Inboard 28mm steel wire ramping rope test certificate

PFEIFER ROPE & TACKLE

CERTIFICATE OF TEST AND EXAMINATION AND DECLARATION OF EC CONFORMITY

Certificate No. RT/92459-1

STBO FWD
FITTED 10/3/10

[redacted]

O/No. PR26478

Customer Wightlink Limited
'St. Helen'

1. Name and address of the maker or supplier of the rope .....

PFEIFER
ROPE & TACKLE
North Road,
Marchwood Industrial Park,
Marchwood,
Southampton SO40 4BL
Phone 023 8066 5470
Fax 023 8066 5471
E-mail sales@ropeandtackle.com
Web www.pfeifer.de

1 No. 16.3 metres c/w thimble eye one end, fused and tapered other end.

2. (a) Diameter of rope ..... 28mm dia.
(b) Number of strands 32
(c) Number of wires per strand ..... 7 (HI-FLEX)
(d) Lay ..... RHOL Galvanised

3. Tensile strength of wire 2160N/mm2 to BSEN12385-4:2002

4. (a) Date of test of sample of the rope 06.06.09
(b) Load at which this sample broke 675kN
(c) Safe working load,
@ F.O.S. 5:1
unless otherwise stated 135kN

5. Name and address of public service, association, company, firm or person making the test ..... **Pfeifer Rope & Tackle Ltd.**

6. Position in public service, association, company, or firm named above of person who made the test Appointed Tester

I certify on behalf of the firm or person named in 1/5 above, that the above particulars are correct

Signature ... [redacted]

Date 09.03.10

The Test House report and selected photographs

LABORATORY REPORT

LABORATORY BASED EXAMINATION AND FAILURE ANALYSIS ON THE FWD STARBOARD 28 mm DIAMETER ZINC PLATED STEEL WIRE ROPES AND CORRESPONDING MEZZANINE DECK SECTION FROM THE RORO FERRY ST HELEN

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

THE TEST HOUSE (CAMBRIDGE) LTD REPORT REFERENCE: T41192
PURCHASE ORDER No. 8000132510
RECEIPT DATE: 5 August 2014
REPORT DATE: 18 September 2014

1. INTRODUCTION

The Test House was provided with a FWD (forward) starboard mezzanine deck section with sheaves, a fractured FWD starboard mezzanine deck beam section and associated FWD starboard steel wire ropes from the RORO (Roll On-Roll Off) Wightlink ferry St Helen (Figures 1, 2, 3 and 4). The FWD starboard inboard side rope, which had reportedly parted during the disembarkation process as the mezzanine deck was lowered after vehicles on the lower deck had left the ship, causing it to drop and make contact with the deck below. There were nine vehicles on the mezzanine deck at the time of the incident which resulted in four injuries. The rope parting site was reported to correspond with the vertical sheave location where the rope would have been in tension.

The mezzanine deck underwent its six monthly LOLER (Lifting Operations and Lifting Equipment Regulation) examination in April 2014, which made an observation for the rope to be cleaned and dressed. On board inspections

were carried out monthly (checklist) by the crew. The rope was dressed on an ad hoc basis and the last record of lubrication was November 2012 although it is verbally reported that the ropes were lubricated with Exxon MOBILARMA LT in April 2014. The subject rope had been fitted to the deck on 10 March 2010, and we were provided with a copy of the rope test certification (Appendix 1). The test certification documented the rope construction and test details as follows.

Diameter: 28 mm
Tensile strength grade: 2160 N/mm^2
Actual breaking load: 675 kN
Lay type: 32 x 7, RHOL (Right Hand Ordinary Lay)
Construction type: Hi-Flex
Safe working load: 135 kN

The wire rope samples, mezzanine deck sheaves and fractured deck beam were examined in The Test House (TTH) metallurgical laboratory and the rope break load tested by a UKAS accredited laboratory as follows.

2. RECEIPT INSPECTION & VISUAL EXAMINATION

2.1 FWD STARBOARD MEZZANINE DECK SECTION

A section of mezzanine deck along with the vertical and horizontal sheaves from the inboard side was flame cut and supplied (Figures 5 and 6). The steel was in a reasonable condition albeit with signs of corrosion and parent metal wastage. The vertical sheave rotated fairly freely, showed corrosion, a region of deformation of the groove side, wear and imprinting on the groove (Figures 7, 8, 9, 10, 11 and 12). The wear was central and the sheave groove was checked using four in-house machined radius gauges (29.00, 29.68, 30.80 and 31.00 mm) based on the recommended 6-10% oversize with respect to the nominal rope diameter (CASAR - Wire Rope Inspection and Examination). The sheave groove and corresponding contact angle was measured at four positions at 90° intervals.

12 o'clock (damage): 31.00 mm and ≤ 90º
3 o'clock: 29.00 mm and ≤ 130º
6 o'clock: 29.00 mm and ≤ 130º
9 o'clock: 29.00 mm and ≤ 130º

The horizontal sheave rotated freely, showed corrosion, wear and imprinting on the groove (Figures 13, 14, 15, 16, and 17). The wear was off centre and the sheave groove was checked using four in-house machined radius gauges (29.00, 29.68, 30.80 and 31.00 mm) based on the recommended 6-10% oversize with respect to the nominal rope diameter. The sheave groove and corresponding contact angle was measured at four positions at 90° intervals.

12 o'clock: 31.00 mm and ≤ 120º
3 o'clock: 31.00 mm and ≤ 120º
6 clock: 31.00 mm and ≤ 120º
9 o'clock: 31.00 mm and ≤ 120º

As the rope enters a sheave, it initially makes contact with the flange of the groove and as it continues to pass over the sheave it moves down the flange until it sits in the bottom of the groove. The wear tread on the horizontal sheave was off centred which is indicative of an incorrect fleet angle (Figures 18 and 19).

2.2 FRACTURED MEZZANINE DECK BEAM

A section of the fractured mezzanine deck beam was flame cut and supplied (Figures 20, 21 and 22). The steel was in a reasonable condition with signs of corrosion and parent metal wastage. The deck beam exhibited a fracture running vertically (Figure 23). The fracture was through a weld between a 9.80 mm and 6.00 mm beam plate (Figures 24, 25, 26, 27, 28, 29 and 30). The fracture propagated through an 8.00 mm plate welded to the beam (Figures 31 and 32). The deck section was further cut to facilitate opening of the fracture for examination (Figures 33 to 42). Further sections were removed from the fractured weld and plate for detailed SEM and metallurgical

examination (Figure 43). The fractured weld showed worm holes, gas porosity and lack of fusion across the surface (Figure 44). The plate surface from both sides showed corrosion beneath the paint (Figures 45 and 46). The fractured plate showed very little corrosion indicative that the fracture had occurred recently (Figure 47).

2.3 FWD OUTBOARD STEEL WIRE ROPE

The rope comprised of a tapered end and flared cut end (Figures 48 and 49). The total length of the rope was measured to be 15,700 mm. The rope exhibited a raised outer strand at 1,400 mm (Figure 50) and a kink at 2,600 mm (Figure 51) from the tapered end. The rope exhibited corrosion, outer strand mechanical wear and lack of lubricant across the whole length (Figures 52 to 59). The interlay strands appeared partially lubricated with limited penetration of lubricant to the inner lay (Figures 60, 61 and 62).

The rope diameter was measured in two planes at metre intervals, results of which are reported in Appendix 2 Page 1. The rope was up to 1.17 mm larger and in the second plane of measurement 1.34 mm larger than the nominal rope diameter of 28 mm.

The rope was of regular right hand lay, with an outer lay length of 170 mm. It comprised of 18 outer strands of seven wires laid right hand, ten interlay strands of seven wires laid left hand, five inner lay strands of seven wires laid right hand and a seven wire central core strand. The construction of the rope (alternate lay directions) was consistent with a non-rotational type rope.

2.4 FWD INBOARD PARTED STEEL WIRE ROPE – BOTTOM SECTION

The rope comprised of a flared cut end and parted site (Figures 63 and 64). The total length of the rope was measured to be 6,675 mm. The interlay strands appeared partially lubricated with limited penetration of lubricant to the inner lay (Figure 65). The rope exhibited corrosion, outer strand mechanical wear and lack of lubricant across the whole length (Figures 66, 67, 68 and

69). After removal of the protective packaging from the parted site (Figures 70 and 71) a loose outer strand was noted at 4,660 mm from the cut end (Figures 72 and 73). The loose outer strand showed a break site at 5,780 mm (Figure 74). The rope exhibited two outer strand wire break sites at 6,000 and 6,035 mm (Figure 75) from the cut end. The parted region exhibited mechanical wear at the outer strands and was fairly dry at the interlay and inner lay strands (Figures 76, 77, 78, 79, 80 and 81).

The rope diameter was measured in two planes at metre intervals, results of which are reported in Appendix 2 Page 2. The rope was up to 1.26 mm larger and in the second plane of measurement 1.05 mm larger than the nominal rope diameter of 28 mm.

The rope was of regular right hand lay, with an outer lay length of 170 mm. It comprised of 18 outer strands of seven wires laid right hand, ten interlay strands of seven wires laid left hand, five inner lay strands of seven wires laid right hand and a seven wire central core strand. The construction of the rope (alternate lay directions) was consistent with a non-rotational type rope.

2.5 FWD INBOARD PARTED STEEL WIRE ROPE – TOP SECTION

The rope comprised of a tapered end and parted site (Figure 82). The total length of the rope was measured to be 9,940 mm. The rope exhibited corrosion, outer strand mechanical wear and lack of lubricant from the tapered end (Figures 83, 84, 85 and 86). The rope exhibited a kink at 2,800 mm (Figure 87) from the tapered end. The rope exhibited corrosion, outer strand mechanical wear and lack of lubricant across the whole length (Figures 88, 89, 90, 91, 92, 93 94 and 95). Two wire break sites were noted at 7,760 mm (Figure 96) from the tapered end. After removal of the protective packaging of the parted site (Figure 97) a loose outer strand was noted at 8,360 mm from the ferruled end (Figure 98). The parted region exhibited mechanical wear at the outer strands and limited penetration of lubricant to the interlay strands (Figures 99, 100, 101, 102 and 103). The parted rope showed dry outer lay

strands (Figure 104), partially lubricated interlay, inner and core strand (Figures 105, 106 and 107).

The rope diameter was measured in two planes at metre intervals, results of which are reported in Appendix 2 Page 3. The rope was up to 1.11 mm larger and in the second plane of measurement 1.16 mm larger than the nominal rope diameter of 28 mm.

The end was cropped from the rope sample at 8,200 mm from the tapered end and individual wire strands numbered (Figure 108). Outer lay strands were numbered one through to eighteen, interlay strands nineteen to twenty eight, inner lay strands twenty nine to thirty three and the core strand was numbered thirty four. Individual wires at the parting site exhibited widespread mechanical wear in the outer strands (Figures 109 to 126 inclusive), mechanical wear and secondary cracks both in the interlay and inner strands (Figures 127 to 146 inclusive). The core strand also showed mechanical wear at the parted site (Figure 147). Individual wire breaks comprised largely tensile overload type fractures mostly of which comprised of classical cup and cone tensile type fractures. A number of wires appeared to have flat fractures and secondary cracks forming at the outer wires within the strand.

Our detailed examination concludes that the dominant factor at the break site appeared to be overload due to excessive mechanical wear which in turn resulted from lack of service lubrication. Corrosion and fatigue are secondary contributing factors which are also attributed to the lack of lubrication.

3. SCANNING ELECTRON MICROSCOPE EXAMINATION AND EDX ANALYSIS

The fracture surfaces from the mezzanine deck beam weld and plate, selected strands and individual wires from the FWD inboard top section of the parted rope were examined in detail using a Scanning Electron Microscope (SEM) in the cleaned condition and the related features analysed via the

microscope's ancillary Energy Dispersive X-Ray (EDX) spectrometer. The observations were as follows.

3.1 FRACTURED MEZZANINE DECK BEAM PLATE AND WELD

The deck beam plate was cleaned in Clarke solution and the fracture surface showed morphology consistent with microvoid coalescence and some post-fracture mechanical damage (Figures 148, 149, 150, 151, 152, 153 and 154).

The fractured deck beam weld section was cleaned in Clarke solution (Figures 155 and 156) and examined. The fractured weld showed gross worm holes, gas porosity, lack of fusion and remnants of red oxide within the pores (Figures 157, 158, 159 and 160). The weld fracture surface showed morphology consistent with microvoid coalescence (Figures 161 and 162).

3.2 FWD INBOARD PARTED STEEL WIRE ROPE – TOP SECTION

Wire strands were removed from the parting site for detailed Scanning Electron Microscope (SEM) and the zinc plating was analysed via the SEM ancillary Energy Dispersive X-Ray (EDX) spectrometer as follows.

Outer lay strand number 4
Outer lay strand number 10
Outer lay strand number 17
Interlay strand number 19
Interlay strand number 21
Inner lay strand number 30
Core strand number 34

The samples were cleaned in acetone and subsequently examined. The SEM examination complimented the earlier reported visual examination and served to further confirm the extent of the mechanical wear, ductile nature of the wires at the break site and wastage of the zinc plating (Figures 163 to 190 inclusive).

Individual wires were removed to characterise the fracture surface in detail as follows.

Outer lay strand number 3 – outer wire
Outer lay strand number 10 – outer wire
Outer lay strand number 12 – core wire
Outer lay strand number 17 – core wire
Outer lay strand number 18 – outer wire
Interlay strand number 27 – outer wire

The wire samples were cleaned in acetone and subsequently examined. The examination confirmed the ductile nature of the wires at the break site along with some fatigue type fractures (Figures 191 to 203 inclusive).

3.3 FWD OUTBOARD STEEL WIRE ROPE

A cross section from the rope was taken at 7,800 mm from the tapered end, Bakelite mounted and prepared for examination by diamond polishing to a 1µm diamond finish. The prepared section was examined using a Scanning Electron Microscope (SEM) and the related features analysed via the microscope's ancillary Energy Dispersive X-Ray (EDX) spectrometer. The observations were as follows.

The section showed debris, flattening and wear of the outer wires. The debris surrounding an interlay strand and within the interstitial wire regions was analysed to be Fe and Zn (Figures 204 to 211 inclusive).

4. METALLOGRAPHIC EXAMINATION

Metallographic sections from the fractured mezzanine deck beam weld, longitudinal wire sections from various strands and a cross section from the FWD outboard wire rope were Bakelite mounted and polished by standard metallographic preparation techniques to a 1µm diamond finish. The prepared sections were then examined in the un-etched and Nital etched conditions, using high power light microscopy. The observations are noted below.

4.1 FRACTURED MEZZANINE DECK BEAM WELD

The transverse section through the fractured weld showed worm holes, gas porosity, lack of fusion and slag inclusions (Figures 212, 213, 214 and 215). The parent plate materials were of different thicknesses and prepared as a single bevel butt weld. The 9.80 mm plate microstructure comprised of banded ferrite-pearlite (Figure 216). The 6.00 mm plate microstructure comprised of ferrite-pearlite with less banding (Figure 217). The parent plate showed a considerable build-up of paint over the years of service (Figure 218).

4.2 OUTER LAY STRAND NUMBER 3 – OUTER WIRE

The break site was of ductile nature with no evidence of galvanising (Figure 219).The parent wire microstructure was consistent with a high strength patented steel wire (Figure 220).

4.3 OUTER LAY STRAND NUMBER 9 – CORE WIRE

The break site was partial ductile/flat with evidence of galvanising and secondary cracks (Figure 221 and 222). The parent wire microstructure was consistent with a high strength patented steel wire (Figure 223).

4.4 OUTER LAY STRAND NUMBER 12 – CORE WIRE

The break site was of ductile nature with little evidence of galvanising (Figure 224).The parent wire microstructure was consistent with a high strength patented steel wire (Figure 225).

4.5 OUTER LAY STRAND NUMBER 17 – CORE WIRE

The break site was of ductile nature with little evidence of galvanising (Figure 226).The parent wire microstructure was consistent with a high strength patented steel wire (Figure 227).

4.6 INTERLAY STRAND NUMBER 26 – OUTER WIRE

An outer wire with a secondary crack was prepared longitudinally and showed the crack originating from the outer surface and propagating along the wire microstructure (Figures 228 and 229). The section showed further secondary crack propagating inwards from the outer surface below the galvanising (Figures 230, 231 and 232). The parent wire microstructure was consistent with a high strength patented steel wire (Figure 233).

4.7 INTERLAY STRAND NUMBER 27 – OUTER WIRE

The break site was partial ductile/flat with evidence of galvanising (Figure 234 and 235). The parent wire microstructure was consistent with a high strength patented steel wire (Figure 236).

4.8 FWD OUTBOARD WIRE ROPE

The FWD outboard wire rope cross section (Figure 237) showed flattening and wear of the outer strands (Figures 238 and 239). Further detailed examination identified absence of galvanising and corrosion of the individual outer lay strand wires (Figures 240, 241 and 242). The section also identified debris between the interlay strands and at the strand wire interstitials (Figures 243 and 244).

5. VICKERS HARDNESS TEST

The prepared longitudinal metallurgical sections of the individual wires were Vickers hardness tested using a light test load of 500g after documenting of microstructural features and the results are reported in Appendix 3 Page 1.

The fractured mezzanine deck beam weld section was Vickers hardness tested to characterise parent metal hardness of both plates using a load of 10kg and the results are reported in Appendix 3 Page 2.

6. BREAK LOAD TESTING

A 2,000 mm test sample was removed from a visually damage free site from the FWD outboard wire rope (Figure 245) between 8,000 to 10,000 mm from the ferruled end and was tested by a UKAS accredited testing laboratory. The break load test result is certified in Appendix 4.

The break load for the sample at 595.8 kN was 79.2 kN (12%) below what had originally been certified for the rope and just marginally above the minimum breaking load of 593 kN for the grade of rope (Table 16 – BS EN 12385-4:2002+A1:2008). The parting was clear of the cast-on grip ends and the rope lay exhibited minimal to no lubrication penetration and regions of interlay corrosion (Figures 246 to 254 inclusive).

7. CONCLUSIONS, DISCUSSION AND OPINION

The mezzanine deck sheaves showed wear and imprinting on the groove. The vertical groove showed a region of deformation and rotated fairly freely. The horizontal sheave showed imprinting and off centred wear suggesting an incorrect fleet angle. Both sheaves showed material wastage through corrosion and absence of lubrication.

The fractured deck beam weld was grossly riddled with worm holes and porosity, lack of fusion and slag inclusions. The weld was covered up with layers of paint during its service and these workmanship flaws identified would have been expected to have been noted during visual inspection after initial fabrication. The flaws resulted in the load bearing capacity of the weld being severely diminished. The fracture propagated through the beam plate in a ductile manner suggesting that the weld and plate fracture was consequential damage arising from the change in loading after the rope failure.

The rope was certified as a 32 x 7 and during the examination it was found to be of 34 x 7 type construction. A question was raised regarding this to which

the reply from the rope supplier addressed it be a typographical error and it is not clear why this error had not been rectified or identified previously. Both outboard and inboard ropes showed dry outer strands, mechanical wear and little penetration of lubrication to the internal strands. The individual wire break sites noted were principally due to mechanical wear and the resulting reduced cross section, the examined strands at the parted site were mostly of ductile nature and secondary break sites and cracks were identified in the interlay strands. External wear is abrasion of the crown wires in the outer strands in the rope resulting from rubbing contact, under pressure with the groove of the sheave and shows as flat surfaces on the outer wire. Internal wear is caused by friction between individual strands and wires in the rope, particularly when it is subject to bending. Both external and internal wear was observed on the examined parted rope strongly pointing to a lack of lubrication during service.

The microstructure of the rope wires appeared consistent with the parent wire having received a patenting type heat treatment. The hardness test results were within the range we would have expected to see in a high strength patented and fully cold drawn parent steel wire.

The outboard rope achieved a break load of 595.8 kN (88% of the original certified value for the rope). The break load tested outboard rope was marginally above the minimum specified break load of 593 kN suggesting that the strength of the rope had decreased due to mechanical wear. The parted rope sections exhibited more mechanical wear than the inboard rope suggesting that the strength of the rope in the vicinity of the failure would have been substantially below the certified value.

Our laboratory based examination and tests have identified a number of factors that had contributed to parting of the inboard rope and these include.

i. The apparent failure to maintain a suitably protective level of service lubricant on the rope, the type of which will be dependent upon the application of rope and environmental conditions the rope is exposed to.

ii. The apparent failure to maintain a suitably protective level of service lubricant on the sheaves.

iii. Apparent failure to monitor the ropes condition via regular effective inspections.

iv. Failure to monitor the groove wear of the sheaves and incorrect fleet angle at the horizontal sheave.

Though not specifically covering deck lift ropes or ropes of St Helen, the reader's attention is drawn to the best practice specified in BS ISO 4309:2010 (Cranes – Wire Ropes – Care and maintenance, inspection and discard). Had the inboard rope been managed in a system following the best practice specified in the above, its condition should have been recognised earlier and the rope discarded before it parted.

Report prepared by

[redacted]

[redacted]

Metallurgist

Report reviewed by

[redacted]

[redacted]

Principal Project Metallurgist

MacGregor post-accident *St Helen* service report

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Service Report

To [redacted]

Copies Vessel Master, [redacted]

Date 02/09/2014

Service [ ] Guarantee [ ] Inspection [X] Installation [ ] Others [ ]

Visit description Annual Inspection of Ro-Ro Equipment

Customer	Wightlink	**Vessel name**	St. Helen
Order No	231507074	**IMO number**	8120569
Service Engineer/ Report by	[redacted]	**Ship representative**	Fleet Technician / CE
Supervised by	[redacted]	**Place of service**	Portsmouth. UK
Date of visit start	21/08/2014		
end	21/08/2014		

Equipment type	Serial no / dwg. no	Operating duty and climate	Tot. op. hrs / op. cycles
1. Bow Ramp/Door		Various	Unknown
2. Stern Ramp/Door		Various	Unknown
3. Garage/Mezz Deck Fwd		Various	Unknown
4. Garage/Mezz Deck Aft		Various	Unknown
5. Hydraulic Power Unit		Engine room	When required

Terms and conditions

Unless the Customer and MacGregor have agreed otherwise in writing, Orgalime General Conditions for the Supply of Mechanical, Electrical and Electronic Products - S 2000 shall be applied to the services referred hereto
The services performed and this report are based on the Customer's order, he Customer's instructions and he facts that were readily available for MacGregor's engineer during the performance of the services

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Report

Item 1. Bow Ramp / Door

1.1 When operated no visible warning light or audible siren noted.
1.2 When closing the ramp the cleat hooks appeared worn with visible lateral movement.
1.3 The port side locking cleat cylinder is leaking oil from the gland seal.
1.4 The sealing arrangement is considered in poor condition with a heavy permanent set along with the compression bar having no apparent clean edge to seal against.
1.5 Arrester chains port and stb are twisted which when fully open places a slight twist in the ramp.

Required Repairs

1.1 Audible siren and visible light to be replaced or repaired to give adequate warning to all passengers and staff that the equipment is being operated.
1.4 All of the sealing arrangement to be replaced with new. Hose test to confirm weather tightness. Sealing bar to be stripped back to its original condition and not painted.

Recommended Repairs

1.2 Hook cleats to be measured for wear and replaced if necessary.
1.3 Port side locking cylinder to be removed for overhaul.
1.5 Chains to be disconnected and de twisted and re connected.

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Item 2. Stern Ramp / Door

2.1 Arrester chains port and stb are twisted which when fully open places a slight twist in the ramp.
2.2 The sealing arrangement has failed; parts of the seal are no longer present.

Required Repairs

2.2 All of the sealing arrangement to be replaced with new. Hose test to confirm weather tightness.

Recommended Repairs

2.1 Chains to be disconnected and de twisted and re connected.

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Item 3. Garage/Mezz Deck Fwd

3.1 Wire ropes have no protection to prevent corrosion.
3.2 All wire rope sheaves are heavy with corrosion with some showing signs of heavy wear in the sheave groove and a visible imprint from the wire rope.
3.3 Many of the hydraulic pipe runs to the locks are corroding.
3.4 The Jigger cylinder is leaking oil from the gland seal.
3.5 The jigger head guide rail has material missing and distortion along the rail.
3.6 The inboard vertical guide rail is damaged.
3.7 During operation no audible siren was noted.
3.8 Wire rope is fouling on the penetration holes when under tension.
3.9 Wire rope is fouling on the side frame when under tension.

Required Repairs

3.2 Heavy sheave wear will shorten the wire ropes lifespan and also damage the wire rope. Sheaves in this condition need to be replaced.
3.7 Siren to be replaced or repaired to give adequate warning to all passengers and staff that the equipment is being operated.

Recommended Repairs

3.1 Wire ropes need protection against corrosion. Adequate greasing will help prevent corrosion.
3.3 Hydraulic pipe runs to be replaced with seamless stainless steel.
3.4 Jigger to be removed for overhaul and pressure tested to confirm.
3.5 Jigger head guide rail to be cropped and replaced.
3.6 Inboard vertical guide rail to be cropped and replaced.
3.8 All penetrations to be adjusted to give adequate clearance when the wire is under tension.
3.9 Frame to be adjusted to give adequate clearance when the wire is under tension. Wire appears to be damaged on the outer core.

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Item 4. Garage/Mezz Deck Aft

4.1 All wire rope sheaves are heavy with corrosion with some showing signs of heavy wear in the sheave groove and a visible imprint from the wire rope. The wire rope is in poor condition with heavy corrosion.
4.2 Many of the hydraulic pipe runs to the locks are corroding.
4.3 The inboard wire supports foul the wire rope when under tension.
4.4 During operation no audible siren was noted.

Required Repairs

4.1 Heavy sheave wear will shorten the wire ropes lifespan and also damage the wire rope. Sheaves in this condition need to be replaced. Wire rope to be replaced, unable to ascertain true condition due to the corrosion.
4.4 Siren to be replaced or repaired to give adequate warning to all passengers and staff that the equipment is being operated.

Recommend Repairs

4.2 Hydraulic pipe runs to be replaced with seamless stainless steel.
4.3 Wire supports to be adjusted to give adequate clearance when the wire is under tension.

Item 5. HPU

5.1 A sample of oil medium was attempted but no sample point present. Oil medium was drawn through a pipe from the air breather which was considered inadequate for an accurate measurement though a laser particle analyser.

Recommend Repairs

Tank to be drained to allow for a sample point to be placed a minimum of 300mm above the base level of the tank.

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Necessary spares

Description	Part no	Qty	Comments / Measurements / Drw no
Ref 1.1 Siren & Light		1	
Ref 1.2 Cleat hook assy.		2	Allow for full replacement
Ref 1.3 Seal kit		1	Locking cylinder seal kit
Ref 1.4 Seal sponge		1	Full seal required
Ref 1.4 Glue-tight	1022536	1	5 ltr tin (covers Ref 2.2)
Ref 1.4 Sikaflex 221	1022146	1	(covers Ref 2.2)
Ref 2.2 Seal sponge		1	Full seal required
Ref 3.1 Wire rope	366/102-17	2	28mm
Ref 3.1 Wire rope	366/102-18	2	22mm
Ref 3.2 Sheave	366/102-19	6	18”
Ref 3.2 Sheave	366/102-20	6	14”
Ref 3.4 Seal kit		1	Jigger cylinder seal kit
Ref 3.7 Siren		1	
Ref 4.1 Wire rope	366/102-17	2	28mm
Ref 4.1 Wire rope	366/102-18	2	22mm
Ref 4.1 Sheave	366/102-19	6	18”
Ref 4.1 Sheave	366/102-20	6	14”
Ref 4.4 Siren		1	
Ref 5.1 1/2” ball valve		1	
Ref 5.1 Penetration		1	

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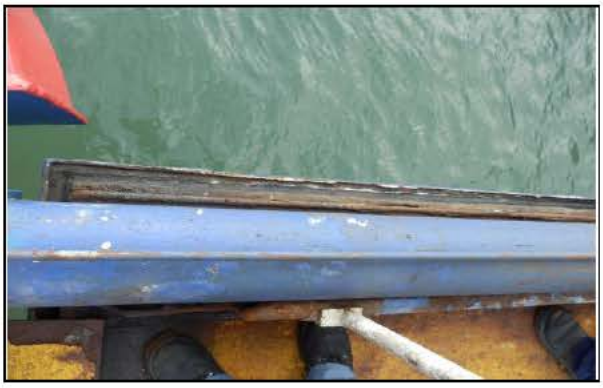
Pictures

Ref. 1.2 Cleat hook worn

Ref. 1.3 Cleat cylinder leaking

Ref. 1.4 Compression bar edge poor



Ref. 1.4 Sealing arrangement

Ref. 1.4 Seal has permanent set

Ref. 1.4 Seal cracked and painted

Terms and conditions

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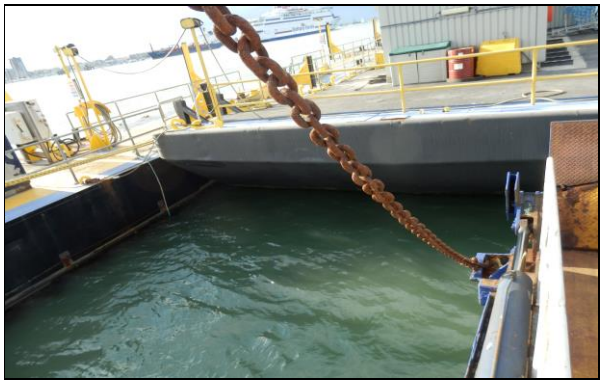
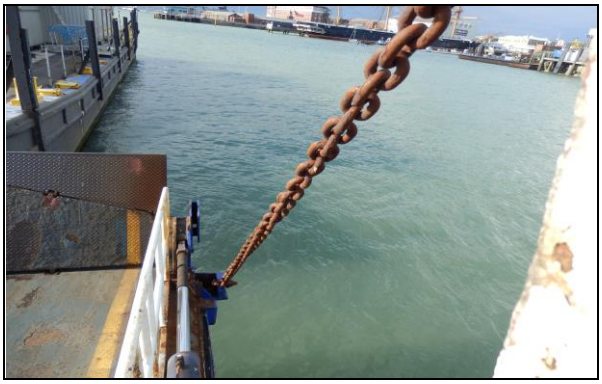
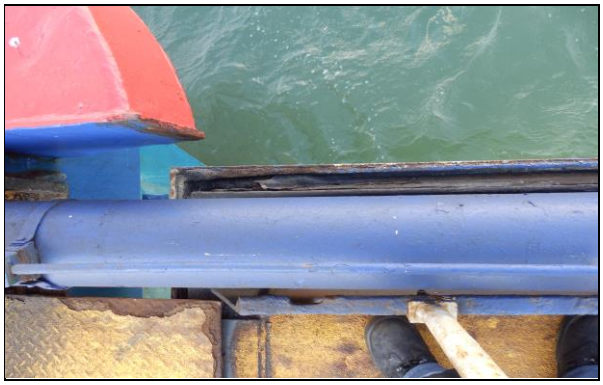
www.macgregor.com



Ref. 1.5 Stb Chain twisted



Ref. 1.5 Port Chain twisted



Ref. 2.2 Seal condition

Ref. 2.2 Seal missing outer skin

Ref. 2.2 Seal condition

Ref. 2.2 Corner damaged

Terms and conditions

Unless the Customer and MacGregor have agreed otherwise in writing, Orgalime General Conditions for the Supply of Mechanical, Electrical and Electronic Products - S 2000 shall be applied to the services referred hereto The services performed and this report are based on the Customer's order, he Customer's instructions and he facts that were readily available for MacGregor's engineer during the performance of the services

Lloyd's Register Quality Assurance certifies that the Quality Management System for MacGregor is ISO 9001:2008 compliant.

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Unit 8. Marshlands Road.
Portsmouth
Hampshire. PO6 1ST. UK
Telephone: +44 (0) 2392 210703
[redacted]
www.macgregor.com

Ref. 3.1 No protection on wire ropes

Ref. 3.2 Example of corroded/worn sheave

Ref. 3.2 Example of corroded/worn sheaves

Ref. 3.3 Example of corroding pipe runs

Ref. 3.4 Jigger cylinder overview

Ref. 3.4 Gland seal leaking

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Ref. 3.5 Jigger guide rail

Ref. 3.5 Guide rail piece missing

Ref. 3.5 Guide rail distorted

Ref. 3.6 Vertical rail damaged

Ref. 3.8 Example of wire fouling

Ref. 3.8 Example of wire fouling

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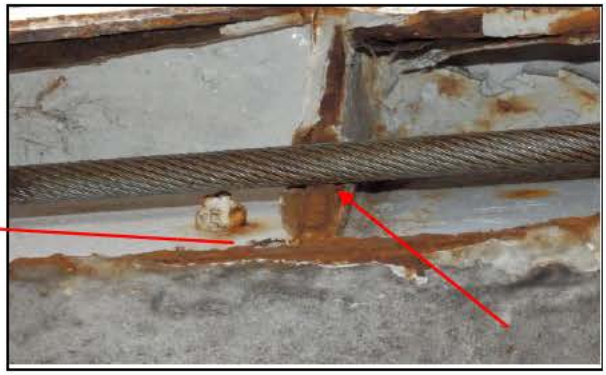
Ref. 3.9 Wire fouling



Ref. 3.9 Wire fouling under tension

Ref. 3.9 Wire fouling

Ref. 3.9 Wire fouling under tension

Ref. 4.1 Example of wear in sheaves

Ref. 4.1 Wire rope condition

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Ref. 4.2 Example of hyd. Pipe condition

Ref. 4.3 Example of wire fouling

Ref. 5 HPU no sample point

Ref.

Ref.

Ref.

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Mezzanine decks risk assessment

WIGHTLINK

RISK ASSESSMENT

VESSEL: St Class - 4	DEPARTMENT/PROCESS: Half Mezzanine Deck Operations		SHEET (1) OF (1)
DESCRIPTION OF WORK:	**HAZARDS:**	**CURRENT CONTROLS:**	**POPULATION AT RISK:**
The Mezzanine Deck is lowered from its stowed position into position for loading. The 'quarter deck' is then ramped, so that cars can proceed onto the Mezzanine Deck. Once the deck is full, the 'quarter deck' is then raised into position.	Malfunction of the Laser Doors, resulting in falls from height. Foot Passengers walking, *and vehicles moving,* under the moving deck. Limb entrapment whilst the deck is moving. Failure to apply the hand-brake will result in vehicles moving; possible crushing of crew-person.	The Laser Doors are fitted with interlocks. *Main deck area is fenced-off under the ¼ deck section to prevent passing under.* Passengers to remain in their cars until the deck is level. Crews trained in correct procedure. A general awareness of Passenger movements is required at all times. Only crew-members trained to Licence to Operate level to operate the Mezzanine Deck.	Directly (1) Indirectly ( ) Visitors ( ) Contractors ( ) Public ( )

RISK: FREQUENCY: (2) x SEVERITY: (3) = 6 → **RISK = TOLERABLE**

REMARKS / RECOMMENDATIONS:
Constant vigilance and regular safety checks are required when operating the Mezzanine Deck.

NAME OF COMPETENT PERSON: [redacted] **SIGNATURE:** [redacted] **REVIEWED:** *24/05/10*

REVIEWED (AS NECESSARY):.....

Mezzanine deck monthly inspection checklist

DECK INSPECTION *ST CLASS MTH CARD 8*

C/O & DECK MATE CHECK

DATE OF CHECK	07/07/14	STATUS	A

STBD FWD MEZZANINE DECK

UNDER DECK		MEZZANINE LEVEL	
Sheaves	✓	Drencher heads & pipe work	✓
Wires	✓	Wires	✓
Cross head	✓	Chains & stanchions	✓
Hydraulic rams	✓	Signage	✓
Pipe work (fixed & flexible)	✓	Gates	✓
Drencher heads	✓	Van guards **(St Helen only)**	✓
Locking bolt markings	✓	Lighting	✓
Signage	✓	**CONTROL BOX**	
Warning beacon	✓	Indicator lights	✓
		Clean, tidy. Check for leaks	✓

MEZZANINE DECK

1. Visual check that deck is in good working order, noting wires, sheaves, securing points, hydraulic rams, cross head, locking bars/bolts flaps and sequence valves, sensors and indicators, warning beacon.
2. Check condition of vanguards.
3. Check stanchions and chains.
4. Check hydraulic pipe work for leaks & chaffing.
5. Check condition of fixed pipe work runs on outboard bulkhead.
6. Check/empty overflow pots.
7. Visual inspection of drencher system pipe work, heads and flexible hoses.

DECK INSPECTION *ST CLASS MTH CARD 9*

C/O & DECK MATE CHECK

DATE OF CHECK	07/07/14	STATUS	A

STBD AFT MEZZANINE DECK

UNDER DECK		MEZZANINE LEVEL	
Sheaves	✓	Drencher heads & pipe work	✓
Wires	✓	Wires	✓
Cross head	✓	Chains & stanchions	✓
Hydraulic rams	✓	Signage	✓
Pipe work (fixed & flexible)	✓	Gates	✓
Drencher heads	✓	Van guards **(St Helen only)**	✓
Locking bolt markings	✓	Lighting	✓
Signage	✓	**CONTROL BOX**	
Warning beacon	✓	Indicator lights	✓
		Clean, tidy. Check for leaks	✓

MEZZANINE DECK

1. Visual check that deck is in good working order, noting wires, sheaves, securing points, hydraulic rams, cross head, locking bars/bolts flaps and sequence valves, sensors and indicators, warning beacon.
2. Check condition of vanguards.
3. Check stanchions and chains.
4. Check hydraulic pipe work for leaks & chaffing.
5. Check condition of fixed pipe work runs on outboard bulkhead.
6. Check/empty overflow pots.
7. Visual inspection of drencher system pipe work, heads and flexible hoses.

RSA inspection procedure

ROYAL & SUNALLIANCE
ENGINEERING

IN - SERVICE INSPECTION - RISK ANALYSIS

Ref No.
05-50-R024.2

Thorough Inspection / Examination of:
VEHICLE LIFTS – FOUR POST
Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Operational & Safety Components Operators controls*	Critical (severe injury) / Possible	Damaged, loose, missing, or ineffective parts.	Visual examination and or operational/functional checks to assess integrity, security and condition of components Check modes of operation are clearly marked on or at the controls. Check to ensure that all controls return to the neutral position when released. Check controls operate correctly, inc. where fitted emergency stops. Check controls for excessive wear/movement. • Reject if controls do not return to the neutral position when released. • Reject if the emergency stop inoperative.
Notices: e.g. Rated capacity plate / warning notices/ instructions etc.*	Critical (severe injury) / Possible	Damaged, missing, loose or ineffective	Visual examination to assess integrity, security and condition of components. Check that adequate information is available to the operator to enable the equipment to be operated safely, e.g. consider safe working load, presence of CE marking where appropriate. • Reject if there is insufficient information available to the operator to enable the machine to be operated safely, e.g. safe working load.
Prime mover, electrical supply and control systems.	Marginal (minor injury) / Possible	Damaged, loose, burnt or inoperative	Visual examination to ensure integrity. Check electrical systems inc. main isolator, wiring for damage or deterioration e.g. security and condition of cable connections, motors, relays and contactors etc. Check integrity of covers/enclosures.

Thorough Inspection / Examination of:
VEHICLE LIFTS – FOUR POST
Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Parts in line of Stress Safety Components Lifting Columns**	Catastrophic (fatal) / Possible	Insecure, damage, distorted, cracking	Visual examination to assess integrity, security and condition of components. Check relative alignment of columns and check for distortion, damage, wear and cracking e.g. at welds. Check of security of base/holding down bolts. • Reject if columns are damaged, distorted, insecure or worn to a degree that the overall stability or load bearing capacity of the lifting machine is compromised
Lifting platform**	Catastrophic (fatal) / Possible	Damaged, distorted, misaligned, cracking,	Visual examination to assess integrity, security and condition of components. Check the integrity of structure including welds and bolts for security. Check ramp/stops for condition and correct operation. Check toe guards, guide rollers and/or guide shoes. • Reject if stops are ineffective.
Free wheel support structures inc. column supports and anchors	Catastrophic (fatal) / Possible	Damaged, distorted, misaligned, cracked parts and components	Visual examination to assess integrity, security and condition of components. Check the integrity and security of the free on wheels structure. Check the free on wheels hanger/locking arrangement/mechanism for smooth, and synchronised operation and that positive and effective engagement to the lifting columns is achieved. • Reject if the free on wheel facility is damaged, or deformed to a degree that the load bearing capacity of the structure is compromised • Reject if the free on wheel facility/column locking mechanism does not fully engage the column in a positive and effective manner.

Thorough Inspection / Examination of:
VEHICLE LIFTS – FOUR POST
Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Lifting Mechanism- Screw Type Motor/s and drive arrangement#	Critical (severe injury) / Possible	Insecure, poorly adjusted, worn, damaged,	Visual examination and or operational/functional checks to assess integrity, security and condition of components. Check security of motors. Check drive belts for tension and condition. Check drive chain/s and sprockets for condition and correct tension. Functional test and alignment check of slack chain switch if fitted. • Reject if slack/broken chain switch ineffective. • Reject if any enclosure, trunking etc. is damaged as to allow electrical live components be access or live conductors are exposed
Lifting screws and nuts**	Catastrophic (fatal) / Possible	Worn, damaged, scoring, lubrication.	Visual examination and or operational/functional checks to assess integrity, security and condition of components Check lifting screws for wear, sufficient lubrication, scoring, damage including visual examination and/or assessment of bearing condition. Check lifting nuts for damage, wear, alignment etc. Reject if lifting nut wear is out with manufacturers limits or when axial movement of the nut relative to the screw is found to be in excess of one quarter of the screw thread pitch, and in accordance with Tech. Bulletin 05-50-TB9.1.1 Examination of vehicle lifts
Lifting nut wear detection devices, lifting nut failure detection devices, #	Critical (severe injury) / Possible	Incorrectly adjusted, inoperative, missing, damaged	Visual examination and or operational/functional checks to assess integrity, security and condition of components. Operational test or functional test and alignment checks to ensure correct operation and adjustment. Reject if inoperative or out of adjustment.

Thorough Inspection / Examination of:
VEHICLE LIFTS – FOUR POST
Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Lifting Mechanism- Rope Type Hydraulic system** (includes rams, anchor pins, bushes, reservoir, pipe work, hoses, valves, pumps and associated fittings).	Critical (severe injury) / Possible	Damage, deterioration, wear, oil leakage, hydraulic creep, insecurity.	Visual examination and or operational/functional checks to assess integrity, security and condition of components Check ram seals for leakage, Check rams for scoring, fittings, wear on ram anchor pins, bushes and associated keep plates. Check hydraulic pumps, pipe – work and fittings for security and damage. • Reject hydraulic system or components when damage, wear, creep/leakage is evident and to a degree that safety is compromised.
Lifting ropes and/or chains and associated components	Catastrophic (fatal) / Possible	Worn, damaged, scoring, broken wires ,corrosion	Visual examination to assess integrity, security and condition of components Check ropes for broken wires, reduction in diameter, corrosion. Check lifting or drive chains for corrosion, damaged links/plates; elongation. Check sheaves for correct operation, wear, scoring, bearing/bush wear • Reject ropes using R&SA rejection criteria Technical Bulletin 05-50-TB1.2.1b • Reject worn (10% bush wear or to a degree that will not allow the rope to be retained) or damaged or misaligned (to a degree that will not allow the rope to be retained) • Reject loose or insecure sheaves

Thorough Inspection / Examination of:

VEHICLE LIFTS – FOUR POST

Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Lifting ropes and/or chains and associated components (continued			Consider Technical Bulletin 05-50-TB5.1.1 and specifically: • Reject damaged, seized or cracked chains. • Reject chains elongated 3% or greater. • Reject chains if wear on link plate edges is reduced by 5% or greater • Reject anchorage pins if material loss is 10% or greater.
Travel Limits#	Critical (severe injury) / Possible	Incorrectly adjusted, inoperative, missing, damaged	Visual examination and or operational/functional checks to assess integrity, security and condition of components Check integrity of switches and operating ramps, flags, rods or linkages. Operational test of upper and lower travel limits and or functional test and alignment checks to ensure correct operation and adjustment. • Reject if inoperative or out of adjustment. • Reject if any enclosure, trunking etc. is damaged as to allow electrical live components be access or live conductors are exposed

Thorough Inspection / Examination of:
VEHICLE LIFTS – FOUR POST
Screw lift or roped type

Issued & controlled by the Technical Support Dept., on behalf of the Engineering Business

Component Parts	Risk of Failure	Mode of Failure	Inspection Methodology / Rejection Criteria
Slack/broken rope protection (safety gear platform lock device)#	Catastrophic (fatal) / Possible	Incorrectly adjusted, inoperative, missing, damaged, seized, excessive lubricant on rods	Visual examination and or operational/functional checks to assess integrity, security and condition of components Operational test or functional test and alignment and alignment checks to ensure correct operation and adjustment • Reject if inoperative or out of adjustment. • Reject if safety gear rods are contaminated with grease/oil • Reject if slack rope device or anti creep pawl ineffective.

Amendment History

Date	Version No.	Description	Change Request Ref.
Mar 2006	2	Amendment to Chain Rejection Criteria	Technical Manager Machinery

RSA thorough examination report: 1 May 2014

In any correspondence relating to this report please quote:

District **K001**
Policy [redacted]
Item No. **LE39**

REPORT OF THOROUGH EXAMINATION OF LIFTING EQUIPMENT

Lifting Operations and Lifting Equipment Regulations 1998
(Regulation 9)

1	*Employer (and/or plant owner)*	**WIGHTLINK LTD AND MEIF SHIPPING (HOLDINGS) LTD AS HOLDING COMPANY AND SUBSIDIARY COMPANIES**
2	*Address*	**WIGHTLINK LTD AND MEIF SHIPPING (HOLDINGS) LTD M V ST HELEN GUNWHARF ROAD PORTSMOUTH HAMPSHIRE PO1 2LA**
	For the attention of	[redacted]
3	*Address at which the examination was made*	**As above**
4	*Description of Lifting Equipment*	**FWD STBD ELECTRIC HYDRAULIC MEZZANINE CAR DECK**
	Distinguishing Number	-
	Makers Name	-
	Year of Manufacture	-
	Safe Working Load (As marked, unless otherwise stated)	**20.25 ton per deck.**
5	*Nature of Examination*	**Thorough Examination carried out within an interval of 6 months under Regulation 9(3)(a)(i) unless otherwise indicated.**
6	*Identification of any part found to have a defect which is or could become a danger to persons. State description of the defect, and any repair, renewal or alteration required to remedy the defect, either immediately or within a specified time.*	**None**
7	*Other defects and remedies*	**The platform longitudinal and transverse deep beams have isolated areas of wastage and a general breakdown of preservation coatings. All affected areas particularly around the diverting sheave and hinge pin and support boxes should be cleaned back to bright metal and suitable preservation coatings applied.**
8	*Observations and condition of ropes and chains, where applicable. Particulars of any supplementary test(s)*	**Suspension ropes remain serviceable , they should be cleaned and dressed** **Note: Design not checked, this report should be read in conjunction with an EC Declaration of Conformity Certificate and/or Initial Thorough Examination Report (inc. load test, where applicable) issued by your manufacturer and/or installer.**
9	*Date of last thorough examination*	**24/10/2013**

9a	*Latest date by which the next thorough examination must be carried out*	**01/11/2014**

Unless otherwise stated, this inspection has been completed in accordance with Procedure 05-20-P01.

I certify that the above equipment was thoroughly examined (unless otherwise stated) and, subject to any remedial action to defects noted on this report, which are or could become a danger to persons, the equipment is safe to operate.

Date of Examination **01/05/2014**

Report Date **01/05/2014**

Signature: [redacted]

[redacted]

Qualification - Engineer Surveyor to

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17 York Street, Manchester M2 3RS
Telephone: 0845 074 0704 Fax: 0161 235 3421 Web: www.rsainspection.co.uk