Safe Use of 2-inch Hammer Unions for Oilfield Applications

API RECOMMENDED PRACTICE 7HU1
FIRST EDITION, MAY 2009

ERRATA, FEBRUARY 2014

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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Safe Use of 2-inch Hammer Unions for Oilfield Applications

1 Scope

1.1 General

This recommended practice (RP) sets forth procedural recommendations as well as an engineering solution to the mismatching of a female 2-inch Figure 402, a female 2-inch Figure 602, or a female 2-inch Figure 1002 hammer union component (sub) with a male 2-inch Figure 1502 hammer union component (wing nut) as described in 3.2. The procedural recommendations described in this RP should be implemented to reduce further incidents.

The engineering solution, which prevents the mating of female 2-inch Figure 402, 2-inch Figure 602 and/or 2-inch Figure 1002 subs with the wing nut of the 2-inch Figure 1502 hammer union, applies to the manufacture of new hammer union components and should not be applied in the modification of existing hammer union components due to unknown factors caused by field wear.

1.2 Objective

The objectives of this RP are as follows.

a) Raise awareness of the incompatibility of these hammer union components, whereby these components will mate improperly when threaded together; and are likely to fail explosively below the rated working pressure of the hammer union parts (male or female).

b) Describe a recommended procedural solution to the industry that will reduce the likelihood of a 2-inch Figure 402, 2-inch Figure 602 and/or 2-inch Figure 1002 hammer union component being made-up inadvertently to a 2-inch Figure 1502 hammer union component. This procedural solution is critical because, depending on industry acceptance and implementation, the engineering solution might take years to effectively eliminate industry equipment manufactured to the original design of 2-inch Figure 402, Figure 602, and Figure 1002 hammer union components.

c) Advise users and suppliers of hammer unions to adopt those procedural recommendations that are reasonably practicable to implement.

NOTE The recommendations in this document build on advice and advisories previously communicated to the industry.

d) Describe an engineering design solution to the industry that makes impossible the mating of female 2-inch Figure 402, 2-inch Figure 602 and/or 2-inch Figure 1002 subs with the wing nut of the 2-inch Figure 1502 hammer union.

e) Recommend users and suppliers of hammer unions implement this new engineering design on their job sites for 2-inch Figure 402, Figure 602 or Figure 1002 components. However, users should exercise caution in reintroducing 2-inch Figure 402, 2-inch Figure 602, and 2-inch Figure 1002 components if already banned from a company's fleet.

2 Terms, Definitions, and Abbreviations

2.1 Terms and Definitions

For the purposes of this publication, the following terms, definitions and abbreviated terms apply.

2.1.1
failure
Mechanical separation of the female/male union components, especially under pressure, such that the equipment no longer is able to perform in the manner intended.

2.1.2
figure number
A designation used by manufacturers of hammer union components to indicate the general design characteristics.

NOTE Depending on the manufacturer and specific design, figure number may represent pressure rating, specific geometric configuration of a union (e.g. flat-faced, misaligning, etc.), electrical insulating capability, etc. of the union type and its components.

2.1.3
incompatible
Hammer union components that have the same nominal size, but different pressure ratings, materials and/or geometry.

2.1.4
inspection
Comparison of equipment conformity to predetermined standards, followed by a determination of action required, if any.

2.1.5
maintenance
Actions to include adjustments, cleaning, lubrication, and replacement of consumable components, as necessary to maintain the serviceability of the equipment.

2.1.6
manufacturer
Individuals or companies manufacturing (or who have manufactured) equipment or materials covered by this RP.

2.1.7
mismatch
Connecting hammer union components that have the same nominal size, but different pressure ratings, material and/or incompatible geometry.

2.1.8
testing
Actions that are carried out on a piece of equipment to determine if that equipment can perform its intended function.

2.1.9
users
Individuals or companies responsible for the use of equipment or material, or implementing recommended practices.

2.1.10
walk-the-lines
The activity of checking the equipment directing the flow of fluid (from high pressure to low pressure) along each branch of the process ensuring that each item of equipment is suitably rated and matched to the physical and environmental conditions to which it is exposed by the operations.

2.2 Abbreviations

H_2S	hydrogen sulfide
HSE	health, safety, environmental
JSA	job safety analysis
MOC	management of change
PPE	Personal Protective Equipment
PTW	permit-to-work

3 Mismatch Description

3.1 General

The most common designations in the petroleum industry for hammer union components with the potential for mismatch, and which are covered by this RP are:

— 2-inch Figure 402,

— 2-inch Figure 602,

— 2-inch Figure 1002, and

— 2-inch Figure 1502.

These hammer union components have a history of failing under pressure due to incorrect matching of components (pressure ratings and/or incompatible geometry). The list of hammer union components that can be incorrectly matched is not meant to be all-inclusive. Users should establish controls to ensure hammer union combinations are safe, especially when more than one manufacturer's components are used.

3.2 Example of the Hazard

The mismatching of either the female 2-inch Figure 402, female 2-inch Figure 602 or the female 2-inch Figure 1002 hammer union component (sub) with a male 2-inch Figure 1502 hammer union component (wing nut) is a worldwide issue in the industry and can cause serious incidents, including fatalities. Complete and proper make-up of hammer union components is required to attain the rated working pressure of the equipment.

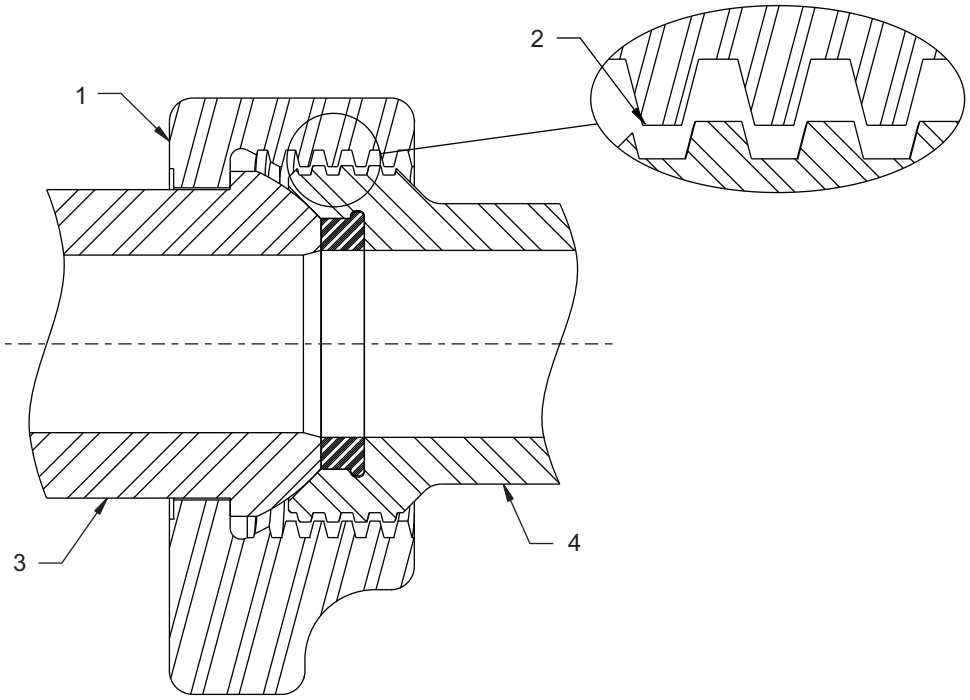
The root cause of the mismatch is that the 2-inch Figure 402, 2-inch Figure 602 and 2-inch Figure 1002 unions were designed with the same thread pitch as the 2-inch Figure 1502 and the female subs have a major (external) thread diameter that is just large enough to engage the minor (internal) diameter of the 2-inch Figure 1502 wing nut internal acme thread. Consequently, although these mismatched hammer union components (2-inch Figure 1502 wing nut with a 2-inch Figure 402, Figure 602 or Figure 1002 female sub) may fully make-up and hold some level of pressure, an explosive failure of the mismatched unions will occur well below the rated working pressure of any of the components, putting people and property at risk.

See IADC Alerts 98-01, 99-33, 00-15, 03-16, and 06-01 for additional information.

3.3 Mismatching 2-inch Figure 402, Figure 602 and, Figure 1002 with 2-inch Figure 1502

A 2-inch Figure 1502 wing nut can be threaded onto a 2-inch Figure 402, 2-inch Figure 602 or 2-inch Figure 1002 female sub as shown in Figure 1. Although the acme thread diameters are different, the pitch (number of threads per inch) is the same. The resulting mating overlap of the threads between these mismatched hammer union components

will not hold pressure. Consequently, the mismatch combinations will make-up and appear to be pressure tight (and may even hold significant pressure), however they will fail well below the rated working pressure of either of the union components (male or female). The failure will be explosive, putting people and property at risk.



Incorrect Assembly

Key

1 2-inch Figure 1502 wing nut
2 improperly made-up acme thread-hazardous!!!
3 2-inch Figure 1502 male sub
4 2-inch Figure 402/602/1002 female sub

Figure 1—Mismatched Male Union Sub and Wing Nut Threaded to a Female Union Sub

4 Description of the Engineering Design Solution

4.1 General

The recommendations described herein are intended to be an engineering solution to the mismatch problem by preventing the inadvertent make-up of a female 2-inch Figure 402, 2-inch Figure 602 or 2-inch Figure 1002 sub with the wing nut of the 2-inch Figure 1502 hammer union. Manufacturers are encouraged to implement this engineering solution on all newly manufactured hammer union components. Users should utilize components and assemblies that implement this solution.

The engineering design solution involves a change of the 2-inch Figure 402, 2-inch Figure 602 and 2-inch Figure 1002 female sub in three different areas as follows:

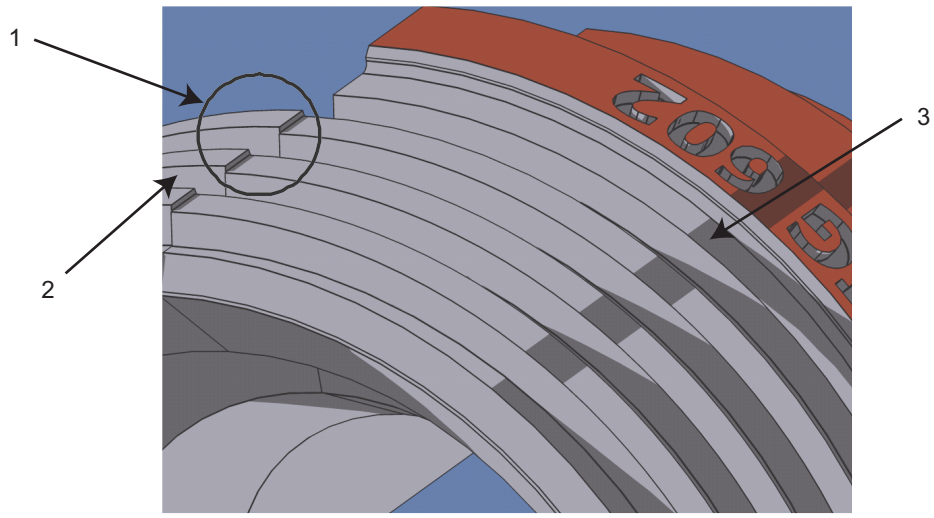
a) reduced thread major diameter,

b) raised shoulder,

c) mark indicating the design.

4.2 Reduced Thread Major Diameter

The major diameter of the external acme thread on the 2-inch Figure 402, 2-inch Figure 602 and 2-inch Figure 1002 female subs shall be reduced so as not to exceed, and thus not allow engagement with, the minimum minor diameter of the internal acme thread of the 2-inch Figure 1502 wing nut. Figure 2 illustrates a reduction of the external acme thread by comparing the original design major diameter (on left with no raised shoulder) with the reduced major diameter (on right with raised shoulder).



Key

1 illustration of reduction
2 old design
3 new design

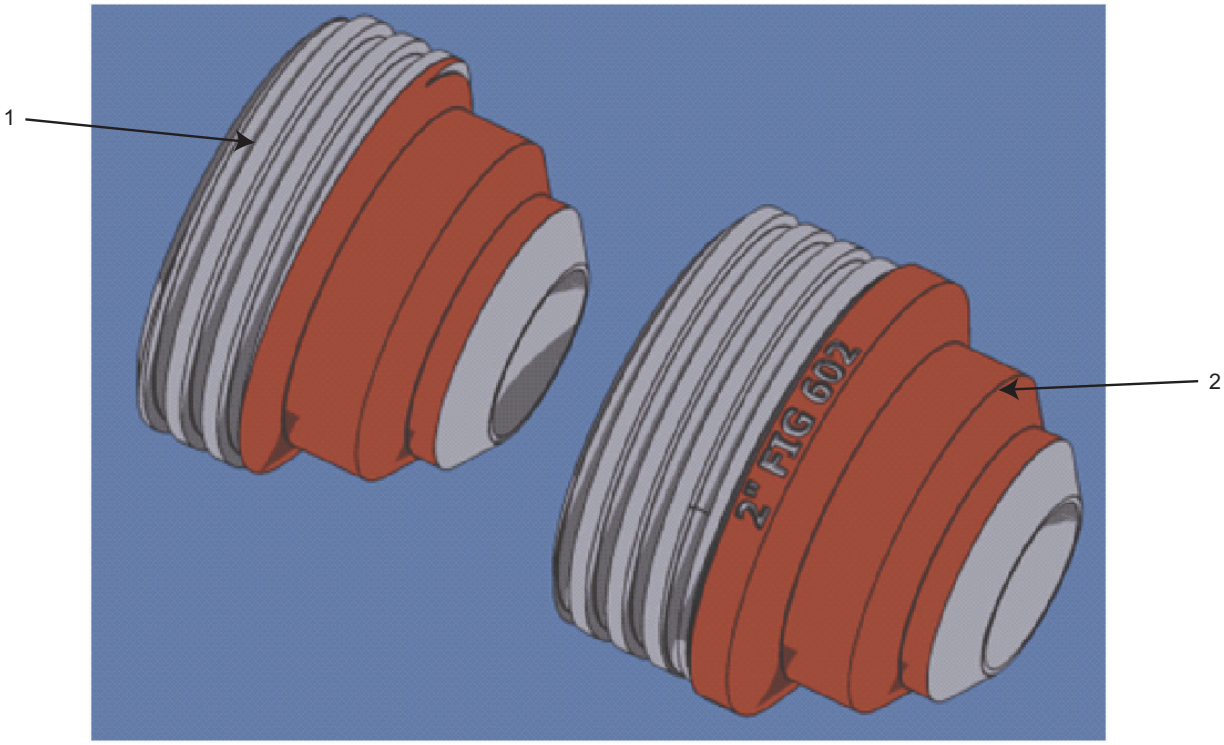
Figure 2—Reduction of External Thread Major Diameter

4.3 Raised Shoulder

A raised shoulder shall be designed into the area behind the threads of the 2-inch Figure 402, 2-inch Figure 602 and 2-inch Figure 1002 female subs to provide a visual indicator of the redesign. This raised shoulder allows the users and suppliers to readily separate their inventory of hammer union components between the original design and the new design that is specifically redesigned to prevent mismatching. Figure 3 shows a comparison of the original geometry without the raised shoulder (on the left) vs the new geometry which incorporates the raised shoulder on the female sub (on the right) of the redesign, allowing for ready identification of the new engineering design that prevents mismatching.

4.4 Mark Indicating Design

The raised shoulder shall be permanently marked with the size and figure number of the hammer union component to provide additional visual indication of the new design. Figure 4 shows a comparison of a female sub of the new geometry, which incorporates the raised shoulder (on the left) vs the original geometry without the raised shoulder (on the right) with the size and figure number marking.



Key

1 old design
2 new design

Figure 3—Raised Shoulder on New Engineering Design Compared to Original Design without Raised Shoulder

5 Measures to Prevent the Make-up of Mismatched Components

5.1 General

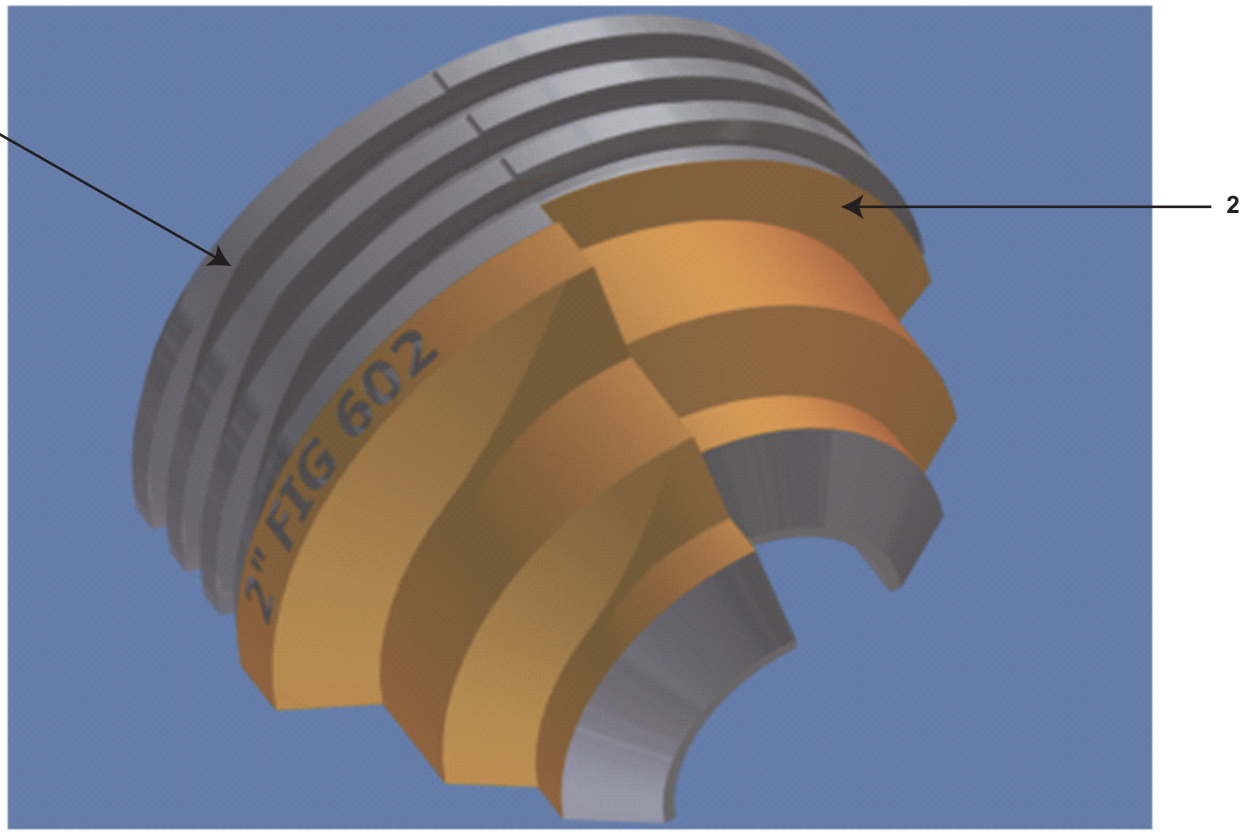
The recommendations set forth herein are preventative measures intended, in the right combination for a given fleet or equipment package, to be a procedural solution to the mismatch problem. Users and suppliers of hammer union components should adopt one or more of these measures that are reasonably practicable for their operations.

5.2 Replace All 2-inch Hammer Union Components in Fleet to 2-inch Figure 1502

Until an industry design specification is developed, as an interim measure, users should consider replacing all 2-inch pipe work hammer union components to 2-inch Figure 1502 and eliminate all 2-inch Figure 402, 602 and 1002 hammer union components from their fleet.

5.3 Go/No-go Gauges

Go/no-go gauges should be used on all 2-inch female subs to determine whether the component is acceptable or unacceptable for use with a 2-inch Figure 1502 male sub and nut. As an example, the gauge shown in Figure 5 will “no-go” on a 2-inch Figure 1502 female sub deeming the component acceptable for use with a 2-inch Figure 1502 male sub and nut. However, the gauge will “go” on a 2-inch Figure 402, Figure 602 or Figure 1002 female sub as shown in Figure 6 deeming the component unacceptable for use with a 2-inch Figure 1502 male sub and nut.



Key

1 new design
2 old design

Figure 4—Marked Raised Shoulder on New Engineering Design Compared to the Original Geometry

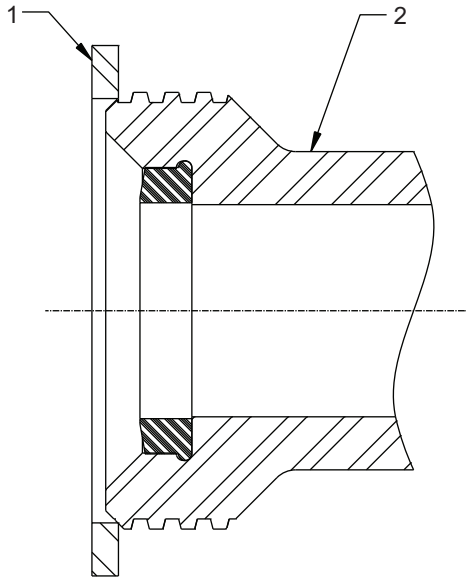
Go/no-go gauges should be used routinely by regular users of 2-inch hammer unions. These gauges should be readily available on all rigs and job sites with 2-inch size unions. Field personnel should be trained in the use of the go/no-go gauges.

Contact union manufacturers for a listing of go/no-go gauge suppliers or refer to IADC Alert 99-33 for further information.

5.4 Inspection and Marking

Hammer union components should be regularly inspected and maintained based on manufacturer's recommendations and experience by the user. Union components that do not meet the manufacturer's minimum service recommendations shall be immediately removed from service. In addition to the manufacturer's recommendations, this inspection process should include gauging of 2-inch female hammer union components to determine the figure number, and marking these 2-inch female unions with the 2-inch Figure 402, Figure 602, Figure 1002, or Figure 1502 designation, thus allowing for ready identification. If a 2-inch female hammer union component is not marked, allowing ready and easy identification of the component, it should not be used until a go/no-go gauge is first used to identify the size and figure of the component and the correct identification is marked on the component.

Marking should be accomplished by either stamping or banding, but should be easy to read when walking-the-lines. Marking applies especially to plugs and instrument fittings or other pressure-retaining equipment with hammer union



Acceptable Female Sub for Use with 2-inch Figure 1502 Male Sub

Key

1 2-inch union gauge ring
2 2-inch Figure 1502 female sub

Figure 5—Go/No-go Gauge Ring Not Accepting a 2-inch Figure 1502 Threads

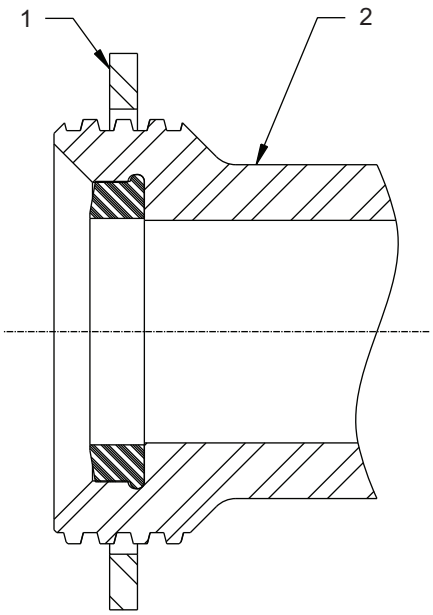
connections. Marking should be the primary means of identification. Competent personnel should carry out the inspection and maintenance procedures.

An inspection schedule should be developed and implemented based on experience, the manufacturer's recommendations and other factors including environment, regulatory requirements, operating time, testing, and repairs. Rejected hammer union components shall be marked to indicate their rejected status and removed from service.

NOTE Specific manufacturer's recommendations are not covered in this document; consult the manufacturers directly for these details.

5.5 Training

Users should train their field personnel, including supervisors, on the hazards of mismatched hammer union components and ensure this information is included in the training matrix for their field personnel. This training should cover recognition of the different hammer union figure types, recognition of union component markings, understanding what components are appropriate for what service, and use of the go/no-go gauge. Training should also include recognizing 2-inch Figure 402, Figure 602 and Figure 1002 female unions newly manufactured according to the engineering design solution described in Section 4. In addition, Health, Safety and Environmental (HSE) orientations for new/transferred staff should include a list of potentially fatal hazards, including mismatched hammer union components.



Unacceptable Female Sub for Use with 2-inch Figure 1502 Male Sub

Key

1 2-inch union gauge ring
2 2-inch Figure 402/602/1002 female sub

Figure 6—Go/No-go Gauge Ring Accepting a 2-inch Figure 402, Figure 602, and Figure 1002 Threads

Users should consider implementing an incentive program that rewards employees that identify and remove components that should not be in their fleet (e.g. 2-inch Figure 402, Figure 602 and Figure 1002 components in the fleet of a company whose policies dictate the use of only 2-inch Figure 1502).

5.6 Management of Change (MOC)

An MOC process should be utilized, including gauging and/or confirmation of markings correct for the service, if a hammer union component needs to be changed out in a system. This is to ensure the replacement does not result in a mismatch. When equipment (such as a manifold) that has been pre-manufactured (or pre-assembled) is in need of repair or replacement, the manufacturer/assembler's hammer union component specifications should be consulted to ensure correct unions are utilized for the repair/replacement. Users should maintain documentation of all hammer union components utilized in their permanent and temporary piping systems. This information should be reviewed and updated when repairing or replacing equipment.

5.7 Permit-to-work (PTW) and/or Job Safety Analysis (JSA)

A PTW and/or JSA process should be utilized for all jobs involving hammer union components. The PTW/JSA should include a walk-the-lines inspection before pressure testing prior to commencement of operations. This walk-the-lines inspection is especially important when temporary hammer union components from a contractor are being connected to installed hammer union components from another company. Inspection of all equipment interfaces (with different owners) should be conducted.

5.8 Job Site Inventory of Hammer Union Components

Users should maintain an inventory of hammer union components by job site and implement a system by which to identify/inspect any additional equipment with hammer union components that arrives on the job site. This inventory control process at the job site should help ensure no mismatches, which is especially important when temporary hammer union components in use by one company are being connected to installed hammer union components in use by another company.

5.9 Color-coding

Hammer union components should be color-coded by the user to indicate the union figure number or working pressure of the equipment. Users who opt to have such a color code should publish the code and make it available to all staff, suppliers, and customers. An example of a color-coding system can be found in Enform IRP 4 [6].

NOTE Color-coding should not be relied upon as the primary design identifier as it is not permanent (due to environmental exposure in field) and can easily be impacted by human error or conflict with other color-coding used in the field.

6 Mitigating the Effects of Mismatched Components Parting Explosively

The following mitigation measures should be considered and applied to protect people in the case of a mismatched hammer union or other component failure. Most, if not all, of these measures should be applied to every job utilizing hammer union components.

a) Use barriers and/or restricted access of personnel for all pressurized operations. Place staff where they are minimally exposed.

b) Orient outlet and instrumentation fittings at 90° or 180° to an employee's expected body placement when it is necessary for an employee to be near pressurized equipment (e.g. to operate valves or read gauges).

c) Locate the temporary pipe connections where there is less exposure to personnel (e.g. under the rig floor).

d) Use a system of restraint for pipework that has been proven in pressurized operations. Examples include fiber rope restraints and safety clamps with wire rope. Personnel should be trained in the proper installation of the safety restraint system.

7 General Safety Recommendations

7.1 General

The general safety recommendations for working with temporary piping, hammer unions, and/or union components described in 7.2 through 7.9 should be considered to help protect people and property. This list is not meant to be all-inclusive.

7.2 Personal Protective Equipment (PPE)

Proper PPE should be used during make-up and breakout of hammer union components. A hazard assessment should be performed to determine the proper PPE based on the specific equipment and tools being used.

7.3 Inspection, Maintenance, and Testing

Hammer union components should be inspected, maintained, tested, and removed from service (due to corrosion, erosion, damage, and deformation of wing nut ears) based on manufacturer's recommendations and experience by

the user. This should include, but not be limited to, inspection of the threads for excessive wear as a result of repeated make-up/break-outs.

NOTE Specific manufacturer's recommendations will not be covered in this document; consult the manufacturers directly for these details.

7.4 Mixing Hammer Union Components from Different Manufacturers

Users, as much as practical, should avoid mixing hammer union components from different manufacturers. Users should establish controls to ensure that if union components from more than one manufacturer become mixed in a union assembly or connection, the resulting combination is safe and not considered a mismatch.

7.5 Documented Safe Practices

Users and suppliers should have documented procedures that reflect safe practices for make-up/breakout, testing and use of pressurized temporary piping and hammer union components.

EXAMPLE Never attempt to tighten or loosen a pressurized union, as doing so could cause the union to disengage. Ensure that a union is not pressurized before hammering to tighten or loosen.

7.6 Pressure Rating Consideration for Dynamic Conditions

Users of hammer union components should consider the effect of pressure surges that might be additive to the maximum anticipated job pressure. Users should select appropriately rated pressure equipment and union connections to adequately control overpressure as a result of a pressure surge.

7.7 Other Mismatch Combinations

There are other possible mismatch combinations not covered by this document, as they are not commonly used in the petroleum industry, such as 1-inch, 1 3/4-inch, 3-inch and 5-inch mismatches. Manufacturers should review all of their products for this issue and advise users of which combinations are subject to this mismatch hazard. Users and suppliers should be familiar with these mismatch combinations as well.

7.8 System vs Component Pressure Rating and Service Application

Users and suppliers should understand the maximum pressure rating of the system, taking into account the lowest pressure rating of any one component and its intended service application [standard vs hydrogen sulfide (H_2S)], before commencing testing and/or operations. Specifically, the system maximum pressure rating must be set to that of the system's lowest rated component.

7.9 Newly Manufactured Equipment not Conforming to New Engineering Design Solution

Users should be aware that there could be some manufacturers that continue to produce 2-inch Figure 402, Figure 602 or Figure 1002 unions, or equipment with these unions, that do not conform to the new Engineering Design Solution (see Section 4 of this RP). Such unions and equipment will continue to be dangerous and users should exercise the preventative measures outlined in Section 5 of this RP.

Bibliography

[1] IADC Alert 98-01 [1], *High Pressure Lines and Hammer Unions*

[2] IADC Alert 99-33, *More on Mismatched Hammer Unions*

[3] IADC Alert 00-15, *Additional Serious Incidents with Mismatched Hammer Unions*

[4] IADC Alert 03-16, *Mismatched Hammer Unions Still being Found*

[5] IADC Alert 06-01, *Mismatched Hammer Union Results in a Fatality*

[6] Enform IRP 4 [2], *Well Testing and Fluid Handling*

[1] International Association of Drilling Contractors, 10370 Richmond Ave, Suite 760, Houston, Texas 77042, www.iadc.org.
[2] Enform Canada,1538 – 25th Avenue NE, Calgary, Alberta, T2E 8Y3, Canada, www.enform.ca.

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