LLOYDS REGISTER AND MARA ENGINEERING REPORTS AND CLEANING PROCEDURES USING BIOX '02' IMMERSION FLUID

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N.B. Reports enclosed within the data pack are verified copies of the originals which are kept at our head office, and are available on request.

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FAO : Gordon S Harvey

Your ref P1885-CO-167

Date 4 September 1991

Dear Sir,

CHIRYU DIVING SYSTEM

We acknowledge receipt of your above referenced letter, dated 2 August 1991 in connection with the above.

We are pleased to advise that Documents PI885-SP-022 Issue 1 Rev 0 Rev 1have been approved.

The whole of the 'work is to be carried out to the Surveyor's satisfaction.

One copy of the Document No. P1885-SP-022 Issue 1 Rev 0 is returned herewith, the single copy of Rev 1 has been retained for record purposes, should you require approved copies, then further documents should be submitted.

Yours faithfully,

Area Manager

Encl.

MARA ENGINEERING LTD

EXAMINED & APPROVED
for compliance with the Rules
& Reg
Subm g Systems
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SPECIFICATION FOR

TESTING AND COMMISSIONING

GAS AND LIFE SUPPORT PIPE WORK

CONTENTS

GAS AND LIFE SUPPORT PIPE WORK PROCEDURE FOR
TESTING AND COMMISSIONING

All gas pipes are linked in such a way so as to provide easily tested and cleaned sub-assembles. The pipes are filled with potable water via a filter system. Open pipe ends are closed off.

A hydrostatic test pressure of 1.5 times the design pressure is applied for a period satisfactory to the surveyor. During this pipes and fittings are examined for integrity.

Some pipes having a test pressure equal to or less than 15 bar pressure tested using air.

After completion of appropriate hydrostatic testing the pipe system are flushed clean by using the re-circulation filtration method detailed in Appendix 1. This does not apply to water/drain lines etc.

Pipe systems intended for use with gas containing high levels of oxygen (i.e. systems having an oxygen content greater than 25%) are further cleaned by the method detailed in Appendix 2.

On completion of satisfactory cleaning, the pipes are reconnected to their respective system. A gas pressure leakage is completed on each gas pipe.

The method of testing gas pipe work is as follows :-

Using dry clean air each pipe in turn is pressurised to 50% of maximum working pressure. Each pipe joint is checked for leakage with the use of a proprietary leak detection agent e.g. SNOOP.

The pressure within the pipe is increased to the maximum working pressure and is rechecked for leaks. If the pipes being tested are not to be used for helium or heliox then this gas pressure test is completed using air only. A pressure drop of 0.5% per 12 hours should not be exceeded, taking into account any temperature The duration of this test should be at least one hour.

Helium or heliox lines are only checked for air leakage with SNOOP at this stage. For pipes which are to be used for helium or heliox the following procedure is used:-

Air pressure within the pipe is reduced to 80% of the maximum pressure, the pressure is then returned to the maximum pressure using pure helium gas and is again checked for During this leak test a pressure drop of 0.5% per 12 hours should not be exceeded, taking into account any temperature change. The duration of this test should be at least one hour.

Open ended vent lines in practice are not subject to any significant differential pressure. They are given a nominal design. pressure in order to size the pipe scantling for practical in service use and are carefully constructed to good working practices. The hydrotest, cleaning and gas pressure tests mentioned above do not apply to these lines. They do however require to be visually examined under operational conditions to ensure than no leakages or physical damage is present and signed off accordingly.

Water and hyperbaric hydraulic lines are to be hydrostatically tested to 1.5 x the Design Pressure. This pipe work may be sufficiently cleaned by hand prior to final assembly, in which case no further cleaning procedure is required after the hydrotest (discuss and agree individual cases with the local certifying authority surveyor). Open ended drain lines only require to be visually examined under operational conditions to ensure that no leakages or physical damage is present and signed off accordingly.

APPENDIX 1

FLUSHING PROCEDURE FOR GAS AND LIFE SUPPORT (<25% OXYGEN) PIPES

EQUIPMENT REQUIRED FOR CLEANING PIPE SYSTEM

A. Biox 02 Liquid / water solution 1:4
B. Pressure pump (minimum flow rate of 40 litres/min.) with in-line filtration to 10 micron.
C. Spare filter elements for the above.
D. Compar particle comparison sampling unit.
E. Compar comparison slides and microscope.
F. Lint free cleaning tissue.
G. A clean tool kit.
H. Pipe identification markers.
I. Flushing samples records book.
J. Miscellaneous interconnection hoses and fitting adaptors.
K. Spare field sample monitor kits.
L. Plastic fluid containers.

METHOD OF FLUSHING PIPES

On completion of hydrostatic testing individual pipes are linked into a series of sub-assemblies. Smaller diameter pipes are not linked with 3/4" or larger diameter pipes. Pipes above 1" internal diameter should be flushed using a proportionally larger pump flow rate (in proportion to internal cross sectional area).

The pipe system is filled with potable quality water. One end of the system is connected to the pressure pump discharge whilst the other free end is connected to the filtration unit inlet. The discharge of the filtration unit is coupled to a header tank containing the Biox 02 Liquid /water solution. The pressure pump continually draws from this header tank.

A mixture of Biox 02 Liquid to water in the ratio of 1:4 is required.

The pump is run for a short period to ensure that the Biox 02 Liquid solution is distributed throughout the pipe system. The system is then left to 'soak' for 15 minutes.

The pressure pump is again run for a period of 45 minutes to circulate the Biox 02 Liquid solution via the filtration pack.

After this time the Biox 02 Liquid solution is blown from the pipes and back into its tank using clean, dry air. Potable water is then pumped through the pipes to remove any remaining droplets of Biox 02 Liquid solution.

Complete removal of Biox 02 Liquid from the system is tested by comparison of the supply and system discharge water PH values.

The flushing out of the system in this way is continued until the difference in PH value is less than 1 PH.

The pipeline assembly is then returned to the 'closed loop' condition and flushing continued using potable water, via the filtration pack, for a minimum of 1 hour.

Samples of the system fluid (water) are taken after this time and inspected for particle content. The Compar comparison system is used and flushing is continued until the correct Compar standard is established in accordance with the list below. (See Appendix 3 for Compar Table)

Compar 4 - All breathing air or mixed gas systems.
Compar 6 - All hydraulic pipeline systems.
Compar. 9 - Miscellaneous potable water systems.

All fluid samples taken are noted in a samples book and given an appropriate identification number.

When the pipe system reaches the required cleanliness standard the water is blown from it using clean air or nitrogen until dry.

On completion of the above, the individual pipes within the flushed circuit are blanked off or reconnected into the appropriate part of the system.

For cleaning oxygen pipes or Heliox mixture pipes having an oxygen content in excess of 25%, additional cleaning is required. (See Appendix 2)

APPENDIX 2

FLUSHING PROCEDURE FOR OXYGEN AND ENRICHED MIX (>25% OXYGEN)

SERVICE PIPES

EQUIPMENT REQUIRED

A. Equipment as listed in Appendix 1.
B. Biox 02 Liquid / water solution 1:4 kept specifically for this task in a heated tank (approximately maintained at 60 C.) and filtered to Compar 4 standard.
C. Inert Gas - Nitrogen, certified clean to medical standards.
D. Distilled water kept specifically for this task in a tank and kept filtered to Compar 4 standard.

METHOD OF FLUSHING OXYGEN AND RICH MIX PIPES

On completion of flushing the pipes as detailed in Appendix 1, the pipes for oxygen service are reconnected to the pressure pump and hot Biox 02 Liquid / water tank in the same way. Preferably they are kept connected and the adjustment made by using a valved manifold system.

The pipe system is then filled with the hot Biox 02 Liquid / water via a dedicated 10 micron filter. The hot Biox 02 Liquid / water is then circulated via the pressure pump and filter in a 'closed loop' arrangement for a minimum of 30 minutes.

The hot Biox 02 Liquid / water is then blown out of the pipe system and back into the tank using a clean inert gas.

Distilled water is then pumped through the pipe system for 15 minutes to remove droplets of the Biox 02 Liquid / water solution. The PH value should be less than 1 and the distilled water discarded when it is above this.

The distilled water is then blown out of the pipe system and back into the tank using a clean inert gas.

On completion of the above, each pipe is blanked off or reconnected into the appropriate part of the system.

RELATIVE RAPIDITY OF BIOX 02 LIQUID EFFECT AT DIFFERENT TEMPERATURES

TEMPERATURE DECREES C.	RELATIVE EFFECT
O5	0%
10	4%
20	10%
30	20%
40	35%
50	55%
60	95%
70	100%

As in all chemical reactions temperature is of great importance for the rapidity of the process.

In practice the lowest temperature recommended is +10 C.

The liquid can be warmed even up to 70 C. where the time of treatment is cut down to 1/10 compared with a treatment at 20 C.

COMPAR CLEANLINESS STANDARDS

CONTAMINATION LEVEL CLASSES FOR FLUID SYSTEMS

PARTICLE SIZE

CLASS	>100	50-100	25-50	15-25	10-15	5-10	1-5	PARTICLE COUNT
							times 1000	TIMES 1000
1	7	15	94	294	701	1617	30.88	336.1
2	7	15	104	370	1810	22320	420.00	444.6
3	7	15	133	529	3677	50050	850.61	915.0
4	22	51	439	1744	12137	165188	2840.0	3019.6
5	32	89	820	3480	29143	450681	8568.0	9052.4
6	43	128	1220	5220	42181	714240	14280.0	15043.0
7	47	147	1415	6090	50142	857088	17186.0	18051.2
8	57	185	1805	7830	67240	1142784	22848.0	24067.0
9	68	224	2196	9870	84051	1428480	27720.0	29244.6

Count per 100 ml sample volume