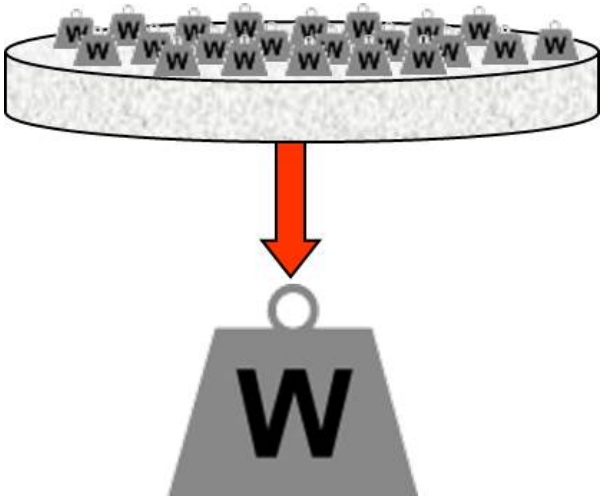
High Pressure Hazard Safety Awareness

Saudi Arabian Saipem Co. Ltd
Drilling Project

UNDERSTANDING PRESSURE

What is Pressure?

Pressure is an expression of force (weight) exerted on a surface per unit area.



In simple words, pressure is the amount of force (weight) applied on one unit of exposed surface area

or

Total weight divided on whole area of exposed surface.

Pressure = Force ÷ Area

UNDERSTANDING PRESSURE

Measurements of Pressure

- ATMOSPHERE (Atm.)

  1 Atmosphere is equal to normal atmospheric pressure.

- BAR

  1 Bar = 0.9869 Atm. (it is roughly equal to 1 Atmosphere).

- POUNDS SQUARE INCH (PSI)

  Number of Pounds each Square Inch area of surface is subjected to.

  1 PSI is a force of 1 Pound per Square Inch.

  1 Bar ≈ 14.5 PSI

- PASCAL (Pa)

  1 Pascal is a force of 1 Newton per Square Meter.

  1 Bar = 100 000 Pa; 1 PSI ≈ 6895 Pa.

  Kilopascal (kPa) = 1 000 Pa

UNDERSTANDING PRESSURE

Amount of Pressure

- Typical air pressure in car tyre is approximately 30 PSI
- Air pressure in Breathing Air Cascade System low pressure manifolds is approximately 100 PSI
- Pressure washer systems eject water with pressure up to 2 000 PSI
- Nominal working pressure of BOP accumulator unit is 3 000 PSI
- Compressed gas cylinders contains pressures up to 4 500 PSI
- Rig Mud systems are operating on pressures up to 7 500 PSI
- Well service activities may utilize pressures up to 15 000 PSI
- Well Control equipment can be rated for pressures up to 15 000 PSI and are subjected to periodical pressure tests

UNDERSTANDING PRESSURE

Potential Risk Areas

- Compressed gas cylinders
- Compressed air
- Breathing air systems
- Drilling muds and fluids system
- Well control equipment control systems
- Water injection
- Pressure testing of equipment
- High pressure washing equipment
- Hydrocarbon processing
- Any enclosed drum, vessel or pipe could be pressurised

HIGH PRESSURE EQUIPMENT ON RIG

Mud Systems

- Mud Pumps
- Pulsation Dampener
- Mud Lines (steel piping, vibrator and rotary hoses)
- Stand Pipe Manifold
- Top Drive System

WHAT CAN [illegible] EARNT


Saudi Arabian Saipem Co. Ltd.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

ACCIDENT DURING STRIPPING MUD PUMP PULSATION DAMPER

Saudi Arabian Saipem Co. Ltd.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

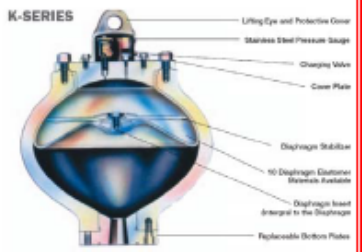
SAS ALERT- 09/12
13 October 2012

ACCIDENT DURING STRIPPING MUD PUMP PULSATION DAMPER

WHAT HAPPENED?

The accident occurred on 13 Oct. 2012, at 11:00 in Saipem Dhahran Base Mechanical Workshop. The maintenance team, consisting of three persons, had been involved in stripping the Hydril K20-7500 pulsation damper's bottom plate, which had a damaged seal groove. Prior to starting the task, the crew checked the pulsation damper gauge for pressure and verified a zero pressure reading. After unscrewing all flange mounting studs and allen-screws from the bottom plate, the crew started to remove the bottom plate with the extractor studs, which enabled them to move the bottom plate slightly. As per the advice of the crew supervisor, in order to remove the stuck bottom plate, it was decided to utilise two inserts in the gap between the bottom plate and dampener body in combination with the extractor studs. While two persons forced the bottom plate with wedges from opposing sides, the IP, who was positioned in front of the bottom plate, was using the pneumatic spanner to screw-in the extractor studs. Suddenly, the diaphragm burst out due to the pressure inside, resulting in the bottom flange being discharged from the pulsation dampener. The bottom plate struck the IP on the thigh of his right leg, throwing him approximately 6 meters due to the differetial pressure wave, and causing serious injury to his right leg.

Position of IP after accident



Pulsation Damper K-Series Diagram

WHAT CAUSED IT?

The gauge read 0 psi as witnessed by three separate people before dismantling of the dampener began. However, the gauge was faulty and showing an inaccurate reading. Consequently, the crewmembers involved in the operation did not anticipate the contained pressure and failed to bleed off by opening the charging valve. The pulsation damper had approximately 750 psi of pressure within, while the bottom plate was being removed. In addition, the contributing causes were:

- Pulsation damper gauge had an expired calibration.
- Pulsation dampener diaphragm was not secured to the diaphragm stabilizer with the diaphragm locking screw, which resulted in the diaphragm expanding like a balloon due to the system pressure, and piercing through the bottom flange hole, as the crew tried to remove the flange.
- Crew had no experience in removal of the pulsation damper's bottom plate.
- There was no PTW issued, Job Safety Analysis completed and TBT conducted prior to starting the task.

PREVENTIVE ACTIONS

- Communicate the relevant Safety Alert to all rigs and logistic base teams.
- System pressure must be bled off completely by opening the charging valve. Following this, the charging valve and gauge must be unscrewed from the pulsation damper. It is recommended to remove the top cover plate during disassembly of the pulsation damper. This information should be reflected in the relevant Job Safety Analysis (JSA) and discuused on the TBT Meeting.
- Whenever personnel are working on pressurized lines and/or pressure vessels, regardless of the product contained, the pressure is to be vented before the work begins.
- Emphasise on implementation of the gauges calibration program. Use only gauges with a valid calibration certificate.
- Hydril K20-7500 Pulsation Damper plate stabilizer should be always secured to the diaphragm with the stabilizer screw (*ensure during replacement of diaphragm elastomer*).
- Pressure vessel maintenance/services to be performed by competent mechanics only.
- PTW is mandatory for any maintanance task perfomed on a compressed vessel.

THE KNOWLEDGE OF THIS INCIDENT COULD PREVENT SIMILAR ONES FROM HAPPENING IN THE FUTURE

This material is presented for information purpose only. Managers and Supervisors should evaluate this information to determine if it can be applied to their own situation and practices. For further information contact: SERGO KIKILASHVILI- Email: Sergo.Kikilashvili@saipem.eni.it; LASHA BUCHASHVILI-Email: Lasha.Buchashvili@saipem.eni.it;

HIGH PRESSURE EQUIPMENT ON RIG

Well Control Systems

- BOPE
- Accumulator Unit
- BOP Control Lines
- Choke Manifold
- Kill Line, Emergency Kill Line, Choke Line

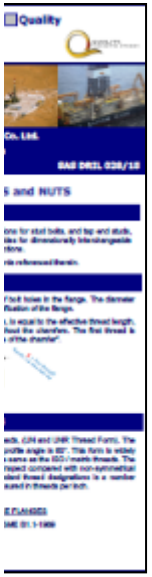
WHAT CA ARNT


Saudi Arabian Saipem Co. Ltd.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

BOP PRESSURE TEST RESULTED


Quality

RECOMMENDED PRACTICES

Technical Operational Quality

saipem

Bulletin

No. 005/2015

QUALITY. TURN BETTER INTO BEST.

RECOMMENDED PRACTICES

Picture 1

Picture 2

Picture 3

Picture 4

Pictures 1 and 2 show an improperly bolted flange, the bolts are too short on one side, and too long on other. Also, the nuts are only partially screwed onto the bolt, so the connection may not be strong enough.

Picture 3 and 4 show the different lengths of stud bolts on the connected flanges and blocks.

The combination of those conditions means that the connection between the equipment may not be as strong as it should be. Flanges are designed so that the entire nut-bolt combination holds the forces on the flange. The job includes proper cleaning of the flanged connections, assembly of the pipe work and equipment, installation of the correct grade, length and diameter, of bolts and nuts, and correct method of tightening of connections. The job is not complete until all of the bolts are properly installed and tightened.

Bolt tightening procedures must be followed. The connections should be tightened uniformly, with the correct torque value specified for the size/grade of bolt used, so the gap between the flanges is even all the way around. Make sure that you follow the correct procedure, use the correct tools, and that you are properly trained in the equipment assembly procedure.

Check all the connections between High Pressure lines, ensuring that bolted flanges and blocks are properly tightened. This must be done as part of the work scope routine safety inspections. Bolts which do not extend beyond the nuts should be reviewed, corrected, and retightening. As a rule; the threads protruding from the top of the nut should be equal to 1/3 of the bolt diameter.

For further details contact drilling.operations@saipem.com

HIGH PRESSURE EQUIPMENT ON RIG

Cementing Systems

- Cementing Pump
- Cementing Piping
- Cementing Manifold

HIGH PRESSURE EQUIPMENT ON RIG

Well Service Equipment

- Coiled Tubing
- Well Testing
- Well Flaring
- Well Killing
- Well Stimulation
- Water Injection

HIGH PRESSURE EQUIPMENT ON RIG

Pipe Handling Equipment

- Iron Roughneck
- Power Tong
- Pipe Spinner
- Hydraulic Pipe Elevator
- Spider Pipe Elevator
- Spider Pipe Slips

HIGH PRESSURE EQUIPMENT ON RIG

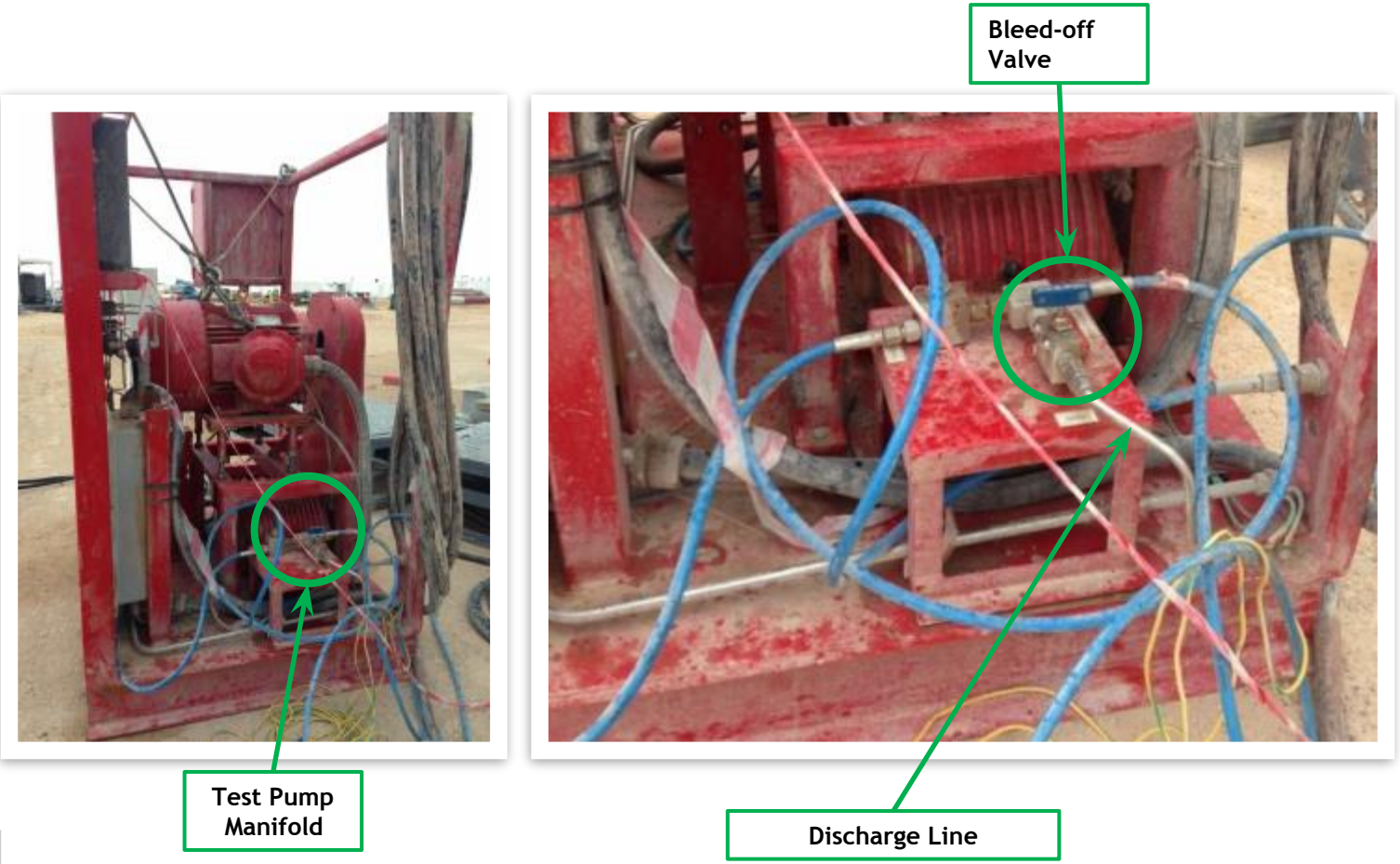
Pressure Testing Equipment

- High Pressure Test Pump
- Test Lines and Fittings

HIGH PRESSURE EQUIPMENT ON RIG

Pressure Testing Equipment

Pressure test pump pressure bleed off to be done only through bleed off manifold



HIGH PRESSURE EQUIPMENT ON RIG

Pneumatic / Hydraulic Hoisting Equipment

- Air Winches
- BOP Hoists
- Supersack Hoists
- Overhead Lifting Equipment
- Hydraulic Cranes

HIGH PRESSURE EQUIPMENT ON RIG

Breathing Air Systems

- Breathing Air Cascade Cylinders
- Breathing Air High Pressure Piping
- Breathing Air Compressors
- Self Contained Breathing Apparatus
- Breathing Apparatus Refilling Stations

HIGH PRESSURE EQUIPMENT ON RIG

Compressed Gases Cylinders

- Oxygen
- Nitrogen
- Propane
- CO_2
- Freon

HIGH PRESSURE EQUIPMENT ON RIG

Compressed Air

- Air Compressors
- Compressed Air Receiver Tanks
- Compressed Air Transfer Lines

HIGH PRESSURE EQUIPMENT ON RIG

High Pressure Cleaning / Washing

- High Pressure Wash Gun
- High Pressure Water Jetting
- Sandblasting

HIGH PRESSURE EQUIPMENT ON RIG

High Pressure Cleaning / Washing

OPERATING PRECAUTIONS

- Never point a pressure washer at yourself or others, whether the pressure washer is operating or not. It could discharge unexpectedly
- Avoid washing of any PPE or clothes with water jet
- Wear appropriate PPE while using pressure washer (as a minimum safety goggles, face shield, steel toe rubber boots, apron)
- Maintain a distance from 8 to 24 inches between the spray-wand nozzle and surface being cleaned
- Never attempt to push or move objects with spray from the washer
- Be aware of the work environment and keep high-pressure spray away from electric wiring, receptacles, or junction boxes
- Turn water pump off, close water supply valve and depressurize equipment when not in use

HIGH PRESSURE EQUIPMENT ON RIG

Portable Power Tools

- Air powered hand tools (grinder, drill, spanner, etc.)
- BOP Bolts Torque Up Wrench
- Hydraulic crimping machine

HIGH PRESSURE EQUIPMENT ON RIG

High Pressure Pipework

Permanent of temporary pipework can be utilized for direction of fluids or gases under pressure from one point to another.

Hard and flexible piping are being utilized in the following operations:

- General pumping operations (transfer of fluids, mud/brine mixing operations, (reverse) circulating well fluids, etc.
- Pressure testing of downhole equipment (casing, packers, tubing, plugs, valves, accessories).
- Cementing.
- Well killing.
- Well stimulation.
- Nitrogen pumping.
- Well clean-up (Flowbacks).
- Well testing.
- Under balanced drilling operations.
- Managed pressure drilling operations.

HIGH PRESSURE PIPEWORK

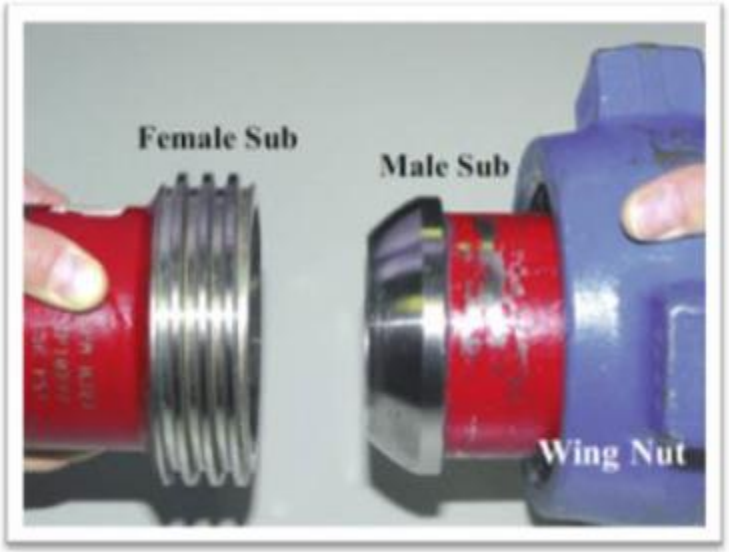
Hammer Union Connection

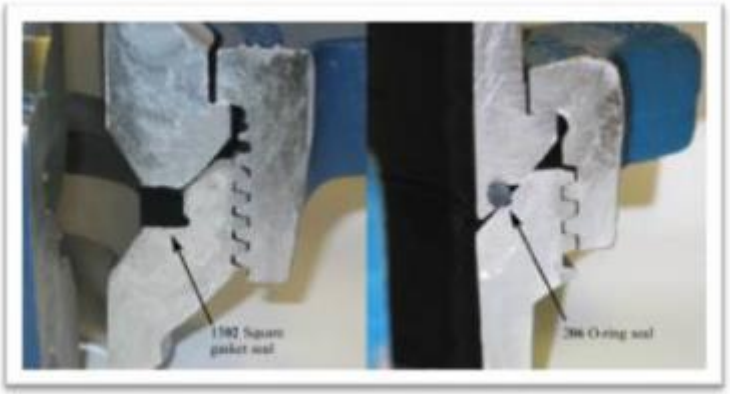
The union parts are identified using a nominal pipe size, a FIG designation and a code e.g.1502.

For example: 3” FIG 1502

- 3” - is the nominal diameter and is close to the inside diameter.
- The meaning of “FIG” is an abbreviation of “figure” – meaning drawing
- 1502 is a code for the working pressure rating:
  - First two digits (15) referring to 15,000 PSI.
  - Last two digits (02) referring to the sealing arrangements (square gasket seal).

NOTE: For H_2S applications pressure rating has to be downgraded, e.g. FIG 1502 pipework for H_2S service shall be utilized for 10 000 PSI pressure only.





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Drilling Quality Bulletin

NO. 017/ 2013

PROJECT: Saudi Arabian Saipem Co. Ltd.

LOCATION: Dhahran Base

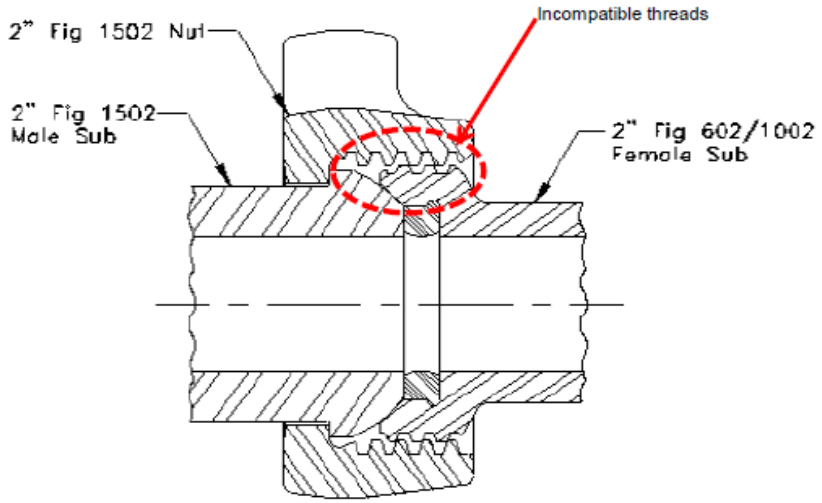
DATE: 26 May 2013

Weco Hammer Unions

Mismatched unions can cause fatal accidents !

IMPORTANT THINGS TO LOOK FOR:

- **Compatible threads per inch**
- **Compatible female – male combination**



Incorrect Combination

2" 602 Thread Half (Female Sub) with 2" 1502 Wing Nut (Male Sub)

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HIGH PRESSURE PIPEWORK

Hammer Union Connection Mismatches

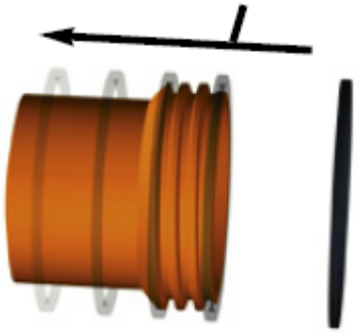
Mismatches in hammer unions are severe mechanical hazards to the integrity of the system. They are weak points that may fail under pressure and can result in serious personal injury, death, and/or property damage.

Such Mismatches occur in 5 main categories:

- Mismatching the same size (unions having the same size, but different figure numbers)
- Mismatching the pressure ratings (union connections of the same size and figure number but with different pressure ratings)
- Mismatching of wing nuts (wing nut of one size and figure number is mounted on the male sub of another size and figure number)
- Mismatching of components (segments and nut of one figure number are made up to a detachable male sub with a different figure number)
- Mismatching of non-detachable and detachable components (assembly of non-detachable nuts on detachable male subs)

Go No-Go Gauge shall be used to avoid mismatching of same size unions

2” Fig 1502 Female: NO-GO



2” Fig 602 Female: GO

HIGH PRESSURE PIPEWORK

Flange Connection

- Flange shall be OEM certified and rated for the pressures it is subjected to
- All studs shall be in place (Grade B7)
- Nuts shall be tightened with pre-defined torque (Grade 2H)
- Bolts shall extend completely through the nut with at least one thread exposed
- Proper O-rings shall be installed between flanges as required

Improper Installation

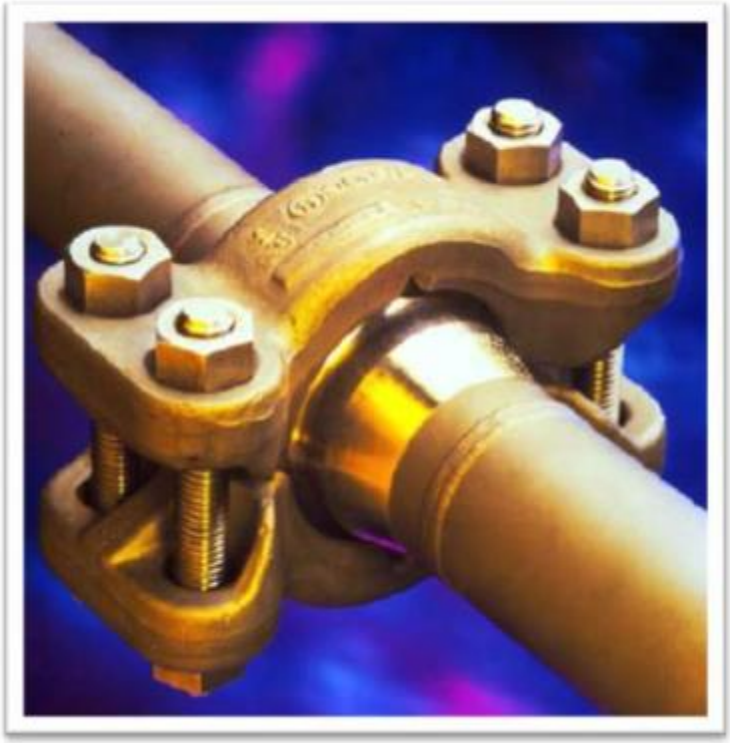
Proper Installation

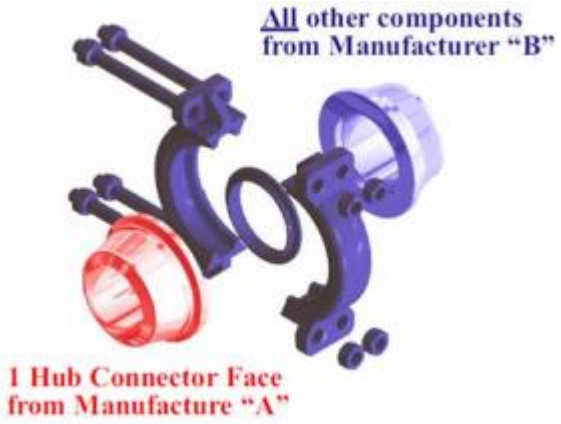
HIGH PRESSURE PIPEWORK

Hub-Type Connection

The mating of hub connector components from two different manufacturers is only allowed if:

- The components are dimensionally the same and mechanically equivalent.
- The hub connector face shall be from one manufacturer and all the other connector components shall be supplied by the other manufacturer.
- The assembled connector integrity has been validated at temperature, pressure and side-loading by the manufacturer supplying the majority of the components.





HIGH PRESSURE PIPEWORK

Welded Connection

- All the welded connections in high pressure systems shall be rated for the pressure they are subjected to during operation.
- Welds shall be made strictly in accordance with appropriate welding procedure by qualified (certified) welder.
- Welds shall be NDT tested, certified and pressure tested.

HIGH PRESSURE PIPEWORK

Threaded Unions

Include but is not limited with:

- High Pressure Fitting
- High Pressure Valves
- Instrumentation Threads, e.g. gauges, sensors
- Hoses with threaded fittings

Considerations:

- Threads shall be rated for the pressures
- Male and Female threads shall be of same standard and dimension

HIGH PRESSURE PIPEWORK

Flexible Pipes - Hoses

- Hoses to direct well fluid from the test tree to the stand pipe or choke manifold - test lines
- Cementing hoses
- Acid line
- Nitrogen lines
- Chemical injection hoses
- Kill and Choke lines
- BOP Control Lines

Considerations:

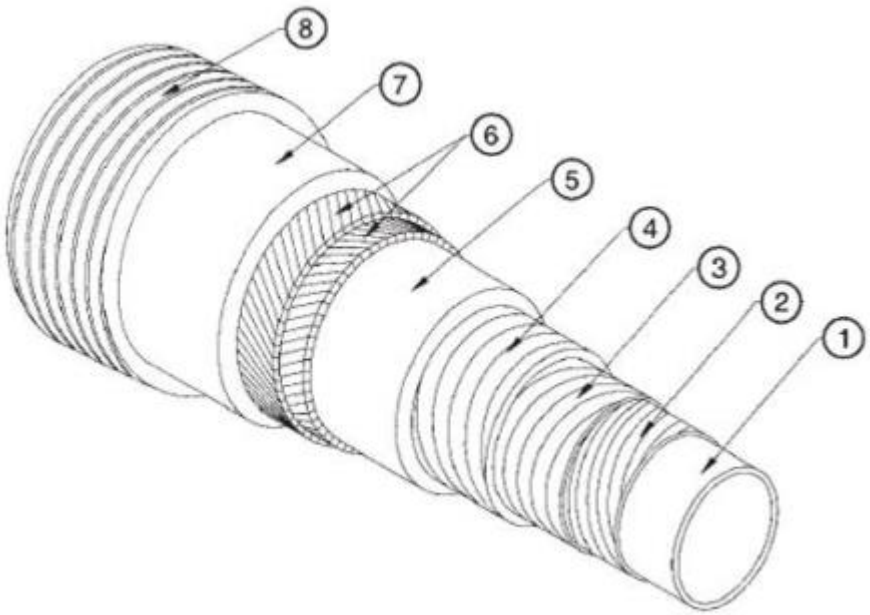
- Hoses shall be rated for the pressures
- Inspection, testing, certification, maintenance handling and storage standards and OEM requirements shall be strictly followed

HIGH PRESSURE PIPEWORK

Flexible Pipes - Hoses

COFLEXIP HOSES

Typical structure of the hoses:



1 Thermoplastic inner liner
2 Aramid tape
3 Zeta spiral
4 Flat steel spiral
5 Thermoplastic intermediate sheath
6 Cross-wound tensile armours
7 Thermoplastic external sheath
8 Outer-wrap interlocked steel carcass

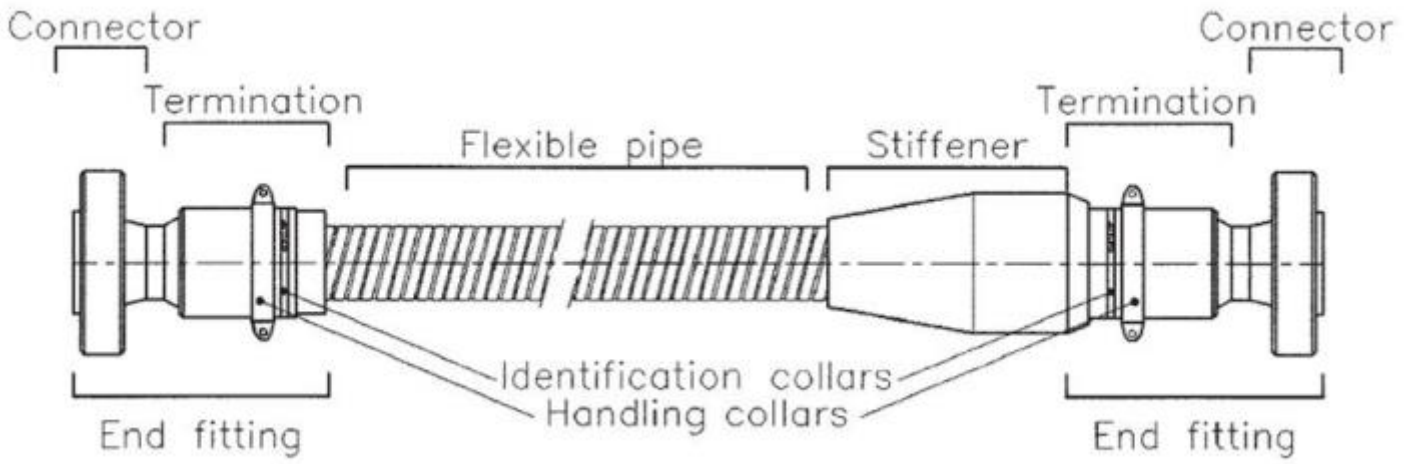
HIGH PRESSURE PIPEWORK

Flexible Pipes - Hoses

COFLEXIP HOSES

A visual inspection throughout the entire length of the line should include:

- Stainless steel outer-wrap : the outer-wrap must always ensure its primary function which is to protect the polymeric sheath underneath from being torn or punctured.
- Termination : record any damage to the coating on the end-fitting, and follow its progression, if any.
- Connector : same as above, with particular attention to the seal area.



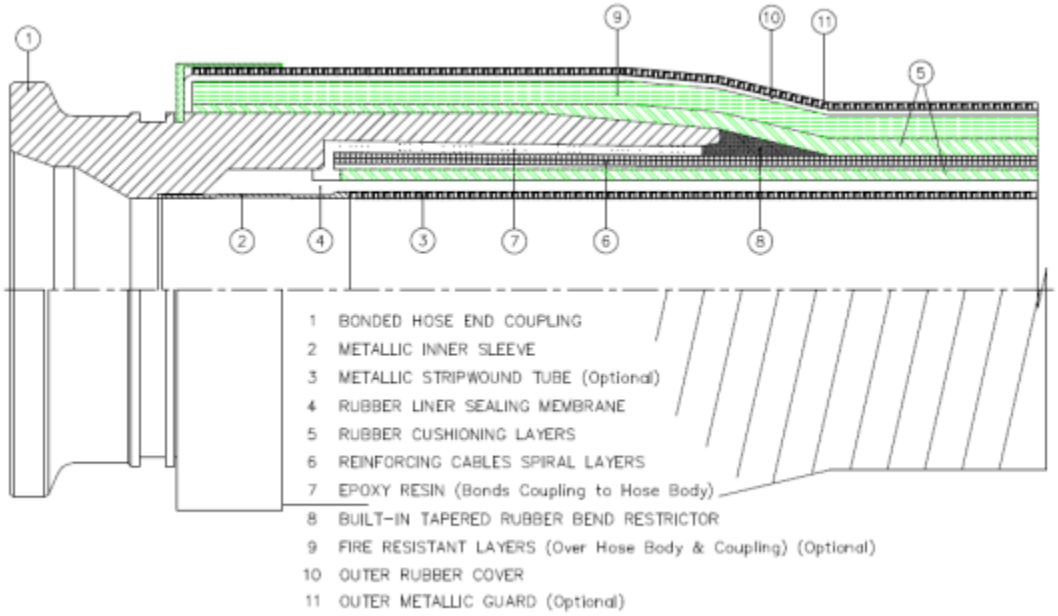
HIGH PRESSURE PIPEWORK

Flexible Pipes - Hoses

HIGH PRESSURE DRILLING AND PRODUCTION HOSES

Critical Elements of the Hoses:

- Rubber liner - The main sealing membrane
- Inner metallic tube - Supports the rubber liner under decompression
- Steel reinforcing cables - Main strength of hose body providing pressure retention
- Rubber cover - External sealing compound preventing water ingress to hose body
- Bonded hose coupling - End coupling retention



HIGH PRESSURE PIPEWORK

Flexible Pipes - Hoses

HIGH PRESSURE DRILLING AND PRODUCTION HOSES

The hoses shall be inspected on a regular on-going basis according to OEM recommendations, international or local regulations / requirements.

Cuts or gouges in the hose should be addressed immediately.

Damage to the outer cover that is not too deep and does not expose the steel cables can be repaired using suitable sealants or patches.

If the damage exposes the steel cables and corrosion is induced, then the strength of the cables is weakened and the hose is not repairable and must be condemned.

WHAT CAN [illegible] EARNT


SAUDI ARABIAN SAIPEM CO. LTD.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

HOSE WHIPLASH RESULTS IN LTI

SAUDI ARABIAN SAIPEM CO. LTD.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

SAS ALERT- 10/16
14 April 2016

HOSE WHIPLASH RESULTS IN LTI

WHAT HAPPENED?

The accident occurred during cellar cleaning operations, using the cellar jet system connected to mud pump. During running the mud pump, the pop-off valve was activated twice and both times the mud pump was stopped in order to reset the pop-off valve. The Toolpusher decided to open the cellar jet connection and verify condition of the jet nozzle, to ensure that it was free from any debris, and flush the HP rubber hose connected to cellar jet system. After cleaning the jet nozzle, the Asst. Driller placed the end of the rubber hose into the cellar, in order to flush the line and washout the area around the cellar jet suction tube. During initial flushing, with the mud pump rate at 8-10 SPM, the fluid was discharged slowly from the hose. Consequently, it was decided to increase the pump rate (SPM) to improve the flow rate. As the Driller increased the pump rate to 40 SPM, the rubber hose whipped out from the cellar grating opening and struck the Toolpusher on his right leg, resulting in injury.


2" High Pressure Rubber Hose

WHAT CAUSED IT?

- High pressure hose was not secured by any means to avoid accidental whiplashing.
- No JSA and Tool-Box Talk were conducted prior to commencement of the task.
- Personnel failed to clear temporarily restricted area and positioned in 'line of fire', during flushing operations.

PREVENTIVE ACTIONS/LESSONS LEARNT

- Install a permanent rigid line dedicated for the cellar jetting system from the mud pump manifold to cellar jet connection, which shall remain secured (fixed) either horizontally or vertically using an anchor clamp and secondary restraint lines.
- Conduct safety meeting and review the incident with the crewmembers to share the incident lessons learnt:
  - HP hoses which may be subject to whipping, shall be equipped with clamps and wire rope safety lines.
  - Personnel must not position themselves in the 'line of fire' and always contemplate the likely direction of unplanned energy release.
  - Use barriers and signage to warn personnel of moving and/ or energized risks.
  - Where changes to work are made for whatever reason, the implications of changes should be properly considered.
  - When planning work, it is key that the hazardous potential needs to be identified. Due to a slight change in circumstances, what might initially be regarded as routine can in fact become complex and be the subject of wider ranging controls.
- Develop JSA for Cellar Jetting Operations to incorporate all the hazards associated with operations.
- Launch the Life Saving Rule Campaign " Moving and Energized Equipment (MEE)".
- All critical rig-up/ down operational stages and safety controls measured shall be documented in the relevant JSA, which shall be reviewed during TBT Meetings with all relevant crewmembers involved in task.

THE KNOWLEDGE OF THIS INCIDENT COULD PREVENT SIMILAR OCCURRENCE HAPPENING IN THE FUTURE

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Click Thumbnail to Enlarge

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

Restraints function to reduce movement of pipe and hoses in the event of a pipe, hose or fitting failure.

They are a mitigation tool that can be used to minimize or restrict damage to personnel and equipment from piping.

They are not capable of restraining every fitting that may break free during a failure event.

Restraints are not a substitute for good integrity management practices including proper design, iron management, proper pipe support, and pressure testing.

When restraints are utilized on pressurized piping and hoses, they must be

- engineered to withstand the anticipated force encountered during a failure
- attached to equipment and/or supports that can withstand the forces that will be put on them

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

WHIPCHECKS

- Intended for use with pressured hose lines, not intended for use with hard pipe.
- Installation must minimize the amount of slack in the cable as much as possible.
- Although whipchecks minimize the area which the hose can whip around upon failure of a coupling, they do not completely restrict movement. This may result in injury to personnel located along side it during an event.
- Whipchecks are typically designed with a 5 to 1 safety ratio, which often limits them to lower pressure operations.
- Whipchecks must be used for their designed purpose and rating.
- Common whipckecks are designed for pressure rate not more than 200 PSI

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

WHIPSOCKS

Consist of twisted strands of metal wire that wrap around a pressured hose with eyes hooks on the connection end that secure to anchor points. The sock diameter reduces when the hose is forced away from the anchor points (coupling failure), tightening around the hose and restraining it from movement. Critical aspects include:

- Intended for use with pressured hose lines.
- Require anchor points for the whipsock eyes.
- They can be used on hose to hose connections or hose to pipe connections.
- Whipsocks are preferable to whipchecks as they can significantly reduce the area of potential movement of a hose during failure compared to a whipcheck.
- Whipsocks are preferable to whipchecks as they can restrain a separation of the hose from an end fitting. A whipcheck may not restrain in this scenario.
- Nominal breaking strength is much higher then of whipcheck.

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

ANCHORAGE

Hard piping shall be anchored on regular intervals in order to eliminate excessive vibrations. Intervals between anchor points will be calculated considering the following factors:

- Piping characteristics, such as:
  - Diameter
  - Wall thickness
  - Metal composition
  - Yield strength
- Pressure rating
- Internal and external forces piping can be subjected to
- Configuration of the piping
- Environmental factors
- Types of connections utilized

HIGH PRESSURE PIPEWORK

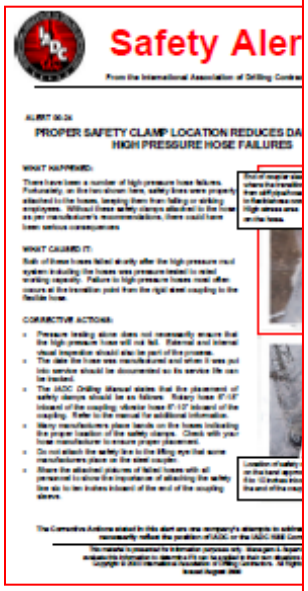
Pipe and Hose Restrains

CABLE & SHACKLE (WIRE & CLAMP)

Critical aspects of this type of restraint include:

- In order for the shackle/clamps to work correctly, they must be tightened adequately onto the pipe to prevent the clamp from sliding.
- They are designed for specific force/pressure ratings. If used beyond their rating they actually increase risk by becoming potential projectiles in the event of a pipe or fitting failure. The manufacturer's intended design must be confirmed in order to use.
- A point for regular tie down is preferable.

WHAT CAN


Safety Aler

From the International Association of Drilling Contr

ALERT 00-24

PROPER SAFETY CLAMP LOCATION REDUCES DA
HIGH PRESSURE HOSE FAILURES

WHAT HAPPENED:

WHAT CAUSED IT:

CORRECTIVE ACTIONS:

Safety Alert

From the International Association of Drilling Contractors

ALERT 00-24

PROPER SAFETY CLAMP LOCATION REDUCES DAMAGE FROM HIGH PRESSURE HOSE FAILURES

WHAT HAPPENED:

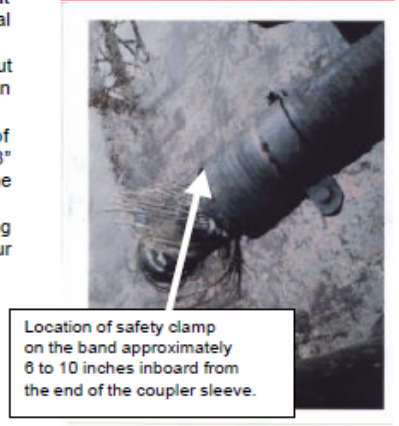
There have been a number of high-pressure hose failures. Fortunately, on the two shown here, safety lines were properly attached to the hoses, keeping them from falling or striking employees. Without these safety clamps attached to the hose as per manufacturer's recommendations, there could have been serious consequences

WHAT CAUSED IT:

Both of these hoses failed shortly after the high-pressure mud system including the hoses was pressure-tested to rated working capacity. Failure to high-pressure hoses most often occurs at the transition point from the rigid steel coupling to the flexible hose.

CORRECTIVE ACTIONS:

- Pressure testing alone does not necessarily ensure that the high-pressure hose will not fail. External and internal visual inspection should also be part of the process.
- The date the hose was manufactured and when it was put into service should be documented so its service life can be tracked.
- The *IADC Drilling Manual* states that the placement of safety clamps should be as follows: Rotary hose 6"-18" inboard of the coupling; vibrator hose 6"-10" inboard of the coupling. Refer to the manual for additional information.
- Many manufacturers place bands on the hoses indicating the proper location of the safety clamps. Check with your hose manufacturer to ensure proper placement.
- Do not attach the safety line to the lifting eye that some manufacturers place on the steel coupler.
- Share the attached pictures of failed hoses with all personnel to show the importance of attaching the safety line six to ten inches inboard of the end of the coupling sleeve.



The Corrective Actions stated in this alert are one company's attempts to address the incident, and do not necessarily reflect the position of IADC or the IADC HSE Committee.

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Issued August 2000

RNT

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

ROTARY AND VIBRATOR HOSES RESTRAINS

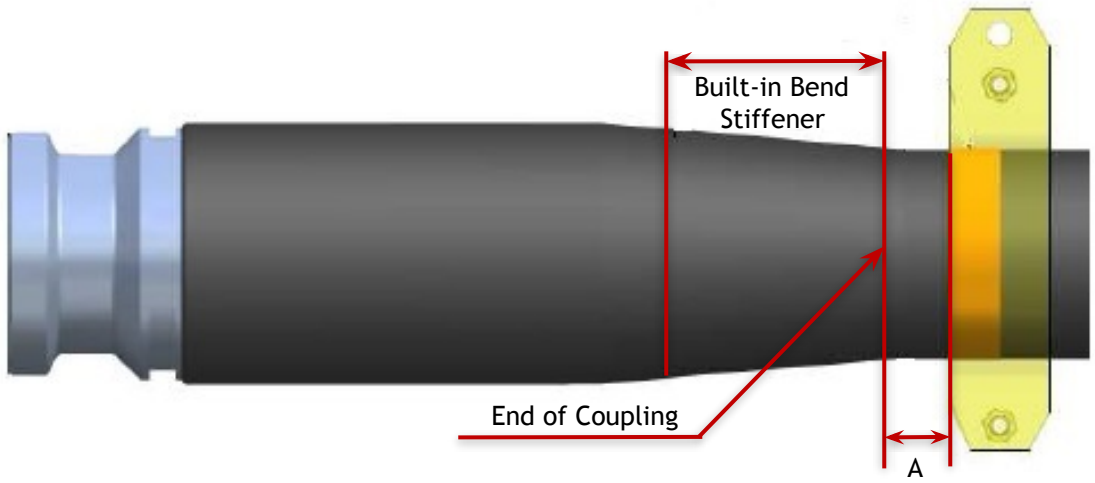
Rotary hoses and Vibrator hoses 8’ or longer are marked with the notation “Attach Safety Clamp Here”. Safety clamps must be installed prior to placing hose into service. The safety clamp is located on the hose body behind the built-in bend stiffener on the following distance (A) from the inboard length of coupling:

- For rotary hose - 6” to 18”.
- For vibrator hose - 6” to 10”.

Safety clamp should be tightened securely, but not to such an extent as to damage hose or reduce the inside bore diameter.

Safety clamp shall never be used for lifting.

Safety clamp installation procedure will be provided by hose OEM.



HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

SLING RESTRAINS

intended for use with high pressure systems. Depending on the specific design, these restraints include soft slings that wrap around the pressured piping, and anchor points, and may utilize sling connections or spines.

Sling restraints are designed to absorb the kinetic energy from moving pipe where rigid systems would otherwise break. Critical aspects include:

- Intended for hard pipe, not for use with hoses.
- Must be specifically engineered for system pressures and forces.
- Correct installation of the system is crucial, and sling slack must be minimized throughout the system.
- Maintenance program for sling quality is critical.
- Chemical corrosion of slings should be avoided.

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains

BLOCK ANCHORS

Block anchors must be of sufficient weight to prevent movement of the anchor in case of a line failure. Because block applications are often not designed but simply mimic other local convention, they may pose a particular hazard.

All anchors, must be appropriately engineered for the potential static and dynamic forces in the case of a failure.

Don’t use block anchors that do not have a channel for the piping. This results in elevation of the block, which negates their restraining effect.

HIGH PRESSURE PIPEWORK

Pipe and Hose Restrains - Practices to Avoid

- Don’t use whipchecks on pipe, regardless of the pressure. They are designed only for hoses.
- Don’t use block anchors that do not have a channel for the piping. This results in elevation of the concrete block on wood shims, which negates their restraining effect.
- Don’t stack items on top of concrete block anchors as these items can become projectiles in the event of a line separation
- Don’t use chains, as they are not designed for use as restraints (exceptions exist, but design of chain for application must be verified)

HIGH PRESSURE EQUIPMENT PROTECTION

Pressure Relief Valves

Pressure Relief Valves (PRV) prevents overpressure damage, rupture and explosion in vessels, pipes, pumps and other pressurized containers that hold liquid or gas. They are designed to be either pre-set of adjustable to a desired relief point at which the completely sealed valve opens to allow the escape of the gas or liquid, reducing or eliminating internal pressure.

Some of the important reasons for excess pressure in a vessel or system are:

- Blocked discharge
- Exposure to external fire
- Thermal expansion
- Chemical reaction
- Heat exchanger tube rupture
- Cooling system failure

Each PRV shall be tested and calibrated on periodical basis:

- Annual calibration, test and certification by 3rd party. Calibration tags shall be provided on each PRV.
- Quarterly internal inspection and function test. Inspection tag shall be provided on each PRV. Records shall be maintained.

HIGH PRESSURE EQUIPMENT PROTECTION

Mud Pump PRV

The mud pump delivery line is protected by means of high-pressure reset relief valve, preset at a certain value of pressure according to the mud pump working pressure.

The discharge lines should be a minimum of 3” diameter, constructed from high-pressure pipe and slope downwards to facilitate drainage.

There shall be no other valves installed between mud pump and end of discharge line.

Screwed valves should be phased out and replaced with a flanged type.

The elbow outlet on the mud tank should be secured by cable and shackle method.

WORKING WITH HIGH PRESSURE EQUIPMENT

Hazard Assessment and Mitigations

- Perform Hazard Assessment to identify and mitigate environmental and operational hazards
- Identify pressure levels in each section of pressurized equipment
- Ensure all components of equipment are rated to the pressures they are subjected to
- Verify equipment are tested and certified for the appropriate pressure levels
- Utilize only OEM equipment. Strictly avoid any homemade modifications and repairs
- Ensure pressure monitoring systems, e.g. gauges, are provided in all critical points, duly calibrated and certified
- Ensure Safety and Pressure Relieve Valves are provided as required, duly calibrated and certified
- Anchor all the components of the high pressure system firmly to eliminate any whipping effect when pressurized
- Ensure adequate primary securing of all components of pressurized systems
- Provide safety restraints, e.g. safety cables, Flowline Safety Restrains, in all connections as required. Safety restrains shall be rated to the pressure equipment is subjected to.
- Implement No-Go Zones procedure barriering off pressurized areas and limiting unautorized access of personnel
- Post relevant warning signs as applicable
- Assign experienced, skilled and trained personnel to activities containing hazards of high pressure

WHAT CAN GO

Saudi Arabian Saipem Co. Ltd.

ONSHORE-OFFSHORE DRILLING PROJECT

SAFETY ALERT

SAS ALERT- 09/14
31 July 2014

Use of un-identified equipment Resulted in Personnel Injury

WHAT HAPPENED?

On 24th of July, operation was functional test of BOPS. After completing test for blind and lower rams, the Night Tour Pusher observed that two nuts on the connection between annular BOP 21 ¼ 2K flange and DSA were not fully tightened. Night pusher instructed chief roustabout and one floorman to tighten the nuts. Man lift was utilized as mean of access to the annular BOP.As the man lift was being lifted to the DSA flange, the opening line co-flex hose (pressurized) disengaged from the annular BOP body and released, at this moment the chief roustabout was abraded by the hose on the face. The man lift was immediately lowered and IP was taken to the clinic for first aid.

IP position at the time of the incident

WHAT CAUSED IT?

- *Un-identified Nipple was installed on the annular BOP.*
- *Mechanic failed to identify potential hazard and risks associated to the poor quality of the equipment.*
- Threads of annular BOP were damaged due to cross thread tightening.
- The nipple connections not fully tighten into annular body.
- Person in charge did not perform final visual observation on all bolts to ensure all nuts are properly tight as required prior to start BOP functional test.

Un-Identified NPT Nipple

PREVENTIVE ACTIONS/LESSONS LEARNT

- Make survey on SAS rigs to identify all NPT Nipples are OEM certified, and discard all non-compliant Nipples.
- Enforce the use OEM nipples where working pressure is easily identified so as to prevent inadequate usage.
- Provide guide lines for proper installation of NPT nipples in BOP annular.
- Implement the preventive maintenance work order instruction is generated for NPT Nipples in order to comply with OEM. To implement a 'repair' or 'replace' work order to guide the life cycle of NPT nipples.
- Implement inspection plan for NPT nipples aligned with Well Control equipment required frequency (every 3 years).
- Maintain minimum, maximum stock of OEM NPT Nipples available in store.
- JSA (NU/Annular BOP) revision to highlight PIC to perform final visual observation on all bolts to ensure all nuts are properly tight as required prior to start BOP functional test.
- Incident to be reviewed with the crewmembers during the safety meeting and safety training sessions.

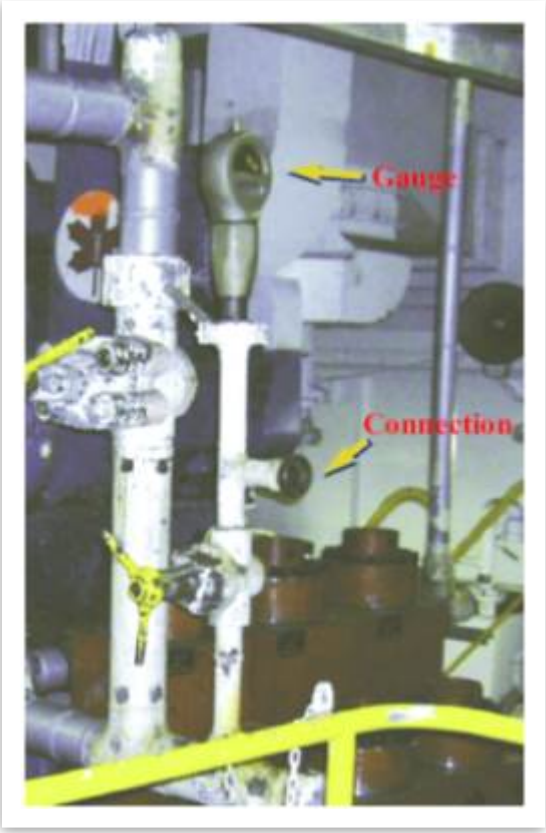
THE KNOWLEDGE OF THIS INCIDENT COULD PREVENT SIMILAR ONES FROM HAPPENING IN THE FUTURE

This material is presented for information purpose only. Managers and Supervisors should evaluate this information to determine if it can be applied to their own situation and practices.
For further information contact: SERGO KIKILASHVILI- Email: Sergo.Kikilashvili@saipem.com ; LASHA BUCHASHVILI-Email: Lasha.Buchashvili@saipem.com.

WORKING WITH HIGH PRESSURE EQUIPMENT

Position of Body

When reading gauges or working on pressured equipment, keep body out of “line of fire” of all connections.



Gauge positioned directly above a pressurized pipe connection

A 1/2" NPT plug projectile is potentially lethal even with 1 000 PSI pressure behind

WORKING WITH HIGH PRESSURE EQUIPMENT

Administrative Controls

- Obtain Work Permit for non-routine operations containing high pressure equipment, such as:
  - Pressure Testing of equipment;
  - Well service operations, e.g. cementing, Coiled Tubing operations, well testing.
- Work out JSA prior to starting operation reflecting all contained hazards and identifying their mitigation measures; JSA shall be agreed and bridged with 3rd party service provider whenever applicable.
- Carry out proper pre job meeting involving all concerned personnel and discussing all hazards and respective mitigations as identified in JSA. Clearly identify duties and responsibilities and ensure proper communication with all crews.
- Carry out pre job inspection on all components of high pressure equipment. Develop relevant check lists as required

WORKING WITH HIGH PRESSURE EQUIPMENT

Vibration

Vibration can be a significant risk to equipment integrity, leading to mechanical failure, fluid release, and potentially serious safety implications. Common areas of vibration are:

- Long pipe runs
- Piping fixtures and instrumentation such as gauges
- Equipment such as valves, chokes, etc.
- Pumps

Common causes of vibration include:

- Excessive pulsation (from pumps for example)
- Mechanical natural frequencies
- Inadequate supports and/or support structure

Common effects of vibration include:

- Loosening of bolts
- Compromising of mechanical joints (backing-off of wing nuts)
- Movement or slackening of tie downs and restraints.

WORKING WITH HIGH PRESSURE EQUIPMENT

Shock Loading

A significant change in the flow rate, or pressure, during an operation (such as the emergency closure of a valve) causes a sudden extra load or “jolt” on the system.

The temporary increase of load on the system usually imposes increased pressure, vibration, and bending forces on the system. During this period of Shock Loading, any sub-standard part of the system (inferior pipe, worn connections, mismatched connections, wrong pressure rated equipment) can fail with potentially disastrous consequences.

Hazardous Fluids

Many fluids used in operations (such as brines or acids) are corrosive to temporary pipework and will cause a reduction in wall thickness. It is important that all pipework and connections used have been properly maintained, inspected, and certified before use. Standard Service components shall not be used on “Sour Service” wells (wells where H_2S, is present), as this will cause stress corrosion cracking, and pitting in the metal as well as destroying any elastomer seals in unions, etc. These factors can lead to premature failure under pressure of components in the system.

WORKING WITH HIGH PRESSURE EQUIPMENT

Depressurizing

- Properly de-pressurize connecting lines before attempting to seal or break joint components.
- When bleeding the pressure from a section of the line, use extreme caution. Slowly bleed pressure following a test.
- Always verify that complete depressurization has occurred through the use of pressure gauges and visible checks.
- Securely support and tie down bleed off lines at the discharge end to prevent uncontrolled movement.

WORKING WITH HIGH PRESSURE EQUIPMENT

Emergency Response

Safety equipment and supplies should be readily available and should include, but are not limited to:

- Emergency spill kit
- Fire extinguisher
- Portable Ladders
- Stretchers
- First Aid Facilities
- MEDEVAC Facilities

RESTRICTED ACCESS AREAS MANAGEMENT

No-Go Zones

- Obtain Work Permit for non-routine operations containing high pressure equipment.
- Limit presence of personnel in the high pressure hazard areas (No-Go Zones).
- Eliminate all unessential / unauthorized personnel from the zones.
- Barricade No-Go Zones, preferably with rigid barriers.
- Provide necessary prohibition signs / warning messages.
- Transmit prohibition and warning messages through Public Address systems.

High Pressure Hazard Safety Awareness

Prepared by:
HSE Department

Saudi Arabian Saipem Co. Ltd.
Drilling Project

Apr.2016