DCIEM Technical Report No. 76-X-52

EVALUATION OF DIVER'S BREATHING HOSE

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DEFENCE AND CIVIL INSTITUTE OF ENVIRONMENTAL MEDICINE
INSTITUT MILITAIRE ET CIVIL DE MEDECINE DE L'ENVIRONNEMENT

DEPARTMENT OF NATIONAL DEFENCE — CANADA

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DEPARTMENT OF NATIONAL DEFENCE - CANADA

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ABSTRACT

The Canadian Forces established a requirement for diver's breathing hose for use with the Kirby Morgan Band Mask (Model 9) for introduction into the Canadian Forces supply system.

This report covers the evaluation of the most suitable hose available for use with the above mentioned diving equipment utilizing various breathing mixtures of compressed air, oxygen or heliox to a maximum depth of 300 fsw.

EVALUATION OF DIVER'S BREATHING HOSE

SECTION 1

INTRODUCTION

General

DCIEM was tasked by National Defence Headquarters, Directorate of Maritime Equipment Engineering, to determine a suitable diver's breathing hose for use with the Kirby Morgan Band Mask KMB-9. To achieve this, the task was divided into three phases: the statement of requirement phase; the market survey phase; and the evaluation phase.

Statement of Requirement

The following is the statement of requirement for KMB-9 Diver's Breathing Hose, capable of:

(1) supplying compressed air to a maximum depth of 250 fsw through a 400-ft umbilical for all diver work rates.

(2) supplying helium/oxygen mixtures to a maximum depth of 300 fsw through a 400-ft umbilical for all diver work rates.

(3) supplying oxygen to a maximum depth of 50 fsw through a 400-ft umbilical for a resting diver work rate.

(4) being used in water temperatures ranging from -2°C to 30°C and in currents up to 3 kts.

(5) being exposed to and withstanding surface temperatures ranging from -30°C to 45°C, and being in contact with oil and marine contaminants.

SECTION 2

SELECTION AND DESCRIPTION

Specifications

To select a suitable diver hose for evaluation, a survey was conducted of Canadian hose suppliers, commercial diving companies, and the United States Navy.

The results of the survey were that the U.S. Navy Mil Spec for diver hose cannot be met by any existing commercial hose. However, the Gates type C3 SAE 100 R3 and type 19-HB were the most suitable. It is possible that the U.S. Navy military specification may require re-defining in light of this fact. Commercial diving companies, by and large use Gates type C3 SAE 100 R3 hose.

In the course of the market survey, a number of interesting points came to light:

(1) the majority of hose manufacturers do not cater specifically to the needs of the diving industry because of the limited market. The Gates C3 hose is the only hose specifically designated as diver hose.

(2) Due to recent labour problems in the rubber industry, diver hose was scarce and in heavy demand.

In view of the fact that SAE 100 R3 hose was available from most Canadian manufacturers, samples of SAE 100 R3 hose were acquired from Gates, Aeroquip, Imperial Eastman and U.S. Divers Co., for evaluation. The Gates Company was the only company with sufficient stock to supply 400-ft umbilicals.

Hose Description

Gates

Available from Gates Rubber of Canada Ltd., 300 Henry Street, Brantford, Ontario, N3T 5R6. (Tel: 519) 759-4141.

Type: 6C3 2-fiber braid hose - SAE 100 R3.

Specification: 6C3, 3/18" i.d. .75" o.d. Maximum working pressure: 1,125 psi. Minimum burst pressure: 4,500 psi. Min. bend radius 4". Wt. per ft. 0.18 lb/ft.

Recommended for: Hydraulic oil lines, anti-freeze solutions or water. Also recommended for diver's air supply hose.

Tube: Black, synthetic rubber.

Reinforcement: Two-fiber braids.
Cover: Black, oil and abrasion resistant synthetic rubber.

Temperature Range: -40°F to +200°F.

Aeroquip

Available from Aeroquip (Canada) Ltd. 287 Bridgeland Avenue, Toronto, Ont. M6A 1Z7. (Tel: (416) 789-1831.

Type: 2583-6 SAE 100 R3 ZQ74.

Specification: 3/8" i.d. 3/4" o.d. Maximum working pressure: 1,125 psi. Minimum burst pressure: 4,500 psi. Minimum bend radius: 4".

Tube: Synthetic rubber.

Reinforcement: Two-fiber braids.

Cover: Synthetic rubber.

Temperature range: -40°F to +200°F.

Imperial Eastman

Available from Imperial Eastman Corporation (Canada) Limited, Barrie, Ont.

Type: D1 non-skive hose SAE 100 R3.

Specification: D106, 3/8" i.d. 3/4" o.d. Maximum working pressure: 1,125 psi. Minimum burst pressure: 4,500 psi. Minimum bend radius: 4".

Recommended for: Medium pressure hydraulics, machine tools, plant equipment, pneumatics.

Tube: Synthetic rubber.

Reinforcement: Two-rayon braid.

Cover: Synthetic rubber.

Temperature range: -40°F to +200°F.

U.S. Divers

Available from Argosy Sports Limited, 239 Station Street, Ajax, Ont. (or any other U.S. Divers equipment distributor).

Type: C4001-00 diver's air hose.

Specification: .375 ± .025" i.d. .750 ± .031" o.d. Maximum working pressure: 1,125 psi.

Tube: Non-toxic, synthetic rubber, impervious to oxygen, helium and nitrogen gas mixtures.

Reinforcement: Two layers of vertical braid, high tensile, synthetic textile fabric.

Cover: Black synthetic rubber, resistant to abrasion, cutting, weathering oil and grease.

Fitting Description

In the selection of hose fittings, the criteria used was to have fittings which could be used to the maximum working pressure of the hose and easily fitted or repaired in the field with minimum equipment and personnel training. The fittings which best meets this criteria is a barb fitting secured with clamps.

The made up hose assembly and fittings are shown in Annex B. With the exception of the barb, which has been lengthened so that three clamps could be used for a more positive attachment to the hose, all other parts are readily available from the distributors noted. The modified barb fitting can be manufactured locally in accordance with specifications laid down in DCIEM's Technical Service Drawing CDTD 10019 - 3/8" I.D. Umbilical Hose Assembly.

Further reference to the fittings may be found in Section 3 of this report.

SECTION 3

EVALUATION

General

The Institute purchased various lengths of diver's hose from the four Canadian manufacturers and conducted toxicological analysis of the respective hoses to determine whether any of them met the required specifications. The Gate type 6C3 2-fiber braid hose SAE 100 R3 was finally selected and subjected to additional tests.

Toxicological Evaluation

The detailed toxicological evaluation of subject hoses is outlined in DCIEM Report 76-X-46, "TRACE CONTAMINANT DETECTION FROM DIVER'S HOSE" Madill H.D. and Burgess W.R.

Breathing Simulation Machine Evaluation

Due to mechanical problems with the Breathing Simulation Machine this aspect of the evaluation was not undertaken. However, subjective evaluations demonstrated that the parameters oulined in Section 1 of this report were met or exceeded by Gates Type 6C3 SAE 100 R3 hose.

Pressure and Gas Compatability Test

The pressure and gas compatibility requirements outlined in Section 1 were met by the Gate 6C3 SAE 100 R3 hose. The subject hose was pressurized to 1000 psi for a period of 48 hours with both compressed air and a 80/20 helium/oxygen mixture without any appreciable drop in pressure. No gas permeation through the Gates hose outer casing was observed. The 400-ft umbilicals were operationally used during the Franco/Canadian Accord "Cold Water" dives conducted in April 1975, to a depth of 300 feet for 60 minutes bottom time in $0^{\circ}C$ water utilizing an HeO_2 mix. Likewise the umbilicals were utilized during "Cold Diver II" held in Halifax, N.S. during October 1975. The depth limitations on this occasion were 250 feet using a heliox breathing mix. In-house tests also demonstrated that the requirements of section 1 could be achieved utilizing Gates type 6C3 SAE 100 R3 hose. Adequate pressure was available to meet all diver work-rate requirements when supplied through a 400-ft umbilical to a diver/divers at 300 feet.

Strain Test

The hose and fittings were subjected to an excessive amount of strain to determine if:

(1) the longer barb fittings as fabricated by CDT & DU provided a positive enough attachment to the hose should the fittings ever be subjected to an excessive amount of weight.

(2) the hose could function as its own strength member if used in an umbilical package in which a lifeline was not included.

In order to carry out this test, a 4-ft section of hose was made up, complete with fittings and pressurized to 1000 psi. The pressurized assembly was then subjected to a dead weight of 300 lbs. with the strain being centered on the fittings. The test position was held for 10 minutes and the hose assembly was observed throughout this period. During this time, there was no pressure loss from the hose assembly, and no obvious signs of any dislodgement to any of the fittings. During the test, the hose section stretched approximately 6 inches but returned to its normal length upon the weight being removed.

In view of the stretch characteristics of the hose subjected to an excessive amount of weight, it should never be used in an umbilical package without a lifeline as a strength member.

SECTION 4

CONCLUSIONS

The Gates type 6C3 2-fiber braid hose SAE 100 R3 met all the specifications outlined in Section 1 of this report. DCIEM Report 76X46 "TRACE CONTAMINANT DETECTION FROM DIVER'S HOST" Madill H.D. and Burgess W.R. outlines the toxicological problems related to the Canadian product and DCIEM has advised the parent company of the side effects of toluene to divers when exposed to elevated levels for long or short periods.

On conclusion of this Unit's evaluation of the diver's breathing hose, four 400-ft hose assemblies were made up and shipped to the respective Fleet Diving Units, in accordance with NDHQ (DMEE) instructions. The respective units were requested (via our CDT & DU 73 201600Z Aug 75) to conduct further operational field evaluations in the areas of suitability, compatibility with the marine environment and problems of gas permeation.

In the absence of Fleet Diving Units' comments or recommendations, it can be construed that this Institute's findings are concurred with regarding the suitability of the Gates type 6C3 fiber braid hose SAE 100 R3 for Canadian Forces use.

It is further concluded that although all SAE 100 R3 hoses may meet the same specifications for commercial use (i.e. hydraulic application, etc.) it may not necessarily meet the specification for use as diver's breathing hose.

RECOMMENDATIONS

The following recommendations are submitted with respect to diver's hose to be utilized with the Kirby Morgan Band Mask (Model 9):

(1) that Gates Type 6C3 (3/8" i.d.) 2-fiber braid hose SAE 100 R3 be procured for introduction into the Canadian Forces supply system.

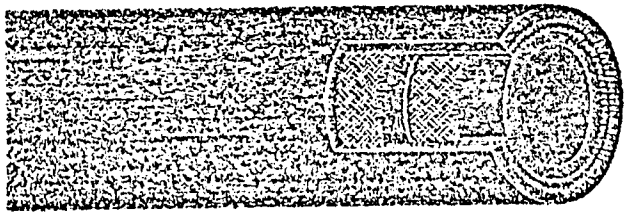
(2) that until such time as the Canadian manufacturer has lowered the toluene content in the manufacturing process of the subject hose that the Contract Demand emphatically specifies the U.S. manufactured product. In addition, a sample from each lot acquired be toxicologically analyzed for trace contaminants at DCIEM.

(3) that the barb fittings shown in DCIEM drawing CDT & D 10019 be approved for use with subject hose.

(4) to avoid unnecessary strain on the barbed fittings or hose, a separate strength member 3/8" polyproplene lifeline be married to any umbilical hose package utilizing the Gates type 6C3 hose.

(5) that the recommendations of DCIEM Report 76X46 "TRACE CONTAMINANT DETECTION FROM DIVER'S HOSE" Madill H.D. and Burgess W.R. are concurred with for implementation.

Type C3 2-Fiber Braid Hose – SAE 100R3



Recommended For: Hydraulic oil lines, antifreeze solutions, or water. Meets or exceeds requirements of SAE 100R3. Also recommended for diver's air supply hose.

Tube: Black, synthetic rubber.

Reinforcement: Two fiber braids.

Cover: Black, oil and abrasion resistant, synthetic rubber.

Temperature Range: –40°F. to +200°F.

SPECIFICATIONS

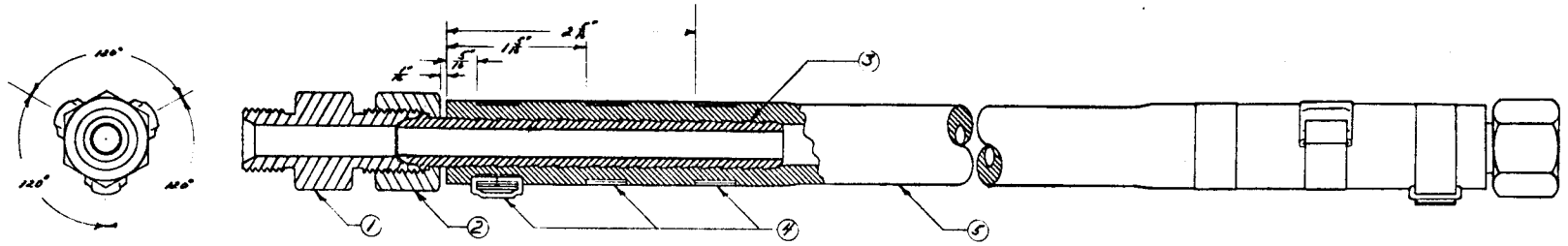
DNB Part No.	Catalog No.	Product No.	Hose I.D. (in.)	Hose O.D. (in.)	Rated Work Pres. (psi)	Min. Burst Pres. (psi)	Min. Bend Rad. (in.)	Wt. Per Ft. (Lbs.)	R.S. Ferrule (Prod. No.)
70112	4C3	3319-0021	¼	.56	1,250	5,000	3	0.11	7266-0034
70114	6C3	3319-0031	⅜	.75	1,125	4,500	4	0.18	7266-0032
70115	8C3	3319-0041	½	.94	1,000	4,000	5	0.28	7266-0033
70116	12C3	3319-0051	¾	1.25	750	3,000	6	0.44	7266 0014
70117	16C3	3319-0061	1	1.50	565	2,250	8	0.55	7266 0013
–	–	–	1¼	1.75	,375	1,500	10	0.64	7266-0022

COUPLINGS

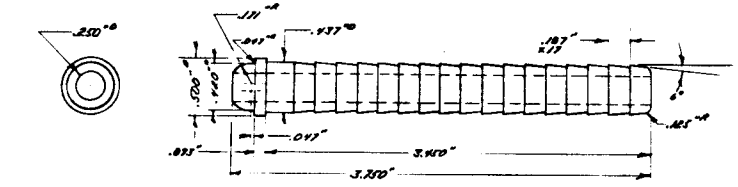
Permanent—Stems and RS Ferrules ..... Pages 20-28
Reusable—Page 31

ANNEX A

Gates Type C3 2-Fiber Braid Hose - SAE 100 R3



CLAMP POSITIONS



Note TOLERANCE ON DIMENSIONS ±.005

BARB MATL BRASS

ITEM

1. COUPLING: OXYGEN - Size 3/8"-18 Tpm. FAIRVIEW STOCK No. 165-R. Manu. BRASS
2. NUT-OXYGEN-Size 3/8"-18 Tpm. FAIRVIEW STOCK No. 137-R. Manu. BRASS
3. BARB-HOSE-AS SHOWN Manu. BRASS
4. CLAMP: 3/8" I.D. x 1/2" WIDE-PRE-FORMED BAND-IT CAT. No. 3401-Manu. 316 STAINLESS STEEL
5. HOSE-3/8" I.D. x 3/8" OD-GATES TYPE C3 2-FIBER BRAID HOSE-SAE 100R3 Cat. No. 625
6. NOT SHOWN BAND-IT POK-KIT TOOL BAND-IT Cat. No. J102 TO INSTALL CLAMPS

DISTRIBUTERS

ITEM 1&2 FAIRVIEW FITTINGS & MANUFACTURING Ltd. 1316 CLARK DR. VANCOUVER BC. DIEPPE INDUSTRIAL PARK MONCTON NEW BRUNSWICK

ITEM 4,5,6 CHARLES JONES INDUSTRIES ARVIN INC STONEY CREEK ONTARIO

DEFENCE AND CIVIL INSTITUTE OF ENVIRONMENTAL MEDICINE 1133 Sheppard Avenue West P.O. Box 2000 Downsview, Ontario			
Drawn by RF	3/8" I.D. UMBILICAL HOSE ASSY. 9/16-18 OXX ON BOTH ENDS		
Traced by			
Checked by			
Approved by	Scale 2"=1"	Date 9-6-85	Drawing number CDTD 10019

ANNEX B

DCIEM Drawing No. CDTD 10019

3/8" I.D. UMBILICAL HOSE ASSY.