Procedure Guideline for the Replacement of Mechanically Assembled Piping Components

For Use Within Certified Pressure Equipment Integrity Management Systems

AB-523

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Table of Contents

FOREWORD

This guideline is intended to provide advice and recommendations to Pressure Equipment Integrity Management System Certificate Holders (i.e. all certified owner-users) for development of a work procedure for simple repairs to ASME B31 pressure piping systems (excluding B31.1 Boiler External Piping), limited to replacement of a mechanically assembled (threaded or compression type fitting) component with an in-kind material or fitting confirmed to be in accordance with the original piping system design. This guideline document is not a requirements document, nor is it intended to be considered as a replacement for a certified quality control system for construction, repair and alteration of piping systems in the case that the replacement in kind work scope exceeds that specified in this guideline.

The guideline is generally intended for use in upstream oil and gas facilities and was developed with input from Alberta Upstream Chief Inspectors Association (UCIA) members, and other Alberta pressure equipment industry stakeholders.

ABSA supports the use of the guideline as a means to improve safety and reliability of the repairs completed within the scope of this document. Neither ABSA nor any of the contributors accept any liability for damage or alleged damage resulting from the use of this guideline.

AB-523 is next scheduled to be revised/reaffirmed in 2027.

Please contact ABSA's Manager of Inspections, Mike Prefumo (prefumo@absa.ca), if you have any questions or suggestions to improve this document.

1.0 GENERAL

1.1 Implementation Guidance

Pressure Equipment Integrity Management (PEIM) System Certificate of Authorization Permit holders may need to repair mechanically assembled pressure piping systems by replacing a component within the piping system. Certificate holders may include the construction, repair and alteration of pressure piping systems in their authorized quality management system scope by addressing all of the required elements, as specified in the AB-518 requirements document. When the scope of piping system repairs contemplated is limited to those specified in section 1.2 below, a work procedure may be implemented within the PEIM quality system to ensure these component replacements are completed safely and in accordance with the regulatory requirements. It is not intended that such a work procedure would be utilized to construct, repair or alter a complete pressure piping system.

If the PEIM Certificate holder determines that component replacement activities are necessary, the PEIM Manual Scope and Application section needs to reflect this additional scope of work and the Repair and Alteration section must reference and describe the use of the work procedure to control the activities.

The work procedure must suit the PEIM Certificate holder's organization. The processes described in this guideline are only examples. Each PEIM Certificate holder's work procedure must describe the processes in use and provide effective control of the necessary activities.

Some training and work process requirements that need to be considered in order to implement the work procedure effectively are:

- Ensuring that components to be replaced are verified as acceptable, in accordance with the piping system design requirements, or through use of equivalent engineering specifications.
- Ensuring that the materials/fittings are correctly specified in procurement practices and verified upon receipt.
- Ensuring that material traceability to specification and grade is maintained to the point of installation.
- Ensuring that the piping/tubing is assembled in accordance with specified requirements.
- Ensuring that leak testing is completed safely and in accordance with requirements.
- Ensuring that the documentation of results of this procedure integrates with the "found work" or work order system that is in use by the company.
- Auditing the resulting work for conformance to the work procedure.

1.2 Application & Scope

This guideline and an ensuing work procedure applies to the replacement of mechanically assembled (threaded or compression type fittings) pressure piping components in accordance with original design requirements. The intent is that the resulting work procedure be applicable to replacement of a singular or one-off component as opposed to projects of a larger scope, such as replacing a piping system. [Note: Replacement of the piping system would require implementation of a quality system procedure in accordance with AB-518 for construction, repair and alteration of pressure piping, and the owner's Certificate of Authorization Permit would require this scope of work.]

Application is to piping system components such as pressure fittings that conform to ASME B16.11 (e.g. elbow, union, tee, etc.), valves that conform to ASME B16.34, or a pipe nipple, which may be replaced in an existing pressure piping system. In-kind replacements only are to be included in the scope of the work procedure. Replacements involving a change in the piping system design will require the work to be completed utilizing the PEIM System Management of Change (MOC) process.

The referenced replacement work will be to an ASME B31 (excluding B31.1 Boiler External Piping) pressure piping/tubing system that is mechanically assembled (e.g. NPT Threaded, or made up of compression type joints).

The work procedure scope will be limited to a maximum piping or tubing diameter of 2.375" (60.3mm) outside diameter for component replacements (NPS 2). [Note: For low pressure applications (i.e. less than or equal to ASME B16.5 class 150) it may be appropriate for the work procedure to permit NPS 3.]

The work procedure scope may include tubing materials and compression fitting assembly replacements (or "tube fittings"). When tubing is being replaced, only one compression fitting at each end is permitted (no intervening connections).

Only manufactured pipe nipples that are identified with the material specification (e.g. A-106B or A-333-6) may be utilized (i.e. no "field threaded" nipples or "field threaded" piping are to be installed under the work procedure).

The tie in joint should be suitably cleaned and prepared for the replacement component(s). The existing components to be left in service should be examined to ensure there isn't any deterioration. All work should be brought to the attention of the Chief Inspector to track and investigate issues and ensure a suitable integrity assessment of the affected piping is completed.

1.3 Safety

The piping or tubing replacement activities should be planned and implemented meeting all the health and safety requirements of the company.

A hazard assessment of the worksite should be conducted, documented and communicated to the workers.

Safe work permits should be used to ensure that all piping and tubing systems to be repaired are isolated, de-energized, drained, vented and cleaned of the service fluid.

Lock outs or tag outs should be used for isolating items such as valves, breakers for pumps, etc. A test of the lockout items should be conducted to ensure the isolation is effective.

Before putting the piping system back into operation only those employees installing the locks or tags shall remove the ones they have installed to ensure the piping system is safe to start.

2.0 MATERIAL VERIFICATION AND PROCUREMENT

All threaded piping, pipe fittings, tubing and tube fittings will be identified and specified in accordance with the existing engineering design; material specifications, piping specifications, line lists and P&IDs to verify that the replacement is in accordance with the accepted original design, not just consistent with the current installation. In some cases, this may require consultation with company technical support personnel.

All replacement material will be obtained in accordance with procurement and purchasing requirements, from the established approved vendor list, ensuring that complete material specification requirements and the requirement for pressure fitting design registration are provided to the vendor. [Note: Although Material Test Reports (MTRs) are not a construction Code requirement for piping fittings, valves and pipe material, provided the material and/or fittings are marked in accordance with the applicable specification, this is an area where many owner’s specifications add this requirement (particularly for sour service). If MTRs are required it would be incumbent upon the owner to train personnel in the MTR verifications that are then required. In cases where the MTR is part of a coded marking system used to maintain traceability to the original required material markings, the MTR may be required for this purpose.]

Pressure fittings and/or materials will be verified to be marked and traceable to the applicable specification and of the proper pressure class or pipe schedule, upon receipt.

Engineering support personnel must be consulted to verify materials when the specifications are not known or if there are any conflicting records or specifications. When this is the case, the job is to be subject to the MOC process.

3.0 ASSEMBLY

Only knowledgeable, trained and experienced (i.e. competent) personnel may make mechanical piping and fitting joints under this procedure. Documentation for such competency will be in accordance with the Owner-User process.

3.1 For National Pipe Thread (NPT) Pipe Connections

All NPT connections must conform to ASME B1.20.1 (See Figure 1 below).

NPT piping connections must be fully engaged to provide the thread engagement required to ensure that a mechanical joint and hydraulic seal are made. Guidance, such as that illustrated in Figure 1, should be provided in the work procedure for thread engagement requirements.

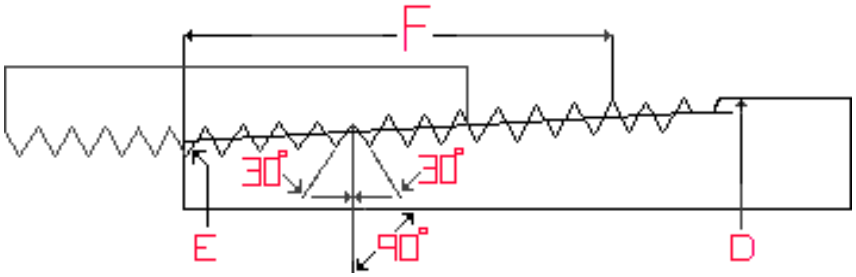
A pipe sealant/lubricant (e.g. "pipe dope") and/or thread tape must be used in the threaded joint. This sealant must be confirmed as suitable to the service it is in. A "Dry" fitting should not be acceptable under the work procedure.

The work procedure should prohibit the use of "close" or "all thread" nipples.

The work procedure should also prohibit use of a threaded pipe bushing from one incremental pipe size to the next (e.g. 1/2 NPT to 3/4 NPT). It is important to leave at least a two pipe size gap between the male and female fittings. An alternative to a bushing is the use of a swage.

The work procedure should prohibit the use of previously used pipe nipples or fittings. Only new materials should be permitted.

FIGURE 1: PIPE THREAD ASSEMBLY DIMENSIONAL REQUIREMENTS



ASME STANDARD, B1.20.1 TAPER PIPE THREAD DIMENSIONS

Because of the taper, a pipe can only screw into a fitting a certain distance before it jams, unlike threading a nut on a bolt. The standard specifies this distance, the effective thread (F). It also specifies another distance, the engagement, which is the distance the pipe can be screwed in by hand without much effort. For workers, instead of these distances, it may be more convenient to know how many threads (turns) to make by hand and how many with a wrench (provided in the two right columns in the table below). The table shows the distances and number of turns called for in the standard. A tolerance of plus or minus one turn is allowed. All dimensions are in inches except for columns specifying number of threads.

NOMINAL PIPE SIZE ***2**	NUMBER OF THREADS PER INCH	O. D. OF PIPE "D"	MINOR DIA. AT SMALL END OF PIPE ***1**	PITCH DIA. AT START OF EXT. THREAD "E"	LENGTH OF EFFECTIVE THREAD, EXTERNAL "F"	Example Hand Engagement plus Wrench Makeup Lengths not necessarily equal to Length of Effective Thread			
						LENGTH OF ENGAGEMENT TIGHTENED BY HAND	WRENCH MAKEUP LENGTH	HAND TIGHT THREADS	WRENCH MAKEUP THREADS
1/8"	27	.405	0.3339	.36351	.2639	0.180	0.111	4.86	3 ***3**
1/4"	18	.540	0.4329	.47739	.4018	0.200	0.167	3.60	3 ***3**
3/8"	18	.675	0.5676	.61201	.4078	0.240	0.167	4.32	3
1/2"	14	.840	0.7013	.75843	.5337	0.320	0.214	4.48	3
3/4"	14	1.050	0.9105	.96768	.5457	0.340	0.214	4.75	3
1"	11.5	1.315	1.1441	1.21363	.6828	0.400	0.261	4.60	3
1-1/4"	11.5	1.660	1.4876	1.55713	.7068	0.420	0.261	4.83	3
1-1/2"	11.5	1.900	1.7265	1.79609	.7235	0.420	0.261	4.83	3
2"	11.5	2.375	2.1995	2.26902	.7565	0.436	0.261	5.01	3

*1 - Minor Diameter at Small End of Pipe - given as information for use in selecting tap drills.

*2 - If permitted, as per section 1.2, this table will require up to NPS 3 data.

*3 – Not consistent with ASME B1.20.1

3.2 For Pressure Tubing Connections

Pressure tubing must be joined using the fitting manufacturer's instructions. These instructions and training are easily acquired from the manufacturer.

Tubing circuits must be well made, plumb, square and level.

Tube ends must enter straight into fittings, not under stress.

Proper bending and forming tools must be used to form the tubing circuit. No freehand bending is acceptable. The distorted tubing from bending shall not enter the tubing fitting.

Care must be taken to use the proper fittings and tubing material as specified in the engineered design. When replacing tubing system parts do not mix, for example, carbon steel fittings with stainless steel tubing. Intermixing of component parts from various manufacturers should not be done without careful evaluation by the owner to ensure the replacement fitting meets the performance demands of the specific application, and that any such intermixing does not void the manufacturers' product certifications or performance warranties. Consistent with recognized international Guidelines for the Management, Design, Installation and Maintenance of Small Bore Tubing Systems (i.e. published by The Institute of Petroleum, ISBN 0-85293 275 8), it is strongly recommended that owners develop and implement a policy with respect to intermixing of component parts from various compression fitting manufacturers.

4.0 LEAK TESTING

Prior to operation, leak testing of the piping system, or portion thereof, containing the replaced fitting or pressure piping is required. When it is not practical to hydrostatically test the system, a hazard assessment should be conducted to evaluate the fluid service hazard and the consequence of leakage. Inconvenience is not an acceptable reason for not completing the appropriate leak testing. If the hazard assessment determines an initial service leak test is acceptable, versus a hydrostatic leak test or leak testing using air or an inert gas (see AB-522 for pneumatic test procedure requirements), then an initial service leak test may be employed to verify leak tightness of the repair. Every effort should be made to conduct a leak test of the system containing the replaced component in accordance with the applicable ASME B31 Piping Code.

The installer's supervisor or equivalent (e.g. Lead Operator) should be notified of the leak test and be provided the opportunity to witness the leak test. [Note: This provision may be included in the work procedure. It is intended simply to provide opportunity for a verification of the installation by the installer's supervisor.]

The person responsible for the replacement installation is responsible for completing a leak test of the repaired piping system in accordance with the

applicable procedure.

Results of all leak tests, including a record of pressure gauges (i.e. gauge number) used, shall be documented on the job report (see Figure 2 Piping Component Replacement Checklist).

All leak tests performed will be undertaken with a maximum regard to personnel safety. All unauthorized personnel will stay clear of the area where the test is being performed.

4.1 Hydrostatic Leak Testing

Air will be vented from the piping system as it is filled.

The metal temperature should be at least 30 degrees F above the minimum design temperature of the piping system

The pressure will be increased gradually to the hydrostatic test pressure as stated within the design specification (typically to 150% of the maximum design pressure) and held for a minimum of 10 minutes.

Following the application of the hydrostatic test pressure, an examination shall be made of all joints and connections. This examination shall be made at a pressure not less than the Maximum Design Pressure. The pressure will be held for a sufficient time for the installer to complete the examination. If leaks are found the pressure piping system must be de-pressured in order to resolve the assembly problem leading to the leakage. Never tighten the assembly or attempt to stop a leak with the system under pressure. Examine the connection for mechanical damage and ensure components and connections are within specifications prior to re-assembly. The leak test process shall be repeated until leak free connections are confirmed.

Best practice (and Code new construction requirements) is that only calibrated gauges should be used for hydrostatic leak testing. The gauges used in the service of a hydrostatic test should have a certification of calibration report indicating last date of calibration (within the calendar year) and the serial number of the gauge must match the supplied serial number on the calibration report. The hydrostatic test gauge range should be between 1.5 and 4 times the hydrostatic test pressure.

4.2 Initial Service Leak Testing

The pressure should be gradually increased until a gauge pressure the lesser of one-half of the normal operating pressure or 25 psi (170 kPa) is attained, at which time a preliminary leak check shall be made.

If the service fluid is liquid, a visual examination of the connections shall be completed. If the service fluid is a gas or vapour at a low enough temperature,

then the procedure should specify use of an industry accepted leak detection fluid (e.g. "Snoop") to visually check the connections. The bubble forming solution shall be applied to all threaded connections, compression fittings and other possible leak sources by flowing, spraying or brushing. The number of bubbles produced in the solution by application should be minimized to reduce the possibility of masking bubbles caused by leakage.

If leaks are found, the pressure piping system must be de-pressured in order to resolve the assembly problem leading to the leakage. Never tighten the assembly or attempt to stop a leak with the system under pressure. Examine the connection for mechanical damage and ensure components and connections are within specifications prior to re-assembly. The leak test process shall be repeated until leak free connections are confirmed.

Pressurize the piping system slowly and in incremental steps, up to the operating pressure.

Check all connections, affected by the replacement components, at operating pressure and record the pressure, test fluid and duration of leak test observation to accurately document the initial service leak test.

5.0 DOCUMENTATION

A Piping Component Replacement Checklist must be used to document the work performed. The information on the checklist must include:

a) The reason for this piping system valve, fitting or pipe nipple replacement.

b) A brief description of the piping system replacement project completed.

c) Name, company and contact information of Installer.

d) Confirmation that the material specification and pressure rating or class or schedule matches the design specification requirements.

e) The material test report is required if the existing procurement procedures within the owner user program specifies so for the replacement part.

f) Documentation of the leak testing.

The Piping Component Replacement Checklist must be signed-off after successful completion of leak testing, by the person responsible for installation, and that of the individual responsible for verifying the leak test, of the replacement component(s).

FIGURE 2: PIPING COMPONENT REPLACEMENT CHECKLIST

Facility or LSD:	
Reason for replacement:	
Description of replacement:	
Installer Name, Company, Contact #:	
System Design Conditions:	Pressure: _____ Temperature (min/max): _____

NO.	FUNCTION	SIGNATURE OR INITIAL AND DATE
		Installer
1	The design requirements for the replacement component have been verified and confirmed.	
2	Replacement material/fitting is in accordance with Company Specifications.	
3	Complete purchase instructions/requirements for replacement material/fitting has been provided to material supplier.	
4	Replacement materials have been received and checked for specification marking, correct pressure class or pipe schedule and for any mechanical damage.	
5	Work permit completed. System isolated, de-energized, drained and vented. Locks or tags installed.	
6	New threads have been visually inspected and are acceptable.	
7	Assembly of piping completed, and the assembly reflects requirements of the original piping system design.	
8	Hydrostatic Test Gauges have correct range, calibration certificate in file. (calibrated within the last 12 months)	
9	Leak Test Information – Record Test Fluid Used: Test Pressure and Temperature: Test Duration:	
10a	Hydrostatic Test completed and Acceptable.	
10b	Hazard Assessment and Service Leak Test Completed and Acceptable	
11	Non-Conformance, #_____, or, None	
12	System drained and dried.	
13	Locks or tags removed. Work Permit completed. Ready to re-commission.	

I certify that the above pressure piping component replacement was completed in accordance with the Pressure Piping Component Replacement Procedure.

Installer Signature	**Date**
Verifier Signature (optional)	**Date**

6.0 REVISION LOG

Edition	Rev #	Date	Description
1	1	2012-05-24	Revisions to identified paragraph on page 5
1	2	2013-09-30	Revisions to identified paragraphs on page 5
1	3	2017-01-27	Revisions throughout as identified on right side
2	0	2022-10-31	New Edition