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**Shell Global Standard for Temporary Pipework**

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**REVISION HISTORY**

<b>Revision No.</b>	<b>Revision Date</b>	<b>Revision Summary</b>	<b>Status</b>
1	2/10/06	Issued after consolidation of inputs from Shell Team, contractors and manufacturers.	First issue for implementation
2 (Draft)	7/08/08	Revised after feedback from Shell Locations and Shell's Service Providers using Temporary Pipework.	DRAFT. Significant re-write after engagement with Shell's Service Providers (Well Operations)
2 (Issue)	8/10/08	Revised after additional feedback from Shell locations and the conclusion of NPST & Restraints ALARP studies.	For ISSUE
3	23/3/09	Main Revision: acceptance of NPST hammer union male and female sub connections, subject to external identification.	For ISSUE
3a	11/5/09	Section 3. Bullet 2. This bullet, which had no associated text, has been removed and the list re-numbered.  5.1.3 vii). This sentence re-worded to clarify the requirement.	For ISSUE
4	16/11/09	Significant additions/changes <ul style="list-style-type: none"> <li>• Section 4. OEM defined in relation to Temporary Pipework.</li> <li>• 5.4.2.1 Inspection and Maintenance</li> <li>• 5.5.8 Restraining Pipework</li> </ul> Minor alterations/additions <ul style="list-style-type: none"> <li>• Section 1 - Title</li> <li>• Section 4 - Definitions: energised fluids, ferromagnetic, flash point, non-energised fluids, OEM.</li> <li>• 5.1.3, 5.1.9, 5.2.2, 5.3.6, 5.4.2.4, 5.4.2.6, 5.4.3.1, 5.5.4, 5.6.3, 5.7.2.6, 5.8.5, 5.8.7, Appendix 1, Appendix 2, Appendix 3.</li> </ul>	For ISSUE

**SUMMARY**

This Global Technical Standard details the requirements and controls to be placed on temporary pipework provided to, installed and used at Shell work sites.

**KEYWORDS**

Temporary Pipework, Hammer Union, Hub Connection, Hoses, CHIKSAN, WECO

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## **1. INTENT OF AND PURPOSE FOR THE TEMPORARY PIPEWORK STANDARD**

This Shell Global Temporary Pipework Standard has been developed to rationalise and control the use of both Shell-owned and Contractor-supplied temporary pipework in order to improve the safety of the wide range of operations that utilise this equipment and the associated pipework connection interfaces. Temporary pipework is a functional description of equipment also known as flow control equipment, treating iron or “CHIKSAN” flowlines. In a large number of applications the connection of this equipment is made with hammer lug or WECO unions which can be an integral, welded or threaded (though threaded make-up is not acceptable except in low (< 285 psi) pressure service to the pipework on which they are formed or joined. There is no single standard or organisation, such as API, Norsok or IADC, which has set the requirements for the design, manufacture and installation of temporary pipework used for operations on wells. Although the same nominal temporary pipework connections from different suppliers are dimensionally compatible, and can therefore be connected, the design standards of the pipe body on which the unions are forged or welded, can be, and often are, different. This Standard identifies and reconciles the acceptable design and manufacturing codes. Additionally, much process instrumentation is hooked up using temporary pipework. The inlets and outlets of this process equipment, including blanked or instrument-tapped temporary pipework connections are subject to the requirements of this Standard.

## 2. OPERATIONAL SCOPE

The scope of the standard covers the pipework design standards and manufacture, provision of pipework for drilling and well servicing operations, maintenance of pipework, the requirements for the review and verification of the process design for which the pipework is required, including the interfaces with the equipment to which the pipework is made up, installation of the pipework, commissioning (inspection and testing prior to use), monitoring and servicing while in operation and de-commissioning.

The operational scope of the Temporary Pipework Standard includes, but is not limited to, its use in / for:

Operational environments: Land, Swamp, Offshore

Operational activities: Activities as follows, but not limited to: pressure testing, pumping (fluids, N<sub>2</sub> and CO<sub>2</sub>), flowing, surging, etc.

Operational conditions: Conditions are as follows but not limited to: low (Arctic) normal and high pressure/temperature, corrosive fluids, hydrocarbon fluids/ gasses, sand production, H<sub>2</sub>S, etc.

### The operations comprise:

- General Pumping Operations (transfer of fluids, mud/brine mixing operations, (reverse) circulating well fluids, etc)
- Pressure Testing of Surface Lines and Equipment (including wellhead, BOP, Xmas tree, flow lines, etc)
- Pressure Testing of Downhole Equipment (casing, packers, tubing, plugs, valves, accessories).
- Cementing
- Well Killing
- Well Stimulation
- Well Fracturing
- Nitrogen Pumping
- Well Clean-up/Flowback
- Well Testing
- Under Balanced Drilling Operations
- Managed Pressure Drilling

### 3. EQUIPMENT SCOPE

Temporary pipework consists of the conduits for directing fluids from a pump or compressor to a wellhead, from a well into process equipment or fluids directed to outlets ending with plugs on which sensors are mounted. Usually, but not always, one source / sink will be the well i.e. the Wellhead or Xmas Tree. Occasionally, temporary pipework may be required for the transfer of fluids between vessels.

The vessels and equipment in the process train are not considered in the Temporary Pipework Standard. However, the inlets and outlets (not necessarily in the flowpath or pumping path) on vessels and equipment, shall meet the requirements of this Standard.

Temporary pipework is mobilised and assembled by a designated contractor for the purposes of performing the contracted operations detailed in Section 2 of this Standard.

Items of Temporary Pipework covered by the Standard include, but are not limited to:

1. Pipework runs (straights), pup joints, elbows.
2. T-pieces.
3. Laterals (Y-pieces).
4. Swivel joints.
5. Treating Loops.
6. Crossovers.
7. High Pressure Hoses.
8. Flanges, Blinds, Plugs, Tappings for Sensors, Sample Points

The pipework connections to be controlled in this Standard are classified as:

- Hammer unions.
- Hub connections.
- Flange connections.
- Pressure sealing threaded (PST) connections.
- Non-pressure sealing thread (NPST) connection of Hammer Union subs to the pipe body.
- Pipe body to pipe body (welded connections).

#### 4. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

Abbreviations / Definitions	Description
CERT/IERT	<p>Completion/Intervention Equipment Review Team.</p> <p>A formal Shell qualification/validation process applied to equipment used in Completion/Intervention operations, comprising a review of the equipment manufacturing and technical files to ensure that the stated equipment specifications can be achieved under the physical operating and environmental envelope for the Completion (or Intervention) operations for which it is required, <i>prior</i> to the use or deployment of the equipment.</p> <p>A similar process is documented in DNV-RP-A203 (Ref [16]).</p>
CHIKSAN	<p>(See also WECO). CHIKSAN piping components, incorporating integral or welded hammer lug union ends for connecting together comprise such fittings as straights or “pup joints”, T-pieces, elbows, crosses, crossovers, blinds, plugs, swivel joints and plug and check valves. A combination of such equipment is often referred to as “steel hose”.</p> <p>CHIKSAN equipment is used for temporary flowlines and piping systems capable of conveying many different fluids including oil and gas, water, slurries, acids and other corrosive liquids.</p> <p>CHIKSAN and WECO are registered trademarks for Temporary High Pressure equipment (flowlines, swivels and wing unions etc.) manufactured by FMC Technologies Inc. Other equipment which, although not genuine WECO or CHIKSAN products, is considered an acceptable alternative by Shell Standards</p>
CID	<p>Connection Interface Diagram. Drawing of the layout of the temporary pipework showing connections and equipment interfaces.</p>
Crossover	<p>Component that provides a link between connections of differently pressure rated or sized equipment.</p>
(Pressure) Down-rated pipe	<p>Pipe, which has eroded or corroded to such an extent that the remaining wall thickness no longer provides the original pipe safety factor. Down-rated pipe is in effect out of specification and cannot be re-specified with a lower working pressure. The process of down-rating pipe is banned.</p>
Energised fluids	<ol style="list-style-type: none"> <li>1. Pumped or flowed liquid with dissolved gas or entrained free gas. Examples: Oil below bubble point, cements with foaming agents.</li> <li>2. A liquid flowed from an “infinite” source. Examples: Oil well, water injector being flowed back.</li> <li>3. Pumped or flowed gas.</li> </ol> <p>[For cases 1. &amp; 2. above select the restraints using the LIQUID Selection Chart. For case 3. use the GAS Selection Chart.]</p>
Ferromagnetic	<p>Of or characteristic of substances such as iron, nickel or cobalt and various alloys that exhibit extremely high magnetic permeability, a characteristic saturation point, and magnetic hysteresis.</p>
FIG no. (see WECO)	<p>Implying FIGure or drawing number designating working pressure of the union.</p>
Flanged Connection	<p>Flanges welded to temporary pipework sections, then made up by bolting them together, utilizing a gasket between the flange faces.</p>

Abbreviations / Definitions	Description
Flexible pipe/ Flanged Flexible Connector	Hose. For the purposes of this Standard “hoses” can be considered as “flexible pipework”. Thus reference to “pipework” can include hoses in an applicable context. [Note: The generic description of a robust “Coflexip-type” hose meeting the requirements of API 16C is a hose having stable length under pressure, comprising (from inside, out): an internal leak-tight polymer pipe; two layers of steel sheathing to prevent the crushing of the polymer pipe and extrusion of the polymer at pressure and temperature through the steel sheathing; at least one pair of helically and oppositely wound armour wires, to give longitudinal and torsional strength; a protective (corrosion) outer polymer jacket; and an impact and corrosion resistant outer steel wrap.]
Flash Point	The flash point of a volatile liquid is the lowest temperature at which it can vaporise to form an ignitable mixture in air.
Hammer Union Hammer Lock Union Hammer Lug Union	Connections comprising male end (wing nut) and female end (threaded stub). The connection is sealed using an elastomeric lip seal placed in the female stub which is energised when the wing nut is hammered up tight to the female stub
HPHT	A well having an undisturbed bottom hole temperature of greater than 300°F [149°C] and a pore pressure of at least 0.8 psi/ft (~15.3 lbm/gal) or requiring pressure control equipment with a rating in excess of 10,000 psi [68.95 MPa]. To qualify for HPHT the well must have the temperature and one of the pressure elements to qualify.
Hub clamp connection	Any connection with (normally) a metal-to-metal seal ring with flanged ends held together with a metal clamp. (Techlok and Grayloc are trade names for this type of connection).
IERT	Intervention Equipment Review Team (See CERT)
Independent Person or Independent Competent Body	Reference is made in the Standard to an Independent Person or Independent Competent Body. Such a person can be part of the equipment owner’s organisation, but shall be independent of Line Management of that organisation and competent to carry out the tasks required of him/her.
Low Pressure	Pressures below 285 psi (1967kPa). [This pressure is defined by the ambient temperature pressure rating of a class 150 flange Group 1.1 materials specified in ASME B 16.5 Annex F (Ref [4])]
M(A)WP	Maximum (Allowable) Working Pressure. This is the maximum pressure to which the pipework can subjected <i>after</i> taking into account any derating for temperature.
MPD	Managed Pressure Drilling. Performing drilling operations with a closed annulus and returns to surface using an equivalent mud weight that is maintained at, or marginally above open-hole pore pressure by manipulation of an MPD choke.
Non-energised liquids	Liquid with no entrained or dissolved gasses and the volume in the lines being very limited, such as in pumping operations.
NPST	Non-Pressure Seal Thread. Pipe where the pipe is screwed through the hammer union and then machined to give a seal face, the sealing being made with an elastomeric seal placed between the pipe ends.
OEM	Original Equipment Manufacturer. (Reference [12] describes the requirements for the use of OEM sourced replacement parts for Well Control Equipment. Temporary pipework is included in the scope of this document when it forms part of the primary well barrier.)
P&ID	Piping and Instrumentation Diagram process diagram including the specification breaks and detailing the process control instrumentation.

Abbreviations / Definitions	Description
PFD	Process Flow Diagram. This is a diagram of the process, usually omitting the instrumentation and controllers.
Stiff Pipe, Rigid Pipe, Hard Pipe, Steel hose	Temporary piping components, such as CHIKSAN equipment, incorporating integral or welded WECO/hammer-lug unions ends for connecting together, comprise such equipment as straights, t-pieces, elbows, etc. as listed in the Standard. A combination of such equipment is often referred to as "steel hose".
Temporary	"Temporary," in the context of pipework, and flowline equipment, applies to any pipework which can be changed-out with out recourse to formal structural or process engineering design reviews.
UBD	Under-Balanced Drilling. Performing drilling operations using a controlled bottom hole pressure that lies below the formation pressure.
Walk-the-Line	An activity to verify that the temporary pipework, including blanked outlets, is installed according to design and is safe to test. It requires physical examination of the pipework directing the flow by the Shell Supervisor and the Contractor Supervisor together.
WECO Union	<p>WECO wing or Hammer-lug Unions have been developed and used for many years as a fast and effective method of connecting high-pressure pipework. The unions consist of male and female subs held together with a winged nut that fits over the male sub, which can be hammered tight. Elastomeric lip seals provide the primary seal between the spherical male and conical female surfaces, with metal-to-metal contact providing a non-pressure tight, secondary barrier. The seal designs (elastomer and metal) vary according to pressure rating and application. The pressure rating of the union is denoted by its "FIG" number, though the same number relates to different pressures for Standard and Sour Service equipment.</p> <p>The Unions are designated by their "FIG" number. Such as 1502 or 206. The last digit in the FIG number is indicative of the seal type – "2" indicating a gasket type seal fitted to the female sub; and, "6" indicating an o-ring seal fitted to the male sub. The numbers (multiplied by 100) to the left of the last digit are indicative of the working pressure of the unions for standard service (all pressures) and sour service below 6,000 psi working pressure. For sour service unions above 6,000 psi working pressure the digits (multiplied by 100) to the left of the last digit are indicative of the test pressure of the union. Thus 1502 in standard service material has a gasket seal and working pressure of 15,000 psi and as 1502 union in sour service material has a gasket seal (different type) and a <i>test</i> pressure of 15,000 psi (but a working pressure of 10,000 psi).</p>
Welded connection	Sections of pipework welded directly together to make-up the line.
Zoned Areas	<p><b>Zone 0:</b> Where ignitable concentrations of flammable gases, vapours or liquids can exist all of the time or for long periods of time under normal operation conditions.</p> <p><b>Zone 1:</b> Where ignitable concentrations of flammable gases, vapours or liquids can exist some of the time under normal operating conditions.</p> <p><b>Zone 2:</b> Where ignitable concentrations of flammable gases, vapours or liquids are not likely to exist under normal operating conditions.</p>

## 5. TEMPORARY PIPEWORK REQUIREMENTS

### 5.1. General

- 5.1.1 Temporary pipework is manufactured for use in either Standard or Sour Service (Ref [7]) environments. Above 5000 psi (34.5 Mpa) Sour Service equipment generally has a significantly lower rated cold maximum working pressure than the equivalent standard service equipment. Where locations regularly encounter sour gas, it is recommended that Sour Service temporary pipework only be supplied. This is entirely due to the requirements to control the use of this equipment and avoid having unions of the same description (that is, the same FIG no.) for different services (standard and sour) and having different pressure ratings. [For example, a Fig.1502 standard service hammer union has a WP of 15,000 psi, (103.5 Mpa) whereas a Fig.1502 sour service hammer union has a WP of 10,000 psi (69 Mpa). The male part of the standard service union can be fully made up to the female part of a sour service hammer union. See Appendix 1.]
- 5.1.2 It is preferred that temporary pipework equipment be supplied as one-piece (integral) forged items, but fabrication from pipe with butt-welded unions is acceptable. Threaded unions of any description are not acceptable except under the conditions stated in 5.1.3 x) of this standard.
- 5.1.3 The following connections and pipework are **forbidden** for operations on wells requiring the use of temporary pipework:
- i) 2" FIG 602 hammer unions and 2" FIG 1002 hammer unions.  
[Note: The Industry has redesigned the 2" 602 and 1002 female subs, preventing their thread engagement in the 2" 1502 wing nuts. See Reference [13]. However, the position in Shell remains that both the "old" style and "new" style 2" FIG 602 and 1002 with the truncated threads are banned from use.]  
[Exception: 2" 602/607 hammer unions manufactured with Left Hand Thread. ]
  - ii) Hammer unions flowing produced, energised fluids from the well at pressures greater than 10,000 psig.
  - iii) Pipework where the pipe body has a lower pressure rating than either of its end connections.  
[Exception: Fig 602 equipment for *sour service* conditions is designated with a WP of 5000 psi due this pipework being historically and currently supplied to this WP by accepted manufacturers rather than 6000 psi.]
  - iv) The pressure de-rating of pipework from its original working pressure specification because of reduction in its wall thickness below the minimum prescribed by the manufacturer to retain its original working pressure.
  - v) Back-welded threaded connections or fittings.
  - vi) Mismatched pipework hammer union components.  
[Note: Refer to Appendix 1 for information on how hammer union components can be mismatched.]
  - vii) Connections, where the equivalence of the design and manufacture of one mating side (male/female/face) has not been established with that of the other mating side (female/male/face).
  - viii) Use of standard service pipework on sour service operations.
  - ix) Non-Pressure Sealing Thread (NPST) pipework *without* external hammer union sub identification. [See APPENDIX 5 & Reference [20]].
  - x) Pressure Sealing Thread pipework nominal size greater than 1/2".

The exceptions and associated provisions to this (5.1.3 x)) requirement are noted below:

<i>exception</i>	<i>provided that/condition(s)</i>
a) Utility Piping, transporting: <ol style="list-style-type: none"> <li>i. Water (excluding produced water).</li> <li>ii. Air.</li> </ol>	The piping meets the requirements of ASME B31.3 Category D piping. [Note: Category D is limited to non-flammable, non-toxic, not harmful to human tissue, fluids with a maximum pressure of 150 psig, -20°F to 366°F]
b) Low pressure pipework and hoses used as: <ol style="list-style-type: none"> <li>i. Suction lines between tanks and transfer pumps.</li> <li>ii. Pump discharge lines to low pressure storage systems.</li> </ol>	<ol style="list-style-type: none"> <li>1. Threaded pipe 2 inch and above is at a minimum schedule 40 and the pressure does not exceed the MAWP; and,</li> <li>2a. the pressure generated in the system does not exceed 285 psig (i.e. pump pressure against a blocked outlet plus upstream pressure &lt; 285 psig) or the MAWP, if less.</li> <li>or,</li> <li>2b. the line is protected with an over-pressurisation device set at 285 psi or below, the capacity of which meets or exceeds the potential flow rate.</li> </ol>
c) Pressure relief systems for <i>land</i> operations.	<ol style="list-style-type: none"> <li>1. The pipe run is drill pipe thread or tubing thread.</li> <li>2. Pipe run is open-ended.</li> <li>3. The crossover to the threaded drill pipe or tubing is made at a distance from the process, assessed as safe, which shall be determined by a “location specific” risk assessment.</li> <li>4. The pressure rating of the line meets with the requirements of ASME B31.3</li> <li>5. The line must be sized and restrained to accept the instantaneous relief capacity of the line safety device (relief valve, rupture disk) without exceeding the pressure rating of the line.</li> <li>6. Lines are pressure tested to vessel test pressure to which they are connected, or should be supported with calculations of maximum release pressure with line sizing and length of relief line.</li> </ol>
d) Hoses designed for pumping CO <sub>2</sub> .	Where these hoses are stainless steel construction having threaded connections.

Where temporary flowlines originate or terminate from field manifolds, wellheads etc., the connections which form an integral part of the manifold, etc., shall be either welded, flanged or clamped (hub-type) to the manifolds.

5.1.4 Pipework for which the working pressure is compromised, as prescribed by the manufacturer due to loss of material, the wall thickness being equal to or less than that prescribed by the manufacturer to maintain its working pressure, shall not be used on Shell operations. Pipework cannot be de-rated to a lower working pressure. The use of pressure de-rated pipe is strictly forbidden – no deviation or dispensation being allowed. Pipework, which is found to have lost material during operations to below the minimum specified by the manufacturer, shall be replaced.

5.1.5 Hoses, flexible temporary pipework, used for transporting fluids at pressures greater than 285 psi, shall be reinforced and validated for the temporary operations for which they are intended, including impulse flexing and tensile testing. All end connections fitted to flexible hoses shall be bonded to the hose such that it effectively becomes an integral part of the hose. The MWP of the hose may be lower than the MWP of the end connections. The MWP of the hose shall be identified and clearly visible on the hose. The working pressure of the hose shall be limited to the lowest pressure-rated part of the hose assembly, which shall be established by “type” burst tests.

Polymers (elastomers and thermoplastics) used as the primary means or back-up to the primary means of sealing of the connection shall be rated for and compatible with: the type of service (standard or sour); the chemicals to which they are exposed; have the capability to resist explosive

decompression in a gas environment; and, maintain their properties over the duration of the maximum operating temperatures, pressures and pressure cycles to which they will be exposed. Metal reinforced elastomer seals shall be installed where there is a risk of extrusion and there is no practical alternative connection type to hammer unions.

- 5.1.6 The MWP of the pipe body between its end connections of the temporary pipework equipment shall be rated to at least the MWP of the end connections.
- 5.1.7 Crossovers shall be rated at the pressure of the lowest rated end.
- 5.1.8 The use of CHIKSAN swivels shall be kept to a minimum. Where frequent movement is expected to occur when the pipework is under pressure, e.g. as between the wellhead and process manifold, swivels shall be avoided, being replaced by a high-pressure flexible hose. Side loading of pipework must be avoided to preserve operational safety factors.
- 5.1.9 Temporary pipework shall only be rigged up or rigged down in areas classed as Zone 1 and Zone 2; it may be used in Zone 0 areas, e.g. to connect to a “gas buster”, once rigged up.

## **5.2. Contracts for Services requiring the Provision of Temporary Pipework**

- 5.2.1 Those with the responsibility for initiating and managing contracts for services requiring the supply of temporary pipework are responsible for ensuring that the contractor’s system for controlling the temporary pipework provided to Shell is capable of meeting, and the personnel entrusted with its maintenance, installation and operation are competent to meet, the requirements of this Standard.
- 5.2.2 The supply of parts used to replace worn or damaged temporary pipework components or entire replacement assemblies shall be sourced from the OEM or his approved supplier. If this is not possible (OEM no longer in business, or equipment for which components required is obsolete) non-OEM components may be used if they are designed, manufactured and validated to the same standards and engineering codes as the original components that they replace. (References [12] [20].)
- 5.2.3 Temporary Pipework supplied for Shell Well Operations shall comply with the codes identified in this Standard. Temporary Pipework supplied for sour service shall comply with the requirements of NACE, Reference [7].

## **5.3. Code Compliance, Design and Manufacture of Temporary Pipework supplied for Shell Well Operations**

- 5.3.1 Temporary pipework shall meet the requirements of ASME B31.3 (Reference [1]) as a minimum, or proven manufacturers’ standards where these can be shown to comprise a higher, more stringent standard.  

[Note: Reference [5] shows that the safety factor for pipework derived from combining API 6A, “Theory of Constant Energy Distortion” (para 4.3.3.3) and API 6A, “ASME method” (para 4.3.3.2) is slightly superior to that derived from using the equations of ASME B31.3, and therefore pipework designed using these codes is acceptable. Standardising on ASME B31.3 gives consistency with permanent flowline design without detracting from safety.]
- 5.3.2 Where standards (e.g. API 16C [17], ASME VIII div 2 [18], API 6A) other than ASME B31.3 Chapter IX are invoked in the design criteria governing the minimum wall thickness, the relation between design or working pressure and test pressure (viz. 1: 1 ½) shall be respected. The governing stress shall be the lesser of the allowable stress for the design pressure and the allowable stress for the test pressure divided by 1.5.
- 5.3.3 The maximum working pressure of pipework used in high temperature applications or exposed to low temperatures, for example, in gas well testing, shall reflect any reduced allowable stress and material testing requirements, e.g. Charpy values, stipulated in the design codes to which the pipework has been built, tensile being strengths determined experimentally at high temperatures.
- 5.3.4 Temporary pipework shall have been “Type Approved” by an Independent Competent Body. The design verification procedures and results shall be documented and include as applicable:

- Product/equipment description (including the restraining system where considered as part of the design).
- Application and limitations.
- Documents reviewed for the Type Approval (e.g. drawings, calculations, material specifications).
- Fabrication procedures, comprising manufacturing methods and sequences, test procedures, NDE procedures & techniques, quality procedures, welding plan, weld procedure specifications and qualifications.
- Equipment marking.
- Documentation to be supplied to the purchaser. (The design documentation and certification media shall be readily identifiable to the type and the pieces respectively, clear, legible, reproducible, and retrievable.)
- Note: As a minimum, manufacturer's material certificates shall satisfy the requirements of ISO 10474 Class 3.1B (Ref [15]).

[Note: The "Competent Body" can be part of the supplier's organisation, provided that the reviewing body can demonstrate its independence of the organisation's Line Management; is additional to manufacturing supervision; and, the records for the design and manufacture of the temporary pipework include the items in the bulleted list above.]

- 5.3.5 New temporary pipework components e.g. connections, restraints, etc. shall undergo an independent design review by a Competent Body and/or be subject of a formal qualification process, e.g. DNV Qualification Procedures for New Technology, (Ref [16]), Shell CERT/IERT process.
- 5.3.6 All ferromagnetic pressure containing components made from forgings or castings shall be subjected to an acceptable level (established by the manufacturer) of magnetic particle inspection in accordance with procedures specified in ASTM E 709 with acceptance criteria per API 6A and API 16C at the finished machine level prior to painting.
- 5.3.7 Each weld shall be subject to 100% volumetric inspection, the inspection method being appropriate to the welding procedure.
- 5.3.8 Flexible hoses, other than for low pressure usage, shall comply with the requirements of API 16C (Ref [17]), or otherwise be suitably validated (see clause 5.1.5).
- 5.3.9 The working pressure and test pressure of the end connections shall be consistent with the working pressure rating of the hose.
- 5.3.10 Hoses shall be anti-static. Otherwise electrical continuity shall be achieved by provision of a conducting wire run along the length of the hose.
- 5.3.11 The hose manufacturer's operating, maintenance, and inspection and test requirements shall be complied with.

#### **5.4. Provision of Temporary Pipework for Drilling and Well Services Operations**

##### *5.4.1. Temporary Pipework and Component Traceability*

- 5.4.1.1 Each temporary pipework component shall be indelibly identified with its service & unique identifier traceable to its type and manufacture. Metal banding or hard stamping, using low stress stamps, where banding is impracticable, shall include the following data:
- the unique identification number, traceable to material certification.
  - the maximum allowable working pressure,
  - test-due date,
  - type of service (e.g. H<sub>2</sub>S, Standard).

The band shall be fitted such that it floats on the pipe and cutting is the only means of removal.

If the data is missing then the item shall be rejected and re-certified.

- 5.4.1.2 Pipework identification, including blind runs, pipe extensions made up to vessel outlets for the purpose of mounting instrumentation, plugs on vessel outlets or unused inlets, etc., shall be *clearly* visible to persons tasked to "walk-the-lines".

[Note: Reliance on colour coding for *categorical* identification is to be avoided, though it is recognised that colour coding can assist with a quick visual identification of service type and pressure rating.]

- 5.4.1.3 Where hoses are fitted with higher rated end connections; the rated working pressure of the hose must be printed on and be clearly visible along the length of the hose.

#### 5.4.2. *Inspection, Testing and Maintenance of Temporary Pipework and Restraints*

- 5.4.2.1 All temporary pipework shall be subject to a regular, (minimum annual) maintenance programme and shall take into account the manufacturers' maintenance recommendations. Where pipework has frequent usage or has been exposed to harsh service (high rate frac proppant operations, well testing with sand production) a job-based inspection programme should supplement time-based inspection.

The yearly inspections shall include the manufacturers' inspection and maintenance instructions but comprise as a minimum:

##### Rigid pipework

- Visual inspection of the pipe bore for erosion and corrosion.
- Visual inspection and inspection by the use of thread and form gauges of threads and load shoulders and inspection of sealing surface conditions. bolts and lock rings, for:
  - male sub inspection,
  - female union thread half inspection,
  - wing nuts,
  - hub inspection, (including clamps and bolts),
  - segment and retaining clip (circlip) inspection,
  - swivel joint ball race inspection.
- Hammer union wing nuts shall be replaced where the lug is too small to strike accurately, delivering a tangential blow. (Reference [20]).
- Magnetic Particle Inspection (MPI) of hammer union segments.
- Wall thickness measurements.
- Pressure testing to maximum working pressure for rigid pipework, unless repairs/modifications have been carried to the item of equipment in which case it shall be subject to a pressure test 1.5xWP.

##### Hoses - "flexible pipework"

- The inspection of hoses shall comply with the above requirements for the end connections.
- The external protection cover for the hose shall be inspected for damage (such as scuffing, kinks and bulges) and action taken to replace the hose.
- The internal bore of the hose shall be checked for wear corrosion and erosion as prescribed by the hose manufacturer.
- Annual pressure test to cold WP or to the pressure prescribed by the manufacturer.

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 Less frequent, or as specified by the manufacturer, but not exceeding 5 years non-destructive examination (NDE) shall incorporate:

- Magnetic Particle Inspection (MPI) of pipework welds.
- MPI/Liquid Penetrant Inspection (LPI) of castings, e.g cast wing nuts.

The above requirements are a minimum. The inspection, testing and maintenance shall be carried out in compliance with the relevant standards or codes and the manufacturer's guidelines or User's procedures where these set additional or more stringent requirements. The inspection equipment used shall be in-calibration. The results of maintenance, inspection and testing shall be recorded for each serialised item of pipework.

- 5.4.2.2 Pipework requiring elastomeric seals shall be prepared with seals suitable for the pipework service and environment and for the fluids pumped or produced. Elastomeric seals and thermoplastic back-up seals shall be inspected and replaced, if exhibiting damage or degradation.
- 5.4.2.3 The remaining duration of the "in-inspection" period at the pipework mobilisation shall be at least 2 months plus relevant contingency and the added planned duration of the operations requiring its *offshore* use; and the planned duration, at mobilisation, of the operations for its *onshore* use.
- 5.4.2.4 Where the pipework is required in HP and/or HT operation, with flow coming from the well, a re-inspection (equivalent to the annual inspection and testing) of the HP/HT pipework line-section shall be undertaken prior to its use, only if it has been mobilised since the last annual inspection and preserved to prevent corrosion from the test date.

[Note: The “Test Due Date” should reflect this derogation, to prevent pipework rejection at well-site certification review.]

- 5.4.2.5 For Nitrogen delivery operations temporary piping shall be given particular consideration. Dedicated N<sub>2</sub> supply line piping shall be retained and utilised solely for Nitrogen pumping operations.
- 5.4.2.6 The elements of the pipework restraint system - including anchor mechanisms and adjustable pipe supports - shall be inspected and maintained in accordance with the manufacturer’s recommendations. (Reference [20]).

#### *5.4.3. Preparation of the Temporary Pipework for Mobilisation to the Wellsite*

- 5.4.3.1 Pipework and accessories shall be transported in racks/containers/baskets designed so that the manual handling risks are as low as reasonably practicable.. (Reference [19]).
- 5.4.3.2 Prior to actual mobilisation, an independent person (e.g. Job Owner, QA/QC Engineer, Logistic Engineer) shall check that the equipment provided is complete and in compliance with the requirements of this Standard.
- 5.4.3.3 The pre-mobilisation check shall confirm that the hammer unions supplied are incapable of being mismatched and all temporary pipework interfaces are compatible.

### **5.5. Temporary Pipework Process Design and Verification**

- 5.5.1 The rated working conditions of temporary pipework used in operations shall be determined by the maximum expected pressure (that pressure applied for the pressure test of the temporary pipework), the maximum and minimum extremes of temperature, flow/pump rates based on plausible “worst case” scenarios and shall comply with the other sections of this Standard.

Depending on the hazards of the temporary operation and environmental conditions, a Process and Instrumentation Diagram (P&ID) or Process Flow Diagram (PFD) or Installation Diagram of the process requiring hook-up with temporary pipework, together with a cause and effect chart, shall be prepared. The connection type and ratings for the temporary pipe shall be communicated to the Shell job owner. [The use of generic P&IDs, PFDs, Schematics and CIDs, is acceptable where a site routinely carries out the same operation with the same temporary pipework set-up. Minor differences in the set-up shall be indicated on the generic documents and their hazards assessed. (Guidance and tools are provided for constructing a diagram of the pipework connections, Ref [9].)]

[Note: As a minimum, the diagram shall show, depending on the type of operation (pumping or producing): direction of flow, piping & piping classes - including hoses & valves, expected fluids, nominal working pressures, isolation points, specification breaks, control/pressure instruments & set points, relief instruments & set points, discharge points, associated equipment such as stand-pipes, mixing tanks, pressure vessels, oily water and production separators, heat exchangers, atmospheric tanks, burners, chokes, manifolds, pumps & compressors, and any points where the temporary pipework and systems are either tied-in to permanent facilities, or draw from permanent services. Consideration shall be given to the installation of equipment and protective systems for use in potentially explosive atmospheres.]

- 5.5.3 ASME B 31.3 Chapter IX (Ref [1]) requires formal flexibility analysis to be carried out; however, where the temporary pipework installation is a duplicate of a previous successfully operating system or is judged adequate by comparison with previously analysed systems, the requirement for formal analysis is relaxed. [The inclusion of swivels, avoiding binding or external loading on connections and avoiding the transmission of vibrations (during pumping operations, for example) through the lines further diminishes any need for flexibility analysis.]
- 5.5.4 Design review and design verification for the particular operation in which the pipework is used shall include pipework support/restraint arrangements and bending moments caused by unsupported pipework or hoses, e.g. pipework made up to flowhead or pumping manifolds).
- 5.5.5 Temporary pipework reaching a surface temperature calculated to be above 158 deg F (70 deg C) or very low temperatures (down stream of the choke manifold, pumping N<sub>2</sub> for example) and readily

accessible to personnel shall be “barriered-off” or otherwise isolated to prevent those personnel coming into contact with it accidentally.

- 5.5.6 Operations carried out in “Arctic” conditions and operations generating low temperatures in temporary pipework, e.g. by the Joule-Thomson effect, nitrogen pumping, shall be evaluated to ensure that the temperatures do not fall below the design range of the of the metallic and polymer components when pumping or flowing fluids. Where the initial environmental conditions are outside the equipment specification, actions (e.g. pumping warm fluid) shall be taken to ensure that it is within specification at the commencement of operations and remains so.
- 5.5.7 The designated maximum working pressure of the pipework for the specific operations being undertaken will reflect any requirements for temperature derating for the pipework components. Where the design codes do not account for the effects of temperature on pipework material, the derating factors in Appendix 4 may be used.
- 5.5.8 While it is mandatory for pipework and associated equipment to be rigorously maintained to prevent mechanical failure, it is a further requirement of this Standard, to mitigate the consequences of a failure, whether pumping or flowing energised or non-energised fluids, that the pipework be effectively restrained, where the rig structure does not prevent the pipework from swinging and from becoming projectiles, or the pipework is not “boxed-in”.

The restraint system shall have been validated and be sufficiently robust to handle the forces generated for the system fluids and pressures given in the table in Appendix 3 (and guidance given in the ABC Guide to Temporary Pipework, reference [20]).

Pipework shall be suitably restrained to anchor points corresponding to the maximum pressure to which it is tested.

- Open ended lines, discharge lines, relief lines, lines run flare pits, etc. shall be anchored or tied down at their ends, or as close as practicable to their ends.
- Hoses used for transporting fluids shall have their connections restrained with suitably rated - see above - safety cables (whip checks).
- Pipework transferring gravity fed liquids between vessels open to the atmosphere (with the pipework connected to the vessels at each end) does *not* require restraints.

## 5.6. Installation of Temporary Pipework at the Well Site

- 5.6.1 Torque wrenches for flange, hub connector and fastener make up shall be provided. They shall be calibrated and controlled under a Quality Management System (meeting the requirements of ISO 9001).
- 5.6.2 All sections of a temporary pipework system shall be installed so as not to impinge on fittings, valves, instrumentation or other protuberances.
- 5.6.3 The make-up of hammer unions, flanges, etc. should be undertaken using tools other than sledge hammers where possible. Where hammers are used they shall be supplied at a weight appropriate to the size of the connection being made up. (Reference [14] for issues with non-sparking hammers; reference [20] for criteria for replacement of badly beaten wing nuts).
- 5.6.4 Where there is a potential for hydrate formation, suitable and sufficient consideration shall be given installing methanol and/or glycol injection points.
- 5.6.5 Anchor points for the temporary pipework restraint system shall be suitable for the potential dynamic loading that could be applied to them.
- 5.6.6 Where fluids are being *pumped* through temporary pipework connected to a well capable of producing H<sub>2</sub>S, the pipework run between the Xmas Tree up to and including the first leak-tight valve shall be suitable for sour service.
- 5.6.7 In the event of the production of potentially high concentration of solids from wells, Chiksan swivels shall be substituted by 90 bends, target tees or laterals. In general, Chiksan swivels shall not be used for well testing operations upstream from the choke manifold to the well head or for

pumping operations pump upstream of the non return valve: only fixed bends or a suitably qualified hose is allowed.

[Note: The only exception allowed is the swivel under a Test Tree.]

- 5.6.8 For HPHT operations on producing wells the pipework connections shall be hub clamp-type with metal-to-metal seals, or flanged, up to the choke manifold.

## 5.7. Commissioning/Testing of Temporary Pipework at the Well Site

### 5.7.1. Requirement to "Walk-the-Lines."

- 5.7.1.1 Prior to pressure testing, the pressure test set up and equipment layout shall be inspected - 'walked' and checked against the connection schematic (CID) or equivalent drawing to confirm that it is safe to test, there being no connection mismatches; that the pipework restraint arrangements have been installed as planned; and, that suitable pressure test safety precautions - such as valves being in the correct position, air bleed points, and barriers - are all in place. Items of equipment that cannot be individually restrained, such as hammer union blanking plugs on process equipment outlets, shall be specifically identified and checked for compatibility with the mating union and process equipment rating.

[Note: During "Walking-the-Lines" the supervisors should verify that gauges, instruments, blanking plugs, tappings, etc. which need to have a physical presence to be read/monitored, or are mounted in an area where personnel are present, are aligned, as far as possible, to point in a direction where they would not harm personnel, if discharged from their mountings.]

### 5.7.2. Pressure Testing of Temporary Pipework at the Wellsite.

- 5.7.2.1 Prior to applying or subjecting the process to pressure a Tool Box Talk (TBT) shall be held to cover the stages in the pressure testing, the dangers from a pressure release, the exclusion of personnel not directly involved with the test, the responsibilities of those involved in the pressure testing.
- 5.7.2.2 Tests shall be undertaken using calibrated pressure indicators and pressure test recorders. The tests shall be recorded and endorsed by operators and supervisor. The records arising from the testing shall be controlled and retained.
- 5.7.2.3 The test pressure applied shall be at least 10% higher than the maximum operation design or expected pressure of the process line-section, and shall respect the maximum working pressure of the equipment and any safety devices and relief valves.
- 5.7.2.4 When hydrocarbons are to be flowed through the process, the pipework and process equipment shall be purged of air.
- 5.7.2.5 Pressure testing shall be conducted with water or other acceptable liquid or gaseous N<sub>2</sub>. Gaseous pressure testing shall be preceded by a hydrostatic test to 1.1 times the gaseous pressure test requirement, respecting the MWP of the pipework.
- 5.7.2.6 Flammable liquids (diesel, base-oil) can be used to pressure test temporary pipework provided that; the pipework is purged of air; the temperature of the flashpoint of the liquid is at least 5 deg C higher than the (ambient) temperature at which the liquid is being pumped; and, a pressure test with water would create potential problems for the operation – induce the formation of hydrates, for example.
- [Note: The flash point of the pumped fluid shall be at least 49 deg C (120 deg F). Reference [21].]
- 5.7.2.7 For Under Balanced Drilling (UBD) operations a final body test shall be carried out after successfully function testing and pressure testing the system and isolation valves with water. A final test of the system with an inert gas is required to ensure gas tightness. The individual component valves need not be tested. This test is restricted to the high-pressure sections from below the BOP, the primary and secondary flow line up to and including the choke manifold and is taken to 90% of MASP or static pressure rating of the Rotating Control Device (RCD), whichever is less.
- 5.7.2.8 The pressure testing shall start with a low-pressure stability hold period prior to the pressure being raised to the test pressure. (The low pressure (~200-300psi, if practicable, i.e. sufficient volume) hold period is to confirm that it is safe to test to high pressure.)

The test pressure shall be brought up in stages, and held for ~1 minute at each stage, until the final test pressure is reached. The final test pressure shall be held, as a minimum, for 10 minutes. Either unexplained or significant pressure drops shall be sufficient reason for the test to be repeated. Retests shall apply the same procedure as the original test

- 5.7.2.6 Where practicable, instrumented pressure trips mounted on the pipe runs shall be functionally tested in-situ. Devices installed for monitoring the pipe erosion on bends should also be checked.

## **5.8. Inspection and Monitoring of Temporary Pipework during Operations**

- 5.8.1 During operation, the pipework shall be monitored for leaks, vibration, movement and correct operation. Leaks and significant vibration shall be sufficient reason to halt a period of flow/pumping.
- 5.8.2 Prior to any period of flow the pipework shall be re-checked to confirm that it is safe to proceed with the flow.
- 5.8.3 Mechanical joints, bolt torque and tie down arrangements shall be checked after periods of vibration.
- 5.8.4 Connection tightening, moving the pipework and similar operations while the pipework is under pressure shall not be permitted.
- 5.8.5 Unless it is unsafe to do so, change out of components, or any other intrusion into the system's pressure envelope shall be cause for re-testing the pipework.
- [Note: Exception made for fixed choke changes on a well test choke manifold.]
- 5.8.6 If the well produces solids, the pipe wall thicknesses of the equipment most vulnerable to erosion shall be checked at least once every 2 hours. [For guidance on where to take the measurements, see reference [20].]
- 5.8.7 The pumping of oxidising fluids to facilitate the burning of produced fluids is not allowed.

## **5.9. De-Commissioning of the Temporary Pipework and its Re-instatement.**

- 5.9.1 The pipework shall be confirmed free of trapped pressure prior to any joints being broken.
- [Note: Non-Return Valves (NRVs) shall be identified and the line downstream of the valve depressured.]
- 5.9.2 Steps shall be taken to drain all vessels and isolate them from the pipe runs connected to them prior to disconnecting the lines.
- 5.9.3 Fluids contained in the pipework, which are flammable, or with potentially adverse environmental impact, or are hazardous to health, shall be contained for suitable means of disposal.
- 5.9.4 Pipe runs which have been exposed to fluids which could potentially adversely affect their integrity for future operations (e.g. 90 degree bends used in a well test producing sand) shall be flagged for quarantine and individual inspection prior to re-use.

Fracturing operations require that procedures with empirically established criteria to be in place to set the upper limit of the velocity of pumped abrasive fluids. Where high pump rates (50-75 bbls / min, 7.95-11.9 m<sup>3</sup> / min) or high flowrates (> 35 ft/sec, 10.7 m/sec) are routinely encountered, job-based pipework wall erosion inspection should be instituted.

## **6. STRICTER REQUIREMENTS AND DISPENSATION FROM THIS STANDARD**

### **6.1. Stricter or more stringent Requirements**

- 6.1.1 Where local experience or national legislation dictates higher requirements than specified in this Standard, the more stringent requirement shall take precedence over the governing requirements of this Standard.

### **6.2. Dispensation from the Requirements of this Standard**

- 6.2.1 In the event that the requirements of this Standard cannot be complied with, the deviation will be reviewed and controlled via the Location Procedure for Dispensation from Shell Standards.

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## APPENDIX 1. MIS-MATCHING OR INCOMPATIBLE MAKE-UP OF HAMMER UNIONS

- Mismatching 2" FIG 602 and 1002 with 2" FIG 1502

(Connecting of Hammer Union products having the same nominal size, but different FIG Nos.)

Nominal Size	Union FIG Nos	Union Integrity compromised by
2"	602, 1002, 1502	A 2" FIG 1502 nut can be screwed onto a 2" FIG 602 or FIG 1002 female subs. Although the ACME thread diameters are different, the number of threads per inch is the same. The depth of mating overlap of the inside nut thread of the higher pressure rated 1502 male union with the female, lower pressure rated, 1002 or 602 union sub outside thread is small (15/1000" in the case of 1502/602 mismatch). The combinations will make-up and appear to be pressure tight at very low pressure. <b>HOWEVER THEY WILL FAIL TO HOLD THE RATED PRESSURE. THUS 2" FIG 602 AND 1002 ARE BANNED FROM USE.</b>

Note 1: ANSON Ltd. has truncated the outside thread diameter the FIG 602 female union by 30/1000" thereby avoiding the thread engagement and make-up with the 1502 male union nut. The ban still applies to ANSON 2" FIG 602 and 1002 unions.

Note 2: Where 2" FIG 602 unions are used to connect equipment not normally disassembled, e.g. on a burner boom, they will need to be replaced with other allowable unions.

- Mismatching different union FIG Nos with the same nominal size

(Connecting of Hammer Union products having the same nominal size, but different FIG Nos.)

The following Hammer Union mismatches are possible and to be avoided.

Nominal Size	Union FIG Nos	Union Integrity compromised by
1"	602,1002	These combinations of the same nominal size have the same ACME thread, that is, FIG 1002 nut could be used with FIG 602 male or female subs. There is some thread engagement with the 4" 602 and 4" 206.
1 1/2"	600, 602, 1002	
2"	402, 602, 1002	
4"	602, 206	
5"	400, 1002	

- Mismatching Pipe Pressure Ratings

(Connecting of Hammer lug Union products having different pressure ratings but with end connections of the same size and Figure No.)

FIG Nos	Pressure Rating Mismatch caused by
1502 Hammer Unions AND lower FIG Nos.	Mixing Sour Gas with Standard Service temporary pipework.

- Mismatching Wing Nuts

(Wing nut of one Size and Figure No. mounted on the male sub of another Size and Figure No.)

FIG Nos	Pressure Rating Mismatch caused by
All Figure Nos where the wing nut fits over the male sub. Specifically, 3" FIG 1502 wing nut on a 3" FIG 602 or 1002 male sub.	Small amount of engagement of the male sub shoulder in the shoulder of the wing nut. The 3" FIG 1502 nut on the FIG 602 or 1002 male sub will make up to a 3" FIG 1502 female sub and hold a low pressure, but part at high pressure. [However, a 3" FIG 1502 nut <u>cannot</u> be connected to a 3" FIG 602 or FIG 1002 female subs.]

- Mismatching of Components

(Segments and nut of one Fig No. made up to the detachable male sub with a different Fig No.)

Figure Nos	Pressure Rating Mismatch caused by
All Figure Nos where the wing nut fits over the male sub. (E.g. 2" 602 detachable male sub with 2" 1502 wing nut.)	Small amount of engagement of the male sub with the segment engaging the wing nut.

- Mismatching of Non-detachable and Detachable Components  
(Assembly of non-detachable nuts on detachable male subs.)

Size	Union Figure Nos	Union Pressure Integrity compromised by
2"	602, 1002	The detachable wing nuts require a longer thread length to compensate for the segments between the wing nut and the sub shoulder. Use of a non-detachable wing nut results in a detachable Union results in lack of thread engagement.
3"	602, 1002	Mounting of non-detachable nuts onto a detachable male sub end results in insufficient engagement between of the male sub shoulder with the wing nut ID.
4"	602, 1002	

In summary, the dangers of mismatched hammer union components are reduced by:

1. Removing from service 2" FIG 602 and FIG 1002 unions in all forms.
  2. Supplying temporary pipework with integral, NPST or welded unions.
  3. Supplying flexible hoses with bonded hammer unions.
-

## APPENDIX 2. HYDROSTATIC TESTING ACCEPTANCE CRITERIA (BASED ON CRITERIA IN API 6A, SECTION F1.11)

1) No visible leakage.

2a) Start of Hold Period

Hold periods shall start after pressure and temperature stabilisation has occurred and the equipment with pressure monitoring devices has been isolated from the pressure source. The time specified for hold times shall be a minimum.

2b) Pressure Stabilisation

Pressure shall be considered to be stabilised when the change rate is no more than 5% per hour of testing pressure or 500 psi / 34.5 bar per hour, whichever is less. Pressure shall remain within 5% of testing pressure or 500 psi, / 34.5 bar which ever is less, during the hold period.

Pressure (psi / bar)	Permissible Pressure variation in psi / bar for given hold period.				
	1 hour	15 mins	10 mins	5 mins	3 mins
300 / 20.7	15 / 1.03	4 / 0.28	3 / 0.21	1 / 0.07	1 / 0.07
500 / 34.5	25 / 1.72	6 / 0.41	4 / 0.28	2 / 0.14	1 / 0.07
1500 / 103	75 / 5.17	19 / 1.31	13 / 0.90	6 / 0.43	4 / 0.28
3000 / 206.7	150 / 10.4	38 / 2.62	25 / 1.72	13 / 0.90	8 / 0.9
4500 / 310	225 / 15.5	56 / 3.86	38 / 2.62	19 / 1.31	11 / 0.76
5000 / 345	250 / 17.3	63 / 4.34	42 / 2.90	21 / 1.45	13 / 0.90
7500 / 517	375 / 25.9	94 / 6.48	63 / 4.34	31 / 2.14	19 / 1.31
10,000 / 690	500 / 34.5	125 / 8.6	84 / 5.79	42 / 2.90	25 / 1.72
15,000 / 1034	500 / 34.5	125 / 8.6	84 / 5.79	42 / 2.90	25 / 1.72
22,500 / 1551	500 / 34.5	125 / 8.6	84 / 5.79	42 / 2.90	25 / 1.72

2c) Temperature Stabilisation

Temperature shall be considered stabilised when the rate of change is less than 1 deg F (0.55 deg C) per minute. The temperature shall remain at or above the extreme during the hold period, but shall not exceed the extreme by more than 20 deg F (11.1 deg C).

**APPENDIX 3. DYNAMIC LOADING ON RESTRAINTS - PIPEWORK  
CONNECTION BURST CASE**

Nominal Pipe Size (ins)	Dynamic Forces created by <u>Seawater</u> for flowline pressures (Kilo Pounds-Force / Metric Tonnes)				Dynamic Forces created by <u>Gas (N2)</u> for flowline working pressures (Kilo Pounds-Force / Metric Tonnes)			
	2,000 psi 138 bar	5,000 psi 345 bar	10,000 psi 690 bar	15,000 psi 1034 bar	2,000 psi 138 bar	5,000 psi 345 bar	10,000 psi 690 bar	15,000 psi 1034 bar
2	8.4 / 3.8	21 / 9.55	42 / 19.1	64 / 29.1	6.8 / 3.1	17 / 7.7	31 / 14.1	42 / 19.1
3	16.4 / 7.4	41 / 18.6	82 / 37.3	124 / 56.4	13.2 / 6	33 / 15.0	59 / 26.8	82 / 37.3
4	27.2 / 12.4	68 / 30.9	135 / 61.4	204 / 92.7	22 / 10	55 / 22.0	99 / 45.0	138 / 62.7
6	56.8 / 25.8	142 / 64.5	-	-	51.3 / 23.3	114 / 51.8	-	-

Note 1: Information extracted from Reference [5]

Note 2: The forces are based on nominal pipe bores corresponding to the nominal pipe sizes. Actual forces may differ slightly corresponding to different pipe inside diameters from those stated in the table above. The actual pipe IDs used in the calculation can be found in the charts in Reference [20].

Note 3: The forces stated in the table above will be the maximum generated in the restraint and the table assumes that the load-elongation characteristics of the restraint are linear and that there is no slack in the restraints.

Note 4: Validation of the forces calculated in reference [5] and tabulated above is documented in references [22] & [23].

**APPENDIX 4. TEMPERATURE DERATING FACTOR (APPLIED TO MAXIMUM CWP) FOR STEEL PIPE TO GIVE MAWP AT TEMPERATURE**

Temperature Deg F	Temperature Derating Factor (Applied to the Cold or Room- Temperature MWP to give the MAWP at the operating Temperature)	MAWP (CWP 5000 psi)	MAWP (CWP 10,000 psi)	MAWP (CWP 15,000 psi)	MAWP (CWP 20,000 psi)
250 or less	1.000	5,000	10,000	15,000	20,000
300	0.967	4,830	9,670	14,500	19,340
350	0.933	4,670	9,330	14,000	18,660
400	0.900	4,500	9,000	13,500	18,000
450	0.867	4,340	8,670	13,000	17,340

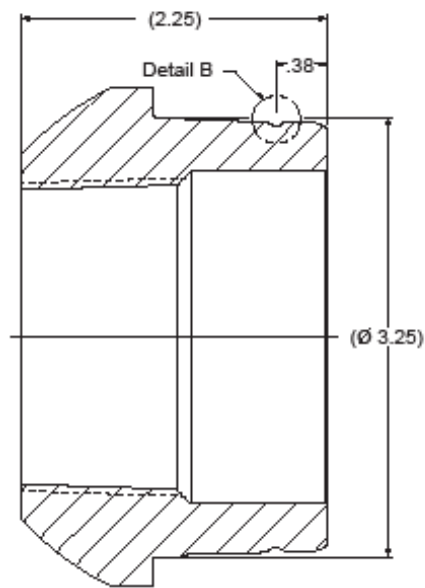
Note 1: For intermediate temperatures interpolate to obtain the derating factor.

Note 2: Table information has been extracted from ASME B31.8-2007 Table 841.116A. The de-rating Factor stated in API 6A (Annex G) for X class 6B flanges (without mechanical loading) is less onerous. ASME B31.3 calculates the de-rating factor as  $St/S$  where  $St$  is the Stress at the temperature and  $S$  is the Stress at room temperature. Some oilfield grade steels e.g. ASTM A519 4130, 4140 are not supported by ASME B31.3 tables, in which case the de-rating factors in this table may be used.

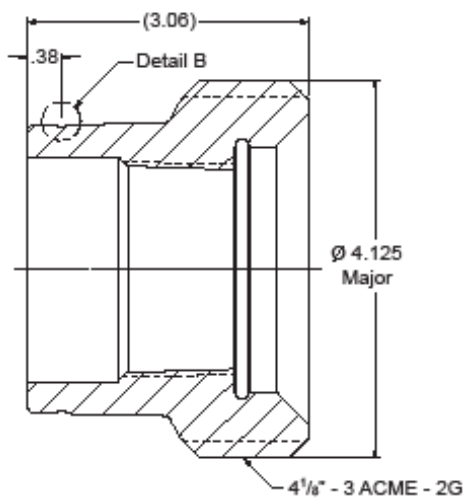
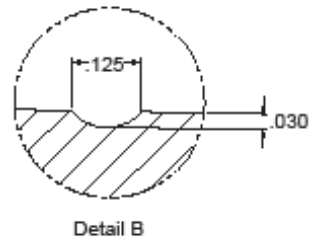
Note 3. Where the pipework WP is certified at a temperature above ambient, the derating factor does not apply up to that specified temperature.

### APPENDIX 5 NPST HAMMER UNION SUB MARKING

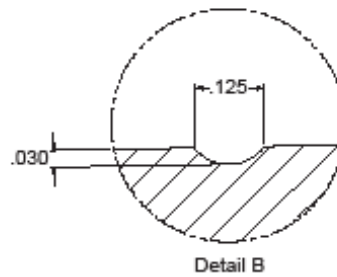
The drawings show the modification - grooves cut on hammer union male and female subs – to be implemented to be able to differentiate NPST from PST subs when the hammer union connection is made up. More information on retrospective implementation and the equipment to carry this out is given in section 4.4.1, ABC Guide to Temporary Pipework, EP2007-3153 revision 3.



Male Sub



Female Sub



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