Annex A

Samson self-operated pressure regulator information sheet

Self-operated Pressure Regulators

Back Pressure Valve Type 41-73 • Valve **opens** when upstream pressure rises

SAMSON

Application

Type 41-73 Back Pressure Valves regulate the fluid pressure upstream of the valve to a pre-adjusted set point value.

Set points from **0.075 psi to 400 psi** (5 mbar to 28 bar)
Nominal valve sizes ½" to 4"
Pressure ratings ANSI 125 to 300
For liquids, gases and steam up to **660 °F** (350 °C)

The regulators consist of a Type 2417 valve with a Type 2413 actuator complete with set point adjustment.

Features

- Low-maintenance, medium-controlled, self-operated proportional regulators requiring no auxiliary energy
- Easy set point adjustment at the valve
- Field retrofit of actuator for simple change of set point range
- No packing - stainless steel bellows provides zero-leak and frictionless plug stem seal
- Spring-loaded, single-seated valve with upstream and downstream pressure balancing by means of a stainless steel bellows
- Plug with soft seal for high sealing requirements
- Low-noise standard plug – special version with a St I flow divider for further noise level reduction (see Data Sheet T 8081)
- All wetted parts are free of non-ferrous metal
- Control line kit available as accessory for direct pressure tapping at the valve body

Fig. 1 · Type 41-73 Back Pressure Valve

Standard version

Type 2417 Valve with Type 2413 Control Actuator

- Sizes ½" to 4"
- ANSI Class 125 to 300
- Body made of ASTM materials cast iron A 126 Cl. B, cast carbon steel A 216 WCB or cast stainless steel A 351 CF8M
- Type 2413 Actuator with EPDM rolling diaphragm
- Plug with metal sealing

Options

- **Low range pressure reducing valve** (only ½" to 2") for pressure set point values from 0.075 to 0.75 psi (5 to 50 mbar)
- **Condensation chamber** for steam and liquids to 650 °F (350 °C)
- **Safety back pressure valve** with leakage line connection and sealing or two diaphragms and diaphragm rupture indicator
- **Control line kit** for pressure tapping at the valve body
- **FKM diaphragms** for oils (ASTM I, II, III)
- **EPDM diaphragms** with PTFE protective foil
- **Actuator for remote adjustment** of set point (autoclave control)
- **Bellows actuator** for valves up to 2" · Set point ranges 75 to 145, 145 to 320, 290 to 400 psi (5 to 10, 10 to 22, 20 to 28 bar); bellows housing made of either AISI 304, AISI 316Ti or St 37.2, bellows made of AISI 316Ti
- **Valve with St I flow divider** for particularly low-noise operation with gases and steam
- **Stainless steel seat and plug with PTFE soft sealing** (max. 430 °F (220 °C)) · With EPDM soft sealing (max. 300 °F (150 °C))
- **Free of oil and grease** for super-clean applications
- **Seat and plug armoured** for better wear

For **DIN version** see Technical Data Sheet T 2517 EN

Principle of operation (see Fig. 2)

The medium flows through the valve (1) as indicated by the arrow. The position of the valve plug (3) and hence the free area between the plug and seat (2) determine the flow rate. The plug stem (5) with the plug is connected to the stem (11) of the actuator (10).
To control the pressure, the operating diaphragm (12) is tensioned by the positioning springs (7) and the set point adjustment nut (6) so that the valve is opened by the force of the positioning spring when both pressures are balanced ($p_1 = p_2$).
The upstream pressure p_1 to be controlled is tapped upstream of the valve and transmitted via the control line (14) to the operating diaphragm (12) where it is converted into a positioning force. This force is used to adjust the valve plug (3) according to the force of the positioning springs (7) which is adjustable at the set point adjustment nut (6). When the force resulting from the upstream pressure p_1 rises above the adjusted set point, the valve opens proportionally to the change in pressure.
The fully balanced valves are equipped with a balancing bellows (4). The downstream pressure p_2 acts on the inner bellows surface, whereas the upstream pressure p_1 acts on the outer surface of the bellows. In this way, the forces produced by the upstream and downstream pressures acting on the plug are balanced.
The valves can be delivered with an St I flow divider. The valve seat must be exchanged if the flow divider is retro-fitted.

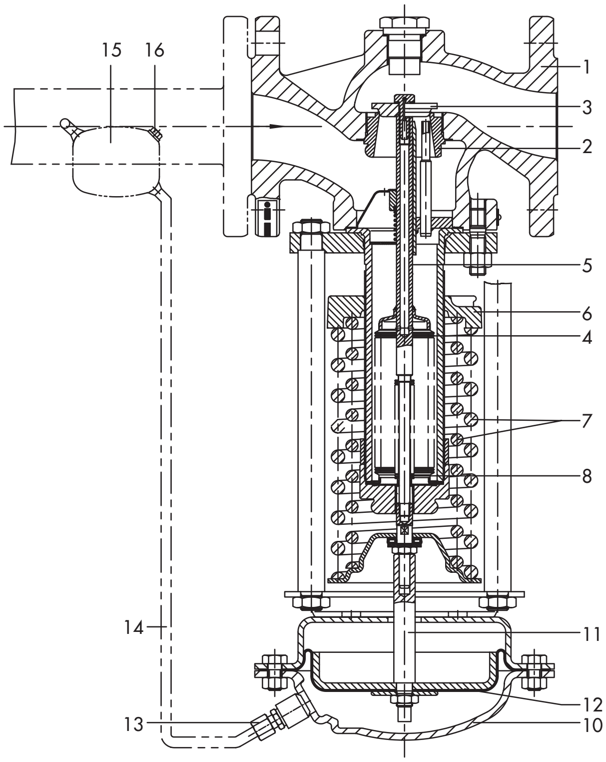
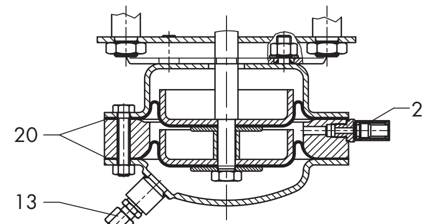
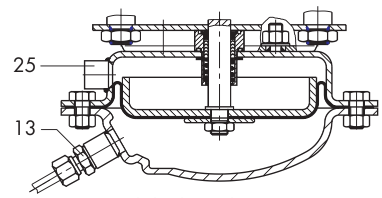


Fig. 2.1 · Type 41-73 Back Pressure Valve, principle of operation



Actuator with two diaphragms and diaphragm rupture indicator

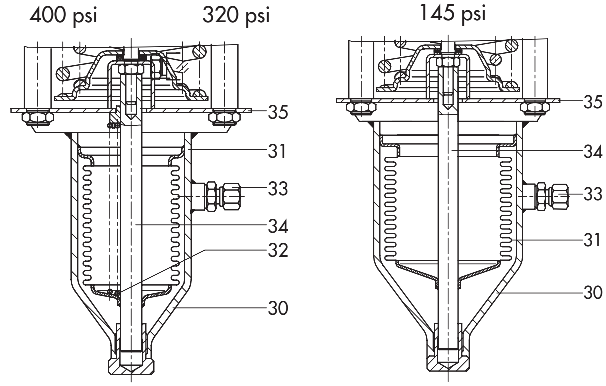


Actuator with leakage line connection

For 290 to 400 psi

For 145 to 320 psi

For 75 to 145 psi

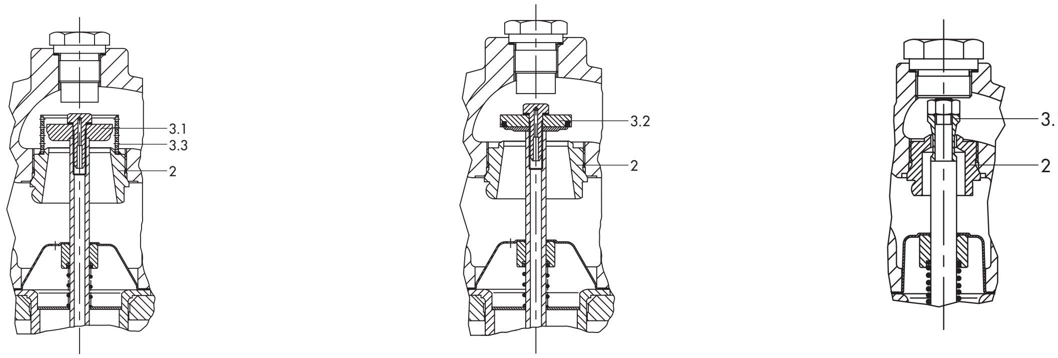


Metal bellows actuator (only for valves up to 2")

Fig. 2.2 · Type 2413 Actuators, different versions

1 Valve body Type 2417
2 Seat (exchangeable)
3 Plug (with metal sealing)
4 Balancing bellows
5 Plug stem
6 Set point adjustment nut
7 Positioning springs
8 Bellows seal
10 Type 2413 Actuator
11 Actuator stem
12 Operating diaphragm with diaphragm plate
13 Control line connection $\frac{3}{8}$"
(screw joint with restriction)
14 Control line
15 Condensation chamber
16 Filler plug
20 Two diaphragms
21 Diaphragm rupture indicator
25 Leakage line connection $\frac{1}{2}$"
30 Metal bellows actuator
31 Bellows with lower part of body
32 Additional springs
33 Control line connection $\frac{3}{8}$"
34 Bellows stem
35 Bracket

Fig. 2 · Type 41-73 Back Pressure Valve



Plug with metal sealing, with St I flow divider

Plug with soft sealing

Valve for small flow rates - $C_V \leq 1.2$ - without balancing bellows

2 Seat
3.1 Plug with metal sealing
3.2 Plug with soft sealing
3.3 Flow divider

Fig. 3 · Type 41-73 Back Pressure Valve, trim versions

Table 1 · **Technical Data** · All pressures in psi and bar (gauge)

Valve		**Type 2417**		
Pressure rating		ANSI 125	ANSI 250	ANSI 150 and 300
Nominal size		1″ to 4″	½″ to 2″	½″ to 4″
End connection		Flat face flanges	Female NPT thread	Raised face flanges
Temperature range		See Fig. 4 · Pressure-Temperature Diagram (according to ANSI B16 series)		
	Valve plug	Metal sealing, max. 660 °F (350 °C) Soft sealing, PTFE, max. 430 °F (220 °C) Soft sealing, EPDM, max. 300 °F (150 °C) Soft sealing, NBR, max. 140 °F (60 °C)		
Max. perm. diff. pressure	½″ to 2″	360 psi (25 bar)		
	2½″ to 3″	290 psi (20 bar)		
	4″	230 psi (16 bar)		
Leakage rate		Metal sealing: Leakage rate ≤ 0.05 % of K_{VS} value Soft sealing: Leakage rate Class IV		
Terms for control valve sizing according to ISA S75.01 and S75.02		$F_L = 0.95$ $X_T = 0.75$		
Actuator		**Type 2413**		
Set point ranges		0.075 to 0.3 psi 1) 2) 0.15 to 0.3 psi 1) 0.375 to 0.5 psi 1) 1.5 to 8.5 psi 3 to 18 psi 10 to 35 psi 30 to 75 psi 65 to 145 psi 115 to 230 psi		5 to 30 mbar 1) 2) 10 to 30 mbar 1) 25 to 50 mbar 1) 0.1 to 0.6 bar 0.2 to 1.2 bar 0.8 to 2.5 bar 2 to 5 bar 4.5 to 10 bar 8 to 16 bar
Maxixmum permissible pressure at the actuator		1.5 • max. set point value		
Max. perm. temperature		Gases 660 °F (350 °C), however, max. 175 °F (80 °C) at the actuator Liquids 300 °F (150 °C), with condensation chamber max. 660 °F (350 °C) Steam with condensation chamber max. 660 °F (350 °C)		

1) Only for low range pressure reducing valve
2) Only ½″ to 1″

Table 2 · Materials

Pressure rating	ANSI 125	ANSI 250	ANSI 150 or 300	
Max. permissible temperature	450 °F (230 °C)	400 °F (205 °C)	660 °F (350 °C)	
Valve	**Type 2417**			
Body	Cast iron ASTM A 126 Cl.B		Cast carbon steel ASTM A 216 WCB	Cast stainless steel ASTM A 351 CF8M
Seat / Plug	Stainless steel AISI 410 WN 1.4006			Stainless steel AISI 316Ti WN 1.4571
Seal ring for soft sealing	PTFE with 15 % glass fiber · EPDM · NBR			
Guide bushing	PTFE with graphite			
Balancing bellows and bellows stem	Stainless steel AISI 316Ti WN 1.4571			
Actuator	**Type 2413**			
Diaphragm cases	Sheet steel A283 Gr.C	Sheet steel St 34-2		AISI 304 WN 1.4301
Diaphragm	EPDM with fabric reinforcement [1] · FKM for oils · NBR · EPDM with PTFE protective foil			

[1] Standard version; further details in "Special versions"

Table 3 · C_V and Kvs values

Size	Seat bore	C_V [1]		C_V I	Seat bore	Kvs [1]		Kvs I
	inches	Standard version	Special version	With flow divider	mm	Standard version	Special version	With flow divider
½″	0.24	–	0.12 · 0.5 [1]	–	6	–	0.1 · 0.4 [1]	–
	0.87	5	3	3.5	22	4	2.5	3
¾″	0.24	–	0.12 · 0.5 [1]	–	6	–	0.1 · 0.4 [1]	–
	0.87	–	3 · 6 · 7.5	–	22	–	2.5 · 5 · 6.3	–
		7.5	–	6		6.3	–	5
1″	0.24	–	0.12 · 0.5 [1]	–	6	–	0.1 · 0.4 [1]	–
	0.87	–	3 · 5 · 7.5	–	22	–	2.5 · 4 · 6.3	–
		9.4	–	7		8	–	6
1½″	1.6	–	9.4	–	40	–	8	–
		23	–	18		20	–	15
2″	1.6	–	20	–	40	–	16	–
		37	–	30		32	–	25
2½″	2.6	–	23	–	65	–	20	–
		60	–	44		50	–	38
3″	2.6	–	37	–	65	–	32	–
		94	–	70		80	–	60
4″	3.5	–	60	–	89	–	50	–
		145	–	110		125	–	95

[1] For C_V = 0.5 and 1.2 (Kvs = 0.4 and 1.0): valve without balancing bellows

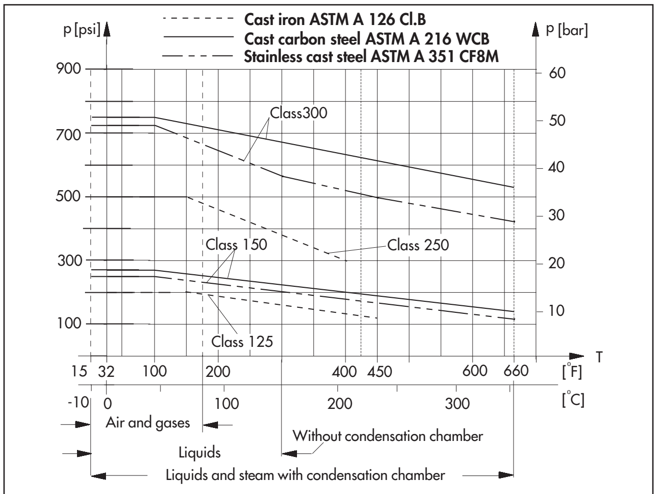


Fig. 4 Pressure-Temperature Diagram

Pressure-Temperature Diagram

The range of application of the valves is limited by the pressure-temperature rating of the body material and ANSI class. The diagram in Fig. 4 is for reference only. For exact values, consult ANSI standards B16.1, B16.4 and B16.34.

St I Flow Divider

When a flow divider St I is installed, the rated Cv value is reduced to CvI. Flow characteristic differences between valves with and without flow dividers do not occur until the valve has passed through approx. 80 % of its travel range.

Valve specific correction terms

For valve correction terms for calculating noise levels, please refer to Associated Information Sheet number T 2500.

Table 4a · Dimensions in inches and weights in lbs

Back pressure valve		Type 41-73							
Nominal valve size		½″	¾″	1″	1½″	2″	2½″	3″	4″
Set point range in **psi**	Length L ANSI 125 and 150	7.25	7.25	7.25	8.75	10.0	10.87	11.75	13.87
	Length L ANSI 250	6.0	6.0	6.0	8.0	9.25	-	-	-
	Length L ANSI 300	7.50	7.62	7.75	9.25	10.50	11.50	12.50	14.50
	Height H1	12.4			14.6		19.7		20.3
	Height H3	2.2			2.8		3.9		4.7
0.075 to 0.45	Height H	16.7					24.0		24.6
	Actuator	∅ D = 14.9, A = 100 in^2							
	Operating spring force F	56 lbf							
0.15 to 0.45	Height H	18.9					24.0		24.6
	Actuator	∅ D = 14.9, A = 100 in^2							
	Operating spring force F	56 lbf							
0.35 to 0.75	Height H	16.7			18.9		24.0		24.6
	Actuator	∅ D = 14.9, A = 100 in^2							
	Operating spring force F	101 lbf							
0.75 to 3.5	Height H	16.7			18.9		24.0		24.6
	Actuator	∅ D = 14.9, A = 100 in^2							
	Operating spring force F	393 lbf							
1.5 to 8.5	Height H	16.7			18.9		24.0		24.6
	Actuator	∅ D = 14.9, A = 100 in^2							
	Operating spring force F	990 lbf							
3 to 18	Height H	16.1			18.3		23.2		24.0
	Actuator	∅ D = 11.2, A = 50 in^2							
	Operating spring force F	990 lbf							
10 to 35	Height H	16.1			18.3		23.2		24.0
	Actuator	∅ D = 8.9, A = 25 in^2							
	Operating spring force F	990 lbf							
30 to 75	Height H	15.4			17.5		22.6		23.2
	Actuator	∅ D = 6.7, A = 12.5 in^2							
	Operating spring force F	990 lbf							
65 to 145	Height H	15.4			17.5		22.6		23.2
	Actuator	∅ D = 6.7, A = 6.2 in^2							
	Operating spring force F	990 lbf							
115 to 230	Height H	15.4			17.5		22.6		23.2
	Actuator	∅ D = 6.7, A = 6.2 in^2							
	Operating spring force F	1800 lbf							
0.075 to 18	Weight for cast steel ANSI 150 [1)] approx. lb	51	53		73	80	121	136	158
3 to 35		39	41		58	68	107	124	146
30 to 230		29	32		51	58	97	114	136

1) +10 % for cast steel ANSI 300

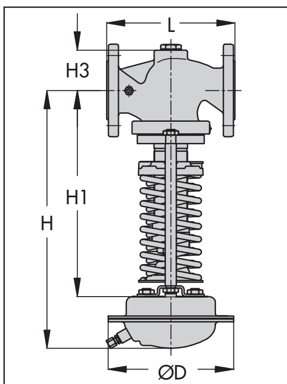
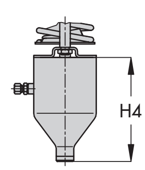


Fig. 5 · Dimensions

Height		Effective diaphragm area 5.1 in^2 (33 cm^2)	Effective diaphragm area 9.6 in^2 (62 cm^2)
H4	inches	7.9	8.5
	mm	200	215



Metal bellows actuator Type 2413

Installation

- Horizontal pipeline with a slight downward slope on either side (for condensate discharge)
- Direction of flow must coincide with the arrow on the valve body
- The actuator must be suspended downwards as depicted
- Pressure tap approx. 3.3 ft (1 m) upstream from the valve. The control line (pipe ⅜″) is to be provided by the customer
- A larger pipe cross-section (expansion piece) downstream of the valve may be installed to compensate for for case with high steam expansion
- A strainer is recommended to be installed upstream of the valve to protect the valve internals from damage by foreign matter.
- Shutoff valves are recommended to isolate the regulator during maintenance

Table 4b · **Dimensions in mm and weights in kg**

Back pressure valve		**Type 41-73**							
Nominal size		½″	¾″	1″	1½″	2″	2½″	3″	4″
Set point range in **bar**	Length L ANSI 125 and 150	184	184	184	222	254	276	298	352
	Length L ANSI 250	152	152	152	203	235	-	-	-
	Length L ANSI 300	191	194	197	235	267	292	318	368
	Height H1	315			370		500		515
	Height H3	55			72		100		120
0.005 to 0.03	Height H	425					610		625
	Actuator	∅ D = 380, A = 640 cm²							
	Operating spring force F	250 N							
0.01 to 0.03	Height H	480					610		625
	Actuator	∅ D = 380, A = 640 cm²							
	Operating spring force F	250 N							
0.025 to 0.05	Height H	425			480		610		625
	Actuator	∅ D = 380, A = 640 cm²							
	Operating spring force F	450 N							
0.05 to 0.25	Height H	425			480		610		625
	Actuator	∅ D = 380 , A = 640 cm²mm							
	Operating spring force F	1750 N							
0.1 to 0.6	Height H	425			480		610		625
	Actuator	∅ D = 380 mm, A = 640 cm²							
	Operating spring force F	4400 N							
0.2 to 1.2	Height H	410			460		590		610
	Actuator	∅ D = 285 mm, A = 320 cm²							
	Operating spring force F	4400 N							
0.8 to 2.5	Height H	410			465		595		610
	Actuator	∅ D = 225 mm, A = 160 cm²							
	Operating spring force F	4400							
2 to 5	Height H	390			445		575		590
	Actuator	∅ D = 170 mm, A = 80 cm²							
	Operating spring force F	4400 N							
4.5 to 10	Height H	390			445		575		590
	Actuator	∅ D = 170 mm, A = 40 cm²							
	Operating spring force F	4400 N							
8 to 16	Height H	390			445		575		590
	Actuator	∅ D = 170 mm, A = 40 cm²							
	Operating spring force F	8000 N							
0.005 to 1.2	Weight for cast steel ANSI 150 1) approx. kg	23	24		33	36	55	62	72
0.2 to 2.5		18	19		26	31	49	56	66
2 to 16		13	15		23	26	44	52	62

1) +10 % for cast steel ANSI 300

Accessories

- Fitting for connection of the control line ⅜″ to the filler plug.
- Condensation chamber for steam condensation and protection of the operating diaphragm against extreme temperatures. This chamber is necessary for steam and liquids above 300 °F (150 °C).
- Control line kit - optionally with or without condensation chamber - for direct attachment to the valve and actuator (pressure tapped directly at the valve body, for set points of ≥ 30 psi (2 bar)).

Ordering information

Pressure Reducing Valve Type 41-73
Nominal size ... Body material ...
ANSI Class ... End connection ...
Set point range ... psi (bar)
Optionally, accessories ... /special version ...

Specifications subject to change without notice.

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Report on the analysis of failed fuel oil regulating valve assembly

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Report on Analysis of Failed Fuel Oil Regulating Valve Assembly

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Job No: A102951
Our Ref: \Datafiles\M\MAIB\Valve investigation\A102951 MAIB final Rep1.doc
Date: 22nd February 2010
Prepared by: [redacted]

Contents

1 Introduction

The Marine Accident Investigation Branch (MAIB) provided a failed fuel oil regulating valve assembly recovered from a scene of fire investigation. Materials Technology Ltd. was requested to inspect the diaphragm component of the valve assembly in more detail in order to determine if this component had failed prior to the fire. This report details the work conducted by Materials Technology Ltd.

2 Background Information

As part of this investigation the MAIB provided the following supporting information;

- Wartsila – A.E Fuel Oil Diagram No. 1.270.292.8220.602 vB
- Fuel Oil safety datasheets
- MAIB schematic diagrams of operation

Product Details:

- Fuel Oil Regulating Valve Assembly: Samson Type 2417 (see appendix for label details).
- Detailed drawings of the valve were not available at the time of this report.

Boat: Oscar Wilde
MAIB Ref: V2-39
Date Seized: 05/02/2010

The valve assembly consists of main fuel pipe which is fitted with two manual valves. Fitted between the two manual valves is a standard regulating valve which controls the flow of fuel through the main pipe. The regulating valve is operated by pressure applied to a diaphragm attached to the top of the unit. When the pressure is removed a spring returns the valve to the end position. The pressure is applied to the diaphragm hydraulically by fuel oil from the mixing tank. This system insures that a pressure is maintained in the mixing tank. When the operating pressure is exceeded the valve operates to divert fuel. At the time of the incident both manual valves were believed to be in the closed position thereby preventing the normal operation of the valve. The fire is believed to have occurred at the valve location.

3 Inspection

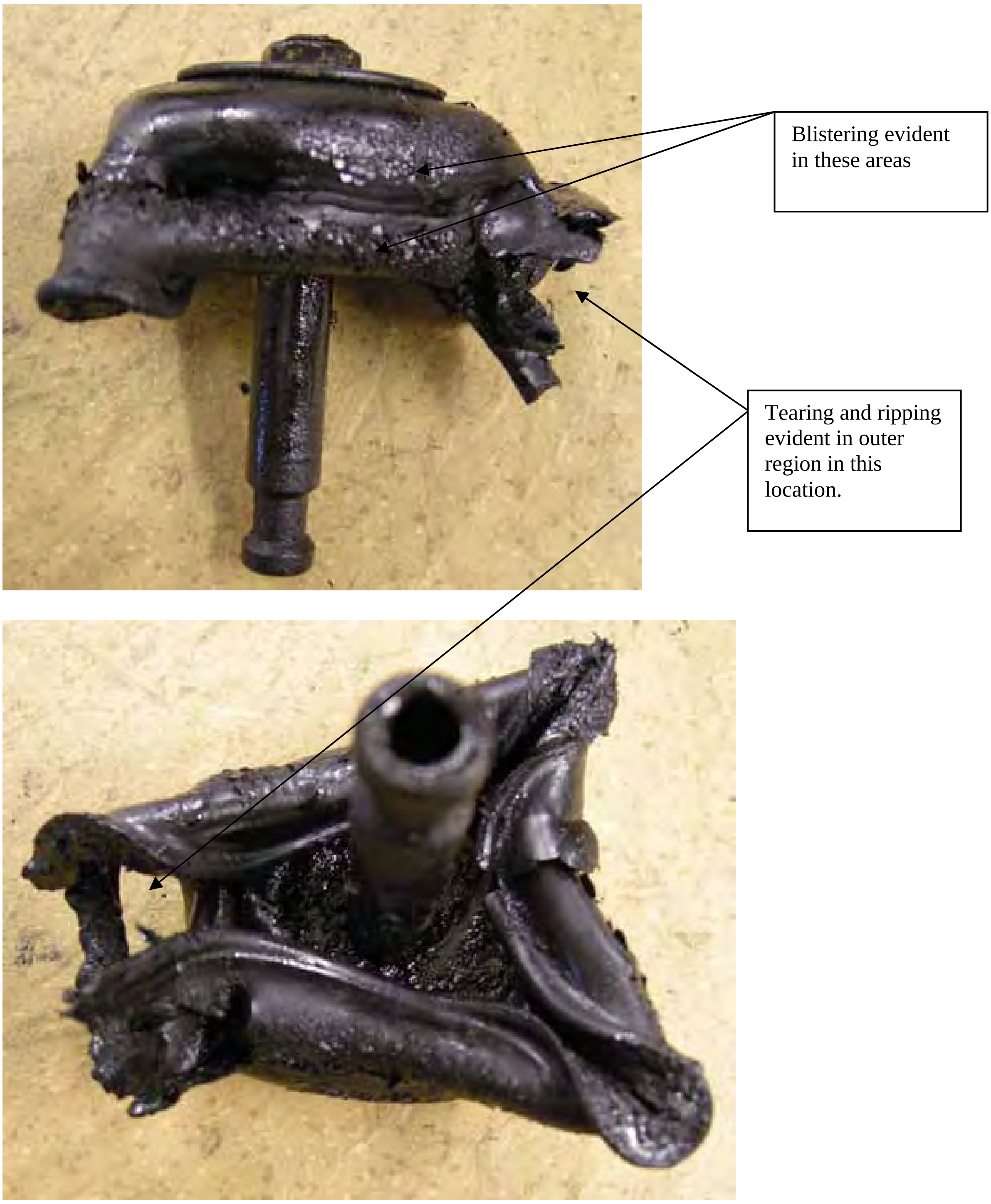
Materials Technology Ltd. conducted an initial visual inspection of the valve assembly specifically focussed in the area of the diaphragm. Photographs of the valve assembly in the as received state are detailed in the appendix. Two identification tags were present and these were photographed and detailed in the appendix.

The diaphragm retainer bolts and housing had already been disassembled upon receipt. The diaphragm was removed from the housing and inspected further. Fuel oil residue was evident on the diaphragm and retainer plates. The fuel oil showed visible signs of degradation / heavy wear as it was black in colour.

Photo 1: Showing diaphragm in situ with top casing removed. Note diaphragm is misshapen. Fuel oil residue is deep black in colour.

Photo 2: Inside view of top casing. Note gasket residue is still present but insufficient to judge quality of seal.

In general the diaphragm was heavily misshapen around the outer edges, this maybe due to normal use or due to the heat from the fire. The diaphragm showed signs of deterioration around a portion of the outer edge with some tearing of the diaphragm evident.



Photos 3 & 4: Showing general views of diaphragm removed from valve assembly.

The main flexing region of the diaphragm also showed signs of heavy wear and creasing with some delamination of the rubber evident. There were also signs of tearing of the reinforcing fabric layer.

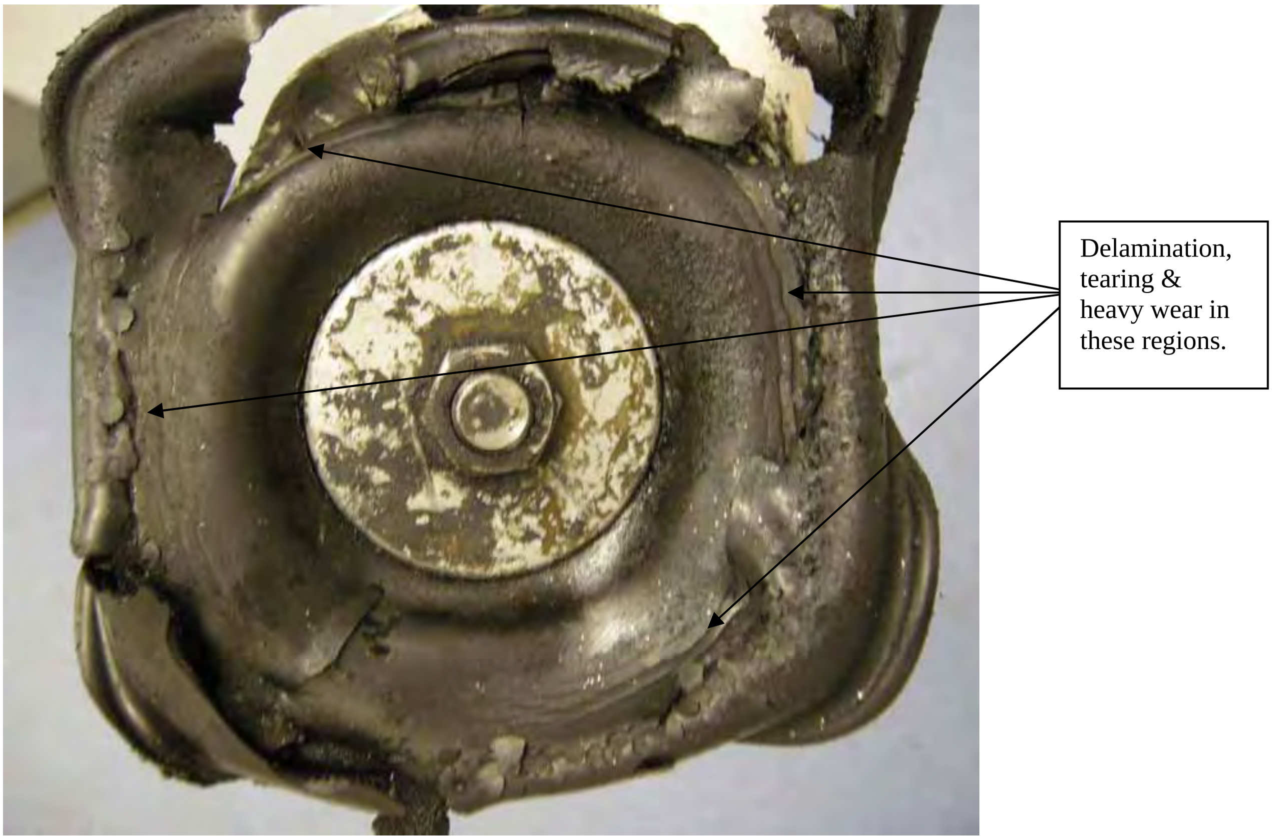


Photo 5: General view of diaphragm showing heavy wear & delamination in main flexing region.

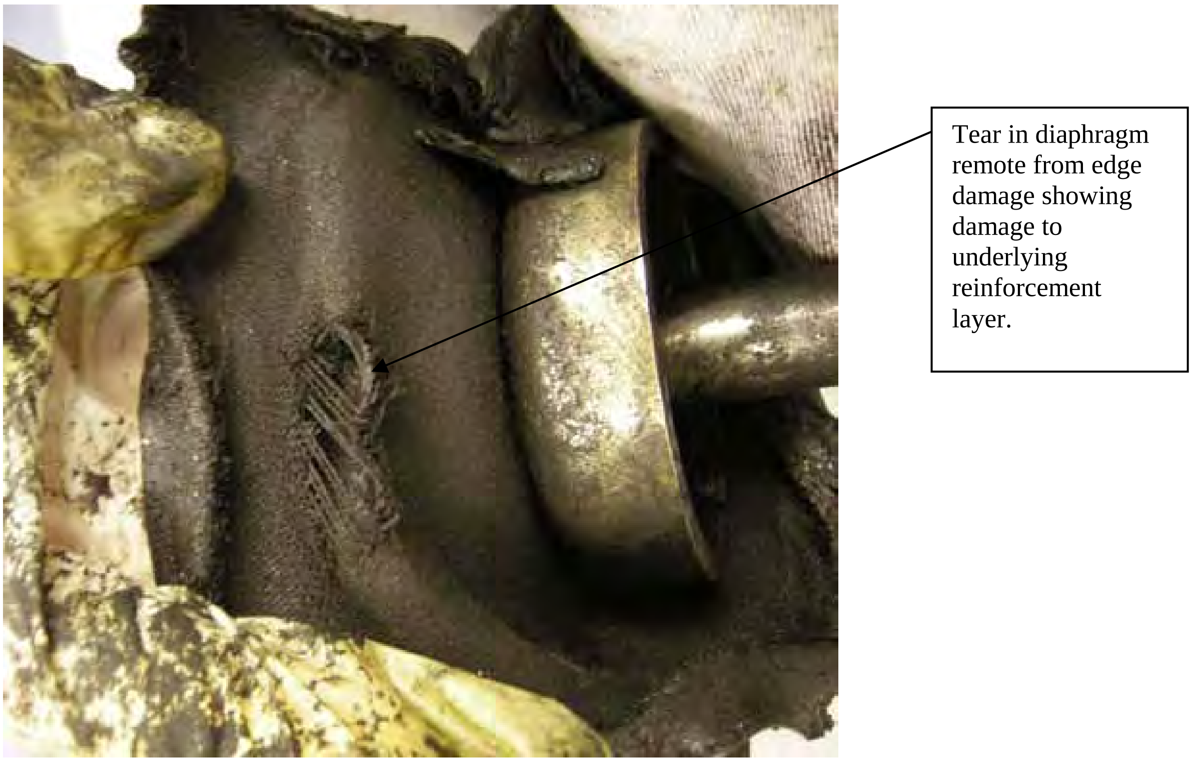


Photo 6: Tear in main flex region of diaphragm showing extensive damage to underlying fabric reinforcement layer.

The upper surface of the diaphragm (fluid side) also showed significant evidence of blistering. Initially this was thought to be due to heat damage. However, closer inspection of the diaphragm showed no burnt residue, charring or heat deterioration. The diaphragm also remained flexible and pliable. The blisters produced significant craters in the diaphragm and hence are thought to be the result of explosive decompression as a result of the failure. This type of failure is normally associated with gaseous products and hence the resulting heat may have contributed to this phenomenon.

Photo 7 & 8: close up of blistering

Blistering damage believed to be due to combination of explosive decompression and or heating during failure.

Photo 9: additional blistering damage

4 Discussion

At the request of the MIAB this analysis has focussed on the damage caused to the diaphragm and therefore Materials Technology Ltd have not attempted to dismantle or investigate other areas of the valve assembly. The main aim has been to determine if the diaphragm damage was the result of fire damage or was the cause of the fire.

The significant deformation of the diaphragm could have occurred during heat exposure (stress relaxation) or due to general wear and tear on the diaphragm. However, as the diaphragm has remained flexible and pliable it is not thought that this deformation has impaired the performance of the diaphragm.

The tearing and delamination of the diaphragm is thought to be relevant to the failure as most of this has occurred around the high flex region of the diaphragm i.e. indicative of high wear. Whilst the tear properties of rubber can significantly reduce on exposure to intense heat the majority of the tearing and delamination is concentrated on the circular region of high flex. It is also possible that the tearing damage in the outer edge portion of the diaphragm has originated from this same region but it has not been possible to confirm this.

The tearing of the rubber and the underlying reinforcement fabric is considered to be highly significant as this is remote from the edge damage and represents an obvious failure of the high flex region. Hence it is likely that the diaphragm has failed due to tearing of the rubber and underlying fabric resulting in a loss of fluid.

The blistering observed on the upper surface of the diaphragm was originally thought to be charring / blistering damage due to heat exposure. However, closure inspection of the blistering shows the blisters to be regular circles with deep pits. This is typical of explosive decompression and can occur as a result of rapid pressure loss in a seal application involving gaseous products. A typical reference example of explosive decompression damage is shown in the photo below. This would not normally be expected with fuel oil as it would not be expected to volatilise easily. However, the resulting fire may have contributed to this damage by causing gaseous products. Hence, the blistering damage is more likely to have occurred as a result of the incident rather than the cause.

Photo 10: Reference example of explosive decompression.

It is believed that the manual valves were closed at the time of the incident. This would have meant that the diaphragm assembly was probably in the situation of full pressure applied with no movement of the valve possible due to the incompressible fluid locked within the valve body. Whilst the diaphragm should be designed to operate at maximum pressure it is not clear from the information provided what other pressure limits were available. Hence, it may have been possible for the diaphragm to have seen a significant overload pressure. This needs further investigation.

5 Conclusions

The failed diaphragm of a regulating fuel valve assembly has been investigated. On the balance of the evidence provided the following conclusions can be made:

1. The diaphragm does not show signs of significant heat damage such as charring or hardening. The diaphragm remains flexible and pliable.
2. The diaphragm shows significant evidence of tearing and delamination around the main flex region.
3. The damage at the edge of the diaphragm is also predominantly tearing damage and may also have originated in the central flex region but this has not been possible to confirm.
4. There is evidence of tears penetrating the entire thickness of the diaphragm remote from the edge damage and penetrating the woven fabric reinforcement

layer. These tears are thought to be the primary failure mechanism of diaphragm and probably occurred prior to any heating.

5. There is evidence of blistering on the upper side of the diaphragm (fluid side) which is typical of explosive decompression damage. However, this is normally associated with gaseous products and would not normally be expected to occur with a relatively non volatile material like fuel oil. However, the resulting fire damage / heating may have contributed to this phenomenon and hence this is probably an effect rather than a cause.

[redacted]

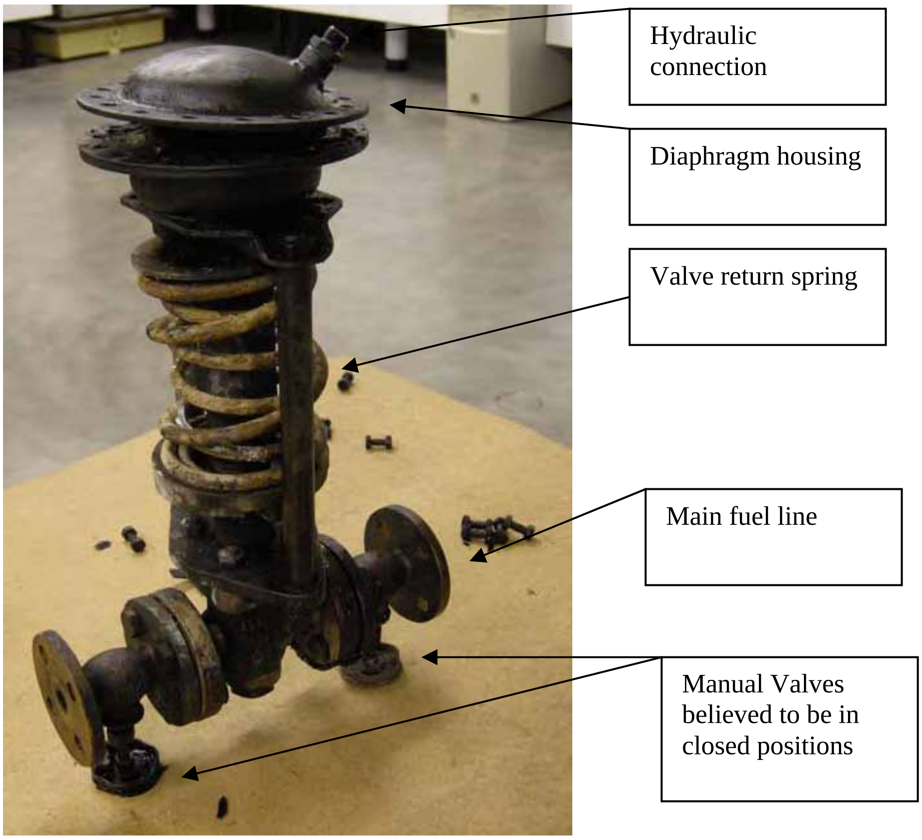
Prepared by: ____

[redacted]
Technical Director

END OF REPORT

Appendix follows

APPENDIX

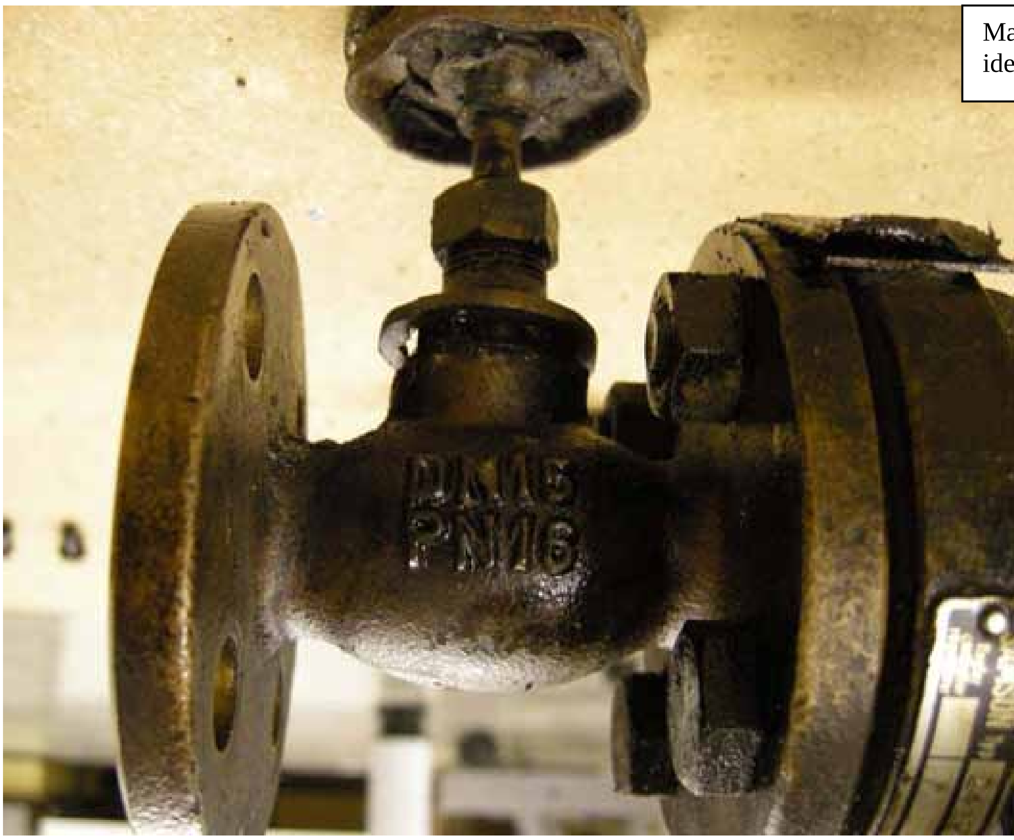

Hydraulic connection
Diaphragm housing
Valve return spring
Main fuel line
Manual Valves believed to be in closed positions


Valve identification
SAMSON
Typ
2417

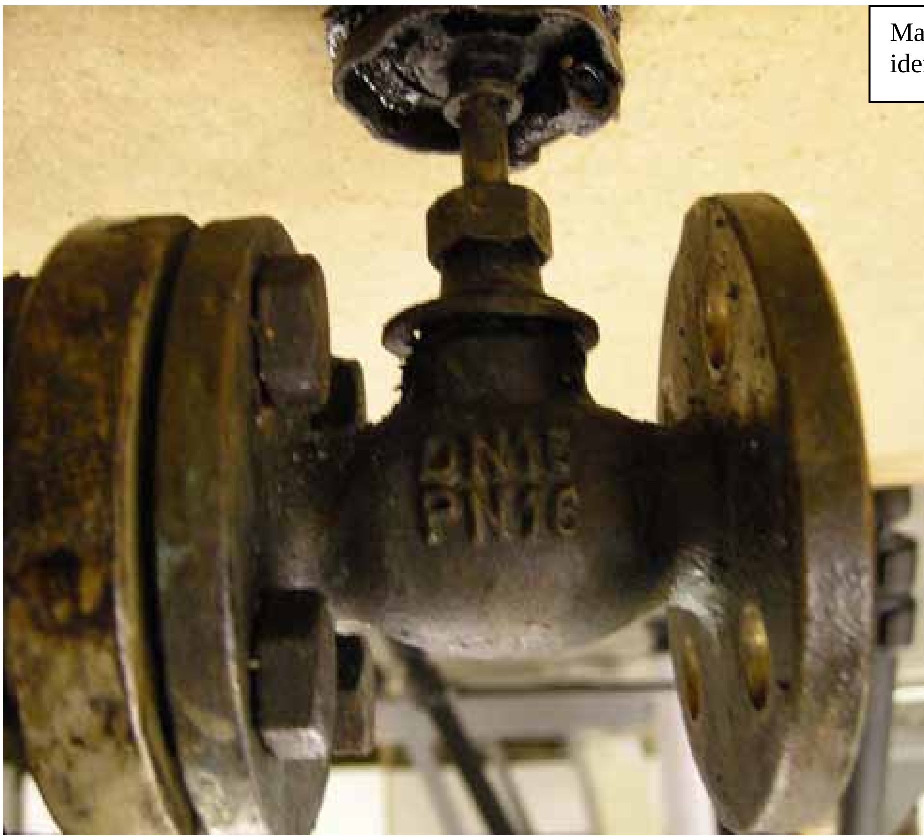
Valve identification label

Valve identification on housing

Manual valve 1
identification



Manual valve 2
identification



Diaphragm housing as received with retaining bolts removed.

Identification plate supplied with valve. Exact location not known.

Oscar Wilde procedure for “at berth fuel oil change-over”

Oscar Wilde - Procedure for "At berth fuel oil change over"

At FWE record the date and time on "At berth change over" log sheet [**Pos 1**]

<u>Commence AE & boiler change over process at FWE.</u>

Change over to DO (Aux engines)

1. At FWE shut off steam heating, record date / time on "At berth change over" log sheet [**Pos 2**]
2. Allow temperature to drop to 100 deg C
3. Print the Kongsberg "Tank Level Gauging And Capacity" screen.
4. Change supply to MGO (NOT return) and close valves V66 & V68 (returns to blackout tank), record date, time & flowmeter reading [**Pos 3**].
5. Shut off filter, trace heating & mixing tank
6. Monitor Visco / temperature readings & AE performance
7. When viscosity has dropped to 4 cSt change over returns to diesel oil system and record date, time and flowmeter readings [**Pos 4**]

Change over to DO (boilers)

1. At FWE shut off heating to fuel oil heater in separator room, record date / time on "At berth change over" log sheet [**Pos 2**]
2. Change supply to MGO record date, time & flowmeter reading [**Pos 3**]
3. Observe boiler and change to MGO operation when fuel oil at boiler is diluted with MGO.
4. When boiler is operating fully on MGO record date, time and f/meter readings [**Pos 4**]

Change over to HFO (Aux engines)

1. 90 minutes before scheduled departure, change over supply & return to HFO and open valves V66 & V68, record date, time and flowmeter reading [**Pos 5]**.
2. When viscosity has increased to 12 centistoke, open steam heating
3. When temperature has reached 125 degrees C, record date, time and flowmeter reading. [**Pos 6]**
4. Print the Kongsberg "Tank Level Gauging And Capacity" screen.
5. Open filter, trace & mixing tank heating

Change over to HFO (boilers)

6. After departure, change fuel supply to HFO and open heating to fuel oil heater [**Pos 5]**
7. When the HFO reaches the boiler change over to HFO operation, record date, time and flowmeter reading. [**Pos 6]**

Record scheduled departure date and time on "At berth change over" log sheet **[Pos 7]**

NOTES:
The items marked [Pos n] refer to the location the information is to be recorded on the "At Berth Fuel Changeover Log Sheet"

The tank levels printout pages are to be attached to the log sheet.

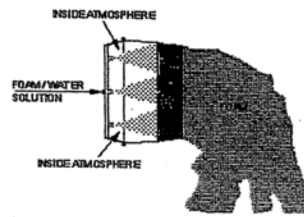
Hotfoam manufacturer's manual system description

UNITOR	Type of document GENERAL DESCRIPTON				Document no. 53-00-056-1-E	
	Issued by [redacted]	Date of Issue 02.03.99	Rev. no. 00	Rev. date 02.03.99	Approved by [redacted]	Page 1 of 2
System FIXED FOAM	Subject **HOTFOAM SYSTEM WITH PROPOR-TIONER, REMOTE OPERATED. LRS.**				Ref. 53-00-056	

SYSTEM DESCRIPTION

The HOTFOAM EXTINGUISHING SYSTEM is a multistage extinguishing system, using first water and then foam when fighting fires. The system can be designed and installed, both as a local application system as well as a total flooding system for engine room and pump. In some situations local application will extinguish the fire, but activation of total flooding may be necessary.

The foam generators are located inside the protected space using the inside atmosphere to generate foam. Produced foam is falling directly from each generator.



It is of utmost importance that the waterspray application starts immediately after the fire has occurred in order to reduce fire and heat damages. While waterspray application is running for a time period of two (2) minutes, the protected area is evacuated and decision is made whether fire can be tried extinguished by firemen with portable equipment, or if system shall automatically continue with foam production.

SYSTEM LAYOUT

This system is designed according to the Lloyd's Register of Shipping (LRS) requirements.

The system is built up by the following groups of components:

The foam central :

The main components in the foam central are the foam tank containing the HOTFOAM concentrate and the foam proportioning equipment. There are two proportioners, feeding one main pipe each.

The selector valve register:

The valve register contain distribution valves corresponding to the different protected spaces. The valves are remotely operated from the control cabinet, with the possibility of manual override.

The distribution piping with the HOTFOAM generators:

There are two main distribution lines and they are monitored for eventually rupture caused by explosion. If rupture, this line is automatically shut down.
Local high risk space (e.g. purifier room) shall be fed by an individual distribution line and in addition be fed by half the required number of foam generators from one of the main lines.

Examination of pipe sample and associated scale deposits removed from the high-expansion foam system pipework on board *Oscar Wilde*
(Figures not included)

The TEST HOUSE

THE TEST HOUSE (CAMBRIDGE) LTD. JOB AND REPORT REFERENCE: T00557

LABORATORY REPORT

**EXAMINATION OF A PIPE SAMPLE
AND ASSOCIATED SCALE DEPOSITS
REMOVED FROM THE HIGH EXPANSION
FOAM SYSTEM PIPEWORK ON BOARD
THE ROLL-ON ROLL-OFF CRUISE
FERRY MV OSCAR WILDE**

For: Marine Accident Investigation Branch
Mountbatten House
Grosvenor Square
Southampton
SO15 2JU

This report comprises:
- Title page : 1
- Test pages : 1 to 8
- Figure sheets : 1 to 22
- Appendices : 1

UKAS DISCLAIMER

This project includes tests and examinations, some of which were completed against UKAS accredited procedures. The scope of laboratory accreditation does not, however, include the analysis of test data or the offering of professional opinions.

LABORATORY REPORT

EXAMINATION OF A PIPE SAMPLE AND ASSOCIATED SCALE DEPOSITS REMOVED FROM THE HIGH EXPANSION FOAM SYSTEM ON BOARD THE ROLL-ON ROLL-OFF CRUISE FERRY MV OSCAR WILDE.

For: **Marine Accident Investigation Branch**
Mountbatten House
Grosvenor Square
Southampton
SO15 2JU

THE TEST HOUSE (CAMBRIDGE) LTD REFERENCE: T00557
RECEIPT DATE : 13 April 2010
INSTRUCTION DATE : 9 April 2010
REPORT DATE: 10 June 2010

1. INTRODUCTION, BACKGROUND AND WORK SCOPE

Instructions to examine the pipework sample and associated internal scale deposits (Figures 1 and 7) were received from Marine Accident Investigation Branch (MAIB).

The pipe sample and scale deposits had been removed by others, and were reported to be from the high expansion foam fire fighting system pipework on board the roll-on roll-off cruise ferry MV OSCAR WILDE. It was further reported that the local weld repair to the pipe had become necessary following leakage during recent acid cleaning of the system.

The client had a number of specific questions in respect of the submitted samples and in this regard had requested the laboratory to:

(i) determine the pipe material type

(iii) determine if scale debris removed from the pipework system nozzles was the product of ferrous corrosion

(iv) determine any effect of welding on pipe corrosion resistance

In the former regard the samples provided were examined in The Test House (TTH) metallurgical laboratory as follows.

2. SAMPLE MATERIAL AND RECEIPT INSPECTION

2.1 Pipe Sample

The pipe sample comprised a 195mm length of 60.8mm od (measured over paint) x 3.21mm to 4.23mm wall thickness (measured over paint and scale) pipe, with part of a fillet welded sleeve connector at one end (Figure 1). A local Manual Metal Arc (MMA) weld repair was evident towards the pipes sleeved end (Figures 1 and 2). The local repair comprised five stringer beads, which were aligned along the pipes principal axis. The pipes outer diameter surface exhibited an upper paint coat of white colour and an under green coloured paint coat (Figure 2).

The two paint coats were solvent stripped from the pipes outer diameter by immersing one end of the pipe in a beaker of Acetone. The underlying pipe surfaces were seen to be totally free from any evidence of galvanizing, and exhibited a "self colour" hot mill scale type finish (Figure 3).

The pipes inner diameter surface exhibited widespread corrosion damage, which took the form of deep local pips and gouge sites (Figures 4 and 5). A deep porous pit site was seen to be apparent underneath the local weld repair site (Figure 6).

2.2 Scale Sample

The scale debris was supplied to the laboratory in a sealed sample container (Figure 7). The sample appeared to be still wet, was of a dark brown hue (Figure 8) and highly ferro-magnetic.

After solvent washing in Acetone and drying, the sample was seen to comprise large ferrous like corrosion scale and finer rust like corrosion products (Figures 9 and 10).

3. DETAILED EXAMINATION OF THE PIPE AND SLEEVE SAMPLE

3.1 Metallographic Examination

A weld cross section specimen (pipe longitudinal direction) was removed from the pipe to sleeve fillet weld and a cross section was removed from the opposite end of the pipe. A further weld cross section specimen (pipe cross section direction) was removed from the local stringer bead weld repair site. The specimens were Bakelite mounted and prepared for examination by conventional mechanical polishing to a 1-micron diamond finish. The prepared specimens were subsequently examined in the "as polished" unetched condition, and then again after etching in Nital.

The sleeve to pipe fillet weld was seen to be of a very poor quality and exhibited lack of fusion along the full length of the welds contact with the pipe surface (Figure 11). The joints apparent leak lightness was clearly seen to have relied on the presence of a tightly adherent high temperature welding slag (Figures 11, 12 and 13), which was present throughout the unfused weld interface.

The sleeve was sent to have been produced from a hot finished low carbon steel and both the inner and outer diameter surfaces were seen to be void of any evidence of galvanizing (Figures 14 and 15).

The sleeve was sent to have been produced from a hot finished low carbon steel and both the inner and outer diameter surfaces were seen to be void of any evidence of galvanizing (Figures 14 and 15).

The pipe also exhibited a microstructure consistent with that of a hot finished low carbon steel. Close examination of the pipes inner and outer diameter surfaces confirmed that no evidence of galvanizing was present either in way of the fillet welded sleeve (Figures 16 and 17), or at the opposite tube end (Figures 18 and 19). The inner pipe diameter surfaces were seen to exhibit consistent and widespread corrosion pitting and gouging (Figures 16 and 18).

The cross section taken through the stringer head weld repair in the pipe served to confirm that the repair had been completed in response to a local through wall perforation of the pipe wall (Figure 20). Though the root of the repair weld contained two scale like accumulations; in this instance the features were attributed to retained welding slag rather than to in-situ corrosion products (Figure 21).

3.2 Pipe and Sleeve Steel Chemical Analysis

Optical Emission Spectrographic (OES) chemical analysis was completed on samples removed from the sleeve (sample T00557-C) and from the pipe (sample T00557-D), test results of which are reported in Appendix 1.

The test results confirmed that both items had been produced from low carbon mild steel. In the case of the sleeve the analysis profile (Appendix 1, lines 1 and 3) was consistent with a silicon killed steel. This contrasted with the pipe steel (Appendix 1, lines 2 and 4) which appeared to have been silicon killed aluminium treated. The analysis profile of both items exhibited relatively low levels of residual elements, suggesting that the parent steel casts had been produced via a hot metal or remelted direct reduced iron route.

3.3 Pipe and Sleeve Surface Analysis

The inner and outer surfaces of samples removed from the pipe and sleeve were analysed by Energy dispersive X-Ray (EDX) analysis, via the ancillary spectrometer attached to a Scanning Electron Microscope (SEM).

The pipe inner diameter surface comprised largely iron-oxygen corrosion products and with no evidence of galvanising (Figures 22 and 23). The pipes outer diameter surface comprised an iron-oxygen scale and paint residues (Figures 24, 25, 26 and 27). Any zinc present in the spectra was confirmed to be in paint and in totally paint free regions of the surface the spectrum comprised an iron-oxygen scale, which was totally free from zinc (figure 27).

The sleeve inner diameter surface comprised largely iron-oxygen corrosion products and with no evidence of galvanising (figures 28 and 29). The sleeves outer diameter surface comprised an iron-oxygen scale and paint residues (Figures 30, 31, 32 and 33). Any zinc present in the spectra was again confirmed to be largely associated with the paint residues.

4. ANALYSIS OF THE SCALE SAMPLE

A representative sample of the solvent washed and dried scale was characterised by SEM-EDX analysis.

The large scale pieces in the sample comprised iron-oxygen corrosion product, along with other chemical species commonly found in sea water (Figures 34, 35, 36 and 37).

The finer particles were similarly seen to comprise iron-oxygen corrosion product along with varying amounts of other chemical species commonly found in sea water (Figures 38, 39, 40, 41, 42, 43 and 44).

Traces of zinc constantly seen in the spectra of both the large and finer corrosion scale products were inconsistent with other observations, suggesting that it had most probably arisen from an extraneous origin.

5. SUMMARY AND ANSWERS TO THE SPECIFIC QUESTIONS POSED BY MAIB

5.1 The laboratory was provided with a sample which comprised a 2" nominal bore schedule 40 pipe with an MMA fillet welded 3" nominal bore schedule 40 sleeve at one end.

5.2 A local MMA stringer bead repair to a through wall perforation was also apparent in the 2" nominal bore pipe piece.

5.3 The pipe and fillet welded sleeve exhibited an external paint protection system, comprising a green undercoat and a white outer coat.

5.4 The outer pipe and sleeve surfaces exhibited a "self colour" hot finished mill scale type finish, with no evidence of any previous galvanizing.

5.5 The pipes inner diameter surface exhibited widespread corrosion damage in the form of local pit and gouge sites, and a deep porous pit site was seen to be present underneath the local weld repair site.

5.6 The pipe and sleeve had both been produced from low carbon mild steel and the joining fillet weld was seen to be of a very poor quality; with much of the leak path barrier comprising welding slag rather than weld metal.

5.7 Metallographic examination of the pipe and sleeve surfaces further served to confirm that neither of them had been galvanized or electro-zinc plated.

5.8 The scale pieces provided were found to comprise iron-oxygen corrosion products (rust type scale) along with other chemical species commonly found in sea water.

5.9 Traces of zinc, which were consistently seen in the spectra of both large and small corrosion scale pieces were inconsistent with all other observations, and was consequently judged to have arisen from an extraneous origin.

5.10 Accepting that the pipe and sleeve had not been protected by galvanizing or electro-zinc plating, welding was not thought to have had any significantly detrimental effect on the pipework systems corrosion resistance.

6. CONCLUSIONS, DISCUSSION AND OPINION

We conclude that the pipe and sleeve were of a ferritic mild steel type and tubulars of a size and type identified would be covered by specifications such as BS1387:1985 or the superseding European standard BSEN 10255:2004.

The pipe and sleeve were both of a self colour hot mill scale finish and neither item exhibited any evidence of galvanizing or electro-zinc plating. The presence of high temperature mill scale at the pipe and sleeve outer diameter surfaces served further to confirm that neither item had been either galvanized or electro-zinc plated; as to apply either of the coating types would have necessitated acid pickling back to clean scale free metal.

The scale sample was found to comprise an iron-oxygen rust type product, along with other chemical species commonly found in sea water. The rust type product was thought to comprise an oxygenated water grown corrosion scale that had become detached from the inner tube surfaces during the recent cleaning operations. The former observation would also well explain why the waterside corrosion pit and gouge sites were largely free from the in-situ tubercles normally seen in the waterside corrosion of ferritic mild steels.

The weld repair to the pipe was seen to have been necessary as a consequence of a local corrosion perforation which had progressed from the inner waterside. The pipe wall perforation and widespread evidence of waterside pitting and gouging corrosion, had, in our opinion, resulted directly from the unprotected mild steel pipes incompatibility with the waterside environment. Similarly, it would be reasonable to assume that corrosion would be widespread in a system comprising unprotected mild steel pipework.

Report prepared and authorised by

[redacted]

Director and Head of Laboratory

T00557 APPENDIX 1

MV OSCAR WILD - CHEMICAL ANALYSIS OF THE SLEEVE AND PIPE STEELS

TWI

TWI LIMITED, Granta Park, Great Abington
Cambridge CB21 6AL, United Kingdom
Tel: +44 (0)1223 8999000 Fax: +44 (0)1223 894717
E-mail: chemanal@twi.co.uk

UKAS TESTING 0088

CHEMICAL ANALYSIS REPORT

ANALYSIS METHOD: OES

MATS DEPT QA REF NO: 9B

MATERIAL SPECIFICATION:

CLIENT: [redacted]
The Test House
Granta Park
Great Abington
Cambridge
CB21 6AL

REF/ORDER NO: T00557

DATE RECEIVED: 16 04 10

TWI REPORT NO: S/10/90

ANALYSIS DATE: 23 04 10

INVOICE NO:

SAMPLE NUMBER	ELEMENT, % (m/m)											
	C	Si	Mn	P	S	Cr	Mo	Ni	Al	As	B	Co
T00557-C Sleeve	0.14	0.20	0.40	0.017	0.003	0.058	0.012	0.037	0.012	0.006	<0.000 3	0.005
T00557-D Pipe	0.11	0.20	0.40	0.012	0.009	0.027	0.011	0.029	0.031	0.005	<0.000 3	0.005

SAMPLE NUMBER	ELEMENT, % (m/m)										
	Cu	Nb	Pb	Sn	Ti	V	W	Zr	Ca	Ce	Sb
T00557-C Sleeve	0.040	<0.002	<0.005	0.005	0.002	0.001	<0.01	<0.005	0.0013	<0.002	<0.002
T00557-D Pipe	0.029	<0.002	<0.005	0.005	0.002	0.001	<0.01	<0.005	0.0029	<0.002	<0.002

COMMENTS: Direct spark analyses on samples mounted in Bakelite.

PAGE 1 OF 1 [redacted] PRINCIPAL RESEARCH CHEMIST SIGNATURE [redacted] DATE ISSUED 23 04 10

Note: the chemical analysis results detailed above apply only to the sample(s) of material submitted to the laboratory

MAT C17-02/02

Hi-fog planned maintenance schedules

Name	Serial No.	Type
8 Safety Systems & Equipment » Fire fighting Hi-Fog		
HIFOG 1W - High Fog Sprinkler System 1W		every 7 day(s)
HIFOG AE PS - High Fog Sprinkler System in Aux Engine Room Port		every 4 month(s)
HIFOG AE SB - High Fog Sprinkler System in Aux Engine Room Stbd		every 4 month(s)
HIFOG BLR - High Fog Sprinkler System in Boiler Room		every 4 month(s)
HIFOG CASING - High Fog Sprinkler System in Casing		every 4 month(s)
HIFOG ME PORT - High Fog Sprinkler System in Main Engine Room Port		every 4 month(s)
HIFOG ME STB - High Fog Sprinkler System in Main Engine Room Stbd		every 4 month(s)
HIFOG SEP - High Fog Sprinkler System in Separator Room		every 4 month(s)
HIFOG WSHOP - High Fog Sprinkler System in Work Shop		every 4 month(s)
HIFOG 1Y - High Fog Sprinkler System 12 mnth Control		every 12 month(s)
HIFOG AUTO - Test of Hi-fog Automatic Release		every 6 month(s)
8 Safety Systems & Equipment » Fire fighting Hi-Fog » Hi-Fog Filling Compressor		
HIFOG KOMP 50H - Service on Hi-fog compressor		every 50 hour(s)
HIFOG KOMP 250H - Service on Hi-fog compressor		every 250 hour(s)
HIFOG KOMP 125H - Service on Hi-fog compressor		every 125 hour(s)
HIFOG KOMP 5000 - Service on Hi-fog compressor		every 5000 hour(s)
HIFOG KOMP 1000 - Service on Hi-fog compressor		every 1000 hour(s)
HIFOG KOMP 500H - Service on Hi-fog compressor		every 500 hour(s)
8 Safety Systems & Equipment » Fire fighting Hi-Fog » Hi-Fog System Hydraulic Compact Unit		
8 Safety Systems & Equipment » Fire fighting Hi-Fog » Hi-Fog System Pump, Gas Driven		
8 Safety Systems & Equipment » Fire fighting Hi-Fog » Hi-Fog System Water Valve Supply		

Job Description	due on	exec. on	Resp	At Cntr	Dur.	Rep.By
HIFOG 1W - High Fog Sprinkler System 1W	12/01/2010	07/01/2010	2nd Eng	0	1 hrs	[redacted]
HIFOG 1W - High Fog Sprinkler System 1W	14/01/2010	16/01/2010	2nd Eng	0	1 hrs	
HIFOG 1Y - High Fog Sprinkler System 12 mnth Control	30/01/2010	02/02/2010	2nd Eng	0	1 hrs	
HIFOG AE PS - High Fog Sprinkler System in Aux Engine Room Port	21/01/2010	23/01/2010	2nd Eng	0	1 hrs	
HIFOG AE SB - High Fog Sprinkler System in Aux Engine Room Stbd	22/01/2010	23/01/2010	2nd Eng	0	1 hrs	
HIFOG 1W - High Fog Sprinkler System 1W	23/01/2010	23/01/2010	2nd Eng	0	1 hrs	
HIFOG 1W - High Fog Sprinkler System 1W	30/01/2010	20/02/2010	2nd Eng	0	1 hrs	
HIFOG 1W - High Fog Sprinkler System 1W	06/02/2010	06/03/2010	2nd Eng	0	1 hrs	
HIFOG 1W - High Fog Sprinkler System 1W	03/04/2010	03/04/2010	2nd Eng	0	1 hrs	
HIFOG SEP - High Fog Sprinkler System in Separator Room	31/03/2010	29/03/2010	2nd Eng	0	1 hrs	
HIFOG ME PORT - High Fog Sprinkler System in Main Engine Room Port	27/03/2010	30/03/2010	2nd Eng	0	1 hrs	
HIFOG WSHOP - High Fog Sprinkler System in Work Shop	27/03/2010	30/03/2010	2nd Eng	0	1 hrs	
HIFOG 1W - High Fog Sprinkler System 1W	17/04/2010	13/04/2010	2nd Eng	0	1 hrs	

FWF AE SB - High Fog Sprinkler System in Aux Engine Room Port 4M

4 MONTH INSPECTION

- Perform all checks listed in section 5.2 (weekly inspection)
- Check the physical condition of all equipment assembled within the GPU and the physical integrity of the tubing distribution network and spray heads.
- Carry out a functional discharge test by activating the flame detector
- Carry out a functional discharge test of the system in accordance with the commissioning instruction. (from ECR, Fire Control Station & local controls)
- Refill the empty gas cylinders.
- Check that all the gas cylinder valves are open.
- Check that the water cylinders are full.
- Update system records.

See Marioff operation manual 5.3 page: 19

FWF AE SB - High Fog Sprinkler System in Aux Engine Room Stbd 4M

4 MONTH INSPECTION

- Perform all checks listed in section 5.2 (weekly inspection)
- Check the physical condition of all equipment assembled within the GPU and the physical integrity of the tubing distribution network and spray heads.
- Carry out a functional discharge test by activating the flame detector
- Carry out a functional discharge test of the system in accordance with the commissioning instruction. (from ECR, Fire Control Station & local controls)
- Refill the empty gas cylinders.
- Check that all the gas cylinder valves are open.
- Check that the water cylinders are full.
- Update system records.

See Marioff operation manual 5.3 page: 19

Resmar Ltd *Hotfoam* service report

Hot Foam System Inspection Report

Tel : + 44 (0) 845 803 3399
E - Mail : Sales@resmar.co.uk
www.resmar.co.uk

Year	Month	Date	Vessel Name	IMO Number	Flag	SOP Number
2009	May	12	*Oscar Wilde*			

Technical Description of Equipment :

Unitor Hot Foam System, consiting of 1 Tank of 600 Ltr capacity, 4 Distribution Lines covering Main Engine Room, Seperator Room, Compressor Room, and Aux Engine Room.

Description of Inspection/Tests:

Visual Inspection of tank completed.
Sample of Foam taken for Analysis.
Main Water Valve tested for correct operation.
Foam Valve Tested for correct operation.
4 x Distribution Valves Tested for correct operation.
Alarms and Fan stops for each space covered tested for correct operation.
Pump checked.
All Distribution lines were blown through using ships air and were all prven to be clear.
System reconnected and left in good working order.

[redacted]
Technician Attending

Wilhelmsen *Hotfoam* service report

UNITOR®
Unitor ASA
P.O Box 300 Skøyen
N-0213 Oslo, Norway
Tel: +47 22 13 14 15
Fax: +47 22 13 45 00
www.unitor.com

ISO 9001 CERTIFIED COMPANY

Certificate
of Inspection

Date:	Name of ship/unit:	IMO No.:	Flag:	Certificate No.:
2008-05-15	OSCAR WILDE	8506311	BHS	ANR/2008/231

Resp. office:	Service station:	Place of service:	Class. society	PL No.:
ANTWERP	ANTWERP	CHERBOURG	DNV	712144890

We hereby certify that the systems and equipment specified below have been inspected and serviced.
The chart reference states the letter code of relevant enclosed Service charts.

Comments to all Service Charts are summarized on Service Chart S - 'Summary of actions' where Performed/Recommended, Maintenance, RepairRef nodeReplacement are specified.
This Certificate is valid only when the Certificate and defined ServiceCharts are duly signed and stamped by UNITOR.

"The Unitor Quality Management System covering the execution of this service is certified according to NS-EN ISO 9001:2000".

NAME	CHART	SERVICE TYPE
FOAM CONCENTRATE TEST;	D2	
HOT FOAM SYSTEM;	M	Complete check

SECOND ORIGINAL

[redacted]

UNITOR STAMP AND SIGNATURE

[redacted]

UNITOR®
Unitor ASA
P.O Box 300 Skøyen
N-0213 Oslo, Norway
Tel: +47 22 13 14 15
Fax: +47 22 13 45 00
www.unitor.com

SERVICE CHART D2

FOAM CONCENTRATE TEST

Date:	Name of ship/unit:	IMO No.:	Certificate No.:
2008-05-15	OSCAR WILDE	8506311	ANR/2008/231

Technical Description:

No	Text	Value	UoM
1	Manufacturer	SABO	
2	Type	HOT FOAM	
3	Alcohol resistant	NO	
4	Foam concentration %	2.0	
5	Date of complete filling/supply	2002-Mar-01	
6	Material of tank	FIBRE GLASS	
7	Tank capacity	600	LTR
8	Brand name	METEOR-P	
9	Protected area	ENG. ROOM AREAS	
10	Tank Location	DECK 4	
11	Confirmation test sample	NO	

Description of Sampling: (1)

Sample taken by: Unitor
Sample taken from: Top
Volume of sample in litre: 2.0

Foam Concentrate Test (2)	Foam Property Tests		Physiochemical Tests		
2.0 % Foam Concentrate in water	Expansion ratio	25 % Drainage time/stability	pH-Value	Specific Gravity/Density	Sediments vol. %
Test values at 20°C / 68°F	9.56	9 M 35 S	6.5	1.015	0.05
Acceptable min/max values: (3)	>6.0	>6M0S	>6.0	1.0-1.11	<1.0

[X] Acceptable [ ] Not Acceptable

(1) Volume of sample container should, according to IMO MSC/Circ. 582 be 2 litres. To avoid contamination the original Unitor sample container (EDP no. 530-576496) is recommended. Small amounts of soap/grease/oil can dramatically influence on test result.

(2) The foam concentrate test complies with the guidelines of International Maritime Organisation (IMO): Maritime Safety Committe, circular 582/670 - "Guidelines for the performance and testing criteria and surveys of low/high expansion foam concentrates for fixed fire extinguishing system" by use of UNI 86 nozzle with the following deviations:

- ageing process in conjuction with expansion ratio, stability and sediments
- potable water instead of sea water/artificial sea water.

(3) Acceptable min/max values are based on recommendations from recognized foam manufacturers.

SECOND ORIGINAL

[redacted]

UNITOR STAMP AND SIGNATURE

UNITOR®
Unitor ASA
P.O Box 300 Skoyen
N-0213 Oslo, Norway
Tel. +47 22 13 14 15
Fax: +47 22 13 45 00
www.unitor.com

SERVICE CHART M

HOT FOAM SYSTEM

Date:	Name of ship/unit:	IMO No.:	Certificate No.:
2008-05-15	OSCAR WILDE	8506311	ANR/2008/231

Technical Description:

No	Text	Value
1	Manufacturer	UNITOR
2	Type	HOT FOAM
3	Liquid tank - Capacity in liters	600
4	Make and type of foam concentrate	UNITOR HOT FOAM
5	Nos. of foam generators	43
6	Covering	ENGINE + E/R AREA'S
7	Plant no	1

Description of Inspection/Tests:

No	Description	Carried out	Not carried	Not appl.	Comm.
1	System secured	X			
2	Foam liquid tank visual inspected	X			
3	Function of pressure/vacuum valve checked	X			
4	Liquid level on foam tank checked	X			
5	Function of liquid level indicator checked			X	
6	Main foam valve visual inspected	X			
7	Rubber compensator between tank and piping inspected	X			
8	Foam pump - Correct rotation checked. NB! Max 2 sec. running time	X			
9	Foam proportioner inspected for damages	X			
10	Adjustment screw for proportioner checked for correct mixing ratio	X			
11	Function tested all selection valves	X			
12	Function of control cabinet checked.(Ref. Unitor doc. no: 53-08-999-7-E)	X			
13	All foam generators visually inspected	X			
14	Piping inspected and blown through	X			
15	System reconnected, sealed and left in operational order, inspection date labels attached	X			

SECOND ORIGINAL
CLASS APPROVED
[redacted]

UNITOR STAMP AND SIGNATURE

Annex I

Wilhelmsen high-expansion foam promotional brochure

UNITOR HIGH EXPANSION FOAM
FIRE EXTINGUISHING SYSTEM

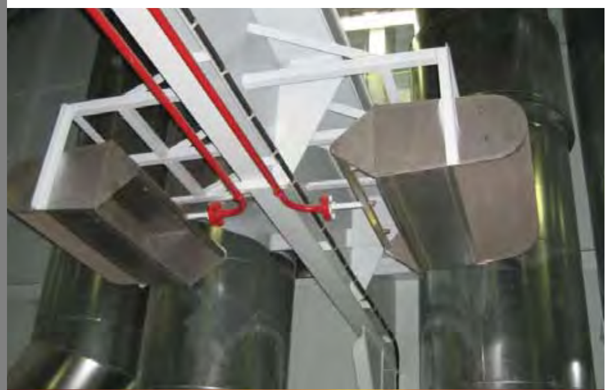
Trust us to protect you, your people and the environment

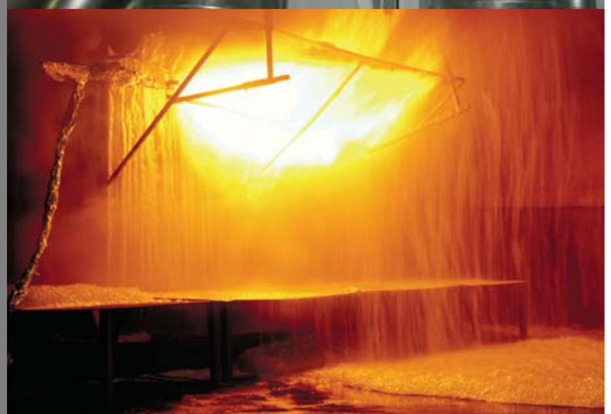
Wilhelmsen Ships Equipment

A COST EFFECTIVE AND SAFE ALTERNATIVE TO CO_2

Extinguishing fires in enclosed high risk areas, such as machinery spaces and pump rooms requires solutions that can be deployed quickly, are effective and minimise the risk to personnel and environment. CO_2 is commonly used as extinguishing medium to protect equipment in machinery spaces. CO_2 is not always an appropriate option as it can be dangerous to the crew.

From a vessel operational aspect, using high expansion foam as fire extinguishing agent for total flooding applications in machinery spaces, is a cost effective and safe alternative.





Unitor High Expansion Foam Fire Extinguishing System (Unitor HiFoam System) uses high expansion foam consisting of a synthetic foam concentrate, water and air, which is highly effective for machinery space applications. The system is an environmentally friendlier, non-toxic alternative and harmless to people.

The system can be applied on merchant marine and offshore structures as design is in accordance to SOLAS and in compliance with Class requirements. The system is approved by all major classification societies.

- **Complies with SOLAS and approved by major classification societies (IACS)**
- **Extensive independent testing according to IMO MSC/Circ.668 and Circ.728**
- **Foam testing according to IMO MSC/Circ.670**
- **Foam concentrate complies with requirements of European Council Directive 96/98 on Marine Equipment Directive (MED)**

Protects equipment and personnel

The Unitor HiFoam System is designed as total flooding system for machinery spaces of Category A, cargo pump rooms and other spaces onboard vessels or on offshore installations needing fire protection.

The system can be installed as total flooding for the entire main machinery room or for individual compartments within that space, pump rooms and other separate machinery spaces. Zoning provides an option for selective and sequential release, which gives optimised protection of your equipment and reduce water capacity needs.

With a filling rate of 1.9 metre per minute, time from detection of the fire to deployment can be kept to a minimum, which will help to limit the damage caused by the fire.

The expansion ration of 1:700 using internal air eliminates the need for extensive air ducting and fans, unlike traditional systems which utilise external air to create the air/foam mix.

The components of the foam concentrate are readily biodegradable and have no hazardous decomposition products. With a non-toxic foam concentrate, human life is not endangered when released. Therefore, the system effectively and safely protects both equipment and personnel.

Solution benefits

Unitor HiFoam System is a high quality, compliant fire extinguishing system that is easy to install, has a space saving installation, is easy to operate and requires minimal maintenance. There is no need for extensive air ducting and fans. For service purposes, replacement of the foam concentrate is available worldwide.

Safe for personnel and equipment

The system has a filling rate of 1.9 metre per minute, the quickest and most effective for machinery space fires. A quick foam discharge minimises fire and heat damage to equipment and structure. Sequential release design provides optimised protection to the enclosed space and reduces water capacity. Moreover, Unitor HiFoam System is non-toxic, safe and secure for the crew.

Cost effective solution

Unitor HiFoam system is designed for optimum system performance, keeping both installation and operational costs low. The high expansion foam does not require an external foam generating room, and there is no need for extensive air ducting and fans. The quick discharge reduces damages and water usage is low. Minimal and easy maintenance keeps operational cost low.

UNITOR HIGH EXPANSION FOAM FIRE EXTINGUISHING SYSTEM

System description

The system can be designed and installed both as total flooding for the whole main machinery space, for individual compartments within that space, pump rooms and other separate machinery spaces.

The system consists of a storage tank for foam concentrate at atmospheric pressure, a foam concentrate pump and mixing equipment located in the foam central room. The foam concentrate is mixed with water in a proportioner or an inductor and is discharged through the foam generators. The nominal working pressure is 6 bar at the foam generators. The system can use both fresh and sea water.

Foam generators are installed at the highest level in the protected space and at strategic locations above high risks areas. The water/foam mixture is expanded with air in the generators. The air used for producing foam is drawn from the protected space, thus, no ducting and fans for external air is required.

The foam produced by the foam generators fall directly by gravity to cover the entire protected space. The system has a Class witnessed 20 metres foam stack height test.

The system can be manually released from the foam central room by directly operating the valves and pumps. It can also be remotely operated, if required, by a control cabinet located centrally with local control cabinets for operational flexibility.

Extinguishing fire using high-expansion foam

Unitor HiFoam System utilises synthetic high expansion foam, which uses air from inside the machinery space to generate high expansion foam for smothering the fire. Different to the traditional foam concentrates, use of internal air eliminates the needs for extensive air ducting and fans.

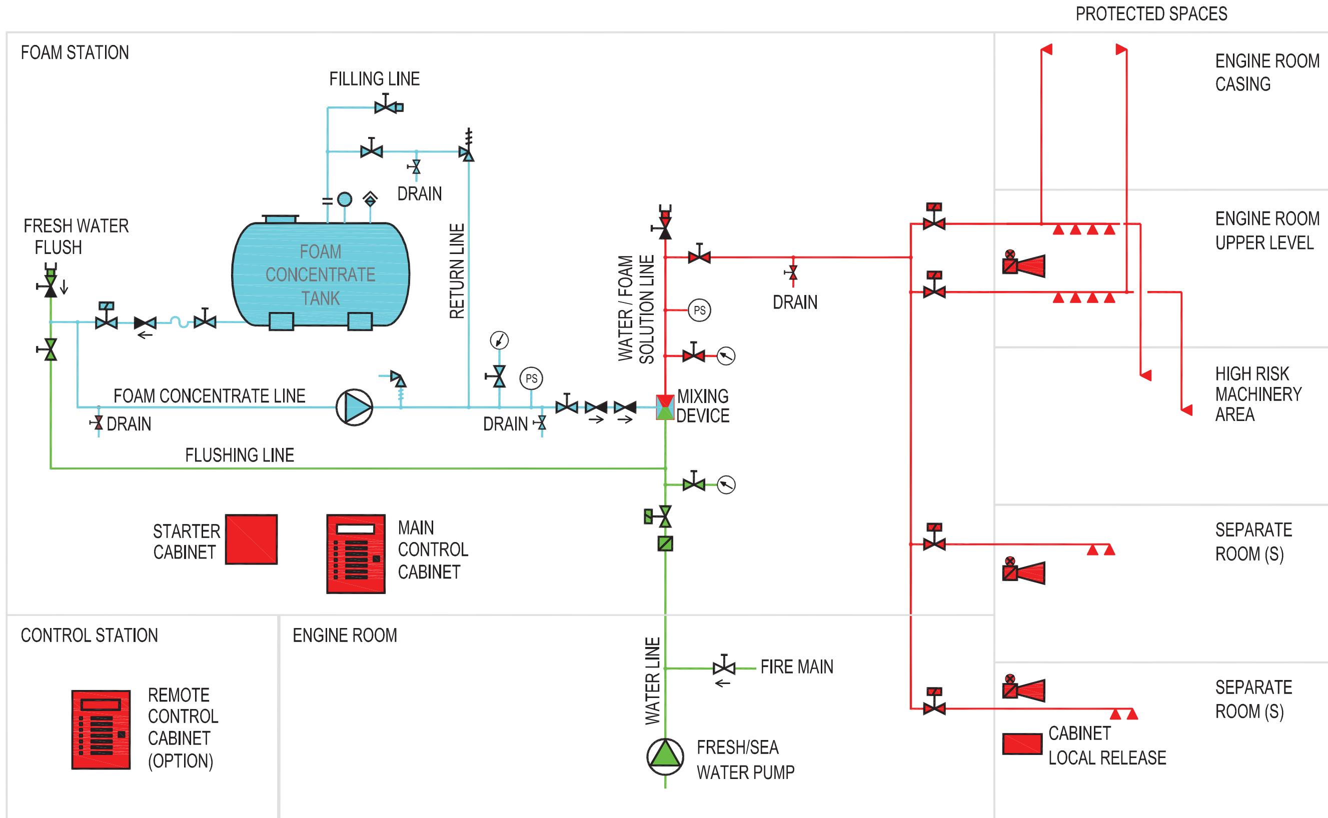
Unitor HiFoam System extinguishes the fire as it fills all void spaces, effectively starving the fire of oxygen and cooling the objects on fire. The high expansion foam has a 1:700 expansion ratio and it has high resistance for heat and smoke generated during fire. The system can use both fresh and sea water.

The foam suppresses fire by separating the fuel from the air, starving the flames of oxygen and immediately eliminating combustion. Foam extinguishes fire by blanketing the fuel surface, smothering the fire and separating flame from the fuel surface, cooling the fuel to lower flammability, and reducing the release of flammable vapours into the air.

For maximum effectiveness it is critical the foam concentrate is mixed with water in the correct proportions throughout the fire fighting operation.

The system can be applied on merchant marine and offshore structures as design is in accordance to SOLAS and IMO MODU Code. The system is approved by all major classification societies.

Standard configuration



Technical data

GENERATORS

Foam capacity	
UFG-90 [m^3/min]	63
UFG-60 [m^3/min]	42
UFG-30 [m^3/min]	21
Material	stainless steel
Nom.working pressure	6 bar (@ generator)
Expansion ratio	1:700
Connection flange	DN 20

FOAM CONCENTRATE

Type	synthetic
Viscosity [cSt] @ -2°C	<60
Lowest working temperature	-2°C
Storage temperature	-2°C to +45°C
Approval	MED certified

MIXING EQUIPMENT

Type	balanced pressure proportioner or inductor
Capacity [l/min]	75 to 20,000
Material	stainless steel and bronze

www.wilhelmsen.com/shipsequipment

What is Wilhelmsen Ships Equipment?

Wilhelmsen Ships Equipment offers fully engineered safety, environmental and insulation solutions for the newbuilds and retrofits in the maritime and offshore markets. The company's main capabilities are design, production, installation (on request) and commissioning.

Annually, Wilhelmsen Ships Equipment delivers over 1500 systems from sales locations around the world. Today, our solutions and equipment are used by roughly a quarter of the world's merchant fleet.

Our safety solutions contain complete systems for smoke and fire detection, fire-fighting for closed rooms and open spaces, and nitrogen inert gas systems, as well as loose safety equipment.

We have a solutions approach to environmental problems and can provide solutions for emissions to air, waste management (such as reduction of waste and oily water), ballast water treatment and fuel efficiency.

Through our company TI Marine Contracting we deliver low-temperature insulation of cargo tanks on gas carriers and terminal piping, as well as fire and comfort insulation of naval vessels.

We are present in all major shipbuilding countries and delivers after sales service through our sister company Wilhelmsen Ships Service with local expertise worldwide.

Wilhelmsen Ships Equipment
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Email: wse.info@wilhelmsen.com
www.wilhelmsen.com/shipsequipment

For service and spares, contact:
Wilhelmsen Ships Service
Tel.: +47 67 58 45 50, Fax: +47 67 58 45 70
Email: wss.info@wilhelmsen.com
www.wilhelmsen.com/shipsservice

Products

ENVIRONMENTAL SOLUTIONS

- Unitor Ballast Water Treatment System
- NOxCare Marine
- Unitor Fuel Homogeniser Systems
  - UFH Reducer
  - UFH Improver
  - UFH Injector
  - UFH Recycler
- Unitor Oily Water Pod

SAFETY SOLUTIONS

Unitor Fire Suppression Systems

- CO_2 Fire Extinguishing System
- Unitor 1230 Clean Agent Fire Extinguishing System
- High Expansion Foam Fire Extinguishing System
- Local Application Fire Fighting System
- Deep-Fat Cooker Fire Extinguishing System
- Water Mist Fire Extinguishing System
- Fire Detection and Fire Alarm System
- Sample Extraction Smoke Detection System
- Low Expansion Foam Fire Extinguishing System
- Dry Chemical Powder Fire Extinguishing System

Unitor-Generon Nitrogen Systems

- Nitrogen Membrane Inert Gas System
- Nitrogen Membrane Controlled and Modified Atmosphere System
- Nitrogen Cylinder System

INSULATION SOLUTIONS

Cryogenic Insulation Land & Marine

- LPG/LNG Tank and Piping

Commercial Marine & Naval Vessels

- Thermal Insulation
- Acoustic Insulation
- Fire Insulation

LOOSE EQUIPMENT

- Oxygen/Acetylene Fixed Systems
- Fire and Safety Equipment

010909•No 707020•rev.01

It's our environment, Act now!

Wilhelmsen Ships Equipment

Part of Wilhelmsen Maritime Services,
a Wilh. Wilhelmsen group company

Annex J

Oscar Wilde major machinery space exercise report

EMERGENCY DRILL PLAN

DOBSON FLEET MANAGEMENT LTD.

Ship Oscar Wilde Date 08.12.2009

Type of Emergency

Fire	☑	Main Engine Failure	☐	Bridge Control Failure	☐
Abandon Ship	☑	Grounding	☐	Electrical Power Failure	☐
Steering Failure	☐	Cargo Shift/Jettison	☐	Structural Failure	☐
Oil Spill	☐	Serious Illness/Injury	☐	Explosion	☐
Heavy Weather	☐	Piracy	☐	Enclosed Space Rescue	☐
Man Overboard	☐	Collision	☐		
Search & Rescue	☐	Helicopter Operations	☐		

Details of Emergency Situation to be exercised

Ship under way from Rosslare to Cherbourg. It is 12 a clock AM (one hour before arrival to Cherbourg). There will be a fire alarm from purifier room. Motorman sent to check and he confirms the fire. GES will be sounded Hi- Fog system activated but fails. WT doors closed. On scene command set up in ECR. 2nd Eng. OSC.

Hazards Expected from this Situation (*including from any IMDG cargo carried*)

Fire is close to the HFO and DO tanks-may cause the explosion

Actions Required for Hazards Expected

Boundary cooling in the purifier room - HFO and DO tank bulkheads

Boundary cooling in deck 2 in ER workshop and air compressor space.

Boundary cooling in ME room

On Board Response

(Consider initial response - use fixed gas extinguishing? Are fire teams required? How should emergency teams deploy and what will their duties be? Does LSA need to be prepared? What about medical treatment?)

Purifier room ventilation to shut down. Powet to be isolated. Start Em fire pump. Engine fire party to attack the fire using foam applicator. ME ventilation to stop. ERP-boudary cooling on deck 2. Deck fire party-back up Intense fire reported in purifier room. Desition to operate the quick closing valves. Stop ME. Start Em. Generator Stop Main Generators. Desition to activate Hot Foam system. Engine fire party to call back and close the WT door. Hot Foam system fails. Captain seeks for assistance from shore side. Deck fire party to relieve the engine fire party to continue extiquish the fire and cool the boundaries in purifier room.

Shore side team arrives and takes over the fire fightning from ship team.

When the fire element is completed we will continue with "Abandon Ship". 201 Passenger cards will be spread all over the ship for search and clearing parties.

Post Exercise Review - Note comments about progress of emergency drill

It was very good experience for ships crew and also to French fire team. The main problem was the language barrier between French team and ships team. Anyway the drill was working and the fire teams attacked the fire and extinquished it. When the shore side fire team arrived the ships team backed up and acted as support team by boundary cooling. The idea was to have the attacking teams mixed with ship crew and shore side crew which did not happened. We should repeat those trainings with shore side to get more experience.

Master ______________________

DOBSON FLEET MANAGEMENT LTD.

Fire and Abandon Ship Drill Evaluation

VESSEL: OSCAR WILDE **Date:** 08.12.2009

Fire Drill	√	X	Comments
Initial action, notification, alarm	✓		
On scene in adequate time (10 mins)	✓		
Do crew know their assignments	✓		
Communication between fire parties		X	Communaction was poor during the drill between BA team and
Fire fighting skill of crew	✓		Leader.C/E [redacted] has been working on this and it is done
Equipment used as per muster list	✓		by now. BA teams radios are changed and we have 4 radios for
Familiarity with equipment	✓		them at the moment. They are working well even from long
Investigating the fire	✓		distance.
Securing power & ventilation	✓		
Setting fire boundaries	✓		
Cooling of adjacent areas	✓		
Handling of casualty	✓		
Team work	✓		

Abandon Ship

Initial action, notification & alarm	✓		
Mustered in adequate time	✓		
Do crew know their assignments	✓		
Donning of lifejackets	✓		
Communication between Master & Muster	✓		
Do crew bring proper equipment	✓		
Is the boat launched in time (10 mins)	✓		
Crew accountability (Muster lists)	✓		

√ Indicates satisfactory performance, does not need a comment but may have one.

X Indicates unsatisfactory performance about which action must be taken by the next fire & boat drill to improve results.

The Master is to complete this form at the first drill after joining the vessel, within 24 hours after each major crew change (i.e when more that 25% of the complement have changed) & monthly thereafter. Discuss at next Safety Committee meeting on board & send copy to DFM with Safety Committee minutes.

Idea based on USCG Drill Evaluation Sheet

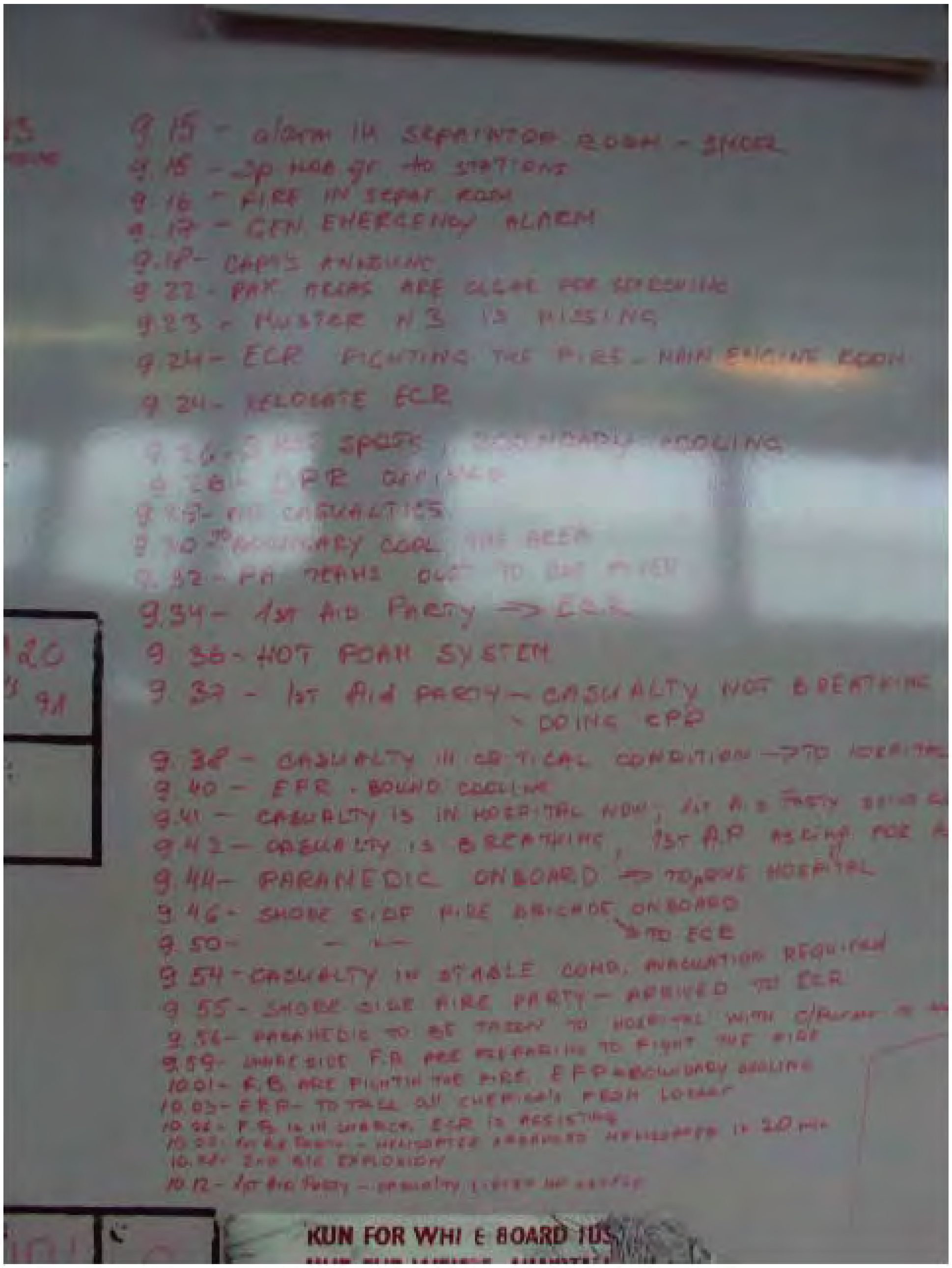
Captain ______________________ **Ship's Stamp**

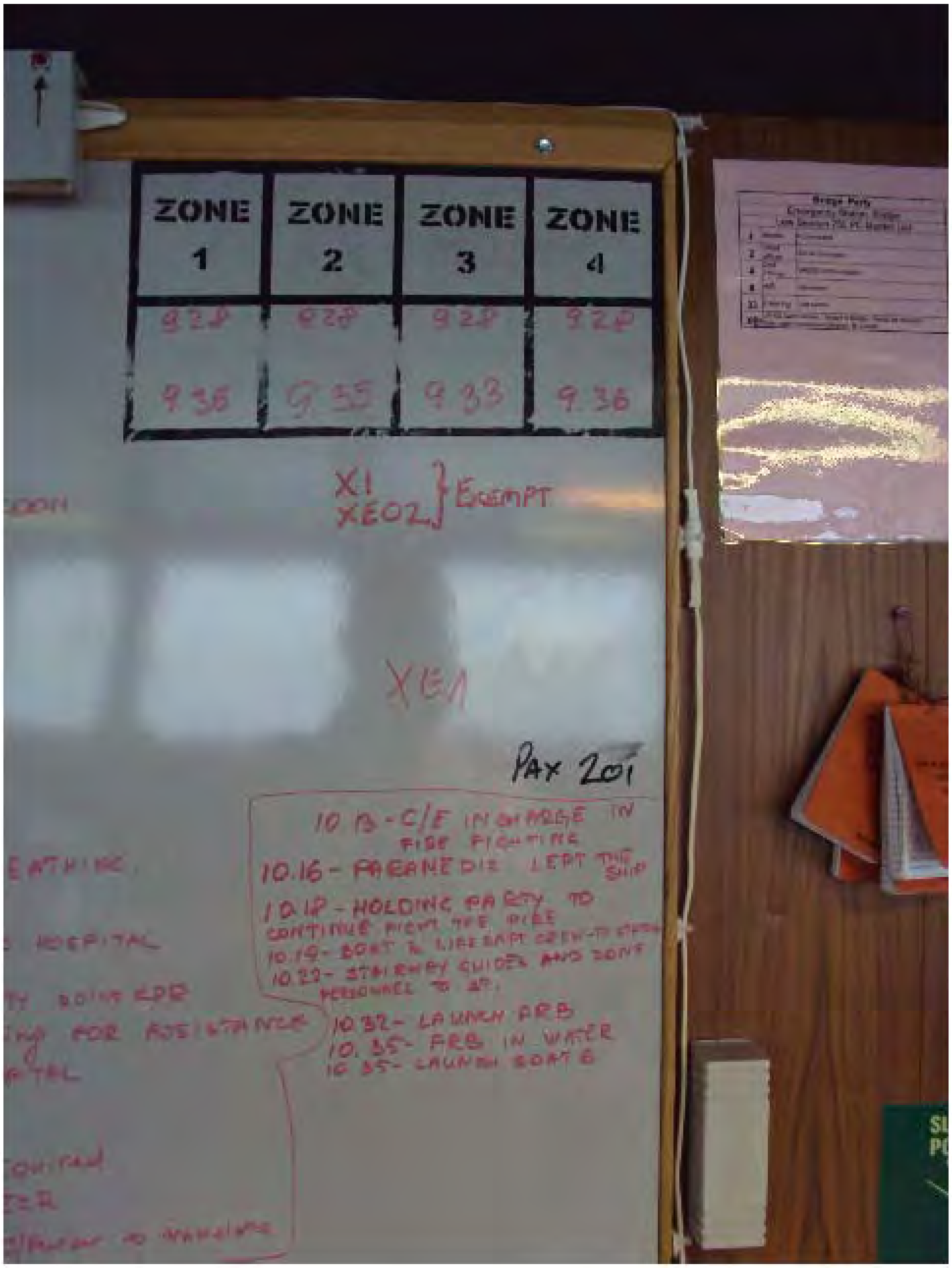
Name [redacted]

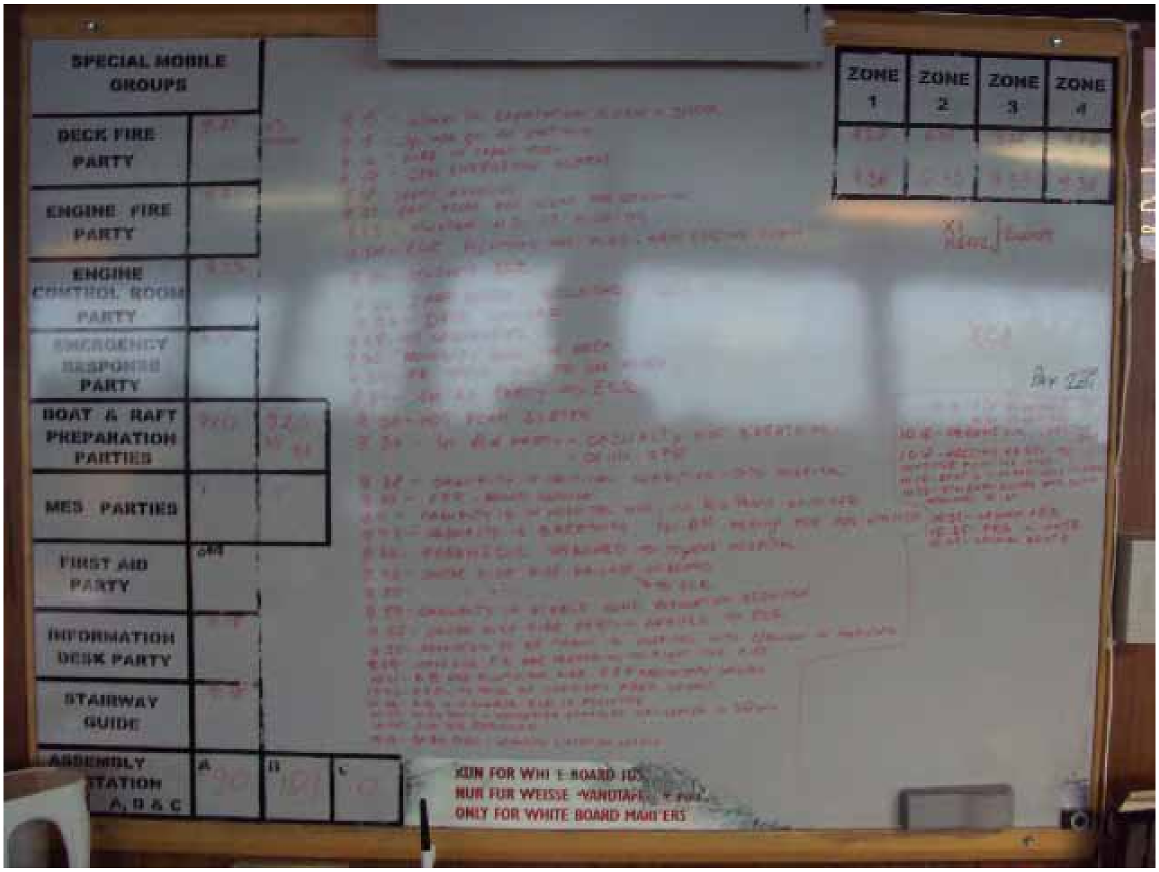
Bullets for drill with French fire team on 08.12.2009

1. Fire in the purifier room
2. GES
3. Hi-Fog system activated but fails
4. WT doors closed
5. Fire parties mustering
6. 2nd Eng OSC
7. OSC set up in ECR
8. Deck fire party to come to ECR bringing extra foam drums.
9. ERP to bring the foam drums from Fire Station 2
10. Purifier ventilation shut down
11. Power Isolated
12. Start Em. Fire pump
13. Engine fire party to go to ME room deck 1 and set up foam branch
14. ME room ventilation stopped
15. Engine fire party enter purifier room to attack the fire
16. 3rd team member to deal with foam drums
17. ERP to set up the boundary cooling in work shop and air compressor space
18. Engine room fire party reports intense fire in purifier room
19. Decision taken to operate quick closing valves
20. Stop ME
21. Start Em Generator
22. Stop Main Generators
23. Operate quick closing valves
24. Engine room fire party to call back to ME room and close WT door
25. Decision to release Hot Foam
26. Hot foam fails
27. Master seeks assistance from shore side
28. Deck fire party will relieve the engine fire party and re-enter purifier room to attack the fire
29. Shore side fire team arrives and takes over the fighting from ships fire teams.


SPECIAL MOBILE GROUPS
DECK FIRE PARTY
ENGINE FIRE PARTY
ENGINE CONTROL ROOM PARTY
EMERGENCY RESPONSE PARTY
BOAT & RAFT PREPARATION PARTIES
MES PARTIES
FIRST AID PARTY
INFORMATION DESK PARTY
STAIRWAY GUIDE
ASSEMBLY
TATION
A, B & C
ONLY FOR WHITE BOARD


9.15 – alarm in separator room
9.16 – FIRE IN SEPAR. ROOM
9.17 – GEN EMERGENCY ALARM
9.23 – MUSTER N3 IS MISSING
9.24 – ECR FIGHTING THE FIRE – MAIN ENGINE ROOM
9.24 – RELOCATE ECR
9.29 – CASUALTIES
9.34 – 1st AID PARTY
9.36 – HOT FOAM SYSTEM
9.37 – 1st Aid PARTY – CASUALTY NOT BREATHING
– DOING CPR
9.38 – CASUALTY IN CRITICAL CONDITION
9.41 – CASUALTY IS IN HOSPITAL NOW
9.42 – CASUALTY IS BREATHING
9.44 – PARAMEDIC ONBOARD
9.46 – SHORE SIDE FIRE BRIGADE ONBOARD
TO ECR
9.50 –
9.54 – CASUALTY IN STABLE COND.
9.55 – SHORE SIDE FIRE PARTY – ARRIVED TO ECR
KUN FOR WHI E BOARD US


ZONE 1
ZONE 2
ZONE 3
ZONE 4
9.28
9.36
9.35
9.33
9.36
X1
XE02
EXEMPT
PAX 201
10.13 - C/E IN CHARGE IN FIRE FIGHTING
10.16 - PARAMEDIC LEFT THE SHIP
10.32 - LAUNCH FRB
10.35 - FRB IN WATER


SPECIAL MOBILE GROUPS
DECK FIRE PARTY
ENGINE FIRE PARTY
ENGINE CONTROL ROOM PARTY
EMERGENCY RESPONSE PARTY
BOAT & RAFT PREPARATION PARTIES
MES PARTIES
FIRST AID PARTY
INFORMATION DESK PARTY
STAIRWAY GUIDE
ASSEMBLY STATION A, B & C
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ONLY FOR WHITE BOARD MARKERS

INFORMATION DESK PARTY (MES MAINTENANCE 750pc)

DATE 08/12/09

AREA	Checked in & Search started	Missing Nrs	Search Results	Passenger Nrs: Adults Manifest Nr.:	Passenger Nrs: Childrens Manifest Nr.:	Crew Nr.: Manifest Nr:	Report to BRIDGE: 4810
INFORMATION	~~31~~, ~~32~~		N/A	N/A	N/A	N/A	
DESK 3000 / 4805	XC TOTAL: 7						
	XC TO ASS "A":		N/A	N/A	N/A	N/A	
STAIRWAY GUIDE:	~~85~~, ~~86~~, ~~87~~, ~~88~~, ~~89~~, ~~90~~		N/A	N/A	N/A	N/A	
ZONE 1 3161	V V			N/A	N/A	N/A	
ZONE 2 4834	V V			N/A	N/A	N/A	
ZONE 3 3014	V V			N/A	N/A	N/A	
ZONE 4 3016	V V			N/A	N/A	N/A	
STATION "A"	V		N/A	20-23-88-90			
STATION "B"	V		N/A	58-99-101			
STATION "C"	V	X1	N/A	0-			
HOSPITAL KEY COLLECTED BY FIRST AID PARTY			N/A				

MAIB Safety Bulletin 2/2010

MAIB SAFETY BULLETIN 2/2010

Failure of fixed high expansion foam system to
extinguish fire on board the passenger ferry *Oscar Wilde*

Marine Accident Investigation Branch
Mountbatten House
Grosvenor House
Southampton
SO15 2JU

MARINE ACCIDENT INVESTIGATION BRANCH

MAIB SAFETY BULLETIN 2/2010

This document, containing safety lessons, has been produced for marine safety purposes only, on the basis of information available to date.

The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 provide for the Chief Inspector of Marine Accidents to make recommendations at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so.

Stephen Meyer
Chief Inspector of Marine Accidents

NOTE

This bulletin is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall not be admissible in any judicial proceedings whose purpose, or one of whose purposes, is to apportion liability or blame.

This bulletin is also available on our website: www.maib.gov.uk

Press Enquiries: 020 7944 3231/3387; Out of hours: 020 7944 4292
Public Enquiries: 0300 330 3000

BACKGROUND

At approximately 1912 (UTC) on 2 February 2010, a fire broke out in the auxiliary machinery space on board the roll-on roll-off cruise ferry *Oscar Wilde*. The ferry had just sailed from Falmouth, UK after completing her annual docking. The seat of the fire was in way of a diesel alternator fuel supply module **(Figure 1)** and quickly spread across the compartment.

Figure 1

As part of the fire-fighting effort, the fixed total flooding system (high expansion foam) was activated but did not extinguish the fire. Although all of the foam solution in the system was deployed into the auxiliary engine room, no foam was produced. The fire burned fiercely for over 1 hour before it was extinguished by the ship's crew.

The fire is being investigated by the Marine Accident Investigation Branch and The Bahamas Maritime Authority.

ANALYSIS

The high expansion foam system was installed in 2002 and was designed to generate foam using the atmosphere from within the machinery compartment. The system was type-approved and had been maintained and tested in accordance with the manufacturer's instructions and current IMO guidance. It had been blown through with air in April 2009 and tested to the satisfaction of a Classification Society/Flag state surveyor during the dry docking. However, technical investigation has identified that:

- 80% of the foam generator nozzles within the auxiliary engine room were blocked by debris **(Figure 2)** and about 50% of the nozzles in the other protected spaces on board were also clogged.

Figure 2

- The distribution pipework for the foam solution contained debris and was corroded **(Figure 3)**.

Figure 3

- There were several sections of the system's distribution pipes in which water and/or foam solution could have been trapped following the testing of the system **(Figure 4)**.

Figure 4

The debris found in the nozzles and piping is most likely to have been rust and scale that had built up in sections of pipe in which water and/or foam solution had previously been trapped. This debris would then have been distributed along the pipes and into the nozzles during the annual blow through tests and when the system was operated. The resulting blockages were sufficient to prevent the aspiration of the foam solution.

ACTION TAKEN

Compliance with IMO guidance on the installation and testing of this system did not prevent its failure. Therefore, The Bahamas Maritime Authority (BMA) will bring to the attention of the International Maritime Organization (IMO) sub-committee on fire protection (FP) in April 2010, the need to urgently review current requirements for the installation and testing of the distribution piping of high expansion foam systems using inside air with regard to:

- The inspection of nozzles following blow through tests
- The elimination of potential liquid traps
- Consideration of the need to flush systems with fresh water periodically

The BMA aims to ensure that any resulting changes to the guidance are approved by the IMO's Maritime Safety Committee (MSC) in December 2010. The Maritime and Coastguard Agency (MCA) has agreed to support Bahamas in its actions at both FP and MSC.

RECOMMENDATION

S109/2010 Owners of ships fitted with high expansion foam systems utilising the atmosphere from within a protected space are recommended to urgently:

- Remove and inspect all foam generator nozzles to ensure they are free from debris.
- Inspect sections of distribution piping in which water or foam solution might collect and to fit drains where appropriate.

Owners, operators or manufacturers that find system nozzles to be blocked or identify corrosion within distribution pipes are requested to inform the MAIB by e-mail (maib@dft.gsi.gov.uk) using the title 'Foam Systems' and include the names of the vessel and the system manufacturer, and the date and place of installation. This information is for internal use only and will be treated in the strictest confidence.

Issued March 2010