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FOUR CASES ON THE MANAGEMENT OF
TECHNOLOGICAL INNOVATION AND ENTREPRENEURSHIP

By

Michael J.C. Martin & Philip J. Rosson

Dalhousie University

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INTRODUCTION

Historically, economists appear to have treated technological innovation as our Victorian forbears treated sex. Something which, through central to human experience, is best not discussed in polite society. Although Adam Smith and Karl Marx recognized the central role of technological innovation in economic growth, until the 1950's economists gave it scant attention. Only Schumpeter can be said to have systematically examined it(1). Fortunately, since the 1950's because of a growing recognition of its central importance to national and corporate wealth (particularly through the impact of 'Le Défi Japonais'), a growing body of scholars of varying disciplinary backgrounds have studied the phenomenon. In consequence, the complex technological and socio-economic process whereby an invention is converted into a socially useful and commercially successful innovation is now less obscure. This improved knowledge of how technological innovation may be stimulated, nurtured and managed is particularly pertinent to Canada's need to seek a much increased degree of technological sovereignty. If it is to help in the Nation's quest to increase its degree of technological sovereignty, it does mean that this knowledge must be disseminated to present and future 'technological innovation managers' through the educational system.

This educational requirement exposes another issue. Managers, like economists, have displayed an equal technology-aversion, apparently viewing technological innovation as a factor either exogenous to, or uncontrollable within, the firm(2). This is partially a reflection of Lord Snow's 'two-cultures', but it does mean that the management of technology has historically been a neglected subject in both the engineering and management schools of universities, so that engineering and management education systems have evolved as 'twin-solitudes'. Fortunately too, this situation is changing. Several Canadian universities offer one or more courses which focus on technological innovation and entrepreneurship in either their engineering or management schools, whilst the recently created Innovation Centres at the Univesité de Montréal and the Univesity of Waterloo offer a range of courses for both full-time and extension students.

Out of recognition of the above need and a personal background in solid-state electronics and management education, one of these authors developed a one semester course entitled "Management, Technological Innovation and Entrepreneurship" during the late 1970's. This is now offered annually, attracting both management (mainly MBA) students of the School of Business Administration, Dalhousie University, and engineering students of the Technical University of Nova Scotia (see Addendum for the course outline). It examines various aspects of the technological innovation process in a corporate setting, with particular reference to Canadian national and Atlantic regional problems. It employs a mixture of lectures, outside speakers (mainly local technological entrepreneurs) and cases. Like many management teachers, these authors believe that case discussions are a vital element in the management education process, but the identification and selection of case materials for this course presented difficulties. Although there are a fair number of cases on some aspects of the management of innovation (see [3]), the total process is not adequately covered and, more importantly, there is a shortage of Canadian cases. Since the course has the unashamedly patriotic (if not chauvinistic) purpose of stimulating students' interests and future participations in Canadian technological innovation and entrepreneurship, this is an embarrassing situation. The authors therefore developed the following four cases as a small first step to remedying the situation. These four cases were developed in Atlantic Canada, as the authors thought it best to start close to home. The four companies involved have experienced mixed fortunes in their attempt to pursue technological innovations. Two of the firms were in the 'entrepreneurial start-up phase' of their evolutions at the time the cases were written. Since then, one company has ceased trading. The other two are somewhat larger and more mature companies, which are seeking to broaden their product bases through technological innovations.

Other cases are planned based upon larger companies located elsewhere in the country. It is to be hoped that the small efforts of the present authors, combined with cases written by authors in other Canadian institutions, will generate a collection of cases illustrating most aspects of the management of technological innovation and entrepreneurship in the Canadian setting.

The cases may be taught, using conventional case teaching methods in appropriate courses at the graduate, advanced undergraduate or extension levels. Guides to teaching the cases have been prepared as a separate Appendix to this report. Copies of this Appendix are available on a restricted basis to bona fide teachers through the Technological Innovation Studies Programme, Technology Branch, Department of Industry, Trade and Commerce. The authors would welcome comments or questions on them from other users.

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3. Tushman and Moore, op. cit., Appendix.

R&D PHILOSOPHY AT ABCO

> "Well, I suppose this philosophy came from conversations I had with the Presidents of Northern Telecom and Bell Northern as well as their top research people, when we were discussing R&D. They said that they would not create a budget or make funds available for someone just to dabble in R&D and hope to come up with a product. They wanted to identify a product need and then identify what the market for that product would be if it could be launched at a certain price level. Then if they were satisfied that the market was there, and it could be sold, they would spend the money to do the R&D on it. I should think our philosophy is similar, except perhaps that we have developed some product ideas for which we felt there was a market, but were unsure because we hadn't done an in-depth market survey for them. We did it more by the "seat of the pants" or by hunch. That is, we thought if we had that particular product we could sell it, so we went ahead to see if we could develop it. But I think for a company to say "we are going to get into R&D and find something, and then when they found something market it" that is the wrong way to go."

It was with these words that Mr. Andrew Eisenhower, President of the Atlantic Bridge Company of Lunenburg, Nova Scotia began his exposition of the R&D endeavours in his multi-divisional company. The Atlantic Bridge Company or ABCO was founded in 1947 by seven associates. Three of these founders are still affiliated with the company, including the brothers Andrew and Martin Eisenhower. All the original founders had a

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This case was prepared by Professors Michael Martin and Philip Rosson of Dalhousie University as a basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. Some of the data and information have been changed to preserve commercial confidentiality. The authors gratefully acknowledge the financial support of the Federal Department of Industry, Trade and Commerce, Technological Strategy Branch in the development of the case.

mechanical engineering background. Three were professional mechanical engineers with practical experience in shipbuiding and seagoing time in the engine rooms of ships or coastal freighters. The remainder were purely practical people, including one who also had a bookkeeping/accounting background. All had a desire to set up the business in Nova Scotia and, being largely Lunenburg people, they wished to orient their business toward the Lunenburg scene. They did not have a definite product that they wished to manufacture, as such, but started off in sales and service of marine engines, deck equipment and other gear which would be used on board ship.

The name of the company has no relationship to its activities from 1947 onwards. One of the original associates had formed a company with this corporate identity, originally to build steel bridges and trawlers in Nova Scotia. However, he was way ahead of his time in the development of these technologies, so this company was idle and the founders chose to use it as a corporate identity to buy a defunct Norwegian naval-training property in Lunenburg from the War Assets Corporation. The company has retained this name ever since.

ABCO's early work in the sales and service of marine engines, etc., led naturally, over a period of time, into the ship repair and maintenance business. It also allowed the company to become involved with fish plants (see Appendix 1 for a description of a fish plant) which led to its first manufacturing operations and product lines. It was the first company in Atlantic Canada to develop fish processing equipment and started manufacturing it from traditional materials such as wood, rubber belting, galvanized iron and framing from ordinary iron. It quickly saw the need for better materials, so it pioneered the use of aluminum and stainless steel in fish plants. Up to that time there had been no government regulations demanding the use of certain types of materials in fish processing, and ABCO's pioneering work is believed to have initiated the development of such regulations. By the late 1940's or early 1950's the company had reached the limit of its growth capacity through these activities, so it set out to try to launch others to broaden horizons. It then entered into the wharf and breakwater construction business, in which it was very active for a number of years, until it saw the opportunity to purchase a company which had a dealership for a major construction equipment account for the province of Nova Scotia. ABCO purchased that company and so was in a position of trying to sell equipment to their competitors in the wharf and breakwater construction business. They, therefore, decided to abandon this construction business and concentrate on equipment sales and service.

The company then entered the mechanical construction business in Newfoundland and Labrador, where the U.S. was building strategic air bases. It employed about 125 men installing diesel electric generating plants on these bases, and undertook the first aluminum type welding work to be performed in eastern Canada - on a fuel dispensing system at the Ernest Herman Airforce Base. It also installed the firefighting stations, the plumbing, heating, air conditioning and hangars and alert facilities in the bases and the associated schools and apartment complexes. This work tailed off from the mid-1950's, so the company again looked for product market opportunities which could be exploited from their small manufacturing base in Lunenburg.

By this time ABCO had established a good reputation in the manufacturing of fish processing equipment and was being consulted on the layout of fish processing plants. This work bordered on a consulting engineering practice, and a subsidiary consulting engineering company called Canadian Plant and Processing Engineering was created to perform it. ABCO operated this company for a number of years and finally sold it to one of its managers who wished to run a consulting engineering business. During the 1950's, ABCO also introduced other innovations into the Maritime Provinces. It created one company to introduce electric space heating into the Maritimes and another to sell institutional and industrial kitchen equipment which was manufactured in an ABCO plant. Both of these companies were subsequently sold as viable commercial entities.

With the advent of reinforced plastics in the mid-1950's, the company felt that this new technology might find some application in the fish processing field. Reinforced plastics is a generic term which applies mostly to polyester resins with fibreglass reinforcement, although there are some special applications for epoxy resins and now, in recent years, there are composites which use carbon fibres, tungsten fibres and other materials for reinforcement. Two men were employed to experiment with vats, tanks, etc. used in fish processing made of fibreglass reinforced plastic. However, the company quickly recognized that this new material was unsuitable for fish processing vessels because the tools used in such processing often produced the scars in the material which exposed the fibres and created sites for bacteriological growth. It therefore started to apply reinforced plastics to the manufacture of cabs for rubber tired construction equipment. This suggested that there was quite a variety of uses for the material, so it began to develop tanks and washer hoods and pipes, etc. for the pulp and paper industry and for some of the chemical industry in eastern Canada. However, after a few years of experience, the company recognized that it was a custom moulding market which competitors could enter with very little investment. Thus ABCO decided it should establish an engineering expertise in reinforced plastic to enter a market for engineered products which the normal custom moulder would not attack. The company consequently decided to build up its engineering staff in its reinforced Plastics Division. This staff provided the basis for its first R&D endeavour which will be discussed shortly (see Plastics Division later).

By the late 1960's, ABCO had evolved into a multi-divisional corporate structure. As well as the Plastics Division, there was the original activity of marine equipment sales and services which evolved during the 1960's into a company which built trawlers and long-liners. The company has since withdrawn from the shipbuilding business, but maintains a ship repair and a refit and maintenance business in its Atlantic Shipbuilding Division. The activities of fish equipment manufacturing took ABCO into the area of materials handling so it now has an Industrial Equipment Division (one of the larger divisions of the company) which is in the light industrial equipment distribution and service business. This Division sells forklift trucks, pumps, warehouse materials such as racking equipment and conveyors, diesel engines for both marine and industrial use, compressors and a wide range of other equipment. In 1969 it purchased the old Acadian Gas Engines Company and the other operations of Co-Salt Limited of England, which operated in Nova Scotia under the name of Grimsby Group Canada Ltd. This company has recently been closed down, but two of its profitable operations have been retained within the Lunenburg production operation. The first is the "marinizing" of engines. That means buying either a gasoline or a diesel engine manufacturer and redesigning and fitting equipment to turn it into a marine engine. Secondly, ABCO has retained the capability to manufacture marine propellors, stern-bearing stopping boxes, and underwater gear for boats, mostly for the inshore fishing industry.

By the early 1980's, ABCO had also become involved in several other business endeavours, including offshore services activities based in Newfoundland, and had evolved the corporate structure shown in Exhibit I.

Plastics Division

"I am a professional mining engineer but now I'm in the plastics business. I feel that my work is more managerial than technical. I've used my engineering background as a tool for judgment more than for innovation. Here at ABCO, I've experienced my first really close relationship between R&D and manufacturing. I've worked in only one other company since graduating from university, and this was an international company which had separate and isolated major R&D facilities. We in the operations area (where I worked), whether it was in sales or production, called upon them by formal request to assist us, but otherwise they worked in isolation from us. In that company we founded an intermediate branch called engineering research which was the most helpful to us in both manufacturing and marketing operations. It could sense the practical pulse of the immediate short-term needs of the industry, could resolve them, and through these resolutions come up with new ideas - usually short-term, which introduced product modifications or, in some cases, new products. I guess this experience is reflected in my view of R&D here. We are seeking to satisfy short-term needs, usually in under three years. In some cases, we are solving immediate customer needs in a matter of months. I would say that the accomplishment factor was higher out of the engineering research group than it was out of the "theoretical" R&D group."
Mr. Harold Steeves, Vice President and General Manager, Plastics Division.

These are the words with which Mr. Steeves began his description of the evolution of R&D activities in Plastics Division. ABCO began experimenting with fibreglass reinforced plastics in 1956, looking for potential replacements for steel, stainless steel and aluminum which were the main construction materials then used in fish plants.

ABCO also applied fibreglass to its boat building activities, so the fibreglass component of the company was initially comprised of boat-building and industrial fibreglass sub-groups. The boat-building business dominated these activities over the 1965-75 period, particularly because (as was stated on page 4), the company's initial forays with industrial applications were unsuccessful. However, as the Division established its industrial fibreglass products out of its R&D programme, the relative importance of its boat-building activities declined, and these latter activities were phased out in the late 1970's.

Fibreglass was viewed as a "magic material" with application potential in that field, since it was obviously a potentially complementary material to stainless steel and aluminum, so they decided to establish a technological expertise in the new field. The R&D effort required to establish this expertise was launched in 1969/70. The company perceived that the pulp and paper and chemicals industries offered potential markets for plastic pipes reinforced with glass fibre.

Briefly, the technology consists of winding successive layers of a fibreglass filament onto a plastic resin substrate mounted on a mandrel. Successive layers of resin are pasted onto the filament during the winding process. Ancilliary items such as T-pieces, flanges, elbows, joint kits, etc. are also manufactured. The mechanical and chemical properties of a pipe are essentially determined by the fibreglass and resin constituents, respectively. The thermo-setting resin provides the matrix into which the fibreglass is embedded.

The original product line developed from this work is the company's P-150 line, which is corrosion resistant piping. The fibreglass is provided by Ashland, Fibreglas of Canada and other companies. The corrosion resistant resin is provided by Dow Chemicals, Shell and other chemical companies. Data on the properties of the fibreglasses and the resin can be obtained from the supplying companies, but much further work must be performed to identify the properties of the composite product.

This investigative work must be performed at several levels:

(1) Laboratory experimentation to determine the properties of the products under laboratory conditions.

(2) Product and process experimentation to determine the properties of the products using varying manufacturing and process techniques, so as to determine the best manufacturing approach.

(3) Field investigations of the properties of the products after being installed in the "end-user" plant or in the commercial environment.

These requirements dictated that ABCO should undertake, what was for them, a substantial R&D effort when work began in 1970. At that time there were no design criteria, guides or manuals which could be applied to the engineering of fibreglass reinforced pipe structures. The technology was too new. ABCO received support from the National Research Council of Canada (NRC) and the Industrial Research Assistance Program (IRAP) to develop such guidelines, and this work provided the foundation for their technical competence in the field. After a few years of designing and testing work they reached a point where they had established enough design criteria competently to engineer piping structures.

During this work, ABCO invented and developed an additional ingredient or material which would provide an abrasion resistant "liner" in a corrosion resistant pipe. They knew that a number of reinforced plastic manufacturers had developed a corrosion resistant pipe, but none had developed one which also provided abrasion resistant properties. Since reinforced plastic has varying (or perhaps marginal) resistance to abrasion, although the abrasion resistant material was developed without a clearly recognized need, the company believed that it had made a potentially commercially valuable invention. They felt at first that the material might have applications in the pulp and paper industries, but found that it was unsuccessful in those markets for technical reasons. However, they retained their faith in the product concept and did discover a good market in the utilities industry,particularly in scrubbers and pollution control plants in the U.S. Such plants processed slurries through pipes which were required to be both corrosion and abrasion resistant. It was out of this work that the company developed its second major product line - the A150 line or abrasion resistant pipe. The original invention was made in the early 1970's, but it took about 4 years of R&D work similar to that cited above to produce a commercially credible product. That is, the company had to develop the techniques to manufacture the abrasion liner in a continuous pipe system with its bends, elbows, fittings, appliances, etc. and the design specification and background testing data required to give its customers confidence in all aspects of the product.

Some details of the Division's markets, including a list of customer installations and a sample of its current product range, is shown in Exhibit II.

R&D Staffing

It would be misleading to view R&D as an isolated function which is separated from the other activities in the Division. The company operates with a primary pool of about a dozen people who, at some time or other, are involved in R&D, either on a full-time basis for short periods (up to a few months) or a part-time basis for longer periods. Throughout its ten-year history, the R&D effort has been based upon a strong relationship with the Division's customers and suppliers. Both major product lines are important components in larger systems which are being installed by systems suppliers in the customers' plants.

For example, if "P" piping is being installed in an environmental pollution controlled system to transport a corrosion fluid where there is a high risk of acid spills, rundowns, lowdowns, etc., Divisional staff must work with the architectural engineers designing the system, the systems suppliers who are making it, and the final customer. This involves identifying the technical specifications needed for the product and designing, testing and producing a product which will satisfy these specifications. This process involves a continual "give and take" between the parties involved. It requires the Division to undertake some of the engineering required to solve the customer's problems and provide him with a good product. For an order of some size, the Division provides a technician to work on the customer's job site and explain how to use the product. Then, when the job is finished, the Division sends a fully-fledged engineer out to the site to "eyeball" and inspect it and make any recommendations for changes. If any failures occur once an installation is in operation, the Division will send staff to identify the cause of failure and, if the failure is due to deficiency in the Division's product, accept responsibility for the necessary repairs and replacement. If the failure is attributable to other causes, the Divisional "troubleshooter" will advise the company on where to go to get the necessary repairs and replacements completed. The company believes that it provides an excellent "after-sales" service, which has contributed to its outstanding reputation in the marketplace. It also regularly holds seminars to explain to its customers how to use its new products as they are phased into the marketplace. These educational activities have played an important role in encouraging customers to switch from steel to reinforced plastic materials.

The Division began its R&D efforts in the early 1970's with the full-time equivalent of between 1 and 2 people. These efforts have expanded steadily over the past 10 years, but do fluctuate with the ups and downs of R&D effort required. There have been as many as 8 people working full-time on R&D for an extended period (that is, for up to 6 months). There is a pool of about 13 individuals who participate in R&D and engineering work (both the R&D and Engineering Groups work under one nominal head), but only 12 people spend a large amount of their time on R&D. Three of these are professional engineers, one with a masters degree and the other two with bachelors degrees, four are engineering technicians with trade qualification from institutions such as the Nova Scotia Institute of Technology and th remainder are draftsmen (with a mechanical engineering orientation), design support staff, inspectors and resin testers for laboratory assistance. One man, whose title is Senior Engineer, has a bachelors degree in chemistry which included three years of pre-engineering training, so he has a good background in "strength of materials," engineering design and drawing, etc. He is viewed as the "thinker." He was particularly associated with the abrasion resistance ingredient that provided the basis for the "A" line and provides a lot of "input" from his own personal experience and background, backed up by continuous reading of the technical literature, including the R&D activities in other industries and attendance at technical conferences and seminars. The Chief Engineer (who is responsible for both the R&D and Engineering Groups) has an aeronautical engineering degree and joined ABCO with about 16 years experience in the "plastics" end of the aerospace industry. He is a strong engineer with a good innate engineering sense who is talking to customers on an almost daily basis. He frequently visits and "eyeballs" installation sites to identify the strengths and weaknesses (if any) in any installations. This work brings him in continual contact with the end users, so he has a close relationship with the customers and can monitor and identify evolving market needs. A third individual, not affiliated with either R&D or engineering, is the Sales Manager. He has worked in the past with one of ABCO's resin suppliers, in various sales jobs leading up to project development and project management. A combination of his current position plus this background enables him, also, to provide a strong marketing and some technical input to the R&D function. These three individuals work in close consort to identify and satisfy evolving product needs.

R&D Funding

> "The very existence of the plastics division is because of the R&D we have done there. There are other plastics companies which have gone out of business or are in very precarious financial positions, some very substantial companies larger than our own. They have not kept abreast of the times and have difficulty in the same sort of product line that we are in. If we hadn't gone into R&D, I think that the market for which we were building 10 or 20 years ago would be so limited that we would just not have that Division of the company today. So its existence is now entirely because of the products that we developed from R&D."
> – Mr. Andrew Eisenhower

Clearly the plastics division would no longer be a viable commercial entity but for the R&D endeavour begun in 1970. Equally clearly, it required more than an act of courage and faith on the part of a relatively small company like ABCO to undertake this endeavour. It lacks the internal financial resources to undertake the size of program required on its own. Throughout the decade of its existence, this R&D program has been financially supported by a sucession of federal government R&D support programs. This began with the IRAP program funded by the NRC referred to earlier and has continued throughout the last 10 years. The main sources of grant support have been the NRC through IRAP and later PILP, and the Department of Industry, Trade and Commerce (DITC) and its Enterprise Development Program (EDP). Less significant funding has also been received from other sources, including currently the Canadian Electrical Association (CEA) which is supporting the R&D on the development of utility poles. The proportion of R&D spending funded by such sources has been as low as 38 percent but typically is in the range of 40 to 50 percent. Since the division spends roughly 8 percent of its sales revenue on R&D, this means that the Division spends about 4.5 percent of its sales on R&D with the balance of 3.5 percent coming from granting institutions.

The Evaluation of R&D Endeavours

> "I would think that the larger companies probably have systems and forecasting developed that smaller companies like ours don't have. What we do is examine whether we think the product will sell, that is whether we think there is a market for it. Generally, that's from our own knowledge of the market, but if we want to have a further examination, we will engage a market research firm to do a market survey for us. If we are satisfied that there is a market need, we will estimate how long we think it will take to develop a prototype (say 3-5 years) and whether we are prepared to invest the money required to develop this prototype. Once we have developed the prototype we re-evaluate it, arrange for it to be tested in a customer's plant and get their permission to show it to their competitors. Thus, we are able to obtain a reaction from a sample of potential customers. If we decide to continue, we are prepared to spend a further five years in developing a market for the product. Mind you, there have been products that we have sought to develop and then set to one side because, as we progressed, we found that there were certain design developments required which would take us too long or cost too much, or we saw problems with the feasibility of the product. It's not a very scientific way. It's a business judgment factor, I suppose, you get just from the fact that you make business decisions."
> - Mr. Andrew Eisenhower

Although Mr. Eisenhower's comments reflect the lead time in developing new products in the Manufacturing Division, they also reflect the philosophy of project evaluation in the Plastics Division. Because of its intimate contact with customers in its current markets, the R&D function is able quickly to sense new product needs. It can then use its technolgoical know-how to evaluate the feasibility of developing products which will satisfy these needs at competitive prices and which will yield an acceptable return on investment. Although the Division does not attempt detailed formal quantification in this process of project evaluation, it has kept a detailed historical record of the growth of aggregate sales turnover and R&D spending (see Exhibit III). Both the "P" and "A" lines could be viewed as quite radical innovations in their markets, which have evolved over the years with a series of incremental product additions and improvements. It would be difficult to disaggregate these inter-correlated growth in sales turnover and R&D spending so as to identify sales dollars attributable to individual R&D projects, but a partial attribution is possible.

In Exhibit IIIA, Line 1 is total sales revenue, Line 2 is sales revenue attributable to R&D efforts and Exhibit IIIB shows R&D expenditures, and Exhibit IIIC shows these as a percentage of sales revenues. In Exhibits IIIB and C the full-lines are gross expenditures and percentages of sales respectively, whilst the dashed-lines are the net figures to the Division, after allowing for government funding. The growth of Lines 1 and 2 reflect the introduction of the A150 abrasion resistant lines in 1972 onwards. The period 1972-76 was one of initial market education and penetration, when the customers were introduced to the product and had to be convinced of its superior properties. Once this educational process had been completed, there followed a period of rapid sales growth from 1976 onwards. Its acceptance also meant that the Division's customers began to think of ABCO as a strong engineering based company and so came back to it with problems and requests for improvements. The company also sought to improve the performance of the product as it gained more and more experience from its application in the field. Thus, Exhibit IIIB shows a sustained growth in R&D spending over a 9 year period.

Manufacturing Division

> "Funnily enough my background is not technical. I was educated in the United Kingdom and came to Canada in 1972 as a marketing manager. I joined ABCO in 1974 as an assistant sales manager, mainly because I was oriented towards the production and marketing of new products. Subsequently, following the retirement of the then plant manager, I was asked to take up his position and, in 1979, we were made a full division of ABCO, with total responsibility for production, marketing. I'm more of a company innovator. Developing new products is a bit like Russian roulette. If you do something and it's quite "chancy" and it comes off - you're the winner! If you blow it - gee!"
>
> "Oh, yes, where I say a gut feeling, it's probably a vague way of describing it. For example, as we go into an experiment with a tomato peeler, we weigh what it's going to cost us, what it is worth to us to get it into that market, and then try to add this "iffy" gut feeling as to how good a risk it is. Then, once we have put those three ingredients together, I guess our gut feeling takes over and we decide to go or not to go. We've been lucky to date I guess. We've not had, I should touch wood on this one, we've not had any major failures so far."
> - Mr. Alec Gingell, Divisional Manager.

Throughout the years, ABCO had retained its activity in one of its original generic businesses - the design and fabrication of fish processing equipment. This business, unfortunately, is cyclical, depending upon the economic cycles in the fishing industry. This meant that this business would make a profit for a few years and then would have to operate at a loss for a few years, because there was insufficient work available to cover its overhead. Therefore, the company felt that it should seek out a line of other proprietary products, based upon its generic expertise in the fish processing business. In the early 1970's, it decided to establish a second R&D endeavour to develop such products in the Manufacturing Division which was responsible for this business.

ABCO again received federal government support from IRAP to found an R&D group in its Manufacturing Division. This group was much slower to get off the ground than its counterpart in Plastics Division, largely because the company had difficulty identifying and engaging the services of a person with the right kind of experience to head it up. The first person appointed did not work out to ABCO's entire satisfaction, so another person was placed in charge. Finally, after a few years, the company located a couple of engineers who were good mechanical designers. They, with some technicians, provided the nucleus of the group which has now developed a number of pieces of proprietary equipment, which are helping to complement the cyclical nature of the traditional business. It is possible that, but for these products which this group has developed, the Division would have been closed down (at least temporarily) due to the current recession in the fisheries industry. Indeed, over one winter, the Division had to increase its labour force by 50 percent, and held this level for two years, to satisfy the demand for new proprietary products in export markets.

The R&D effort has mainly been concentrated on two things:

(1) More sophisticated fish processing equipment, particularly largely pneumatic fish unloaders.

(2) Specialized processing gear for the vegetable industry, particularly vegetable blanchers.

Each of these are described in turn.

The Division was the first company to develop automatic fish air unloaders suitable to work on both the pellagic and the commercial fisheries. An air unloader is essentially a large vacuum cleaner, bearing in mind that the term vacuum cleaner is really a misnomer, because the higher the vacuum you pull the less material you get out. If the nozzle of a vacuum cleaner is put right down to the floor, no dirt is sucked off the floor, but if an airflow is maintained over the dirt particles on the floor, then this airflow picks up these particles. An air unloader works on the same principle. An airflow is created over the fish and this transports them to a location where fish and air can be separated. The operation has to be performed very gently so the fish remain undamaged.

Prior to this development, fish have to be unloaded from trawlers by hand or mechanical means. The development was prompted by an initial investigation of potential export markets, where, in particular, the Europeans are far more critical of fish quality than the operators of the average Canadian plant. Although the Division tried to get people interested in its pneumatic unloading equipment, it was traditionally frowned upon in the European market. Therefore, the above engineers conducted an investigation of the Division's unloaders then in service (about 75) to identify the problem areas in their operational use. They identified six different sections on an unloader which could give problems under certain conditions and, one by one, these problems were eliminated. In particular, traditional air unloaders had been designed based upon grain handling equipment. A cyclonic vortex is created which separates the grain from heavier extraneous material. Grain can withstand more vigorous cyclonic flows than fish and, because of their origins, traditional fish unloaders subjected the fish to excessive flows causing unnecessary fish damage. The Division derived this conclusion from an investigation of the aerodynamics of these traditional unloaders and designed new cyclonic systems which treated the fish more gently without loss of separation efficiency. The new design considerably reduced fish damage and, as an added bonus, the energy consumption of the unloader was reduced by about 20%. The Division is currently seeking to patent its new design.

In 1979, the Division was approached by the British White Fish Authority (WFA) to look into the possibility of introducing pneumatic unloading into the port of Fleetwood, England. This is one of the larger fishing ports in the world and employed 126 lumpers (fisheries dock workers) for manual unloading, plus a mixture of conveyors and buckets unloading systems. The WFA sent a team of people over to Lunenburg to conduct a preliminary trial on the unloader and the outcome of that visit was a deal whereby the prototype was installed on a "sale or return" basis in the port of Fleetwood. Under the deal, the WFA had the right to publish the performance record of the unloader on a worldwide basis. This exposed the Division to considerable commercial risk, since if the trial were to prove unsuccessful, its failure would be given worldwide publicity. Fortunately, the trial was successful and Fleetwood bought the prototype unit and ordered two more. The positive outcome of the trials also led to purchase orders from the ports of Bremerhaven, Germany who ordered two units, L'Orient, France who ordered one and three more units were ordered by the Republic of South Africa. An outline of the Fleetwood trials is given in Exhibit IV. The positive outcome of these trials established the Division's reputation in overseas market. The Division still has a less enviable reputation in the domestic market. It's domestic reputation is based upon the 75 units currently in use, many of which are 15 years old and technically obsolescent.

The Division has developed other products for the fisheries industry from its R&D efforts. One example is a 'scallop shucker'. The prototype was designed by the federal government's Fisheries Research Laboratories in Halifax which the Division developed into a commercial product. Another example is a 'phosphate machine,' developed in collaboration with a customer. This applies tri-polyphosphate (a preservative) to fish fillets. The current range of processing equipment offered to the fisheries industry by the Division is shown in Exhibit V.

The second major product which is emerging from the Division's R&D efforts, like the scallop-shucker, is a spin-off from a federal government R&D establishment. In the late 1970's, representatives of the federal Department of Agriculture Research Station at Kentville, Nova Scotia asked ABCO to participate in the development of a vegetable blancher from a laboratory model (which had been researched and designed at Kentville) to a commercial prototype which could be tested on the market.

Blanching is an important step in the treatment of high quality foods prior to freezing or canning. It is a steam scalding treatment which kills the enzyme activities on vegetables such as peas, beans, carrots, etc. It is an energy-intensive process, so that the post-1973 energy crisis has increased costs in the food processing industry. The prototype blancher developed at Kentville and ABCO reduces energy requirements by 90 percent and so offers substantial cash savings to the processor. It also follows that it produces only 10% of the effluent of other blanchers. This is another major advantage, as vegetable processing plants have a major problem getting rid of effluent as it has a high 'biological oxygen demand' (bod) count from the organic material present. The Division estimates that the "payback" period for the processor installing such a blancher will be under two years. The current model is described in more detail in Exhibit VI.

ABCO began development work on the blancher in late 1978 and had the first prototype unit ready for field trials by the middle of the 1979 harvesting season. These trials identified the good features of the machine. They also identified the "bugs" which were required to be eliminated by suitable re-design and re-adjustment of the equipment. This re-design work was completed in the winter of

1979-80, so the second prototype unit was tested in the 1980 harvesting season. Further modifications were made in the light of this experience in the winter of 1980-81. Two units of the final commercial model were tested in the 1981 season, one in the Annapolis Valley of Nova Scotia, and the other in France. Another unit was exhibited at the major annual food equipment show in San Francisco in 1981. Interest in the blancher has been considerable with over 800 inquiries from across the world but, in early 1982, the first sale had yet to be made. As a result of the San Francisco show, a tentative agreement has been made between ABCO and the largest organization selling food processing equipment in the world for the latter to become sales agents for the machine. Some sales are expected in 1982.

Other food processing equipment is being developed, based upon the "know-how" gained in the development of the above blancher. First, representatives of one Californian company which is developing an automatic tomato peeler, attended the San Francisco show. They saw that part of the ABCO blancher could be used in the tomato peeling process, so ABCO has reached an agreement with the company to supply the part. The Californian company will develop the balance of the equipment, but ABCO will enjoy the worldwide rights to manufacture it. The field trials on the prototype tomato peeler were held in the Fall of 1981 and, again after design changes, further trials will be held in the 1982 season. Both companies hope to be in a position to take orders by the fall of 1982.

Second, different vegetables require different methods and levels of blanching, so it is necessary to develop units which will blanch specific vegetables. The Division is just starting development work on a blancher specifically designed for the potato industry which has potentially large local and worldwide markets. It is also beginning experimental work on the fluidization and blanching of spinach with a view to designing a spinach blancher. Further details of the vegetable blanchers are shown in Exhibit VI.

The Division's approach to marketing reflects the early experiences of ABCO when it was quickly realized that in order to build up to a reasonable size, the company had to develop and sell products outside of Atlantic Canada. Initially, fishing equipment was marketed in central Canada and on the west coast, and later in New England and elsewhere in the United States. Over the past six to eight years, one person's time has been invested in trying to develop markets throughout the world, and trips have been made through Central and South America, Australia, Europe and Africa. Several pieces of equipment have been sold in England, Germany, France, Norway, Iceland, South Africa and Central and South America. The Division perceives its current markets to be largely the Atlantic rim countries.

Worldwide sales are expected to increase with the development of proprietary equipment for both the fisheries and the food processing industries. The bulk of the food processing market is expected to be in the U.S., in Wisconsin and the states to west and south through to the West Coast - Washington, Oregon and California and even, to a more limited extent, into Mexico. The next largest market should be in Europe. The Division has an agreement with the Food Machinery Corporation (FMC) who will distribute its blanchers throughout North

America (Canada, U.S. and Mexico). It is also hoped that FMC will become the distributors for equipment in Western Europe and Israel. The advantage of working with FMC is that it is the largest corporation in the food processing business with full technical staff, including food technologists and plant engineers. The Corporation has its own laboratories, so if a customer has some peculiar food processing requirements, they can identify its processing needs and recommend an equipment manufacturer who should be able to design and develop it. The Division identifies and formulates its R&D project mainly from market feedback and contacts in the field. Its entrenched relationship with FMC provides admirable support for this approach.

The above market feedback is supplemented with judicious reading of the appropriate literature. International fisheries industry magazines and technical journals are circulated around the engineering staff and sometimes ideas are picked up from other industries. Ideas from fishery equipment such as the de-watering drum can be adapted to the vegetable processing industry. In seeking out and identifying market needs, the Division tries to steer away from "me-too" products. It prefers to build specific items of equipment which no one else has. Then it can be "first to market" such equipment and any future competitor has to prove that his equipment is as good as or better than the ABCO unit already on the market.

Given the new product concept, the Division estimates the number of units it could sell at a given dollar price and completes a detailed estimate of total costs of developing the product. For larger products, this estimation process usually requires a couple of weeks of effort by engineers, who sit down and put a proposal together. All the costs are estimated ranging from accommodations, meals, telephone calls, hours and personnel involved, materials requirements including brought-in items and outside services such as electricians and steam fitters as well, as the labor cost of manufacturing taking into consideration any union problems which might occur. Government financial support is sought if it appears to be appropriate. The expected revenue is calculated. This will include an allowance for the items of ABCO ancilliary equipment which the customer could be expected to buy if the main equipment is purchased from the company. For example, a customer may buy a unit from ABCO at a price of $25,000, but require a further $40,000 worth of ancilliary equipment if the main unit is to work effectively. It is most likely that he will also buy this ancilliary equipment from ABCO, so this likelihood is allowed for in revenue estimation. Total revenues and costs can then be compared to see if the R&D project or product concept appears to be commercially attractive. Probability of technical and commercial success, or conversely, the risk of failure, is a very "iffy" thing requiring subjective management and technical judgment. This evaluation process involves both engineers and marketing people and, whenever possible, an end use customer who will have a better understanding of his own needs. In the event that his needs are unique so that no one else is interested in the product, at least he provides a market for the prototype. Sometimes the product concept can be modified to satisfy the needs of a broader range of customers. For example, one prototype unit was developed, designed for the specific needs of the "up-front" customer. It turned out that that customer had a unique processing method that required sophisticated control features. A simplified version of the prototype was developed to satisfy a broader range of customer needs, and this has been successfully sold. Development lead time varies a great deal from under a year for some products, such as a phosphate machine, 18 months for a product like the scallop shucker, to several years for the air unloaders and vegetable blanchers. The Division likes to develop two new products a year.

R&D Staffing

Of the seven people employed in the R&D function, two work on fish processing equipment, two on vegetable processing equipment and three are skilled draftsman. Two are professional mechanical engineers, one of whom has been with the company for five years and the other for one year. The Head of R&D has years of experience in the metal fabricating industry. His previous experiences include work with De Havilland as a production manager, and he also had responsibility for the fabrication of large sections of the "Bras D'Or", the prototype hydrofoil craft built for the RCN. He brings considerable practicable experience to the engineering of new products which compliments the academic knowledge of the younger graduate professional engineers. The group also includes a designer draftsman, who previously worked with Piper Aircraft and has a very methodical approach to solving engineering design problems. Another individual, with a machine shop production background, carries out a lot of the field installation and testing work. The group is supported with two other draftsmen for detailed work. Technical work is 90% mechanical engineering, but the development of the vegetable blanchers has required an expertise in heat-transfer, steam-flow and the effects of steam on products. The Division can also call upon the expertise of the R&D staff of the federal laboratories, with which it collaborates, for help on specific problems.

The R&D staff are complimented by nine production engineering staff who do much of the estimation required in developing new products. They have either a shop floor or engineering office background, so that collectively, they are knowledgeable at all levels and have a practical awareness of the rugged and demanding end-user environment in which the equipment will be located.

<u>R&D Funding</u>

> "I think R&D is one of the best usages of tax dollars that the government made. I think it's an excellent way. In fact, sometimes I think it would be an awful lot better, a lot easier, if they took all their programs, scrapped the whole works and gave us export and R&D tax credits. Then those who were really serious about it would get the dollars and those that get government funds and screw around would be out in the cold. We put a lot of effort into R&D and a lot of effort into export, and I know that some companies use these programs who are not really serious. We like to think in our part of the world we have to be serious, because our market is outside the Maritimes."
> - Alec Gingell

Like the Plastics Division, Manufacturing Division has made judicious use of government R&D support grants in funding its own endeavours. Two products which were spun-off from the federal government laboratories - the automatic scallop shucker (from Fisheries Canada) and the vegetable blancher (from Agriculture

Canada), were developed under licence from Canada Patents and Developments Limited (CPDL) using federal government R&D support programs. At various stages, they were supported by 100% government funding under the "contracting out" program, and 50-75 percent funding under at first COPI and later PILP. The Division also entered into a joint venture with the Nova Scotia Research Foundation (NSRF) to develop a fully automatic jigging machine.

Government support programs have been crucial to the funding of the R&D endeavour. Current R&D spending runs at 6-7% of gross sales of around $3 million. Government funding is only sought if it can be used to subsidize the development of a worthwhile product.

Appendix 1 - Description of Fish Plants

At the time that ABCO started in business in the Atlantic Provinces, there were two basic types of fish plants. One was the fresh-packed plant, designed for fresh and frozen fish. The other was the salt fish plant. The plant was historically situated on the shore with wharf facilities. The inshore fishing boats or the larger trawlers came to the wharf. The fish was unloaded through the holds of these ships and taken into a holding-room, prior to being fed to fish processing lines.

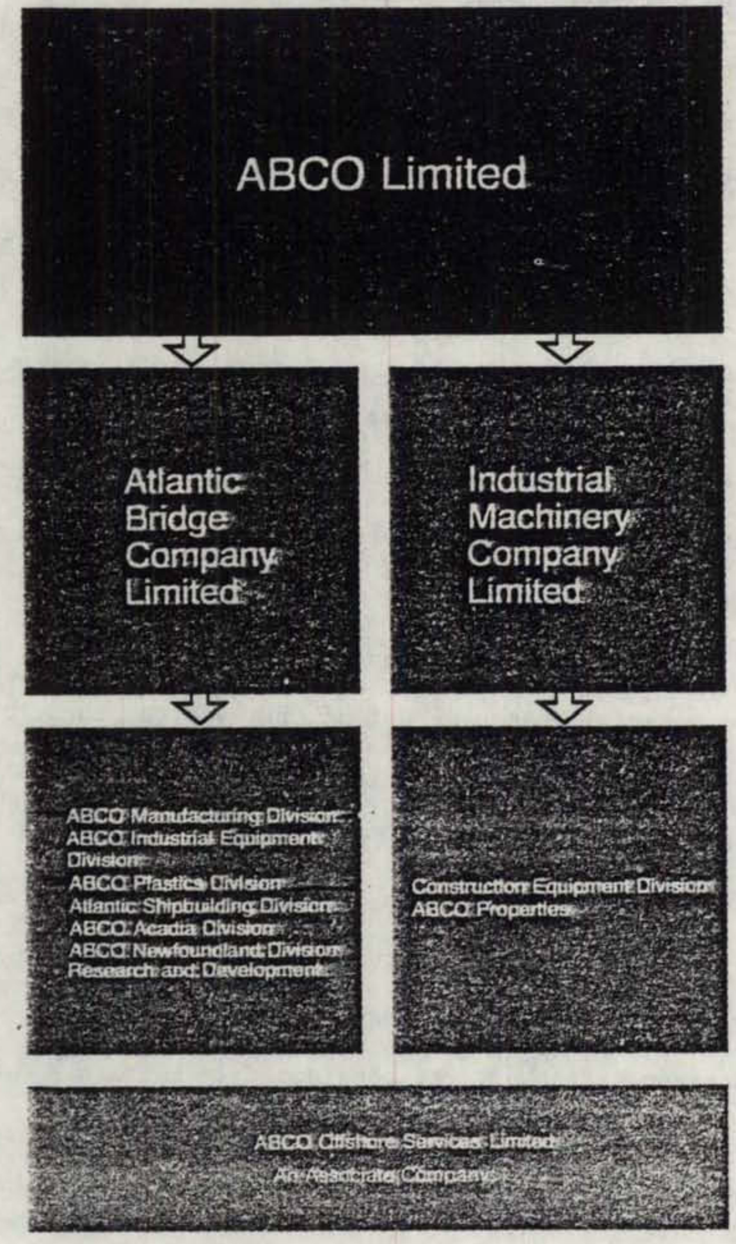
In a fresh and frozen fish plant, the fish wre first filleted, then skinned, then graded and sometimes treated with a "dip" of one nature or another. After grading, they are selected to go into a certain type of pack. This could be a simple one-pound pack or a five pound pack or an institutional pack. These were the ones that were in use when ABCO first entered the business and then shortly after that, the fish stick was developed. There the fish fillets were frozen into large blocks and passed through saws or slicing machines until they were cut-down to the size of the fish stick. Then they would be battered, breaded, and cooked. There were only a few plants that actually got into the cooking. Most plants just went into the freezing stage and then delivered the blocks to another plant where the cooking was done. All plants had to have plate or glass freezers where the fish were frozen and from that the fish would be cartoned and go into refrigerated storage prior to shipment via refrigerated trucks to the market place.

The salt fish plant would take the fish and split it open and then the fish would be salted in piles until such time as it was decided to ship it. At that time, it would be taken out of pile, go through a washing machine and then be dried. The dried fish would be shipped to the market in the dried and split condition. Some plants developed a boneless pack. In that case workers would take the dried split fish, remove the dried fish from the bones and skin, and sell a boneless pack.

Much later, in the early 1970's, it was recognized that there were quantities of herring and capelin which could be harvested off the shore, and another type of fish plant arose. This was the fish meal plant where huge quantities of herring and capelin would be caught, brought into the plant and put through a very large steam or flame cooker. The material that came out of this was put through a continuous screw-press and the fish cake that came out of that screw-press then went into a dryer where it was dried into meal and finally bagged. Somewhere along the way in the process, there would be effluent from the cooker and a liquid would come off the press. These liquids would be taken together through a concentrator and finally into an evaporator. Fish oil was obtained from certain species of oily fish such as red fish or herring. Fish meal was also made as a by-product from the fresh and frozen fish plant where after the filleting, the frames and the skin and the heads of the fish went through the same process that was described for the herring and capelin and meal is made from the offal. Usually these plants were much smaller than the plants that take the whole fish.

Exhibit I

ABCO LIMITED
CORPORATE STRUCTURE



A Company with its roots in the Atlantic Provinces of Canada with its major markets in North America and rapidly-growing export markets in other countries of the World.

ABCO LIMITED consists of two Companies — Atlantic Bridge Company Limited which began operations in 1947, and Industrial Machinery Company Limited which became part of the ABCO organization in 1956. Both of these Companies have several divisions.

Exhibit II

ABCO LIMITED
PLASTICS DIVISION - PRODUCTS
AND INSTALLATIONS

ABCO

ATLANTIC BRIDGE COMPANY'S PIPING SYSTEMS

The Atlantic Bridge Company's Abrasion Resistant "A" Series fiberglass pipe has proven itself handling SO2 scrubber slurries, running at velocities designed for under 10 ft./sec. and solid concentrations of 10-15%. Actual operating performance has been estimated at higher speeds and solid concentrations in the piping system, but our experience is with these design conditions:

A150 and A100 Pipe has handled:

- Wet "Coal fly ash" slurries from precipitators
- Scrubber slurries from coal fly ash, limestone and resultant sulfates and sulfites

We have supplied A150 and A100 piping for:

Scrubber Internals: Spray lances
Spray Headers
Underbed Spray Piping
Drain Collection Piping

Scrubber Externals: Manifold Headers
Dump Lines
Supply Lines
Recirculating Lines

Settling Pond Piping: Lines from the scrubber to settling ponds

Specialties: Abrasion lined tanks
Strainers
Fabricated Elbows
Specialty Flanges
Specialty Nozzles

The "A" Series Pipe uses Hetron resin in its structural cage with its high heat resistance and fire retardance. The reinforced abrasion liner of "A" Series Pipe is specially compounded and developed over a 10 year period, starting by installations on wood chip lines in pulp and paper mills. Experience dates to 1965 in these applications.

Handling the abrasive and corrosive conditions found in Scrubbers began in 1971. It started with test pieces and has grown to include all slurry lines in scrubber installation.

Sales have been to scrubber manufacturers, utilities and contractors. A150 pipe is approved by many consultants to replace rubber lined pipe. A150 pipe has outperformed rubber lined pipe. As users gain experience with the A150 pipe, they install it in more places for handling slurries.

We have supplied P100 and P150 Piping for:

- Make up water lines
- Handling oil fly ash slurries

ABCO's P150 series piping contains a resin-rich reinforced internal layer to provide maximum chemical resistance and protection for the filament wound structural layer.

ABCO's Piping Systems:

The resin-rich reinforced internal layer of the P series Pipe and the reinforced abrasion liner of the A series Pipe is carried throughout all fittings and flanges. ABCO produces rugged, reliable, thick wall pipe and, similarly, rugged, "Not press molded" fittings and flanges.

Experience installing and operating ABCO's piping systems proves its value.

Test pieces of A series piping taken from systems operating at over 4000 hours, and 6000 hours, show "no wear."

Prefabrication/Crating:

ABCO offers a proven prefabrication system. Piping systems can be shipped to the job site with 60% of the joints made. (The 60% figure from an actual job). There have been many truckload shipments to places as far as Texas and Minnesota, all arriving in perfect condition.

ABCO Offers:

- The economics and performance of "A" Series Piping
- The ruggedness and chemical resistance of "P" Series Piping
- Prefabrication that saves dollars
- A proven tapered piping joint system up through 12"
- Rugged, fully lined fittings and flanges
- A complete piping system program with specialties and standards

Chemical Liner

The heart of any chemical resistant pipe is in its ability to withstand aggressive chemicals. In ABCO P150 Pipe, this is achieved with a carefully engineered Chemical Liner that is continuous, regardless of the number of flanges, tees, elbows or joints utilized in a system. It is this total systems approach to manufacturing that gives ABCO Pipe the maximum possible resistance to chemical attack.

The ABCO Chemical Liner is the first and most critical stage of corrosion resistant pipe production. This is done carefully on a polished steel mandrel to achieve the exceptionally smooth interior finish that will produce a Hazen-Williams coefficient flow factor of 150.

The key to the Chemical Liner's success is in the ABCO Resin System which employs Vinyl Ester resin. Use of this resin is made because it is tougher than most other resins. Because of its unique molecular structure, it is more elastic, maintains higher tensile strength values and is inherently more resistant to aggressive chemicals. These properties combine to better protect the important ABCO Chemical Liner against cracking or crazing during transport, installation and use under static or dynamic load conditions or a combination of those.

Construction of the ABCO Chemical Liner is a two part process that begins with the Chemical Barrier. This consists of a resin rich surface reinforced with dynel veil that is 0.01" thick and applied at a ratio of 90 per cent Vinyl Ester resin to 10 per cent reinforcement. This is completely cured to guarantee a Barcol hardness of 90 per cent or greater of the resin manufacturer's specified hardness.

The second stage in constructing the ABCO Chemical Liner is the application of the ABCO Anti-Wicking Barrier. This reinforces the Chemical Barrier and contributes to the structural strength of the pipe.

The Anti-Wicking Barrier is 0.10" thick and consists of noncontinuous glass strand having fiber lengths of 0.5 to 2.0 inches. Application of this reinforcement is done so that lengths are arranged randomly in a resin rich layer that is 25 per cent glass and 75 per cent vinyl ester resin. The finished barrier is the equivalent of two layers of 1½ ounce glass mat.

Together, these two barriers form the ABCO Chemical Liner and afford a maximum of chemical and corrosion resistance to any ABCO P150 piping system.

Testing is done regularly to ensure the highest possible liner quality. These tests include those for chemical resistance (ASTM C581), hardness (ASTM 2583), and glass content (ASTM 2584).

The end product of these first critical stages of ABCO P150 Pipe and fitting construction is a highly chemical resistant liner that is totally integrated throughout the entire ABCO P150 Pipe and Fitting System, regardless of the shapes and directions it takes.

ABCO

ABCO P150 FIBERGLASS FILAMENT WOUND 1½"-12" PLASTIC PIPE & FITTINGS

SPECIFICATION

Section 1. **Purpose**

The following specification is a guide to performance and manufacturing criteria for ABCO P150 filament wound pipe and fittings.

Section 2. **Standards**

ABCO P150 is classified in accordance with ASTM D2310-71 "Standard Classification for Machine-Made Thermosetting Resin Filament Wound Pipe" as:

Type 1 - Filament Wound
Grade 2 - Glass Fibre Reinforced Polyester Resin Pipe
Class E - Polyester Liner, Reinforced

and conforms with ASTM D2996-71 "Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe" as

Type 1 - Filament Wound
Grade 2 - Glass Fibre Reinforced Polyester Resin Pipe
Class E - Polyester Liner, Reinforced

with the exception that the pressure is rated by a short term burst strength of 1500 PSI and that diameters comply with Section 3.6. ABCO P150 meets and exceeds where applicable, U.S. Department of Commerce, National Bureau of Standards, Voluntary Products Standard PS-15-69 and Canadian Government Specifications Board Standard 41-GP-22

Section 3. **Filament Wound Pipe Construction**

Section 3.1 **Resin:** Vinylester (polyester) resin
ie., Derakane 411, or Atlac 580, or Epocryl DRH-322

Section 3.2 **Chemical Barrier:** 0.01" of Nexus Veil; 90% resin, 10% reinforcement

Section 3.3 **Anti-wicking Barrier:** 0.10" Chopped Strand Glass (equivalent to 3 oz. Mat per sq. ft.); 75% resin, 25% reinforcement

Section 3.4 **Structural Layer:** Filament wound continuous roving. Winding Angle: 55°; 30% resin, 70% reinforcement

Section 3.5. **Exterior Protection:** 0.01" of Resin Coating containing U.V. absorbers for protection against spillage and atmosphere.

Section 3.6 General Specification and Rating

Nominal Pipe Size (inches)	I.D. (inches)	O.D. (inches)	Wall Thickness (inches)	Weight Lbs/ft.	Pressure/Temperature Maximum Rating	(1) Ultimate Burst psi	(2) Support Spacing (feet)	Std. Lengths (feet)
1.5	1.50	1.88	0.19	0.6	150 psi at 200° F.	3000	5.5	10
2	2.00	2.38	0.19	0.8	150 psi @ 200° F	3000	6.0	21
3	3.00	3.38	0.19	1.2	150 psi @ 200° F	2700	6.5	21
4	4.00	4.40	0.20	1.6	150 psi @ 200° F	2700	7	21
6	6.00	6.48	0.24	3.0	150 psi @ 200° F	2700	9	21
8	8.00	8.56	0.28	4.8	150 psi @ 200° F	1600	10	21
10	10.00	10.64	0.32	7.0	150 psi @ 200° F	1600	11.5	21
12	12.00	12.74	0.37	9.6	150 psi @ 200° F	1600	12.5	21

** All values except pressure temperature maximum rating are average values. Tolerances can be obtained from ABCO Ltd.

(1) Ultimate pressure is based upon failure by weeping, not rupture.

(2) At 200° F based on specific gravity of 1.3 and 0.5" deflection.

Section 3.7. Typical Physical Properties

PROPERTY	VALUE
Tensile strength, longitudinal	9000 psi.
Modulus of Elasticity in Tension	1.3×10^6 psi
Thermal conductivity	1.3 btu/in/ft²/°F/hr.
Thermal expansion	1.4×10^{-5} in/in/°F
Specific Gravity	1.6
Flow Factor (Hazen-Williams Coefficient)	150

Note: All tests were run on pipe samples

ABCO A-150 ABRASION-RESISTANT FIBERGLASS FILAMENT WOUND PLASTIC PIPE & FITTINGS

SPECIFICATIONS

Section 1. **Purpose**

The following specification is a guide to performance and manufacturing criteria for ABCO A-150 Abrasion-Resistant Filament-Wound Pipe and Fittings.

Section 2. **Standards**

ABCO A-150 Abrasion-Resistant is classified in accordance with ASTM D2310-71 "Standard Classification for Machine-Made Thermosetting Resin Filament-Wound Pipe" as follows:

Type 1 - Filament Wound
Grade 2 - Glass Fiber-Reinforced Polyester Resin Pipe
Class E - Polyester Liner, Reinforced

and conforms with ASTM D2996-71 "Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe" as:

Type 1 - Filament Wound
Grade 2 - Glass Fiber-Reinforced Polyester Resin Pipe
Class E - Polyester Liner, Reinforced

ABCO A-150 Abrasion-Resistant meets and exceeds where applicable, U.S. Department of Commerce, National Bureau of Standards, Voluntary Products Standard TS-15-69 and Canadian Government Specifications Board Standard 41-GP-22.

Section 3. **Filament Wound Pipe Construction**

Section 3.1 **Resin:** ABCO Vinylester (polyester) resin abrasion mix.

Fire retardant polyester or vinylester resins for structural and external layers where required (i.e., Derakane 411, or Hetron 901, or Hetron 197, or Epocryl 322).

Section 3.2 **Abrasion Liner:** 0.11 of Veil and Chopped Strand Glass with 80% Abrasion Resin Mix.

Section 3.3 **Structural Layer:** Filament wound continuous roving.
Winding Angle: 55°; 30% resin; 70% reinforcement.

Section 3.4 **Exterior Protection:** 0.01" of Resin Coating containing U.V. absorbers for protection against spillage and atmosphere.

Section 3.5. General Specification and Rating

Nominal Pipe Size (inches)	I.D. (inches)	O.D. (inches)	Wall Thickness (inches)	Weight Lbs/ft.	Pressure/Temperature Maximum Rating	(1) Ultimate Burst psi	(2) Support Spacing (feet)	Std. Lengths (feet)
1.5	1.50	1.88	0.19	0.6	150 psi at 200° F.	3000	5.5	10
2	2.00	2.38	0.19	0.8	150 psi @ 200°F	3000	6.0	21
3	3.00	3.38	0.19	1.2	150 psi @ 200°F	2700	6.5	21
4	4.00	4.40	0.20	1.6	150 psi @ 200°F	2700	7	21
6	6.00	6.48	0.24	3.0	150 psi @ 200°F	2700	9	21
8	8.00	8.56	0.28	4.8	150 psi @ 200°F	1600	10	21
10	10.00	10.64	0.32	7.0	150 psi @ 200°F	1600	11.5	21
12	12.00	12.74	0.37	9.6	150 psi @ 200°F	1600	12.5	21

** All values except pressure temperature maximum rating are average values. Tolerances can be obtained from ABCO Ltd.

(1) Ultimate pressure is based upon failure by weeping, not rupture.

(2) At 200°F based on specific gravity of 1.3 and 0.5" deflection.

Section 3.6. Typical Physical Properties

PROPERTY	VALUE
Tensile strength, longitudinal	9000 psi.
Modulus of Elasticity in Tension	1.0×10^6 psi
Thermal conductivity	1.3 btu/in/ft²/°F/hr.
Thermal expansion	1.4×10^{-5} in/in/°F
Specific Gravity	1.6
Flow Factor (Hazen-Williams Coefficient)	150

Note: All tests were run on pipe samples

INSTALLATION LIST OF ASCO A & P SERIES PIPE

FOR

FLUE GAS DESULFURIZATION PROJECTS AND UTILITY SYSTEMS

	Utility	A.E.	System Supplier/ Eng. Constructor	Areas Used	Installation Date
1	Kansas Power & Light Lawrence #4	Black & Veatch	Combustion Engineering	Internal slurry headers & external manifolds	11/71
2.	Kansas City Power & Light	Black & Veatch	Combustion Engineering	Internal slurry headers & external manifolds	1/73
3	Louisville Gas & Electric Paddy's Run #6	Fluor Pioneer	Combustion Engineering	All slurry piping in-&-around SO_2 system	1/73
4.	New England Power Brayton Point	C.T. Main	P.J. Riley	Flyash slurry piping from precipitator to ponds	11/74
5.	Potomac Electric Power Co., Dickerson Station	Bechtel	Chemico	Internal slurry nozzles	1/75
6.	Northeast Utilities Millstone Units	Stone & Webster	Stone & Webster	Main circulating water pipe. Nuclear rating, Class 2	3/75
7.	Northern States Power Sherburne 1 & 2	Black & Veatch	Combustion Engineering	-internal slurry headers & external manifolds -slurry piping to thickeners	1/76
8.	New England Power Co. Salem Harbor Station	C.T. Main	P.J. Riley	Flyash slurry piping from precipitator to ponds	1/76
9.	Kansas Power & Light Co., Lawrence #5	Black & Veatch	Combustion Engineering	Internal slurry headers & external manifolds	1/76
10.	Kansas Power & Light Co., Lawrence #4 revamp	Black & Veatch	Combustion Engineering	All slurry piping in-&-around SO_2 system	3/76
11.	CILCO Duck Creek #1, Module D	Commonwealth Assoc.	Riley Environeering	All slurry piping in-&-around SO_2 system	3/76
12.	Columbus & Southern Ohio, Conesville 5 & 6	Black & Veatch	Blount Brothers	Slurry piping to ponds	3/76
13.	Northern Indiana Public Service, Bailey #7	Self	Davy Powergas	Internal slurry headers	5/76
14.	So. Carolina Public Service, Georgetown #2	Burns & Roe	Babcock & Wilcox	Internal slurry headers	5/76
15.	Southwest Public Service, Harrington St. Station	Self	Combustion Engineering	All slurry piping in-&-around SO_2 system	6/76
16.	New Mexico Public Service, San Juan 1 & 2	Stearns & Rogers	Davy Powergas	Internal slurry headers	6/76
17.	Texas Utilities	Metcalf & Eddy	Research Cottrell	Solids disposal	6/76
18.	Western Illinois Power Co-op.	Burns & McDonnell	Riley Environeering	Misc. yard piping	6/76
19.	Kansas Power & Light Jeffries 1 & 2	Black & Veatch	Combustion Engineering	All slurry piping in-&-around SO_2 system	8/76
20.	New Hampshire Public Service, Merrimack Station	Self	Self	Waste water treatment	3/77
21.	Northeast Utilities Uncasville Middletown Norwalk Devon	C.T. Main	Self	Waste water treatment	3/77
22.	Columbus & Southern Ohio, Conesville 5 & 6	Black & Veatch	Universal Oil Products	Internal header piping	4/77
23.	Indianapolis Power & Light Co., Petersburg #3	Gibbs & Hill	Universal Oil Products	Pond return water	4/77

Utility	A.E.	System Supplier/ Eng. Constructor	Areas Used	Installation Date
24. Georgia Power	Self	Self	Bottom and flyash lines to ponds	5/77
25 UPA/CPA Coal Creek 1 & 2	Black & Veatch	Combustion Engineering	All slurry pipe in-&-around SO_2 system	6/77
26. Alabama Electric Power Co-op. Tombigbee Station	Burns & McDonnell	Peabody Systems	All slurry piping in-&-around SO_2 system	6/77
27. Kansas Power & Light Lawrence #5 revamp	Black & Veatch	Combustion Engineering	All slurry piping in-&-around SO_2 system	8/77
28. Southern Illinois Power Co-op., Marion Station	Burns & McDonnell	Broyles & Broyles	Yard piping	10/77
29. Commonwealth Edison Powerton Station	Sargent & Lundy	Universal Oil Products	Pond return water Internal headers & demister wash piping	1/78
30. CILCO - Duck Creek #1 Modules A, B & C	Commonwealth Assoc.	Riley Environeering	All slurry piping in-&-around SO_2 system	3/78
31 Southern Illinois Power Co-op., Marion Station	Burns & McDonnell	Babcock & Wilcox	Internal slurry headers	3/78
32. Georgia Power Harlee Station	Self	Self	Flyash slurry piping from precipitator to ponds	3/78
33. Basin Electric Power Coop., Laramie River Stations 1 & 2	Burns & McDonnell	Morrison-Knudsen	Misc. yard & slurry disposal piping	6/78
34. Basin Electric Power Coop., Laramie River Stations 1 & 2	Burns & McDonnell	Research Cottrell	Misc. yard piping	8/78
35. So. Indiana Gas & Electric A.B. Brown No. 1	Mid Valley Eng.	FMC Corporation Santa Claus Boiler	All slurry piping in-&-around SO_2 system	9/78
36. Public Service New Jersey Bergen Station Mercer Station Hudson Station	Self	Self	Waste water treatment	9/78
37. Potomac Electric Power Co., Dickerson Units 1 & 2	Bechtel	Chemico	Internal slurry headers	9/78
38. Pacific Gas & Electric Jim Bridger Station	Bechtel	Universal Oil Products	Demister wash piping	10/78
39. Sikeston Board of Mun. Utilities, Sikeston Station	Burns & McDonnell	Babcock & Wilcox	Slurry headers	1979
40. Southern Carolina Public Service, Winyah Unit 3	Burns & Roe	Babcock & Wilcox	Slurry headers	1979
41. Texas Power & Light Co. Sandow Unit 4	Brown & Root, Inc.	Combustion Engineering	All slurry in-&-around SO_2 system	1979
42. Texas Municipal Power Agency, Gibbons Creek #1	Tippett & Gee	Combustion Engineering	All slurry in-&-around SO_2 system	1979
43. Northern States Power Sherburne 1 & 2	Burns & McDonnell	Combustion Engineering	Replace R.L. slurry piping in A-150	1979
44. Interlake, Inc.	Riley Environeering	Riley Environeering	All slurry in-&-around SO_2 system	1979
45. Caterpillar Tractor Co. Mapleton Plant	Giffels Assoc., Inc.	FMC/Illinois Piping	All slurry in-&-around SO_2 system	3/79
46. East Kentucky Power Co-op., Spurlock Gen. Plant #2	Black & Veatch	Combustion Equipment Associates	All slurry piping in-&-around SO_2 system	9/79

Utility	A.E.	System Supplier/ Eng. Constructor	Areas Used	Installation Date
47. South Mississippi Elec. Pwr. R.D. Morrow #1 & #2	Burns & McDonnell	Riley Environeering	Internal spray header	12/79
48. Springfield Water, Lgt. & Pwr. Dallman #3	Burns & McDonnell	Research Cottrell	System piping	3/80
49. Tennessee Valley Authority Widows Creek #7	Self	Combustion Engineering	Slurry headers, manifolds and piping	5/80
50. Salt River Power District Coronado #1	Bechtel	Pullman Kellogg	Slurry piping	7/80
51. Louisville Gas & Electric Mill Creek #1	Pioneer	Combustion Engineering	Slurry piping, manifold, internal slurry header	7/80
52. Louisville Gas & Electric Mill Creek #2	Pioneer	Combustion Engineering	Slurry piping, manifold, internal slurry header	7/80
53. Minnkota Power Coop. Milton R. Young Station	Black & Veatch	Self	Slurry piping	7/80
54. Utah Power & Light Naughton Unit #3	Bechtel	Universal Oil Products	Demist spray header	8/80
55. Hoosier Cooperative Mirom #1	United Engineers	Mitsubishi/Stearns-Roger	Internal slurry header	9/80
56. Hoosier Cooperative Mirom #2	United Engineers	Mitsubishi/Stearns-Roger	Internal slurry header	9/80
57. Tennessee Valley Authority Paradise #1 & 2	Self	Chemico	Slurry nozzles	9/80
58. City of Lakeland McIntosh Plant #3	C.T. Main	Babcock & Wilcox	Internal slurry header	9/80
59. P.S. Co. of New Mexico San Juan Stn. #3	Sargent & Lundy	Davy McKee	Slurry manifold	9/80
60. P.S. Co. of New Mexico San Juan Stn. #4	Bechtel	Davy McKee	Slurry manifold	9/80
61. Houston Lighting & Power Parish #8	Bechtel	Chemico	Demist spray headers Internal slurry header	10/80
62. Allegheny Power Systems Mitchell #3	Gibbs & Hill	Chemico	Internal slurry header	10/80
63. Louisville Gas & Electric Mill Creek #4	American Air Filter	American Air Filter	Slurry supply piping	10/80
64. Kansas Power & Light Jeffrey #3	Black & Veatch	Combustion Engineering	Slurry piping, manifold, Internal slurry header	3/81
65. Southwest Electric Power Henry W. Pirkey #1	Sargent & Lundy	Universal Oil Products	Demist piping	6/82

Exhibit III

ABCO LIMITED
R & D AND SALES -
PLASTICS DIVISION

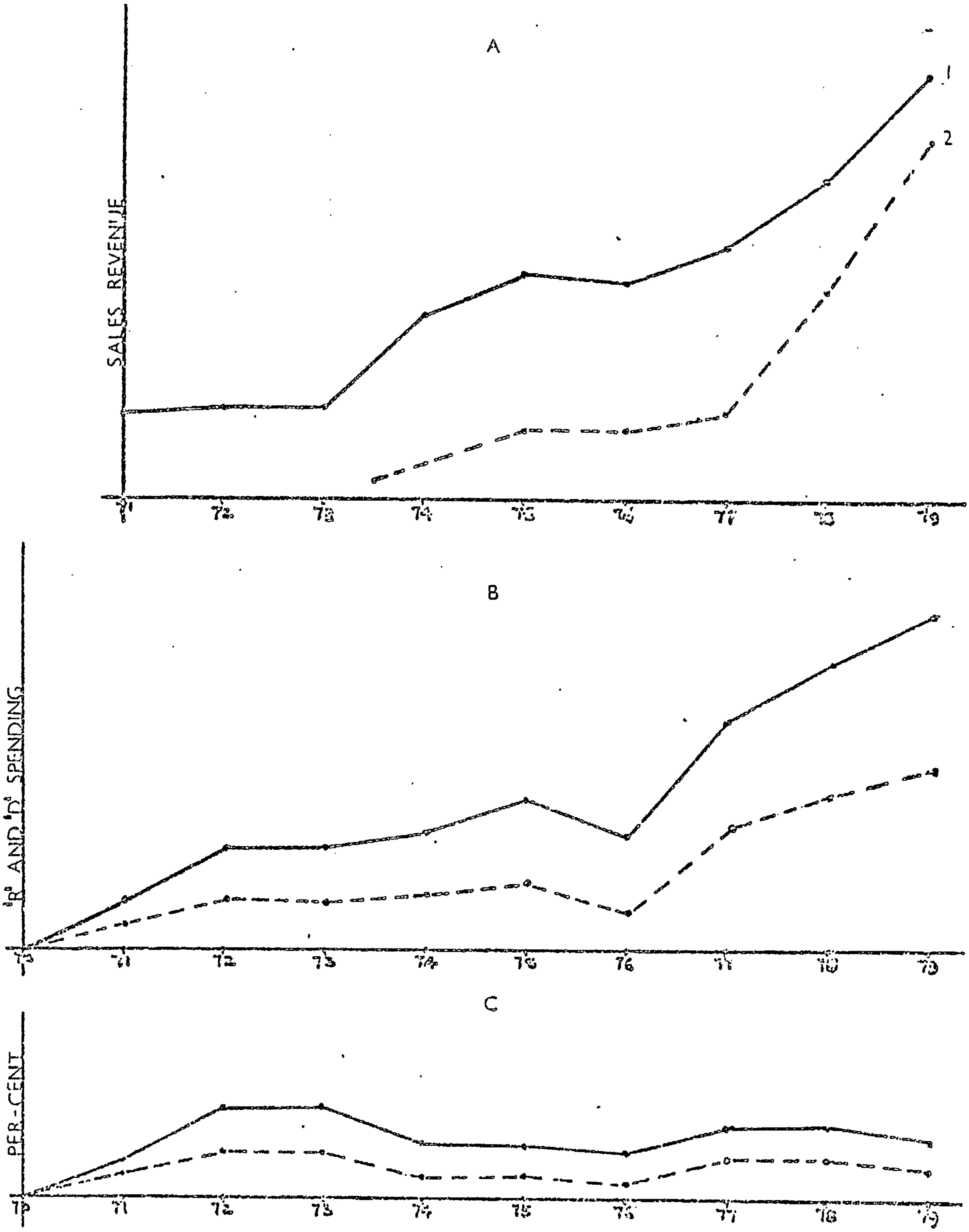


Exhibit IV

ABCO FISH DISCHARGER TRIALS AT FLEETWOOD ENGLAND

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THE WHITE FISH AUTHORITY
HULL
ENGLAND

ATLANTIC BRIDGE COMPANY LTD., LUNENBURG, NOVA SCOTIA, CANADA B0J 2C0 TEL: (902) 634-8821 TELEX: 019-21654

FLEETWOOD INSTALLS PNEUMATIC FISH DISCHARGER

Fleetwood is the first port in the UK to use the ABCO pneumatic fish discharger. Installed in Oct. /79, it has been undergoing trials supervised by the White Fish Authority and is now in full commercial operation.

The move towards mechanisation started when the Fleetwood Fishing Vessel Owners' Association was forced into voluntary liquidation last year, directly as a result of declining fish landings at the port. Port operations were then taken over by the formation of two new companies, Fish Handling (Fleetwood) Co. Ltd. and Fish Ancillary Equipment Co. Ltd.

The new companies immediately set out to increase fish landings by improving the port's efficiency and reducing landing fees, attracting more vessels — French, Icelandic and Faroese as well as British. Fish Handling (Fleetwood) Co. Ltd. now control the day to day operations and employ the dock labour force. Capital assets, including the fish discharging equipment, are owned by Fish Ancillary Equipment Co. Ltd.

Some form of mechanisation was clearly needed to reduce the number of dockers and thus costs whilst ensuring that fish was discharged quickly, efficiently and without excessive damage. Speed was important. The Fleetwood market starts at 8 a.m. and ideally all the fish should be in the auction hall by this time. An 11:30 a.m. market for late fish invariably produces lower prices.

After negotiation with the new companies the Transport and General Workers' Union agreed to the port's mechanisation and to new manning scales and working practices.

The White Fish Authority was then approached for assistance. The Canadian ABCO pneumatic discharger made by the Atlantic Bridge Co. Ltd. was investigated and showed sufficient promise for one to be imported to Fleetwood for trials. The WFA negotiated for ABCO to supply a discharger, the WFA to carry out extensive trials and Fish Ancillary Equipment Co. Ltd. to buy the discharger if the trials were successful. The WFA organised and staffed the trials, while Fish Ancillary Equipment Co. Ltd. took out options on an additional two machines.

The trials have now been completed and the equipment has performed well. Fish Ancillary Equipment Co. Ltd. have taken up their options on the two extra dischargers which are now at Fleetwood being prepared for operation.

The Atlantic Bridge Co. Ltd. has been making pneumatic fish dischargers for nine years, mostly for the Canadian market. Fleetwood has the latest portable model in which several significant design improvements have been incorporated to reduce fish damage. It consists of a 0.3m bore aluminum tube reaching down into the ship's fish room and connected to a suction unit on the wharf. The tube is telescopic in both vertical and horizontal directions and is controlled by blocks and tackles. The vertical tube can be lengthened by fitting extension pieces and the whole assembly is slung from a pivoted arm and can be stowed vertically clear of the vessel.

Air, fish and ice are sucked from the fish hold and through the tube into a cyclone chamber forming part of the suction unit. In the cyclone the fish and ice are separated from the air by centrifugal force and gravity, the fish and ice falling into a water tank sealing the cyclone base, while the air is drawn out by a centrifugal fan.

The fish and ice pass through the water onto a partially submerged inclined conveyor which lifts it from the unit.

The motor, cyclone and tank assembly is housed in a skid mounted steel framework. The motor is an 85hp Deutz air cooled diesel, with a belt drive to the suction fan and an auxiliary drive to a hydraulic pump which powers the conveyor and a small winch to raise and lower the suction tube assembly. Electric drive is available as an alternative to diesel and, in fact, the second and third Fleetwood machines are electrically driven.

A schematic layout is shown in figure 1.

The advantages of mechanisation were clearly demonstrated during the trials when the WFA monitored complete discharges by both the ABCO and conventional methods. Traditionally Fleetwood has used a basket and conveyor system to discharge large trawlers. This typically involves 10 men in the fishroom, three electric capstan operators, three hatchmen, three men tipping baskets and one man hosing and stowing pound boards.

The baskets are filled in the fishroom and hoisted to wooden staging set up on the vessel's deck. They are tipped onto a conveyor run out from the quay which takes the fish to the sorting tables in the main fish hall.

In contrast the recommended fish room crew using the ABCO method is four men plus another controlling the machine. The sorting operation is the same for both methods of discharge.

New fish room working practices are required to work the ABCO system to its full advantage. There are two distinct and separate operations involved. With a full fish room a "breaking in" procedure is required. The uppermost fish are loosened and the open end of the vertical suction tube positioned so as to take up the top layer. This continues until a space along the fish room alley has been cleared. A ninety degree bend is then bolted to the open suction tube followed by one or more short trough sections. The main discharging operation can then commence.

The pounds are emptied by flowing the fish into the troughs which can reach all parts of the fish room by adding extra sections. Quick action permanently fitted butterfly nuts are fitted to all sections. As the trough is extended snap on cover plates are fitted to the first sections, thereby maintaining suction at the open end.

The WFA trials lasted four weeks and 14 landings were monitored. Samples were taken from each landing and examined for damage. Some were taken from the market after discharge and others directly from the fish room for comparison. Just over 10 tonnes of fish were individually examined, covering a wide range of species, size and freshness.

Results showed that the pneumatic discharger caused no more fish damage than traditional methods and that most of the discharge damage was caused by hooks and forks within the fishroom.

Some fish damage, especially to soft fish, was expected from the pneumatic discharger itself. The high velocities achieved in many types of pneumatic discharger cause bruising of the flesh as the fish pass through the various ducts. The ABCO discharger uses a relatively low suction and hence air speed. In practice this means that the fish must be within a few inches of the suction tube to be taken up but, on the other hand, the slower velocity results in minimal fish damage.

Such slight damage as occurs is more than compensated by the reduced hook and fork damage in the fishroom, which is very much less than when filling baskets using the traditional method.

Using the ABCO discharger means that the fish are briefly washed before being sorted and sold on the market. This is contrary to normal UK practice and some merchants had complained that washing made it more difficult to assess fish quality because good quality fish were less glossy and poor quality fish less discoloured. Concern was also expressed that washed fish could dry out in hot weather. Other merchants, however, felt that washing was an advantage in that they could rely on buying a full 10 stone of fish in each kit instead of an uncertain mixture of fish plus some ice and slime. Overall the merchants have accepted the discharger.

The discharge rate quoted by the Atlantic Bridge Company was 12.5 tonnes per hour. This was not met during the Fleetwood trials, 10 tonnes an hour being achieved by crews with some experience of the discharger's use. Existing working procedures in the fishroom did not suit the discharger and considerable time was lost through nozzle blockages and multiple handling.

Using the basket and conveyor method the discharge rate varied between 10 and 16 tonnes per hour, depending on the ship and the number of hoists possible. But when converted to a rate per man, even the 10 tonnes per hour achieved by the ABCO discharger was approximately double that of the basket and conveyor system.

The two additional machines bought by Fleetwood are a handed pair and can be used together to discharge a large vessel via a single hatch. When this pair are fully operational the largest ships using Fleetwood should be discharged quickly and efficiently.

New working methods are required for maximum efficiency and so the WFA has produced a set of guidelines for using the discharger. These recommend the size and organisation of the fishroom crew and optimum procedures for discharging fishrooms of varying size and layout.

The WFA has also produced a special blunt tined rake to replace the hooks and forks used during much of the discharge. Fish Handling (Fleetwood) intend to bring the procedures and implements into use when further improvements, both in reduced fish damage and increased discharge rates, are confidently expected.

The Fylde Ice and Cold Storage Co. Ltd. has been appointed European agents for the ABCO discharger.

Michael Moore
Technical Writer

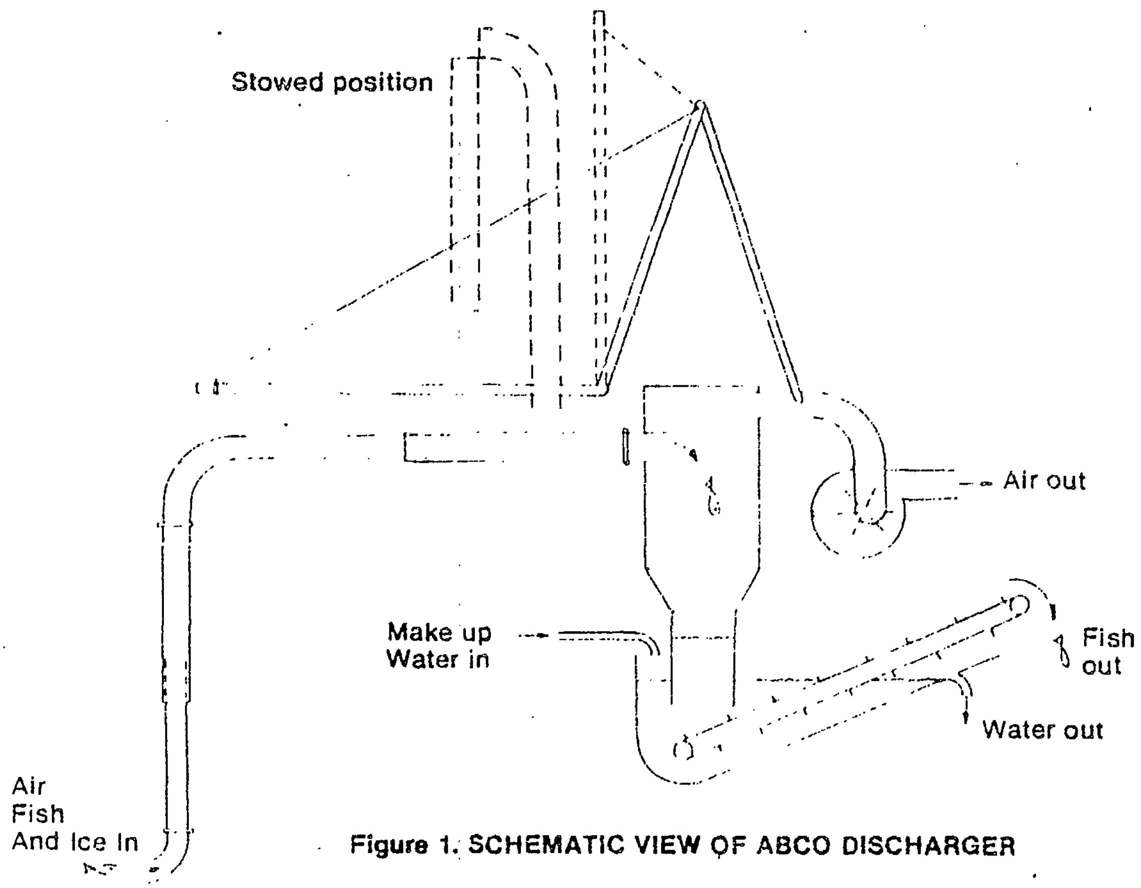
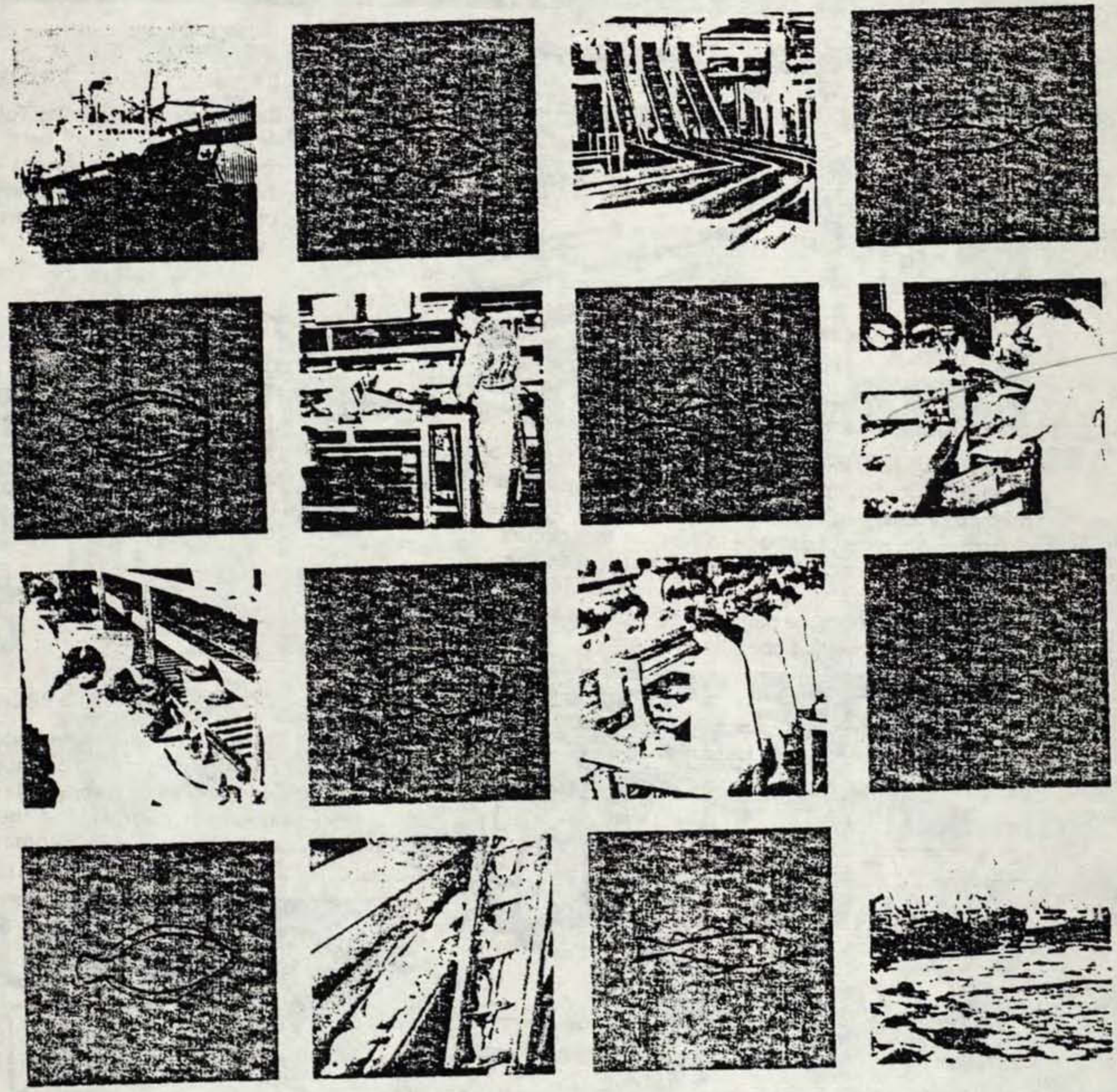


Figure 1. SCHEMATIC VIEW OF ABCO DISCHARGER

Exhibit V



ABCO
FISH PROCESSING
EQUIPMENT

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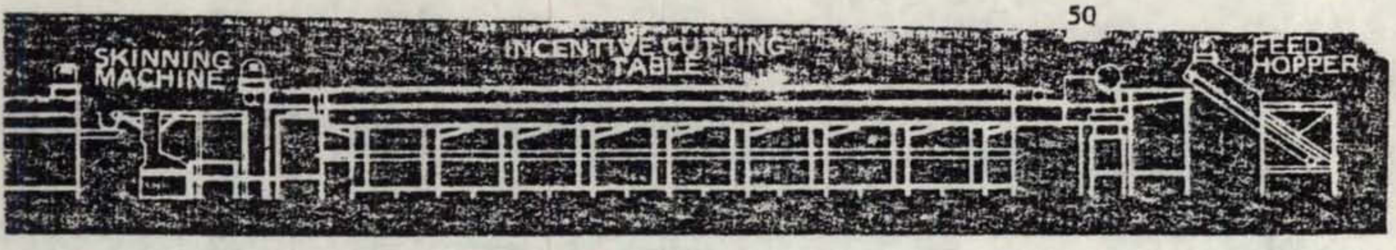
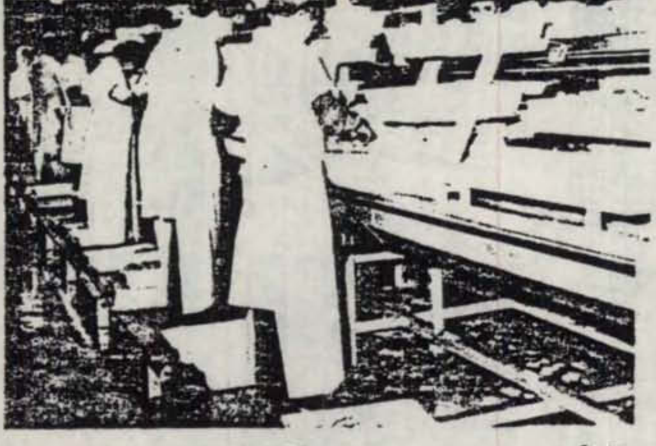
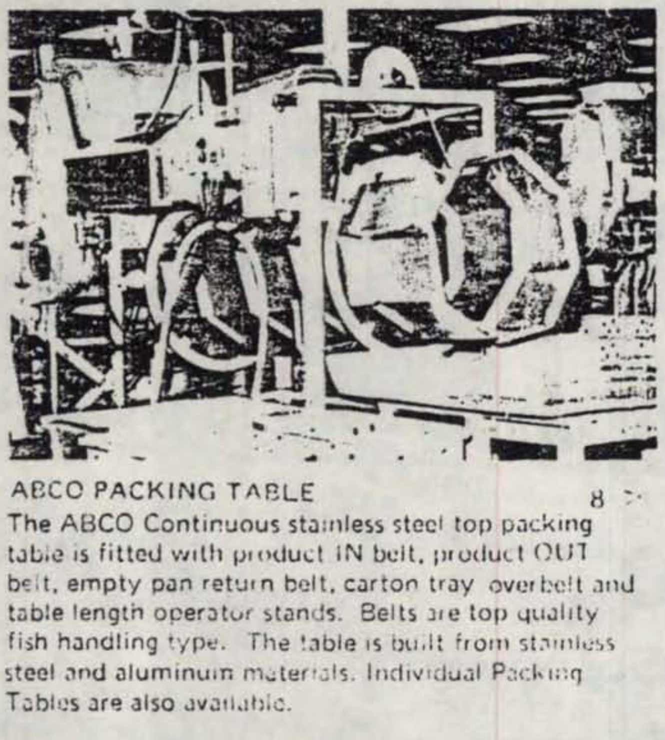




ABCO BLOCK DEPANNER 6 >

The ABCO Block Depanner offers a fast energy efficient method of removing the Frozen Blocks of Fish from the Freezer Pans without damage to the pans that occurs with traditional Knock Out Tables. Today's packaging requires accurately sized pans in good condition. The expected life-span of the pans can be substantially extended, thus lowering operating costs.

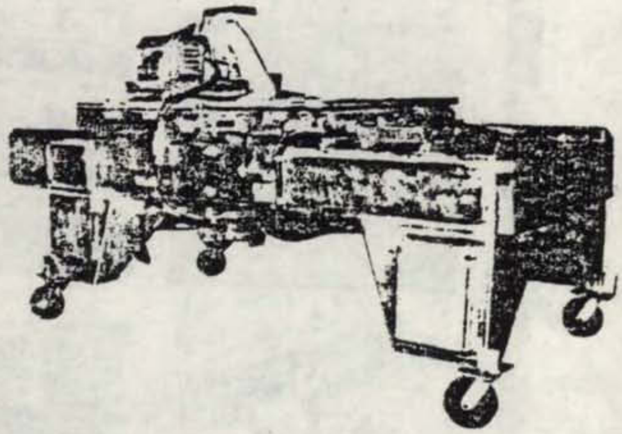


ABCO PACKING TABLE 8 >

The ABCO Continuous stainless steel top packing table is fitted with product IN belt, product OUT belt, empty pan return belt, carton tray overbelt and table length operator stands. Belts are top quality fish handling type. The table is built from stainless steel and aluminum materials. Individual Packing Tables are also available.

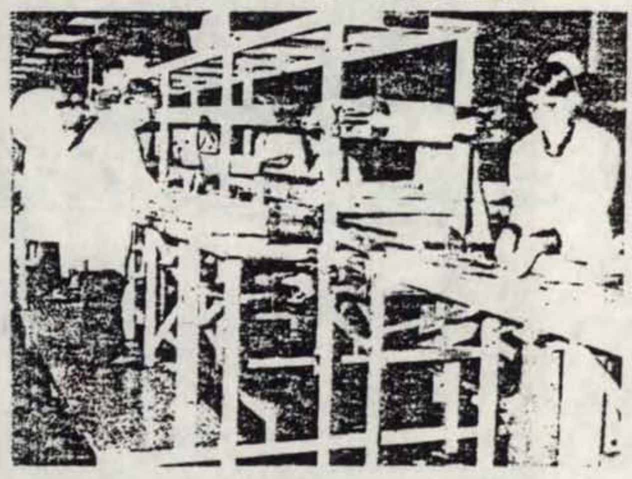
< 5 ABCO CANDLING AND TRIMMING TABL

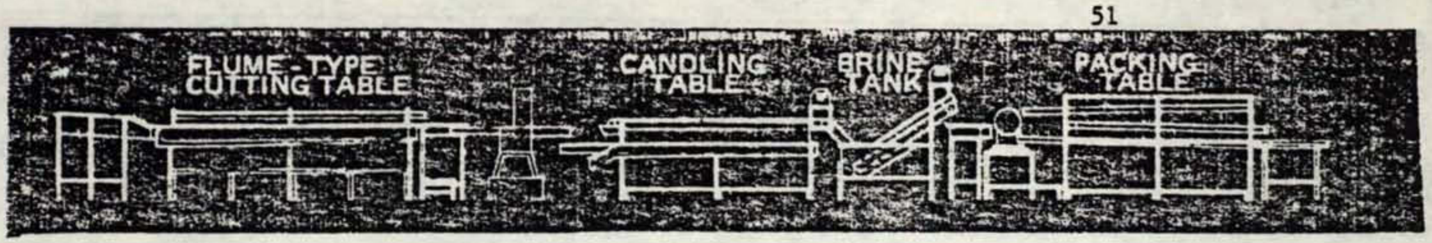
The ABCO Candling and Trimming Table is fitted with product IN belt, product OUT belt, opal perspex candling surfaces, watertight fluorescent candling light and table length operator stands. Belts are top quality and the tables constructed of aluminum and stainless steel.

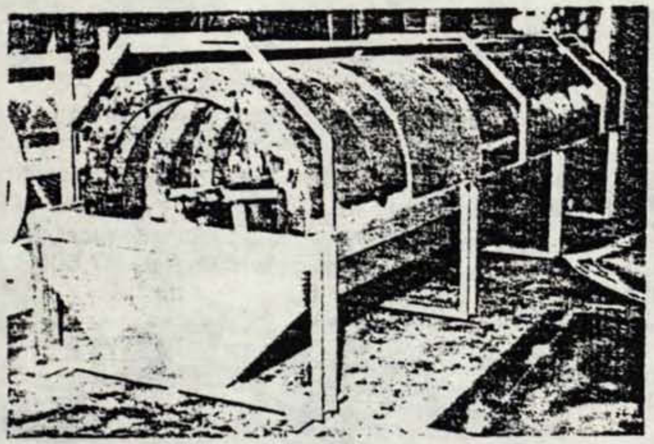


< 7 ABCO PHOSPHATE APPLICATOR

The ABCO Phosphate Applicator is available for both Continuous Flow or Batch Applications. The stainless steel drum is designed to gently flex the fillets and ensure maximum absorption of the additive. The additive supply system ensures automatic and accurate metering of the treatment solution.





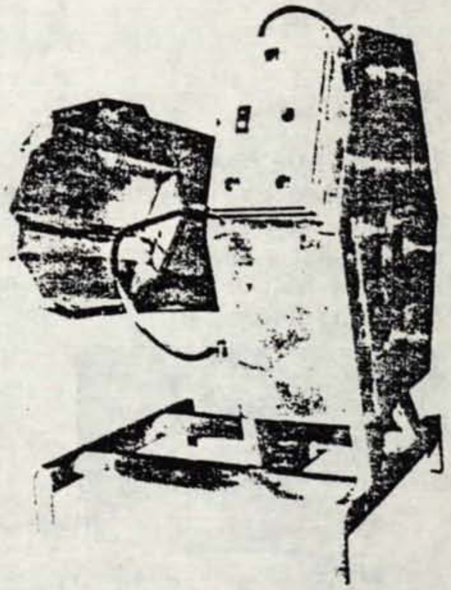


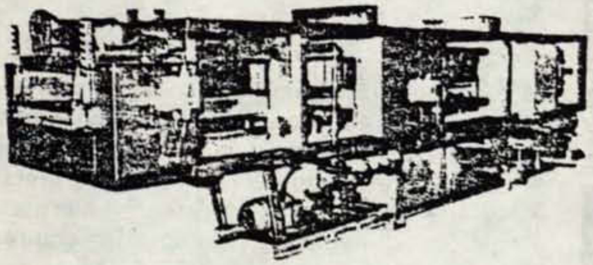
< 9 ABCO DEWATERING DRUM

The ABCO Rotary Dewatering Drum is designed for first stage dewatering of coarse offal, i.e. fish frames, skins and trimmings. The drum has ¼" (6.35 mm.) dia. perforations on 3/8" (9.52 mm.) centres and can be fitted with internal spirals for controlled through-put. This unit is of mild steel construction with Totally Enclosed Fan Cooled Electric Drive.

ABCO PHOSPHATE BATCH APPLICATOR 10 >

The ABCO Batch Applicator has been designed for easy inclusion in existing Process Lines that require a high degree of accuracy in the percentage of phosphate solution to be applied to the product. It is fitted with pre-calibrated adjustable timers for easy operation.





< 11 ABCO PAN WASHER

The ABCO Pan Washer is designed to wash fillet and block freezing pans at a rate of up to 500 pans per hour. Filtered water is re-circulated and provides for a hot pre-rinse, hot detergent wash and fresh water rinse.

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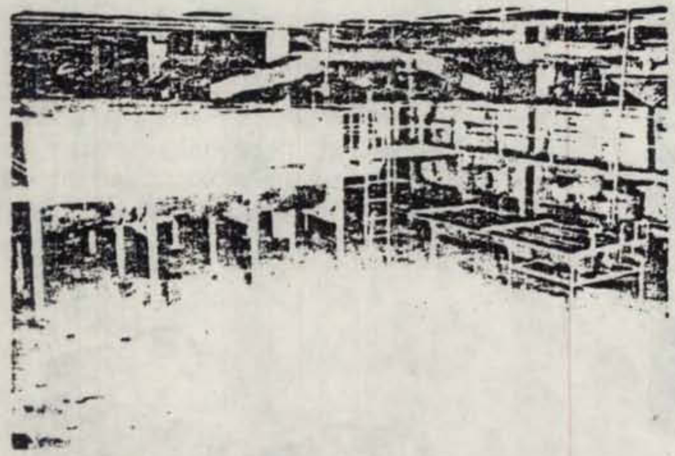
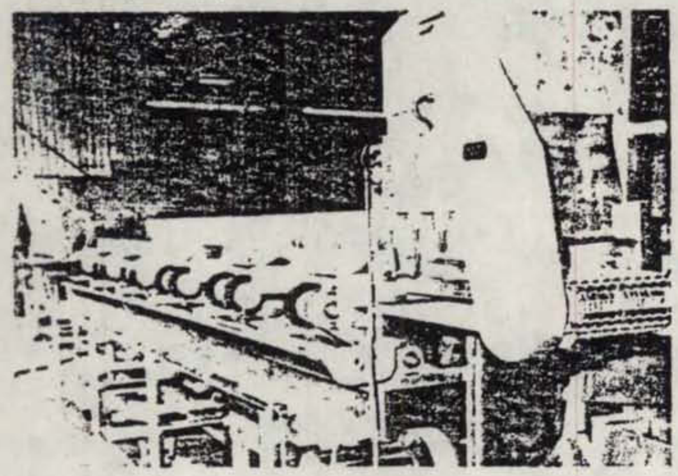


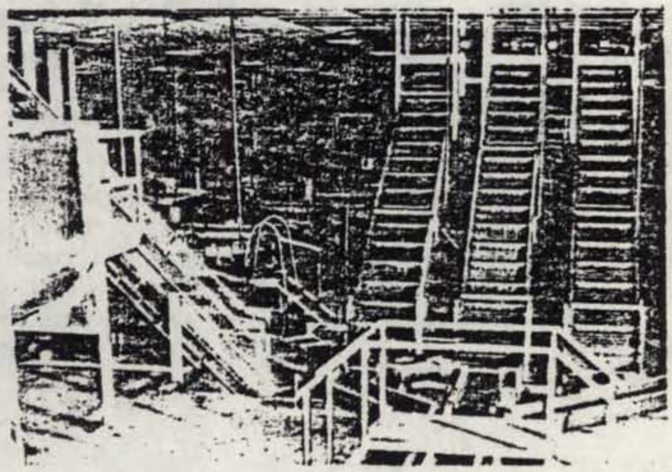
ABCO CONVEYOR SYSTEMS >

ABCO produce a wide variety of conveyor systems. The range covers, belt, chain scraper and screw conveyors suitable for all stages of processing. They are produced in stainless steel, aluminum or mild steel depending on application.



< ABCO ROUND FISH HOLDING TANK

ABCO Round Fish Holding Tank. The ABCO Round Fish Holding Tank System, when used in conjunction with the ABCO Air Unloader, enables a fish plant to unload rapidly in bulk, then process the catch at a pre-determined rate. The efficiency of the plant is raised considerably, as this system reduces fish handling. Each tank holds approximately 17,000 lbs (or 7,711 kilograms) of fish.



< ABCO GENERAL CRAB PROCESSING LINE

ABCO produce complete Crab processing lines for both Batch and Continuous cooking systems. Items such as Crab Hoppers, Butchering and Cleaning Tables, Continuous Cookers, Crab Baskets, Cooling Tanks, Shucking Tables, Brine Freezers, etc. can be custom built to meet your specific requirements.

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ABCO DESIGN ENGINEERING

This brochure shows a representative sampling of the wide variety of equipment manufactured by Atlantic Bridge Company for the fish processing industry. All equipment is based on designs which have proven to be acceptable for installation by nearly all the major fish processing plants in Eastern Canada. While the basic concept for each item is based on standard proven designs, each is available in a wide variety of arrangements and sizes to suit customers individual needs. All equipment is built to conform with sanitary conditions as established by the Canadian Department of Fisheries so that all parts which may come in contact with the product during handling and processing are made from either corrosion resistant aluminum or stainless steel, mild steel being used only in the handling of waste products.

While this brochure is concerned only with items for the fish processing industry, ABCO also manufactures a wide variety of equipment for other industries or customers. Included among these latter items are highway salt and sand spreaders, small to medium sized storage tanks, small barges, light structural fabrications and hydraulic trap and line haulers. We are equipped to custom design, and manufacture, a wide variety of equipment in either aluminum, stainless steel, mild steel or glass reinforced plastic to conform with customers special needs or specifications. We solicit your enquiry.

ABCO PRODUCES
Culling and Weighing Tables
Feed Hoppers
Round Fish Hoppers
Weigh Stations
Utility, Panning - Knock Out Tables
Dip and Wash Tanks
Screw and Belt Conveyors
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CAMBRIDGE Stainless Steel Belting
EXACT WEIGHT and BERKEL Scales
Fish Boxes and Pans
GOULDS and GORMAN RUPP Pumps
DEUTZ DIESEL Generators and Main Propulsion Units
COPPERLOY Ramps and Dockboards

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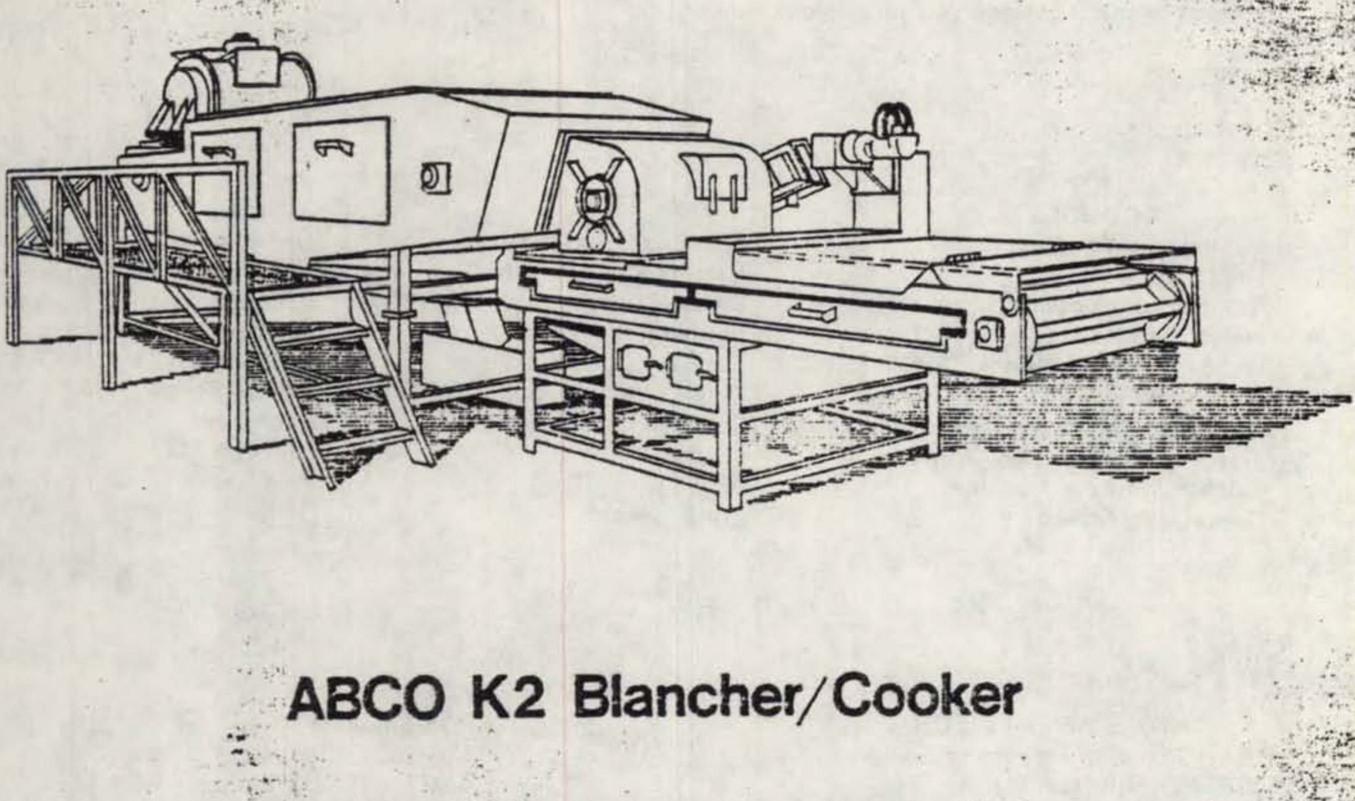


ABCO K2 Blancher/Cooker

ABCO K2 STEAM BLANCHER COOKER

ABCO

Manufacturing Division

General

For the last 50 years blanching has been used as an important step in the preservation of high quality foods, especially vegetables destined for freezing. The process, which consists of a short heat treatment designed to inactivate natural enzymes, is energy intensive. Most food processors are now having to come to grips with all aspects of their operation that involve the consumption of energy.

Using the I.Q.B. technique, the Department of Agriculture at their Research Station at Kentville, Nova Scotia and ABCO have developed the K2 system. This system has shown that significant amounts of energy can be saved while reducing effluent volumes, with the added attraction of producing product with higher nutrient retention.

Extensive testing under commercial processing conditions indicate that, depending on product through-put, degree of blanch specified, etc., the unit requires about one-tenth the steam normally used by a water blancher to process a given vegetable (comparisons would be even more favorable for conventional steam blanchers). For such products as peas, cut beans, carrot slices and dices the normal requirement of steam runs somewhere around 2 lb. of steam for each pound of product blanched. Test results indicate that the K series blanchers will blanch about four to seven pounds of product / lb. steam or 0.14 -0.25 lb. steam / lb. product running at through-puts of 4,000 - 7,000 lb. / hr. These are averaged figures and involved running the unit below maximum system efficiency in order to mesh with the other components of the processing line in which the K blanchers were operated.

A second area of major concern is in the production of effluents which must be handled by sewage systems. In actual tests the K blanchers produced about one tenth the volume of effluent at one fifth to one fourth the total BOD load as compared to the water blancher which was operated in parallel with it. Furthermore, the K-system employs an evaporative cooler thus eliminating a large volume of cooling water. As a bonus, the absence of free water on the product going to the freezer allows for more rapid and better freezing. With the K-system the capacity of the freezer used was very nearly doubled relative to that which would be expected when using its conventional water system.

Process Description

The K2 blancher achieves its efficiencies by only passing a monolayer of the product through the heat section, hence the transit time is very brief, and consequent energy requirement is low.

The condensing system passes its high energy load to the product during its condensation on the outer surface.

The product is at the same time passing through a turbulent steam system which tends to fluidize the monolayer and promotes the distribution of the heat energy to the product.

Since the product is passed so rapidly through the system, leaching of nutrient is reduced to an absolute minimum.

The heat enthalpy in the condensed steam is now allowed to equilibrate in the holding section where the product is contained in buckets, having reflective sides and upper faces. This piling up of the product allows deep heat penetration by adiabatic effect, and thus assures blancher, or cook, without the further input of energy.

Since the product passes through a rotary valve at both intake and exhaust an absolute minimum of energy is wasted to the atmosphere.

These elements combine to give the previously mentioned energy and effluent advantages as well as a high quality product (at least equal to conventional product as determined by trained taste panels) with significantly improved retention of nutrients in most cases. As an example of what can be accomplished regarding nutrient retention, work with the K-1 system showed a 52% increase in retention of ascorbic acid in broccoli when the experimental system was compared to conventional water blancher / cool procedures. In real terms the values involved are 114 mg ascorbic acid per 100 g of product in the raw broccoli, 104 mg / 100 g in the K-1 product and 68 mg / 100 g in the water system. Not all vegetables respond this well but most do show significant improvement. Ascorbic acid was used as an indicator since it is highly sensitive and water soluble.

ABCO

Product Detail

The ABCO K Series Blancher / Cooler is fabricated as an all welded monocoque structure of double wall construction filled with a high efficiency insulation. All load points have large stress distribution areas, and bearings and other load bearing components have been sized for minimum maintenance and long life.

The structure is fabricated from corrosive resistant aluminum alloy, and all food contact areas are constructed from stainless steel or Food and Drug approved high temperature polypropylene homopolymer.

Hygiene plays an important part in food processing, and every effort have been made to provide a machine with easy access to all areas for the sanitizing crew, thus allowing for smaller down time at product "switch-over".

As Manufacturers of Food Processing Equipment for over thirty years, ABCO is fully versed in the day-to-day operational problems encountered in the Food Processing Industry.

All equipment is of rugged construction, and designed for easy maintenance.

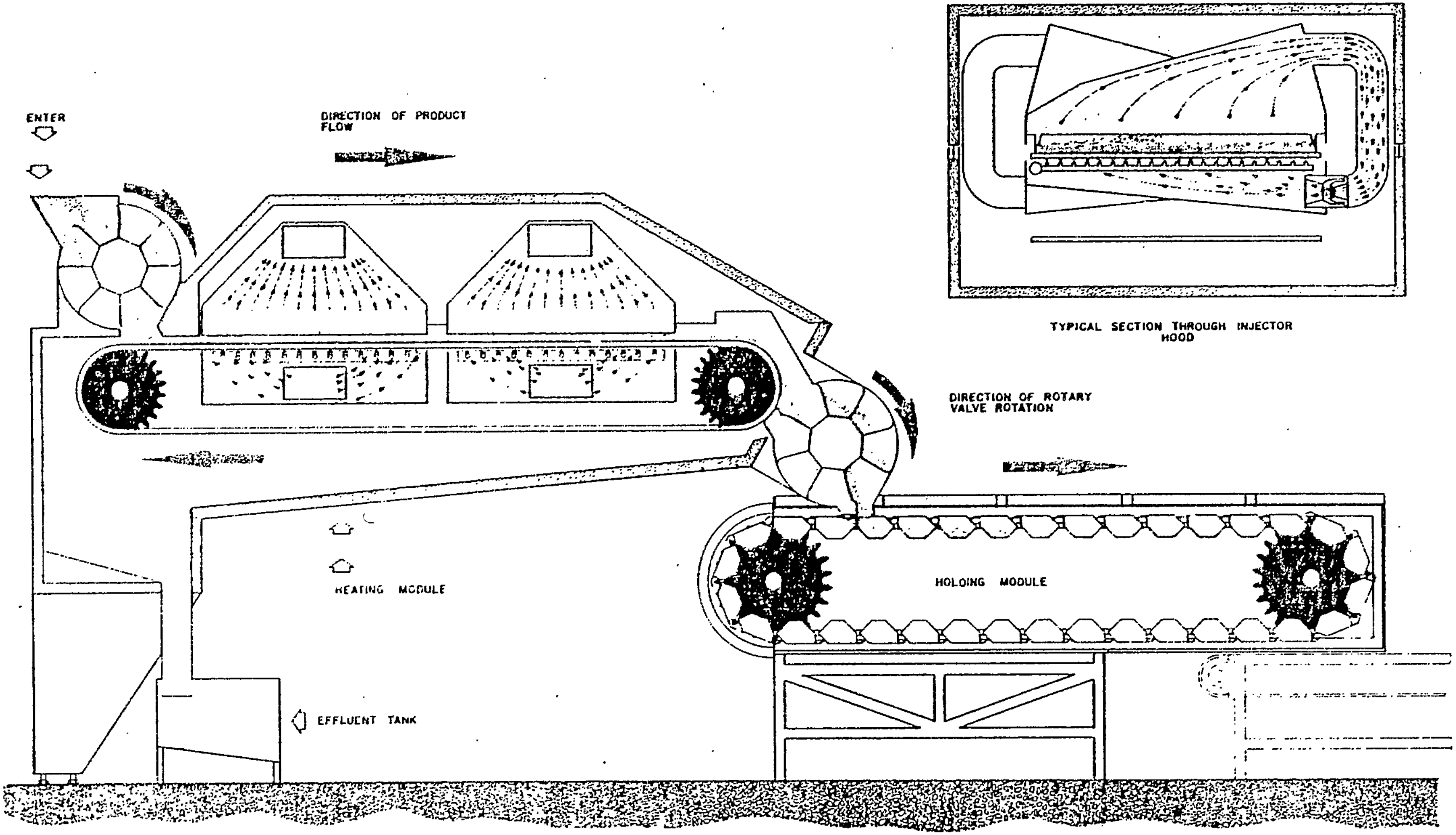
General Specifications

Maximum Height (opened)	12'-6" (3.8 M)
Discharge Height	3'-3" (1.0 M)
Feed Hopper Height	10' (3.0 M)
Overall Length	22'-8" (6.9 M)
Overall Height	12'-6" (3.8 M)
Overall Width	13'-6" (4.1 M)
Shipping Weight	3,400 lbs. (1,542 kg)
Power Supply	3 phase, 208 / 416 VAC-230 / 460 VAC-575 VAC, 100 amp. power supply
Heat Medium	Saturated Steam. 85 PSIG regulated (5.9 bar.)

The K2 blancher is the culmination of a development program spanning seven years. The original K-1 prototype was built by Agriculture Canada's Engineering and Statistical Research Institute, Ottawa.

Manufacturing Rights to the unit are under licence from Canadian Patents and Development Limited, a Crown Corporation of the Government of Canada.

NOTES



ABCO K2 BLANCHER

PROCESS FLOW ILLUSTRATION

ASDIC LIMITED

It was a Wednesday in June 1981 and the first item of business for Mr. Graham James that day was a pleasant one. The day before, Mr. James - General Manager of ASDIC Limited - had heard that the company's newly developed satellite transmitter had been certified for commercial use. The company had been developing the transmitter for about a year, having experienced a succession of problems with 'bought in' transmitters that went into the building of its drifting buoys. Using the new transmitter would mean an end to supply irregularities, better cost control, and more 'added value' in the final ASDIC product. This all looked good for ASDIC's drifting buoy programme, and Mr. James planned to draft a memorandum congratulating those that had worked on the development of the transmitter.

The Company

ASDIC Limited is situated in Shaldon on the Canadian seaboard and occupies a modern plant with a floor area of 125,000 square feet. This plant is equipped for the manufacture of electronic and mechanical components and equipment from the prototype phase through to volume production. More than 300 personnel are normally employed by the company: approximately 25% of these come under the Engineering Department, where engineers, technicians, draughtsmen, and various

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This case was prepared by Professors Philip Rosson and Michael Martin of Dalhousie University as a basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. The names of the companies, locations and the personnel involved have been changed to preserve anonimity. The authors gratefully acknowledges the financial support of the Federal Department of Industry, Trade and Commerce, Technological Strategy Branch in the development of the case.

support staff work. The firm is one of the largest private employers in the city of Shaldon. The principal products of the company are:

* sonobuoys
* bathythermograph buoys
* drifting and moored ocean data buoys
* ice beacons
* custom buoy systems
* communications antennas and ionospheric sounders (see Exhibit I)

The firm is organized in a matrix structure, with functional managers arranged along one edge of the matrix, and product managers arranged along the other (see Exhibit II). The Environmental Data Systems Group, comprising about one third of the Engineering staff, specialises in the development and production of systems for collecting, analysing, and disseminating meteorological and oceanographic information. This made the Group responsible for drifting buoys and their development.

Drifting Buoys - CODS and FGGE Contracts

Although ASDIC had prior experience, a Canadian Ocean Data System (CODS) contract in 1975 gave impetus to its buoy programmes. This was an 'incubator' contract in that the government's objective was to help create a centre of excellence in Canada for ocean buoys of all kinds. For two main reasons, this type of contract was particularly valuable to ASDIC. First, the contract award implied recognition that ASDIC was a leading Canadian company in this field. Second, it also provided the opportunity for the company to establish a dominant position in the Canadian drifting buoy market (see below), and an opportunity to penetrate the world-wide market.

Part of the CODS contract required that ASDIC develop a buoy which was to act as a free drifting platform for the measurement of barometric pressure and sea-surface temperature. Air pressure was to be measured to an accuracy of $\pm$ 1.0 millibar (mb) over the range 900 to 1050 mb. Water temperature measurements were to be accurate within $\pm$ 0.5°C over the range -5°C to +40°C. The buoys were to transmit data through a special battery-powered transmitter to the Nimbus-RAMS satellite system, which is able to compute the position of the buoy, an important element in the study of weather patterns. Finally, the buoy was to be designed to have a life of between 6 and 12 months, depending upon the ambient ocean temperature (which affects the life of the battery).

Some 50 buoys were built and tested under the first phase of the contract. Thirty buoys were tested in ocean waters, and a further 20 were tested to destruction in the firm's well-equipped test facilities. This process took about 18 months to complete. Then, after design production modifications, a one year experiment was conducted on a further 30 buoys in phase two. Twenty buoys were deployed in the Atlantic, Pacific, and Indian Oceans. Only four buoys failed prematurely due to electrical or mechanical problems, and two buoys collected and transmitted information for more than 18 months. Without independent references, it was difficult to measure data quality from the test buoys, but where this was feasible, performance was to specification. The 10 remaining buoys were tested in controlled situations to gauge the effect of fouling on the buoys and pressure system. As well as meeting the accuracy and working life requirements listed above, launching characteristics were found to be satisfactory. The buoys in question were launched from a variety of ships, while in motion, by untrained crews, and without the assistance of a crane.

As a result of its work under the drifting buoy part of the CODS contract, ASDIC was successful in winning the FGGE* contract in December 1977. The contract called for the building of 74 drifting buoys which were to be ready for shipment at two dates in March and April 1978. The 74 drifting buoys marked Canada's contribution to FGGE. Other nations also had buoys built for the international programme, while the United States made the additional commitment of resources to put the TIROS Satellite in orbit. All of Canada's buoys were built by ASDIC, and because Canada provided more buoys than any other nation, ASDIC effectively became FGGE's largest supplier.

The ASDIC buoys (see Exhibit III) were shipped to various ports and then deployed in the southern ocean waters where the FGGE experiment was conducted. The buoys measured barometric pressure and sea surface temperature and then transmitted these data via the TIROS polar orbiting satellites. Despite an higher than expected rate of early failure due to unknown causes, the majority of the Canadian-built buoys gave useful reports for over 6 months, and 7 operated for over 2 years. The fact that FGGE buoys required a

* FGGE is the acronym for "First GARP Global Experiment" where GARP is the acronym for "Global Atmospheric Research Program."

different battery-powered transmitter from that used in the CODS programme (because of the different satellite and data collection system), may have led to the early failures.

With its experience in building buoys under the CODS and FGGE contracts, ASDIC began to win orders for drifting buoys from other sources. Some of these were quasi-governmental, in that various oceanographic institutes became interested in the buoys. Other orders came from the private sector where oil companies used the buoys to chart currents in areas like the Beaufort Sea, or to assist in the conducting of environmental impact studies in offshore drilling areas. These purchases either came from the oil companies directly, or from consulting firms working on their behalf. The next spurt of drifting buoy activity, however, came when ASDIC received a further government contract in 1979.

The PAPA Buoy Contract

In September 1978, ASDIC submitted a proposal to Government for the supply of 10 meter discus buoys (see Exhibit IV) to be moored in the North Pacific Ocean. The proposal resulted from the company learning that the Canadian government was shortly to announce a decision to terminate the operation of weather ships at Ocean Station PAPA (at 50°N and 145°W in the north east Pacific Ocean, 1100 kilometres west of Vancouver Island.) Station PAPA was established in 1950 with two refurbished navy frigates. Since 1967, on alternating six week cruises out of Victoria, B.C., two especially constructed Canadian Coast Guard ships had maintained continuous observations at that station. The termination decision was taken because of steadily increasing operating costs, which were estimated at $6 million for 1978. ASDIC believed that their moored ocean data buoy would meet the government's new requirement for an unmanned weather station.

Numerous concerns were expressed about a sudden termination of the ship's observations, and as a result the Atmospheric and Environmental Service (AES) deferred a number of other programmes so as to fund the operation of the ships for two more years. This meant that the first ship would be withdrawn in June 1980, and the second one year later. In November 1978, AES initiated a project to develop and put into operation alternate meteorological observing systems in the north-east Pacific. With a target operating budget of one quarter that of the ships, no way was seen to duplicate their whole programme, which covered upper air, surface, and special observations.

By early 1979, the idea of moored buoys looked less promising. The requirement for two 10 meter discus buoys and their periodic exchange in order to maintain one on station, together with the risk of capsizing or losing a buoy in this, one of the world's stormiest oceans, made the approach appear too costly. In view of this, and given the promising results obtained with drifting buoys under FGGE, it was decided to consider a system based on drifting buoy usage. As a result, in November 1979, ASDIC was awarded a contract "To undertake research and development on an ocean data buoy system, to develop and test a cost effective, alternate for the surface level programme of the weather ships now serving Ocean Station PAPA in the north-east Pacific Ocean, including a one year trial of the experimental buoys in the north-east Pacific Ocean." This contract was to take three years to complete.

The AES programme of research, of which ASDIC's PAPA contract was a part, involved three main steps. In order to develop an economical operational alternative to the high capability moored buoys, work was necessary to:

1. Establish a real-time data reception facility;

2. Gain initial network experience by using the simple FGGE type buoys with drogues (a drogue is a contrivance used to steady and delay the movement of the buoy); and

3. To develop more capable and cost effective buoys, primarily by improving the drogues and adding anemometers (wind gauges) to the simple buoys.

ASDIC was to produce 28 buoys through the contract, which were to be delivered for testing and development purposes.

Ten drogued buoys were deployed and tested during 1980. Tests by AES showed that when the drifting buoy information was available, better weather maps could be produced. The evaluation procedures showed that the buoy information permitted more accurate location of high and low pressure centres, better definition of troughs (and hence more accurate placement and better indication of the intensity of fronts), and more accurate determination of pressure gradients. As well as these positive results, certain recommendations for improvements resulted from these tests. One of these concerned the collection of wind speed and direction data. The work on incorporating an anemometer into the drifting buoy was still underway in June 1981.

By the middle of 1981, the AES programme using drifting buoys was looking quite promising, even though some uncertainties remained. The

AES real-time TIROS receiving station in Edmonton, Alberta, was equipped with a minicomputer system, and computer programmes developed to ingest the buoy reports and decode, sort, verify, and convert data from other data collection platforms. This meant that shortly after completion of the satellite pass (about 5 minutes), weather reports were available for distribution - the whole process from ingestion to distribution being fully automated.

The AES assessment of the drifting buoy programme as of July 1981 was that reliable meteorological surface data could be obtained, and that a buoy operating life of a year or more was achievable. These were important factors, for:

1. the recovery of faulty buoys could not be really entertained when ship costs were of the order of $5,000 a day, and

2. continuous data collection would require 'reseeding' of the north-east Pacific when the buoys deployed drifted out of the area and/or ceased operating.

AES expected to pay at least $10,000 per unit for each of the three types of buoy:

Undrogued drifting buoy - pressure and temperature only
Drogued drifting buoy - pressure and temperature only
Drogued drifting buoy - pressure, temperature, & wind

ASDIC personnel were somewhat unsure of where the PAPA contract would lead them. Some felt that if there was a lack of success with wind measurements, it could signal the end of AES interest in drifting buoys. This was doubly concerning since ASDIC was not directly responsible for the anemometer development themselves, only for adapting and installing them in the drifting buoys.

Then there was the whole question of cost-effectiveness. One particularly cost-effective method of collecting surface data involved the use of commercial ships; these could make the observations and then transmit the same via satellite. Such a programme would depend greatly on gaining the cooperation of vessel owners whose ships plied routes that took them through the north-east Pacific. AES had managed to recruit over 100 ships in Canadian Pacific ports in the first 6 months of 1981 and was interested in this alternative.

Drifting buoys could play an important role in the north-east Pacific and other oceans. A strong case exists for their use in ocean areas that are crossed by few vessels, and generally, the case for their usage is stronger as they are made more durable, capable, and economic.

In this connection, the newly certified satellite transmitter was a welcome development. In the past few years, the company purchased transmitters from three sources. Their first supplier, a U.S.-based operation was entirely satisfactory for the first year or so, and its product was extremely reliable. Then, it began to develop other product lines and decided not to continue with regular production of the transmitter ASDIC was buying. Instead, the supplier moved to batch production of the transmitter and ASDIC found that there was a resulting deterioration in product reliability. This problem of poor reliability showed-up early in the PAPA programme. In fact, the viability of the project was questioned because of this technical problem, but ASDIC instituted a program of reliability shake-down and burn-in testing prior to shipment, and was able to turn the programme round in time to save it. After this experience, ASDIC looked for alternative sources for the TIROS transmitter. Their next supplier was a French company whose delivery was fine but prices prohibitive. Finally, ASDIC switched suppliers to a Norwegian firm, as a stop-gap measure while developing their own transmitter. ASDIC felt that the manufactured cost of its own transmitter (see Exhibit V) would be much less than the price of bought-in units. In view of this difference, it was anticipated that the development costs (shared jointly with government) of the transmitter could be quickly recovered. In addition scope existed for cost reduction of the final unit, for the transmitter was the most expensive component of the buoy.

ASDIC's accumulated experience with the design and manufacturer of drifting buoys was, by 1981, quite considerable. The 300 buoys it had produced over the last few years were estimated to be at least half of those supplied around the world. ASDIC's main competitors tended to be other firms that had supplied buoys to the Global Weather Experiment in 1978. Yet despite the build up of skills and experience, the drifting buoy business was still small in relation to the company's overall sales. The annual revenue ASDIC derived from drifting buoy work averaged about 4% of total sales since 1977. Moreover, for the government contract work described above, the maximum allowable profit margins in effect were 7½% (FGGE), and 8½% (PAPA), margins that were much lower than those necessary to provide funds for additional R&D.

Company sales exceeded $20 million in 1980, having grown quite steadily from $6 million in 1969. The profitability of the company had, however, been subject to marked fluctuation and this had resulted in changes of ownership and direction.

Company History

ASDIC was founded in 1947. The initial intention was that the company should market the range of instruments, test gear, radar and radio equipment manufactured in England by the parent organisation, a company that had developed an enviable reputation in the fields of radio, radar, and navigational systems. The company moved to Shaldon in 1949 with the promise of assistance from the provincial government should a manufacturing facility be established. The company began manufacturing in modest premises. The first efforts of the new organisation resulted in the development of a tactical anti-submarine simulator - an analogue computer simulator very advanced for its day and which remained operational for nearly 20 years. Many defence contracts were filled over the next 6 years in the fields of anti-submarine warfare, communications and electronic counter measures. The basis of ASDIC's current engineering expertise in ocean technology was laid during the next 15 years. Variable depth sonars, ionospheric sounders, VHF transmitters, and sonobuoys were developed and produced in the 1950's. The increased volume of work meant that a need existed for increased space and working capital. The problem of space was overcome by building a new plant in Shaldon, while that of financing was resolved by a large U.K. based transnational corporation buying a controlling interest in the company in 1959.

The 1960's saw further development in established areas as well as the initiation of large deep sea buoys, loop antenna and automatic direction finder work. Employment levels swelled to 550, and two more plant expansions took place during the decade. By 1968, the company was in urgent need of new contracts. The firm's experience in building sonobuoys for the RCN led them to examine the U.S. defence market. One bid for the supply of bathythermograph transmitters to the US Navy was successful. This $2 million contract made the company realise that anti-submarine warfare was an area of great future potential, especially in the U.S. As a result, a sonobuoy development programme in this area was funded by the firm.

Contract delays, and a general slowdown in contract work, led to layoffs in 1969, and the possibility of a total closedown of the operation loomed large. This outcome was avoided; in April 1970 the assets and business were purchased by a group headed by a former board member. The group raised money from private investors and gained a Department of Regional Economic Expansion grant, as well as securing a loan from the provincially owned Development Corporation. The new company - ASDIC Limited - won contracts for sonobuoy production and completed jobs that had been in progress. Some new contract bids were successful in the 1970's but problems of maintaining steady business volume continued. One hundred and seventy workers were laid off in 1973, as the company found it difficult to balance its production and research capacity with levels of demand.

A $10 million expansion plan was unveiled in 1975, $6 million being provided by federal and provincial government. Half of the $10 million was to be used to construct a larger office and production facility. This was necessary in view of the expanded operations of the business, and given the desire to consolidate two production operations, three offices, and two warehouses, in one location. The other $5 was to be spend on capital equipment and inventory. In the summer of the following year, however, the company was in difficulty once again. The bankruptcy of a major supplier caused production interruptions, cost over-runs, and a cash flow crisis while construction of the new facility was incomplete. Gradually the supply and production problems were overcome, and the financial strain placed on the company was offset when control of the company passed over to Titan Industries, a Canadian-owned corporation based in Ontario. Titan was a major supplier of parts and components to the automotive, steel, and aerospace industries, and planned to 'balance and diversify' ASDIC's production line, but operate the plant on a decentralised basis.

In March, Titan acquired 54% of ASDIC's equity, while previous stockholders remained minority shareholders. In the same month, ASDIC moved to new plant in the Shaldon Industrial Park.

Company Diversification

One of ASDIC's main problems had been brought into sharp focus over the few weeks prior to June, 1981. The company had learned that a large sonobuoy bid was not successful. As a result, sales and profits would be considerably down in 1981, and a substantial number of assembly workers and other staff had to be laid off. This was not a new situation for the firm, but was nonetheless worrisome. The management of ASDIC recognised that the company was overly dependent upon the military market in general, and the sonobuoy business in particular. A number of attempts at diversification had been made over the years, and the establishment of the Environmental Data Systems and Communications Systems product groups reflected these initiatives. However, in 1980 sonobuoy sales were still 90% of company sales, with the remainder split between environmental data systems (7%) and communications systems (3%).

Two previous periods had seen intense attempts at diversification which had come to nothing. In 1968, ASDIC formed a research division which came up with a number of new product ideas, including a heart pacemaker, an electronic stethoscope, and a pipeline crawler that would undertake x-ray inspections of pipelines. Each of these products would have required quite substantial investments in development and marketing, and these were not forthcoming at the time.

Another attempt to diversify had been made in 1973 when ASDIC acquired the assets and products of Sophisticated Sensors Ltd. (SSL) of Ontario. The President of ASDIC at that time, stated that 'this step marks a significant turn in direction for ASDIC. While we will continue to generate activity in government related contract work, it is our intention to move aggressively into the commercial products field.' A new department was formed to manage the affairs of SSL, called the Business Products Division, ASDIC Limited.

SSL had entered the nuclear field in 1965 with a device which recorded microinch changes in the size of material specimens and nuclear radiation. The device was developed for use in Canada's nuclear reactor export programme. Two other products were manufactured by the company. Ferricare was a product which dealt with the care and handling of magnetic tapes used in the computer and broadcasting industries. Another device was the Floatrex air cushion support roll. This consisted of a roll air support bearing much like an elongated cannister. Air was forced into the cannister where it would be allowed to escape through passages cut into the sides. The air flowing out of the cannister was capable of supporting photographic film and other web type materials without solid contact. The product was used in paper, film, and foil processing in North America and Europe. ASDIC management estimated that the new Division would generate $4 million in sales within 3 years. This was not to be, however, for it transpired that the markets for SSL products were smaller than originally estimated, and/or in some cases customers developed their own products as solutions to problems that had been identified by SSL.

New Product Planning

The company had started to look for new product fields again in 1980. This new search was part of a five year planning exercise, which was one of the responsibilities of the Market Research Analyst, John Barr. During the year he had been with the firm, Mr. Barr had come to recognize the implications of ASDIC's dependence on the sonobuoy business. In view of the limited sales of the other product groups, he felt it important that the firm come up with other products that would generate substantial revenue. One thing that occurred to

Mr. Barr from talking with longer-servicing colleagues was that ASDIC had persisted in developing and building components rather than product systems. He wondered whether this might be due to the way ASDIC tended to operate, i.e., as a supplier of technical solutions to problems periodically identified by other organisations (and largely government) rather than applying its technical skills to market needs it identified for itself. Mr. Barr was inclined to think that the company had skills that would allow them to develop a number of markets. He saw these skills as being in data acquisition and telemetry (or transmission of information from "remote" areas).

New product planning proved to be quite difficult over the months, for ASDIC's marketing group was small and its attention was turned in to the company rather than out towards the market. Because ASDIC was mostly involved in contract work, the marketing group was chiefly involved in administering these contracts. This required attention to the scheduling of work and deliveries, and to recording costs, and claiming necessary payments. The Marketing Director spent most of his time on the sonobuoy business, and was away from the office a good portion of the working week. As a result none of the marketing personnel spent much time out in the marketplace attempting to sell the company's existing non-sonobuoy products or investigating new product possibilities. This meant that the Environmental Data System and Communication System group sales really came through ASDIC's reputation for distinctive competence in the field, rather than specific marketing efforts. In fact, the company had been completely surprised to receive a recent order for drifting buoys from a European oceanographic institution. Subsequent investigation showed the order to have been planned for 18 months and to have come the company's way because of contacts between the European institution and members of a federal government laboratory, which had been closely involved in the FGGE program. Some promotion of the company's products took place when it exhibited at various trade shows, but again, lack of marketing resources constrained these efforts.

If product innovation was not easy, neither was the process of planning. Mr. Barr felt that the product managers expected him to produce the plan. He, however, saw his role as coordinator rather than creator. The product managers were appointed from the engineering ranks within the company, for the belief was that the highly technical nature of the products demanded managers that could talk to customers in technical terms. This uncertainty concerning the marketing/engineering planning interface needed to be resolved.

Exhibit I

ASDIC LIMITED

PRINCIPAL PRODUCTS

1. ANTI-SUBMARINE WARFARE

a) Sonobuoy

These are air-launched devices designed to detect underwater sounds and to relay the information back to listening aircraft by means of FM VHF radio transmission. The received signals may then the analysed, leading to identification and location of the underwater sound source. Sonobuoys are used extensively in the search for submarines and ASDIC has the capability of producing 700 units per day.

b) Bathythermograph Buoy

This is a device for measuring water temperatures and is to be deployed prior to acoustic sonobuoys in order correctly to interpret the data recorded and transmitted by the sonobuoy. Again, these are air-launched: minutes after launching their useful life is over and the set is automatically scuttled.

2. ENVIRONMENTAL DATA SYSTEMS

These are reliable, cost-effective means for gathering data. An important feature is their ability to operate automatically in remote locations, and often under harsh conditions. A variety of systems are built, including:

a) Drifting Ocean Data Buoys (described in the case)

b) Moored Ocean Data Buoys

These are large discus buoys used for offshore sensing of:

* wind speed and direction
* air temperature
* air pressure
* relative humidity
* magnetic north
* wave height and period
* ocean current and temperature at the surface and depths

c) Ice Beacons

These are self-contained units which are used to track the movement of ice flows or icebergs. They are deployed by lowering from a helicopter to the surface, and one inch spikes prevent 'skating' across the ice during windy periods.

EXHIBIT 1 . . . continued

d) Custom Buoy Systems

New buoy applications can be custom designed and built.

These systems are all comprised of meterological and oceanographic sensors, power supplies, data processors, HF, VHF, or UHF communications, and a shore station for data dissemination.

3. COMMUNICATIONS SYSTEMS

a) Aperiodic Loop Antennas

These unique, broadband receiving antennas offer a number of distinct advantages over other products available:

* optimum directional characteristics
* substantial gain
* light in weight and simplicity making for easy transportation and erection.

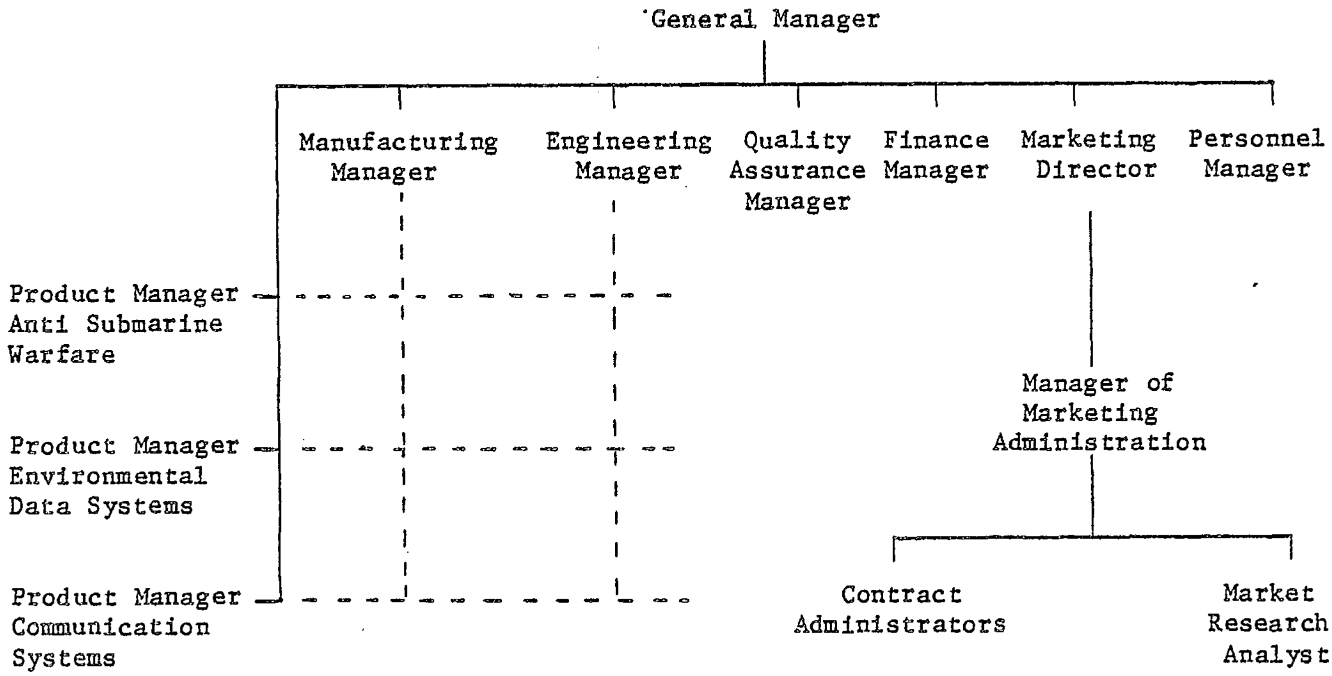
b) Ionospheric Sounders

Long distance radio communication is dependent upon the ability of the ionosphere to reflect the transmitted signal. This system features:

* vastly improved capability for long range HF communications
* detection of optimum frequency for HF communications
* the sounder can be used in a static or mobile role

Exhibit II

ORGANISATION STRUCTURE



Note In this matrix organization, each of the three product managers interact with the functional groups as begins to be suggested by the dashed lines

Exhibit III

THE ASDIC FGGE DRIFTING BUOY

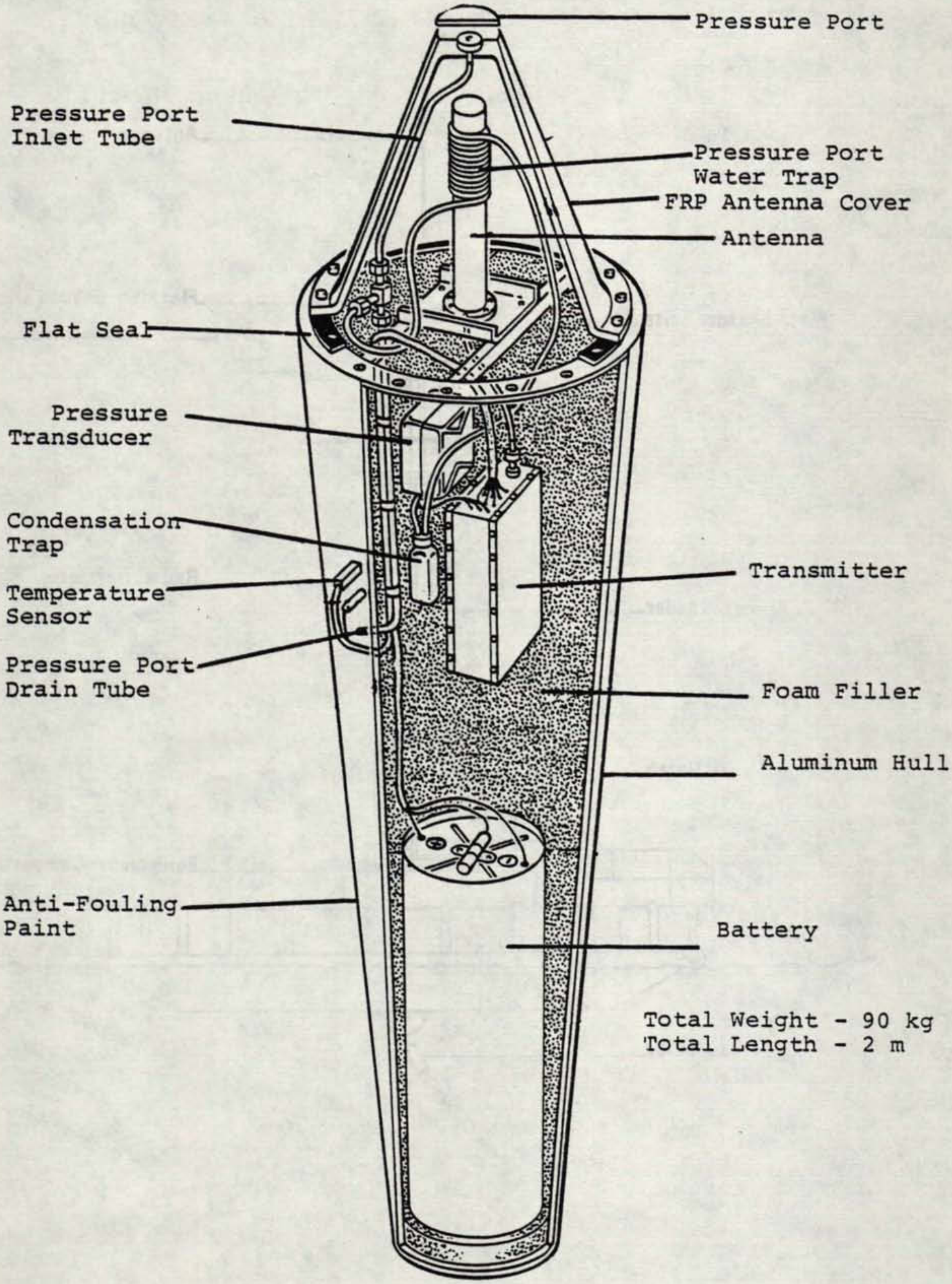


Exhibit IV

THE ASDIC 10 METER DISCUS BUOY

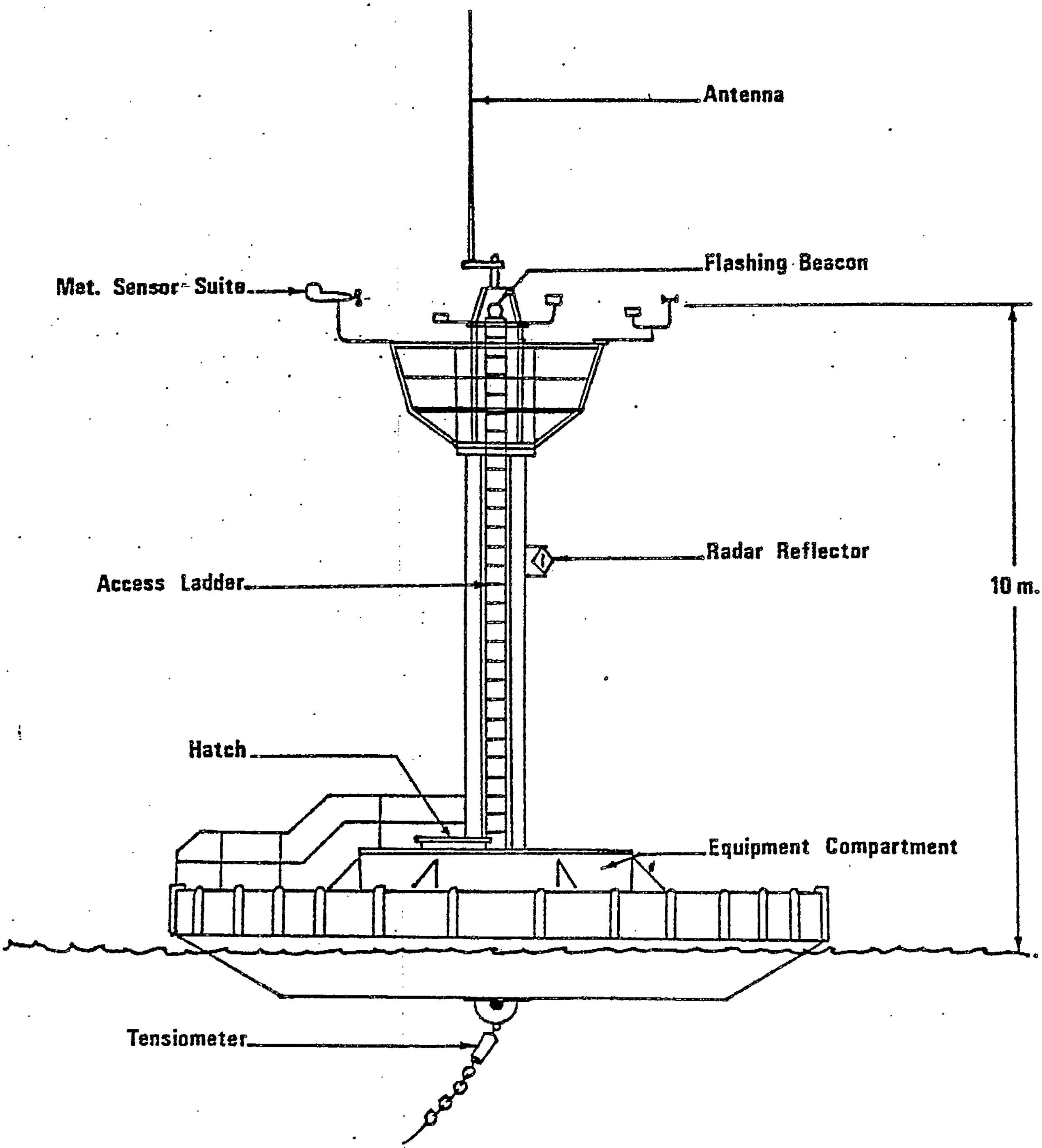
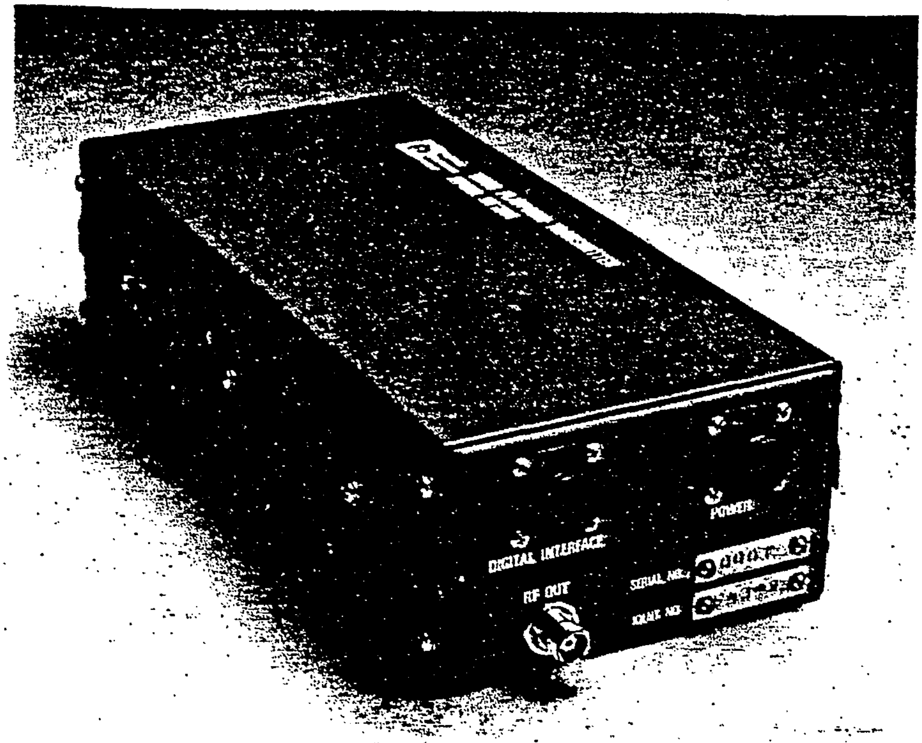
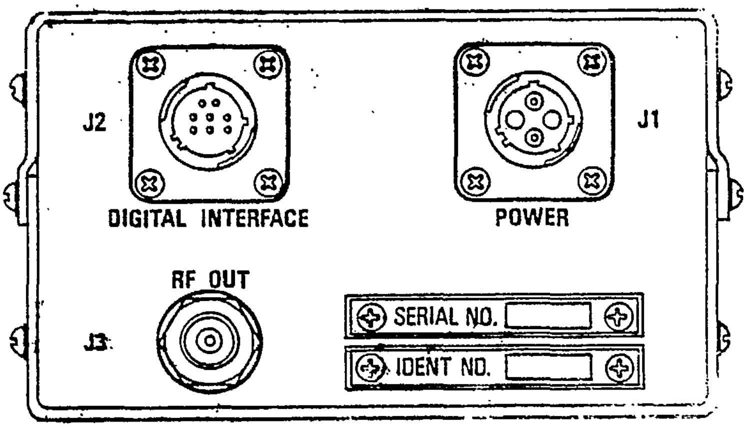


Exhibit V

SATELLITE TRANSMITTER





JOHN CURRIE AND INTERNAV LTD., SYDNEY, NOVA SCOTIA

"My father was originally from Cape Breton and like most Capers, wanted to get back. My mother was from Massachusetts. I was born and brought up in New York. Apart from the duration of World War II, I spent all of my summers here in Cape Breton, first with my parents, then after marriage, with my wife and children. One summer we came here and never did go back. It is not very often that people on summer vacation leave their house and home and never go back. That's a rarity. My kids never did go back to their old home. By the time they went back to straighten everything out, our house was sold to somebody else. They never even saw their friends again. My dog is still an illegal immigrant in Canada. We've been coming here so many summers that moving was not really a problem. Cape Bretoner's are very friendly people. It's one of the easier areas of the world to move into. I can't really say why I made that decision; it was, I think, partially personal. I did like the area, and I'm sure that that is part of it, but it definitely looked to me like an area that had to blossom for my kind of oceanographic fishing-type equipment."

With these words, John Currie, President of Internav Ltd., described how he came to set up his company on Cape Breton Island, Nova Scotia, close to where Alexander Graham Bell developed the telephone and the hydrofoil and Guglielmo Marconi built the first station for transmitting wireless telegraphy signals across the Atlantic to Europe.

This case was prepared by Professors Michael Martin and Philip Rosson of Dalhousie University as a basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. Some of the data and information have been changed to preserve commercial confidentiality. The authors gratefully acknowledge the financial support of the Federal Department of Industry, Trade and Commerce, Technological Strategy Branch in the development of the case.

Having grown up in New York city, John Currie studied physics at Queen's College in Buffalo, New York State, and on graduation took his first job with the Sperry Gyroscope Company on Long Island. He worked for Sperry for about 10 years, first on inertial guidance systems for the B-58 and the X-15 aircraft, and later helped develop the Loran C Navigational system for the U.S. Military. He was then invited to join the Laboratory For Electronics (L.F.B.) company in Boston to develop a Loran C capability there. L.F.B. had developed the Navigational and bombing system for the F-105 fighter plane. He worked at L.F.B. and a couple of other companies in the Boston area for several years and then decided that he really wanted to get out of the defense business and start his own company. He felt that the Loran C system had commercial potential outside of the aerospace business. By this time, he had acquired both management and engineering experience. Shortly before leaving Sperry, he had been promoted to senior engineer, which was the last position before entering management. At L.F.B. he started out as a project engineer and later became program manager for various Loran C programs on aircraft and helicopters. He had tried to interest L.F.B. in developing a commercial type Loran C receiver but had been completely unsuccessful, and this was one of the reasons why he left that company.

He started his own company in Waltham, Massachusetts, in October, 1971, being its first president and owning (and still owning) about 48% of the stock. This company, International Navigation Ltd., is still operating in Massachussets. With this company he developed and produced the first low-cost Loran C receivers to be used on fishing boats and, for a long time, International Navigation was the only manufacturer in that market. He quickly discovered that there were a lot of other seafarers besides fishermen, who wanted to navigate, and the company did a fair amount of work for hydrographics surveying teams. It helped develop a system that is used by Decca Surveying in the U.K., called Pulse 8 and Decca bought a large number of receivers for work in the North Sea exploration program. When he formed the company, Mr. Currie anticipated that the Loran C navigational system would be adopted by the U.S. coastguard and, in effect, gambled on that outcome, since the coastguard had yet to get congressional approval for doing so. In the event, that system was adopted by the U.S. coastguard. By 1976, he recognized that it would be a good move for Canada to join in an hemispherical Loran C system, rather than trying to go its own way, so that it would also become the Canadian navigational system for at least a decade or so. He, therefore, decided to set up Internav Ltd. in Sydney.

His choice was based upon three considerations. First, it provided him an opportunity to return to his father's "native heath" of Cape Breton. Second, the total Atlantic Canadian fishing areas and fleets of about 20,000 vessels are encompassed in a 500 mile radius about Sydney, which represents a lucrative market for his products. Third, he could reasonably expect a good amount of government support, because Sydney was located in a depressed area. He recalled that one of the reasons why Massachusetts had become so strongly entrenched in the electronics industry was because government money had been pumped into that State from the 1920's onward, to compensate for the closing down of the woollen mills there. He believed that a similar investment potential could develop in Cape Breton. Four, he knew the area pretty well from his numerous summer vacations and had relatives and friends living there. It also had a lot of favorable attributes from a "quality of life" standpoint. The Bras D'Or lakes offer some of the best boating in the whole world and the Cape Breton highlands constitute an area of outstanding natural beauty. Both are within a short drive of Sydney so, in the long run, he thought it could be a very good area into which he could entice professional type people to move.

Internav began operations in February 1977, with three people from the plant in the States and 10 people hired locally. Two of the three Americans returned to Massachusetts, and the third stayed in Sydney as the general manager. In the summer of 1977, Mr. Currie and his family started their annual vacation in Cape Breton and, as was stated earlier, have stayed there ever since.

Internav's Markets

The principal of the Loran C navigational system is outlined in Exhibit I and is very simple. A Loran C receiver on a seagoing vessel receives the specially timed Loran signals from the master station and two or more secondary stations in a Loran C chain. The receiver then measures the difference in arrival time between the master signals and the secondary signals to devise two intersecting lines of position which it computes into the corresponding latitude and longitude coördinates of the vessel's current location. Other important navigational data are provided, dependent upon the sophistication of the receiver installed on the vessels. A Loran C receiver is a relatively inexpensive and accurate navigational instrument, but is clearly dependent upon the existence of a chain of Loran C transmitter stations. The major markets for the comany's products are any small fishing and pleasure boats operating in seas provided with Loran C coverage. The markets therefore developed in step with the development of Loran C coverage. The Canadian coverage has expanded steadily from 1977, beginning with British Columbia, the Great Lakes and the Atlantic Seaboard. When a new transmitter opens up in Labrador in the spring of 1983, there will be complete coverage along the whole of the Atlantic Canadian coastline. The timetable for the installation of Loran C transmitters is known in advance so a company can readily predict the size of its target markets as they grow with this expansion. Later it should expand into some of the areas of the Arctic where localized low-cost systems will apply too. Ignoring this last possibility, the total Canadian market constitutes some 25,000 vessels.

The company manufacturers and markets a product range of Loran C receivers and peripheral equipment which retail at prices between \$1,000 and \$5,000 (see Exhibit II). Most of these units are sold through a dealer network. The dealers provide any "after sales" services required and enjoy a relatively high price mark-up of 50% (that is a dealer will pay \$2,000 for a unit which he retails at \$3,000). Internav also sells about 5% of its products to the military for installation on RCN vessels. The military market contributes rather more than 5% of the total sales revenue, because military land and sea receivers require special product enhancements which significantly increases their prices. Total market size is strongly influenced by the rate of technological change in the micro-electronics industry. Products are being continuously improved to exploit the latest performance improvements and cost reductions in micro-electronic technology. Thus a product becomes obsolescent before it wears out. Although a few of International Navigation's customers are still using receivers which they bought up to 10 years ago, many replace units every three - five years. After, say four years, they find that they can buy a new receiver that is about 10 times as effective as the old one at the same dollar price as they paid earlier. Given the present inflation rates, customers recognize that they are getting a much better buy for their money, so they scrap the old one to replace it with a new one.

Offshore Markets

International Navigation at Woburn, Mass. (where it has re-located from Waltham) and Internav at Sydney exclusively manufacture and market products for the U.S. and Canada respectively. Each holds the "world-wide" or "offshore" rights to market products developed in its own facilty. That is International Navigation has the world-wide rights for selling products developed at Woburn, and Internav the corresponding rights for products developed at Sydney. International Navigation presently holds the major portion of these offshore rights because it has been in operation longer, but Internav should enjoy a growing proportion of these rights as it develops its own products in the future. Internav has sold about 15% of its products offshore during the first few years of its operation, but again, this proportion should increase in two or three years.

In both North America and worldwide, competition in the marketplace is quite tough. There are several U.S. and two Japanese companies which provide strong competition. All these companies are small, but those in Japan have an advantage in that their government subsidizes all their R&D for them.

Start-Up Financing

The company was founded with an initial capitalization of $200,000. $50,000 was provided by International Navigation, approximately $90,000 by a grant from the Department of Regional Economic Expansion (DREE) and approximately $60,000 by a loan from Industrial Estates Limited (IEL). Initial working capital was mostly provided through loans from the parent company. Later on, the Cape Breton Development Corporation also provided loans to support the initial R&D efforts. The Corporation also provided initial support in terms of site selection and the rental of physical plant at lower than market rates.

By early 1982 all of these loans have been paid off and the company was entirely Canadian owned. In early 1982 Mr. Currie owned 80% of the equity of the company with the balance owned by the Federal

Business Development Bank. Further financial information is shown in Exhibit III.

Manufacturing Operations

Internav began manufacturing operations in 1977, initially making the range of Loran C receivers that had been developed in the American company and selling them in the Canadian market. In its early years of operations, International Navigation was acutely aware of its lack of marketing expertise, so granted the off-shore worldwide marketing rights of its products to Simrad, a Norwegian company which had a well established "top-notch" reputation for selling echo-sounders and communications gear to the fishing industry throughout the world. For some strange reason, Simrad's "worldwide" marketing rights applied everywhere, except to Canada, so Internav was able to sell products in the Canadian market without violating the original agreement with the Norwegian company. A description of Internav's 1982 product range is shown in Exhibit II.

The company began its operations in 1977 with a workforce of 10 people and, with a continuous sales growth, the workforce grew steadily to a peak of 55 in the summer of 1981. Products are manufactured on quite straightforward assembly-line basis, but the "seasonality" of the marketplace is a continuing problem for the company. Winter (December) sales are much lower than summer (July) sales. Ideally the company would like to follow a constant production rate manufacturing strategy, making to stock in the winter season, but so far this has proved to be financially infeasible. Ideally, Mr.

Currie would have liked the company to have been making pre-tax profits of $200,000 year by 1981, but it was actually making only $35 - 40,000 a year, because sales growth had not been as rapid as had been initially anticipated. Internav needs to generate $130,000 a month to break even and, historically, has been unable to generate sufficient cashflow during the peaks of its season to provide enough working capital to "make-to-stock" during the succeeding troughs. The seasonality in the company's sales is illustrated in Exhibit IV.

R&D Activities

For the first years of its operations Internav was essentially a manufacturing branch-plant of the U.S. company. Mr. Currie initiated an R&D endeavour in 1978. This R&D facility now (January, 1982) has five graduate engineers, four "technologists" who are graduates of two-year programs of the College of Cape Breton and a number of technicians. The latter are non-degreed individuals who have developed a capability for understanding electronics "on-the-job". Whilst under training, these technicians have been partially subsidized by Canada Manpower support programs, which Mr. Currie has found to be very valuable in terms of subsidizing his in-house training program.

The company performs two categories of R&D:

Contract work to determine the propogation characteristics of Loran C transmitters in various geographical locations. Such detailed signals strength field studies are vital preliminary investigations in the development of new Loran C navigational systems. The company has performed studies on the Great Shield in Ontario and a lot of work with the Canadian Coast Guard off the east coast. It has also performed some work for the French lighthouse service in the Mediterannean. Currently it is performing a survey in the Beaufort Sea with Dome Petroleum. These projects have enabled the company to establish a good understanding of marine navigational problems and the role of the Loran C systems in helping solve these problems.

At the same time, the company has built up its skills in microprocessor development and programming as applied to ship-board Loran C systems. This has enabled them to add a succession of incremental technological improvements in established product lines and develop new products. For example, they have developed a new receiver, the LC-720, which they are planning to market in Spring 1982 and are also developing an airborne receiver under contract with the Department of Supply and Services, Science Procurement Branch. The company views contract R&D for the development of new electronic systems as a profitable activity which it hopes to increase in the future.

In the present (early 1982) business climate, the company finds it very difficult to support an R&D group on the profits from its sales, so finds contract R&D (particularly the propogation field strength studies) very important from the standpoint of maintaining stability in its R&D operations.

Future Plans

Turning to the future, Mr. Currie recognizes that by about 1987 the Loran C business will have begun to fall-off. Every vessel will be equipped with a Loran C unit, the market will be saturated and only the replacement market will remain. Therefore, Internav has a good solid market for another two or three years, but after that must find new products. To do this the company plans to utilize its general navigational expertise in a number of different ways.

First, it intends to support high precision positioning applications offshore for the oil industry, which should be a growing lucrative market as offshore hydrocarbon resources are increasingly extracted.

Second, Internav is developing an airborne Loran C receiver which will enable it to expand out of the seasonal marine navigational market.

Third, Mr. Currie wants to expand R&D contract services to the RCN. He recognizes that the navy's frigate program will require all kinds of radio navigational expertise, in terms of computer programming, signal processing etc. He wishes to expand his R&D capabilities and offer contracted services over and above those required as an adjunct to the development of new receivers. He is currently seeking military security clearance for his staff so that the company can expand into that market.

All navigational aids have a useful life and then they are replaced by something else. They are also initially developed by the military, and the military is now planning to develop a satellite (as against shore) based navigational system. Once such a system has been developed, it will subsequently be made available for civilian use and then a "new" offshore vessel market will be created. The 25,000 vessels currently being equippped with the land-based Loran C system will require replacement receivers to use the new satellite-based system.

In the shorter term, Internav anticipates an annual growth rate of 10-15% for a few years. This would be based upon the continuing Loran C business, plus a growth in exports based upon the new products currently being developed and an increasing involvement in the offshore hydrocarbon industry. This should lead to a growth in employment from the present level of 40 to 100 people, with a corresponding increase in annual dollar sales turnover.

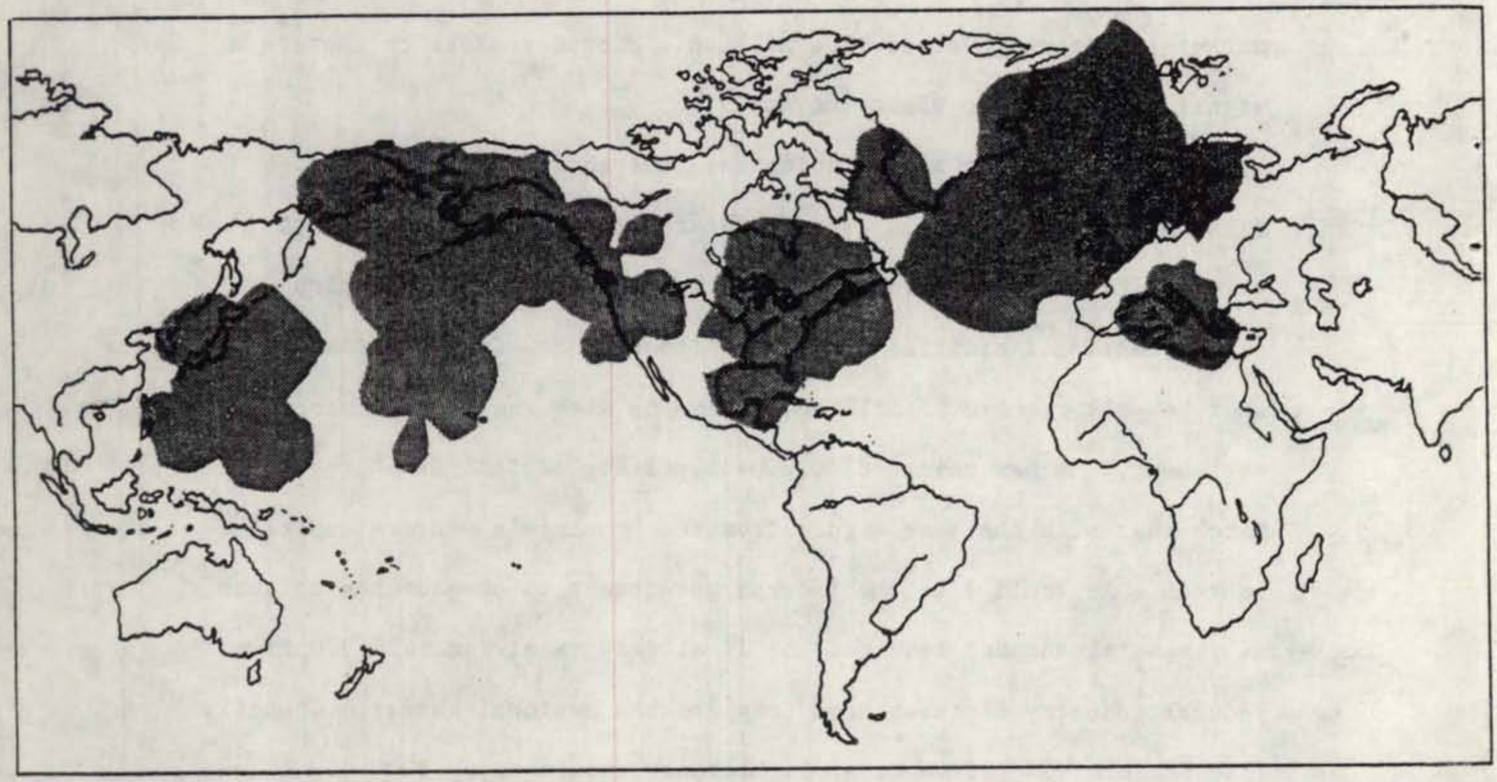
The biggest potential growth opportunity, however, is presented by expected developments in new technology and has necessitated setting up a new company Micronav Ltd.

Micronav Ltd.

When Mr. Currie worked for L.F.B. in Boston, the V.P. of R&D was Dr. Morris Myer who was the founding father of a replacement for the instrument landing system (ILS) which is used in all the world's airports at present. This replacement is known as Microwave Landing System (MLS) and will be introduced into airports beginning in 1985 or 1986. Micronav has been established to exploit the market opportunities created by the introduction of this new system. The worldwide market is expected to reach $3-4 billion with the Canadian market amounting to about $200 million. Micronav seeks to capture a significant share of these markets.

The new company is beginning the substantial R&D effort ($5-6 million of R&D investment over the next 3 to 4 years) required to develop "hardware" to secure this market share. It will develop flight-testing facilities at Sydney Airport. Mr. Currie estimates that he will require $3 million to come up with the first prototype equipment. He has raised $300,000 of private capital and hopes to match that with the same figure from the Province's venture capital sources. He would like the federal government to provide the balance of financial support required and is already receiving $429,000 from federal industry minister Herb Gray and the National Research Council (see Exhibit V). If successful, Micronav should enjoy $20 - 30 million a year annual sales and employ 500 people by 1990.

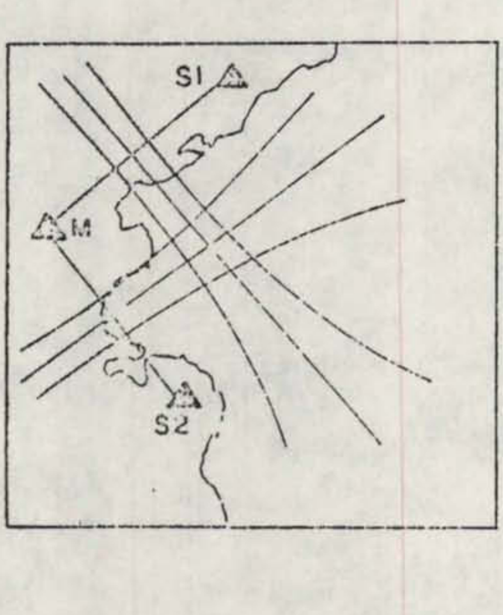
Exhibit I



The Loran C System

Loran is the acronym which stands for LOng RAnge Navigation and actually refers to a hyperbolic system of radio navigation.

The Loran A system began during World War II when it became necessary to have a means of determining position which was independent of the weather. By 1974, eighty three Loran A stations were in service around the world, operated and maintained by the U.S. Coast Guard and foreign government agencies.



During the late 1950's and early 1960's, when the nature of radio wave propagation was better understood, an improved system was developed, Loran C. This system proved to be much more accurate and dependable than Loran A and the usable range of the system increased greatly. Loran C's very stable groundwave signals mean that position accuracy in good coverage areas can be extremely high - often as close as a few tens of meters. At longer ranges, beyond about 900 to 1,000 miles, the system's skywave signals can also be used, though extra care is required by the operator and accuracies are correspondingly lower.

Today, there are twenty Loran C chains in operation around the world providing efficient coverage for many of the world's navigable waterways. Still more are proposed.

Since the introduction of Loran C, surprising advances in electronics technology have brought this versatile navigation system within the economic reach of thousands of commercial and pleasure boat owners. The microprocessor has had incredible impact, making it possible to store vast amounts of information in very small spaces, efficiently and economically.

It is for these reasons - the superior performance, reliability and dependability of Loran C - that in January of 1981, the U.S. Loran A system was terminated and Loran C will be exclusively maintained.

And Loran C is more than just a tool for the navigator. It can be used in a variety of ways. Extremely accurate clocks have been built which use the Loran C frequency of 100 kHz as a timing standard. It is also an important element in vessel traffic control systems, providing position information to dispatchers in distant locations.

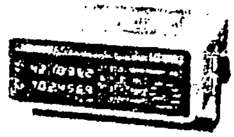
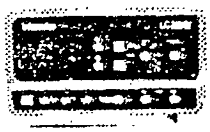
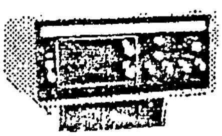
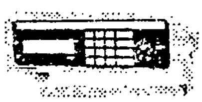
How does the LC 360 make use of this remarkable system? Once operating, the LC 360 receives the specially timed Loran signals from the master station and two or more secondary stations in a Loran C chain. A typical Loran chain is shown at the left. The LC 360 then measures the difference in the arrival time between the master signals and the secondary signals to derive two intersecting lines of position or LOP's. Then the LC 360 does much further, converting the Loran C Time Differences into the corresponding latitude and longitude and providing a variety of important navigation data.

Exhibit II

INTERNAV LTD.
PRODUCTS AND PRICES

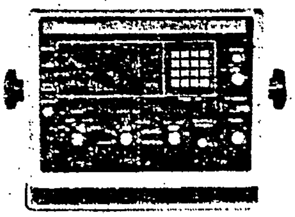
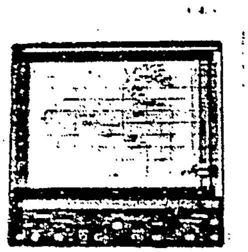
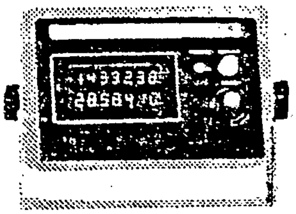
internav

COMMERCIAL LORAN-C PRODUCTS PRICE LIST

UNIT	DESCRIPTION	SUGGESTED LIST PRICE	SUGGESTED SYSTEM
	**LC-360 Navigation System**		
	Combined receiver/navigation computer displays TD's, Lat/Long, true speed and course made good, plus range, bearing, track error, and time to go to any of 40 waypoints. Includes Steer Command, Cycle Guard®, non-volatile memory, four internal notch filters AC or DC power.	4,750	
	**LC-204 Receiver**		
	Dual 7 digit readouts, memory, two external notch filters. AC or DC power	4,650	
	Option: — Serial or parallel data output	555	
	**LC-123 Receiver**		
	Dual 6 digit readouts, memory, steering, time to go, SNR, blink, Cycle Guard®, up to 4 internal notch filters (specify operation area with order) DC power only.	2,995	
	Options: — Steering, time to go, SNR, blink, Cycle Guard®, retrofit package	350	
	— 2 external notch filters	350	
	**LC-112 Receiver**		
	Single 7 digit readout. Alternating TD display can be "split" to continuously show last 3 digits of 2 LOPs. 5 position memory recall, SNR, blink, Cycle Guard®, 2 internal notch filters. 12 VDC power.	1,975	
	As above, with 4 internal notch filters for Canadian East Coast	2,400	
	Options: — 2 external notch filters	350	
	— 24 VDC or 115 VAC power	100	

Internav also offers a wide selection of specialised Loran C services, including transportable Loran C transmitters, precision survey receivers, signal monitoring equipment, data analysis, and field engineer support. Details available on request.

OVER

UNIT	DESCRIPTION	SUGGESTED LIST PRICE	SUGGESTED SYSTEM
	**CC-2 Navigation Computer** Displays present position in latitude and longitude. Shows true course made good and groundspeed, plus distance, time, true bearing, and cross track error to any of nine preselected waypoints. AC or DC power. CC-2 is an add-on option to LC-204, 123, and 112.	4,500	
	**TP-2 Track Plotter** Plots track made good on 10" x 15" X-Y chart. Wide scale range, AC or DC power. TP-2 is an add-on option to LC-360, LC-204, 123 or 112.	5,500	
	**IL Remote Display** Simultaneously repeats Loran LOPs (or lat/long from CC-2 or LC-360) at remote location in chartroom or steering station. AC or DC power. IL is an add-on option to LC-360, LC-204, 123, and 112.	950	
	Accessories Antenna Cable (75' supplied) Operator handbook (1 supplied)	on request 10	

NOTES:
- Suggested List Prices are FOB Sydney, Nova Scotia and do not include Federal or Provincial Sales Taxes
- Effective 1 December 1980
- Manufacturer reserves the right to change prices and/or specifications without notice.

Sub-total	
Federal Sales Tax	
Provincial Sales Tax	
Installation	
Total System Price	

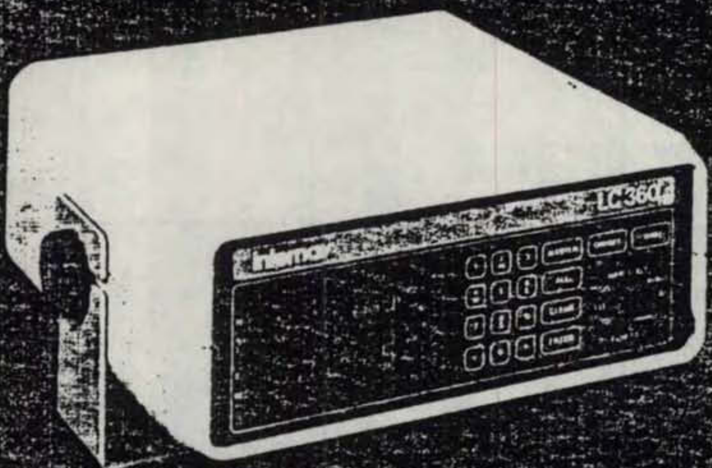
More Nova Scotia built Internav Lorans have been sold in Canada than all other makes combined.

Dealer

internav

Internav Ltd
Point Edward Marine Park,
Sydney, Nova Scotia B1P 6J9
Phone 902-539-0660
Telex 019-35126

WORLD LEADERSHIP IN LORAN C



LC 360

Navigation System

internav

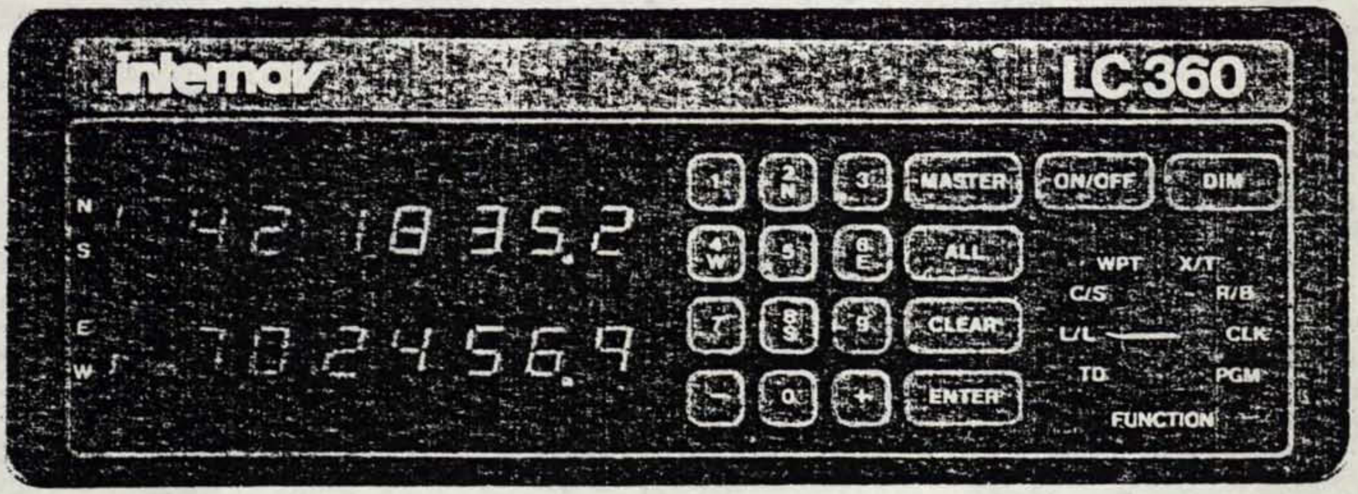
LC 360 · Unsurpassed performance, yet easy to use.

Internav's LC 360 is a completely new navigation system which provides unequalled latitude and longitude precision and a variety of other key navigation displays in a compact, cost effective unit.

Combining an exceptionally accurate Loran C receiver and a high technology microprocessor, the advanced LC 360 is a major step forward in marine navigation.

Until now, multifunction Loran systems have meant complex operating procedures for the user. The LC 360 puts the latest electronic technology at your fingertips with simple, easy to use controls.

And there's another big plus. As a fifth generation design, the LC 360 has all the built-in reliability and performance that you'd expect from Internav · America's first and most experienced Loran C company.



Precision · Watchword for the LC 360.

Most Loran latitude/longitude converters provide position data to hundredths of minutes · some only to relatively coarse tenths of minutes. The LC 360 provides latitude and longitude to tenths of ***seconds,*** a resolution standard equalled only by Internav's earlier CC-2 navigation computer. This is because the LC 360's high accuracy receiver measures and displays the basic Loran signals in hundredths of microseconds · ten times the precision of other sets.

Then, there's instant conversion from TD's to lat/long, and vice versa. And a forty waypoint memory, with "Instant entry" of your present position as an accurately logged waypoint at the touch of a button. Fishing marks, diving locations, good anchorages can all be logged and returned to again and again · precisely.

It's a non-volatile memory, too, so that your stored Loran chain, secondary, waypoint and other important data aren't lost when you turn the set off. Just press the ON key and your LC 360 is ready to go again.

Course and speed are always available and, after inserting your destination and en-route waypoints, the LC 360 will continuously and accurately display your range, bearing, time to go, and any off track error as you proceed. With Internav's ultra-precise Steer Command system you'll find track keeping easy and effortless.

Other standard features include a special code display to advise the status of the signals being used, a blink alarm to warn of shore station malfunction, four internal notch filters and Internav's unique Cycle Guard to enhance fringe area performance.

And you can increase the versatility of your LC 360 with an Extended Capability Package to display GMT or local time (with a separate split second stopwatch), and to give you magnetic courses and bearings, range in statute miles, tenths of miles, and yards or meters, and speed in MPH. The package also includes autopilot coupling and, for vessel traffic control or similar applications, there's a periodic data output for recording or transmitting your position.

Speed · always available and accurate.

Whenever you're underway, whether at one or sixty knots, trolling or racing, the LC 360 is continuously and accurately measuring your true speed over the bottom, unaffected by tides or wind. And whenever you need it, it's instantly displayed.

Course-Keeping has never been easier · or more accurate.

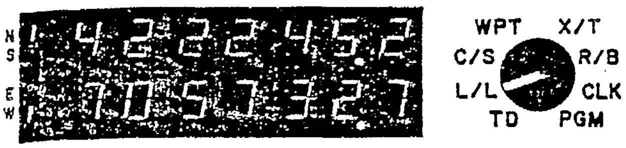
Internav's unique Steer Command is standard in the LC 360. Enter your destination and any intermediate waypoints · either as lat/long positions or Loran Time Difference (TD) intersections · and proceed directly to them without worrying about current or leeway.

A quick glance at the display shows ⊔⊔ · you're precisely on course. But drift a little off track, even a matter of yards, and the symbols promptly alert you and provide a steering command to regain course.

As the center panel examples show, if the on-course ⊔⊔ changes to ⊔⊏, then the lower "command arrowhead" is telling you to correct to port. When the on course ⊔⊔ changes to ⊐⊔, then a correction to starboard is commanded. It's simple, fast, and extraordinarily accurate.

LC 360 operation is simple, logical, intelligent.

TD Press the ON key, enter the Loran chain number and the first digit of the secondary stations you wish to use, and their Time Differences will be displayed. Next time out, just press the ON key and the LC 360's non-volatile memory will do the rest.



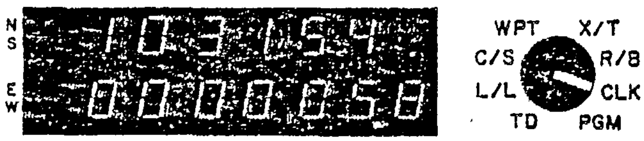
L/L Enter your approximate latitude and longitude and the LC 360 immediately computes your position in degrees, minutes, seconds and tenths of seconds.*

C/S Whenever you're under way, your course (upper right) and true speed over the bottom (lower right) are continuously available. True course and speed in knots and tenths of knots are standard in the LC 360: magnetic courses or MPH are options.

WPT Enter your destination and up to forty waypoints as Loran Time Differences or as latitude/longitude. When selected, each is displayed by individual number, TD and lat/long. At any time, pressing the ENTER key instantly logs your present position as a waypoint.

X/T Our cross track error (upper right) is 1.2 nautical miles off the great circle course, and our time to go is 56 minutes. We are proceeding from waypoint 01 to way point 02, and the Steer Command "arrowhead" is directing us to alter heading to port to regain track.

R/B After reaching waypoint 02, we've decided - by simple key entries - to go directly to waypoint 05. The LC 360's Steer Command shows we're exactly on track, our range to waypoint 05 is 5.6 nautical miles (upper right) and our bearing to it (lower right) is 060 True.

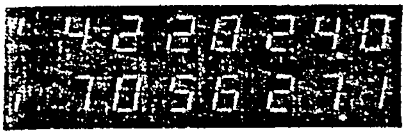


CLK Key in GMT or local time and the LC 360 will accurately maintain hours, minutes and seconds in the upper display. Pressing ENTER resets a stopwatch (lower display) to 0 hours, minutes, seconds and tenths of seconds to measure elapsed time.

PGM The Extended Capability Package allows selection of magnetic courses and bearings, speed in knots or MPH, distances in nautical or statute miles - or yards or meters below one mile. All are selected in the program mode and are thereafter stored in the non-volatile memory.

*Optional readouts available.

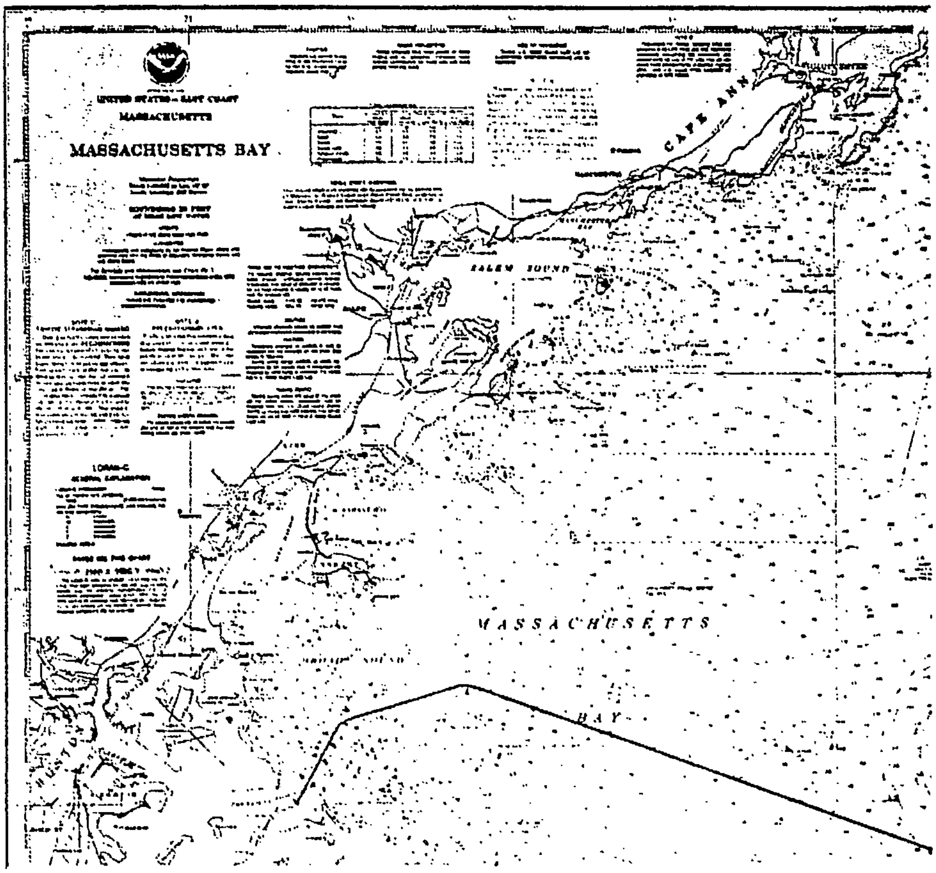
From Seattle to Hong Kong ... or along a string of lobster pots ... through rough weather, fog or a clear day ...



L/L Your vessel is heading out of Boston Harbor bound for Georges Bank, east of Nantucket Island. Your present latitude and longitude at the entrance to Boston North Channel is clearly shown on the LC 360.

WPT Your next waypoint (02) is just north of the North Channel '1' bouy and is entered as lat/long.

R/B Range to waypoint 02 from your present position is 1.79 nautical miles. Bearing is 032 degrees true. Steer Command keeps you on track.



C/S Entering the Boston Harbor traffic lane (outbound), course made good is 110° true. Actual speed over the ground is 16.2 knots. Steer Command indicates off course to starboard.

X/T Turning the function switch to X/T shows that you are .1 nautical miles from the desired track. Time to go to the next waypoint is 2 hours, 42 minutes. A slight heading correction to port will remove the off track indication.

Internav · World leader in Loran C

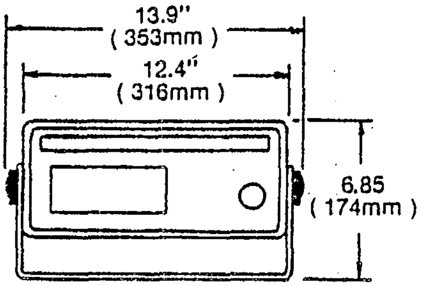
The LC 360 Navigation System is the latest in a range of exceptional Loran C equipment by Internav · America's oldest and largest commercial Loran C manufacturer.

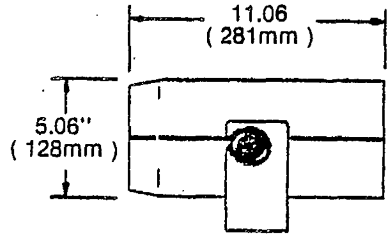
Originating with the LC 101 built back in 1972 · many of which are still providing dependable, accurate service to U.S. and foreign users · and extending through the LC 204 · often described as the world's best Loran C · to the rugged LC 123 and the elegant, lightweight LC 112, Internav Loran C equipment has established a solid reputation for quality, reliability and performance under the most demanding operating conditions. All current Internav receivers are built to meet the RTCM Minimum Performance Standard for commercial vessels.

But Internav's leadership extends beyond commercial shipping. Specialized Internav Loran C equipment is in wider use in oil exploration, oceanography and similar exacting fields around the world than any other make.

Why? Because Internav builds the world's most accurate Loran C receiver · the LC 404. Purchased in quantity by the U.S. and foreign government agencies for its unsurpassed precision, the LC 404 has set a standard of excellence unequalled by any other Loran C receiver.

There are many Loran sets on the market today. But only the LC 360 is backed by the experience and know-how of Internav · the world leader in Loran C.





SPECIFICATIONS

	DISTANCE	RELIABILITY OF CYCLE SELECTION
RANGE: Groundwave	0-700 Nautical Miles*	100%
	700-900 Nautical Miles*	98%
	900-1200 Nautical Miles*	94%

*This distance is based on all sea signal path. As land masses increase between the transmitters and the receiver, this distance will decrease.

ACCURACY: Groundwave .... .3 microseconds.

REPEATABILITY .... Better than .09 microseconds.

Acquisition time for master and two secondaries .... 2.5 minutes
All alarms extinguished .... 6 minutes
Velocity .... 80 Knots
Readout .... Dual eight digit display with .01 microsecond resolution
Minimum signal conditions for track:
- Sensitivity .... 1 microvolt/meter
- Dynamic Range 105dB
- Signal-to-Noise: .... S/N 1:10

Minimum signal conditions for search and settle to full accuracy:
- Sensitivity .... 20 microvolts/meter
- Dynamic Range .... 90 dB
- Signal-to-Noise: .... S/N 1:3

Size .... 12.4" wide x 5.06" high x 11.06" deep
Weight: .... (Receiver only) 10 Lbs.
Power supply: .... 12 VDC. 115/230 VAC, 50-60Hz.
Power consumption .... 30 watts

Memory Storage .... Stores constants for computing Lat/Long from Time Difference numbers of all Loran C chains.
Computational accuracy .... 50 feet with updates every four seconds.
Number of waypoints .... Forty

OPTIONAL ACCESSORIES

Extended Capability Package
Remote Readout IL
Aircraft Velocity Option (to 400 Knots)
Computer Generated Loran A Navigation
External turnable notch filters
RS-232 data output for transmitting or recording Loran C positions.

Specifications subject to change without notice.

International Navigation Corp.
65 Wiggins Avenue
Bedford, Massachusetts 01730
Phone: 617-275-2970
Toll free: 1-800-343-4414/15
Telex: 923352

Internav Ltd.
Point Edward Marine Park
P.O. Box 1261
Sydney, Nova Scotia B1P 6J9
Phone: 902-539-0660
Telex: 019-35126

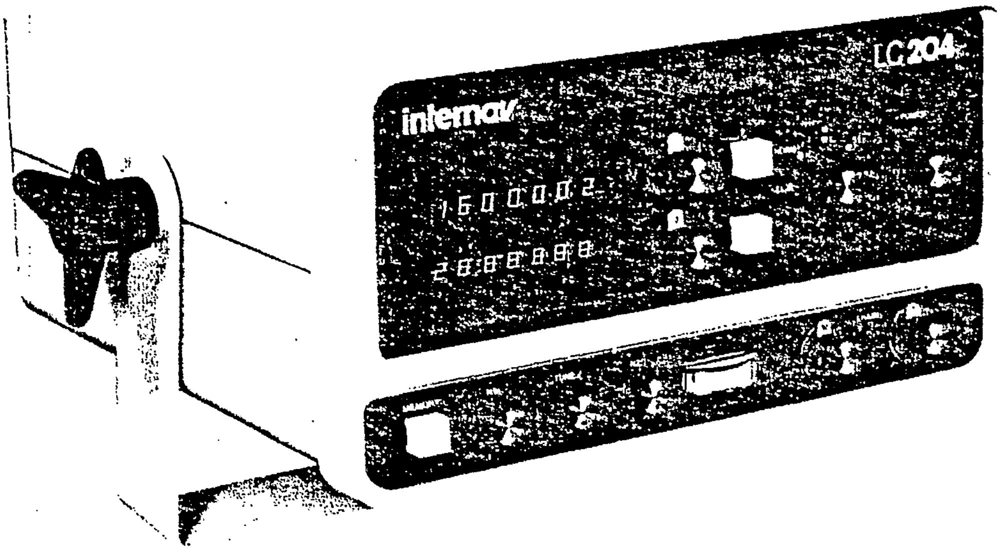
internav

LOCAL DEALER

internav®
Limited

The 204 Loran C Receiver

The fully automatic Loran C receiver for reliable – long range – accurate navigation



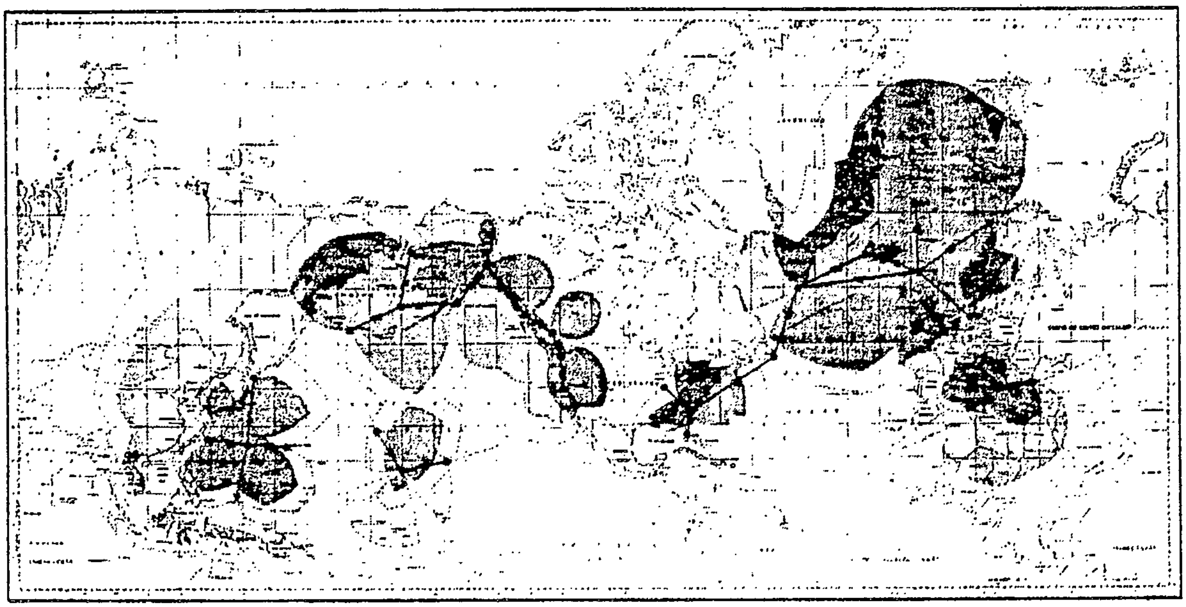
INTERNAV a leading supplier of Loran C navigating equipment, introduces the ultimate in truly automatic acquisition and tracking receivers – the INTERNAV LC 204. Outstanding in appearance yet ruggedly constructed to withstand the toughest marine conditions, the 204 takes full advantage of the remarkable Loran C system. Resulting user benefits are 24 hours a day, all weather operation with outstanding accuracy, either close inshore or far out at sea. The 204 combines the advantages of advanced technology with the proven reliability of INTERNAV's highly successful Model LC 101.

- Short and long range coverage with unmatched accuracies
- Reliable day and night operation
- Two position line data for immediate "fix"
- Fully automatic acquisition and tracking using cycle and phase matching
- Memory Mode freezes Display
- Manual back-up controls
- Built in test switch
- Solid state, modular circuitry
- Simple to operate
- 200 foot accuracies to a 1200 mile range
- Extended range tracking to over 2500 miles
- 50 foot return tracking accuracies on ground waves
- Signals received equally strong day or night
- Signals reliably received regardless of weather

Manufactured in Canada by: Internav Limited [illegible]
[illegible]
Tel. 902 539-0660
Telex 019-35126

internav®

GROUND AND SKYWAVE COVERAGE EXISTING WORLD-WIDE



Range – Groundwave	1,200 nautical miles
– Skywave	2,500 nautical miles
Accuracy – Groundwave	200 feet
– Skywave	0.5 to 2 nautical miles*
	*With verified cycle selection
Acquisition Time (Master and Two Slaves)	30 seconds
Settling to Full Accuracy	5 minutes
Repeatability	50 to 120 feet
Velocity	40 knots
Readout	Two 7-decimal digits Resolution – 0.01 microsecond (five feet on the baseline)
Sensitivity	2 microvolts
Dynamic Range	105db
Interference Rejection	2 Variable Notch Filters
Size (Receiver only)	14½″ Wide x 8″ High x 16″ Deep
Weight (Receiver only)	30 lbs.
(With Coupler, Cable & Mounts)	40 lbs.
Supply Voltage	115V AC 50-60 Hz 230V AC 50-60 Hz 11 / 45 VDC
Power Consumption	60 Watts (In-Track Mode) TYPICAL

Optional Accessories

- Coordinate Converter, CC
- Track Plotter/Recorder, TP2
- Remote Indicator, IL
- Interface for Computer Processing.
- Other Accessories may be provided upon request.

Printed in Canada

Internav LC 112 Automatic Loran C Receiver

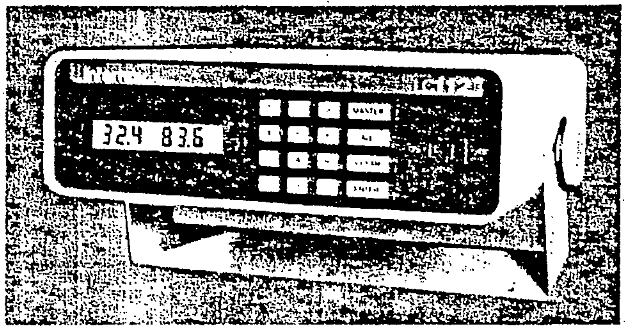
Internav introduces the first Loran C receiver with "Touch Pad" Keyboard

Featuring:

- **Unique "Touch Pad" sealed keyboard.**
- **Simple and logical operation.**
- **Multiple position recall.**
- **Retains chain & secondary data while power is off.**
- **Compact, elegant design.**
- **Low power consumption.**
- **Large high visibility liquid crystal display.**
- **High precision .01 microsecond readout.**
- **Splash-proof.**
- Designed and manufactured to conform to the U.S. Coast Guard endorsed RTCM Minimum Performance Standard (115 220 VAC Model).

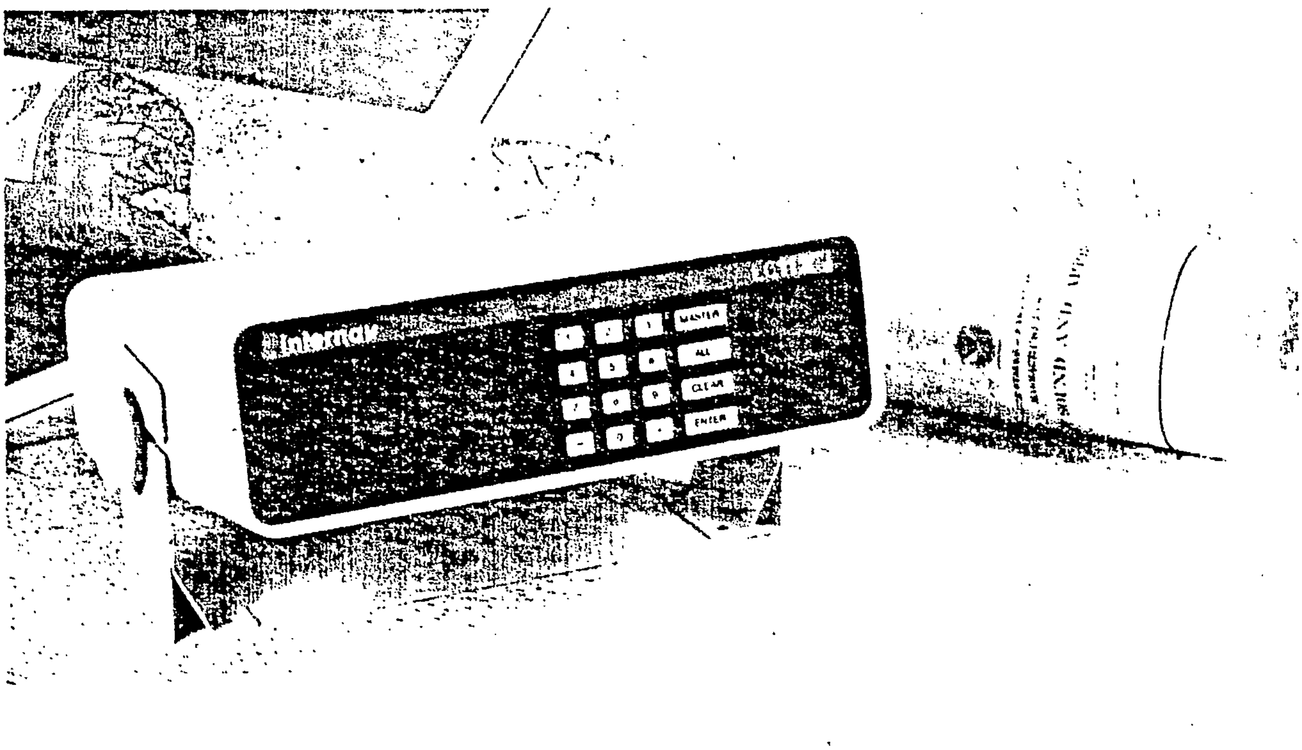
Internav's new fully automatic LC 112 is a new achievement in versatility. This new economy priced unit is simple and easy to use, yet it offers many features found only in expensive receivers.

The microprocessor automatically acquires Loran C signals and simultaneously tracks all the time difference numbers in any selected Loran C chain. The LC 112 then alternately displays any two selected time difference numbers on its big LCD digital display. Internav's remarkable "Split Display" can read out the last three significant digits of both numbers simultaneously for an immediate position fix.



Professional Quality. The LC 112 Receiver has been tested to U.S. MIL Standards for vibration, shock, temperature, humidity, salt spray and electromagnetic interference. Yet its compact size and low cost make it a natural for the commercial fisherman or recreational boater. It can operate on any Loran C chain in the world.

In addition, the 115 220 VAC version of the LC 112 has been designed and manufactured to meet or exceed all Minimum Performance Standards (MPS) of the Radio Technical Commission for Marine Services (RTCM) adopted 12/20/77, including Addendum #1 dated 7/19/79, as endorsed by the U.S. Coast Guard for use aboard vessels over 1600 gross tons when calling at ports in the Continental U.S.



Receiver Accuracy. Accuracy of the LC 112 is equal to the best inherent in the Loran C system, typically better than 400 yds. absolute in groundwave coverage and between one-half and two nautical miles in skywave. Repeatability—returning to a known Loran C position—can be as close as 50 feet.

The eight digit liquid crystal display is highly visible in daylight and automatically illuminates for night viewing.

Computer Operation. A unique feature of the new LC 112 is its sealed "Touch Pad" keyboard. Confusing knobs and switches have been eliminated. Simply turn the power on, enter the four-digit chain number and first digits of the lines of position as shown on the chart, and the LC 112 does the rest automatically. Even more amazing, the LC 112 has a non-volatile memory which retains the chain number and secondary stations, *even when the receiver is turned off!* That means you don't have to reprogram your LC 112 every time you want to use it. Set it up once at the beginning of the season, and touch nothing else but the on-off switch from then on. Of course, you can cancel and reprogram at any time.

Because its design is based on the very latest microprocessor technology, the LC 112 fits into a compact case only 12" wide and 3¾" high. Power consumption is only 15 watts at 12 VDC, about the same as a small cabin light. It's also available in 115 or 220 VAC.

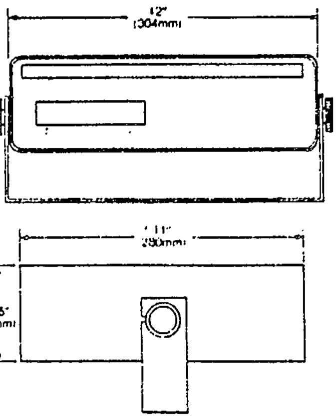
Operator Versatility. Internav has incorporated all the sophisticated features professional fishermen and yachtsmen have asked for. The LC 112 can display signal status, signal to noise ratio, as well as automatic display of "blink" when a Coast Guard transmitter is temporarily unreliable. Four preset internal notch filters are included to screen out all major interferences existing in the North American continent.

Multiple Memories. One feature is particularly valuable to navigators and fishermen; the LC 112 has a position "memory" that is able to store and recall five separate Loran C positions which you may wish to return to.

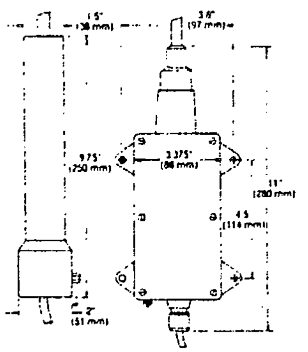
Equipment Options. Internav options can make your LC 112 even more versatile. Add the CC-2 Navigation Computer for complete solutions to most navigation problems—across the bay or across the world. Add the TP-2 Track Plotter to obtain graphic recordings of your vessel's voyage. The IL Remote Readout will repeat Loran C numbers at a secondary steering or navigating station. You can even obtain an RS 232 Data Output for transmitting your Loran C position over VHF. Tunable notch filters are also available for receiver operation outside continental U.S. waters.

Internav Reliability. The LC 112 Loran C Receiver is designed for rugged sea duty. A fourth generation product, the LC 112 features a degree of reliability obtainable only from a company which builds only professional quality marine electronics—Internav.

Receiver Outline/Mounting Dimensions



Choice of Tubular or Box Antenna Coupler



Specifications

Range—Groundwave	1200 nautical miles
Skywave	2000 nautical miles
Accuracy—Groundwave	less than 400 yds (absolute)
Skywave	0.5 to 2 nautical miles (with verified cycle selection)
Typical Acquisition Time (master and first two of four secondaries)	30 seconds
Typical to Correct Time Differences	2.5 minutes
Repeatability	50 to 120 feet
Velocity	80 knots
Readout	7 digit readout 0.01 microsecond resolution
Sensitivity (tracking)	1 microvolt meter
Dynamic range (tracking)	105 db
Signal to noise ratio (tracking)	S/N 1:10
Weight—Receiver only	9 lbs
Weight—Coupler and cable	5 lbs 4 oz
Supply Voltage	115/220 VAC, 50-60 Hz or 12 VDC
Power Consumption	15 Watts
Colour	White cabinet with blue accent panel
Data output	BCD serial

Optional Accessories .... Remote Readout, IL
Navigation Computer CC-2
Aircraft Velocity Option (to 400 kts)
External tunable notch filters
RS 232 data output for retransmitting Loran C position over VHF

Dealer Sales and Service across Canada

Manufacturer reserves the right to change specifications

Internav Ltd
Point Edward Marine Park,
Sydney, Nova Scotia B1P 6K3
Phone 902-539-0660
Telex 019-35126

Internav LC270 Loran C Receiver with exclusive Escort IV Steering System

With Internav's LC 270 Loran C Receiver you get accurate, dual readout Loran C plus a whole lot more. And the cost is surprisingly low.

EASY OPERATION

Just press the ON switch. A built-in continuous memory retains all the critical data so you don't have to. The critical data includes GRI, secondaries to track and display, and all waypoints.

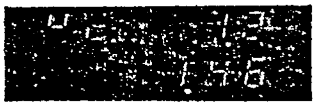
4 LOP CAPABILITY

The LC 270 automatically acquires and tracks the master and up to four* secondaries. Then two selected LOP's are displayed in the big dual readout. This helps you get the most accurate fix from your Loran C.

*Tracks three secondaries when Escort IV Steering System is in use.

STEERING WITH THE ESCORT IV STEERING SYSTEM

You may enter up to four waypoints or destinations into the LC 270's continuous memory. Then the Escort IV Steering System does the rest. You just start the program.

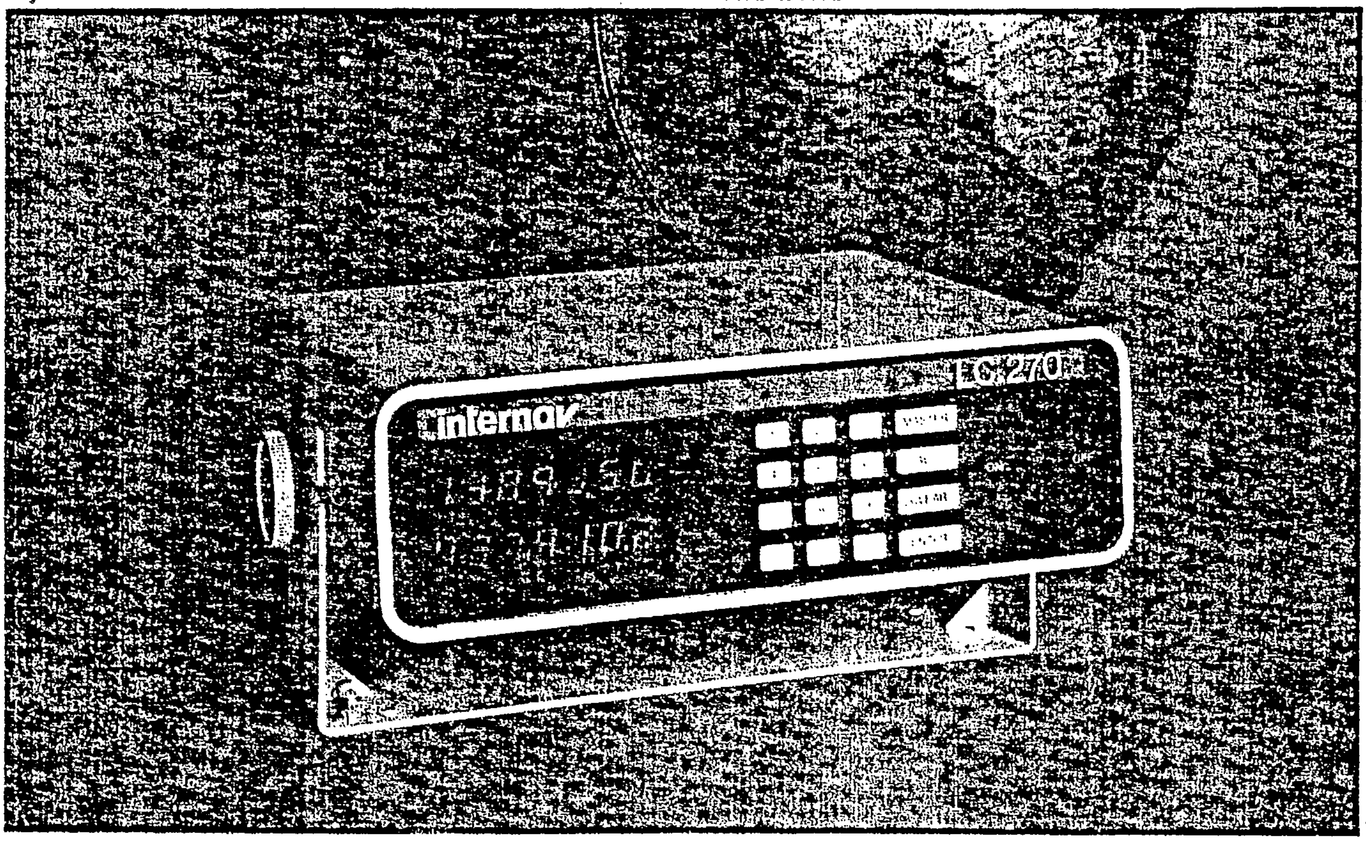


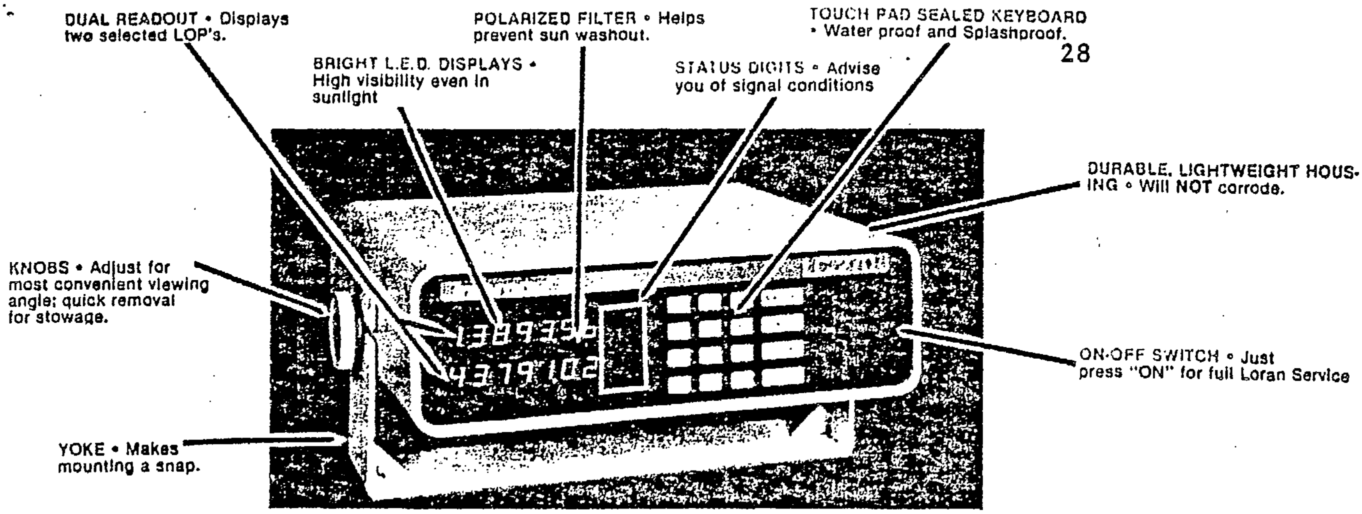
Steering display shows off course to starboard by 1.2 miroseconds. 1 hour, 46 minutes remains until arrival at destination

COOL EFFICIENCY FROM THE WORLD LEADER IN LORAN C

The LC 270 is a lightweight in both size and power consumption. It draws only 19 watts at full intensity and still provides an incredible variety of features. Status indicators advise you of the condition of all signals being tracked • A Blink alarm alerts you to unusable Loran C signals • You can request the signal to noise ratio of any signal being tracked • Four internal notch filters screen out all major interference in North America • A data output connector is included for driving remote accessories.

The LC 270 is built tough and tested tough enough for sea duty and is backed by service across the U.S. and worldwide.





SPECIFICATIONS

RANGE .... 1000 nautical miles
ACCURACY .... < 0.25 microseconds*
REPEATABILITY .... Better than .05 microseconds

Acquisition time for master and two secondaries .... 30 seconds
Settling to correct TD's .... 2.5 minutes
All alarms extinguished .... 6 minutes
Velocity .... 80 knots
Readout .... A dual 8 digit display with .01 microsecond resolution. The eighth digit is a status indicator.

Minimum signal conditions for track:

- Sensitivity .... 1 microvolt/meter
- Dynamic Range .... 105 dB
- Signal to Noise 1:10

Minimum signal conditions for search and settle to full accuracy:

- Sensitivity .... 20 microvolts/meter
- Dynamic Range .... 90 dB
- Signal to Noise 1:3

Size .... 12" wide × 3.75" high × 11" deep
Weight .... 9 lbs.
Power supply .... 115/230 VAC 50-60 Hz or 12 VDC
Power consumption .... 19 Watts
Serial data output for computer recording or driving accessories.

*Meets RTCM Minimum Performance Standard.

OPTIONAL ACCESSORIES

Remote Readout IL
CC-2 Navigation Computer
Aircraft Velocity Option (to 400 kts)
External tunable notch filters

LOCAL DEALER

International Navigation Corp.
65 Wiggins Avenue
Bedford, Massachusetts 01730
Phone: 617-275-2970
Toll free: 1-800-343-4414/15
Telex: 00923352

Internav Ltd
Point Edward Marine Park
P.O. Box 1261
Sydney, Nova Scotia B1P
Phone: 902-539-0660
Telex: 019-35126

Internav

Exhibit III

INTERNAV LTD.
FINANCIAL INFORMATION

Summary of Income and Expenses
Three Years Ended December 31, 1981

	1981 (Unaudited)	1980	1979
	$	$	$
Sales	2,159,105	1,806,270	1,707,280
Cost of Goods Sold			
Inventory, beginning	471,902	424,870	315,107
Materials	1,081,930	1,020,382	917,665
Freight In	29,462	26,251	15,058
Direct Labour	238,655	185,751	223,580
Overhead	269,696	223,452	225,083
	2,091,645	1,884,706	1,696,493
Inventory, ending	652,945	471,902	424,870
	1,438,700	1,412,804	1,271,623
Gross Profit	720,405	393,466	435,657
	33.4%	21.8%	25.5%
Expenses			
Selling	177,699	218,098	190,306
Administrative	265,243	179,214	152,165
Engineering	37,092	27,553	18,510
	480,034	424,870	360,981
Operating Income (loss)	240,371	(31,404)	74,676
Other Income (loss)	-	63,887	(39,527)
Income before taxes	240,371	32,483	35,149
Income Taxes			
Current		(2,433)	2,433
Deferred	32,000	12,648	
	32,000	10,215	2,433
Net Income	208,371	22,268	32,716
Sales	9.6%	1.2%	1.9%

Unaudited Balance Sheet
December 31, 1981

ASSETS	$
Current	
Cash	1,564
Receivables	632,764
Inventory	652,945
	1,287,273
Receivables	7,929
Equipment, at cost less depreciation	293,723
Deferred Product development costs	276,823
	1,865,748

LIABILITIES	$
Current	
Bank Indebtedness	373,164
Payables and Accruals	377,713
Long Term Debt Payable within one year	45,000
	795,877
Payable to Director	75,911
Loans Payable International Navigation	53,492
Long Term	299,365
Deferred government assistance	45,427
	1,270,072
Deferred income taxes	44,648
	1,314,720

SHAREHOLDERS' EQUITY	
Capital Stock	600
Contributed Capital	49,400
Retained Earnings	501,028
	551,028
	1,865,748

Exhibit IV

INTERNAV LTD.
SEASONALITY OF BUSINESS

Monthly Cash Receipts as a Percentage of Annual Totals

Month	Percentage of Annual Cash Receipts
January	5
February	5
March	7
April	7
May	10
June	13
July	13
August	13
September	10
October	7
November	5
December	5
	100%

Exhibit V

INTERNAV LTD.
TWO NEWS STORIES

Cape Breton firms to receive government aid

By CLAYTON CAMPBELL
Sydney Bureau

SYDNEY — Two Cape Breton companies will receive government assistance totalling $849,000 to aid in the expansion and development of operations and equipment.

Under the capital assistance project of the ocean industry development agreement signed recently between Nova Scotia and federal governments, Industrial Welding Limited of Cheticamp will receive a $210,200 development grant to assist in the expansion of hydraulic deck gear and other metal fabricated products.

The firm, owned by Roger and Raymond Deveau, will receive a similar amount under the regional development incentives program to help in expansion of the firm's operations.

Micronav Company Limited of nearby Point Edward will be awarded a $429,000 grant from the National Research Council to assist in the development of a microwave landing system for sale in Canada and abroad.

Industry Minister Herb Gray made the announcements at a news conference here Monday.

"My department is pleased to support these local firms," he said.

"The two development incentives awarded to Industrial Welding are examples of how the recently-signed ocean development agreement will be used to supplement and complement other federal government programs, and to support and encourage the development of ocean related activities throughout Nova Scotia," he said.

Mr. Gray pointed out that the microwave landing system (MLS) is the most advanced type of landing system under development, and is expected to be used in all airports.

The MLS is a new type of equipment designed to enable aircraft to land in adverse weather conditions. It will replace the instrument landing system (ILS) now in use throughout the world.

The minister told the conference the MLS market value is expected to be several hundred million dollars, and "it is hoped Micronav will be able to address this very large market in an effective and timely way."

Cape Breton-The Sydneys MP Russell MacLellan said the announcements are "encouraging for the economy of Cape Breton, and will have a direct bearing on industrialization and economic opportunities."

He said Internav Company Limited, from which Micronav was founded, is one of the top companies in Canada manufacturing technical marine navigation equipment.

"MLS is the system of the future, and Micronav is the only company in Canada that is looking to supply the department of transport (and) to sell the system abroad as well," Mr. MacLellan added.

He called the local development of the MLS an "exciting prospect that, if successful, will produce hundreds of jobs in this area."

He indicated that further government assistance may be forthcoming as the MLS project progresses.

Cape Breton-East Richmond MP Dave Dingwall told a news conference that Mr. Gray's announcements are "good news in tough economic times." He said the monies made available to the local firms "will go a long way to lessen unemployment in Cape Breton."

Micronav president John Currie said sale of the MLS in Canada would total about $200 million, with worldwide sales reaching $3 billion to $4 billion.

He said the company has started preliminary work on what will be "a gigantic program."

He said two technical people have been hired, with 11 more to be added to the staff within six months.

Another 17 will be hired in 1983 and 10 more in the third year of operation.

"This is a long-term program that will require by the early 1990s about 400 employees," he said, adding that it will take up to 30 years to equip all the airports in the world.

Mr. Currie said the company will have "all kinds of training programs for this highly-technical project. But we are not in any hurry. We have plenty of time to do it right."

DREE's new Sydney office 'will provide closer liaison'

By CLAYTON CAMPBELL
Cape Breton Bureau

SYDNEY — The department of regional economic expansion Sydney office will strengthen the department's close involvement with all economic and related developments in Cape Breton, Industry, Trade and Commerce Minister Herb Gray said here Monday.

Speaking at the official opening of the downtown office, Mr. Gray said it will provide a closer liaison with the business community, local groups and other development agencies in Cape Breton.

Besides providing advice and assistance regarding government programs, the office will coordinate its activities with other federal departments and agencies, including the Cape Breton Development Corporation.

"The three-member office will encourage the establishment of export industries, which are technologically advanced and competitive in world markets," he said. "Concurrently, work will be undertaken to foster smaller indigenous manufacturing industries based on local resources, producing for local markets."

Emphasis will also be placed on steel, coal, coke, offshore resources and the resulting spinoff industries.

Mr. Gray went on to mention that the new office will work closely with the Sydney Steel Corporation (Sysco) and the provincial government to develop further steel-related opportunities such as foundry and metal fabrication.

"Of considerable importance is the potential that exists for offshore industries in the areas of research, management and utilization of the resources of the Atlantic Shelf and Eastern Artic," he said.

Cape Breton-The Sydneys MP Russell MacLellan says the office will make Cape Bretoners aware of the department's functions and programs.

He pointed out that the office will serve the entire island, and "it is up to all of use to utilize it."

Cape Breton East-Richmond MP Dave Dingwall says a local DREE office "is long overdue."

"I am glad to see that it is finally here, for it will provide benefits of economic and professional assistance to the people of Cape Breton," he added.

Senator Al Graham said the office is "a manifestation of the accepted role of the federal government to bring government closer to the people."

The office, he said, will mean that the people of Cape Breton can count on greater government efficiency in the future.

PETER MACAULAY AND MICRONET LIMITED

It was a beautiful summer day in Nova Scotia and Peter Macaulay periodically glanced up from his reading materials to look at the sailboats dotting the waters of Halifax's harbour and the Bedford Basin. On Saturday afternoons Macaulay often spent a couple of hours in his apartment, reading newspapers and trade magazines that had piled up during a busy working week. Although the computing magazines were absorbing, he found himself thinking about the pleasures of owning a good-sized sailboat of his own. As President and fifty per cent shareholder in a new but highly successful company, he was confident that these pleasures were not so very far away.

Peter Macaulay

Peter Macaulay was born on the very first day of 1946, the eldest child and only son in a family of three. The challenge of physics attracted Macaulay during his teenage years, and after graduating from high school he went to Carleton University in Ottawa where he studied mathematics and physics. He gained his B.Sc. in 1970 and then moved to Montreal and McGill University where he began a masters

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This case was prepared by Professors Philip Rosson and Michael Martin of Dalhousie University as a basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. The authors gratefully acknowledge the financial support of the Federal Department of Industry, Trade and Commerce, Technological Strategy Branch in the development of the case.

degree in nuclear physics. During the summer of 1971 he worked on a physics experiment in Montreal. Much of this time was spent at a computer console, and this first experience with the computer so excited Macaulay that he decided to drop physics and pursue a career in the computing field. As a result he went to work for Control Data Corporation in Ottawa.

Six months later the company was installing one of its Cyber computers at Dalhousie University and needed a resident systems analyst. Macaulay was promoted to this position and was glad to be going home again. The appointment provided useful experience of installation and support work.

Once the system was operating smoothly, however, the question of promotion again arose, this time to a post in Toronto. Macaulay was not anxious to make this move. As an alternative it was agreed that he would remain in Halifax, but be called upon regularly to work elsewhere in North America for short periods. This proved to be a very broadening experience, for he was involved in working on various computer systems, and in several capacities. In all, Macaulay spent four years working for Control Data Corporation.

In 1975, Macaulay joined Dalhousie University as Assistant Director of the Computer Centre, where he worked on configuration requirements of the systems, software design, and relations with vendors. Then he moved to become Director of the Systems Programming Department which was responsible for all university administrative packages, eg. payroll, registration. During this time he started working on consulting assignments in the evening and this was how he met Peter Gregson.

Gregson had also grown up in Halifax. Unlike Macaulay, however, he had stayed in Halifax to attend university, gaining bachelor and master degrees in engineering at the (now) Technical University of Nova Scotia in 1974 and 1976 respectively. Gregson's work experience had been mostly gained with the Defence Research Establishment Atlantic in Dartmouth, N.S. Here he had been involved in the design of microprocessor data acquisition packages for experimental hydrofoil research.

Gregson had started doing consulting work, because, like Macaulay, he sought more of a challenge than his full-time job provided. The two men were brought in to complement each other on a consulting job. Gregson was an electrical engineer with experience in hardware design. Macaulay was a systems analyst with experience in developing software. The two men found that they had compatible personalities, similar value systems, and common ideas about systems design and implementation. This led them to work together on a number of subsequent consulting assignments. By August 1977 they were joint-owners of their own company - Micronet Limited.

Establishing Micronet Limited

In establishing their company, Macaulay and Gregson were conscious of two significant trends. First, the cost of microprocessors was just starting to fall and they foresaw a $10.00 chip in the not-too-distant future. Second, energy costs were climbing; in particular, Nova Scotian electrical costs were the second highest in Canada. Given these trends, the two founders saw great potential for an electronic controller to save energy. Confident that their allied skills would enable them to develop such a device, their next task was to find a place to test out their ideas.

Macaulay was at the time living in a condominium apartment building in Halifax, and it was decided to approach the owners of the apartments with an energy conserving scheme. The proposal was made in April 1977. Essentially, it was argued that considerable savings on the $100,000 electric power costs could be made by installing a computer controller.

As a condominium development, the individual apartment owners had a board to represent them, but the board members felt this proposal sufficiently important to be reviewed by everybody. This presented a real uphill selling situation, for all owners had to be made to understand the proposal and convinced of its worth. Three or four presentations were made to the apartment owners - some of whom were engineers and conversant with the subject matter, while others, eg. librarians, had no knowledge of electrical systems or computers whatever. After numerous meetings this proposal was successful, and a contract for $5,000 was awarded.

The partners monitored the building's electrical usage pattern and power bills. They found that the building exerted an extremely high load on the power system at about 6.00 pm, when apartment owners arrived home from work and started turning on lights and appliances. This peak loading pattern meant higher bills for the building, for the charges were pro-rated to consumption in this period of roughly 15 minutes each day. Since some of the energy demands of the apartment owners could not be shifted from 6 pm, Macaulay and Gregson simply proposed a scheme whereby the computer controller would switch hot water heaters off, and then on again, around this peak time. This idea was accepted and the system's installation subcontracted. It was at this stage that the company was incorporated, for the partners felt this afforded some protection should things not go quite to plan.

The business was very much a part-time venture, and so over the next few weeks the evenings were taken up watching how the computer performed. It transpired that the system saved some $15,000 for the apartment owners in the first year, and this pleased them immensely. This initial contract gave the partners good experience with the controller itself, the software, and also in dealing with customers. In addition, the idea of focusing on computers and energy saving gained some reinforcement.

With the success of this $5,000 contract, Macaulay toyed with the idea of going full-time. In the end he decided this was too early, but being disenchanted with his work at Dalhousie, he switched jobs. Again he remained in Halifax, but now he joined the payroll of Computer Communication, Inc., a Californian-based company. For the next two years Macaulay sat waiting in his apartment for the phone to ring. When it did he had to get the next flight out to go to Houston or Chicago, or wherever the company wanted him. This was not too disruptive since Macaulay was a bachelor. While waiting for phone calls, he had quite a bit of time to get Micronet moving. Using one of his two bedrooms as an office, he maintained contact with the first installation, but also looked at new opportunities for energy controllers. A number of small jobs were undertaken during the next two years and sales grew from $10,000 in 1977/78 to $50,000 in 1978/79. However, other jobs had to be let go because they could not be done in the evening. In the end, Macaulay resigned from Computer Communications, Inc. to go full-time with Micronet. During the two years with the company, he had been earning a very good salary and had managed to save enough to help finance Micronet.

With the decision to go full-time made, premises for the company had to be found. Two rooms were taken in the old Keith Brewery building near the Halifax waterfront. An office manager was hired, and in the course of the next year an electronic technologist was added. The company started to bid on larger energy controlling jobs, as well as others, and doubled sales to $100,000 between September 1979 and July 1980 (see Exhibit I). During this period, the company was getting many telephone calls from people who wanted to know whether 'this' or 'that' could be made. While the business was tempting, it was decided that efforts should be concentrated as far as possible on energy and computers.

The Nova Scotia Power Corporation Contract

During the summer of 1980, the company bid on a contract to take the energy controller developed for the apartment building, redesign it, make it smaller, and put it in a package for the Nova Scotia Power Corporation (NSPC). The NSPC would take delivery of 860 microprocessors which would then be installed in the homes and industrial sites of randomly selected customers. The on-site microprocessors were to monitor consumption continuously throughout the day, relaying the information via the telephone line to a larger computer. This larger deck computer would then 'massage' the data and present reports to NSPC management. Once electricity usage patterns were established, it was possible that the same system could be used actually to control this usage. However, the first phase was to be one of monitoring, and this state of the electricity load study was to run over three years. The NSPC contract was valued at $600,000 and was part of a larger $3 million load management project funded 80/20 by the Candian Federal and Nova Scotian Governments.

Micronet felt that it had several advantages over other firms that would be bidding. First, it was a Canadian-owned company. Second, it was Nova Scotia-based. Third, it had successfully built a microprocessor of this kind before. Against these advantages, Micronet saw its small size and newness as factors that might mean the contract was awarded elsewhere. Because of this possibility, it was decided to join forces and co-bid with a very large US company. The firm in question was the Harris Corporation, a multinational headquartered in Florida. Much of Harris' work was in military contracts and the company also manufactured its own chips very competitively. Under the joint arrangement, Micronet was to be responsible for the microprocessors and Harris would manufacture the deck computer.

Micronet won the NSPC contract in competition with a Calgary-based firm and another company from the US. Micronet's owners attributed their success in winning the NSPC contract to two main factors. The tie-in with Harris was certainly influential. This married large company dependability with a new Canadian firm that had some highly relevant experience, and was handily located. The second factor was contract cost. Micronet suspected that their bid was lower than the other two because their system involved more effective data transmission over the telephone lines.

The award of the contract was a great boost for Micronet. It meant that they grew from 3 full-timers to 10. Now that the business was somewhat less risky, Gregson - married but with no family - joined the company full-time. He, in turn, hired 6 employees to work on the assembly line. The firm changed from being research and development (R and D) - oriented to full manufacturing operations. The offices of the company were moved just a couple of blocks to premises on Hollis Street, where after some $15,000 was spent on leasehold improvements, manufacturing began.

From the beginning of their association, Macaulay and Gregson had wanted to build robust computers, and this philosophy was continued on the NSPC contract. Starting with the original 1977 apartment controller design, several prototypes were devised, until finally an acceptable product emerged. (see Exhibit II). The product went into manufacturing in October 1980. Conscious of the problems that supply interruptions can lead to, and mindful of the fact that Micronet's performance in filling the contract would be closely studied, it was decided to buy parts early. Financially this was feasible, for the NSPC had agreed to pay 50 per cent of the contract at awarding time. Aside from some slippage in the first two months of the contract, Micronet was able to meet the delivery targets set in the contract. Poorer performance by other supplying firms meant that in July 1981, some of Micronet's computers were sitting on NSPC shelves awaiting installation.

Growth Problems

By July 1981, Mirconet had 15 full-time employees and would achieve close to $1 million sales for the 1980/81 year. Needless to say, the growth of the company had brought some attendant problems. Perhaps most difficult for Macaulay and Gregson was communicating their own personal philosophies to their employees. As far as the owners were concerned, robust products were crucial in differentiating Micronet from other firms. Yet, some of the 'professional' employees (computer scientists, systems analysts, engineers), took a while to appreciate the merits of this approach. Another problem had to do with work effort. At first, Macaulay and Gregson were surprised when a person they wanted to talk to about something important, had left the office by 5.30 pm. This was a problem with 'professional' employees, but more especially with the assembly line workers. On reflection, both partners realised that although they were prepared to put in 20 hour days, there was no reason to expect the same of others.

Flexible working hours were tried in the first months of the NSPC contract. Macaulay was anxious to get away from a rigid 8.30 am - 4.30 pm working day, for he viewed this as potentially stifling creativity and creating dissatisfaction. However, after two months or so, it was clear that flex-time was not working, mainly because people were taking improper advantage of the freedom it offered. With these problems in mind, Macaulay and his office manager drew up an employee handbook. This spelled out what was expected of the employees and what the company stood for. A year or so later, the handbook was in its third version and was felt to have been a successful move on the part of the company.

Finance had not been too much of a problem to date. The small scale activities of the first few years had been financed largely from within the company. Some Government assistance was also provided. For example, a $10,000 grant was made by the Provincial Department of Development to help develop the kiln controller (see Exhibit I). A Federal Business Development Bank loan for $15,000 was also secured, although Micronet was not anxious to repeat this as the loan had required much work over eight long weeks. In addition, the company had been aided by the 50 per cent up-front financing of the NSPC contract. The company realised, however, that as it grew, it would require additional financing, and thoughts were being given to sources of venture capital at the present time.

Some problems had been experienced, however, with the company's bankers - one of the major Canadian banks. Although the company was doing sales of $1 million currently, they had only been able to secure a line of credit from their bank for $75,000. Macaulay felt that they should be able to push that to $100,000, but had not received a sympathetic hearing to this proposal. In fact, Macualay was fairly unimpressed by the attitude and practice of his bank. He felt that the bank did not really understand how small electronics firms operated. In particular, Macaulay saw the company's newness, high growth rate, and lack of significant tangible assets, as characteristics that made the bank quite uneasy. Initially thought was given to moving the banking activities elsewhere, but eventually it was realised that the problem was a general one in the Halifax area. Had Micronet been located along with many of Canada's other electronics companies in Ottawa, the problems would have been much smaller, for there the banking community had become accustomed to this type of firm.

Management was something new to the two partners. Macaulay had some managerial experience which he had gained at Dalhousie University, where he supervised 8 - 10 people. Business management, however, had been very much learned on the job. Macaulay felt comfortable in the role of President, but like many managers, found immediate problems occupying much of his time. Personal problems among the employees, and cashflow difficulties were but two examples of this. In order to find time for thinking more about the future, a recent practice had been for planning meetings to be held away from the office. Typically, a room was reserved at the Halifax Board of Trade where interruptions were minimal. These monthly meetings were regarded as most helpful - money had been saved, it was thought, for a longer-term plan helped prevent impulsive, and often mistaken decisions about matters of more pressing concern.

New Product Development

Having reached $1 million of business in 1980/81, the target for 1981/82 was set at $2 million. Macaulay regarded this target reasonable in view of the expertise they had developed in filling the NSPC contract. The company now had a proven product and had considerable experience in manufacturing the automatic meter reader. As well, good relationships had been built with parts suppliers, which augered well for the future.

Further sales of the NSPC-type unit had been made to American Science and Engineering Inc. in Boston. This company was actively involved in energy studies in a number of states in the USA and overseas. To date, about 100 units had been shipped at a price of around $1,000 each. Although the units had to bear air freight costs, the price was profitable to Micronet. Regular sales of 200 or so units each year were foreseen to this firm, as energy conservation activities continued in the US and other overseas markets.

Macaulay realised, however, that other products were needed if growth was to continue. Two new products had recently been announced. There were: The productivity monitoring network (Exhibit III), and the portable load monitor (Exhibit IV). Each product was based on the hardware developed for the NSPC contract, but with different software. The main motive in launching these two products was to generate further sales by capitalising on company experience, and by keeping R&D expenses under control. Although the NSPC hardware was not necessarily ideal for these new products, it was very satisfactory and: 1) involved a very familiar manufacturing process, and most importantly 2) had proven itself in the field.

The productivity monitoring network was aimed at industries where large volume production takes place and where machine down-time and inefficiency would seriously damage performance. An installation had been made at a local carpet mill, and $2 million of enquiries had recently been made at the Production Show in Toronto. The company knew that it had potential in the textile and moulding industry, but discovered wider possibilities at the Show, and was now working to see how much of this business it could turn into sales. In the 1980/81 year, the productivity monitoring network contributed 15% of the $1 million sales. The portable load monitor was newer. It had been developed for consultants that wanted a portable and self-contained system for energy studies, and no sales had been made so far.

It was felt that the common hardware utilised in the three Micronet products would become obsolete in about 18 months. In the meantime, while past R&D spending and production experience was being worked hard, new hardware was being developed. About 12 new sets of hardware had been made, but the owners wanted to be extremely confident that the new design was right before going ahead. Gregson was in charge of these efforts and, although a part-owner of the business, he had to bring his ideas before a review group. This consisted of Macaulay and the R&D staff of five.

Micronet was looking at new ventures in addition to the initiatives already described. The company continued to get calls from outsiders with 'neat' ideas. One of these seemed promising and involved the use of a special kind of venetian blind to reduce heat losses through the windows of buildings. The inventor claimed that 30% heat savings could be made, for the blinds created an extra air pocket between the interior of the building and the outside surface.

Micronet was approached to develop a microprocessor to control the opening and closing of the blinds so as to conserve heat. Although Macaulay had questions regarding the volumes of business possible, a $50,000 development fee was charged for the work undertaken. Long term prospects looked promising, for if a volume market was identified and developed, a $200 price tag for a product that cost $30 to produce looked feasible. At the moment this project was 'on hold' while the inventor was investigating funding possibilities with the Department of Industry, Trade and Commerce.

Another possibility was the development of a ship stabilisation model. This would involve a shipboard computer controlling the uprightness of the vessel. This could be achieved through moving water in the hull, deploying fins on the side of the side, or some other method. A device of this kind could potentially change the seaworthiness of a fleet and would have implications, among others, in the fishing industry - where trawlers could be worked more productively. At the moment, however, Micronet was discussing this matter with the RCN.

Short and Longer-Term Business Plans

Generally, Macaulay saw Micronet growing by producing controllers that were 'smarter and smarter.' The company should prosper, he thought, if it based its strategy on producing good hardware which was accompanied by intelligent, almost robotic, software.

Software development was seen as the main thrust of the business. Competitively, this made most sense because the product hardware could be copied by any able firm, whereas the software was much more difficult to emulate. A competitor could, it was true, discover what Micronet claimed its software accomplished, but discovering how it did this was another matter. Given this business approach, Macaulay planned to recruit most actively in the software area. As a rule of thumb, he felt that the work of one electrical engineer could keep about ten computer scientists employed in software development.

The skills that would be critical to Micronet's continued success would, then, lean heavily on the software developers it was able to recruit. Fortunately, there had been no problem in recruiting good people so far, and none was envisaged. Thus far, Micronet had recruited locally, but over the course of the next year it would be necessary to advertise in Ottawa. Macaulay was sure that there were skilled Nova Scotians working for electronics companies in Ottawa who would welcome a chance to return home. Once these people reached a certain position, according to Macaulay, lifestyle became more important than extra salary. He felt confident that he would be able to attract good people based on quality of life considerations. As well as Micronet's location being attractive, its size and newness were also seen as positive features. In the owner's opinion, many people were attracted to a small and young companies, where they could demonstrate initiative, and make some concrete contributions.

One matter of some concern was the location of the company's premises. If the kind of growth that was planned did materialise, it was likely that the company would have to move from the downtown

Halifax area. The present location was very suitable: it was close to the owners' homes, and to offices of important organisations, eg. NSPC, government. Also, it was well served by bus-routes that the assembly workers depended on. It looked as if a move would be to a facility in an off-centre Dartmouth location, and it seemed that this might create difficulties as bus services were poorer in these areas. However, this was a problem for the future.

Software and certain hardware features gave Micronet something of an edge over its competition. The company had identified four main competitors (3 US, 1 Canadian) and tried to find out as much about their products as possible. In each case, Micronet's automatic meter reader had more user programmable features than others. Three physical features were also useful in differentiating Micronet's product. First, it would operate over a wider temperature range, (-40oC to +80oC). Second, it worked in the rain! Third, it would operate under other adverse conditions eg. partial product failure, because of the robust design principles held so important by the co-founders. Because of these reassuring features, Micronet was able to command a premium price for their product.

The U.S. market was seen as a particularly important growth point for the automatic meter reader, and Micronet was planning to tap this through American Science and Engineering Inc. of Boston, as well perhaps, as through direct sales. So far the company had sought local approval for its products and was authorised for use in Nova Scotia, California and Oregon. Currently, however, the product was with the Federal Communications Commission in Washington, D.C. awaiting approval for use statewide. This approval would remove the last barrier to full-scale acceptance of Micronet's product in the U.S.A.

One question Macaulay and Gregson were grappling with at the moment was whether to implement a profit-sharing plan. This type of arrangement had initially appealed to the partners and they had considered including employees of 12 months standing or more in such a scheme. Recently, however, they had begun to have doubts about the wisdom of this. Macaulay had heard that when shares were dispersed in this way, 'going public' was that much more difficult and expensive. He confessed, however, that he needed more information here. As well as this point, the partners wondered whether they should give up shares when there was no demand for this from their employees. The 'professional' staff were still getting a lot of satisfaction from the challenge of their jobs, and it was doubtful whether the assembly-line workers would be interested in shares.

The public offering question showed up one drawback of being located in Halifax. Occasionally, on an issue of this kind, Macaulay was unable to get much useful advice locally. Fortunately, he had found a partial way around this problem. Through the Provincial Department of Development he had come into contact with a venture capital company in Boston, that had several people with 'hands on' electronic company experience. Macaulay consulted these people quite regularly by telephone, finding them a source of helpful information and advice. Aside from this drawback, Halifax was to Macaulay an ideal location to service the US market, which figured prominently in growth plans. The products Micronet sold were relatively light and high in value. This meant they could bear air freight charges. Furthermore, with a daily flight from Halifax to Boston, and many onward connections, Micronet could serve the US market very readily.

Growth was a key objective of the Micronet owners. The targeted sales for 1984/85 were $20 million, which Macaulay envisaged would be generated by three main product lines manufactured by a company of 50 employees. Although some diversification would be necessary, it was felt that too much broadening of the product line should be avoided. Macaulay constantly had to remind himself that Micronet should concentrate - on devising computer solutions to energy and productivity problems. Within this field, Macaulay wanted Micronet to develop a reputation for manufacturing a very reliable product, which upon malfunctioning, could be quickly corrected. This reputation was already being cultivated - Micronet offering a 12 month warranty on their products. (Most electronic failures occur in the first month or so, otherwise systems are good for up to 3 years - so the Micronet warranty was effectively a 3 year one.)

One type of product that could play a large role in Micronet's growth as a company was a so-called 'artificially intelligent controller'. Macaulay felt that the energy savings of up to 15% were relatively easy to make in many buildings. As the apartment job had shown, simply switching off the electric hot water heater for a 15 minute period saved the owners this amount. Moving beyond 15% was more of a challenge, but this was where a great deal of potential lay. Macaulay felt that if you could talk 20% savings to owners of apartment, office, or industrial buildings then the selling job should not be too difficult. Savings of this kind could only be achieved, to his mind, by turning the energy saving job over to a computer. The microprocessor would model the energy use patterns in the building and then devise an optimum control strategy. Product development was underway. The product again used generic Micronet hardware, but required more extensive software, which pushed the likely selling price towards $5,000. The initial ideas for marketing the product rested on two targets: heating and ventilating engineers, and building owners. The company was planning to advertise this product in a special supplement THE FINANCIAL POST was running in the middle of August 1981. A six inch square ad would cost about $1,200, but with a circulation of 200,000 and a readership, of perhaps, 400,000, this was considered a good investment. Additionally, Macaulay imagined they could get some good free copy in the supplement by writing to the editor, pointing out that their products were unique and Canadian.

As well as this line of product development, there was the distinct possibility that the NSPC contract could lead to more sales for Micronet. Depending upon the outcome of the three year monitoring operation, the NSPC might decide to proceed further. This could mean more monitoring devices (the NSPC having about 350,000 customers), or a move toward control devices. In the meantime, other electrical utilities in Canada might develop an interest in the automatic meter readers.

If the company did grow as planned, Macaulay and Gregson recognised that it would present them with new challenges. Sales of

$5 million, let alone $20 million, would require a different type of organisation than existed now (see Exhibit V). More management skills would be required and neither partner felt they matched up to the requirements. At around the $5 million sales mark, Macaulay saw several possibilities. First, the company could 'go public' and skilled managers brought in to run the company. Second, the company could acquire another firm that was better able to manage Micronet's future. Third, the owners could sell the business. Should this last possibility come about, Macaulay would want to move on to fresh challenges. Running a business had been very stimulating for him and a natural outlet for his interests in goal setting and problem solving.

For the time being, however, Micronet's future looked very rosy. The 20% profit that the company had made on the NSPC contract - where a very steep learning curve had been enjoyed - had been ploughed back into the business. Macaulay and Gregson had paid themselves their salaries, but the rest of the profits had gone into product development work. The new products - the productivity monitoring network, and portable load monitor - were now a reality, and would expand sales along with the automatic meter reader. Although the company had little money at the bank, Macaulay estimated the net worth of the business at around $300,000. Both partners looked forward to the challenges of the next few years. Although the idea of a 60 foot sailboat was attractive, at the moment Macaulay had neither the money nor the time to indulge that passion. In the meantime, though, it acted as a good motivator.

Exhibit I

MICRONET LIMITED PROJECTS

Some of the early projects of Micronet included:

1. KILN CONTROLLER

This controller was designed to reduce energy consumption in lumber and fish drying. The controller was designed for a local kiln manufacturer's product and fitted to their current units. The Nova Scotia Department of Development provided $10,000 funding for the development of this project.

2. BODY SURFACE MAP

This real-time EKG data collection system was supplied to the Victoria General Hospital in Halifax. The system is used in the Intensive Care Unit to collect data from 128 electrodes on a patient's body. The data are then used to plot a topographical body surface map of the electro-potential of the heart beat.

3. RULES OF THE ROAD

This electronics system for displaying the marine rules of the road was designed and produced by the company. It displays some 240 light patterns on demand. Although designed for a local market, export sales were felt possible.

4. CENTRAL RECORDING SYSTEM

A central recording system for the Halifax Law Courts was installed to tape, in one location, the cases being presented in the courtrooms. This information is archived, and also used by judges in their deliberations.

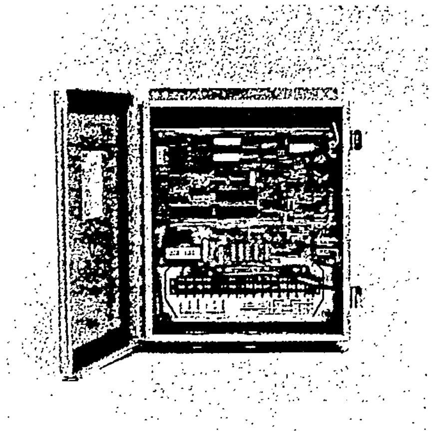
Exhibit II

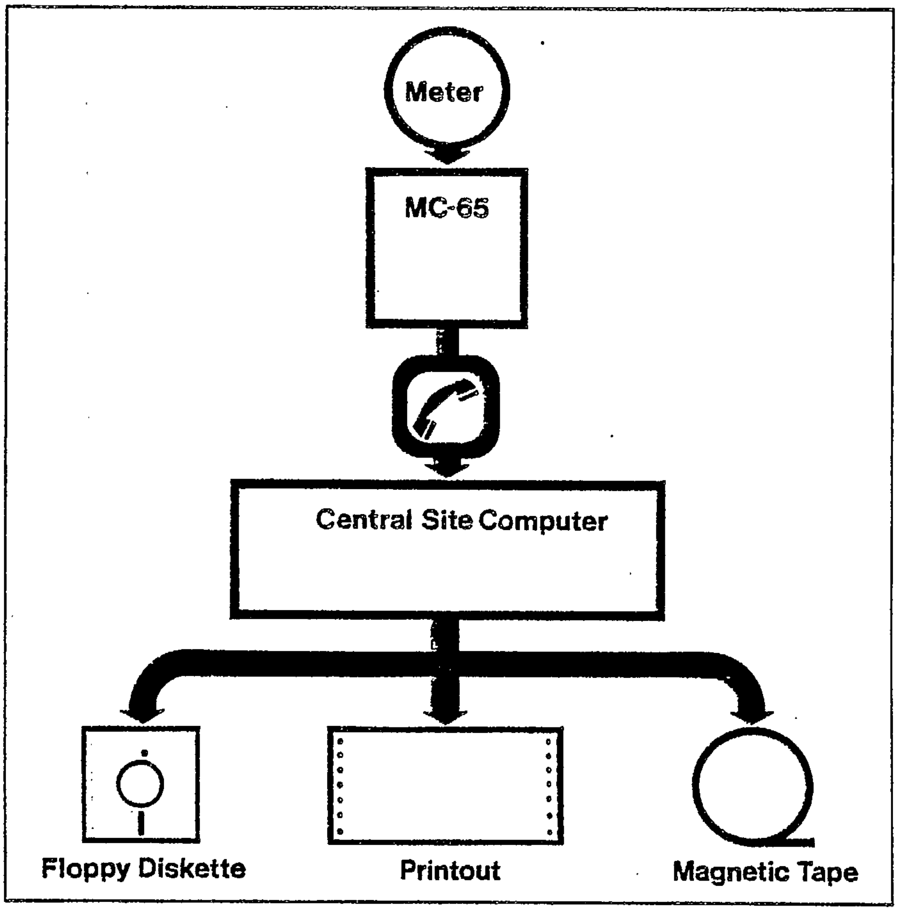
Automatic Meter Reader

Introduction
Micronet's AMR will transmit consumption information from any electric, gas, water or other meter, via telephone, from remote locations. It provides machine readable reports on magnetic tape or floppy diskette for printing and analysis. The AMR is capable of accumulating and storing data for long periods of time, and allows periodic or continous status checking of remote meters.

Applications
— Produces machine-readable reports of power meter readings

Features
— Improves cash flow
— Transmits data via telephone system
— Eliminates personal visits to read remote meters
— Report includes total consumption, total demand, user resettable demand





Specifications

Inputs

1. 2 sense inputs — voltage inputs	
Input voltage	12v to 30v dc
Input resistance	1200 ohms
minimum on/off time	0.5 seconds
2. Pulse initiator Inputs — switch closures	
maximum voltage at maximum current	0.4V, 20mA
minimum on/off time	0.5 seconds

Outputs

2 control outputs	200V, 0.5A, 10W

Telephone Interface

Direct connection to telephone network

Communications

Serial 300 baud asynchronous communications via telephone network or integral 20 mA interface

Power Supply

AC Power	480 VAC, 240 VAC, 120 VAC, 50mA

Temperature

Storage and operating	-25° C to +85° C

Weight

Including backup battery	12 Kg

Data Storage Specifications

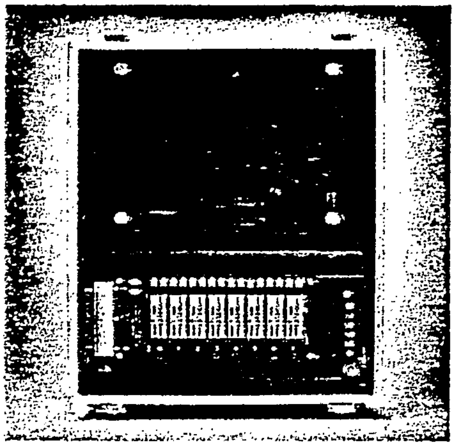
Data Storage

Pulse Initiator 1 and Pulse Initiator 2 Separate Storage
— 15 minute accumulator
— non-resettable accumulator
— resettable accumulator
— keyswitch accumulator
— maximum 15 minute count is 4094 pulses

Shared by Pulse Initiator 1 and 2
— daily totals (20 meter days)
— historical data (20 meter days of 15 minute pulses, or 80 meter days of 60 minute pulses)

Exhibit III

Productivity Monitoring Network



Introduction

Real-time productivity information is now available for any manufacturing equipment. Micronet Limited has developed this microprocessor based system which monitors production performance and provides reasons for machine downtime. Management benefits from up-to-the-minute information which aids decision making in regards to plant and personnel efficiency.

Applications

— Maximize productivity
— Identify reasons for downtime
— Increase hourly output
— Preventative maintenance planning

Features

— Provides up-to-the-minute productivity information
— Provides management-ready reports formatted on 8½ × 11 paper
— Monitors 16 machines and/or downtime reasons
— Collects data for management information systems
— Collects data for factory computer systems
— All information is networked via a data highway
— Provides supervisors with a log of current machine activity

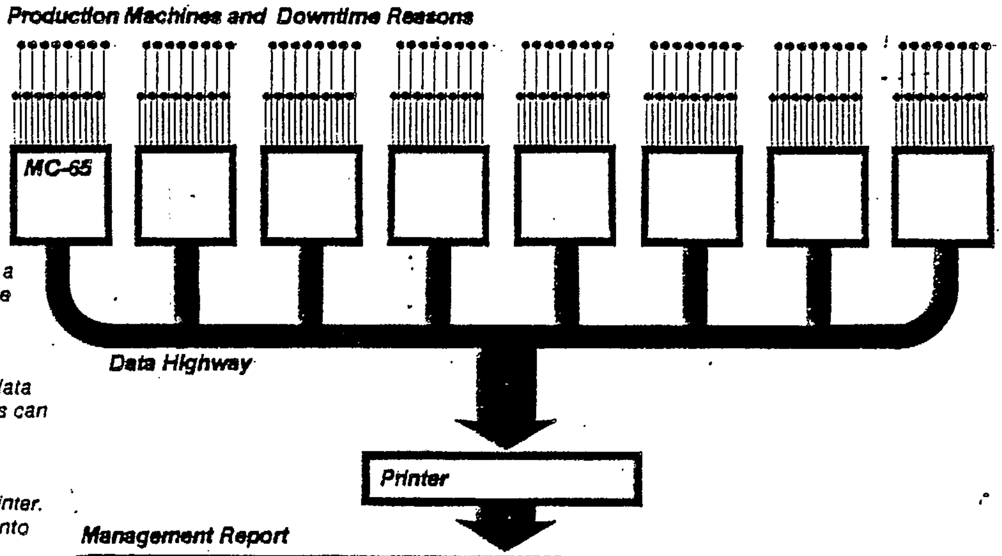
Production Machines and Downtime Reasons
In the factory machines and user-determined downtime reasons are monitored by the Productivity Monitoring Network.

MC-65
The heart of the system is an MC-65 microcomputer. Each computer can accommodate up to 16 inputs, sensing a combination of machines and downtime reasons.

Data Highway
The monitoring network is linked to a data highway. Up to 8 monitoring computers can be accommodated on each highway.

Printer
The Data Highway terminates at the printer. Up to 8 separate highways can be fed into each printer.

Management Report
A management-ready productivity report is delivered in conventional 8½ × 11 format.



PRODUCTIVITY MONITORING NETWORK

MANAGEMENT REPORT

MACHINE 423 - SPINNING FRAME 23 SHIFT TARGET 254.3 YARDS/HOUR

STATISTICS	
ELAPSED TIME	08:00:00
RUN TIME	06:23:45
DOWN TIME	01:36:15
NUMBER OF STOPS	22
AVERAGE DOWN TIME	00:04:22
TOTAL PRODUCTION	2512.5
PRODUCTION RATE	314.1
PRODUCTIVITY (%)	123.5

DOWNTIME REASONS	STOPS	TIME	PERCENT
1 - MATERIAL BREAK	12	01:12:28	75.3
2 - OUT OF STOCK	3	00:14:25	15.0
3 - JAM-UP	6	00:03:12	3.3
4 - SET-UP	1	00:06:10	6.4
5 - MECHANICAL	0	00:00:00	0.0
6 - ELECTRICAL	0	00:00:00	0.0
7 - NO BOXES	0	00:00:00	0.0
8 - PREVENTATIVE	0	00:00:00	0.0
9 - UNKNOWN	0	00:00:00	0.0

Specifications

Inputs

16 pulse counting or state sensing inputs	
— 8 protected voltage inputs	12-120 VAC 0.01A
— 8 contact sense inputs	
open contact minimum resistance	100 Kohm
closed contact maximum resistance	500 ohm
— maximum pulse count rate	1 pulse/second
— minimum pulse duration	0.5 seconds

Outputs

Downtime reason request relay contacts	120 VAC 1 A

Communications

Full duplex 300 baud serial communications via RS-232-C to the Production Monitor Network, a printer and/or a computer terminal.

Power Supply

AC power	120 VAC 0.1 A 60 Hz

Temperature

Operating temperature range	0-50° C

Weight

Total MC-65 installed	7.5 Kg

Size

Outside dimensions	356 × 305 × 127 mm

Options

Inputs

AC inputs from 12 VAC to 240 VAC
DC inputs form 10 VDC to 32 VDC
Pulse counting to 50 pulses/second
Contact sense input protection module

Output

Normally closed contacts on downtime reason request output.

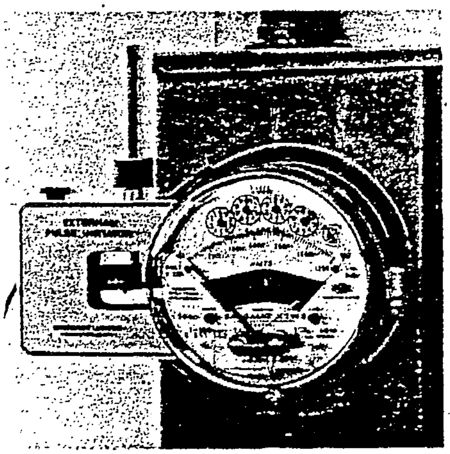
Exhibit IV

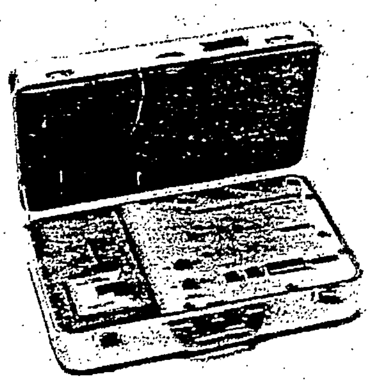
Portable Load Monitor

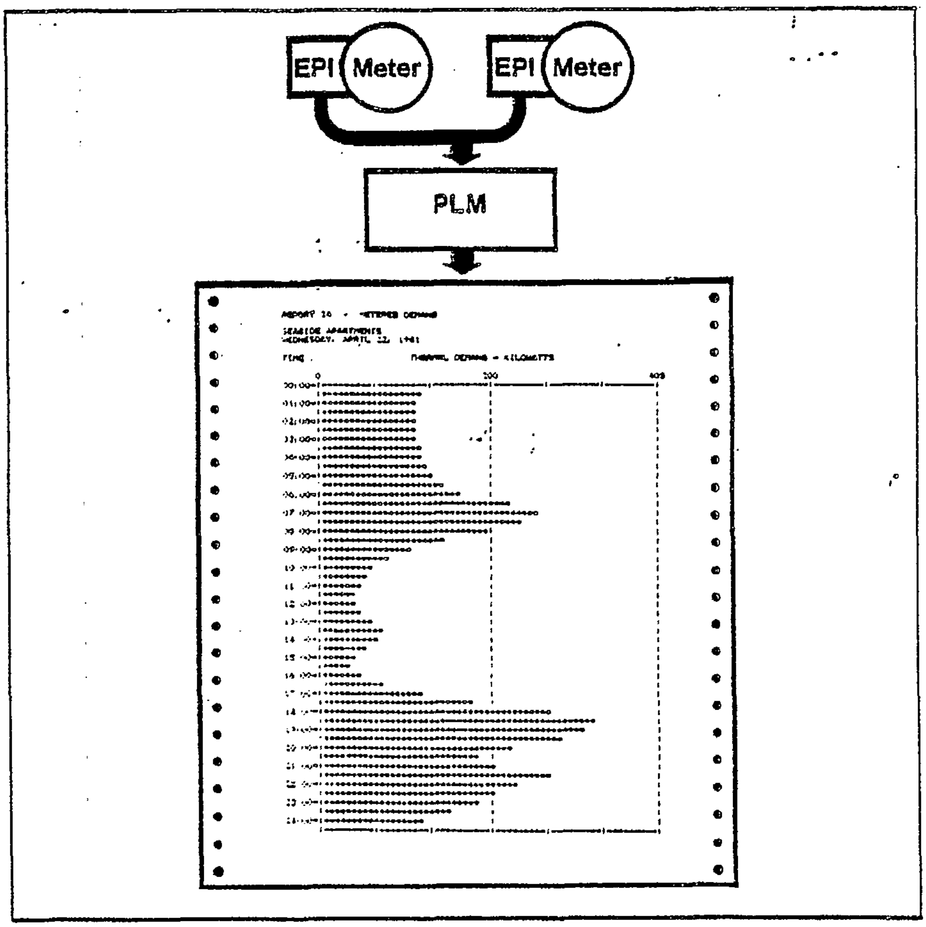
Introduction
A valuable tool for consultants involved in energy use studies, the Micronet PLM is a self contained turnkey system which can monitor and record load profiles and energy consumption from power meters. Features include ease of installation without power interruption, machine readable reports and printed reports. The system operates unattended for up to one week at a time.

Applications
- Energy use studies
- Billing verification
- Monitor and record load profiles and energy consumption from power meters

Features
- Easy to install without power interruption
- Produces a management-ready 8½ × 11 report
- Data can be formatted to user-selected requirements
- Runs unattended for up to 1 week







Specifications

Inputs

— pulse initiators inputs	2
— External Pulse Initiator supplied	1
— minimum pulse duration	.02 seconds
— maximum pulse rate	4 pulses/second
— pulse input	switch closure 100 ohms or less

Communications

Full duplex 300 baud serial communications via RS-232-C to the Portable Load Monitor, a printer and/or a computer terminal.

Power Supply

AC power	120 VAC 0.1 A 60 Hz

Temperature

Operating temperature range	0-50° C

Weight

Total MC-65 installed	8.5 Kg

Size

Outside dimensions	
Portable Load Monitor	340 × 530 × 170 mm
External Pulse Initiator	100 × 100 × 45 mm
Cable assembly	4m

Options

Extended temperature operation to -40° C
Additional External Pulse Initiator
Clip-on current transformer probe for direct input
Pulse cable assembly 8 meter extension

Exhibit V

MICRONET LIMITED
ORGANISATION CHART

PRESIDENT

P. Macaulay

MARKETING	FINANCE AND ADMINISTRATION	RESEARCH AND DEVELOPMENT	SERVICE	PRODUCTION
P Macaulay	S Wilcox	P Gregson	P Burris	G Jollimore

ADDENDUM

MBA 634/COM 434

MANAGING TECHNOLOGICAL INNOVATION AND ENTREPRENEURSHIP

This course is of particular interest to individuals seeking careers in high-technology organizations as scientists, engineers or managers. Such individuals are most effective if they understand the process of technological innovation - that is, the process whereby an R&D invention is converted into a socially useful and commercially successful product. The primary thrust of this course is an analysis of this innovation process in small and large high-technology business, including multinational corporations. It also examines government policies for stimulating technology development, particularly in the context of the Canadian "branch plant" economy and truncated technology base, with specific reference to the problems of developing a technology base in the Atlantic Provinces. M.B.A. students may take it for credit in the International Business Studies Programme.

Teaching Method: Lectures
Outside Speakers
Case Discussions.

Required Text: Draft Manuscript hand-outs of "Managing Corporate Technological Innovation and Entrepreneurship", Michael Martin, Reston Publishing Company, 1983.

Supplementary Texts:

"R&D Management Bibliography," Thomas E. Clarke, Stargate Consultants Ltd., 1981.

"The Technical Entrepreneur - Inventions, Innovations and Business" Donald S. Scott and Ronald M. Blair (Eds), Press Porcêpic Ltd., 1979.

"Readings in the Management of Innovation" Michael L. Tushman and William L. Moore, Pitman, 1982.

OUTLINE SCHEDULE

The Technological Innovation and Entrepreneurship Process

Illustrative Examples

Defining the Process - Viewing it in the context of Popper's and Kuhn's ideas on the methodology and social-psychology of science. The evolution of technologies and high-technology industries.

The Corporate Setting

Defining the technological base of the firm.

Defining and reviewing the spectrum of technological strategies available to the firm and their implications for its technological base.

Forecasting future technological markets - Technological and Social Forecasting Techniques.

Environmental and Regulative Concerns in Technological Innovation.

The R&D Setting

General Considerations - Organization, Strategic Planning & Budgetting

Creative Thinking - The Creative Process. Stimulating and Enhancing Techniques.

Project Evaluation - Revolutionary and normal innovations.

Project Selection Approaches

Project Management and Control

Project Needs and the Personal Development of R&D Staff.

The Operations Setting

Transferring the project from R&D to manufacturing. Alternative frameworks for technology transfer. Matrix Management. The Learning Curve or Technological Progress Function.

The Entrepreneurial Setting

Small is Beautiful - Technological innovation through small high technology companies. Incubator organizations and the cascade of spin-off companies in "Silicon" Valley, Route 128, and "Silicon Valley-North" (Ottawa) etc.

Entrepreneurship - The entrepreneurial process. Characteristics of entrepreneurs.

Small Business Entrepreneurship - Setting up a new high-technology business.

TECHNOLOGICAL INNOVATION STUDIES PROGRAM

PROGRAMME DES ÉTUDES SUR LES INNOVATIONS TECHNIQUES

REPORTS/RAPPORTS

1. Litvak, I.A. and Maule, C.J., Carleton University. **Canadian Entrepreneurship: A Study of Small Newly Established Firms.** (October 1971)

2. Crookell, H., University of Western Ontario. **The Transmission of Technology Across National Boundaries.** (February 1973)

3. Knight, R.M., University of Western Ontario. **A Study of Venture Capital Financing in Canada.** (June 1973)

4. Little, B., Cooper, R.G., More, R.A., University of Western Ontario. **The Assessment of Markets for the Development of New Industrial Products in Canada.** (December 1971)

5. MacCrimmon, K.R., Stanbury, W.T., Bassler, J., University of British Columbia. **Risk Attitudes of U.S. and Canadian Top Managers.** (September 1973)

6. Mao, J.C.T., University of British Columbia. **Computer Assisted Cash Management in a Technology-Oriented Firm.** (March 1973)

7. Tomlinson, J.W.C., University of British Columbia. **Foreign Trade and Investment Decisions of Canadian Companies.** (March 1973)

8. Garnier, G., University of Sherbrooke. **Characteristics and Problems of Small and Medium Exporting Firms in the Quebec Manufacturing Sector with Special Emphasis on Those Using Advanced Production Techniques.** (August 1974)

9. Litvak, I.A., Maule, C.J., Carleton University. **A Study of Successful Technical Entrepreneurs in Canada.** (December 1972)

10. Hecht, M.R., Siegel, J.P., University of Toronto. **A Study of Manufacturing Firms in Canada: With Special Emphasis on Small and Medium Sized Firms.** (December 1973)

11. Little, B., University of Western Ontario. **The Development of New Industrial Products in Canada. A Summary Report of Preliminary Results, Phase 1.** (April 1972)

12. Wood, A.R., Gordon, J.R.M., Gillin, R.P., University of Western Ontario. **Comparative Managerial Problems Early Versus Later Adoption of Innovative Manufacturing Technologies: Six Case Studies.** (February 1973)

13. Globerman, S., York University. **Technological Diffusion in Canadian Manufacturing Industries.** (April 1974)

14. Dunn, M.J., Harnden, B.M., Maher, P.M., University of Alberta. **An Investigation Into the Climate for Technological Innovation in Canada.** (May 1974)

15. Litvak, I.A., Maule, C.J., Carleton University. **Climate for Entrepreneurs: A Comparative Study.** (January 1974)

16. Robidoux, J., Garnier, G., Université de Sherbrooke. **Factors of Success and Weakness Affecting Small and Medium-Sized Manufacturing Businesses in Quebec, Particularly those Businesses Using Advanced Production Techniques.** (December 1973) (Available in French)

17. Vertinsky, I., Hartley, K., University of British Columbia. **Project Selection in Monolithic Organizations.** (August 1974)

18. Robidoux, J., Université de Sherbrooke. **Analytical Study of Significant Traits Observed Among a Particular Group of Inventors in Quebec.** (August 1974) (Available in French)

19. Little, B., University of Western Ontario. **Risks in New Product Development.** (June 1972)

20. Little, B., Cooper, R.G., University of Western Ontario. **Marketing Research Expenditures: A Descriptive Model.** (November 1973)

21. Little, B., University of Western Ontario. **Wrecking Ground for Innovation.** (February 1973)

22. Tomlinson, J.W.C., University of British Columbia. **Foreign Trade and Investment Decisions of European Companies.** (June 1974)

23. Little, B., University of Western Ontario. **The Role of Government in Assisting New Product Development.** (March 1974)

24. Cooper, R.G., McGill University. **Why New Industrial Products Fail.** (January 1975)

25. Charles, M.E., MacKay, D., The CERCL Foundation. **Case Studies of Industrial Innovation in Canada.** (February 1975)

26. Hecht, M.R., University of Toronto. **A Study of Manufacturing Firms in Canada: With Emphasis on Education of Senior Officers, Types of Organization and Success.** (March 1975)

27. Litvak, I.A., Maule, C.J., Carleton University. **Policies and Programmes for the Promotion of Technological Entrepreneurship in the U.S. and U.K.: Perspectives for Canada.** (May 1975)

28. Britney, R.R., Newson, E.F.P., University of Western Ontario. **The Canadian Production/Operations Management Environment: An Audit.** (April 1975)

29. Morrison, R.F., Halpern, P.J., University of Toronto. **Innovation in Forest Harvesting by Forest Products Industries.** (May 1975)

30. Mao, J.C.T., University of British Columbia. **Venture Capital Financing for Technologically-Oriented Firms.** (December 1974)

31. Tomlinson, J.W.C., Willie, C.S., University of British Columbia. **Guide to the Pacific Rim Trade and Economic Data Base.** (September 1975)

32. Ondrack, D.A., University of Toronto. **Foreign Ownership and Technological Innovation in Canada: A Study of the Industrial Machinery Sector of Industry.** (July 1975)

33. Mao, J.C.T., University of British Columbia. **Lease Financing for Technology Oriented Firms.** (July 1975)

34. Watson, J.A., University of Alberta. **A Study of Some Variables Relating to Technological Innovation in Canada.** (June 1975)

35. Sheehan, G.A., Thain, D.H., Spencer, I., University of Western Ontario. **The Relationships of Long-Range Strategic Planning to Firm Size and to Firm Growth (Ph.D. Thesis).** (August 1975)

36. Killing, J.P., University of Western Ontario. **Manufacturing Under Licence in Canada (Ph.D. Thesis).** (February 1975)

37. Richardson, P.R., University of Western Ontario. **The Acquisition of New Process Technology by Firms in the Canadian Mineral Industries (Ph.D. Thesis).** (April 1975)

38. Globerman, S., York University. **Sources of R & D Funding and Industrial Growth in Canada.** (August 1975)

39. Cooper, R.G., McGill University. **Winning the New Product Game.** (June 1976)

40. Hanel, P., University of Sherbrooke. **The Relationship Existing Between the R & D Activity of Canadian Manufacturing Industries and Their Performance in the International Market.** (August 1976)

41. Wood, A.R., Elgie, R.J., University of Western Ontario. **Early Adoption of Manufacturing Innovation.** (1976)

42. Cooper, R.G., McGill University. **Project Newprod: What Makes a New Product a Winner?** (July 1980) An Empirical Study. Available at $10.00/copy. Send all orders payable to: Quebec Industrial Innovation Centre, P.O. Box 6079, Station A, Montreal, Quebec, H3C 3A7.

43. Goode, J.T., University of British Columbia. **Japan's Postwar Experience with Technology Transfer.** (December 1975)

44. Knoop, R., Sanders, A., Concordia University. **Furniture Industry: Attitudes Towards Exporting.** (May 1978)

45. Peitchinis, S.G., University of Calgary. **The Effect of Technological Changes on Educational and Skill Requirements of Industry.** (September 1978)

46. Marfels, C., Dalhousie University. **Structural Aspects of Small Business in the Canadian Economy.** (May 1978)

47. Wright, R.W., University of British Columbia. **Study of Canadian Joint Ventures in Japan.** (1977)

    Tomlinson, J.W.C., Thompson, M., **Mexico.** (1977)

    Tomlinson, J.W.C., Hills, S.M., **Venezuela and Columbia.** (1978)

    Tomlinson, J.W.C., **Brazil.** (1979)

48. Chicha, J., Julien, P.A., Université du Québec. **Les Stratégies de PME et leur Adaptation au Changement.** (Avril 1978) (Available in English)

49. Vertinsky, I., Schwartz, S.L., University of British Columbia. **Assessment of R & D Project Evaluation and Selection Procedures.** (December 1977)

50. Dhawan, K.C., Kryzanowski, L., Concordia University. **Export Consortia: A Canadian Study.** (November 1978) Available at $15.00/copy. Send all order payable to: Dekemco Ltd., Box 87, Postal Station H, Montreal, Quebec, H3G 2K5.

51. Litvak, I.A., Maule, C.J., Carleton University. **Direct Investment in the United States by Small and Medium Sized Canadian Firms.** (November 1978)

52. Knight, R.M., Lemon, J.C., University of Western Ontario. **A Study of Small and Medium Sized Canadian Technology Based Companies.** (September 1978)

53. Martin, M.J.C., Scheilbelhut, J.H., Clements, R., Dalhousie University. **Transfer of Technology from Government Laboratories to Industry.** (November 1978)

54. Robidoux, J., University of Sherbrooke. **Study of the Snowmobile Industry in Canada and the Role that Technological Innovation has Played in Its Economic Performance.** (English Summary only). (Available in French)

55. More, R.A., University of Western Ontario. **Development of New Industrial Products: Sensitivity of Risk to Incentives.** (January 1979)

56. Peterson, R., York University. **A Study of the Problems Brought to the Attention of the Business Student Consulting Teams Sponsored by the Ontario Government's Small Business Assistance Programme.** (February 1979)

57. Cooper, R.G., McGill University. **Project Newprod: What Makes a New Product a Winner?** (July 1980) An Empirical Study. Available at $10.00/copy. Send all order payable to: Quebec Industrial Innovation Centre, P.O. Box 6079, Station A, Montreal, Quebec, H3C 3A7.

58. Farris, G.F., York University. **Comments on the Course: Management of Creativity and Innovation.** (February 1979)

59. Smith, J.G., McGill University. **The Renewable Energy Business Sector in Canada: Economic Prospects and Federal Government Initiatives.** (May 1979)

60. Tomlinson, J.W.C., University of British Columbia. **Cross Impact Simulation of the Joint Venture Process in Mexico.** (December 1978)

61. Grasley, R.H., York University. Dermer, J.D., University of Toronto. **The Status of Innovation in the Strategies of Larger Canadian Corporations.** (March 1979)

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63. Scott, D.S., Blair, R.M., University of Waterloo. **The Technical Entrepreneur. Inventions, Innovations & Business.** (1979) Available at $18.95/copy. Send all orders payable to: Fitzhenry & Whiteside Limited, 150 Lesmill Road, Don Mills, Ontario, M3B 2T5.

64. Kolodny, H.F., University of Toronto. **Sociotechnical Study of Productivity and Social Organization in Mechanical Harvesting Operations in the Canadian Woodlands.** (May 1979)

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69. Peitchinis, S.G., University of Calgary. **Technological Changes in Banking and their Effects on Employment.** (January 1977)

70. Clarke, T.E., Laurie, G., Peterson, R., Pieczonka, W.A., TIME. **Proceedings of the T.I.M.E. (Technological Innovation Management Education) for Canada Workshop.** (September 29 & 30, 1979)

71. Palda, K., Pazderka, B., Queen's University. **Background to a Target: An International Comparison of the Canadian Pharmaceutical Industry's R & D Intensity.** (July 1980)

72. Kirpalani, V.H., Concordia University. MacIntosh, N.B., Queen's University. **Small Firm International Effectiveness: An Exploratory Survey.** (June 1980)

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78. Peitchinis, S.G., University of Calgary. **The Introduction of Computer-Aided Design/Computer-Aided Manufacturing CAD/CAM Systems and their Employment Implications.** (September 1980)

79. Hewitt, G.K., Concordia University. **R & D in Selected Canadian Industries: The Effects of Government Grants and Foreign Ownership.** (January 1981)

80. Litvak, I.A. and Maule, C.J., Carleton University. **Entrepreneurial Success or Failure - Ten Years Later. A Study of 47 Technologically Oriented Enterprises.** (October 1980)

81. Adams, P.F., University of Alberta. **Development of a course: "Initiation of Technology Based Enterprises".** (April 1981)

82. Meincke, P.P.M., University of Prince Edward Island. **A Preliminary Study to Determine the Feasibility of Establishing an Industrial Innovation Centre on Prince Edward Island.** (March 1981)

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91. Plowright, T., Institute for Research on Public Policy. **Computer Learning: A Study of the Policy Environment for Computer Learning and its Effects on Industry.** (July 1983)

92. Crozier, J.E., Assisted by: Kyles, S., Canadian Institute of Metalworking, McMaster University. **A Study to Identify the Manpower Requirements for the Effective Utilization of an Interactive Graphics Design Drafting and Manufacturing System.** (December 1983)

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Office of Industrial Innovation
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