Annex 1

Theory of Operation Document produced by Micron Eagle Hydraulics Limited

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MICRON EAGLE HYDRAULICS LIMITED
THOERY OF OPERATION
INSTALLATION OF CURSOR WINCH ON FWD BELL SYSTEM
CSO WELLSERVICER

Issue Number : 001

Date: 12th February 2009

Recipient: [redacted]

Customer: Technip UK Ltd

Project: Installation and commissioning of Cursor Winch on Fwd Bell Handling System on the CSO Wellservicer

REV.	REVISION STATUS	REV DATE	ORIGINATOR	CHECKER	APPROVER
			Signature	Signature	Signature
A	For Issue		[redacted]	[redacted]	

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1.0 INTRODUCTION

Micron Eagle Hydraulics Ltd. (MEH) have been contracted to supply, install and commission the Hydraulic system for driving the Fwd Cursor Winch on the CSO Wellservicer.

1.1 Scope

The scope of this document is to provide the necessary information to Technip on the Theory of Operation of the Cursor Winch hydraulic system and interface with the existing controls.

1.2 Responsibilities

Responsibility for the issue of this document lies with the Engineer associated with the work. All requests for amendments to this document should be made to the Engineer.

1.3 Terms and Abbreviations

The following abbreviations and their meanings are used throughout this document:-

MEH	Micron Eagle Hydraulics Ltd
HPU	Hydraulic Power Unit
Client	Technip UK Ltd

1.4 Industrial Standards

P5 1991	Guidelines to Contamination Control in Hydraulic Fluid Power Systems
BS ISO 4413 1998	Hydraulic Fluid Power. General Rules Relating to Systems
BFPA Ed 8/99	British Fluid Power Association, Fluid Power Engineers Data book

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2.0 General System Description

The Cursor Winch will be mounted on the Fwd Bell Handling Trolley and attached to the Cursor by means of a steel rope which will be reeved 4 times. The purpose of this winch is to provide a means of recovery in an emergency situation. In normal operation the cursor winch is required to have a constant tension mode to keep the wire rope taught while the Bell is travelling in the Moonpool.
To drive the winch in a constant tension mode additional electric motors and hydraulic pumps will need to be installed at the pump room.
To drive the winch in emergency mode the existing 35l/min supply that is already at the trolley top will be utilised.

3.0 Theory of Operation – Constant Tension

There are two electric motor / hydraulic pump sets (item 8) provided to drive the winch in constant tension mode. Only one is required for constant tension mode the second being a standby unit. At all times when the Cursor is moving one pump set must be running. These will deliver a constant flow to the raise port of the dual speed winch motor (item 2). The constant tension pressure will be set by means of an unloading relief valve (item 7) which will be located in the HPU room local to the pumps. This will need to be set during commissioning. The unloading part of the relief valve is controlled by a 24v DC solenoid valve which needs to be energised to build constant tension pressure. This would be best controlled by a timer so that the motor can start on no load and after a set time the system is 'loaded up' to the constant tension pressure. The lower port on the motor will be connected back into the 13 bar return line of the existing system at the most convenient break in point. Isolation Ball Valve BV3 (item 3) will be open for constant tension mode and closed for emergency mode. Isolation Ball Valve BV1 (item 3) will be closed for constant tension mode and open for emergency mode.
A pressure switch (item 6) has been provided in the constant tension line to allow an electrical interlock to be fitted to the system so that the bell cannot be raised or lowered unless constant tension pressure is available.
When in constant tension mode the emergency single speed winch motor (item 1) will be in a 'freewheel' mode. Isolation Ball Valve BV2 (item 5) will be open for constant tension mode.
The emergency raise / lower DCV (item12) will remain in neutral for constant tension operation.
The Diverter valve (item 13) will be in the position shown for constant tension mode.
The brake release 24v DC solenoid valve (item 15) will be actuated from the bell winch joystick. This can be done either on the deadman switch or on the centre position switch if indeed there is one. To release the brakes the valve needs to be energised.
There is a failsafe on the brake circuit facilitated by the pilot operated DCV (item 16) which will only allow the brakes to be released when the constant tension system is healthy.

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4.0 Theory of Operation – Emergency Recovery

For emergency operation the single speed motor will be used to perform the lifting of the Bell / Cursor assembly. The raise and lower function would be controlled local to the winch with the manually operated DCV (item 12). For emergency mode Isolation Ball Valve BV3 (item 3) and BV2 (item5) would be closed. Isolation Ball Valve BV1 (item 3) would be open.
Diverter Valve (item 13) must be moved to the emergency position to allow a 'bypass' around the solenoid operated brake valve (item 15). The release of the brakes will then be controlled totally by the pilot operated DCV (item 16).
Diverter valve (item 18) must be moved to the emergency position to allow the brake valve (item 16) to be actuated from the Raise/Lower line shuttle valve (item 11) when in emergency mode.

5.0 Cursor / Bell Latch Cylinders

The Cursor latch cylinders will be actuated through a 24v DC solenoid operated valve which has a supply taken from the 'P' line to the emergency DCV. The supply to the Latches has a pressure reducing valve inline if needed.
With the valve in the de-energised position no fluid will pass to the cylinders, when the valve is energised this will allow fluid to open the latches.

6.0 Console

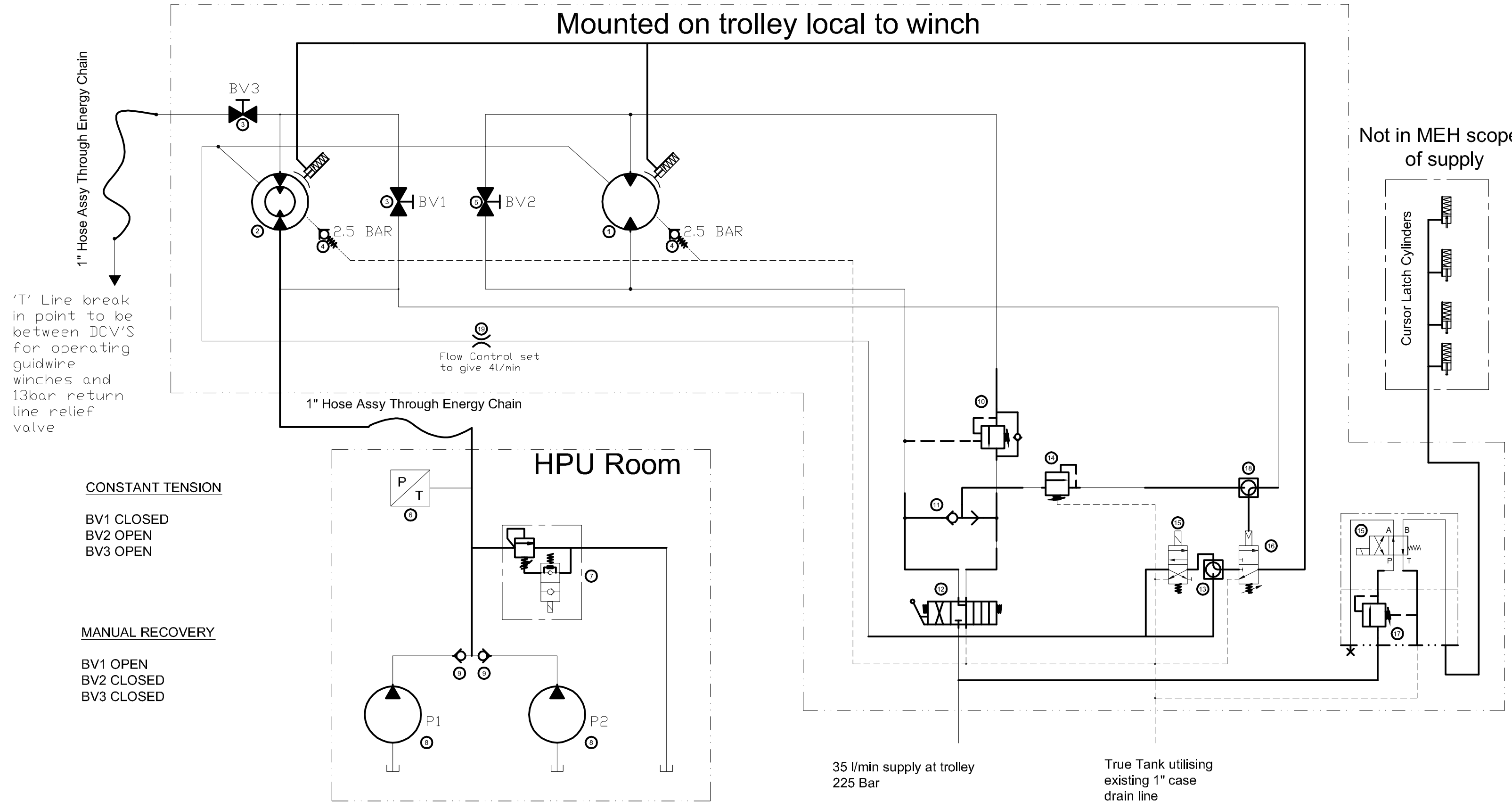
It is our intention to mount all valves inside a control console which we will mount to the winch base on the same side of the frame as the winch base anchor point. We intend to have the Isolation Ball Valves, Diverter valve, Emergency operation DCV and pressure gauges on the console face or easily accessible from one location. We intend to include pressure gauges for system pressure, constant tension pressure and brake release pressure.

[redacted]

Micron Eagle Hydraulics Ltd

Annex 2

Hydraulics Circuit Schematic produced by Micron Eagle Hydraulics Limited



CONSTANT TENSION

BV1 CLOSED
BV2 OPEN
BV3 OPEN

MANUAL RECOVERY

BV1 OPEN
BV2 CLOSED
BV3 CLOSED

Item	Description	Part No
1	Hagglunds Single Speed Motor	Supplied by Technip
2	Hagglunds Dual Speed Motor	Supplied by Technip
3	1" BSPP High Pressure Ball Valves	BKH-1
4	2.5 Bar Check Valves	HNRV-34-2.5B
5	¾" BSPP High Pressure Ball Valves	BKH-34
6	Rexroth Pressure Switch	HED 80A 12 / 350 K14A T03
7	Integrated Unloading Relief Valve	7VR250P8W20-1H24S
8	15Kw motor c/w Marzocchi Gear Pump	3D10FG
9	1" BSPP check valves	HNRV-1
10	Sun Load Holding Valve	CBCG-LJN-ECV/S
11	⅜" BSPP Shuttle Valve	SV-3 / 8-S
12	Walvoil DCV	SD11 / 1
13	½" BSPP High Pressure 'L' Ported Valve	9105004
14	Integrated Pressure Reducing Valve	1PA65P3W35S-Steel
15	Dofluid 24V Solenoid Operated DCV	DCA02-4x2-24V
16	Wandfluh Pilot Operated DCV	AP4Z60a/63-S770
17	Atos Pressure Reducing Valve	H3-031 / 32 / 23
18	¼" BSPP High Pressure 'L' Ported Ball Valve	9105002
19	⅜" BSPP Flow Control	NDV-G3 / 8

DO NOT SCALE

THIS IS A CAD PRODUCED DRAWING AND IS NOT TO BE CHANGED MANUALLY

IF IN DOUBT ASK

Revision No	Date	Revision Reason	Revised By	Checked By	Approved By	Customer Approval
1	18.02.09	For Approval	[redacted]	[redacted]	[redacted]	

Micron Eagle Hydraulics
ORIGINATOR [redacted]
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CUSTOMER: Technip UK Ltd

TITLE: Fwd Cursor Winch Circuit for Wellservicer including Bell Hooks

DATE	SCALE	DRAWING No.
28.01.09	N.T.S.	ME24213-001

Annex 3

Aide Memoire Document to the Project Management Handbook

The OOS Project Management Model

Following the requirements of this model will prompt project personnel to assess if the key components of Project Management are in place, which in turn will give a clear indication of control being exercised and the likelihood of success in delivering the project to scope, cost and schedule. Project management principles will be applied to any activity within OOS that has the potential to impact upon the operation of vessels, plant or equipment. **The principles will be applied regardless of the financial value of the project, in order to ensure that a common standard is in place for all activities that require management.**

CONTROL MEASURE : STAGED GATE REVIEWS

Each phase of the Project will require Sign Off by the Project Sponsor prior to commencing the next stage. *The documentation and requirements for each stage are detailed in this procedure and when delivered will form part of the Execution Plan.*

CONTROL MEASURE : PROJECT EXECUTION PLAN (PEP)

The PEP will be developed throughout the various stages of the Project which will culminate in a completed plan at the end of Stage 4 prior to the Project Execution Stage. *The PEP will detail how the Project will achieve its stated objectives.*

"It is not sufficient for the Project Manager and the Project Team to declare the Project complete, shut up shop and move on to the next job.

There must be a structured Project Close Out which is fully recorded for management review."

START → **STAGE 1** DEFINITION OF WORKSCOPE → STOP *Sign Off Required Briefing Report Complete?* → **STAGE 2** FEASIBILITY OF PROJECT → STOP *Feasibility Report Signed Off? MDR Updated?* → **STAGE 3** KICK OFF → STOP *Presentation Sheet Signed Off? MDR Updated?* → **STAGE 4** PLANNING → STOP *PEP Signed off? MDR Updated?* → **STAGE 5** PROJECT EXECUTION → STOP *Project Complete? As Builts registered? MDR Updated?* → **STAGE 6** PROJECT CLOSE OUT → END

STAGE 1 DELIVERABLE :
The Project Briefing Report

As a minimum, this should contain:

- ✓ High level summary of scope and objectives
- ✓ Key risks, sensitivities, opportunities, concerns
- ✓ High level schedule and cost breakdowns
- ✓ Resource requirements
- ✓ Reporting requirements for each Project stage
- ✓ Success criteria

The Purpose of the Project Briefing Report is to:

- Clearly indicate how the Project will be managed within OOS
- Establish Project purpose, feasibility and expectations for all stakeholders, in particular OOS Project Sponsor, Team Members and Line Management
- Determine Project scope and limits including all deliverables
- Provide OOS Project Manager with authority to engage Company resources to Project activities
- Emphasise commitment to Project Management principles, from tender to delivery.

STAGE 2 DELIVERABLE :
The Feasibility Report

As a minimum, this should contain:

- ✓ Defined purpose, scope and objectives including limitations or exclusions
- ✓ Analysis of workscope, schedule, duration, costs and resource
- ✓ Risk register following high level risk assessment against success criteria
- ✓ Initial MDR (Master Document Register)
- ✓ High level Work Breakdown Structure showing key components and elements
- ✓ Project controls including meeting cycles, reviews, contractor management etc.

The Purpose of the Feasibility Report is to:

- Determine whether Project goals, objectives and deliverables are achievable against schedule, corporate schedule windows, location, budget, resources (inc availability of specialist contractors)

Update MDR with Feasibility Report

PROJECT NOT FEASIBLE?
Move to **Stage 6 Close Out** and detail reasons why it is not.

STAGE 3 DELIVERABLE :
The Presentation Sign Off Sheet

The Presentation to the Project Team, Sponsor and Stakeholders representative must detail the Project purpose, objectives, success criteria and outline the project workscope and deliverables. **Evidence of attendance at the Presentation in the form of a Sign Off sheet will be required prior to commencing Stage 4.**

Purpose

The Kick Off Stage is to be undertaken once the make up of the Project Team is defined. The purpose of this stage is to reiterate the Project objectives, deliverables, interfaces etc. whilst starting to draw upon the skills and experience of the team members.

The Kick Off should establish the timeline for the stages of the Project along with the roles and responsibilities of the team members to ensure that the team goals are aligned from the start. ***From this point, all meetings should be minuted with actions assigned and entered into the database.***

Update MDR with Sign Off Sheet

STAGE 4 DELIVERABLE :
The Project Execution Plan (PEP)

As a minimum, this should contain:

- ✓ Complete and detailed WBS
- ✓ Complete and detailed Cost Breakdown
- ✓ Complete schedule showing Critical Path
- ✓ Procurement and Contractor Management Plan inc. QA/QC, Certification requirements
- ✓ Risk Register based upon detailed WBS
- ✓ Project Management Report (PMR)

The Purpose of the PEP is to:

Develop the detailed workscope required to successfully complete the Project.

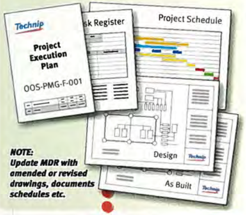
Update MDR with Project Execution Plan

STAGE 5 DELIVERABLE :
Successful Completion

The key deliverable from this Stage will be the successful completion of the Project in line with the requirements of the Project Execution Plan.

Purpose

The purpose of this Stage is to manage the execution of the Project to ensure successful delivery of the Project objectives.



NOTE: Update MDR with amended or revised drawings, documents schedules etc.

STAGE 6 DELIVERABLE :
Document Package containing:

- ✓ Work completed/review of the WBS
- ✓ Outstanding/incomplete work packages
- ✓ Specific variations with explanations
- ✓ Completed Risk Register
- ✓ As built schedule
- ✓ Financial breakdown
- ✓ Complete MDR detailing As Builts and any documentation revisions or updates
- ✓ Lessons learned, detailing all areas including those that worked out well
- ✓ Review of Contractor performance
- ✓ Review of Team performance.

Once Signed Off by the Project Sponsor, the delivery of the Document Package will signal the Technical and Financial Close Out of the Project.

Purpose

The purpose of this Stage is to document the Project lifecycle, capturing what was achieved and explaining variations from the Project Execution Plan.

Update MDR with completed and Signed Off Close Out Document Package.

CONTROL MEASURE : MASTER DOCUMENT REGISTER (MDR)

A Master Document Register (MDR) will be required to ensure proper controls of documentation throughout the lifecycle of the Project. *The MDR will also be used to check which documentation will require revision to As Built status as a part of the Close Out process.*

Effective Management of risk is recognised throughout Technip as a key component in the successful delivery of world class projects.

The OOS Project Handbook (OOS-PMG-001) outlines the model to be followed and defines expectations for what should be achieved by Project Teams at key project stages.

This booklet acts as an aide memoire on how to achieve these expectations. It sets out the basic processes by which risks will be identified, evaluated, managed and communicated within individual projects and across the organisation.

The processes described are well tried and tested and for many this will be a reaffirmation of what they are already doing.

Nevertheless, these guidelines should drive a common language and consistency of approach which will provide a basis for learning and improvement in project delivery and the techniques used for managing project risks.

PROJECT MANAGEMENT MODEL CHECKLIST

STAGE 1 : DEFINITION OF WORKSCOPE

- ✓ *Has the Project Briefing Report been completed?*
- ✓ *Are the Project objectives clear?*
- ✓ *Has Project Briefing Report been signed off by the Project Sponsor?*

STAGE 2 : FEASIBILITY OF PROJECT

- ✓ *Has the Project Feasibility Report been completed?*
- ✓ *Has the Project Schedule been checked against the corporate schedule?*
- ✓ *Has Project Feasibility Report been signed off by the Project Sponsor?*
- ✓ *Has the signed off Project Feasibility Report been placed in the Master Document Register (MDR)? (If the Project is not feasible, move to Stage 6 and explain why it is not.)*

STAGE 3 : KICK OFF

- ✓ *Has the Project Presentation been completed?*
- ✓ *Has the attendance been recorded on the Presentation Sign Off Sheet?*
- ✓ *Has Presentation Sign Off Sheet been signed off by the Project Sponsor?*
- ✓ *Has the signed off Presentation Sign Off Sheet been placed in the MDR?*

STAGE 4 : PLANNING

- ✓ *Has the Project Execution Plan been completed?*
- ✓ *Is there a clear and detailed Project workscope?*
- ✓ *Has the Project Execution Plan been signed off by the Project Sponsor?*
- ✓ *Has the signed off Project Execution Plan been placed in the MDR?*

STAGE 5 : PROJECT EXECUTION

- ✓ *Is the Project following the Project Execution Plan?*
- ✓ *Are there any documents or drawings that need to be revised?*
- ✓ *Have all As Builts been registered and placed in the MDR?*
- ✓ *Has a Project Management Report been completed?*
- ✓ *Is the Project complete?*

STAGE 6 : PROJECT CLOSE OUT

- ✓ *Are all variations, outstanding and incomplete tasks recorded?*
- ✓ *Are all lessons learned captured?*
- ✓ *Has contractor and team performance been measured?*
- ✓ *Has a Close Out Document Package been completed and signed off by the Project Sponsor?*

Annex 4

Risk Assessment Report -
Installation of the Emergency Winch on the Forward Bell

DATE :	13/02/09			CLIENT : N/A	
WORKSITE :	Wellservicer			PROJECT TITLE : (if applicable)	Wellservicer emergency dry docking 2009
JOB BEING ASSESSED :	Installation of the emergency winch on the Fwd Bell				
JRA REF NO: (Site or Project)				JOB SUPERVISOR (Name & Position)	
ATTENDEES :	[redacted]	Dive system Superintendent Asset Technical		ATTENDEES (cont.) [redacted]	HSE Advisor
	[redacted]	Dive system Superintendent Asset Technical			
	[redacted]	Dive Technical Engineer Assert Technical			
	[redacted]	HSE Superintendent OOS			

REFERENCE DOCUMENTS:	Man riding winch design report OR011415DR0002 Wellservicer forward bell contingency recovery system OR011415DR0001 Bell cursor catch pivot brackets OR006491-R-001 Forward bell winch installation OR013880
COMMENTS:	

DISTRIBUTION LIST:

JOB BEING ASSESSED : | **JRA Reference No.:**

WHO / WHAT IS AT RISK: | **WHAT ARE THE EFFECTS:**

ITEM NO.	**JOB/TASK STEP**	**HAZARD / HAZARDOUS EVENT**	**CAUSES OF HAZARD OCCURRING**	**EXISTING CONTROLS**	**INITIAL RISK(IR)** **Sev Prob IR** **(eg H3 D Med)**	**ADDITIONAL CONTROLS/ ACTIONS** **ACTIONEE** **TIMESCALE**	**RESIDUAL RISK(RR)** **Sev Prob RR** **(eg H3 B Low)**
1,A	Pick up drum and base from the dock bottom, using the guide wire winches to lift inboard of the vessel	Dropping of the base and drum personnel injury and damage to the equipment	Failure of attachment of rigging	Certified lifting points on the base frame, lift plan in place any additional rigging to be utilised to be certified. PTW system to be used area to barriered off around the bottom and top of the moon pool area during lifting operations.	HDS 4B Med	Rigging plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications to between dock floor, bell hanger and dive control, PTW to be implemented by dive technical supervisor.	HDS 2B Low
1,B	Cross hauling into bell hanger and store in final position.	Dropping of the base and drum personnel injury and damage to the equipment, trips and falls	Failure of attachment of rigging	Certified lifting points on the base frame, lift plan in place any additional rigging to be utilised to be certified. PTW system to be used area to barriered off around the bottom and top of the moon pool area during lifting operations.	HDS 4B Med	Once equipment is in position rigging foreman to ensure all barriers to be re-erected in bell hanger area. De rig and store items.	HDS 2B Low

2	Cursor frame to be pinned / locked off to trolley	Personnel injury Trips and falls	Dropped objects from trolley Working at height	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger	HS 3 B Med	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW.	HS 3 B low
2,A	Position bell on dry dock bottom.	Dropping the bell dropped objects, personal injury damage to equipment.	Failure of bell wires equipment left on top of bell and surrounding area, personnel ignoring barriers.	Ensure barriers are in place around the moon pool area in the dock bottom; check the area and bell for any potential dropped objects, Designated personnel on the dock bottom in radio communication to ensure integrity of area around the bottom of the moon pool.	HDS 4B Med	Rigging plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications to between dock floor, bell hanger and dive control, PTW to be implemented by dive technical supervisor.	HDS 2B Low
2,B	Disconnect port and starboard bell main lift wires.	Personal injury equipment damage	Dropped objects from the bell hanger, Personnel working at height,	Ensure barriers are in place around the moon pool area in the dock bottom; check the area and bell for any potential dropped objects, Designated personnel on the dock bottom in radio communication to ensure integrity of area around the bottom of the moon pool.	HS 4B Med	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW.	HS 3B Low
2,C	Recovery of the port and starboard bell wires to the bell hanger, and close door.	Equipment damage	Wires snagging on the bell	Wires to be monitored during the recovery operation.	D1 A Low	Good communications to be maintained during operations	D1 A Low

2.D	Lower cursor on to moon pool door	Personnel injury	Failure of cursor wire Dropped objects Working at height	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger Tool box talk.	DS 4B Mid	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Lift plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications ,tool management in place	DS 4B mid
3	Lifting of components on to trolley from bell hanger Base Drum Hydraulic motors	Dropping of any components personnel injury and damage to the equipment, trips and falls	Failure of attachment of rigging Poor rigging practice Personnel working at height,	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger	DS 4B Mid	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Lift plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications ,tool management in place	DS 4B mid
4	Assembly of winch on fwd trolley	Dropped objects ,personnel injury and entrapment, damage to equipment, trips and falls	Personnel working at height, and working in confined area	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger Tool box talk.	HS 3 B Low	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW.	H B 3 B Low
5	Lifting heave compensator from bell hanger to top of trolley	Dropping of any components personnel injury and damage to the equipment, trips and falls	Failure of attachment of rigging Poor rigging practice Personnel working at height,	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger	DS 4B Mid	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Lift plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications ,tool management in place	DS 4B mid
6	Lifting of hydraulic control panel from bell hanger to top of trolley	Dropping of any components personnel injury and damage to the equipment, trips and	Failure of attachment of rigging Poor rigging practice Personnel working at height,	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel	DS 4B Mid	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Lift plan is place (designated	DS 4B mid

		falls		only in bell hanger		personnel to be allocated) all personnel to be suitably trained and experienced, good clear communications ,tool management in place	
7	Installation of hydraulic control panel and heave compensator. Welding and grinding operations	Personnel injury Welding sparks Fire, sparks from grinding	removal of combustible material	Ensure barriers are in place in bell hanger area potential equipment that could be affected from welding covered or removed Reference hot risk assessment	HDS 4 C Med	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Fire watch onsite at all time when welding and grinding designated personnel to be allocated) all personnel to be suitably trained and experienced, Earth cable to be connected close to welded area on trolley.	HDS 4 B Med
8	Cursor frame work removal	Personnel injury Welding sparks Fire, sparks from grinding Working at height	removal of combustible material	Ensure barriers are in place in bell hanger area potential equipment that could be affected from welding covered or removed. Scaffolding installed inside cursor frame and external Reference hot risk assessment	HDS 4 C Med	Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Fire watch onsite at all time when welding and grinding designated personnel to be allocated) all personnel to be suitably trained and experienced Scaffolding inspection carried out by inspector daily	HDS 4 B Med
9	cursor frame installation of new sheave assembly	Personnel injury Welding sparks Fire, sparks from grinding Working at height	Failure of attachment of rigging Poor rigging practice Personnel working at height, removal of combustible material	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger Scaffolding installed inside cursor frame and external Reference hot risk assessment	HDS 4 C Med	Rigging plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, PTW. Scaffolding inspection carried out by inspector daily Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW.	HDS 4 B Med

10	Installation of emergency hooks on to cursor frame	Personnel injury damage to equipment.	Failure of attachment of rigging Poor rigging practice Personnel working at height,	Ensure barriers are in place in bell hanger area potential dropped objects from trolley Designated personnel only in bell hanger Scaffolding installed inside cursor frame and external	HS 3 C Med	Rigging plan is place (designated personnel to be allocated) all personnel to be suitably trained and experienced, PTW. Scaffolding inspection carried out by inspector daily Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW.	HS 3 B Low
11	Modification to bell buoyancy at hook positions	Personnel injury	Personnel working at height,	Ensure barriers are in place in bell hanger area Moon pool door close Designated personnel working on bell Scaffolding installed around bell	HS 3 C Med	Scaffolding inspection carried out by inspector daily Appropriate working at height equipment to be worn at all times, work to be controlled under the PTW. Appropriate PPE /RPE .method statement submitted	HS 3 B Low

COMMENTS:	

REFERENCE INFORMATION FOR USE DURING THE JOB RISK ASSESSMENT

THIS INFORMATION SHOULD NOT BE CONSIDERED A COMPLETE LISTING OF ALL POTENTIAL HAZARDS AND CONTROLS.

Guidewords for Hazard Identification

Access	Coordination	Flare radiation	Other ongoing operations	Redundancy	**Temperature extremes**
Adequate equipment	Current	**Fumes / Vapour**	Overload	Release of	**Traffic**
Blow-on blow-off	Discharge	Environmental	Overflow	Rotation	Weather
Body positioning	Disintegration	Heave	Overpressure	Rupture	Work at height
Break / fracture	Drive	Impact	**Particles**	Sharp edges	
Caught between	Dropped	Injury	**Pinch point**	Poor visibility / lighting	
Certification	Ejection	Intakes / outlets	**Portable electrical equipment**	Power / Energy Isolation	
Circulation	Entanglement	Loss of power	Pollution	Recovery	
Collision	Environmental	Loss of position	Poor visibility / lighting	Slip, trip or fall	
Communication	Explosion	**Noise**	Power / Energy Isolation	Smoke	
Confined space	Fire	Obstructed vision	Recovery	Spillage	

Examples of Standard Control Measures Available

Task done under a Client Permit	Task done under a Technip Permit	Work equipment assessment	Mechanical isolation
Generic risk assessment in place	Lift plan in place	Certified lifting equipment	Recognised task Supervisor
Good communications (**specify main parties involved**)	Toolbox talk	Standard deck PPE	Good housekeeping standards

Detailed Technip procedure or work instruction	Trained, competent personnel	Technip Lifting Rules applied	Disposable oversuits
Detailed Third Party procedure	Barriers & signs erected	Certified pressure equipment	Barrier cream
Suitable environmental conditions	Tannoy announcements	COSHH assessment	Vessel DP & IMCA Common Marine Insp. Audits
Fall arrest equipment	MSDS data sheets	Electrical isolation	Correct tools

APPENDIX 1 – TECHNIP RISK ASSESSMENT MATRIX

The grid contains both alpha numeric and numeric indices (shown in brackets).
The alpha numeric indices are for categorisation of initial and residual risk.
The numeric indices are to facilitate incident categorisation for Synergi reporting purposes.

Annex 5

Extract from Aberdeen Hydraulics Report to the MAIB

5 Brake Failure Scenarios

Power Pack Running

1. Pressure reducing valve (14) traps pressure on to the pilot of variable pilot valve (16), thus allowing pressure through to release the brakes.

2. Pressure reducing valve (14) delays the pilot venting from variable pilot valve (16), thus causing a delay in the brakes applying.

3. Variable pilot valve (16) sticks in the operated position due to contamination, thus allowing pressure through to release the brakes.

4. Very high tank pressure in excess of 16 Barg, thus allowing the brakes to release via the “T” port of variable pilot valve (16).

Power Pack Not Running

5. Obstruction in the brake line between the brake and variable pilot valve (16), thus preventing the brake actuators from venting when the variable pilot valve (16) is in the spring offset position.

6. Obstruction in the “T” line form variable pilot valve (16), thus preventing the brake actuators from venting when the variable pilot valve (16) is in the spring offset position.

The brakes would however apply in scenarios 1,2,3 when shutting down the power pack. Power pack run down time would be a consideration of how long the brakes would remain released until the pressure in the system decays to below 16 Barg.

Dependent on the source of back pressure of scenario 4, the brakes may or may not apply when the power pack is shut down.

The brakes would not apply immediately in scenarios 5 & 6 if the power pack was shut down. The pressure may however leak away over a period of time dependent on internal leakage of variable pilot valve (16) and or the nature of the obstruction.

6 Winch Load Holding Capabilities Scenarios (Manual Recovery Only)

Dynamic braking in this circuit is achieved by counterbalance valve (10) even without the brakes applied in a correctly configured circuit with the power pack running the winch should not lower off uncontrolled. The winch however would creep due to internal leakage.

Insufficient Charge Pressure

Failure to ensure adequate charge pressure at the low pressure side of the motor to ensure the piston pressure is greater than the case pressure will have the tendency for the motor to go into “free wheel” mode once the oil which is supporting the load against the counterbalance valve (10) is exhausted. In all circuits natural leakage is experienced due to normal clearances between moving parts and to a greater extent in worn systems. Once the oil leaks away the counterbalance valve (10) becomes ineffective.

Oil leaking away from the pistons allows the motor to rotate. The pistons which are open to tank will have the tendency to be pushed in by the case pressure. When these pistons disengage form the Cam ring the motor is not capable of supporting any load.

Incorrect Counterbalance Valve Setting

The counterbalance valve comes with a factory setting of 210 Barg. Allowing for a maximum load induced pressure of 161 Barg. Counterbalance valves should be adjusted to approximately 130% of the maximum load induced pressure present to ensure the valve is fully seated.

A point to note is that with this model of counterbalance valve, **anti clockwise** rotation increases the set point of the valve.

7 Calculations

Line Pull- Cursor only

$$\text{Line Pull (Te)} = \frac{\text{(Cursor Mass(Te) +Rope Mass(Te))*Sheave Eff. * Bearing Eff.}}{\text{No. of Falls}}$$

$$\text{Line Pull (Te)} = \frac{(4 +1)*1.12 * 1.05}{4}$$

Line Pull (Te) = 1.54 Tonnes

Drum Torque

Drum Torque (Nm) = Line Pull (Kg) * 9.807*Working Radius (m)

Drum Torque (Nm) = 1540* 9.807*0.3563

Drum Torque (Nm) = 5381 Nm

Pressure Required

$$\text{Pressure (Barg)} = \frac{\text{Drum Torque (Nm) *20*PI}}{\text{Motor Displacement (cc/rev)*eff}}$$

$$\text{Pressure (Barg)} = \frac{5381 *20*PI}{9204 *0.95}$$

Pressure (Barg) = 38.6 Barg

Line Pull- Cursor and Diving Bell.

$$\text{Line Pull (Te)} = \frac{(\text{Cursor (Te)}+\text{Bell (Te)} + \text{Rope (Te)})*\text{Sheave Eff}*\text{Bearing Eff}}{\text{No. of Falls}}$$

$$\text{Line Pull (Te)} = \frac{(4+11+1)*1.12*1.05}{4}$$

Line Pull (Te) = 4.7 Tonnes

Drum Torque

Drum Torque (Nm) = Line Pull (Kg) * 9.807*Working Radius (m)

Drum Torque (Nm) = 4700* 9.807*0.3563

Drum Torque (Nm) = 16423 Nm

Pressure Required

$$\text{Pressure (Barg)} = \frac{\text{Drum Torque (Nm)} *20*\text{PI}}{\text{Motor Displacement (cc/rev)}*\text{eff}}$$

$$\text{Pressure (Barg)} = \frac{16423 *20*\text{PI}}{9204 *0.95}$$

Pressure (Barg) = 118 Barg

The above calculations identify that only approximately 38.6 Barg of pressure is required to support the mass of the cursor with approx 1 Tonne of rope paid out and 118 Barg of pressure to support the mass of the cursor and bell, again with approximately 1 Tonne of rope paid out.

This would indicate that the counterbalance valve at its factory setting of 210 Barg would be capable of supporting the mass of the cursor, rope and bell.

8 Conclusions

8.1 In order for the cursor to descend unaided the following conditions would have to be met: -

- Brakes Released
- Hydraulic Integrity compromised

8.2 With reference to the section above Brake Failure Scenarios there are multiple reasons to why the brakes would have remained in the released position. This will require further investigation to pin point the root cause of failure.

8.3 The utilisation of the Hagglunds motor and the failure to adhere to the manufacturers recommendations in respect to supplying sufficient charge pressure directly impacts on the load holding capabilities of the motor when used in a lifting application.

8.4 The failure of not using the uppermost port of the Brake actuator although not in line with the manufactures recommendations, it is not felt that this would have a detrimental effect on the brake actuator operation.

8.5 The brake adjustment on both brake bands were found to be out with tolerance but at time of inspection the Cursor winch was suspended and held.

Annex 6

Extract from Control Panel Inspection Report carried out by SMS Consultants, University of Bath

1. Summary.

A hydraulic pilot operated directional control valve was examined in order to determine the cause of an operational malfunction that resulted in the failure of the brake on a hydraulic crane motor to lock the motor in position, thereby allowing the suspended load to fall after several minutes.

The probable cause has been attributed to the restriction of free movement of the flow control spool back to the fully closed position, caused by material deformation around the lip of the spool bore at the pilot chamber end of the valve body. This deformation appears to have been caused by high localised stresses around the bore lip, attributable to a thin ring of raised material located on the underside surface of the spool shoulder. This ring of material appears to be the result of incomplete machining of the undercut to the spool shoulder. The effects of this plastic deformation have been exacerbated by the apparent lack of concentricity of the pilot chamber recess relative to the spool bore which has resulted in an asymmetric countersink chamfer around the bore lip.

It has not yet been determined why the pressure in the brake line did not drop sufficiently through internal leakage past the spool to allow the brake to operate. Tests have shown that brake line pressure can be retained above 40 bar by a similar valve with the spool fixed in the same position as that of the malfunctioning valve for a period in excess of 18 hours. It has been stated that the brake is held off by pressures above approximately 23 bar.

The origin of thewear marks observed on the inner surface of the adjuster spring chamber has not been determined.

Annex 7

MAIB Flyer

MAIB

MARINE ACCIDENT INVESTIGATION BRANCH

FLYER TO THE SHIPPING INDUSTRY

Fatality on the diving support vessel *Wellservicer*

A crew member suffered fatal injuries while carrying out modification work on the diving bell recovery system of the diving support vessel *Wellservicer.*

The modifications were part of an upgrade to enable recovery of the bell in the event of the main bell winch system failure. This involved the installation of a new winch arrangement for the bell's cursor[1].

The new winch had been operational for several days, but had not been fully commissioned. Before the accident, the new winch was used to raise the 4 tonne cursor to allow riggers to work on top of the bell. The winch system was designed such that the brake was automatically applied when the winch control was placed in the neutral position and when hydraulic power was removed.

Once the cursor was in position the brake of the new winch was applied to lock it in position. Several riggers then worked on top of the bell for a period of time.

Part of the modification required the removal of buoyancy blocks from the top of the diving bell. A rigger climbed on top of the bell to do this, but the blocks were very cumbersome and it became apparent that the cursor would have to be raised further to enable the blocks to be removed. Power was applied to the new winch and an operator went to a control position sited above the cursor and diving bell from where he began to raise the cursor. From the control position, the operator was unable to see the top of the diving bell and he was directed by a rigger using hand signals from a visible part of the deck below. Once the cursor was at a suitable height, lifting was stopped, power to the winch was switched off and work on top of the bell set to continue. A few seconds later the winch rendered and the cursor fell, trapping the rigger between the diving bell and the cursor.

Despite his colleagues' best efforts and rapid evacuation to hospital, the rigger died from his injuries.

The cause of the winch failure was attributed to a faulty pilot valve in the cursor's winch control system, which prevented the winch brakes from applying once hydraulic power was removed.

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[1] Cursor: An arrangement in the shape of an inverted bowl, which guides the diving bell into the ship from below, whereupon the two mate, enabling the diving bell to become integral with the ship and her movements.

Safety Issues

- The installation team failed to apply the most basic of safety principles while working under the suspended load. Regardless of whether the winch had been commissioned and declared fully functional, the cursor should have been supported by additional means, before anyone went underneath it.
- It is extremely inadvisable to place any confidence in the safe operation of machinery that has not been fully commissioned and which therefore has not been properly tested.
- The design of the hydraulic circuit for the new cursor winch meant that the two brakes fitted to the winch did not operate independently, as they were required to do, since a single, defective, pilot valve was common to both brake circuits.
- At the time of the accident, the design of the winch's hydraulic system had not been approved by the vessel's operators or the classification society tasked with approving the whole system. Had such approval been sought for the hydraulic system it is highly probable that the anomaly in the brake circuit design, as highlighted above, would have been identified. Formal approval of systems and their component elements is an essential safety barrier which should never be circumvented before equipment is used.
- *Wellservicer*'s operators had numerous management procedures and safety tools in place to ensure safe working. These were either not applied or were applied ineffectively, to the extent that no-one recognised the risk posed by the suspended cursor. Safety management systems and procedures are useless if their purpose is not understood and applied with diligence by all stakeholders.
- Lines of responsibility between the vessel and shore-based staff became confused. As a result, overall management of the modification project lacked direction and control. Responsibilities should be clearly defined, and understood; it is better to ask too many questions than to carry on with a potentially hazardous task in blind faith that other people are doing what is expected of them.

This accident was subject to MAIB investigation, the report of which can be found on the MAIB's website at:

www.maib.gov.uk

A copy of the flyer and / or the report will be sent, on request, free of charge.

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