variable stability and control characteristics, have provided the means for systematically investigating the effect on handling qualities of the numerous individual parameters involved. The small helicopter at present used for this work is undertaking flight programs to provide new information, essential to designers, on suitable values for these parameters, on limitations due to pilot response and on the probable flight behaviour of projected aircraft. A larger helicopter has been acquired to provide an increased future capability for airborne simulation. Flight investigations of the properties of turbulence and their effects on aircraft behaviour have continued through the use of two jet aircraft. During the past two years one of these, a T-33 has been used primarily to study the occurrence of turbulence in clear air, particularly in and near jet streams. Measurements made by this aircraft have enabled the magnitude of various terms in the energy equations to be deduced, providing further insight into the mechanisms

leading to the generation of turbulence. The other aircraft is an RB57F operated by the USAF. This aircraft has been fitted with an NRC recorder with a memory capability triggered only by atmospheric disturbances above certain critical levels. Over a period of more than a year this recorder has accumulated data on more than 50 disturbances encountered at stratospheric altitudes between 12,190 m and 19,500 m (40,000 and 64,000 ft.), representing approximately 1.2 per cent of the total flight time spent at these altitudes, which are typical of supersonic transport cruising levels. The instrumented T-33 aircraft has also been used to evaluate the persistence of high intensity vortex wakes behind large aircraft, since these wakes present a hazard to other aircraft and are becoming a significant factor in establishing air traffic separation criteria. Considerations of flight safety, which initiated the successful development of a crash position indicator for fixed-wing aircraft, led to a programme to develop a comparable device for helicopters. A mobile test rig has been built and is in operation for experiments to study the behaviour of lightly loaded objects released in the presence of rotor air flows, and to evaluate possible systems prior to full-scale flight trials. Flight research relating to aircraft applications has necessitated the continuance of work on airborne magnetic detector systems for ASW and geophysical purposes, and on the behaviour of fluids when dropped in bulk from aircraft for forest fire suppression. The North Star aircraft, used as a flying laboratory for aeromagnetic research, has also been employed recently for the preliminary assessment of infra-red techniques for various survey purposes. During the past year, a small aircraft has been equipped as a vehicle for a programme to develop aircraft spray systems having improved characteristics of uniformity of droplet size distribution. A second T-33 aircraft has also been equipped to participate in hail suppression experiments being conducted in Alberta, just east of the Rocky Mountains. This aircraft is capable of dispensing pyrotechnics containing silver iodide, while flying above buildings cumulus towers. The pyrotechnics are launched vertically downwards and are fused to generate silver iodide at a maximum rate immediately above the freezing level.

STRUCTURES AND MATERIALS

The study and analysis of the flight operations environment is a pursuit that demands, more than any other, the international co-ordination and exchange of information. Through the Advisory Group for Aerospace Research and Development, Canada has participated in a number of programs, two of the more important current ones being: (1) the compilation of a reference source of aircraft response to flight turbulence based on the pooled data of the NATO countries, and (2) the analysis and ultimate preparation of data sheets covering high intensity noise fields and structural responses which may be involved in the phenomenon of acoustic fatigue. The Canadian share of funding to defray AGARD's costs of carrying out these coordinated efforts,

is contributed jointly by the DND, DOT and NAE, with NAE carrying the technical responsibility. During the past few months, the measurement of flight load statistics has emphasized the exposure of light aircraft such as are used in survey, pipeline overflying, and agricultural or special commercial operations. Reports have been prepared and will continue to be prepared and made available as data are received and processed. The increased use of flight load statistics recorders and fatigue spectrum monitors has raised the need for improvements to the technique for the input-output calibration of low-frequency large-amplitude acceleration indicators and counters. The development of an electro-hydraulic system is currently in hand and is expected



Rig for study of Helicopter icing

to be in operation in time to handle the new generation of DND operational V-G-H recorders. In this connection, NAE has carried out advanced computer programming for analysis of the Leigh Instruments V-G-H recorder, and will work with DND in processing the output from this new operational aid for the CF-5 aircraft.

The results of work in the near field sound pressures of a choked jet during what is termed the screech cycle, has evoked very great interest from operators and manufacturers. The object of this work was to establish a possible correlation of pressure fluctuation over a structure in the near field noise. Instrumentation was developed to measure instantaneous pressures near to a two-inch diameter screeching jet, as an extension and complement of our previous root-mean-square field pressure measurements. Flow visualization of the sound field oscillations were projected onto a two square feet diameter screen, with the aid of an improved Schlieren system, and a film of the stroboscopic motion has been released for technical viewers.

The flight impact simulator has been used to document a number of study sequences of bird impacts against aircraft windshield and airframe components. Now calibrated up to 420 knots, and controllable with $\pm 2\frac{1}{2}\%$, impact records correlating velocity, temperature, strain, and fracture modes are obtained with high speed photography and chart recorders. Current evaluations of a DND trainer aircraft will also see the completion of a controlled enclosure capable of handling steady state temperatures from -54°C to $+66^{\circ}\text{C}$ (-65°F to $+150^{\circ}\text{F}$).

FATIGUE AND FRACTURE

In the very heavy demand for fractographic analysis of metal failures, a number of opportunities have been afforded to test and improve techniques for the examination and interpretation of fracture surfaces. Investigation of service fatigue in the main spar flange of the CL41 aircraft, for example, has enabled the direct fractographic comparison of a service-produced crack with its laboratory equivalent produced under full-scale simulated test conditions. Correlation of the load programme crack progression lines, the individual striations, and the relative striation spacings observed in the fracture surfaces, are being analysed to improve post mortem interpretation techniques. In a continuation of this particular project a modification introduced by the manu-

facturer is undergoing simulated flight load spectrum tests, with the expectation of achieving an acceptable service life rating. Also in hand is a complementary study of crack propagation rates and fracture topography of ASTM — A325 high strength steel bolts, which are being failed under programme loads featuring predetermined mean load level and load amplitude relations. Following an observation of the rather poor fatigue performance of a welded 18(250) maraging steel component, an investigation of fatigue in simple butt-welded plate samples prepared by a qualified manufacturer and by the NRC Experimental Workshops, was carried out. The results for as-received rolled and aged plate subjected to pulsating tension, indicated a fatigue limit of about 44 ± 36 ksi. For the butt-welds, a fatigue limit of only 18.7 ± 15.3 ksi was found. While removal of the weld bead by grinding appears to increase the average life, particularly when grinding is carried out after aging, the best performance achieved in this regard was still inferior to that reported by other investigators for specimens taken from bar stock.

MISCELLANEOUS INVOLVEMENTS

Services rendered to the industrial and scientific community through the special abilities of the staff and laboratory facilities represented a substantial level of laboratory effort. Analysis of the Tutor Aircraft fatigue exposure prior to setting up a laboratory fatigue test involved: study of the flight load spectrum and synthesis of an equivalent spectrum block simulation, metallurgical and residual stress analysis of critical parts, and measurement and analysis of stress and deflection influence lines for a wing unit-loading grid. Assistance in accident and materials failure analyses saw several dozen electron fractographic examinations carried out, including requests from the Department of National Defence, Department of Transport, Commercial airlines and automobile road accident investigators. Special lecture and technical instruction course material included such topics as finite element analysis, jet efflux noise, electron fractographic techniques, principles of strain gauge circuits and strain measuring instruments, statistics of secondary load reference standards evaluation, and blast pressures in the NAE pneumatic gun muzzle efflux, etc.

These activities to a small degree outline the activities of the National Aeronautical Establishment.

RADIO AND ELECTRICAL ENGINEERING DIVISION AND ASTROPHYSICS BRANCH

Approximately equal effort is devoted to basic and to applied research in the Division's program. Astronomy figures prominently on the basic side, both through research activities by staff astronomers and through the operation of the Algonquin Radio Observatory which is maintained as a national radio observatory. The transfer to the Division, on April 1, 1970, of the optical and radio astronomers of the Department of Energy, Mines and Resources will consolidate the programme and provide a strong focal point for astronomical research in Canada.

The applied research effort covers a wide range, with emphasis on the application of computer techniques to a variety of fields. Prominent in this program is the establishment of a central computer facility which will be used co-operatively with federal and provincial agencies in the evaluation of terminal equipment and software used in computer-aided learning systems. Other applied projects include the application of microwaves to industrial drying processes; the development of precision electrical instruments and standards, and research and development in the field of biomedical engineering.

RADIO AND ELECTRICAL ENGINEERING DIVISION

ELECTRICAL ENGINEERING

ANTENNA ENGINEERING

The development of antennas and transmission components for specific applications occupies much of the effort in this section. Extensive antenna test facilities are maintained which are available to other government departments and industry as well as to NRC personnel. The theoretical program is broadly based and involves the development and application of mathematical techniques for the solution of fundamental problems in electro-magnetic and antenna theory.

Several meteorological studies are under way, including the recording of meteorological data at Rogers Pass, B.C., to assist snow physicists and highway engineers in avalanche control. Another study involves observations with a 16.5-GHz radar to obtain information on precipitation particles. The section also supplies technical support for the Alberta Hail Research Project at Mynarski Park, Alberta.

One of the section projects is primarily concerned with the means of exploiting direct conversion of microwave energy to heat for industrial drying. Recent developments include an automated device for tuning resonant microwave heating systems, and special-purpose industrial drying chambers and moisture sensors. The program is conducted in close cooperation with industry through Canadian Patents and Development Ltd.



Radiation pattern measurements of a parabolic reflector antenna.

DATA SYSTEMS

The programme of this section has two aspects — the development of data systems for researchers and a study of man-computer communications, both fostering better use of computers. Computer and related techniques are being applied to problems in research, in engineering, in management, and in the arts.

A number of small automated systems to control apparatus and the recording of data collected by the apparatus, as well as the data acquisition and control system at the Algonquin Radio Observatory, are being developed in consultation with the researchers who use them.

The man-computer communications activities are twofold. Both the hardware and software of the graphics facility itself are being continuously improved and extended. In parallel, programming is being developed which applies the system to the needs of creative users such as film animators and musicians. This work is conducted in collaboration with such organizations as the National Film Board and Radio Canada, as well as with individuals. A subsidiary aim of this study is to encourage the interchange of ideas between engineers, researchers, and artists. To this end the section sponsors biennial seminars to which individuals interested in interactive computer graphics are invited.

Development of electronic musical instruments and synthesizers for industry and education is conducted in cooperation with university music faculties, who assist in the evaluation of instruments and techniques.

A study of methods of processing and compressing data for efficient storage and retrieval is soon to be undertaken using a new interactive graphics facility.

INSTRUMENT SECTION

RF METROLOGY

In this area the aim is to establish and maintain national reference standards of certain radio frequency quantities. Primary standards of power, attenuation, and impedance are established and other quantities such as voltage are derived from them. An important consideration in the establishment of such standards is the relation they bear to those of other countries. The section is currently engaged in international intercomparison of standards under the auspices of the international Bureau of Weights and Measures.

BIOENGINEERING

In the field of Bioengineering the work is divided between basic studies of biologically generated signals and the development of improved measurement techniques and apparatus, including improved prosthetic devices and radio-telemetry systems for biological data. In co-operation with hospital authorities, standards of electrical safety in the construction and operation of hospitals are continually reviewed.

AIDS TO THE HANDICAPPED

The section holds a unique position in the work being done to aid those handicapped by blindness, in the development of electronic devices which enable the blind to perform useful job functions, and in its role as a source of advice and direction to agencies which provide assistance to the handicapped.

SOLID STATE

Projects under this heading include fundamental studies of crystal structure, in particular of anthracene and alkali halide crystals. Investigations of the photoconductivity of ionic crystals containing defects are under way. Theoretical studies of the energy to form a pair of vacancies in an ionic crystal have given results which correlate well with those of other laboratories and indicate that a fundamental change in the treatment of polarization is necessary.

HYBRID SIMULATION

Specialized methods are being developed for use of analog computers controlled by digital elements in simulating digital control systems and in educational roles.

RADAR ALTIMETER AND RADAR STUDIES OF PRECIPITATION

A continuing program supports basic research on precipitation using specially developed radar facilities, and includes study of the polarization properties, vertical velocity, and radar reflectivity of precipitation particles.

A unique radar altimeter of high accuracy permits photographic evaluation of forest timber content and is now being further developed for use as a profile recorder for topographic mapping.

PRECISION MEASUREMENTS

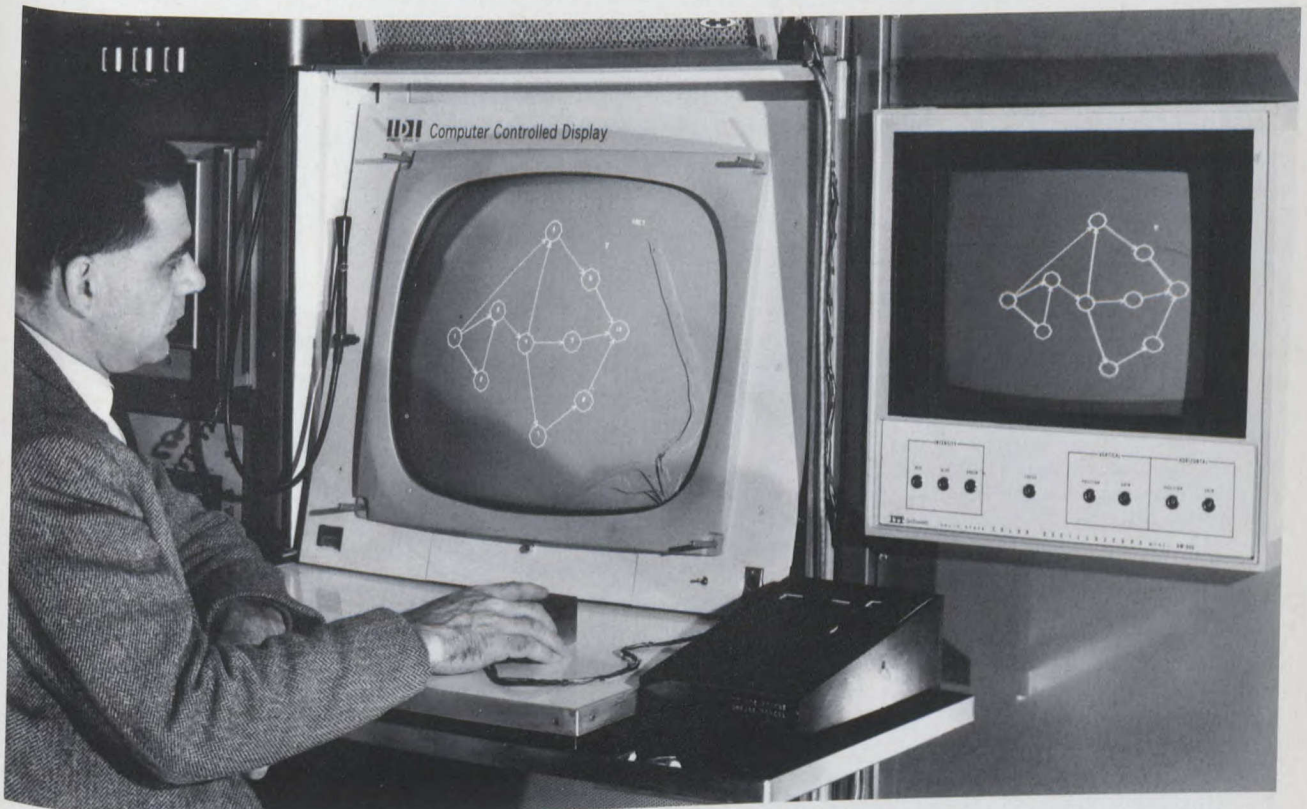
New developments in precision measurements include a direct-current comparator bridge for measuring precision resistors up to 1 megohm, a 2000-ampere current comparator with a 2-kVA energy transfer capability for current transformer calibrations which incorporates all standard North American and International ratios, and a null detector especially designed for use with current comparators. Work has been initiated on a phantom burden for current transformer calibrations in which the burden volt-amperes are returned to the supply rather than being dissipated, and on the application of feedback to an ac-dc thermal converter to increase its speed of response.

COMPUTER AIDED LEARNING

This program was initiated to further co-operative development in Canada of computer aided learning (CAL) systems. To involve jointly educators and system designers, the section provided a

large digital computer facility, and made it available for CAL research to co-operating educational agencies across Canada by telephone and remote computer terminal. The preparation of curriculum materials and the evaluation of special terminal devices is contributed by the cooperating educators, while the system design is the responsibility of the section.

Developments in progress include such specialized terminal facilities as computer-controlled audio and video storage, bilingual character generation, transparent overlays allowing interaction with any display by touching the surface with the finger, computer programs that can correct misspelled keyboard entries automatically and others that will accept titles and texts of documents and classify and index them without human intervention for later retrieval. Longer term research includes the study of voice control of computers and thin film research having potential application in data stores of large capacity.



Interactive computer graphics network analysis (critical path method).

Astrophysics Branch

The Astrophysics Branch was created in April, 1970, for the purpose of co-ordinating the work of the various groups engaged in astronomical and related research. It is composed of the personnel and facilities transferred at that time from the Department of Energy, Mines and Resources together with those already in the Radio and Electrical Engineering Division of NRC.

The Branch is responsible for the operation of three major astronomical facilities—the Dominion Astrophysical Observatory, the Algonquin Radio Observatory and the Dominion Radio Astrophysical Observatory — in addition to a number of smaller observatories and observing stations. The research program covers a wide range of topics in both optical and radio astronomy and in the related fields of meteoritics and upper atmosphere research.

ELECTRON PHYSICS

The section is devoted, primarily, to fundamental experimental research. One group is investigating phenomena occurring at solid surfaces in ultra-high vacuum; another is concerned with laser induced effect in solids and liquids. The surface research group is presently engaged in the following experiments:

- (i) Scattering of monoenergetic inert gas atomic beams from a lithium fluoride crystal.
- (ii) The effect of surface material, pre-treatment and geometric arrangement on the phenomenon of accommodation pumping.
- (iii) The interaction of injected helium with point defects in tungsten crystals.
- (iv) Multiple ionization by sequential electron impact in a trapped-ion source.

The quantum electronics group is involved in the development of single frequency, stable lasers and their application to the study of resonance radiation in solids. An optical line narrowing effect has been discovered which yields a hundred-fold increase in spectroscopic resolution of ionic spectra in solids. Applications of this effect to spectroscopy and a novel optical memory system are being studied. Projects presently under way are:

- (i) Line widths and energy transfer measurements of the zero phonon R1 line in ruby at liquid helium temperatures. Comparison with theoretical studies, also being done here, suggests that the Cr-Al super-hyperfine interactions determine the linewidth.
- (ii) Construction of a stable, single-frequency tunable dye laser to permit extension of the above studies to other materials.

RADIO ASTRONOMY

The section is engaged in three basic activities: (1) the design and construction of radiometers and auxiliary instrumentation for the Algonquin Radio Observatory; (2) a research program in galactic and extragalactic radio astronomy; and (3) optical, radio and theoretical studies of the sun.

Astronomers of the section are engaged, both independently and in co-operation with university astronomers, in a variety of observational programs. One of these programs, involving astronomers from the University of Toronto and Queen's University, is an investigation of the sizes and structure of quasars and other compact sources using the technique of very long-baseline interferometry pioneered by the Canadian group. Routine observations of variable sources have been in progress for several years and are yielding important clues to the physical processes occurring in these puzzling objects.

Routine daily observations of the solar flux at a wavelength of 10.7 cm have been made for many years at the Algonquin Radio Observatory and, more recently, also at the Dominion Radio Astrophysical Observatory. These data are accepted internationally as an index of solar activity.

The recently completed Ottawa River Solar Observatory, near Ottawa, is a new facility for optical solar research. The telescope is designed to provide large-scale, time-lapse photographs of structure in the solar atmosphere both in the continuum and the light of H-alpha. This programme is directed towards an improved understanding of the causes of solar activity and associated explosive events. The observational programme is complemented by theoretical studies of chromospheric phenomena.

ALGONQUIN RADIO OBSERVATORY

The Algonquin Radio Observatory, about 160 miles west of Ottawa, is operated as a national observatory whose facilities are available to all Canadian scientists. The site is remote from large centers of population ensuring comparative freedom from radio noise of terrestrial origin. A permanent staff of engineers and technicians is responsible for maintenance of equipment, and accommodation is available for astronomers visiting the observatory for observing sessions. The major instrument is a precision 46-meter parabolic telescope which ranks among the most powerful in the world for observations at centimeter wavelengths. A variety of radiometers and feeds enable both continuum and spectral-line observations to be undertaken. A data acquisition



system employing a general purpose digital computer forms an integral part of the telescope facility. Observing time on the instrument is allotted to qualified users by a programming committee; approximately 60% of the available observing time is used by university staff members and their graduate students.

Other facilities include a general-purpose 10-meter parabolic telescope and a horn reflector used for absolute measurements of the intensity of emission from radio sources at centimeter wavelengths. Observations of solar emission at a wavelength of 10.7 cm are made routinely with a 2-meter parabolic reflector and a multi-element interferometer.

DOMINION ASTROPHYSICAL OBSERVATORY

The Dominion Astrophysical Observatory, founded in Victoria in 1918, has been the principal federal government laboratory for astrophysical research using optical telescopes for more than fifty years. Research programmes undertaken at the observatory are based on studies of stellar spectra and, when desirable, these data are supplemented by photometric observations. Programmes in process include studies of stellar atmospheres and stellar structure, double stars and star clusters, the motion and distribution of stars in the galaxy, and the properties of the interstellar medium. Several members of the staff are also involved in the development of new instrumentation both for the spectrographs at the telescopes and for the analysis of the observed data.

The 1.85 m (72-in.) telescope of the observatory is equipped with an all-purpose Cassegrain grating spectrograph giving dispersions from 15 to 120 Å/mm. A low-dispersion spectrograph is also available. The 1.2 m (48-in.) reflecting telescope is used principally at the coudé focus with an excellent spectrograph giving dispersions from 2 to 30 Å/mm. A Varo image tube and a high-resolution scanner, with limited range, are additional features of this spectrograph. The small secondary mirrors with multi-layer, and image slicers at the slit of the coudé spectrograph make this instrument remarkably efficient.

A variety of specialized measuring instruments and intensity microphotometers is available, and a newly developed data-acquisition system enables the observations to be digitized for computer analysis.

UPPER ATMOSPHERE RESEARCH

AURORA AND AIRGLOW

Auroral ionization and ionospheric electric and magnetic fields are being investigated by VHF radio wave scattering from electron density fluctuations. In addition, direct measurements of the plasma electron density and temperature are being made with high resolution probes carried on rockets launched from Churchill, Resolute, and Nova Scotia. The Nova Scotia site is located to intercept the 1970 and 1972 total solar eclipses. Optical auroral spectra, photometric intensities, time-lapse photography, and magnetic field measurements are being recorded by ground-based and rocket-borne instruments to study the dynamic and photochemical processes in the disturbed upper atmosphere. Measurements are also made at conjugate magnetic field locations in the arctic and antarctic regions.

DOMINION RADIO ASTROPHYSICAL OBSERVATORY

The radio observatory near Penticton is devoted to the study of natural radio emissions from astronomical objects, principally the galaxy, quasars, remote galaxies and pulsars. The observatory has a remarkably quiet site which has made possible observations in the frequency range 10 and 200 MHz which can only be made with difficulty, if at all, at other observatories. Two very large antenna arrays (10 MHz and 22 MHz) have been built on the site and have produced new data on the spectra of radio sources at low frequencies. Observations made during the recent sunspot minimum with the 22-MHz T-shaped array are being analyzed to produce maps of radio emission from the galaxy. Other observing facilities include a 25.6-m paraboloid and spectroscopic synthesis interferometer at present under construction, and intended for high-resolution studies of radio spectral lines. A transverse-scan video tape recorder and a hydrogen maser atomic clock are used in long baseline interferometry (LBI). A series of LBI measurements of Jupiter between Penticton and Algonquin was successful in detecting fringes from several of the burst-emitting regions on the planet. LBI measurements of the pulsar CP 0329 at 408 MHz are being analyzed in an effort to study density inhomogeneities in the interstellar plasma. A related experiment involves post detection correlation of pulsar signals received at Penticton and Jodrell Bank.

DIVISION OF MECHANICAL ENGINEERING

The recent efforts of the Division of Mechanical Engineering were distributed approximately as follows:

Transportation Technology	46%
Manufacturing Technology	29%
Standards and Standardization	11%
Computer Application Developments	7%
Medical and Surgical Instrumentation	4%
Engineering and Biological Control Systems	3%

TRANSPORTATION TECHNOLOGY

The transportation work has been roughly equally divided among land, sea, and air developments. On the land there has continued a substantial body of activity related to the welding of rails for the Canadian railways, apparatus for preventing the malfunctioning of railway switches in the winter time, and work pertaining to gas turbines and compressors for gas pipelines. There has also been a need to examine various aspects of the introduction of containers into ocean and land shipping, whether by rail or road.

Although the shipbuilding activities of the country have been somewhat quiet during the year, there has been a substantial body of research and development activity pertaining to special purpose ships, marine air cushion vehicles; and there has been in hand a very large project related to the navigational improvements of the St. Lawrence River in both summer and winter conditions.

The air transportation activities of the Mechanical Engineering Division of the National Research Council have naturally been related to the aspects of air transport coming within the field of concern of the Division, namely research and development work and certification pertaining to new engines. The research and novel investigational work has been mostly concentrated on various aspects of engines appropriate to VTOL aircraft.

It is, of course, necessary in an extensive research programme of this sort to be reasonably certain that there will be a market for the eventual application of the VTOL aircraft for commercial air transportation in the late 1970's and beyond, and for this purpose we have accordingly established a close liaison with potential manufacturers and interested Canadian air carriers as well as with various government departments and agencies at the federal, provincial, and municipal level.

As a result of this opportunity to exchange views on various aspects of economics, noise, safety, let-down aids, etc. related to VTOL engineering research programmes, it has been interesting to

note the keen attention that is being given to this revolutionary form of air transportation. As a result, there is now in our minds little reason to doubt that VTOL aircraft will be an important series of types in the latter part of this century, when the rapid trend toward increased urbanization in this country coupled with the general population growth, will make it increasingly difficult to set aside property in the centre of urban areas for other types.

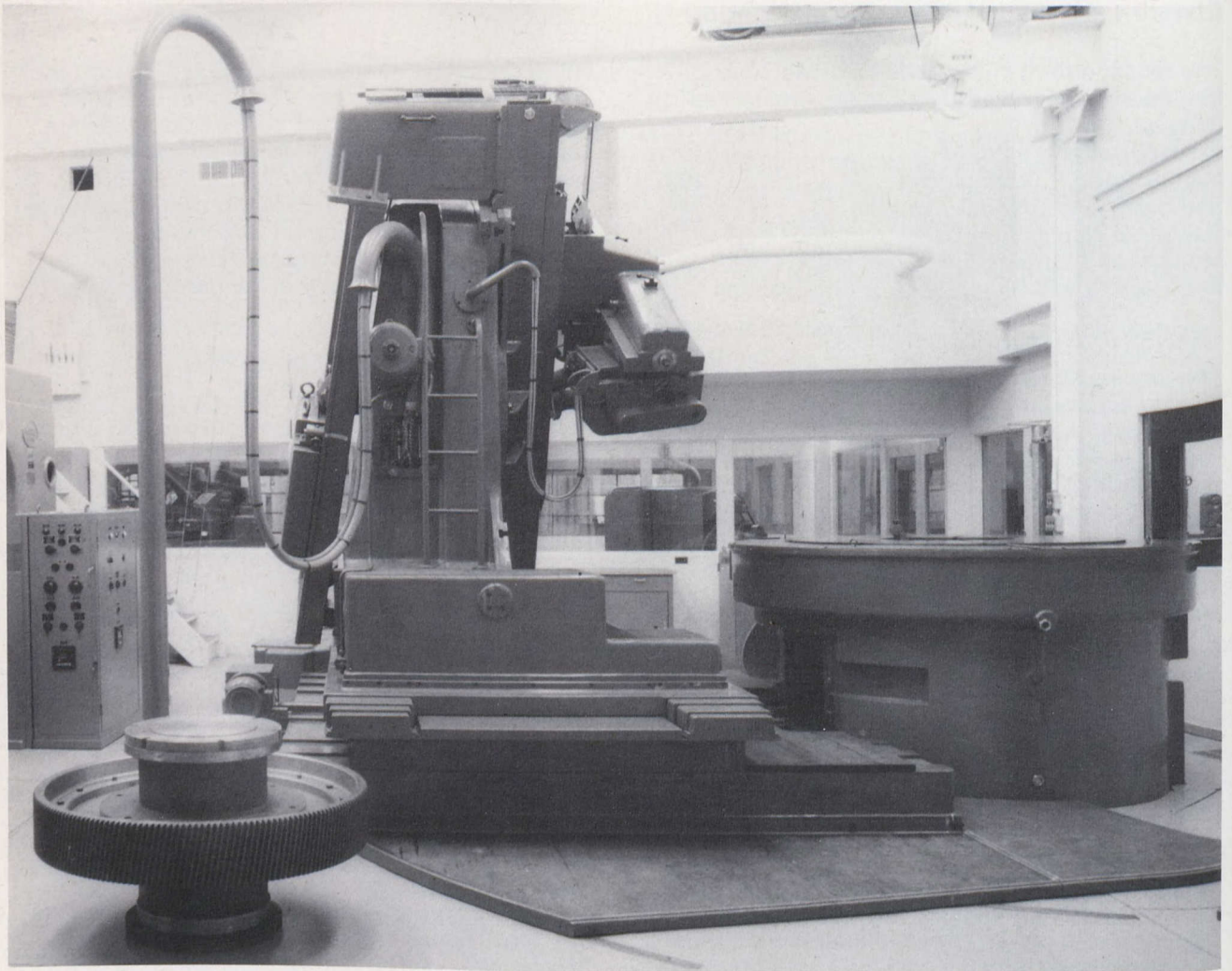
MANUFACTURING TECHNOLOGY

In the manufacturing field, a first activity consists in the application of 2-phase heat transfer pipes to the maintenance of permafrost in various kinds of Arctic construction, and the de-icing of navigational buoys on the East Coast of Canada. A second project, now reaching the exploitation stage by a Canadian company, is the use of high pressure water jets for cutting various kinds of materials, the first one of which is newsprint, which is necessarily cut at very high speeds if paper machines or re-winding machines are not to be hampered in their operation.

A variety of manufacturing processes not yet in general use in Canada are being energetically used and widely publicized in single or two-page newsletters which have themselves given rise to a most enthusiastic response through Canadian industry. Several examples of the new technologies are the generation by grinding of precision case hardened gear teeth, the generation of complicated shapes in a variety of materials by electrochemical machining, and the application of numerical control for much enhanced productivity of machine tools on single articles or small lots. There have already occurred a number of instances in which these various technologies are of valuable consequence to the Canadian industry.

STANDARDS AND STANDARDIZATION

In addition to the calibration of instruments, lubricating oils, fuels and various apparatus for Canadian industry as required by the National Research Council Act, the various laboratories of the Division of Mechanical Engineering have been involved in the certification of the airworthiness of helicopters and various gas turbine engines in conditions of snow and sleet.



Maag 360 and 90P Gear Grinders in a temperature controlled room of the Manufacturing Technology Centre, this Maag 360 utilizes the Ferranti precision indexing read-out. Many Canadian firms make use of these facilities when faced with emergencies in their own operations.

COMPUTER APPLICATION DEVELOPMENTS

In the present circumstances of highly expensive construction of prototype machinery and the expense of arranging complicated experiments even with conventional machinery, the application of computers to the simulation of projected machinery performance has become very important. In the Mechanical Engineering Division of the National Research Council, typical examples of work pertinent to the investigation of the parallel operation of compressors on gas pipelines, the transients resulting from changes in operation and the corresponding controls; systems analysis of certain control components and the general control features of a new nuclear power station, and of a hydro electric power station (in collaboration with the University of the West Indies); dynamics of high speed railway container cars; and new designs of reciprocating engines.

MEDICAL AND SURGICAL INSTRUMENTATION

There continues to be a vigorous requirement for new instrumentation for medical and surgical purposes. The work in progress in this line of endeavour ranges on the one hand from the design of prototype instruments for extremely difficult but very important operations on the spinal chord, to, on the other, the final arrangements for production and marketing of a suturing instrument for blood vessels. The first activity is a collaborative one with the Montreal Neurological Institute and Queen's University, and the second one is related to the licensing of a Montreal manufacturing firm.

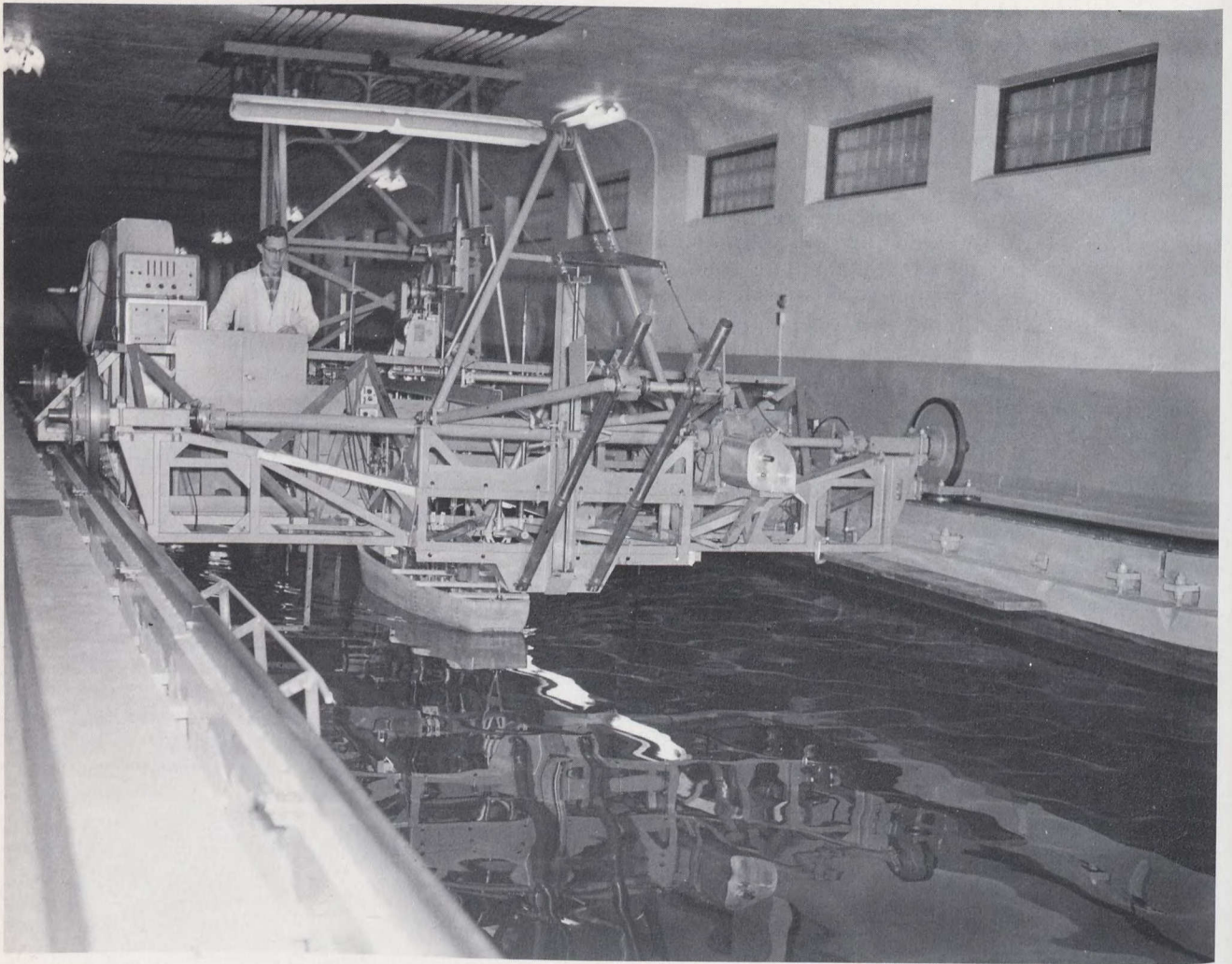
ENGINEERING AND BIOLOGICAL CONTROL SYSTEMS

Work continues vigorously in the industrial application of control theory — mechanical, electronic, and fluidic, and the application of control system technique to animate beings. In particular a considerable body of work has now been accomplished in relation to the effects of microwaves on birds, and the possible supply of electrical control impulses to the muscular system of paralyzed people. This latter subject is still at too early a stage to be assessed finally. Conversely, progressively more detailed investigations are being made of biological control systems as possible models for better and more reliable engineering systems. In particular, the nervous structure of the spinal chord of a cat has been examined at high magnification and in con-

siderable longitudinal detail; and the observations have made evident the extreme reliability attained in this circumstance by the provision of parallel controls and the remarkable decentralization resulting from closed subsidiary loops.

CONCLUSION

Since it is of course self-evident that this kind of activity needs to be related in a widespread but nevertheless detailed way with the technical and social activities of the country as a whole and with certain corresponding activities in other countries, it has been necessary to evolve a steadily enlarging system of communication. This system consists in the most general sense of an Advisory Board and is supported by a variety of personal contacts, partly through associate committees and partly in the form of direct liaison with other organizations. In engineering work it is of course also necessary to deal in an enormous amount of quantitative detail. This sort of information is customarily transmitted by short films, by ordinary business letters, by the system of newsletters referred to above, by technical reports, and by papers presented to learned societies.



Towing tank for testing the hydro-dynamic qualities of ship design.

DIVISION OF BUILDING RESEARCH

Our geography presents us with a wide spectrum of the world's climatic conditions so it is only natural that we should have formed a national study centre to meet these varying conditions and to apply new techniques to these old problems as new technologies are evolved. Some of the more recent studies have included the following:

SEALANTS

The stresses to which sealants are subjected in use are indicated by the amount and rate of joint movements in actual buildings. Measurements on expansion joints of two buildings, therefore, have been recorded for over a year and the results statistically evaluated. In these two cases there was found to be a high degree of correlation between temperature changes and joint movement. In the summer the movements are also influenced by changes in relative humidity which tend to counteract the temperature-induced changes. Consequently, movements in summer are less per degree change than in winter. The thermal coefficient of expansion was calculated for the wall and compared with the coefficients for the wall components. The calculated coefficient was less than the published values indicating that there are restraints to free wall movement. The maximum movement in a 25.4 mm (1 in.) expansion joint was calculated to be about 25 per cent at the 95 per cent confidence level.

Tests are in progress to determine the effect of temperature on tensile properties of three different types of sealants.

THE NATURE OF HYDRATED PORTLAND CEMENT

The main cementing constituent of concrete is calcium silicate hydrate (C-S-H) produced during hydration of portland cement. To realize the full potential in design and enable predictability of performance of concrete, it is essential to understand the nature of this hydrate.

This Section has developed a model for the C-S-H material which not only incorporates all known information from chemical, physical and mechanical properties but also, it is hoped, provides some understanding by which it will be possible to predict properties that will enable improvements to be made.

The model recognizes that C-S-H is unhomogeneous, poorly crystallized and of variable composition. This silicate which is a layered crystal

and water, termed "interlayer water", occupies positions between these layers. Calcium ions also occupy positions between the layers. The model incorporates the idea that the amount of calcium and water between the layers can be altered by the conditions of preparation, such as water-to-cement ratio, temperature and admixture content, and explains most of the properties of practical importance through the layered nature of the silicate and the calcium and water between them.

It is recognized that the above nature of the material is unstable and changes in conditions such as drying and wetting, and application of stress, can cause changes leading to drying shrinkage, creep and other properties.

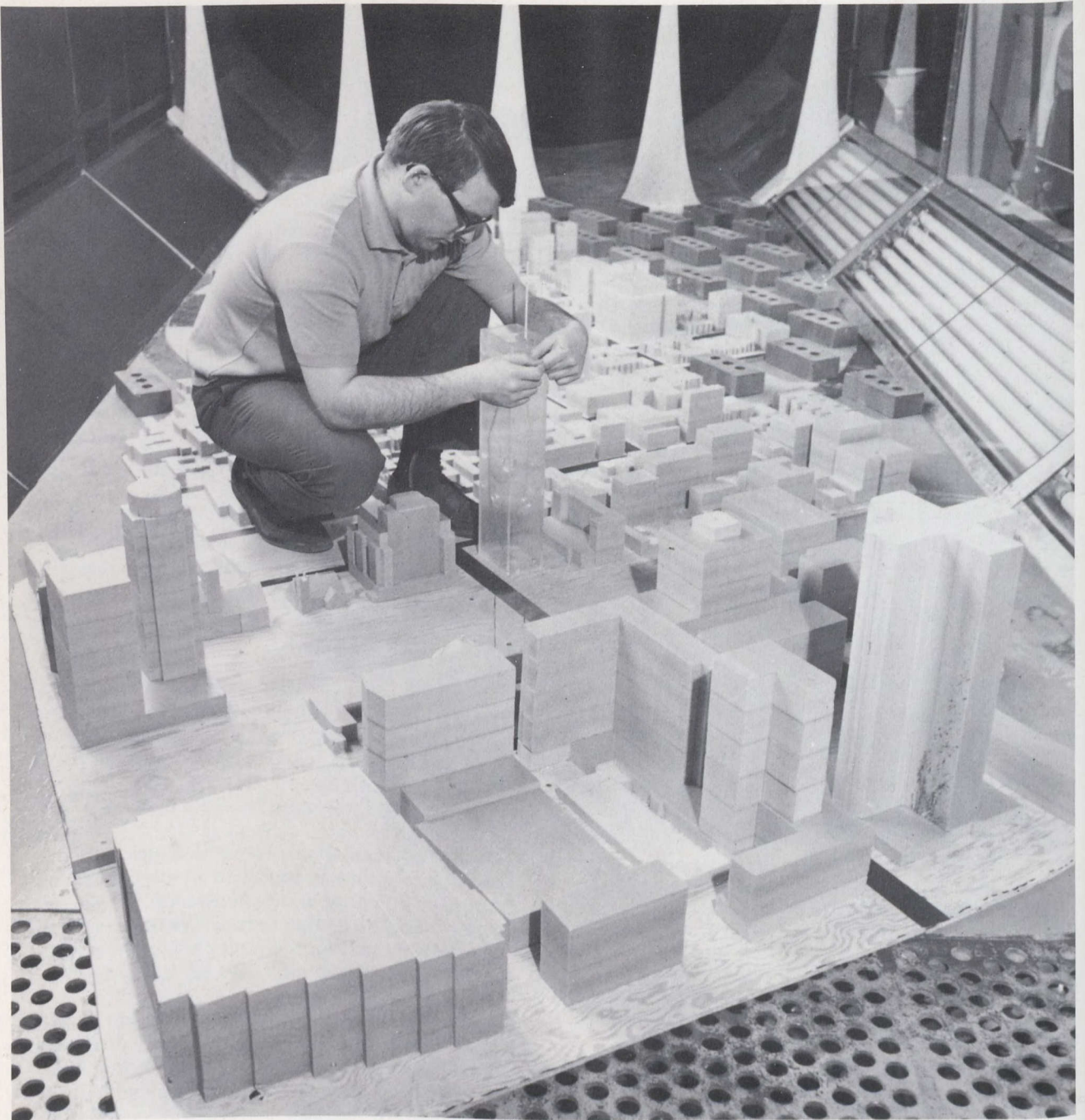
Based on the model, work is continuing, which it is hoped will lead to development of improved properties of concrete.

WIND EFFECTS ON BUILDING STRUCTURES

Wind pressure measurements on two full-scale office buildings in Montreal (33 and 45 storeys in height) have been carried out which serve as a basis for the evaluation of the results of wind tunnel studies and analytical methods of determining wind loads on tall slender buildings. Wind tunnel studies on a scale model of the 45-storey building in Montreal and the surrounding area have been started as part of a cooperative project with the Low Speed Aerodynamics Section of the National Aeronautical Establishment (see photo).

For the full-scale measurements a new data acquisition system was obtained which records on computer compatible magnetic tape. This system is now being expanded to handle additional channels of input for the next phase of the field work, the instrumentation of a 58-storey building in Toronto.

The analysis of the records has provided general confirmation of the validity of recently developed analytical methods and wind tunnel modelling techniques. Five papers on experiences with wind pressure measurements on full-scale buildings have been presented or published recently.



Low speed aeronautical wind tunnel modified by spires to create a turbulent shear flow simulating surface winds over model of downtown Montreal. Instrumented plexiglas model of a 600 ft. office building, on which full-scale pressure measurements have been taken, in centre. A co-operative project of Division of Building Research and National Aeronautical Establishment.

FROST ACTION IN BUILDING MATERIALS

Great progress has been made in developing practical means for the protection of concrete and brick from frost damage but several problems are still unsolved, causing considerable losses to the economy. It is clear that no significant improvement can be achieved without the thorough understanding of the mechanism of frost action in porous materials, which is the aim of a study being carried out in the Section. Water in the cavities of porous bodies, such as concrete, remains in a liquid-like state at temperatures well below 0°C. The quantity of the water in the solid was found to depend on the prevailing relative humidity based upon the vapour pressure of under-cooled water and not upon that of ice. The consequence of this is that, for thermodynamical reasons, the cooling of porous systems to temperatures below 0°C decreases the internal relative humidity; thus the material must lose water to be at equilibrium. Measurement of the volume changes and thermal effects suggests that damage occurs when the amount of water lost in a given time, by flow and distillation, is less than the amount that must be removed to maintain equilibrium. From this it follows that high porosity, high degree of saturation, high rate of cooling and low permeability adversely affect the frost resistance of materials, which conclusions are consistent with experience in the field.

FROST ACTION

Studies are in progress on the vertical heaving forces exerted by freezing Leda clay on 8.9 cm (3.5 in.) diameter steel pipes and a one foot diameter steel plate held in a fixed horizontal position at the ground surface by a reaction frame anchored in rock. The uplift force measured on the steel pipes was equivalent to a vertical shear stress of greater than .875 kg/cm² (12.5 lb./in.²) applied over the surface of the pipe frozen to the ground; the vertical force exerted on the steel plate was in excess of 13,608 kg (30,000 lb.).

PERMAFROST ENGINEERING

Studies to assess the effect of a large fill on permafrost were begun at the Inuvik Airport in 1957. Additional instrumentation was installed to determine the effect on ground temperature of paving the airstrip in 1969. Observations of ground temperature and settlement were con-

tinued at the town of Inuvik and at dykes constructed on permafrost near Kelsey in Northern Manitoba. A study of the field performance of different types of anchors in permafrost is being carried out at Thompson, Man.

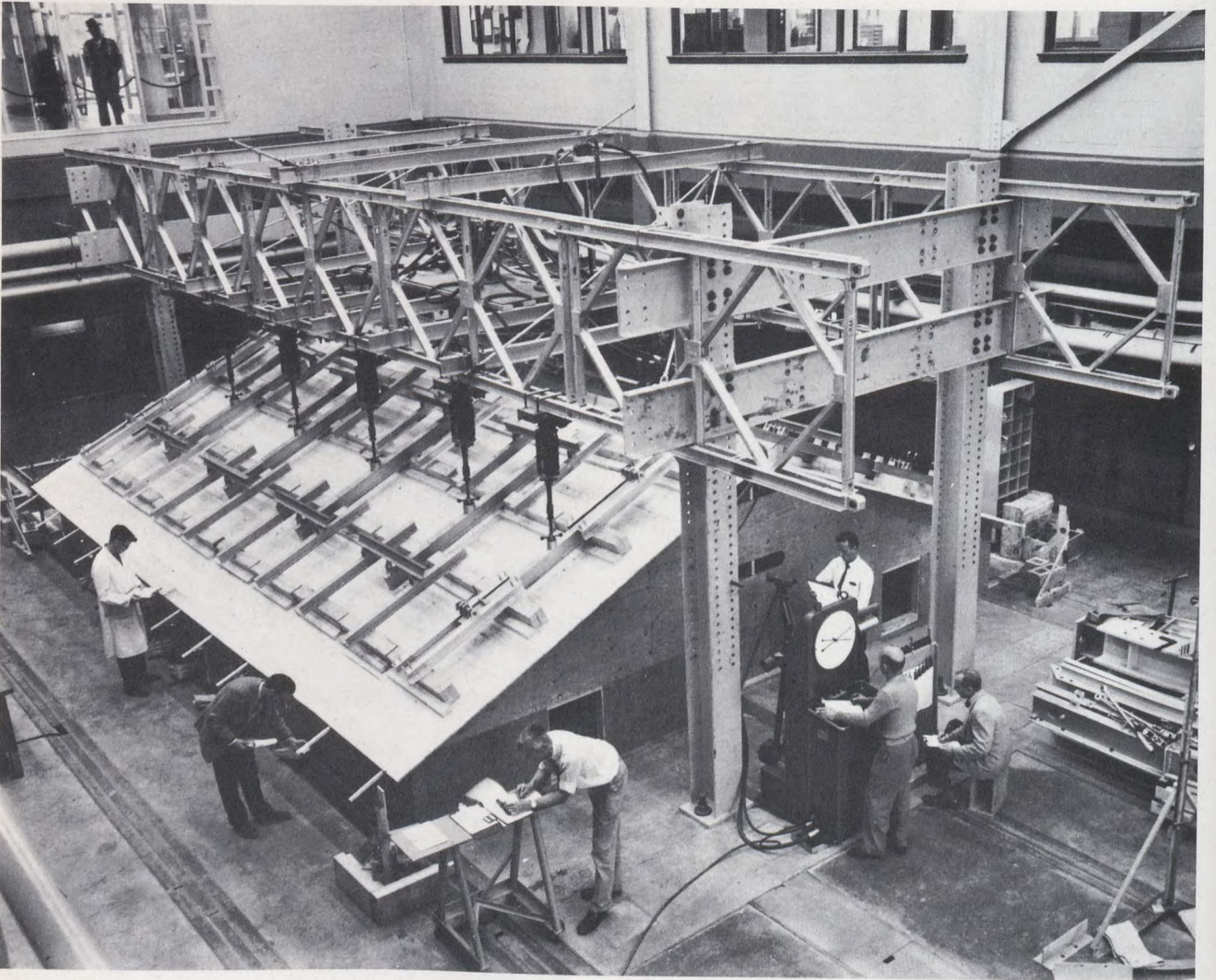
ICE ENGINEERING

An investigation of methods of predicting the date of break-up for lakes has been carried out over the past three years. It was found possible to predict the break-up date of small lakes with a standard error of 2.0 to 4.5 days using regression equations based on past break-up and air temperature records.

Observations were made of the deformation behaviour and strength of ice from the St. Lawrence River under conditions of constant rate of strain. These observations showed that a ductile-to-brittle transition occurs for ice at a strain rate of about 5×10^{-3} min.⁻¹. Information on the deformation characteristics of ice is required for determining the forces that ice can exert against structures.

SNOW LOADS

After the completion of a 10-year general survey of actual snow loads on roofs, which resulted among others in a joint Canadian-USSR paper, observations are now only taken in two special areas of interest. The first concerns loads on large flat, single and multi-level roofs, which are the most common type of roof on commercial and industrial buildings. These observations are providing further data on the contrast that usually exists between low *average* loads on exposed upper roofs, and high *peak* loads due to drifting on adjacent lower roofs. The second concerns the very high ground loads that accumulate at higher elevation in the mountains of Western Canada. A survey is being carried out with the help of DBR staff located at Rogers Pass, B.C. and Vancouver to provide information on the increase of ground snow load with increasing elevation above sea level at a number of sites.



Universal structural testing installation consisting of an anchorage base, reaction frames and hydraulic loading system for large scale tests on building components.

AVALANCHES

Studies on avalanches are being carried out at Rogers Pass, B.C. The investigations have confirmed that the size of avalanches, as measured by the weight of snow contained in them, follows a log-normal frequency distribution at sites where several avalanches run each winter. Observations are also being made on the impact pressures caused by avalanches. Pressures ranging between .049 and .126 kg/cm² (0.7 and 1.8 lb./in.²) have been observed for snow dust, and between .035 to 1.33 kg/cm² (5 to 19 lb./in.²) for denser dry snow flowing along the surface.

The Division has recently completed an Environmental Laboratory which accommodates divisional work and facilities on the thermal and air conditions inside the buildings and the related performance of building enclosures.

The building consists of:

- a two-storey section providing office space, a central core laboratory area on each floor, with closely controlled temperature and humidity, a calorimeter laboratory incorporating a large exterior wall opening facing west to provide solar exposure of specimens installed for test; and
- a three-storey section and associated two-storey mezzanine with crane to accommodate studies on the response of full-scale prototype wall and window systems to simulated weather conditions.

The building is fully air-conditioned and contains a central refrigeration system, distributing coolant at -51°C (-60°F) to large environmental testing chambers and other low-temperature apparatus. It is also serviced with a central digital data acquisition and control system.

The construction of the building, although employing traditional materials, incorporates the basic principles of enclosure design evolving out of the work of the Division. The wall construction features the rain-screen concept and insulation located on the weather side of the main structural steel frame and concrete block in-fill. The insulation is placed between steel studding that is supported from the block and which carries a stucco cladding. The cladding is broken by expansion joints designed also to equalize air pressures across it. The windows also incorporate the two-stage method of weather-tightening, as well as thermally protected metal frames and reflective-coated, sealed-double-glazing units. The roof construction features

insulation placed over a primary membrane on a concrete deck sloped to drains, with a secondary membrane covering the insulation and sloped to the same drains. Chamfered edges on the lower surface of the insulation perimeter provide channels for drainage of any water reaching the lower membrane and for pressure equalization at the parapet to minimize wind uplift forces on the upper membrane.

SAFETY AND ECONOMY OF STRUCTURES

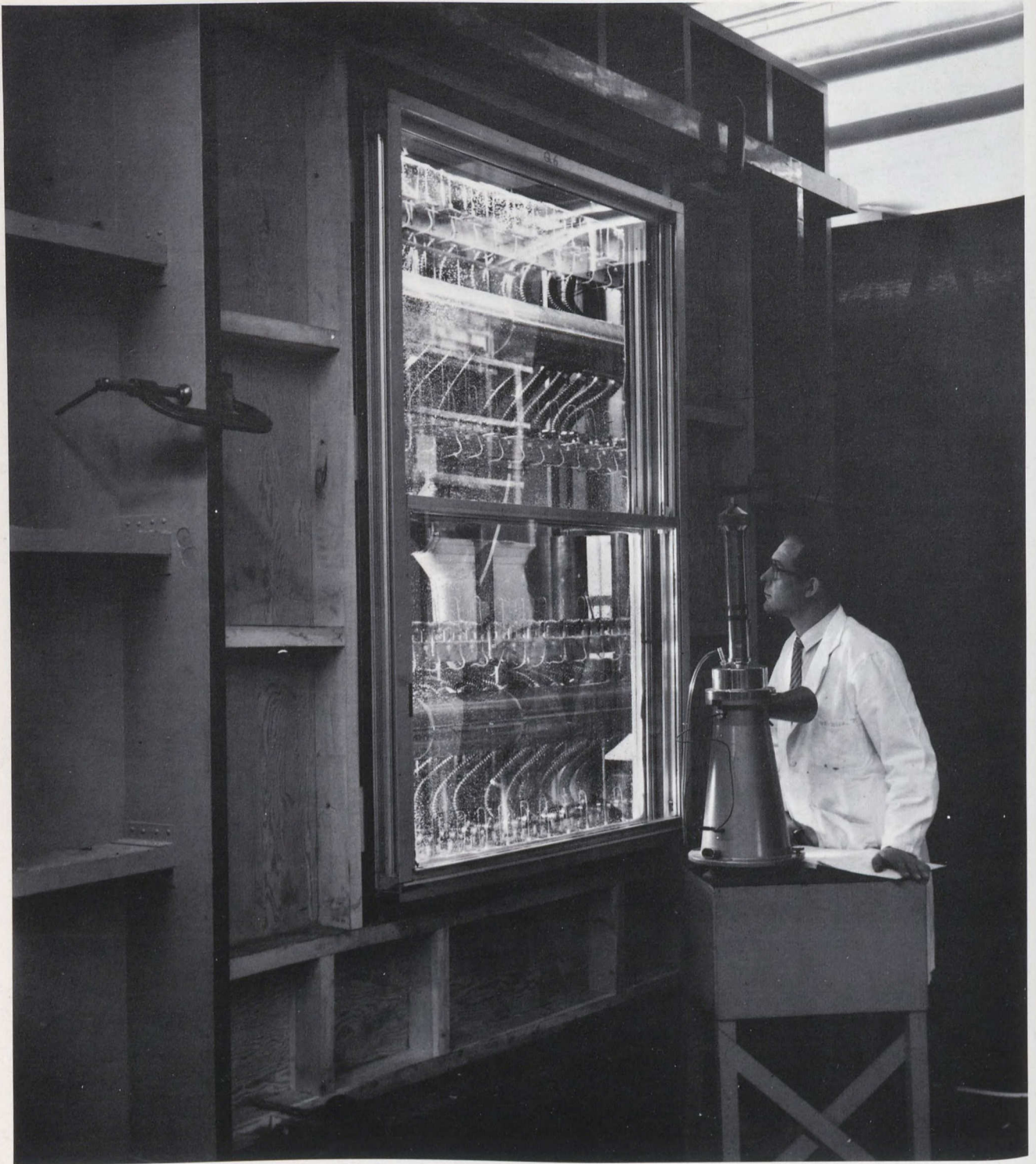
As part of a continuing study on structural safety and economy closely tied to the National Building Code of Canada, two areas have been investigated: (i) the application of "limit state design" as a basis for structural calculations; (ii) probability studies in the areas of combined loads and structural resistance.

Limit state design contains two main improvements over existing allowable stress and plastic design. The first is a greater emphasis on the structural conditions ("limit state") to be designed for such as cracking, excessive deflection and collapse. The second advantage lies in the use of three sets of partial safety factors — one set for the loads, another for the material properties or dimensions, and a third factor which takes into account the consequences of failure and minor errors.

A study of the probability of failure under combined wind load and dead load was used to evaluate and suggest changes in existing safety provisions for stress reversal. A probabilistic study of bending strength and ductility ratio of reinforced concrete has been completed which will help to assess existing design provisions and safety factors.

FIRE IN HIGH BUILDINGS

Recognizing that, in a fire emergency, complete evacuation of a high building within any reasonable period is impracticable, attention has been directed towards studies of measures that might be employed to permit occupants to remain in a high building while fire fighting is in progress. The work of the Building Services Section has developed a better understanding of the stack effect that in cold weather creates conditions that cause air to flow into the lower storeys and out of the upper storeys of a building. These studies have included measurement of air pressure differences in a number of high buildings in Ottawa



Rain-simulating apparatus with a window in position for testing.

and Montreal during the winter. In the event of fire, smoke will similarly pass through a building from lower to upper storeys under the influence of air pressure differences. Reports of fire incidents in high buildings have confirmed this and have shown that smoke will pass through stair and elevator shafts with all doors closed.

As a result of an intensive study in conjunction with the Building Services Section, suggested methods of smoke control have been developed. These relate to typical plans of high buildings and are examples of ways by which the problems of smoke movement can be overcome. Three basic approaches have been utilized. These are: mechanical injection of air to create favourable pressure differences; venting to the exterior; and vertical division of a building into two separate zones. It became apparent during the course of the studies that any control technique must be applied to the building as a whole, because any change in air pressure conditions in one part of the building will modify those in other parts.

VIBRATIONS AND BUILDING DAMAGE

The effects of demolition operations on surrounding buildings have been investigated. Earlier work using blastings had shown the velocity of vibration to be the most useful parameter to correlate with building damage. These results were extrapolated to the more continuous sources used in demolition work and the results broadly confirmed the previously predicted damage threshold level.

EARTHQUAKE LOAD REQUIREMENTS FOR 1970 EDITION OF THE NATIONAL BUILDING CODE

Considerable work has been done in implementing the proposals of the Canadian Committee on Earthquake Engineering for earthquake resistance requirements of the 1970 edition of the Code. In addition to the clauses in the Code proper, an extended commentary and bibliography was prepared as a Supplement to the Code.

THERMAL DECOMPOSITION PRODUCTS

Organic polymers such as plastics and cellulose undergo both decomposition and oxidation reactions in a fire. A better understanding of the chemistry of these reactions is needed in dealing with various aspects of fire research such as combustion, flame retardancy, and formation of smoke and toxic products. Studies on the mechanism of thermal decomposition of various polymers have therefore been undertaken.

The life hazard due to the toxic products depends on the nature of the gases given off, their concentration and the duration of exposure of the products to those trapped in a building. The Fire Section is engaged in studies on the quantitative analysis of toxic gases and vapours evolved from the combustion of polymers. Studies on the influence of flame retardants on the mechanism of thermal decomposition of polymers have also been started.

SLOPE STABILITY

Landslides are a common feature in the slopes of stream valleys and terraces in the Leda clay deposits of Eastern Canada. These slides appear to be rotational slips which often retrogress a considerable distance into the slope, and in some instances become large flow slides. The slides occur at periods of exceptionally high groundwater, such as prevail during rapid snow melt, indicating that an ample water supply is a necessary condition for their initiation.

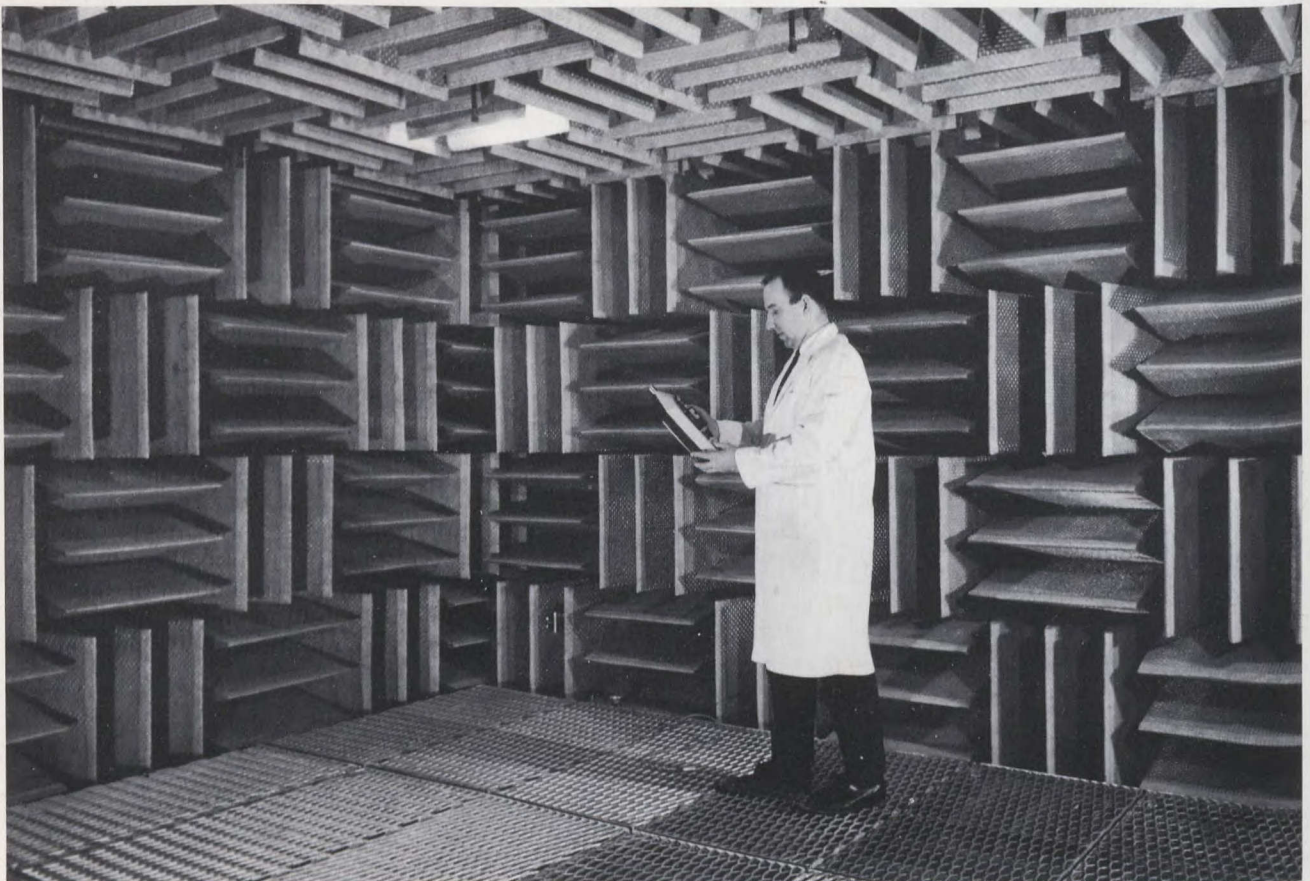
A complicating factor in the analysis of slopes of Leda clay is the presence of a weathered crust. The crust consists of at least two layers — an upper, strongly oxidized crust, and a lower layer of grey clay that may be quite sensitive. The upper part of the crust is highly fissured and water moves freely through it.

In current studies of slope stability, the Section is investigating the shear strength of the clay in the range of low stress that exists in slopes. It was found that in this range of stress the behaviour was not that of an intact clay, but rather that of a predominately "frictional" material that dilates at low strains. This type of behaviour and its implications has not been considered in earlier studies of slope stability.

LIBRARY

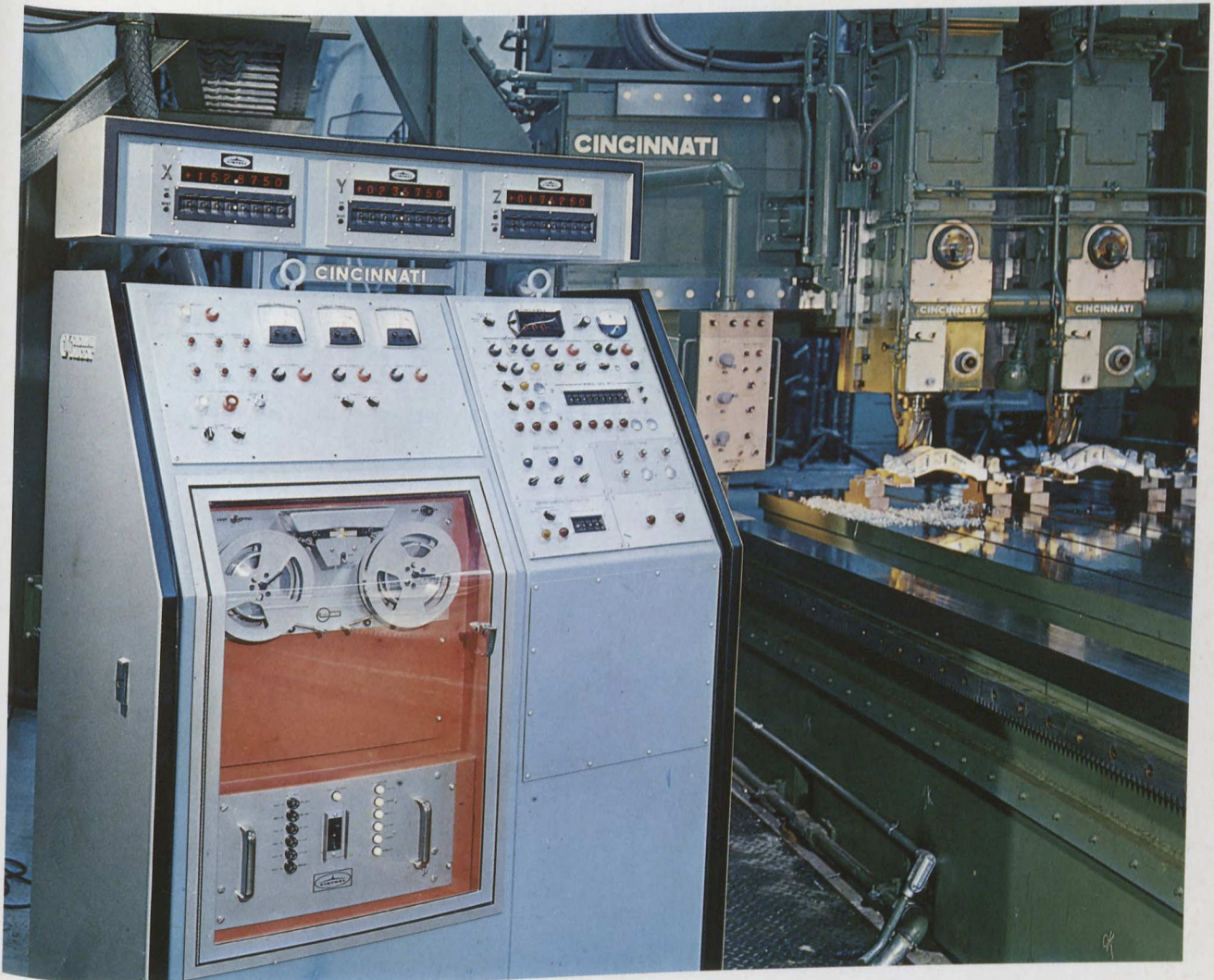
The Library of the Division of Building Research serves not only the needs of the Research staff of the Division but the needs of Engineering Consultants, Architects, Contractors, University Professors and Graduate School students across Canada. Like its parent, the National Science Library, it is an "information transferral agency" serving the needs of all Canada. It has links with other building information sources throughout the world. Librarians, documentalists, architects, engineers, management consultants and other research workers frequently visit and work in the Building Research Library to make use of its unique collection in several fields, such as its extensive collection of Scandinavian building research literature. Since the document collection is classified by the Universal Decimal Classification, the professional staff are frequently consulted for advice and help. Every two

years the Building Research Library distributes its "Selected List of Books". In addition, the monthly bulletin "Recent Additions to the Building Research Library", is sent to 400 organizations and individuals. The Library also assists in the compilation of Canadian Building Abstracts which are published twice a year, and the Book Notes section of the Division of Building Research's quarterly "Building Research News". *The foregoing is a very brief description of the activities of four of the ten laboratory divisions as well as the National Science Library. The other six laboratories are Atlantic Regional, Biochemistry, Division of Biology, Division of Chemistry, Prairie Regional and Division of Physics and should your particular problems be in those fields, the Council would welcome the opportunity to consider them.*



Anechoic chamber for studies of noise.

MISCELLANEOUS EQUIPMENTS AND SERVICES



LAND NAVIGATION SYSTEMS

Modern military tactics require that ground vehicles of all types be deployed in the field, and reach prescribed destinations in an accurate and timely manner despite highly unfavourable conditions such as unfamiliar, featureless terrain, areas devastated by battle damage, near-zero visibility at night, or in reduced visibility weather conditions. For the past decade, Aviation Electric Limited has been engaged in the development and supply of dead-reckoning navigation systems to fulfill these requirements, and has produced electro-mechanical versions of such systems in considerable quantities and for many countries. In recent years, more stringent philosophies concerning human factors, reliability, and maintainability, as applied to military equipment, have been developed, and these, in turn, have engendered a whole new family of advanced land navigation systems at AEL, based upon the use of a rugged, field-proven, but still miniature electronic computer. The new systems are designated the "500-Series" and are specifically designed to be suitable for both armoured and non-armoured vehicles of all types.

The photograph shows the grouping of sub-system units which comprise the LNS-517 system. In normal use, the directional gyro is run-up and slaved to North from the magnetic sensor signal in approximately five minutes, after which the system is ready for use. In an emergency, the system can be switched to an instant reaction mode where the magnetic sensor provides the heading signal until the gyro is up to operational speed.

LNS-517. Complete system incorporating all electronic units

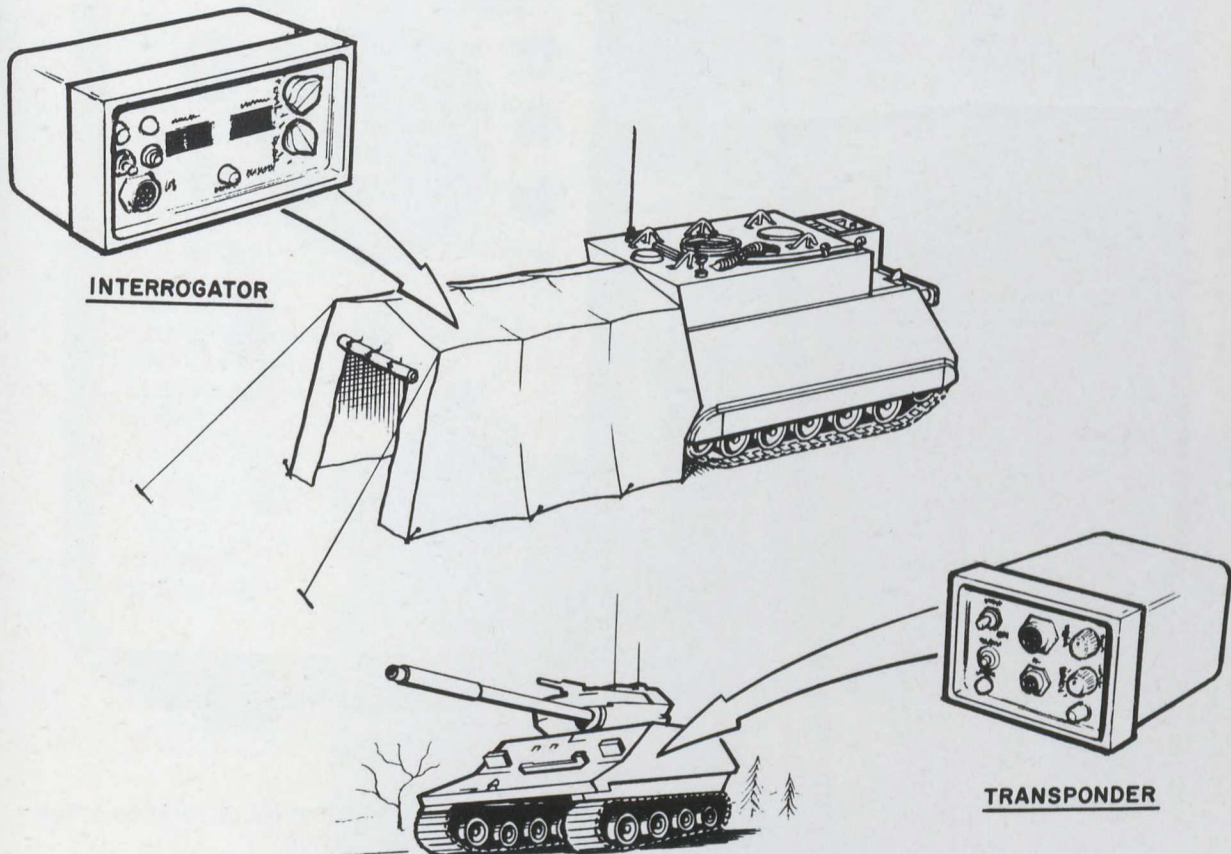


An important adjunct to the LNS, available from AEL, is the Position Interrogation and Transmission System (PITS). This compact, fully-automatic, solid-state system comprises two units, a Transponder located in the vehicle and an Interrogator positioned at a base command location. The system enables a commander to obtain, via the existing radio net, a numerical read-out of the position in map co-ordinates of any vehicle under his command, and without any co-operative activities whatsoever being required of the vehicle crews. It therefore provides an important aid in the command and control of vehicles deployed in the field.

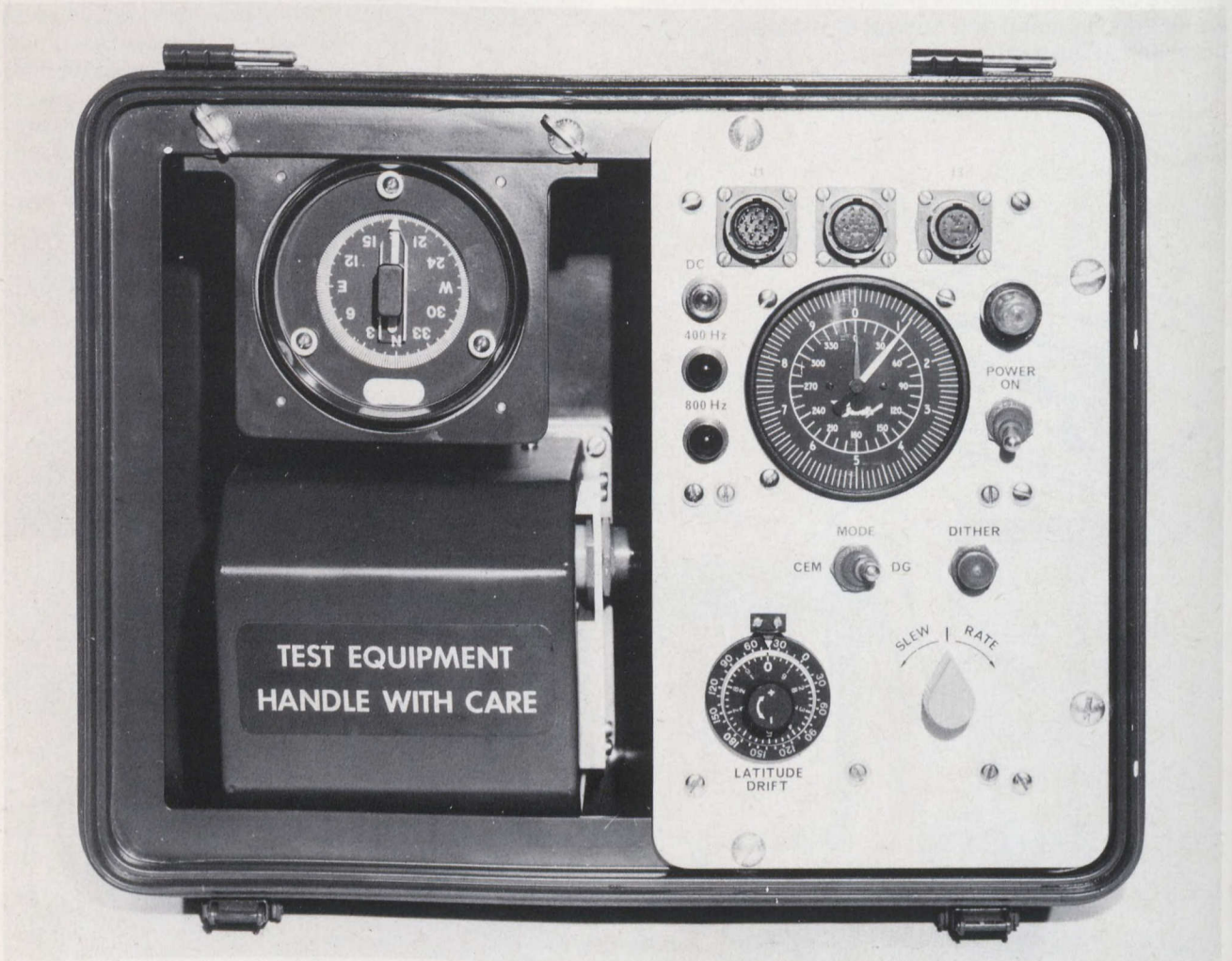


PITS units: vehicles Transponder at left and command post interrogator

PITS concept



The company's range of navigation systems accessories and support items includes test-sets, manuals and installation kits, for many vehicles, any of which can be configured or arranged to custom requirements on special order.



LNS portable field tester for calibration of the system's electronic units

A particularly valuable feature of these systems is that they are fully self-contained and do not require external co-operating elements, such as radio beacons or satellites. Further, they are passive and, accordingly, are not subject to detection by enemy operated sensors. The systems operate from two input signals generated in the vehicle. One is from a heading reference device, which may be a gyro or a magnetic sensor, and the other is a "distance-travelled" signal derived electrically from a small unit attached to the speedometer receptacle on the vehicle's transmission gear-box. Generally, for steel, tracked armoured vehicles, the gyro-type heading reference is required; while for wheeled, or aluminum-armoured vehicles, a magnetic sensor can be used at an appreciable cost reduction with only a mild penalty in accuracy. A combination of both types of heading reference is featured by one of the new systems (LNS-517) and is particularly applicable to certain types of vehicle and performance requirements. All 500-series systems employ the same nucleus sub-systems, namely, the Electronic Computer, the Electronic Indicator, the Static Inverter and the Electrical Distance Transmitter, together with the optional Vehicle Position Plotter. Other units are added to this group according to the type of heading reference employed. The following summarizes the equipment format of the four new systems, over and above the nucleus units, and also indicates typical applications.

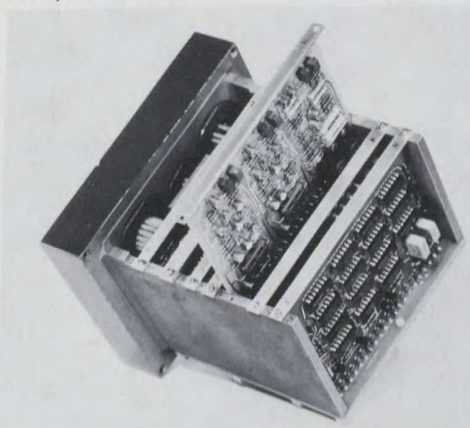
LNS-515: MK.5 Gyro-Compass and Gyro Control Unit (S. G. Brown) provides the heading-reference. The system is suitable for steel-armoured vehicles.

LNS-516: Teldix KK-12 Directional Gyro and a North Seeking Gyro Control Unit, and a special Static Inverter are required. The system is suitable for steel-armoured vehicles.

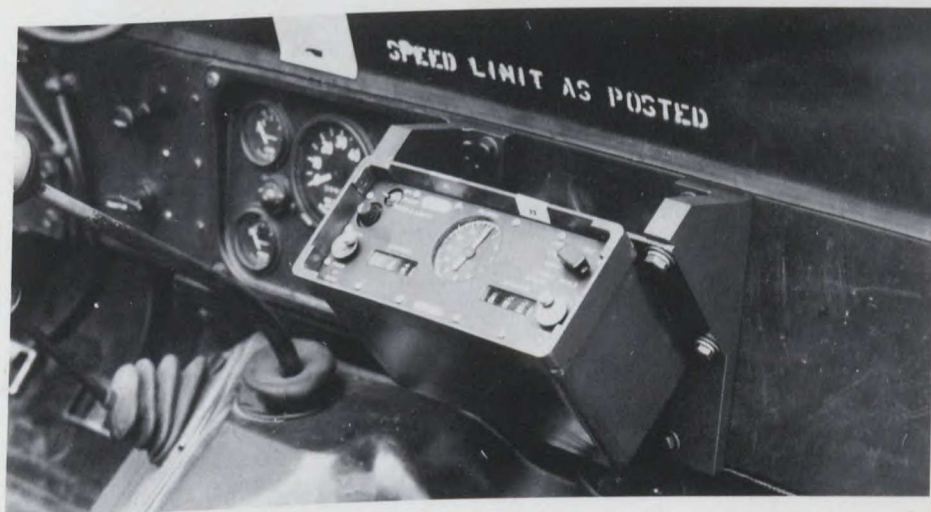
LNS-517: Teldix KK-12 Directional Gyro and the AEL Magnetic Sensor provide the heading reference system. Additional units required for this system are a Slaving and Compensating Unit, and a Heading Control Unit. The system is intended for use in non-steel-armoured vehicles.

LNS-518: AEL's Magnetic Sensor provides the heading reference. An additional unit designated the Compensating Unit is required. The system is for use in non-steel-armoured vehicles in situations where somewhat lower accuracy is acceptable but at the same time a very real reduction in capital outlay is achieved.

Internal assembly of LNS Electronic Computer. All units of the system are of the same rugged, compact design



Typical installation of Indicator, Heading and Position



FIREMAPPER

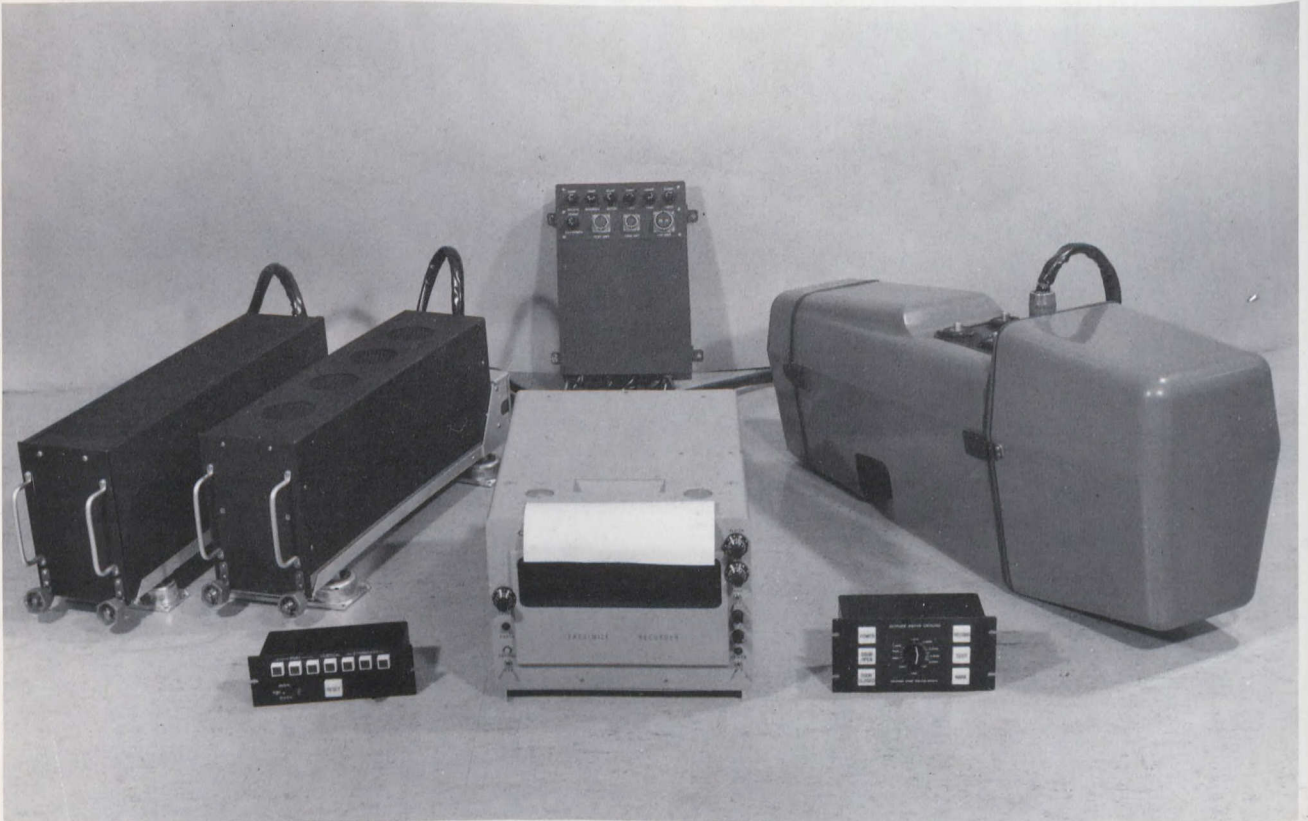
The Firemapper infra-red line scanning system is the result of a joint development programme between Computing Devices of Canada Ltd. and the Canadian Forestry Service. Primarily designed for forest protection applications, Firemapper has been used for diverse operations ranging from ice patrol in the Arctic, wild life research (Moose Census Studies), to thermal mapping of small water bodies. Firemapper can be used for rapid surveys of thermal energy where temperature sensitivities of 1°C or better are acceptable.

CHARACTERISTICS:

V/H (Velocity Height Ratio)	— Adjustable over the range 0.025 to 0.33 radians per second.
Scanning Angle	— $\pm 60^{\circ}$ about vertical axis
Scan Shaft	— 6000 r.p.m.
Spatial Resolution	— 2.5 milliradians
Detector Type	— Indium Antimonide (InSb)
Detector Coolant	— Liquid Nitrogen
Dewar Hold Time	— 4 hours minimum
Spectral Range	— 2.5 to 3.5 microns (Filters are available for 3.5 to 5.5 and 4.2 to 5.5 microns)
Image Record	— 70 mm Tri-X Pan.

N.B. An optional instantaneous display is available which provides an 8 in. wide strip image on direct print paper.

Minimum temperature resolution — $\pm 0.5^{\circ}\text{C}$ from a 20°C source filling the instantaneous field of view.



REMOTE SENSING

The Barringer Remote Sensing Correlation Spectrometer is a portable instrument intended for the quantitative measurement of nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) in an optical path between a suitable source of visible and ultra-violet (UV) radiant energy. The sensor is designed for maximum versatility in the remote measurement of gas clouds in the atmosphere using the day sky or ground-reflected solar illumination as the light source. It may also be used with artificial sources such as quartz-iodine or high pressure Xe arc lamps. The instrument is intended for fixed ground station, ground mobile or airborne installations.

The sensor contains two telescopes to collect light from a distant source, a 2-grating spectrometer for dispersion of the incoming light, a disc-shaped exit mask or correlator and an electronics system. The correlator functions as a high contrast reference spectrum for matching against the incoming spectra and is comprised of arrays of circular slits photo-etched in aluminum on quartz. The slit arrays are designed to correlate sequentially in positive and negative sense with absorption bands of the target gas by rotation of the disc in the exit plane. The light modulations are detected by photo-multiplier tubes (PMTs) and processed in the electronics to produce a voltage output which is proportional to the optical depth or burden (ppm-meters) of the gas cloud under observation. The system automatically compensates for changes in average source light intensity in each channel.

Applications of the Correlation Spectrometer include the following:

- Ambient pollutant contributions with remote lamp — a modulate Xe lamp is set up several thousand meters from the sensor and the ambient concentration of gas measured down to ppb levels.
- Vertical Burden Monitoring — Fixed station monitoring of total pollutants in the air above the monitoring station.
- Pollutant Profiling — Vertical looking sensor is transported around the target area to determine total emissions and mass flow.
- Source Monitoring — Measurements of SO_2 concentration at stack exits from ground level or helicopter.
- Dispersion & Mass Flow — Rapid near synoptic profiles of stack emissions.



View of Control Panel

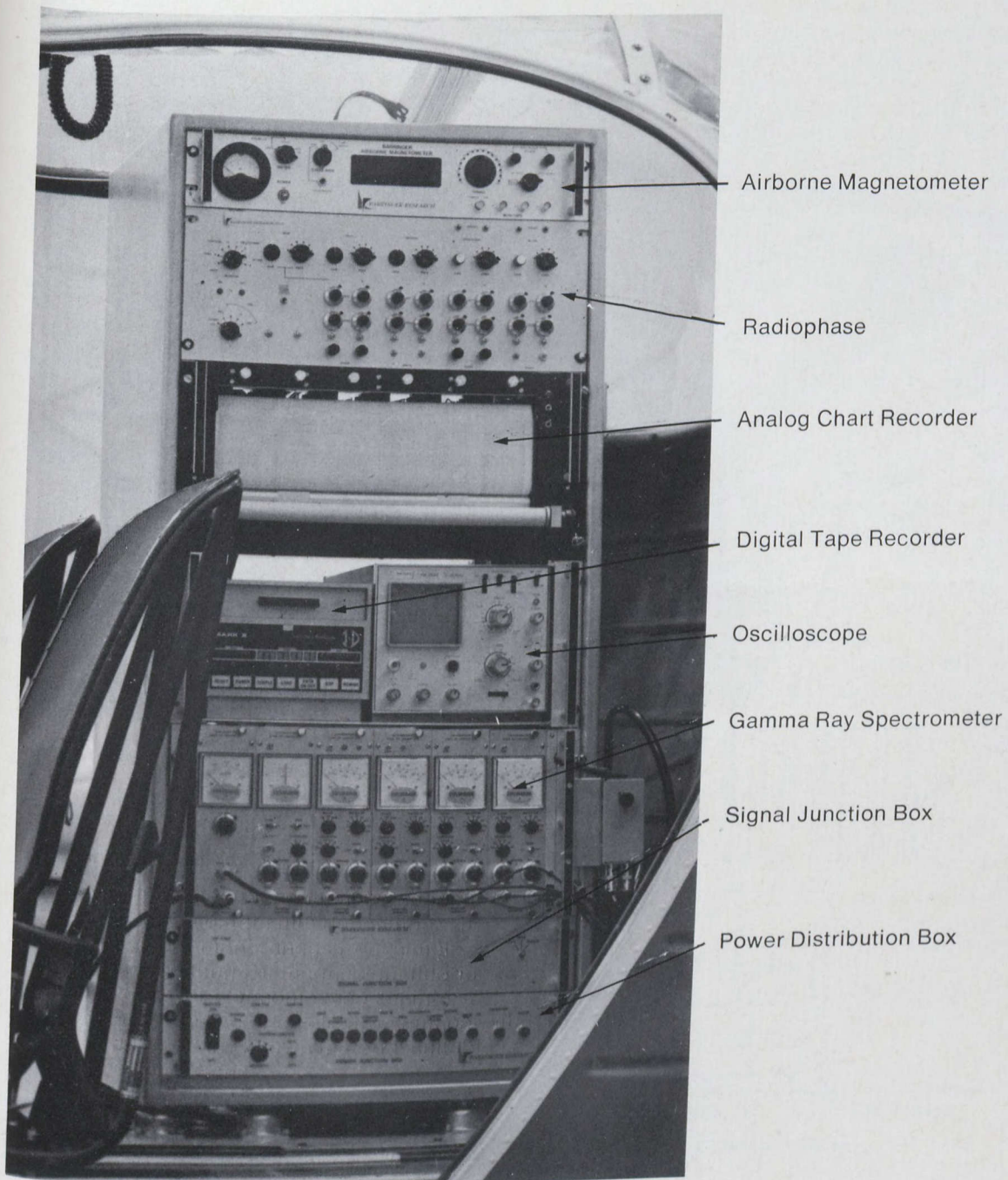
HELICOPTER-ELECTRO-MAGNETIC SYSTEM

The Barringer Research Limited helicopter electro-magnetic system consists of a 4.87 m (16 foot) "bird", approximately 50.8 cm (20 inches) in diameter, which is towed beneath a light helicopter such as a Hiller FH100, Alouette, or Jet Ranger by means of a 30.4 m (100 foot) tow cable. At the nose of this bird is located a powerful transmitter coil which generates an intense magnetic field at a frequency of either 400 or 1,000 Hertz depending on the survey application. Located in the tail of the bird, coaxially with the transmitter coil, is a receiver coil and pre-amplifier. This coil senses minute changes in the audio frequency magnetic field from the transmitter which occur as a result of the induced eddy currents in the terrain beneath the bird. Noise levels are such that changes of the order of 1 part per million of the primary magnetic field can be detected under good flying conditions. Both the in-phase and quadrature-phase components of the scattered magnetic field (with respect to the primary magnetic field) are detected and the output data is fed to a paper chart recorder or magnetic tape recorder. Thus the measurement is basically one of the mutual impedance between the two coils and of the manner in which this mutual impedance is effected by sub-surface conductors such as ore bodies. Systems of this sort form a primary exploration tool in exploration for the sulphides of copper, nickel, etc.

Surveys are performed by flying along parallel lines spaced at intervals of 80 to 160 m (1/2 to 1/10 of a mile) depending on the survey resolution, with a "bird" height of 30.4 m (100 feet). The anomalies resulting from such a survey are plotted on a photo mosaic and interpreted in terms of well established theory which employs the magnitude of the anomalies as well as the in-phase and quadrature-phase components in order to arrive at a conductivity-thickness value which is indicative of the type and economic significance of the anomaly.

AIRBORNE SENSORS RADIOPHASE

The Barringer *RADIOPHASE* system is a small light-weight airborne sensor suitable for either fixed wing aircraft or helicopter, which senses the presence of steeply dipping structural conductors such as faults or shear zones in the terrain beneath the survey aircraft. The system employs the plane waves propagating from VLF and other radio transmitters. Simultaneous measurement is made of the vertical electric field and both the inphase and quadrature-phase (with respect to the vertical electric field) components of the horizontal magnetic field. Theoretical calculations and tank modelling experiments have demonstrated that these magnetic field components are diagnostic of the geometry and electrical properties of conductive structures and that when operating at VLF frequencies the system has a penetration depth of the order of hundreds of feet. Surveys are flown along parallel lines, spaced equally at distances from 160 to 1,609 m (1/10 to 1 mile) depending on the desired resolution, with a mean aircraft altitude of 61 to 305 m (200 to 1,000 feet). Survey data is presented in the form of contours of inphase and quadrature-phase magnetic field intensity and clearly indicates the presence of conductive inhomogeneities.



Helicopter Mounted Geophysical System



Helicopter carrying Radiophase/E-Phase installation and Gamma Ray Spectrometer

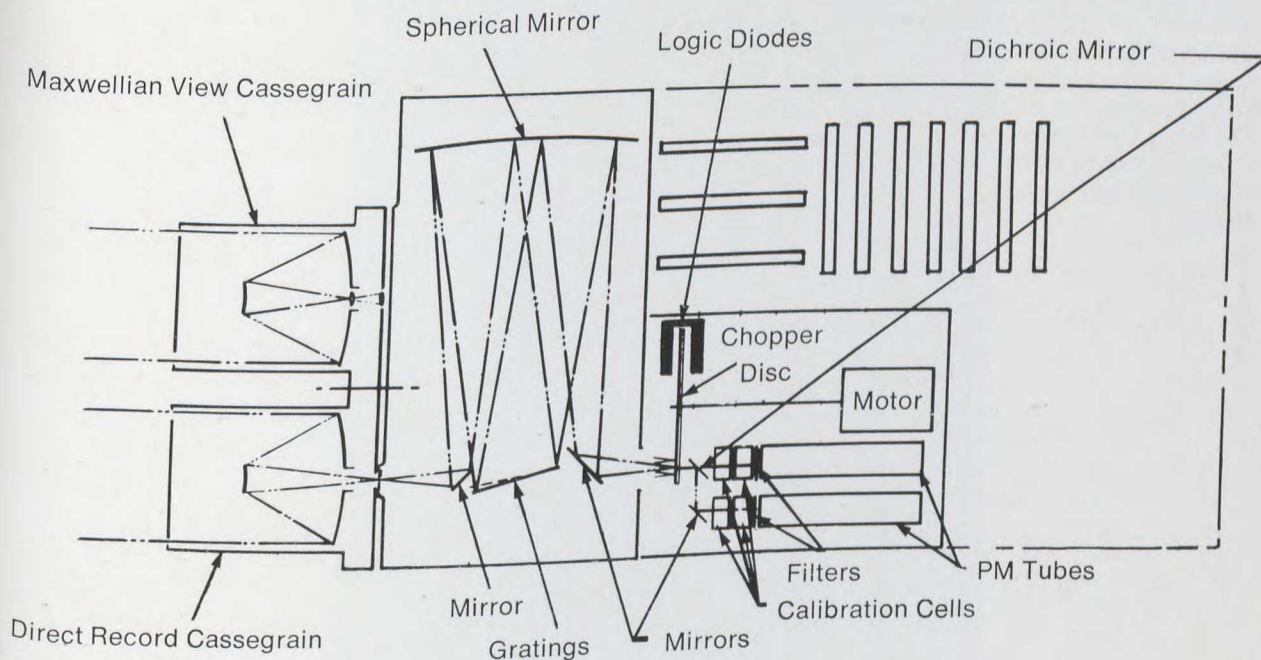


Remote Sensing Correlation Spectrometer

E-PHASE

The Barringer E-PHASE system is a small light weight airborne sensor, suitable for fixed wing aircraft or helicopter, which directly senses the resistivity of the terrain beneath the survey aircraft. Typical applications of such a system include mapping the distribution of permafrost in the discontinuous zone, location of construction aggregates such as sand and gravel, the location of certain types of clay, the mapping of the depth of bedrock, and general geological mapping. The system employs the propagated plane waves radiated from VLF and other radio transmitters. Such transmitters may be already existing or specially installed for the purpose of the survey. Simultaneous measurement is made of the vertical electric field and the in-phase and quadrature phase (with respect to the vertical electric field) components of the horizontal electric field. Extensive theoretical calculations have been performed in order to evaluate the performance of the system over uniform half spaces, layered earth, and vertical and dipping contacts between

two regions of different resistivity. Results of these calculations have demonstrated that the system has excellent potential for resistivity mapping and this has been borne out in many surveys. The effective penetration depth of the system depends upon the frequency of the remotely located transmitter that has been selected. The penetration depth at VLF frequencies, for example, is of the order of hundreds of feet, whereas the penetration depth when utilizing broadcast band transmitters is of the order of tens of feet. Thus simultaneous measurement of these field components at several frequencies yields useful information as to the vertical resistivity profile. Surveys are flown along parallel lines spaced equally at distances of 160 to 1,609 m (1/10 to 1 mile) depending on the spatial resolution desired of the survey. Aircraft altitude is of the order of 61 to 305 m (200 to 1,000 feet). The survey data, presented in the form of contours of apparent resistivity, has proven to be highly diagnostic of the sub-surface characteristics.

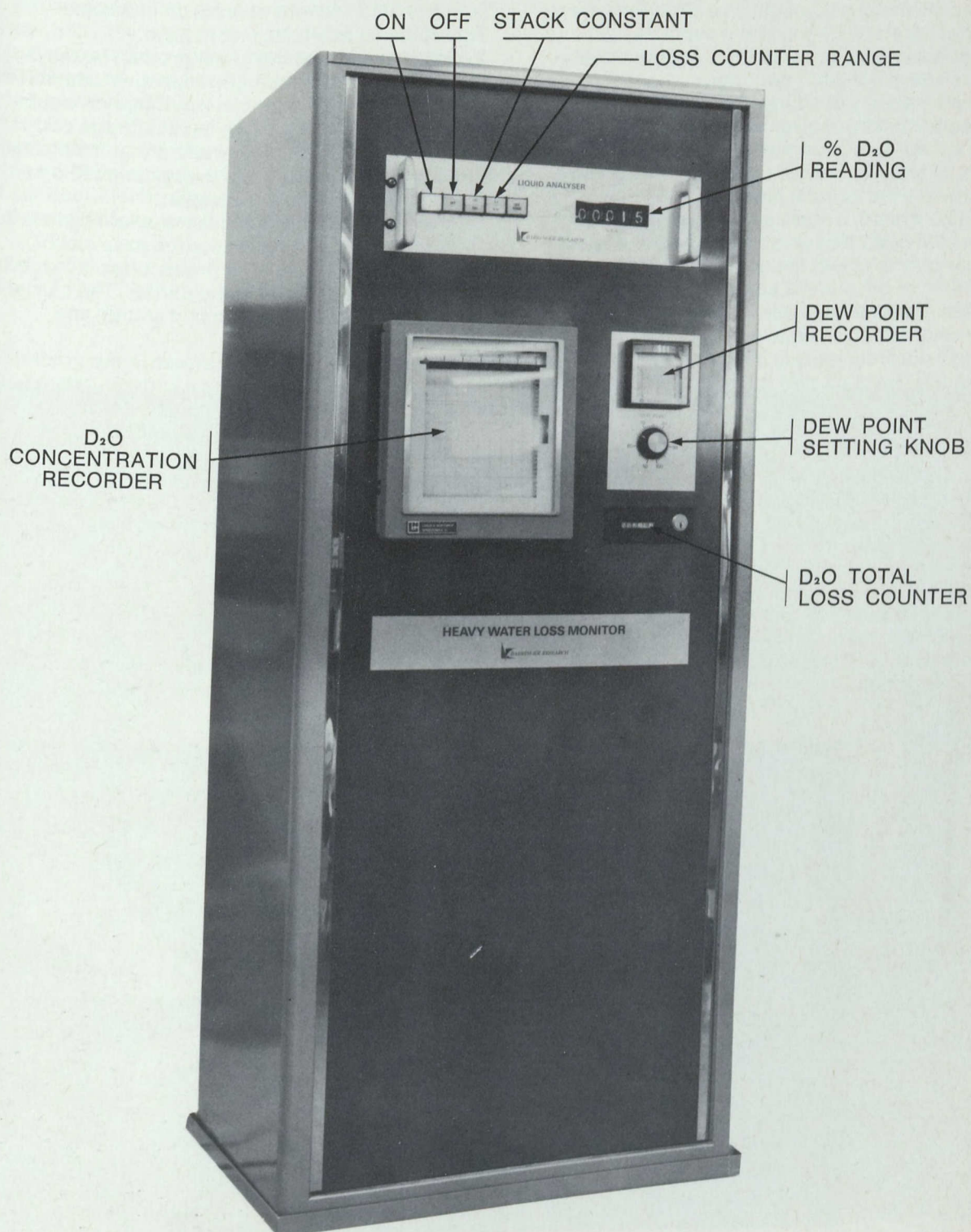


NUCLEAR POWER PLANT INSTRUMENTATION

Barringer Research Limited offers a versatile line of instrumentation for detection, measurement and analysis of heavy water, suited to the needs of both heavy water producers and users and particularly nuclear power plants.

The Barringer Heavy Water Liquid Analyser is an automatic instrument for continuous, real-time analysis of isotopic mixtures of heavy and light water. The analyser operates on the principle of an infra-red spectrometer. A spectral distribution method of comparing the sample transmission on two distinct wavelengths is employed. (This makes the analysis widely independent of the absolute sample transmission and hence insensitive to broad spectrum contaminants or variations of the infra-red source radiation.) The analysers of this type may be built with varied sensitivity and range. The present practical limits are from a range 0 - 1% with sensitivity 1 ppm D_2O or H_2O , to a range 0 - 50% with sensitivity 100 ppm D_2O or H_2O and resolution ranging up to full four decimal digits.

The Barringer Heavy Water Loss Monitor is a fully automatic instrument developed to measure and record heavy water losses through the exhaust stack of nuclear reactors. This is achieved by continuously sampling the exhaust air from the exhaust duct, condensing the carried moisture out and feeding this liquid sample into the Barringer Liquid Analyser. The instrument is able to detect as small variations in D_2O content as 1 mg to 10 μg D_2O in cubic meter of air, and integrate overall losses of D_2O up to 10,000 Kgm, in periods between resets at rates as low as 10 mg/sec.



STERILIZATION PLANT — COBALT 60

This Cobalt 60 Sterilization Plant was designed by Atomic Energy of Canada as a high efficiency irradiator for sterilizing medical supplies.

Throughputs range up to 48 units per hour equivalent to 4.29 m³ (162 ft.³) per hour.

The plant consists of an irradiator building of composite construction of block and concrete which serves as a biological (protective) shield. Cobalt 60 is the source of radiation; the system comprises a flat vertical plaque carrying the Cobalt 60 source, a source raising and lowering device, the source pass mechanism and a water storage pool to shield the source when not in use. Operation of the plant is centered in a main console — the console also houses the controls for the maintenance system.

Nominal plant capacity is 300,000 curies of Cobalt 60. The plant may be modified to increase the capacity.

Materials to be irradiated are pre-packaged in corrugated cartons. The cartons are then moved by a power input conveyor to the load position where they are fed automatically onto a monorail carrier and conveyed into the irradiation room — the cartons are then fed automatically from the carrier into the source pass mechanism where they are indexed through different positions about the exposed Cobalt 60 source.

The monorail carrier has two product box positions. An upper position which receives un-irradiated product boxes at the load/unload

station from the input storage conveyor and a lower position which receives an irradiated box at the source pass mechanism.

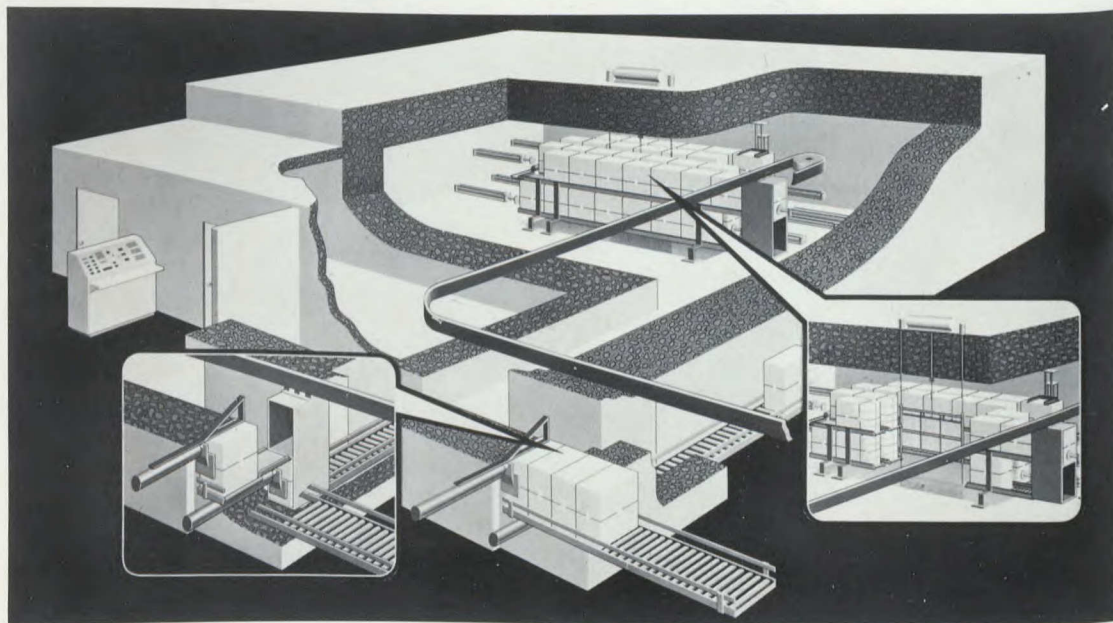
Loading and unloading of the product boxes is done automatically at their respective stations; at the load/unload station the irradiated product box is discharged onto the outlet storage conveyor into the sterile area while an un-irradiated product box is loaded into the upper position from the input storage conveyor.

At the source pass mechanism the un-irradiated product is loaded into the source pass mechanism, while an irradiated product box is loaded into the lower position of the carrier. The carrier then returns to the load/unload station and the sequence is repeated.

The exposure time of the cartons in the irradiation room is pre-set on the control console. Irradiation time is basically determined by product density-dose required and the activity of the source.

This Medical Supplies Sterilization Plant is a fully automated facility, when the source pass mechanism is loaded, the system maintains a constant day-in-out throughput.

The input and output storage conveyors may be designed to accommodate a sufficient supply of cartons to maintain an input and output volume for a desired number of hours; this means that complete plant operation may be carried on — requiring only the presence of one qualified technician.

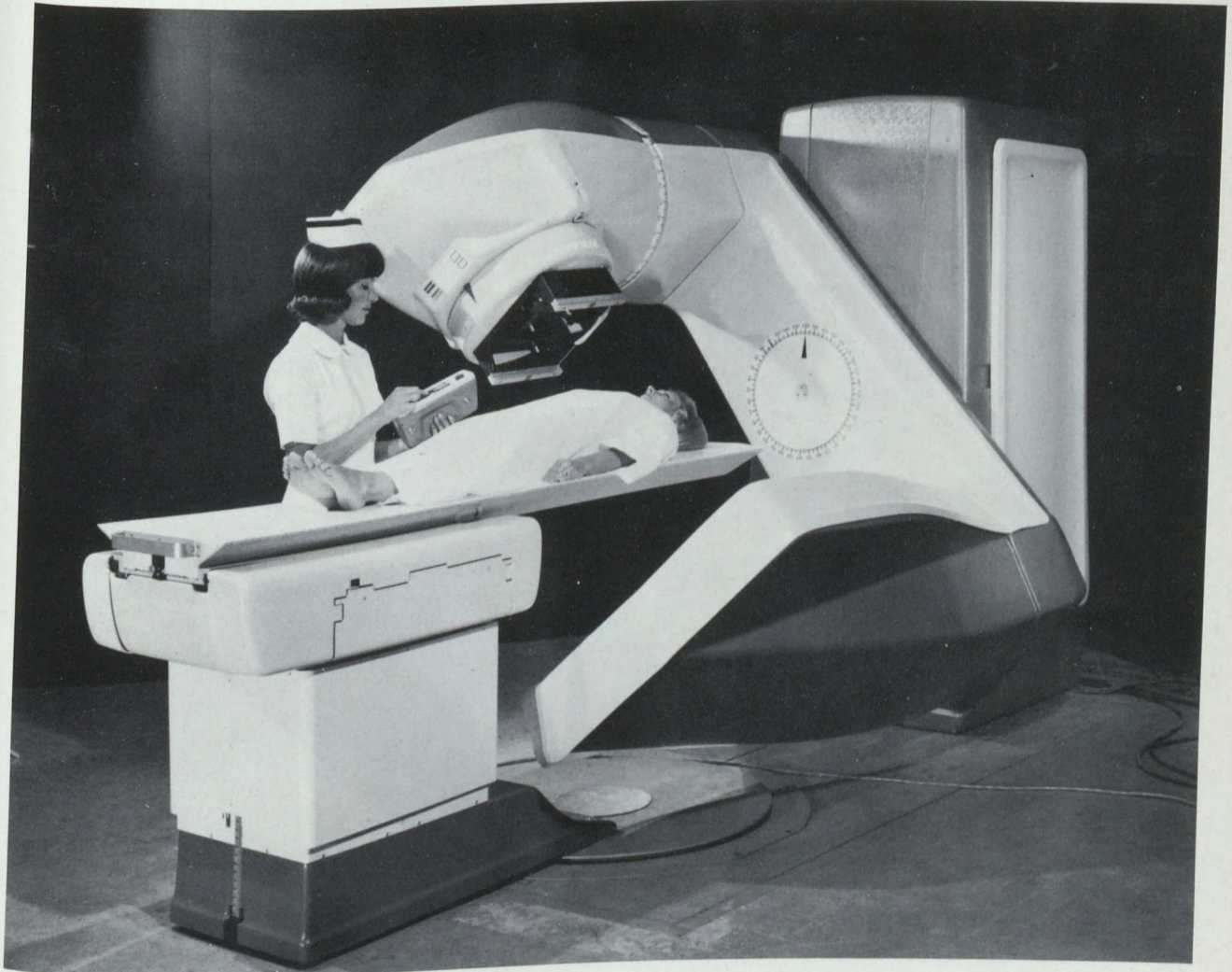


CANCER THERAPY UNITS

Since 1952 Atomic Energy of Canada has produced radiation therapy equipment which has found universal acceptance as being one of the most reliable units with a minimum of sophistication. These units are now in use in many military hospitals around the world.

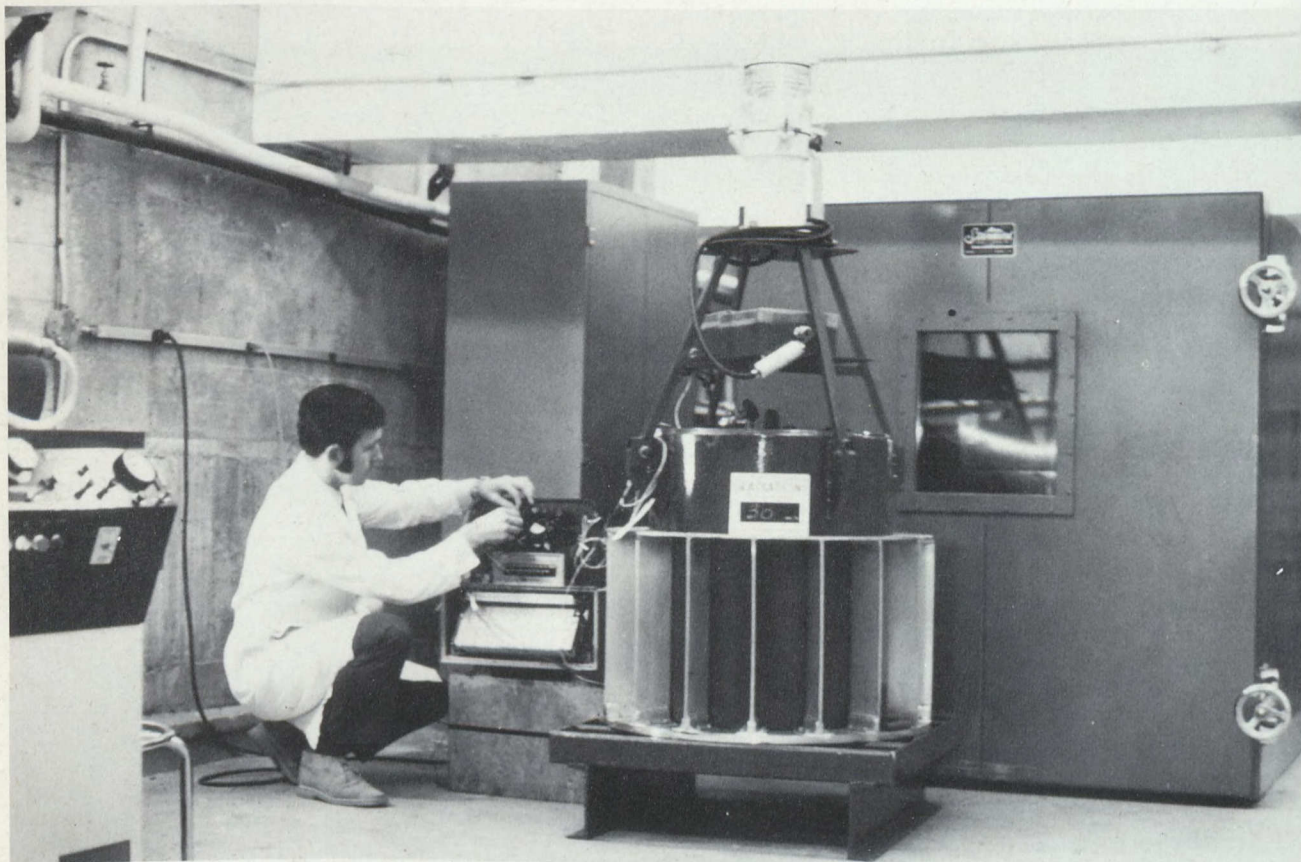
This one, the Theratron 780 is considered to be the most accurate now in existence and is capable of being fully computerized.

In addition Atomic Energy also produces a teletherapy simulator and a unit for brachytherapy.



COBALT 60 ELECTRICAL GENERATOR

This equipment is capable of producing electrical power up to 50 watts. These generators are highly suited for applications in space, under water and remote locations because they require no maintenance and are capable of producing electrical power for several years without refueling. A generator of this kind has been installed on the St. Lawrence Seaway at Brockville, Ontario, to power a light buoy. Another is operated near Resolute Bay in the Northwest Territories and supplying electrical power to a package of weather instruments. Radioisotope generators of this kind are designed to meet all safety requirements of atomic energy regulatory agencies.



TRANSPORTABLE GENERATING SETS

Deutz Diesel (Canada) Ltd. have been producing generating sets in Canada for over fifteen years. This equipment is used throughout Canada as stand-by power for runways lighting and control towers as well as being prime power sources for remote localities. Due to the proven reliability of the equipment they are also used as stand-by power sources for hospitals.

150 KW

150 KW DEUTZ air-cooled diesel stand-by generating set, 4160 V, 3-phase, 60 cycle, 1800 RPM, as supplied to the Defence Forces of Canada for emergency runway lighting and control tower power supply. Units of this type have been installed across Canada for many years. The outstanding feature of these fully automatic units is the rapid attainment of full voltage and frequency, even after prolonged idleness in unheated buildings. Voltage and frequency regulation are held within close limits and the design of the units facilitates easy maintenance. The units are equipped with all necessary safety shut-downs.

20 KW

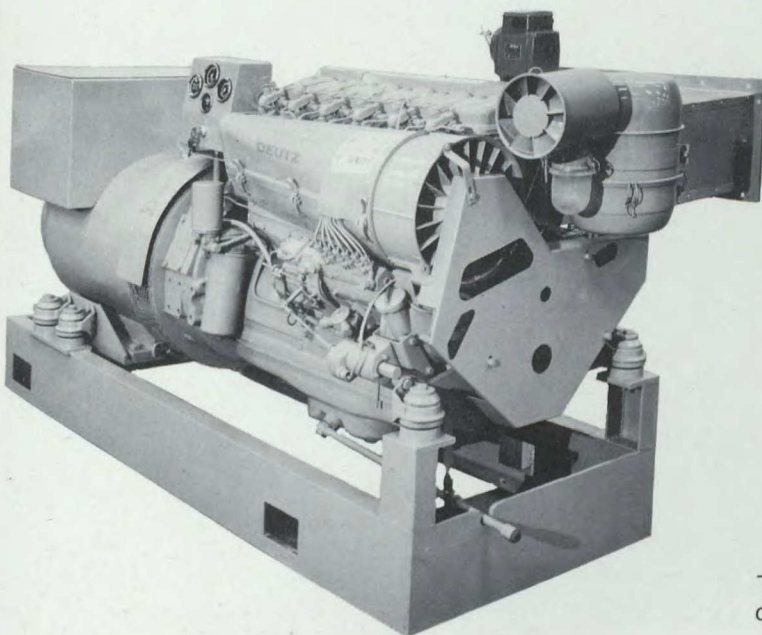
Composite photograph of diesel generating sets supplied for a communications system. All units are powered by DEUTZ air-cooled diesel engines, equally suitable for service under tropical as well as arctic conditions. Good cold starting charac-

teristics and easy accessibility for maintenance are important design features. Each unit is rated at 20 KW at 220V, 3-phase, 50 cycle. For 60 cycle applications a correspondingly higher output can be offered with these 4-cylinder engines (both larger and smaller models are available and have been supplied for civilian and military applications). In addition to stationary units, both truck- and trailer-mounted units are available. For this particular project complete truck-mounted units were furnished to protect sites in case of disaster affecting also the stationary stand-by units. The truck-mounted units duplicate the stationary ones and have their own fuel and lubricating oil supply tanks for extended service.

50 KW

50 KW (62.5 KVA), 120/240 V, single-phase, 60 cycle, fully automatic air-cooled diesel generating set, type F6L 912, for various installations of the Armed Forces of Canada. Flexible mountings and cooling air discharge louvre control motor are clearly visible. The unit maintains a permanent speed, i.e. frequency, regulation of zero % droop between no load and full load. The engine is of the heavy-duty, cold starting type.

If you will refer to the article, "Outdoor (Transportable) Regulator Station For Heliports" you find this generating set being used as the basic power supply.

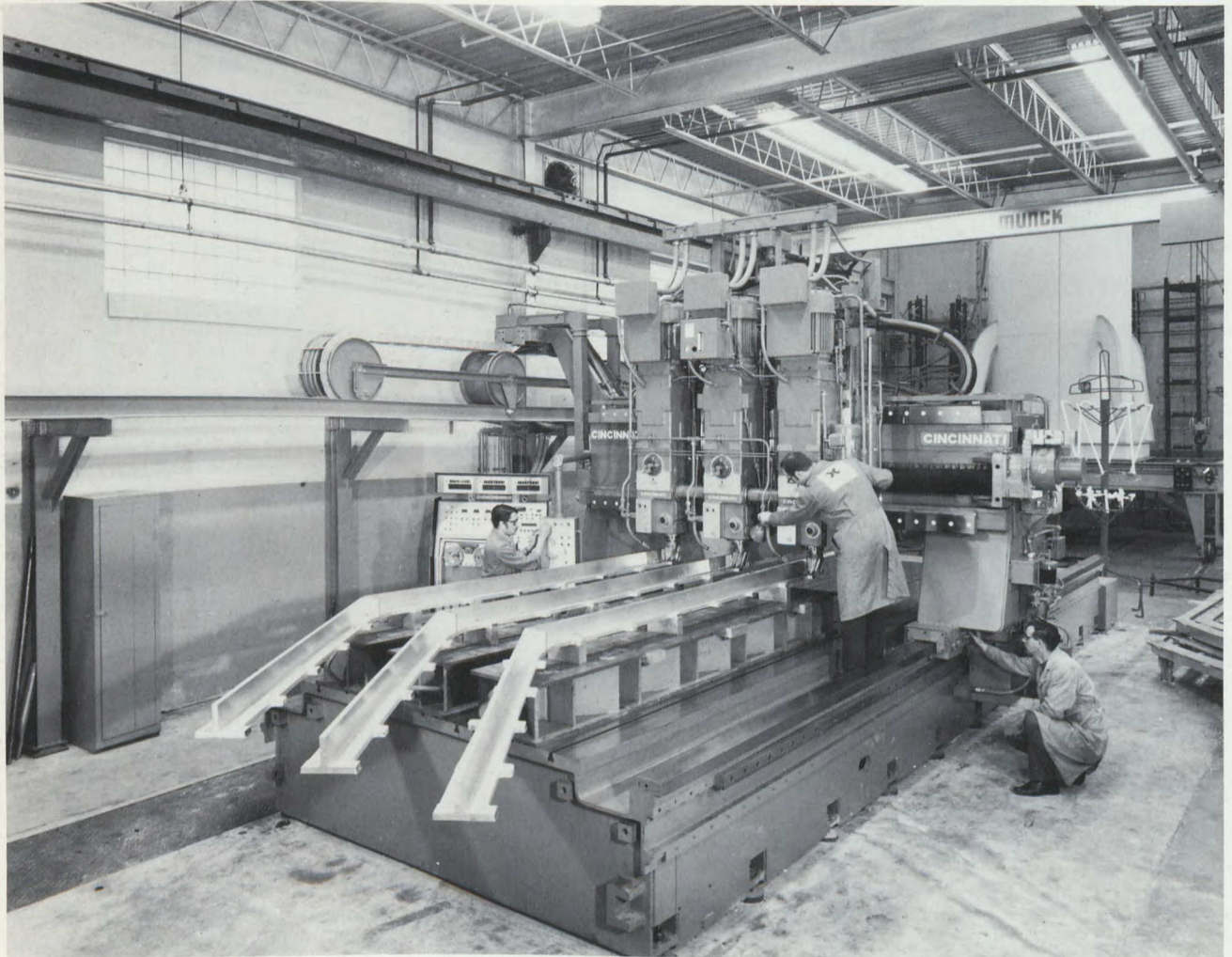


Type F3L-912 heavy duty DEUTZ air-cooled diesel.

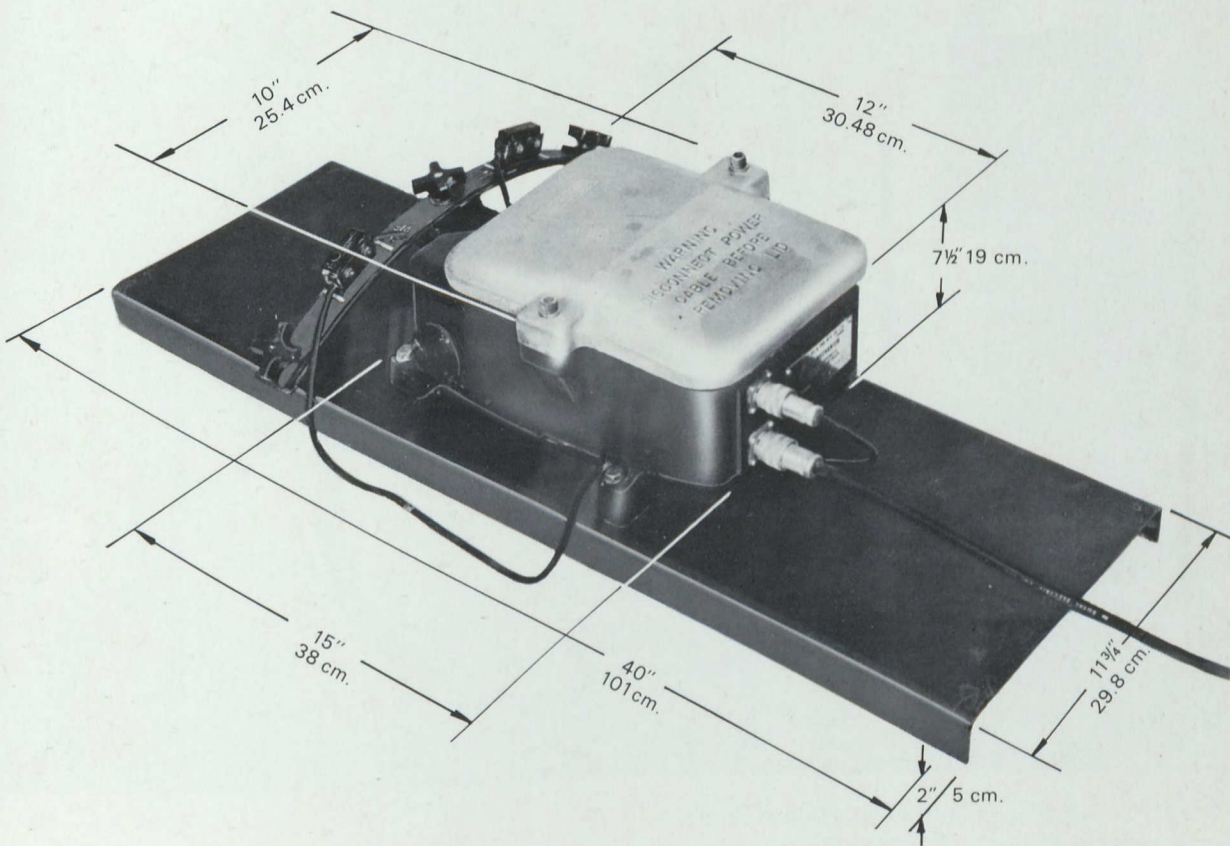
CUSTOM MACHINE SHOPS

The Cincinnati 213 cm x 731 cm (7 ft. x 24 ft.) vertical 3 spindle gantry type numerically controlled profile milling machine is a good example of the type of equipment in those basic machine shops which add immeasurably to Canada's industrial make-up. It is in such plants that the "hard core" of machined parts for to-day's aerospace programmes are completed. At the same time some of them, such as, Universal Die and Tool, are equally experienced in the demands made on production services for the in techniques and tools to satisfy ordnance facility needs.

The work on the table of the mill in this picture is three spar caps for the DC-10 which measure 6 m (20 ft.) in length and as a forging weigh 340 kg (750 lb.) and as a finished machining weigh 32 kg (70 lb.). Similar parts for the DC-9 and the earlier DC-8 were also produced here. The cylindrical object in the background is a heat treat furnace with an internal diameter of 183 cm (6 ft.) and which can handle parts up to 6 m (20 ft.) in heights. It is specifically approved for aluminum alloys in the 7075T6 and T73 as well as the 2014 T6 ranges where temperatures up to 538°C (1,000°F) with controls of $\pm 3^\circ$ are required.



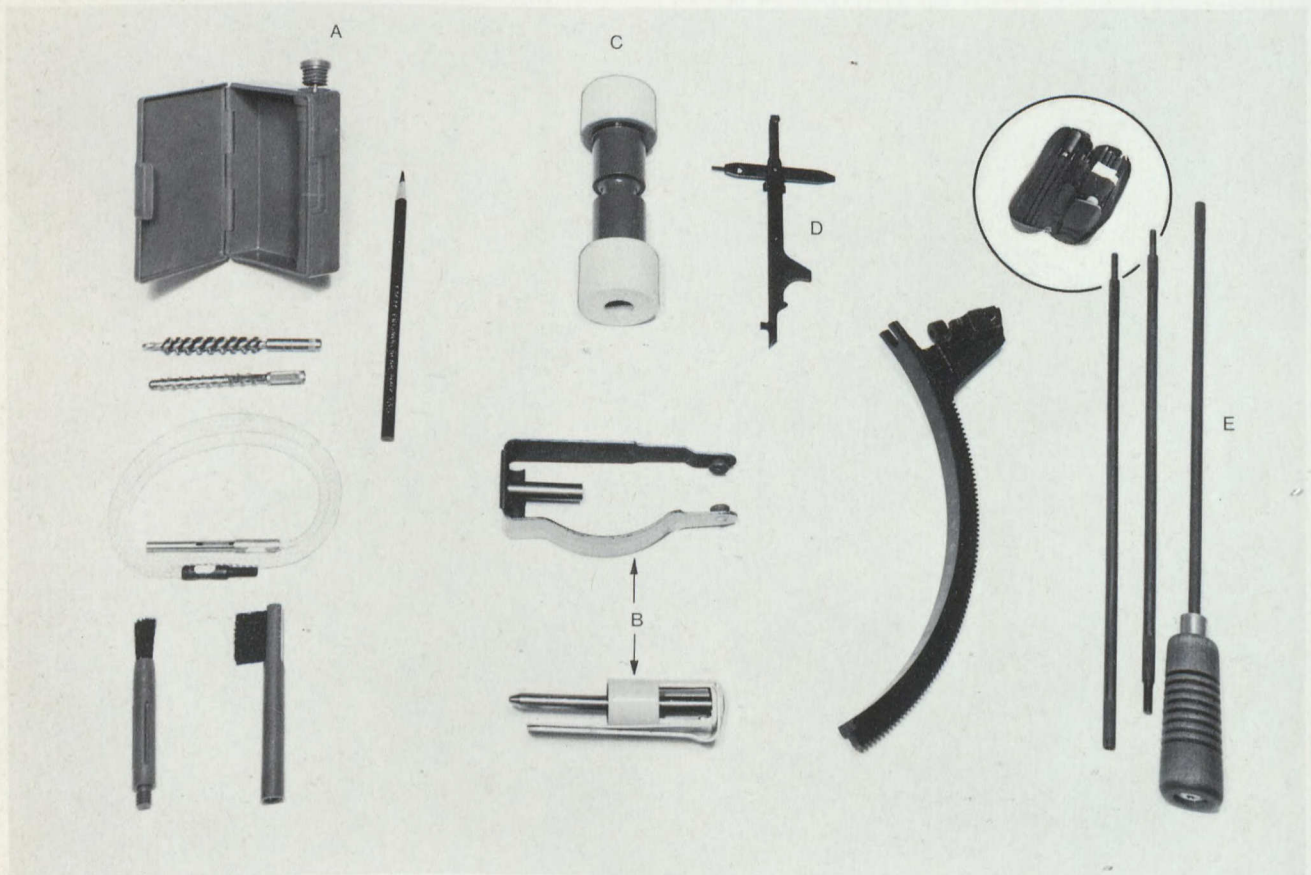
This same firm has also produced such items as the Trainfire Target which is an electrical target device which imparts a high degree of realism to musketry training. Unlike many others of its kind this device through its unsophisticated design and extremely rugged construction has proven to be most serviceable under the extremes of our climate.



The photograph on this page is a sampling of the smaller range or ordnance items produced. They include a Small Arms Universal Cleaning Kit at "A", Blank Firing Attachments for rifles and sub-machine guns at "B", a Tension Bar for steam aircraft catapults at "C", a Maintenance Tool for automatic rifles and a gear toothed Sight Quadrant at "D". The 3 piece steel Cleaning Rod at "E" is one part of the larger kit in the inset.

These two Cleaning Kits are considered capable of cleaning and maintaining any equipment

from a hand weapon (pistol) to a .5 machine gun, including shotguns, by merely changing the accessory brushes which screw onto the Pull-through or Cleaning Rod. The two kits have been designed as a family and common parts are used throughout with each and every weapon receiving its own individual attention. Due to these features ordnance spares are greatly reduced and at the same time the cost of overall item is kept low as it is now used in quantity across a family of weapons as opposed to individual items for each separate weapon.

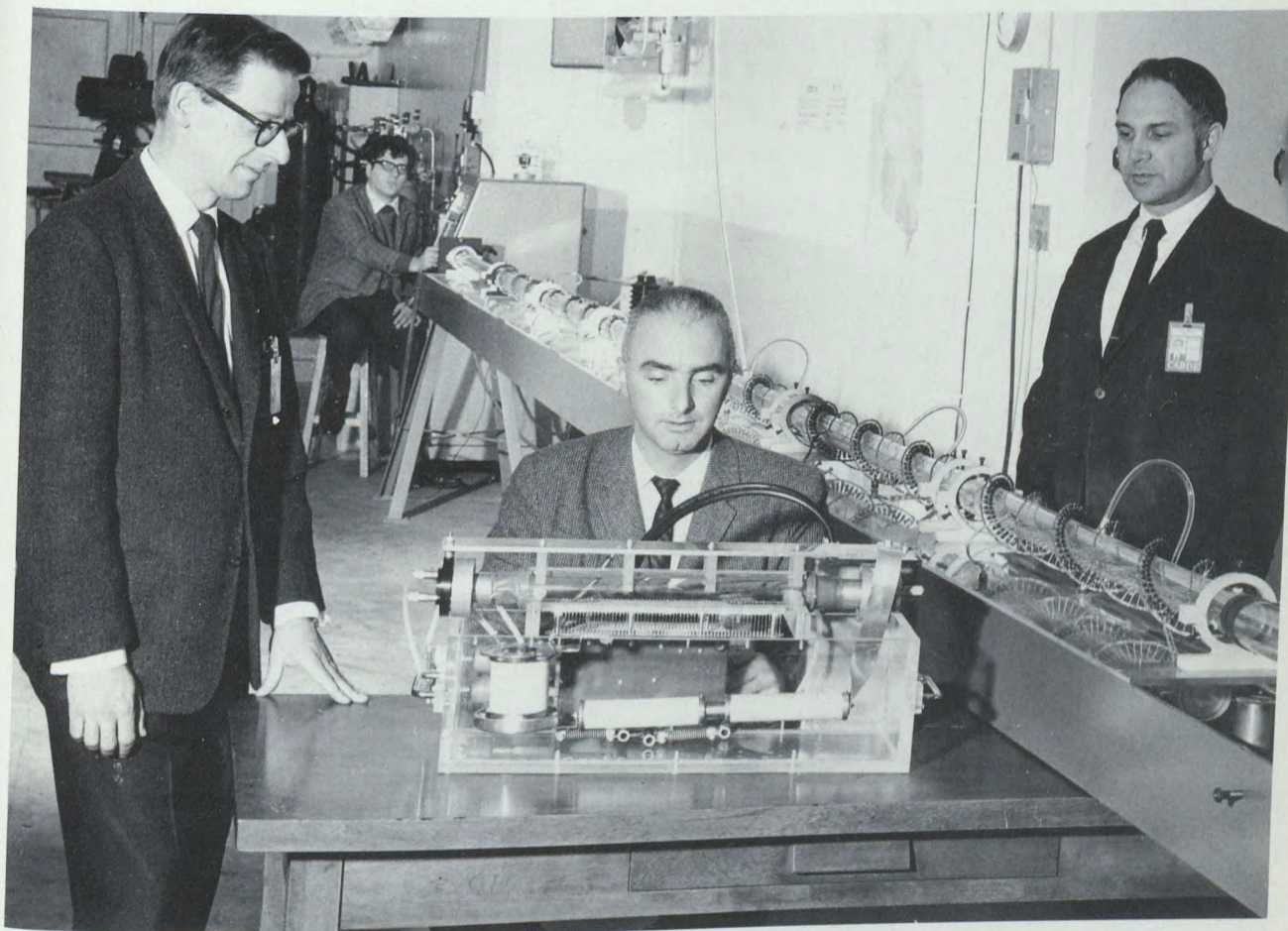


DEFENCE RESEARCH BOARD

The Defence Research Board is part of our National Defence complex and is concerned with providing scientific advice to the Minister of National Defence, meeting the research requirements of the Canadian Forces, contributing to the collective defence research efforts of our allies, and supporting basic research of defence interest in Canadian universities and applied research of defence interest in Canadian industry.

In the most general sense, this means ensuring that scientific knowledge is applied to the strengthening of present and future security. In meeting this objective, there is, on the one hand, a short-term role in which advice and assistance

to the Minister and the Canadian Forces is applied to current policies and activities. In this role DRB attempts to maintain access to all scientific knowledge that might be of benefit to the Department and to assist in applying it to current objectives and activities of DND. On the other hand, there is the long-term responsibility of DRB to conduct a research program that will (a) maintain a cadre of expert defence scientists, (b) strengthen future security by contributing to allied defence science and (c) gain knowledge of defence science from allies in exchange for the Canadian contribution. This part of the program must be selected to allow for a range of possible future defence policies and programmes.



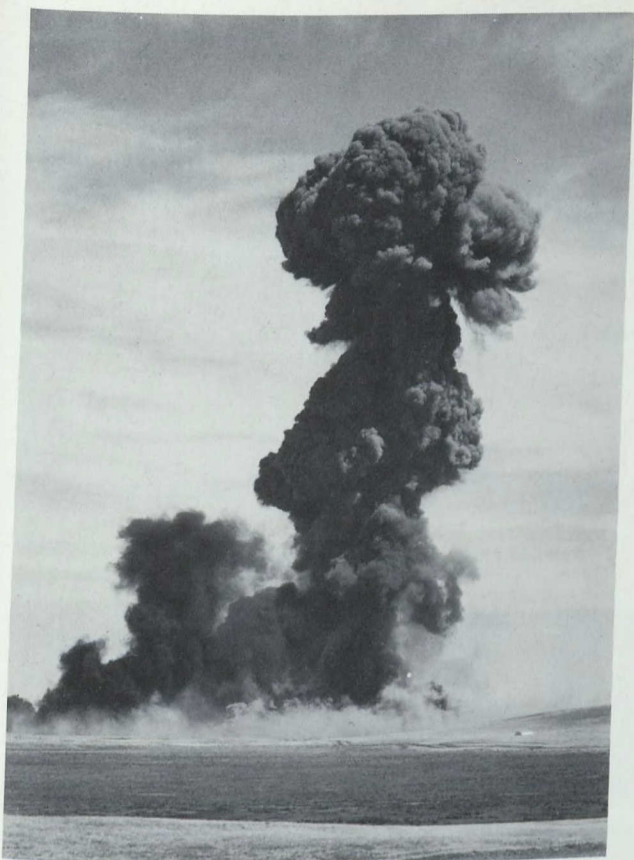
A team at DRB has invented gas lasers which operate at atmospheric pressure, a giant step forward in laser technology. This 9.14 m (30 ft.) long helical laser produces more than 5,000,000 watts in an ultra-narrow beam.

Another first for the Board during 1971 was the design and construction of a "DDT Destructor" which is neutralizing Department of National Defence stocks of DDT solutions, now considered a pollutant. Set up at the Defence Research Establishment Suffield, near Medicine Hat, the destructor will be employed also to neutralize stocks held by other Federal Government and Provincial departments and the holdings of municipalities. The plant will then be modified to destroy DDT in solid formulations with further modifications planned for other pollutants. The DRES plant is believed to be the only one of its type in the world.

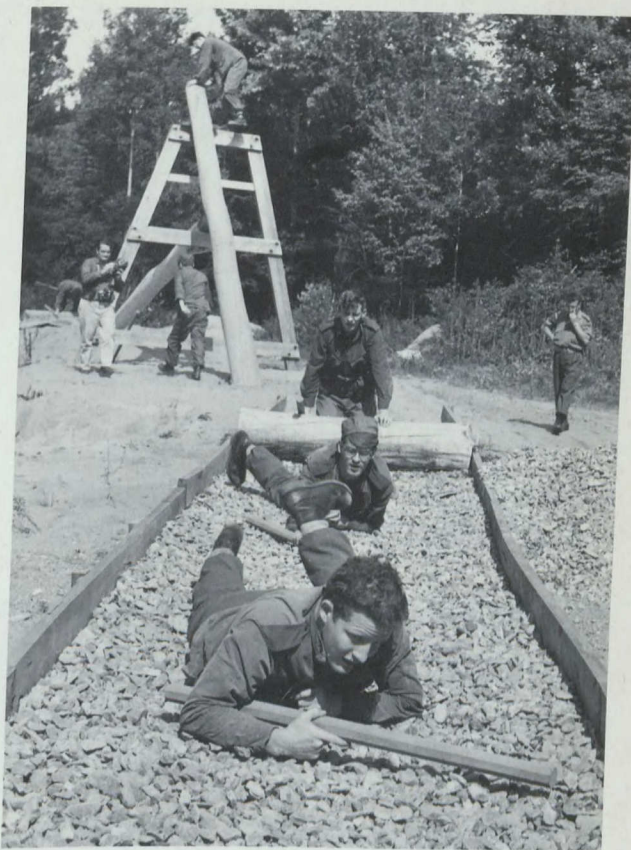
This short presentation cannot deal with all of the facets and operations of DRB but will serve to inform you of its existence and demonstrate the diversity of its operation.

CNAV "QUEST", the uniquely "silent" research vessel employed by the Defence Research Establishment Atlantic, serves as a platform for at-sea research by the Dartmouth, N.S., laboratory. Here the ship is engaged in acoustics investigations.





In association with Australia, Britain, and the U.S., the Defence Research Establishment, Suffield, near Medicine Hat, Alta., is the locale for shock and blast trials which simulate nuclear explosions employing charges of TNT. This explosion of a 500-ton sphere of TNT, tangential to the ground surface and built from blocks supported in a styrofoam cradle, was one of the most successful of the several multi-ton explosions carried out at DRES. It provided data on the response to air blast and ground motions of many equipments exposed for the Canadian Forces and other organizations. These equipments included radomes, turbine ducting, and topmast and whip antenna for the DDH 280 destroyer, as well as communication antenna, radiation detectors and trench overhead covers (SKOP) for the land forces. It also included many of the items command in the NBCW Section of the book.



The Defence Research Establishment, Ottawa has established a course for Armed Forces personnel designed to test the durability and other characteristics of fabrics. A soldier prepares to slide down a tree trunk as two others begin crawling over crushed rock.

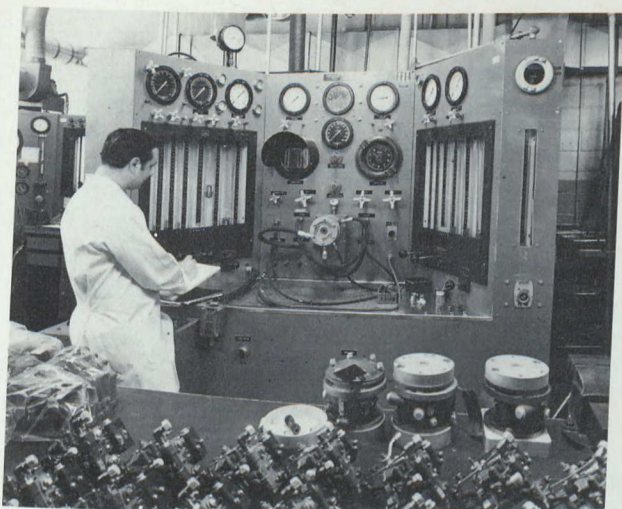
REPAIR AND OVERHAUL FACILITIES

Since 1931 Aviation Electric has provided an instrument and aircraft accessory overhaul facility which not only became part of the Canadian commercial back-up but also became a proven source for Canadian Forces equipment. Over the years, similar reliance has been placed in the firm by users, both military and commercial, from the United States as well as from many other countries who use these controlled facilities. Facilities are fully approved by the Canadian Ministry of Transport, the Canadian Armed Forces and the U.S. Federal Aviation Administration, for the overhaul of airborne and ground equipment. Service covers the full range of electrical, electronic, electro-mechanical and hydro-pneumatic areas and includes repair and overhaul of complete systems such as ignition, flight

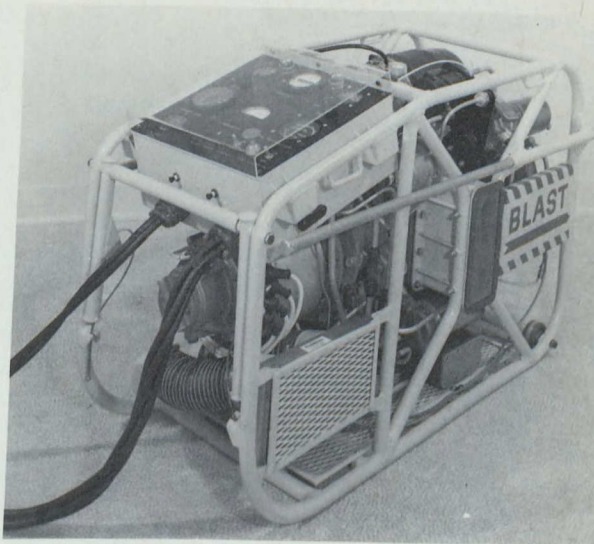
controls and airborne data computers. In addition, the company services equipment in the marine and industrial fields such as radar, radio communication equipment, navigators and industrial controls. The company designs and manufactures specialized test equipment for fuel controls and other engine accessories, APUs', servoed altimeters, auto-pilots and flight navigation control systems. Also provided is a full range of Ground Support equipment designed and manufactured to customers' specifications. This includes mobile and stationary electrical generators, 400 and 60 cycles, gas turbine, diesel and gasoline engine driven; portable airborne gas turbine APUs'; and naval gas turbine water pumps.



A partial view of the ground support equipment repair and overhaul shops. This division also designs and manufactures all manner of ground support equipment filling both military and commercial requirements.

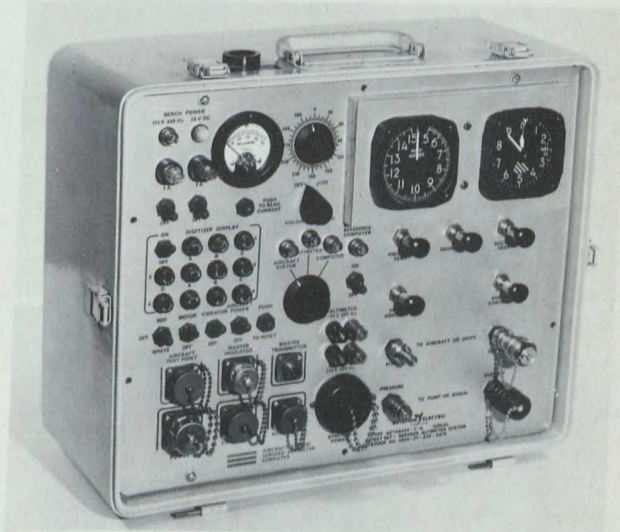


Overspeed governors on test following overhaul. AEL will also work up proven maintenance procedures supplying both the equipment and maintenance manuals to back up your equipment relative to your own particular needs.

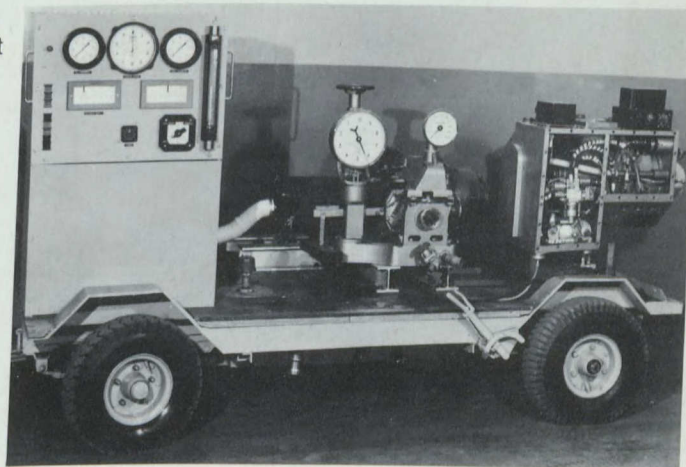


Portable airborne gas turbine (APU).

Another example of AEL's ability to produce maintenance equipment in support of the user is this portable servoed altimeter tester.



AEL not only carry out repair and overhaul tasks but they also design and produce test equipment which assists the user in carrying out his own maintenance. Shown here is a piece of mobile gas turbine test equipment.



OIL POLLUTANT RECOVERY

R.B.H. Cybernetics have developed a process and produced a family of complete packaged equipments which deal effectively with oil spills and other oil contaminants. The function of the main equipment "Slicklicker" is dependent upon "preferential wetting", but capacity is due to the materials used in, and the design of, the pick-up belt. Simply stated, "preferential wetting" takes advantage of the fact that oil attracts oil, and rejects water. Thus, when the pick-up belt has been treated with oil, it becomes oleophilic and hydrophobic. The separation of oil from water takes place as the oleophilic belt is passing through the oil/water mix from which the oil is to be removed. The oil is attracted to the pick-up belt and the water is left in place. Hence, there is a clean separation.

The continuously moving oil-soaked belt then passes through squeeze rollers which express most of the oil from the belt, but leave enough oil in so the "preferential wetting" phenomenon will still continue when the belt returns to the oil/water mix. Since this is an absorption process, each fibre of the belt picks up oil both on its surface and within the pores of the material. Without the patented construction of the belt, expressing this amount of oil by means of squeeze rollers could cause destruction of the belt. The construction used, however, allows a continuous unloading of the oil taken up by the belt, without building up destructive pressures which could burst it.

Accordingly, a sturdy and simply operable and serviceable machine has been developed which can separate and pick up to 204.5 litres (45 Imp. ga.) of oil per minute from water surfaces; a tremendous quantity for the size and weight of the machine.

The materials and construction of the belt also give a capability of picking up oil/water emulsions and the unloading process is such that to a large extent, these oil/water emulsions are broken down, so little chemical de-emulsifier is required. This ability to pick up emulsions not only enhances the ability to clean up oil spills, where emulsions inevitably form, but also gives it unique capabilities for use in refinery separators, in sewage treatment plants where oil is a problem, and in fact, wherever there is an oil/water/emulsion separation problem.

One very marked advantage of the equipment over other pick-up systems is that the end of the pick-up boom does not need to be held at the oil/water interface. In normal operation it extends

past this interface into the water. The fact that the belt and roller can extend into the water allows the machine to be used under any wave conditions that the vessel on which it is mounted can withstand. The moving pick-up belt picks up only the oil, leaving the water where it is. Some water is entrained in the oil but under most circumstances the mix pick-up should be close to 98% oil.

The capabilities of the equipment were most graphically demonstrated at the scene of the *Arrow* spill on Canada's east coast in February 1970 when some 17,275,000 litres (3,800,00 gal.) were released. Working on heavy Venezuelan bunker fuel at .6° C (33°F) water temperatures and in freezing air temperatures, four machines picked up 9,092 to 22,730 litres (2,000 to 5,000 gal.) each per day of oil and oil-soaked debris. The machines could have picked up more, but there was no method of disposing of the picked-up oil faster than this. As the oil was not boomed, the boats had to move from place to place to catch the floating gobs. As a result of its success on this spill, the head of the task force set up to handle the clean-up has recommended to the Canadian Government that each Canadian harbour have a "Slicklicker" in an active state and two on stand-by in case of a larger spill.

The equipment can be used from any boat with a fairly low freeboard. On the *Arrow* spill small landing craft were used. On Lake Athabasca in northern Alberta it was mounted on decking laid across two 4.87 m (16 ft.) rowboats, as nothing else was available. However, we have available and recommend the "Sea Truck", a 3 x 7.6 m (25 x 10 ft.) fibre-glass barge, with landing ramp, which can operate at speeds up to 32 kilo/hr (20 mph) with a 2 ton load. This is a very shallow draft, highly stable boat with optional power supplies. A companion craft, based on the catamaran principle, also carries the basic equipment and is now in service on Canada's east coast.

The explosion-proof model of the equipment, which is called the "Oleovator", is used to improve efficiency of A.P.I separators in refineries and can be used in any in-plant situations where it is necessary to separate a non-miscible liquid from water. The great advantage the Oleovator has over other separators is that it will pick up, and largely break down emulsions.

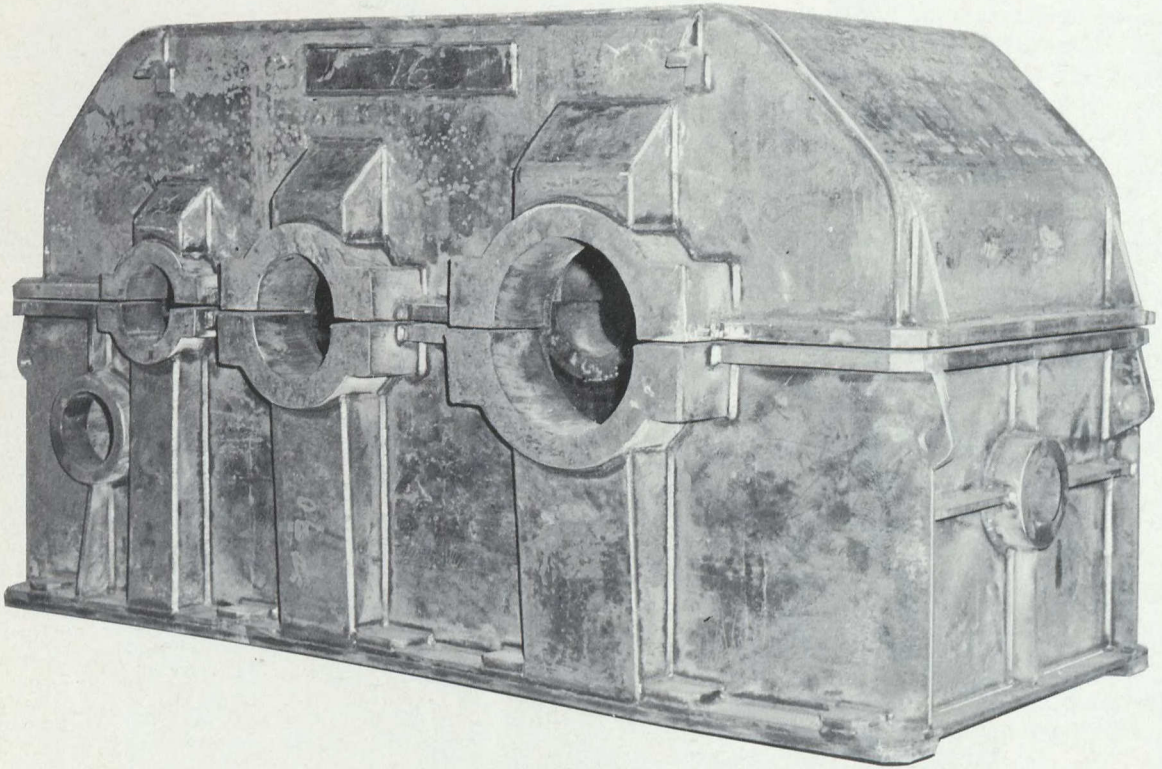
This decreases the amount of de-emulsifier required, effecting a considerable saving in many instances.

Problems in these areas will invariably have their own peculiarities and should be referred to R.B.H. Cybernetics for further study and assistance.



GENERAL STEEL FABRICATION

Dahmer Steel as well as producing a line of trawling booms and cranes also to custom requirement, meets a wide range of industrial needs. The selection of these productions given here will illustrate the diversity of their activities.



A heavy-duty gear box 3.65 x 1.21 x 1.82 m (12 x 4 x 8 ft) fabricated of steel plate in various thicknesses from 1.9 to 20.3 cm (.75 to 8 in). Note the smooth, neat appearance of the welding.



A 16.7 x 2.4 m (55 x 8 ft) autoclave constructed to code UW12A and fabricated from A212B firebox plate with a working pressure of 7 kg/cm² (100 PSI).



Stainless steel vessels with inside welds finished to #4 polish to meet strict sanitary code requirements. Constructed of type 316 stainless steel, they are 2.4 m (8 ft) high with a 1.8 m (6 ft) diameter.

AIR CUSHION VEHICLES

To meet the demand for effective, economical transportation, particularly in those areas not easily accessible, including Arctic regions, Bell Aerospace Canada has developed a heavy-haul air cushion vehicle.

This ACV is capable of handling a 22,680 kg (50,000 lb.) payload on a rugged flatbed structure of welded aluminum extrusions. The transmission systems, lift fans, propellers and skirt elements have been proven in over 100,000 hours of hovercraft operation. It is powered by two 1,300-shaft-horsepower ST-6 "Twin Pac" power plants built by United Aircraft of Canada Ltd., having multi-fuel capability and cold-weather starting features which have been proven during more than five million operating hours.

The design of the vehicle permits economic production and ensures that operating costs will be approximately one quarter that of present heavy-lift helicopters. The concept of modular construc-

tion, where no piece is greater than 12 m x 2.4 m x .91 m (40 x 8 x 3 ft.), permits rapid assembly or disassembly for transportation by road, rail and air and operation on the new site. The design also features minimal maintenance and crew training. The flatbed design caters to a variety of superstructures and therefore allows transformation to many different types of craft and of course uses. Present potential uses include Coast-Guard support roles, mass-transit ferry; mining, oil and construction industries support.

SPECIFICATIONS:

Length: 19.8 m (65 ft.)

Beam: 11.2 m (37 ft.)

Height (on cushion): 6.7 m (22 ft.)

Skirt Height: 1.2 m (4 ft.)

Weight, max. gross: 40,000 kg (88,000 lb.)

Fuel capacity: 9,000 litres (1,980 Imperial)

Speed (calm water, typical pay load): 45 knots



ELECTROPLATE FUSING SYSTEM

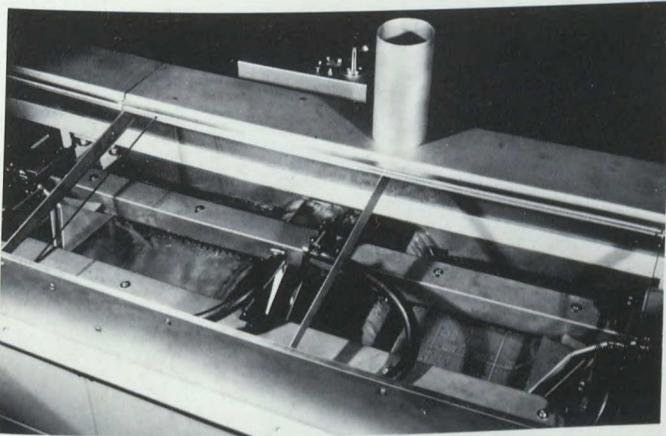
Electrovert manufactures equipment for use in many phases of printed circuit board production, in addition to the reflow melting and fusing of electroplate. For instance, for the assembly and inspection of p.c. boards, fluxing, pre-heating, automated soldering and post-cleaning. It also has designed a series of armature soldering machines which are used extensively in the automotive industry.

One of the most important properties of a printed wiring board is the solderability of its conductors. Good solderability and corrosion protection are achieved when an intermetallic bond is formed between a fused, smooth and oxide-free electroplate alloy and the base conductor. Also all bare copper edges should be covered to prevent "oxide tunnelling."

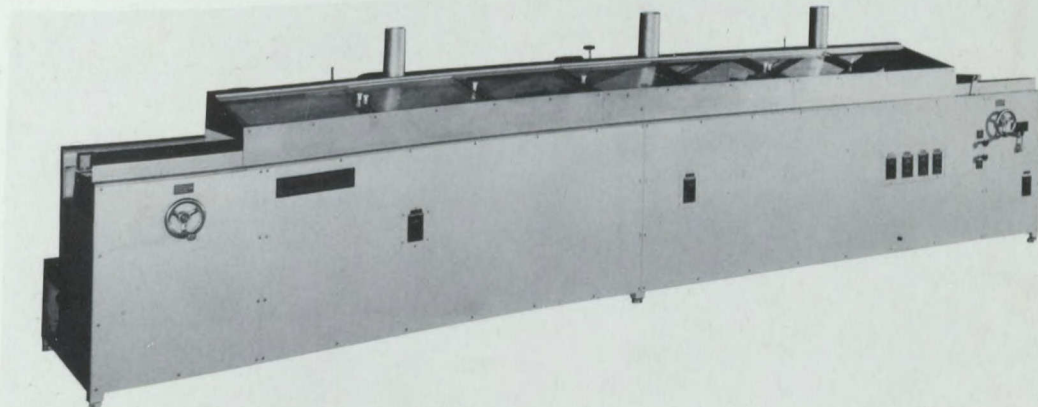
Printed circuit boards prepared in this manner can be soldered at lower temperatures and shorter dwell times. Also the resulting soldered joint will be reliable even when only mild fluxes are used.

The reflow melted and fused coating provides a thickness which is a function of the initial electroplated thickness. An original tin-lead electroplate of 0.0003 to 0.0005 inches (7.5 to 12.5 microns) is sufficient for satisfactory fusing and provides for full coverage and protection of all copper edges and surfaces. Given the proper thickness electroplate, the Electroflo will form a fused coating, meeting the thick fusing requirements of MIL STD 275C, by an automated system using the Electrovert wave pumping principle that prepares the pc board and then melts and reflows the electroplate. While still molten the hot fused solder alloy covers the land areas, and copper edges of the circuit. The fused plating eliminates porosity and forms a metallurgical bond to the printed conductor at the interface.

Boards processed on the Electroflo System may be stored for an extended period of time without loss of solderability. The process also will not distort the board or cause mechanical strain.



Close-up view of the Electro-Flo wave cleaner with rotating brush showing the spray nozzles.



ASPHALT, CRUSHERS AND PAVING PLANT

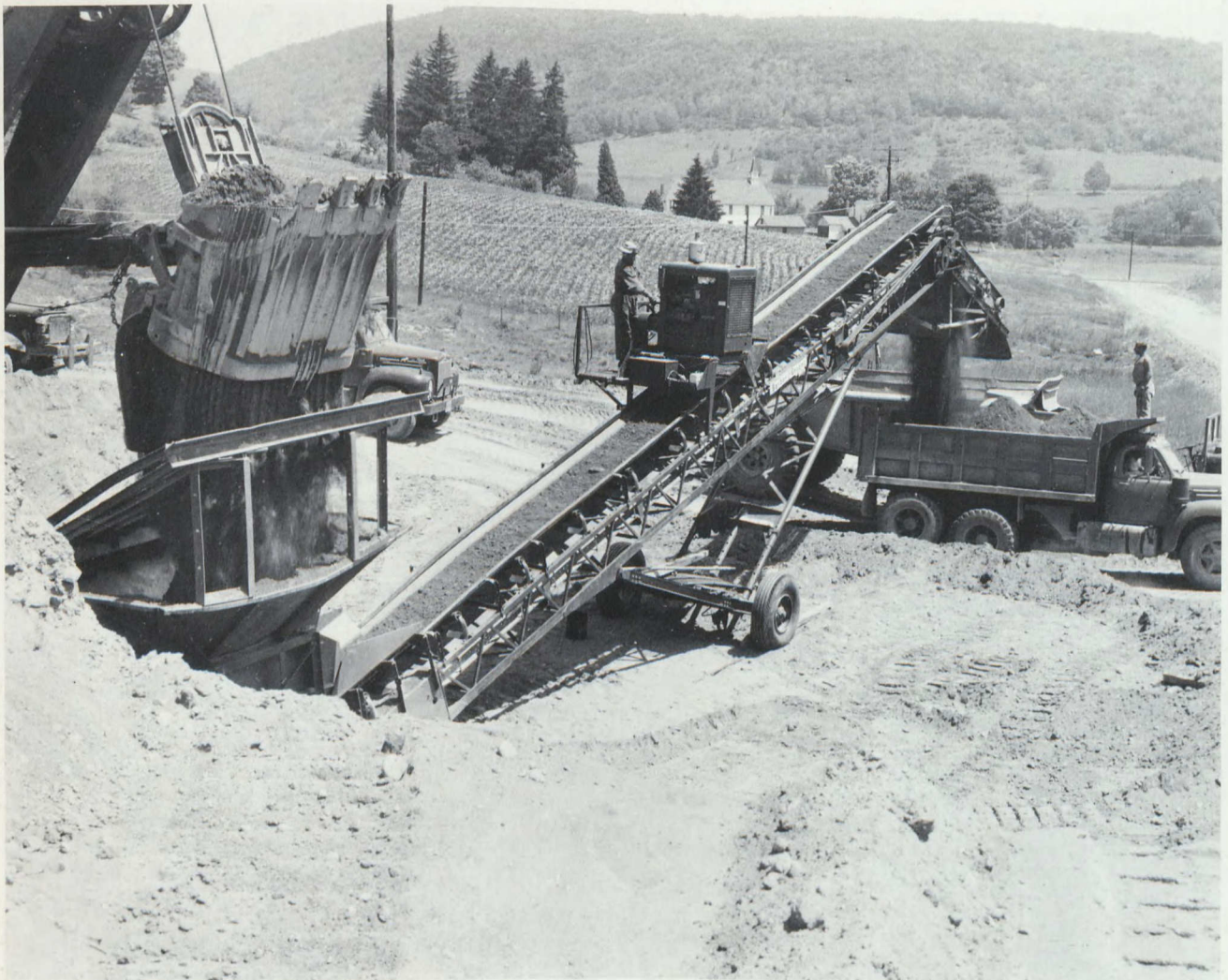
Model SA-41 crawler-mounted asphalt finisher from Barber-Greene Canada Ltd. paves from 2.43 to 5.48 m (8 ft. to 18 ft.) wide in thicknesses from 6.5 to 20 mm (¼ in. to 8 in.) at speeds up to 32 m (165 ft.) per min., is available with either tamping or vibratory screeds and automatic screed controls for every operating requirement.



Portable Gyrasphere closed circuit aggregate plants combine either 91 cm or 121 cm (36 in. or 48 in.) crusher with double or triple deck screens mounted on a single, highly portable chassis. Screens range from 1.21 to 3.65 m (4 ft. to 12 ft.) to 1.52 to 4.87 m (5 ft. to 16 ft.). The Gyrasphere crusher eliminates costly maintenance welding, yet will take maximum size feed and produced finished sizes at capacities far in excess of conventional jaw-roll plants.



Manufactured by Barber-Greene Canada Ltd.
Model PS-70 portable conveyor screening plant
manufactured by Barber-Greene Canada Ltd.
Sized aggregate can be produced at the job site
at rates up to 572 metric tons per hour (630 short
tons). Units available with both single and double
deck screens, belt widths from 47 to 91 cm (18 in.
to 36 in.) and trap or hopper feed. Pneumatic tires
permit fast moves on the job site and fast travel
between sites.



Model KI-35 asphalt mixing plant with all components — aggregate feeder, dryer, dust collector and mixer — mounted on a single, highly portable chassis. Plant is 10.66 m long, 2.43 m wide, (35 ft. by 8 ft.) and has a travel height of 4 m (13.5 ft.). Capacity ranges from 27 to 36 metric tons per hour (30 to 40 short tons).



Pit Panther dual portable aggregate plant from Barber-Greene Canada Ltd. produces up to 408 metric tons per hour (450 short tons) of three aggregate sizes, and is ready for travel without dismantling. It includes 101 cm by 76 cm (40 in. by 30 in.) pneumatic-tire-driven double-roll crusher, 30.5 to 91 cm (12 in. by 36 in.) fast set jaw crusher, 1.5 to 4.87 m (5 ft. by 16 ft.) full triple-deck horizontal screen, high-capacity rotary elevating drum, and plate feeder, all mounted on a single chassis.



CHAIN SAWS

Pioneer Saws Ltd., a subsidiary company of Outboard Marine Corporation of Canada Ltd., manufactures a complete line of portable chain saws and saw chain. Saws available range from light-weight consumer saws to high-output professional saws used by loggers world-wide. All models have low vibration levels; quiet, spark-arresting mufflers; and automatic re-wind starting. Some saws are available with transistorized ignition, automatic chain oiling and nylon fuel tanks. These saws are designed to enable the user to easily make adjustments and do field maintenance.

Pioneer manufactures accessories to adapt these saws to many uses. Available is a multi-purpose

cutter for cutting concrete and steel, a brush cutter, and power take-off stand to enable the saw to power a pump or compressor. Many other accessories such as roller-nose guide bars, sprockets, and various chains are available. A number of models are designed specifically for commercial application and are presently fulfilling many military uses. The Pioneer model 650 is standard with the British army for demolition, clearing military sites, and for use during national disasters. Pioneer Chain Saws are distributed world-wide. Parts, service, and product knowledge is available in nearly every country.



CANADIAN ARSENALS LIMITED

FILLING DIVISION

Canadian Arsenals Limited consists of facilities to load explosives and propellants into end-products, such as artillery shells and charges, mines, bombs, grenades, torpedo warheads, depth charges, anti-submarine projectiles, signals underwater sound and rockets. Initiating, delay, tracer, conducting and pyrotechnic compositions are manufactured. These are loaded into detonators, delays, primers, tracers and cannisters. Assembly into end-products includes filling and assembly of various fuzes, amongst which is the proximity.

The facility is staffed and equipped to cover all activities from the quality acceptances of the basic materials and components to the production of explosive compositions, the filling operations, the assembly and the final inspection of the end-products.

Continuous experimental development work is conducted to improve reliability, performance, safety and cost of compositions used in electrically, stab or friction initiated explosive devices. Development also embraces the miniaturization of initiators. New compositions and initiators are designed to meet specific needs.

Cast and press loading of explosives into large and small volumes and variety of shapes are standard operations. The pelleting of explosives, including various initiatory compositions, is also a part of such operations.

A close process control is maintained throughout all activities of the manufacturing cycle and those functions associated with it. Quality assurance programs meet U.S. Military Standards. Safety and security are priority factors. In support of these programs and controls are the various laboratories. Laboratory equipment is traceable to standards of primary reference.

Equipment in the chemical laboratory includes semi-micro balances, differential thermal analyzers, spectro-photometers, friction pendulum, ignition temperature tester, drying facility and ball and disc impact sensitivity apparatus. Here

also, small batches of sensitive substances are produced before scaling up for full batch production and these operations are often used to develop the specialized techniques required to handle new formulas. Such techniques are important where exacting accuracies or handling of sensitive or dangerous materials are involved. In the electronic laboratory, calibration and environmental tests of electronic components and assemblies are performed. Some of the equipment is for static and dynamic testing of electrical parameters, temperature and humidity cycling, vibration, spin, centrifuge and shock. Also available are very high speed spinners and very high-g simulators. This capability includes the measurement, analysis and assessment of proximity fuzes in the development or investigation phases.

A radiographic laboratory of five separate units covers a range from 10 to 300 Kilovolts as well as a 220 Curie Cobalt source. Large and small assemblies, including those in the millimeter range, can be processed on a conveyor line basis. Proofing under quality assurance responsibility encompasses tests of detonators, delays, fuzes, primers, flash, smoke and other special explosive devices. Testing is carried out for sensitivity, pressure bar, sand crushing, dent test output, delay times, jolt, jumble, drop, low and high frequency vibration, and light and smoke generation output.

Precision gauges and specialized machinery, due to the nature of the work involved, are in many instances designed and fabricated on the premises in a well-equipped toolroom.

The facility has a high volume production and material handling capability. Some recent manufacture covers 20 mm and heavier calibre artillery ammunition, anti-personnel mines, signals underwater sound, anti-submarine projectiles, assemblies for flares and various separate fuzes, including proximity.

SMALL ARMS DIVISION

The Small Arms Division of CAL has provided the Canadian Armed Services with equipments and designs consistent with the exacting demands of ordnance work where consistency and long life to rigorous specifications is taken for granted. High speed deep-hole drilling, high quantity and accuracy broaching as well as internal chroming facilities are but three of the techniques available at Small Arms which ensure a production in accordance with specifications and to inspection standards.

The very special qualities of any Arsenal and more particularly CAL, as it is a self-reliant and completely self-contained operation, makes it a valuable back-up source to other segments of the defence industry or to industry at large where the peculiar and specialized techniques of any established arsenal are understood.

The design services available at SAD have made vast improvements on such standard and internationally recognized weapons as the FN Rifle and the Sterling SMG as well produced the 9 mm Browning pistol (Canadian Pattern HP) which is used as a standard side arm in a variety of countries.

The facilities at the Small Arms Division are of more than ordinary interest, as would be expected, and brief summaries of the more salient features are noted.

Metrology and Gauge Laboratory:

The Metrology Laboratory is certified by the Quality Assurance Branch of the Department of National Defence for the calibration of gauge blocks and other precision measuring equipment.

The gauges and other measuring equipment in this laboratory maintain standards which are traceable to National Research Council (Canada), National Physical Laboratories (United Kingdom) or the National Bureau of Standards (United States).

Honing:

The Division has considerable capacity for internal honing with a honing machine equipped to hone bores from 38 - 203 mm (1½" to 8") 2D for Internal Diameter and lengths up to 3.7 m (12 feet). Surfaces finishes are produced in order of 8 RMS (micro finish). Recoil and Recuperation systems on the 105 & 155 mm Howitzers are re-worked on this equipment.

Deep Hole Drilling:

Pratt and Whitney ½ B drilling machines capable of drilling holes up to 19 mm (¾") diameter by 127 cm (50") long.

Barnes drilling machines, presently drilling up to 44.4 mm (1¾") diameter by 2.4 m (96") long.

Bryant drilling machines for precision drilling of small holes to fine positional tolerances in irregularly shaped components.

Other than the drilling of all types of small arms barrels these machines have applications for the drilling of a wide range of components for industry in general.

Broaching:

The Broach Department has 13 surface broaching machines which are pit installed to ensure ease of handling material from floor level and are serviced by an overhead crane system to facilitate the handling of heavy broach tooling. The machines range in size from 10 metric (10 tons) with a 1.7 m (66") stroke to 25 metric (25 tons) with a 2.3 m (90") stroke and are of the double ram type with both oscillating and shuttle table arrangements thus permitting maximum use of operator's time during the cutting period of the machine cycle.

Heat Treatment and Metal Finishing:

The Heat Treating Department is equipped to handle ferrous metal parts in sizes up to that encountered in weapons as large as 20 mm calibre. The bulk of the heat treatment of finished parts is carried out in atmosphere controlled Lindberg carbonitriding furnaces. Barrel forgings are heat treated in non-atmosphere pit furnaces. Induction heating equipment is available in the form of 10 KW and 25 KW units (450 KC) with and without oil quenching facilities. Molten salt and lead baths are available for cyanide hardening, neutral hardening, tempering and nitriding. Facilities are available for the heat treatment of all varieties of tool steels.

A special purpose department equipped for electropolishing and hard chromium plating of gun barrel bores and external plating on a variety of small parts. Support facilities include special bore scrubbing and lapping machines and lead-tin alloy plating for use on special conforming anodes.

For further information ask for the separate brochures which exist for this facility.

AMMUNITION DESIGN AND DEVELOPMENT

Space Research Corporation (Que). Inc., has developed a wide range of shells for different applications against a wide variety of user requirements.

The company had conducted full service development programs on these systems, from concept through system study, initial design, detail design, feasibility and advanced development to technical evaluation. Shells have been subjected to hardware analyses to confirm viability for performance, range and accuracy, lethality, safety, fuze compatibility, materials technology, suitability for bulk manufacture, and storage handling and loading. In order to evaluate these parameters, many hundreds of units have been tested at company and service agency facilities.

The technology applied has made use of latest developments in plastics and has pioneered use of a wide variety of techniques not previously used in shell application. Greater flexibility in structural design has been introduced while exceeding the lethality of a conventional shell of comparable weight. Space Research's experience has been applied to overcome the problems associated with both spin and fin stabilized shells. In related fields the company has demonstrated its ability to provide new concepts in ordnance (conventional and radical). It has the demonstrated knowledge to conduct systems studies to determine the service feasibility of concepts. It has proven capability and manufacturing capacities to conduct the necessary hardware programs. The company has also developed gun launched rockets and has been active in the field of package design of instrumentation and payloads for the high 'g' environment.

Recent revival of interest in "conventional" ordnance has established a requirement for capability in the fields of sophisticated structural design and flight dynamics coupled with a knowledge of the service requirements of gun/weapon systems. This capability has been established at Space Research.

The Aeroballistic Laboratory at North Troy/Highwater straddles the U.S.-Canada border, and is the main SRC facility. Staffed by a permanent complement of approximately 100 engineers, technicians and supporting staff, this site contains electronics, instrumentation and photographic laboratories, along with extensive machine shops and ranges.

The 10,000 acre complex includes a large firing range for both horizontal and vertical flights. It is instrumented with both tracking and surveillance radars, telemetry receiving stations, high speed photograph stations, and electronic facilities for special instrumentation. Normal launch control and surveillance procedures for range co-ordination and safety are followed. Other smaller ranges are equipped for small arms testing, explosive studies, rocket static testing and special purpose programs.

Among the complex of guns regularly employed at this site is the 52.4 m (172 ft.), 41.6 cm (16.4 in.) smooth bore which recently attained a velocity over 3,048 mps (10,000 fps) with a cone-sabot combination weighing 63.63 kg (140 lb.). Other guns installed here are 127 mm, 155 mm and 203 mm rifles and extended calibre smooth bores. The range staff conduct design, development, testing, and evaluation programmes for both government and industry.

IMPACT EXTRUSION COMPONENTS

One of Canada's largest manufacturers of aluminum impact extrusions is General Impact Extrusions (Manufacturing) Ltd., Toronto, Ontario. This Company specializes in the impact extrusion of metals, primarily aluminum. Its fabrication capabilities include a wide variety of precision defence components, collapsible tubes, vials, mailing containers, aerosol cans and other lithographed parts for the packaging industry; and various components for the automotive, appliance, electronic and atomic fields.

General Impact Extrusions have, for many years, produced parts and components for defence applications. Items produced include pistons, ammunition shells, missile parts, flare casings, rocket components, tail fin assemblies, and many other precision cold forgings.

Impact extrusion is a process of cold forming metals under high pressures. This method is a most efficient way to produce cans, shells and other hollow shapes. It is a high output process ideally suited to satisfy not only the precision military requirements, but also the high volume requirements of the packaging, automotive and electronic industries. Press capabilities

for impacts are up to 15.24 cm (6 in.) diameter in lengths of up to 63.5 cm (25 in.) and for precision forward extrusions up to 6.4 cm (2.5 in.) diameter in lengths of up to 3.04 m (10 ft.) maximum.

G.I.E. production facilities include 24 extrusion presses and well over 160 miscellaneous machine tools, draw presses, coining presses, lathes, automatic chuckers, multispindle chuckers, automatic drills, automatic screw machines, drill presses and special purpose machines to handle components from 3.175 mm ($\frac{1}{4}$ in.) to 177.8 mm (7 in.) diameter in lengths of up to (25 in.)

Heat treating, annealing, anodizing and alodining facilities are also available to ensure that the level of quality control demanded by the Company is, in fact, maintained.

A competent engineering staff is available for your assistance. Engineering services include alloys selection, strength and performance specifications, part designs, and production engineering. Other services include small lot production for pre-production testing, evaluation and testing of physical properties and performance.



MINE ANTI-PERSONNEL NON-METALLIC C3A1 (M25)

These mines were developed by the Canadian Army and have been accepted as standard by ABC countries. The C3A1 version contains an aluminum shell 6 gr detonator, while the M25 contains a gilding metal shell M 46 detonator. The two versions are otherwise identical. Each is a low cost plastic groundburst mine supplied in 2 principle assemblies, consisting of the body assembly; 5 x 7.5cm (2 in. diameter by 3 in. long) with a weight of 57 gm (2 oz.); and the charge assembly, 3.8 x 5.6 cm (1.5 in. long by 2.2 in. diameter with a weight of 28 gm (1 oz.). The total weight of the explosive is 9.45 gm. The body assembly has a transit plug, which is removed after the body assembly has been emplaced and replaced by the charge assembly, fitted with a safety clip. Removal of the safety clip prepares the mine for function, under a load of 7.25 — 11.8 kg (16 to 26 lb.). As long as the safety clip remains in place, loads of extreme magnitude will not cause actuation.

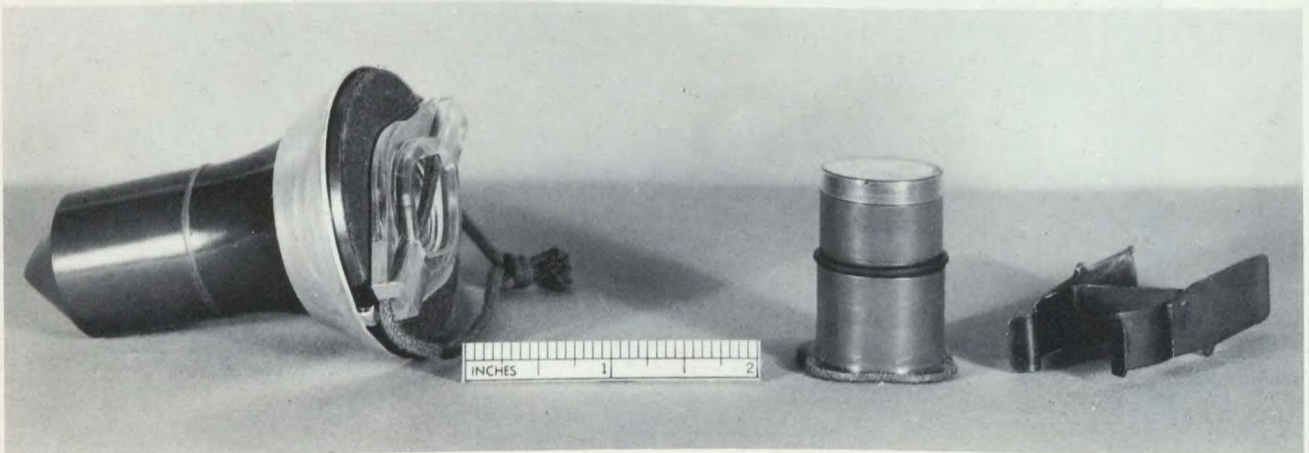
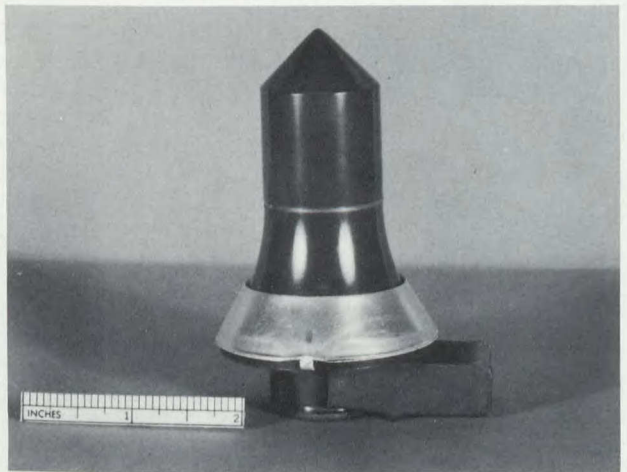
The mines are coloured olive drab and are designed with integral camouflage material. Emplaced mines, after removal of the safety clip, are operationally undetectable with conventional electro-magnetic detection equipment. A detector ring can be fitted if this should be required, which makes the mine detectable by standard methods. This Anti-Personnel Mine is suitable for use in all classes of mine fields in primary or secondary roles. Examples of operational use would be to protect positions to prevent the lifting of Anti-Tank Mines and to deny terrain to attacking forces. The mine has been loaded by Canadian Arsenals Limited, Filling Division, with components supplied from various sources. The item is in volume production for the United Kingdom.

MINE ANTI-PERSONNEL NON-METALLIC PRACTICE C4A1

The mine is a practice version of the C3A1 (M25) H.E. mine.

The emplacement assembly and function of the practice mine is the same as for the H.E. version. On actuation, the mine produces a blue coloured smoke signal.

Identification of the components is made through the use of standard NATO colours. It is constructed of plastic materials and is reusable at least five times by replacement of the spotting charge and the re-cocking of the body assembly. This item has been in volume production for the Canadian Forces and the United Kingdom by Canadian Industries Limited and other contractors. Imitation inert and dummy versions of the C3A1 Anti-Personnel Mine have been manufactured and are available as required.



FUSE ASSEMBLIES AND PRECISION METAL PARTS

Marsland Engineering Limited has an established high quality in-house facility to produce fuses of the M524 type at a high production rate.

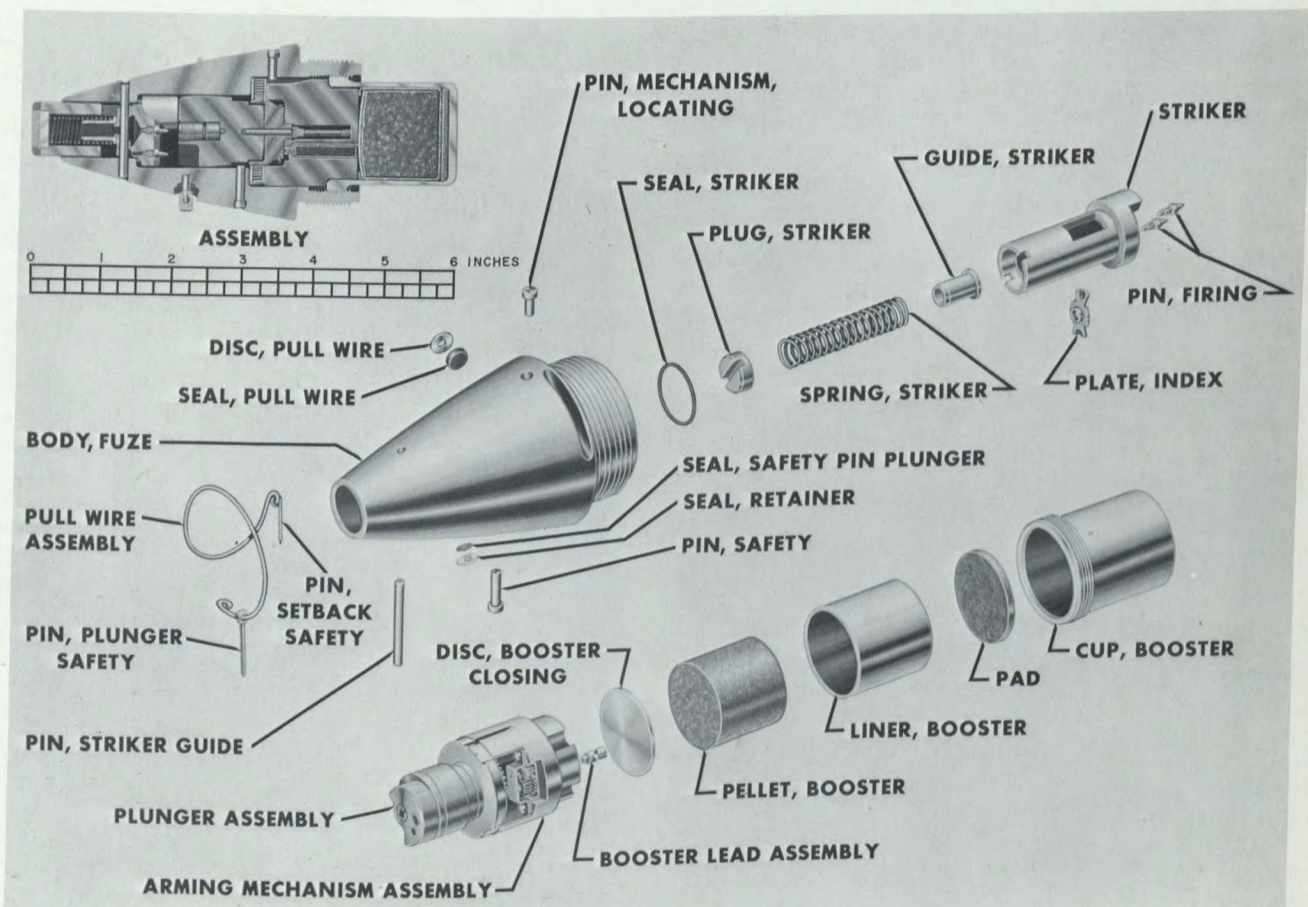
This integrated capability is built around equipment easily adapted to the production of precision parts for commercial needs while giving the facility more scope than a single purpose ordnance plant.

The Company has a long history as a quality supplier of mechanical parts and assemblies from stampings through machining of complex shapes and the cutting of gears, pinions and cams, on modern automatic equipment. All of these facilities are utilized in the kit for the M524 fuse which is supplied to loading plants as required. Wherever there is a demonstrated need for special production machining equipment, the

Company designs and builds linear as well as rotary transfer machines of high accuracy, so that unskilled operators can be used to achieve maximum output quickly.

Other products include teleprinter equipment, military display systems for ship and aircraft installations, electronic components such as loudspeakers, transformers, resistors and television tuners.

A very complete electro-mechanical design and production engineering department is fully staffed at all times and is supported by development and environmental test laboratories. The Company has successfully handled research and development contracts for many international customers in both the commercial and the military fields.



TRANSPORTABLE SHELTERS AND HOUSING UNITS

The requirement for a transportable shelter, whether to provide temporary/permanent medical areas, to shelter Polar exploratory teams, or to provide a base with environmental control for the repair and maintenance of delicate instrumentation will invariably be thought of or provided under circumstances of exigency. The shelter will usually be produced at a high cost and to low specifications which fail to meet requirements. ATCO (Research & Development), operating in Canada's severe environmental conditions, has designed modular units to meet varying uses across a wide range of temperatures. In most cases they are air transportable, and in many cases, as assembled units, can be placed in site position by helicopter. The following pages will outline the depth of ATCO's contribution to this field.

ELECTRICAL EQUIPMENT SHELTER (EL 816)

The EL 816 is an advanced concept Electrical Equipment Shelter designed for the U.S. Navy, which features air, sea and land mobility, a complete electrical distribution and monitoring system, and self-contained environmental control. ATCO's EL 816 provides operational efficiency in extremely severe environmental conditions; -34.5 C° to 49 C° (-30°F to 120°F) wind-driven snow at 161 km/hr (100 MPH), salt spray normal to naval ship operations, sand and dust found in arid desert regions, fungus, mildew, water and vermin.

The overall dimensional specifications are 2.4 m wide by 2.4 m high by 4.8 m long (8 ft. x 8 ft. x 16 ft.). Within this area are two isolated and EMI shielded rooms. The smaller room houses all power conversion equipment, the master electrical control panel for three types of input service and air conditioning and heating systems. The larger room provides an operational area for five operators in front of an equipment rack designed to handle a 1.8m (6 ft.) instrumentation and control console. Conditioned air is ducted to and from each rack position and into the operators area.

The floor, roof and wall sections are bonded sandwich panels using aluminum face sheets, phenolic impregnated paper honeycomb with polyurethane insulation. Structural members are of high strength aluminum alloy extrusion. Design environmental conditions meet temperatures of -32C° (-25°F) to 52C° (125°F) in wind gust conditions exceeding 161 km/hr (100 MPH).



MODULAR RELOCATABLE FIELD HOSPITALS

Modular relocatable hospital complexes, of the type pictured, have been designed and fabricated for many military and civilian purposes in the past few years. Several have served as casualty facilities or hospitals in South East Asia, Pakistan, Venezuela and Canada. Sizes range from 12-bed dispensaries to 100-bed hospitals completely pre-finished with cabinets and fixtures, and equipped with full environmental control suitable for the climatic conditions encountered.

These units may contain the following facilities:

- General administration offices
- Emergency treatment facilities
- Pharmaceutical services
- Kitchens
- Operating room
- Sterile room
- Admission services
- Laboratory services
- Lead shielded radiology section
- Laundry and maintenance services
- Scrub room
- Recovery room

These hospitals can be designed to meet any required combination of private, semi-private or ward configurations by virtue of their modular concept.

All hospitals have utilized economies of wood frame construction and are designed around a knockdown, modular concept and if necessary can be relocated. In one case a hospital facility was completed in less than six months, replacing the original structure which had been destroyed by fire, and has proved to be, after several years, a highly efficient, durable, and aesthetically attractive structure which would compliment any community.

Similar structures of a modular, relocatable nature are available for other institutional-type facilities, such as schools, laboratories and recreational buildings, or commercial facilities such as banks, mercantile centers and motel/hotel combinations.

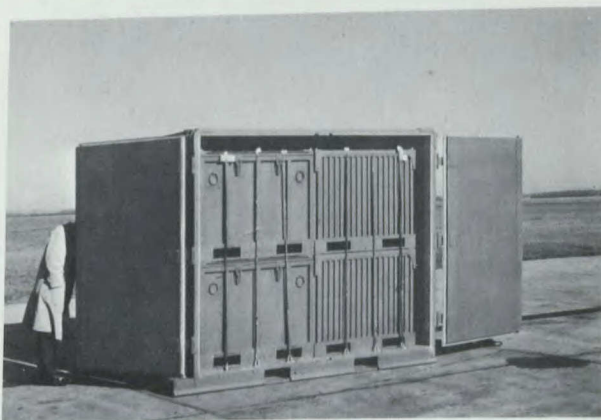
LIGHTWEIGHT MULTI-PURPOSE CONTAINER/PACKAGING SYSTEM (MC/P)

The Lightweight Multi-Purpose Container/Packaging System provides lightweight, versatility and durability in container/packaging hardware. The ATCO MC/P embodies a totally new concept in the rapid mobility and air transportability of support equipment, for long and short term deployment.

Designed to accomplish objectives pertaining to the USAF "Bare Base" program, the MC/P system hardware is composed of a Master Consolidation Container to contain an inter-mix of full-size and half-size Modular Containers, Cargo Cage Modules and combinations of Modular Shelving Assemblies for general purpose cargo. The ATCO MC/P system provides for 463L cargo handling and restraint compatibility, in addition to other existing air cargo, rail, road and ship restraint systems. Integral sling tie-down points facilitate crane lifts and helicopter sling load. Forklift capability is built into the Master Container and all Modular Containers and Cargo Cage Modules.

The components of the MC/P utilize aluminum and other lightweight materials to maintain optimum strength-to-weight ratios for durability and rough handling capabilities. Wall and roof sections of the Master Container are constructed of high density foam core material sandwiched between aluminum face sheets.

Significant features are environmental control for humidity-sensitive cargo and collapsible modules to reduce empty shipping volume by a factor of three. Other containerization of a similar nature is also provided for munitions to ISO type shipping modules.

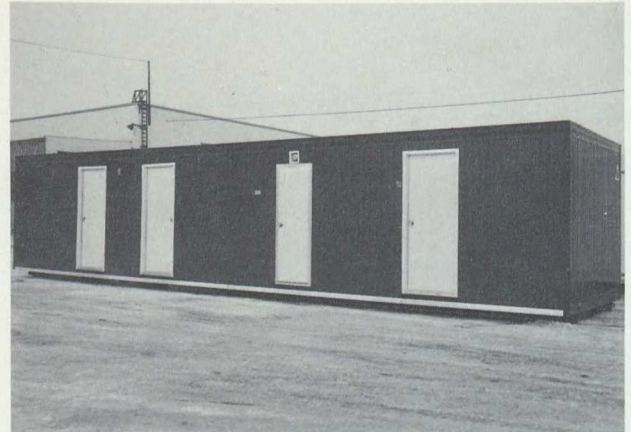


AIR TRANSPORTABLE CAMP

The ATCO Air Transportable Camp is a complex of various unit configurations, designed to provide rapid mobility by a typical modern air cargo plane to remote locations unserved by over-land transportation.

Air Transportable units are fabricated by up-to-date production line methods using basic wood construction techniques with metal clad exteriors for maximum durability from the elements. Interior treatments are aesthetically pleasing and roomy for living, sleeping and administrative activities. Joining corridors are available to centrally cover entrances and to join units to eliminate the need for personnel to expose themselves to outside conditions while moving from unit to unit within the complex.

Unit specifications provide for maximum unit size within the envelope of a typical cargo aircraft. Nominal dimensions being 2.7 m wide by 11.8 m long (9 by 39 ft.), an average camp complex is composed of 10 units, and when located will provide self-contained accommodation, eating, recreation and administrative facilities for 40 to 50 men.



RELOCATABLE METAL BUILDINGS

The relocatable steel building is an expandable, steel structure, ideally suited for use in an aircraft hangar, equipment maintenance facility or storage warehouse. It is manufactured in several sizes with optional insulation and special stressing for heavy snow loadings.

The building is fabricated in 3 m (10 ft.) sections that provide a clear span of 7.3 m to 18.4 m (24 to 60 ft.). Sections can be added in multiples of 3 m (10 ft.) sections to increase the size of the building as required. Optional section length of 2.4 m or 2.7 m (8 or 9 ft.) is available for air cargo transportation.

A standard 12 m (40 ft.) wide building section, in its folded configuration for transport is 6.5 m long by 3 m wide by 66 cm high (21.5 ft. x 10 ft. x 26 in.). Installation and erection is achieved with a minimum of tools and equipment with an unskilled crew.



HELICOPTER TRANSPORTABLE CAMPS

This camp complex is manufactured in several optional configurations by standard production line methods. Helicopter camp units are available with numerous custom features to provide a completely self-contained comfortable living, sleeping and administrative facility. The primary criterion is to achieve rapid deployment and re-deployment for a highly mobile military unit or work force. The complex is designed to withstand severe climatic extremes, ranging from arctic to tropical, in arid or high humidity conditions. Economics of conventional wood construction are utilized, together with exterior metal cladding for protection from the elements, lightweight styrospan insulation and modern interior finishes to achieve and aesthetically appealing yet durable living environment.

Unit specifications provide maximum weights within the capability of typical freight helicopters and range between 725 kg and 1725 kg (1600 to 3800 lbs.) depending on optional features and equipment installed. These helicopter units are cube form with the typical shell size being 2.7 m to 5.5 m (9 to 18 ft.) nominal.



AIRMOBILE MAINTENANCE SHOP (AMS)

A lightweight, high strength, helicopter road transportable mobile shelter with numerous military and commercial applications. It meets military requirements and standards for worldwide environmental service conditions.

The AMS features a vertical expansion ratio of 2:1 and can be deployed or folded by three men in five minutes with no special tools required. The vertical folding feature provides for transportation inside a CH-47 Helicopter. The shelter can also be transported as a helicopter sling load and has over the road mobility as a truck load or by its own mobilizer.

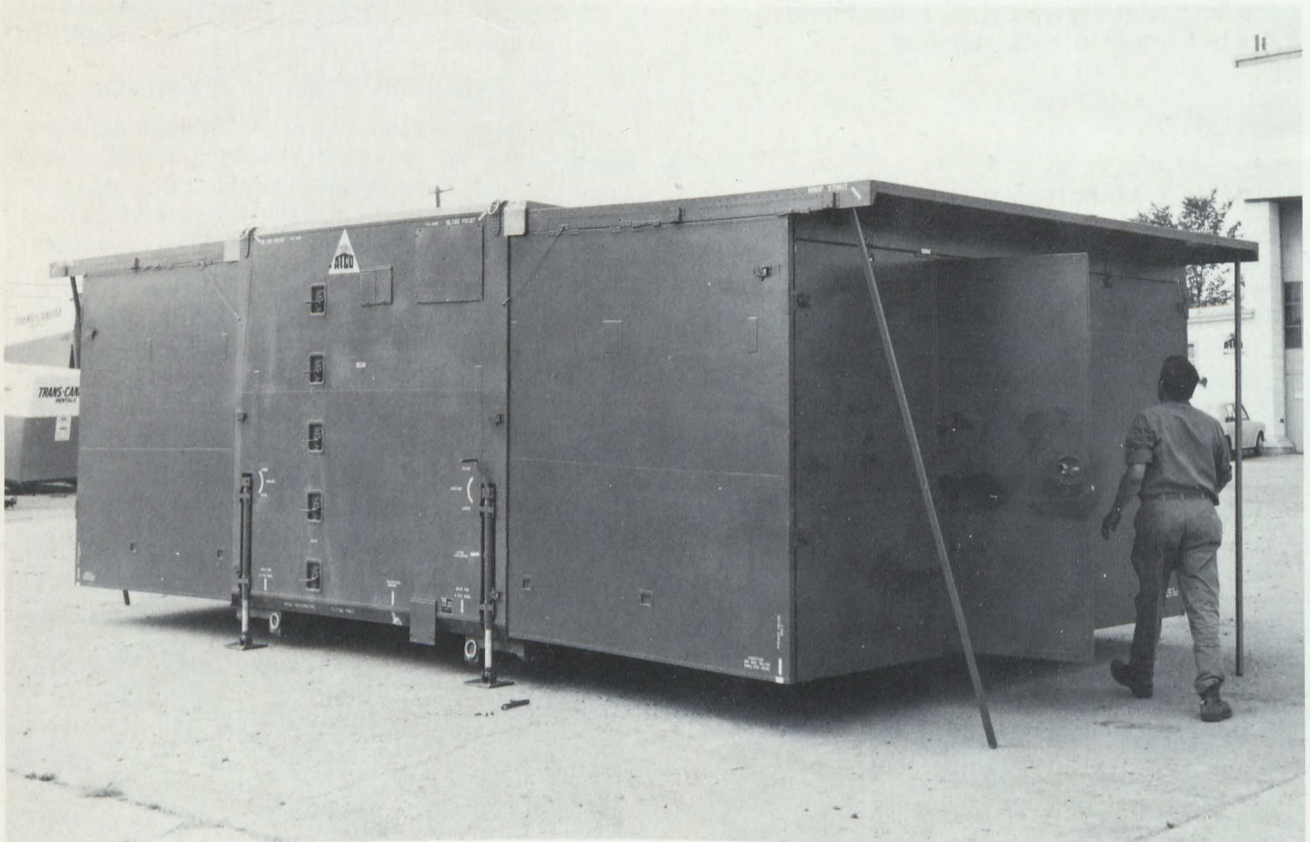
The unit provides 9.2 m² (100 ft.²) of floor area. The AMS is 2.03 m (6.6 ft.) wide by 4.93 m (16 ft.) long and weight 808 kg (1780 lb.) including tool cabinets and detachable mobilizer. The floor, roof and wall panels are constructed of bonded sandwich panels using aluminum face sheets, and phenolic impregnated paper honeycomb. Operational environment range is -54°C (-65°F) to +74°C (+165°F).



MULTI-PURPOSE EXPANDABLE SHELTER (E 277)

The Multi-Purpose Expandable Shelter is a light-weight, highly mobile, self-contained, insulated, air transportable shelter with many military and commercial applications. It will meet military requirements under extreme environmental service conditions.

The E 277 design incorporates a lateral expansion feature which provides a floor area enlargement ratio of nearly 3:1 and can be deployed by 3 men in less than ½ hour without special tools. Self-contained lifting, towing, leveling, cargo handling and restraint mechanisms are provided. The ATCO E 277 is designed for air transport or as a helicopter sling load, or transport by truck, rail or ship. Floor area in deployed configuration exceeds 24 m² (260 ft.²) and weighs 1044 kg (2300 lbs.). Dimensional specifications in the expanded mode are 6.41 m (21 ft.) wide by 4. m (13.2 ft.) long and 2.17 m (7 ft.) of head room.



SMOKE GENERATOR, AIRCRAFT, ORANGE

Helicopter pilots operating in remote areas frequently require reliable ground wind information prior to landing at unprepared sites. A coloured smoke generator has been designed specifically to meet this requirement.

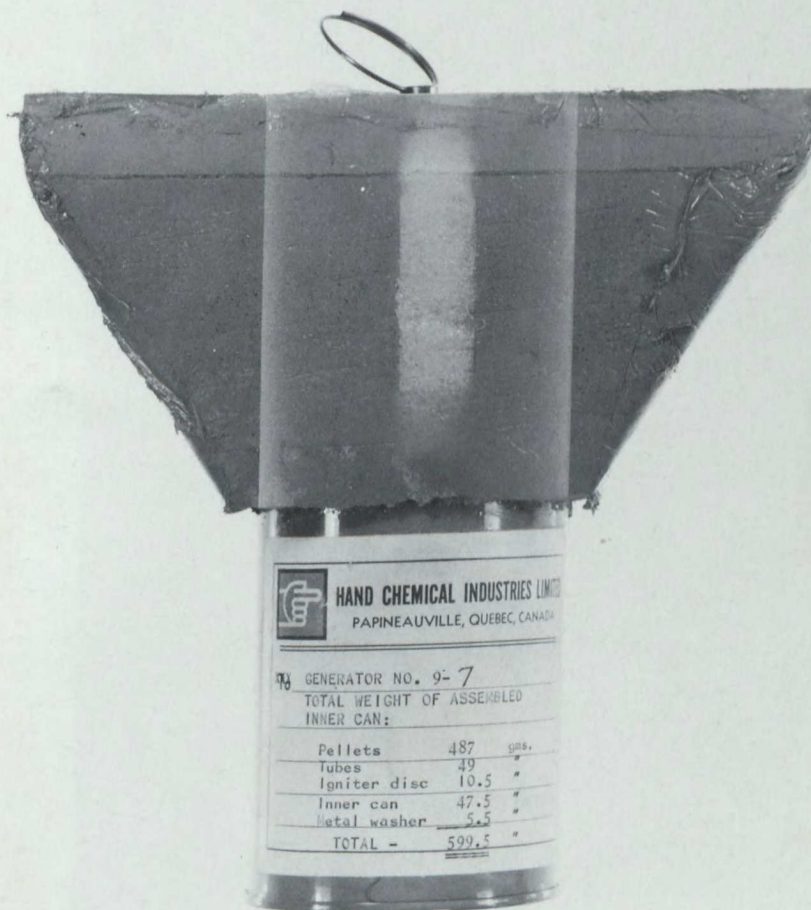
The smoke generator functions on land or water, does not bury itself in soft ground or marsh, and creates no fire hazard even in dry grass, or similarly inflammable ground cover. The store is designed to obviate the probability of accidental initiation in the aircraft.

The smoke generator contains an extremely low-temperature burning composition producing an orange smoke, visible from a 2,000 foot altitude at a slant range of one mile, against either summer or winter backgrounds. Smoke duration is two minutes. (Altitude 610 m and slant range 1.6 km). The generator is a 7.6 x 20 cm (3 in. diameter metal cylinder 8 in. H.). This cylinder is surrounded

over its upper half by an expanded poly-foam body, 51.6 cm² (8 in.²) in cross section but tapered in its lower half. This body acts as a flotation chamber in water, ensures that the generator will land in an upright position on the ground, and retards the device in air-drop to reduce landing shock and earth penetration. The total (unpacked) weight of the item is 2¼ pounds. The generator, including the firing mechanism is completely sealed.

The generator is armed by a pull-type mechanism (three pound pull). A fifteen second delay allows ample time for ejection from the aircraft. Burning will go to completion regardless of immersion in either salt or fresh water.

The light re-touched area indicates the position of the can within the floatation element of the generator.



SUPPORT KIT, OVERHEAD PROTECTION (SKOP)

In the construction of a conventional two man hair-pin shelter some 80.4 kg (177 lb.) of stores are required. From this figure it may be seen that an extremely large addition would be made to the logistic tail if this much needed protection were to be carried. The conventional shelter is not an acceptable answer to the problem.

The Support Kit, Overhead Protection (SKOP) weighs less than .85 kg (2 lb.) has a volume of 104.87 cc (64 cu. in.) and can be erected, supporting 45.72 cm (18 in.) of compacted earth, in less than 10 minutes.

The Kit, now accepted as Standard A in the Canadian Army, consists of:—

- (a) A camouflaged coated polyolefin film.
This is a membrane which is 2.43 m x 1.52 m

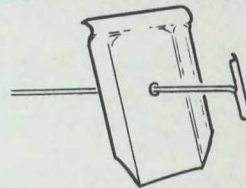
(8 ft. long by 5 ft. wide) and is .010 in. in thickness. To those familiar with the original equipment the woven polyolefin now used is considerably stronger than the older polyester.

- (b) Eight aluminum anchors.
The 15.2 cm x 10.1 cm (6 in. x 4 in.) anchors are chemically treated to improve camouflage characteristics.
- (c) Four terylene cordage assemblies.
The cordage assemblies have a toggle at each end for rapid connection to the anchors. So that the 3.96 m (13 ft.) long cordages may be tensioned and adjusted to avoid obstacles in the ground, they are provided with a guy line hitch.

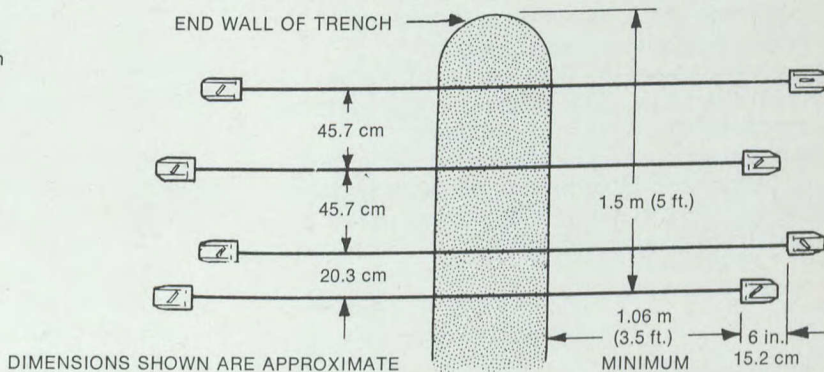


1 DIG YOUR FIRE TRENCH and pile earth 1.2 m (4 ft.) from edge of the part you want to cover.

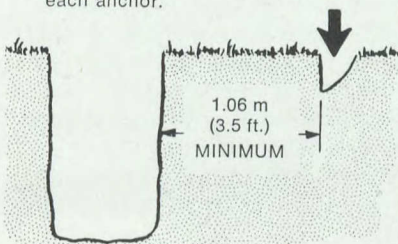
2 ATTACH ANCHORS TO CORDS by pushing the metal end of the cord through the hole in the anchor — do this to all cords and anchors.



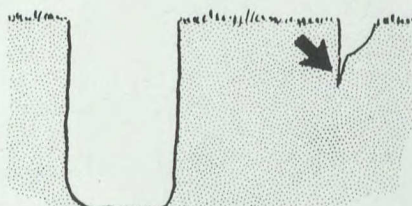
3 LAY CORDS ACROSS TRENCH at 90° as shown, with front cord about 5' from the end wall of the trench.



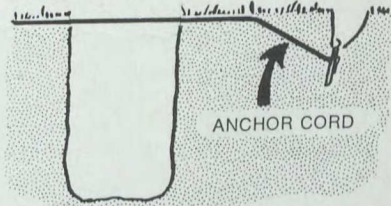
4 DIG IN THE ANCHORS
Dig out a shovelful of earth for each anchor.



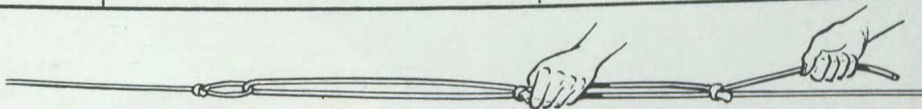
Then cut with the shovel as shown parallel to the trench — this is for the anchor.



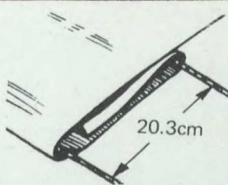
Cut a slot for the cords at right angles to the slot for the anchor. Put the anchor and cord in place, fill the hole and tramp it down.



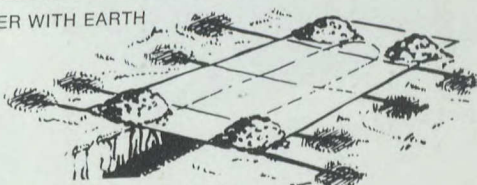
5 TIGHTEN THE CORDS by pulling on the free end of each with a steady pull until well tightened.



6 SPREAD THE PLASTIC SHEET over the cords. Ensure that the sheet is even on both sides of the trench. Fold the sheet around the front two cords as shown. This will allow the sheet to extend about 18 inches beyond the end wall of the trench.



7 COVER WITH EARTH



Pile earth on each corner of the plastic sheet to hold it in place.



Pile and pack a ridge of earth a foot high around the edge of the plastic sheet.



Gently fill earth in towards the centre packing it as you go. The earth cover must be at least a foot thick. Camouflage as required.

CONTAINER HEATER CARTRIDGE

Developed by the Termotrol Division of Galt Equipment Ltd., this unit is for the movement in freight container, of cargo requiring protection from freezing.

The Termotrol CH17 cartridge heater was proven in service operating on railroad and truck. It is completely self-contained; powered by a lightweight high speed Diesel engine. Its main features are the high overall efficiency attained by using the total energy concept and its easy removeability from the container. Its design is simple and its construction rugged. A filled bulb thermostat directly actuates fresh air by-pass dampers to limit the heat input to the container to prevent overheating.

SPECIFICATIONS:

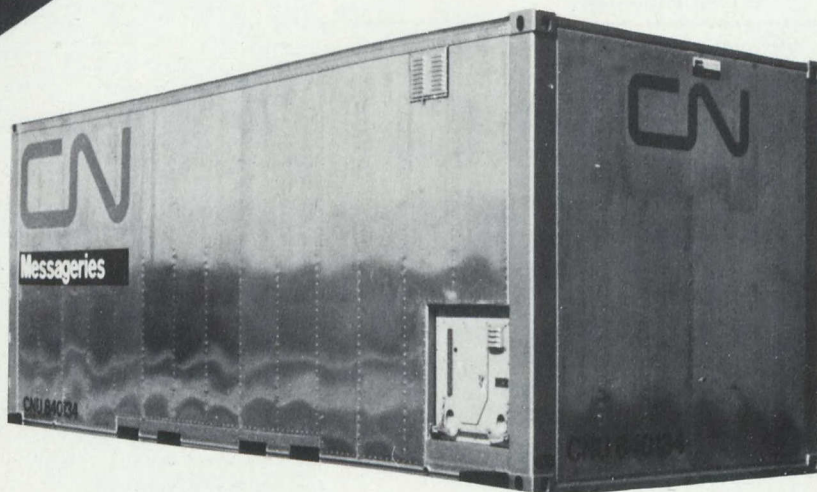
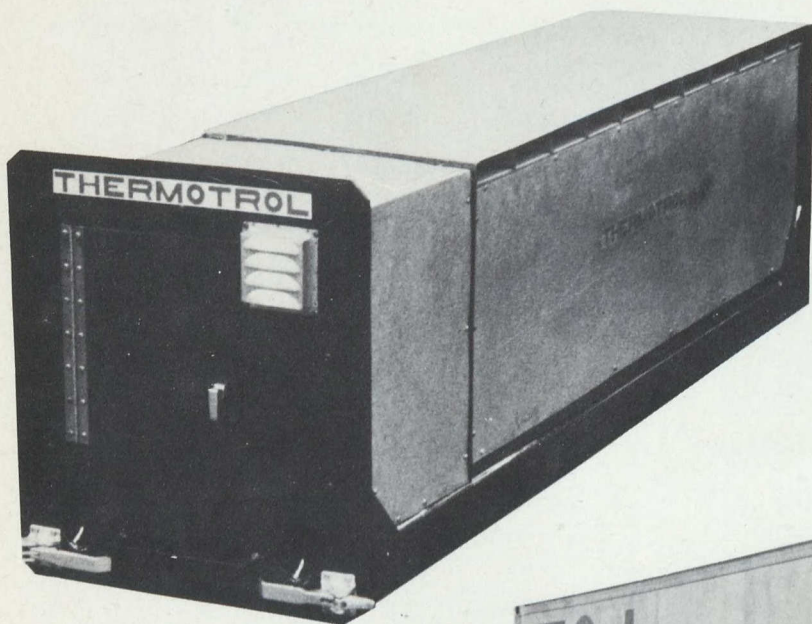
Prime Mover: 3 H.P., one piston, aluminum Diesel

Dimensions:	L	W	H
	242.5 cm (95.5 in.)	53.3 cm (21 in.)	64.7 cm (25.5 in.)

Weight: 228.6 kg (500 lb.)

Range: 5 days fuel, 10 days lube-oil

Capacity: 17,000 BTU/hr.



FASTENING AND CLOSURE DEVICES

Velcro* is a fastening device consisting of two mating tapes which are woven or produced by a continuous moulded process.

The hook, or male section, is covered with very small stiff hooks. The loop, or female section is covered with equally small soft loops. When placed together the hooks and loops engage, creating a highly versatile and secure closure, yet capable of easy adjustment. To open, it is simply peeled apart.

Velcro* closures have been opened and closed up to 32,000 times and still have demonstrated no likelihood of failure. Normal widths of the tapes are 1.6 cm, 1.9 cm and 5 cm ($\frac{5}{8}$, $\frac{3}{4}$ and 2 in.).

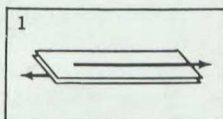
The tapes can be constructed from a variety of materials, with nylon being the most commonly used for clothing and equipment. They are also available in polyester, Nomex (high temperature resistant nylon), stainless steel, Nomex/stainless steel and Beta glass/teflon.

The two most commonly used types are known as Hook 65 and Hook 80 with the difference being that Hook 65 is used where the application calls for frequent opening and closing and it is produced with over 400 hooks per 6.45 cm^2 (in.^2) while Hook 80 is used where there are fewer uses made of the closure and it is equipped with over 200 hooks per 6.45 cm^2 (in.^2). Some of the applicable data for these two types are as follows:

A. Straight Shear, Lengthwise.

Hook 65 has a minimum pull of $.35 \text{ kg/cm}^2$ (5 lb./in.²).

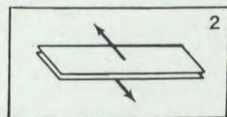
Hook 80 has a minimum pull of $.42 \text{ kg/cm}^2$ (6 lb./in.²).



B. Straight Shear, Width.

Hook 65 has a minimum pull of $.35 \text{ kg/cm}^2$ (5 lb./in.²).

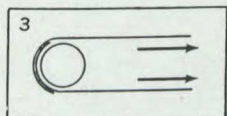
Hook 80 has a minimum pull of $.42 \text{ kg/cm}^2$ (6 lb./in.²).



C. Curved Shear, Lengthwise.

Hook 65 has a minimum pull of $.7 \text{ kg/cm}^2$ (10 lb./in.²) on 11.4 cm (4.5 in.) radius.

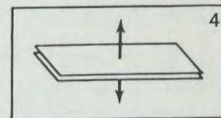
Hook 80 has a minimum pull of $.84 \text{ kg/cm}^2$ (12 lb./in.²) on 11.4 cm (4.5 in.) radius.



D. Tension or Latching Effect.

Hook 65 has a minimum pull of $.35 \text{ kg/cm}^2$ (5 lb./in.²).

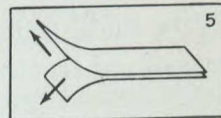
Hook 80 has a minimum pull of $.28 \text{ kg/cm}^2$ (4 lb./in.²).



E. Peel, Lengthwise.

Hook 65, 340 gms per 2.5 cm of width (.75 lb. per in.).

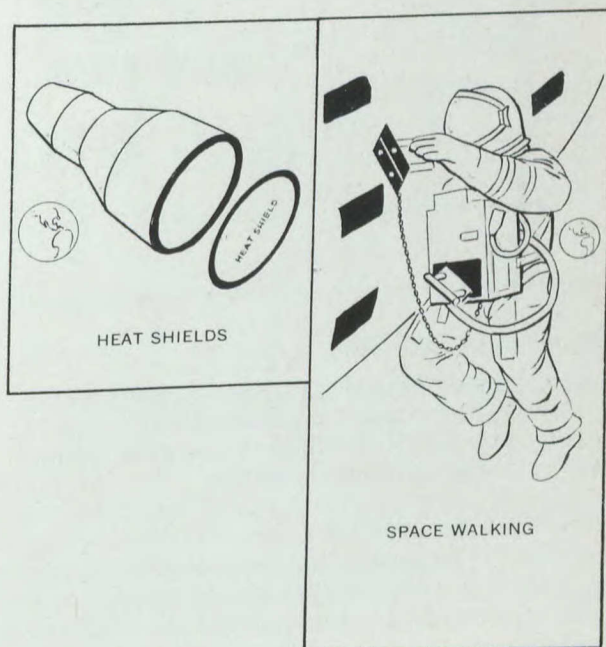
Hook 80, 181 gms per 2.5 cm of width (.40 lb. per in.).



The most descriptive statement that can be made about Velcro is that the end use of the closure is limited only by your imagination. In proof of this statement the following will demonstrate the acceptance of the closure in various fields.

SPACE PROGRAMMES

The fastener tapes and closures were used in spaceflight since the first manned launch in 1961 and have proven their usefulness on the face of the moon. Their value as means of closure and adjustment for securing and anchoring in the weightlessness of space is unequalled. The highest praise from the ranks of the astronauts and those closely associated with them came from Dr. Charles Berry, NASA Medical Director, who observed that flight without Velcro would be most difficult if not impossible.



LOOP TAPE APPLICATIONS

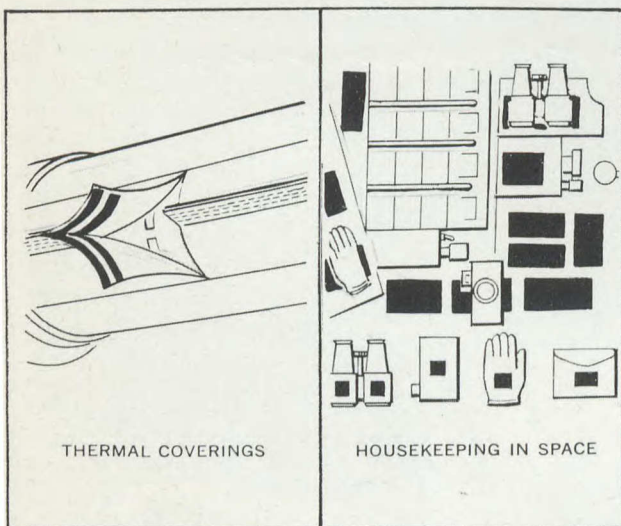
Floor covering of Apollo Command and Lunar Modules for anchoring of astronauts to floor during weightlessness; at spacecraft walls, ceiling tunnel, hatches, seats and on instruments.

HOOK TAPE APPLICATIONS

At shoe soles and heels, food bags, navigational and scientific instruments, utility equipment, stowage bag attachment, cameras and accessories, pens and pencils, flight plans, maps and charts, personal hygiene articles, sun glasses and others.

ASTRO-VELCRO CLOSURE

In space suit assembly, life support back pack, LM hammock and blanket assembly, Velstraps for watchbands and cue cards, stowage bag closure, ruck sacks, saddle bags, survival gear, medical and suit repair kits.



MID-TEMP CLOSURES

Attachment of thermal blankets in Apollo spacecraft and around descent stage of LM. Thermal insulation protection around TV cameras, attachment of tethers to equipment bins.

HI-GARDE CLOSURES

Heat shield attachments at bottom surface and around rocket nozzles of LM, bundling and attachment of lunar experiments, lunar equipment and lunar material sample bags.

Some of the other specialized versions mentioned here are described below.

HI-AIR* COMPONENTS

(Flame Retardant) Special woven hook and loop tapes made of Nomex* composite to meet or exceed existing F.A.A. requirements. A special flame retardent precoated adhesive is available and recommended when bonding.
 Shear: .84 kg/cm² (12 lb./in.²)
 Tension: .56 kg/cm² (8 lb./in.²)
 Peel: 227 gms per 2.5 cm wide (.5 lb./in.)

ASTRO-VELCRO* COMPONENTS

Self-extinguishing tapes woven to meet the unusual requirements of the U.S. National Aeronautics and Space Agency. The loop tape is constructed of Beta glass ground yarns and polyester monofilament hooks #80. A special flourel backing is applied as a binder coating to each tape. This unique product is specially designed to resist burning in a pure oxygen atmosphere such as those encountered in the space programme.

Shear: .56 kg/cm² (8 lb./in.²)
 Tension: .14 kg/cm² (2 lb./in.²)
 Peel: 453 gms per 2.5 cm wide (1 lb./in.)

HI-GARDE* COMPONENTS

All metal, heat and corrosive resistant woven hook and loop tapes. Usable to 427°C (800°F) in applications where type A.I.S.I. #300 corrosive resistant series steels are suitable.

Shear: 1.4 kg/cm² (20 lb./in.²)
 Tension: .21 kg/cm² (3 lb./in.²)
 Peel: 227 gms per 2.5 cm wide (.5 lb./in.)

MID-TEMP* COMPONENTS

High temperature nylon and non-corrosive metal woven in combination to supply a fastener where heat 205° to 260°C (400° to 500°F) conditions exist. Tapes consist of Nomex ground with corrosive resistant wire for loops and hooks.

Shear: .7 kg/cm² (10 lb./in.²)
 Tension: .21 kg/cm² (3 lb./in.²)
 Peel: 184 gms per 2.5 cm wide (.4 lb./in.)

HOOK TAPE RCU #84 (RESTRICTED CYCLE USE)

A specially woven Hook Tape Component designed to meet the requirements of those applications where abnormal strength and ruggedness

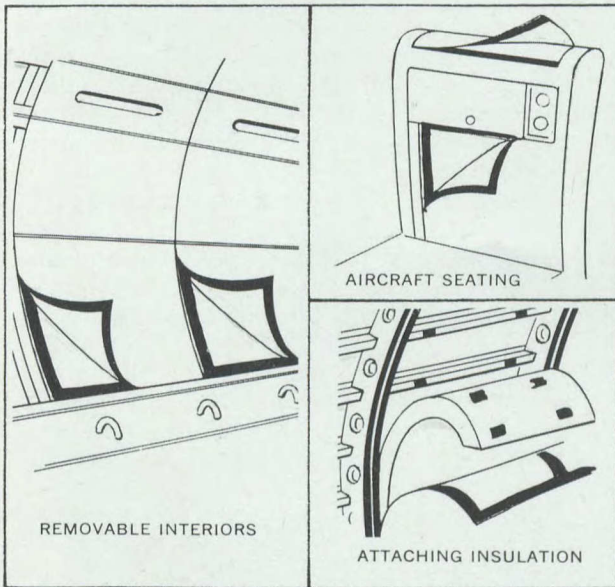
are required. Due to the construction and physical properties of the Hook tape, its use with Loop Tape is limited to approximately 200 opening and closing cycles as degradation occurs to the Loop tape rapidly. The chemical properties of the RCU Hook #84 tape were so designed as to allow its use in areas of extreme humidity and moisture, but the above cycle life restrictions must be noted. Excellent examples for use of the above would be the installation and hanging of ceiling and wall panels.

Shear Strength: 1.26 kg/cm² (18 lb./in.²)

Tension: .56 kg/cm² (8 lb./in.²)

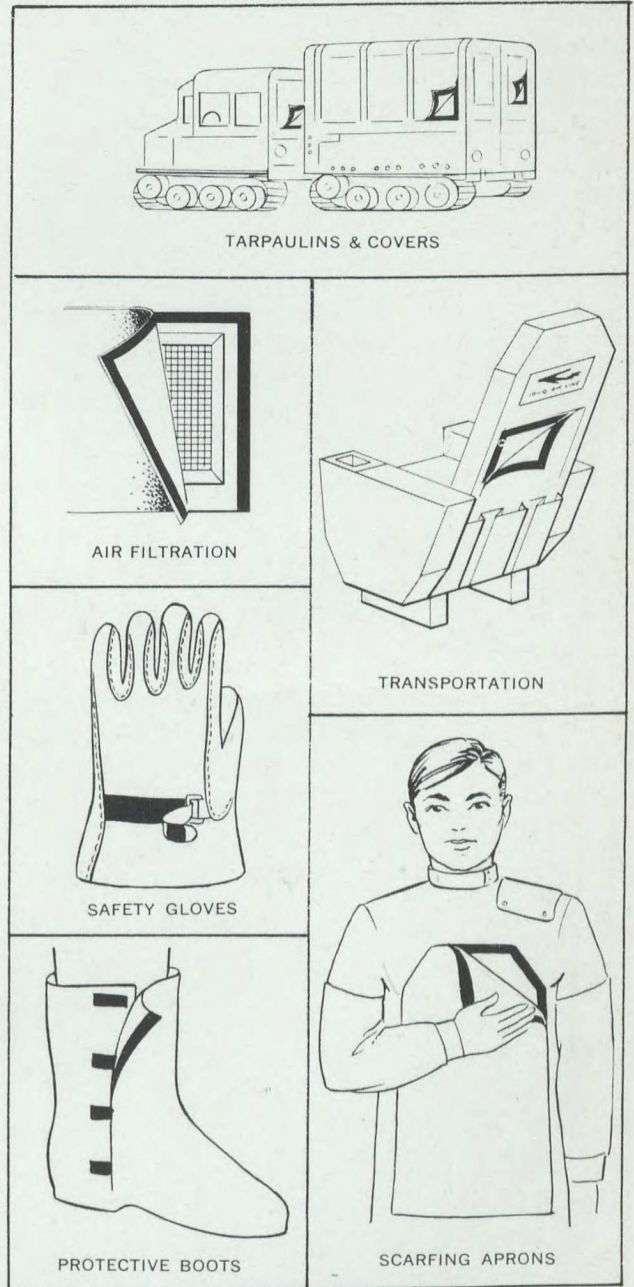
AIRCRAFT

Of prime concern to the aircraft industry is the ever constant problem of excess weight. No other re-usable fastener known today can offer as much holding power with so little weight per pound of hold as Velcro. In addition, all of its other features (complete adjustability, stress load fastening, ease of maintenance, jam and snag proof, interchangeability, etc.) have made Velcro a long accepted part of modern design.



INDUSTRIAL

The industrial applications of Velcro followed rapidly when the numerous advantages (light-weight, non-metallic, non-corrosive, non-jamming and maintenance free) were assessed relative to the stringent demands of such a wide gamut of users.



MILITARY

In the Canadian Forces wide use of these closures have been made in the clothing and personal equipment fields and here you are asked to refer to the Military Clothing and Personal Equipment section of the illustrated section of this book where specific uses are described.

MEDICAL

The use of these closures has received wide acceptance and recognition in the medical field. Its unique qualities provide the medical profession with a completely new concept for fastening items ranging from patient gowns and hospital bedding to bandages, braces and specialized clothing or apparatus used in operating rooms. Because Velcro is non-metallic, completely adjustable, and can be sterilized thousands of times, it is a natural fastening medium for medical purposes. Even the new world of disposables is turning to these tapes since their simplicity and ease of operation permit "throw away" apparel to fit properly and remain comfortable during use.



BED AND STRETCHER RESTRAINTS

ABDOMINAL, WRIST, ANKLE SUPPORTS

ARM BOARD STRAPS

BLOOD PRESSURE CUFF

SPECIAL PRODUCTS

To meet the need of automated and high volume production it was essential to take the hook and loop principal and combine it with a fast method of attachment. The following products combine the simplicity of hook and loop with easy installation.

The new POP-ON disc fasteners were created to simplify installation of Velcro* brand products. The compact discs measure .938" in diameter ($\pm .005$) and are made of glass reinforced nylon, faced with a moulded Velcro* tape configuration. In the center a .130 diameter hole ($\pm .002$) makes ready for quick attachment to a substrate with rivets, screws, or nails. The mating component for POP-ON discs are POP-Mates, POP-ON, or POP-IN fasteners of the opposing element.

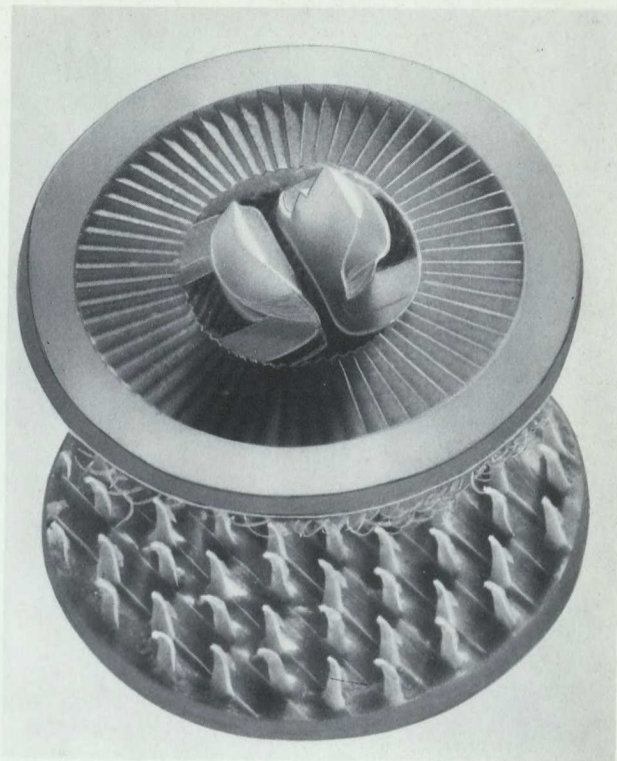
The new POP-IN disc fasteners combine the Velcro* fastening techniques with simplicity of installation. Compact discs made of glass reinforced nylon measure .938" diameter ($\pm .005$). It incorporates a retaining stud on the underside, while the top is faced with one of Velcro's* moulded configurations. Designed for a .250" diameter hole ($\pm .002$) with a thickness of .036" ($\pm .003$). Requirements for strength, cycle use, adjustability and reuseability can be met by various combinations of POP-MATE, POP-ON or POP-IN fasteners of the opposing element. VELTRACK fastener is a one inch wide semi-rigid vinyl extrusion faced with a moulded Velcro* hook or arrowhead configuration. The underside has two parallel locking tracks to provide a simple method of attachment into a .250" elongated slot ($\pm .002$) with .036" ($\pm .003$) thickness. To further simplify installation, VELTRACK fasteners can be delivered precut to required lengths. Mating components could be a POP-MATE, or VELTRACK, POP-ON or POP-IN fastener of the opposing element.

EDGECLIP fastener is a strip of clear vinyl measuring 15/16" wide with 11/16" turned up hang-over on the back to grip the edge of any thin rigid material 1/16" thickness. The face of EDGECLIP fastener will be comprised of one of the Velcro* moulded hook configurations. EDGECLIP fastener can be customized to small precut specifications or up to 48" in length. This product could provide a universal convenience for attachment.

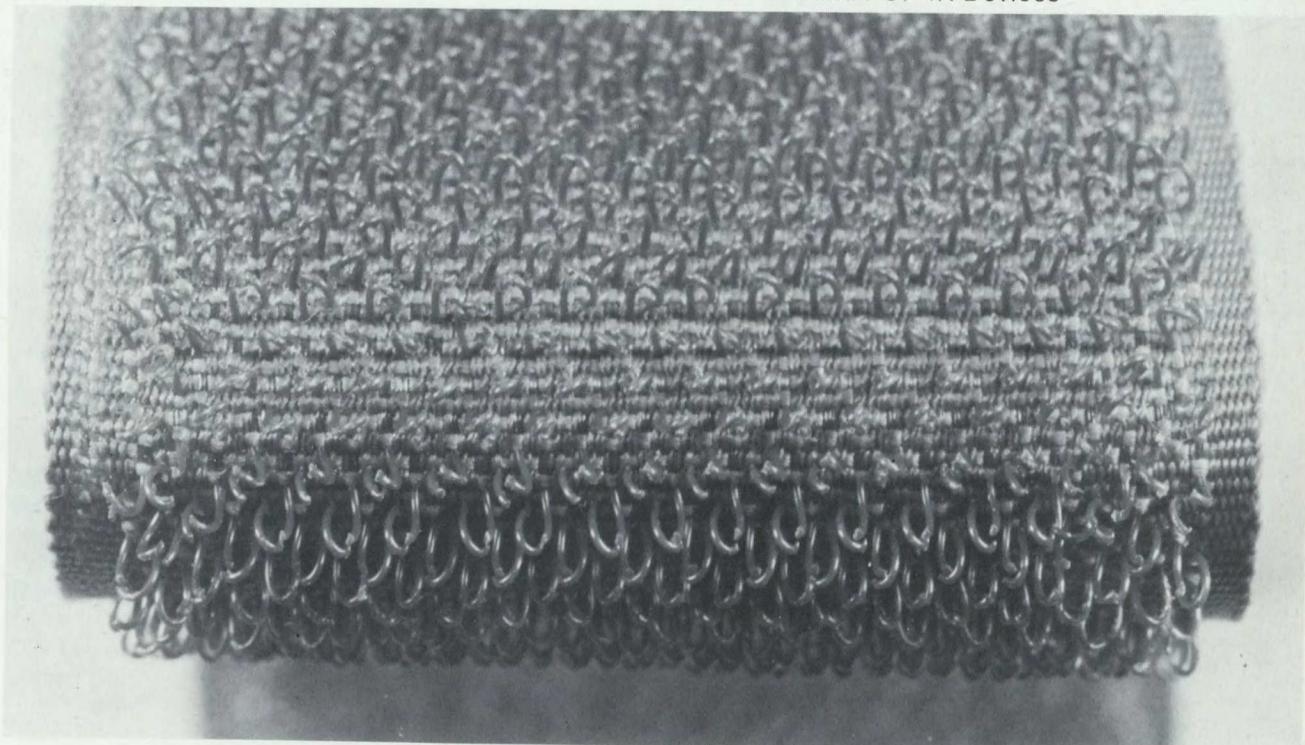
These products are available in the various hook and loop combinations but are mainly used in high shear or tension configurations.

Probably the most descriptive statement that can be made about this closure is one which is attributed to industry — the end use is limited only by your imagination — Canadian Velcro look forward to discussing your future fastening problems with you.

*Velcro is a registered trade mark of Canadian Velcro Limited.



POP-ON and POP-IN Devices



A view of the "hook" or male section at approximately 12x magnification

THE DHC-7 STOL AIRLINER

The DHC-7 STOL Airliner project was begun by de Havilland after the company had conducted a world-wide market survey of short haul transport requirements. United Aircraft of Canada Limited has participated in the development of a quiet engine/propeller combination which will limit external noise to 95 PNdB at 152 m (500 ft) from the aircraft during take-off and landing.

It is a four engined, high-wing monoplane with high lift devices on the trailing edge and spoilers on the wings. The fuselage is circular in cross-section and the tail unit is a cantilever structure with the tailplane mounted on top of the fin. The tricycle gear is retractable with twin wheels on all units.

The power plants are four 1120 SHP Pratt and Whitney (UACL) PT6A-50 turboprop engines each driving a four bladed propeller of 3.43 m (11 ft 3 in) diameter. Special gearing within the engine allows the propellers to turn at low RPM to reduce noise level. Fuel is in integral wing tanks.

Seats for 48 passengers are arranged in pairs on each side of the aisle at 81 cm (32 in) pitch. An outward opening door is on the rear port side. Emergency exits are on each side of the front cabin and on the right hand side at the rear.

Galley and toilet are at the rear. The entire accommodation is pressurized to a differential of 2.98 kg/cm² (4.26 lb in²)

The DHC-7 is capable of mixed passenger/cargo or an all cargo role. Special door installations are proposed to accommodate standard airline containers and heavy duty floors with tie-down fittings can be supplied.

Military applications include utility passenger/cargo transport, search and rescue, and air ambulance.

SPECIFICATIONS

Wing span	28.35 m	(93 ft)
Length overall	24.49 m	(80 ft 4 in)
Height overall	8.0 m	(26 ft 3 in)
Tailplane span	9.45 m	(31 ft)
Min propeller/ fuselage clearance	.75 m	(2 ft 5 ⁵ / ₈ in)
Wheel track	7.16 m	(23 ft 6 in)
Wheelbase	8.40 m	(27 ft 7 in)

WEIGHTS:

Max payload (48 passengers, or cargo)	4,808 kg	(10,600 lb)
Max Take-off weight	18,598 kg	(41,000 lb)
Max Landing weight	17,690 kg	(39,000 lb)

PERFORMANCE

(estimated at 17,464 kg (38,500 lb))

FAR 25 at S/L, LSA, except as noted):

Max cruising speed: 240 knots 444 km/h; 276 mph
at alt. 2,286 m (7,500 ft) and
weight 17,237 kg (38,000 lb)

Stalling speed: 63 knots; 117 km/h 73 mph
at 16,783 kg (37,000 lb)

Rate of climb, enroute 502 m/min (1,650 fpm)

Rate of climb,
one engine out 320 m/min (1,050 ft)

Service ceiling
(R/C 100 fpm) 7,163 m (23,500 ft)

Service ceiling,
one engine out 5,944 m (19,500 ft)

Take-off run 364 m (1,200 ft)

Accelerate-stop distance 548 m (1,800 ft)

Take-off to 10 m (35 ft) 548 m (1,800 ft)

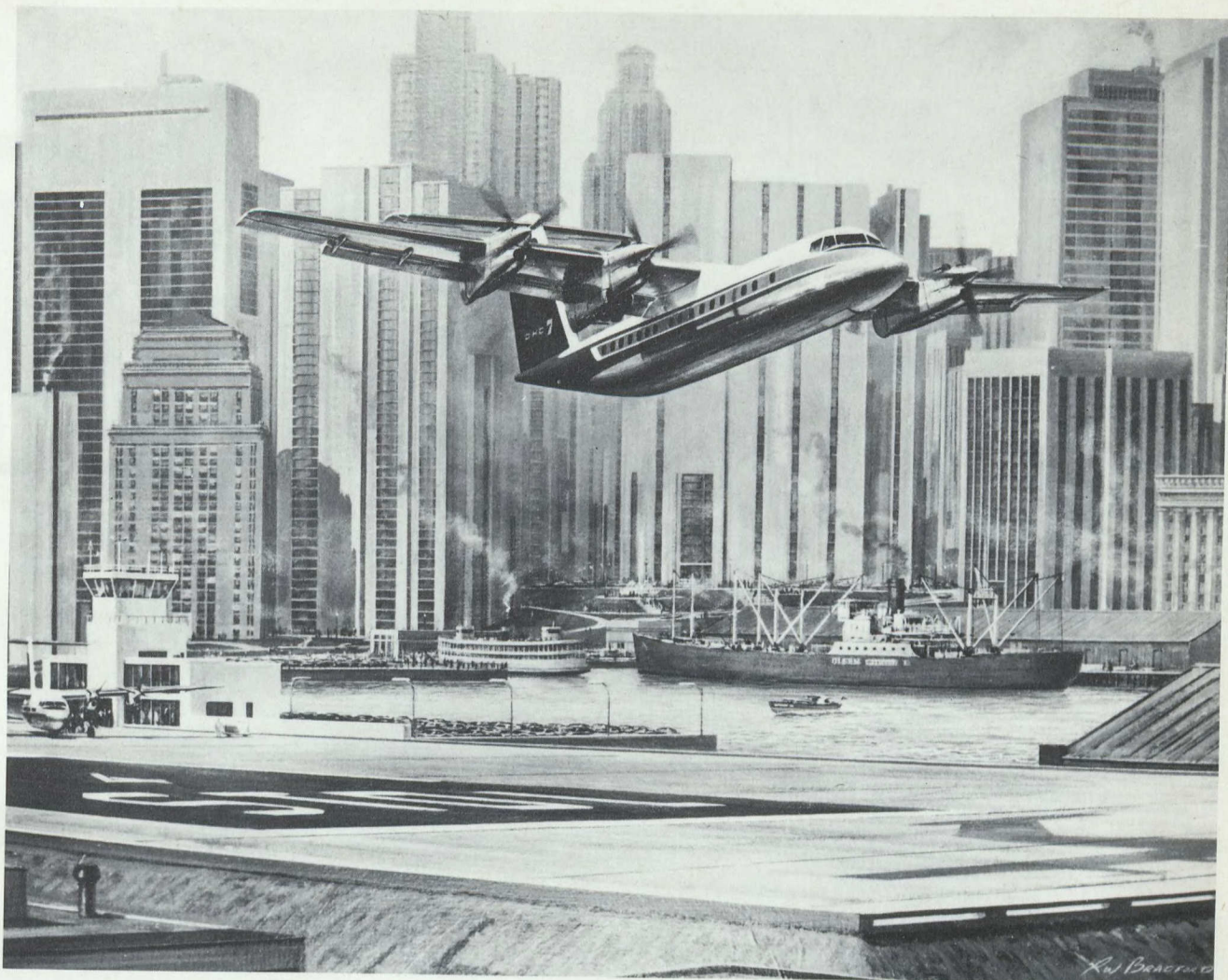
Landing from 10 m (35 ft)
at 16,783 kg (37,000 lb) 347 m (1,140 ft)

Landing run 229 m (750 ft)

Landing field length 579 m (1,900 ft)

Range at 4,570 m (15,000 ft) with max
(passenger, payload, reserves for 100 nm
(115 miles; 185 km) plus 45 min. hold
410 nm (760 km; 472 miles)

Range at 4,570 m (15,000 ft) with
2,563 kg (5,650 lb) payload, reserves as above
980 nm (1,816 km; 1,128 miles)





Published by the Department of Industry, Trade and Commerce, Ottawa, Canada
Publié par le Ministère de l'Industrie et du Commerce, Ottawa, Canada

Information Canada
Ottawa, 1972