The Pathway to ASME PCC-1 2013 Appendix A Compliance and why it’s of Critical Importance

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In November 2013, the American Society of Mechanical Engineers (ASME) released its updated PCC-1 guidelines \[1\] for pressure boundary bolted flange joint assemblies (BFJAs). Contained within the document is Appendix A, which represents a major change from the previous 2010 release and is considered to be one of the most critically important changes for BFJA technicians, operators, and other industry professionals. Appendix A contains significant guidance for the levels of training and experience required for technicians working on BFJAs.

In the past, BFJAs were not as highly regulated as welded joints, despite the fact that both types of assemblies carry the same risk and are often securing the same process at the same pressures and temperatures. In fact, as documented by the Society of Petroleum Engineers in its paper number SPE 164981\[2\], about 60% of leaks have been associated with manual human intervention in process systems. The most common activities involved with associated leaks include:

- Incorrect fitting of flanges, gaskets or bolts during maintenance
- Valves in incorrect position after maintenance
- Breakdown of the isolation system during maintenance

The paper states that a major contributing factor can be explained by a lack of competence of personnel involved in such activities. This conclusion is supported by a recent joint study by the Norwegian University of Stavanger and the Norwegian Oil and Gas Association \[3\].

According to the study, the Norwegian oil and gas industry realized that the prevention of hydrocarbon leaks is of great importance because they are the most critical precursor event that can lead to major accidents. Yet, careful analyses and new training, methods, and personnel competency can greatly reduce the number of leaks in oil and gas installations.

Specifically, the study states that the number of hydrocarbon leaks on offshore installations on the Norwegian continental shelf peaked just after the year 2000, when more than 40 leaks per year of an initial rate greater than 0.1 kg/s were found. In response, the Norwegian Oil and Gas Association conducted a training and reduction project from 2003 through 2008, which resulted in only 10 hydrocarbon leaks greater than 0.1 kg/s in 2007.

Also, in 2011, the same association began a new project to further reduce leaks, which shows promising results. So far, the study has shown that more than 50% of leaks are associated with the failure of operational barriers during human intervention in process systems. The single operational barrier that has failed most often is the verification of critical activities.

Training, experience and assessment

Clearly, in the Americas, ASME has drawn the same conclusions, which has resulted in the new requirements of PCC-1 Appendix A. According to the document, ASME has highlighted three major levels of qualifications. These require different degrees of training, experience and assessment. Qualification to ASME PCC-1 can only be claimed once all the three elements of training, experience, and assessment have been achieved.
Along with providing comprehensive guidance for the assembly and assurance of new and in-service BJFAs, ASME PCC-1 now outlines in specific detail the requirement for the training of bolted joint personnel, including:

- Qualified bolting specialists
- Qualified senior bolting specialists
- Qualified senior bolting instructors

The requirements for each of these roles are extensive, and renewal and maintenance of qualifications are mandatory. In order to meet the requirements, companies will need to upgrade training procedures and deliver them via a qualifying organization to address any gaps specific to the ASME PCC-1 training and assessment requirements. Companies such as Hydratight have developed a multi module training program that aligns to the ASME PCC-1-2013 requirements.

- Module 1 Foundational Training
- Module 2 Principles of Joint Integrity
- Module 3 Joint Integrity Quality Assurance
- Module 4 Work Place Assignment
- Module 5 Works Scope Management
- Module 6 Joint Integrity Data Management
- Module 7 Supervisor Project Management

However, company managers should note that thorough training will take much longer than previous bolted training programs to cover all the requirements. For example, although only 5 days are required for the foundational module of the training curriculum, the training requirements from ASME include in excess of 200 individual topics.

ASME guidance expects all 200 individual topics to be covered during the training. Some industry managers and contracting companies could potentially misinterpret or dangerously dilute the requirements or try to shortcut the requirements. But to upgrade an individual technician to a bolting specialist will typically take as much as three weeks of training.

Furthermore, certification is not simply a matter of achieving qualifications once, with the expectation that the certification will last a workplace lifetime. All levels include requirements for requalification through a renewal program every three years, as well as specific years of experience as outlined in Table 1.

Table 1: ASME Defined Roles and Experience

<table>
<thead>
<tr>
<th>ASME Defined Roles</th>
<th>Experience Required</th>
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<tbody>
<tr>
<td>Qualified bolting specialist</td>
<td>6 months continuous</td>
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<tr>
<td></td>
<td>1 year infrequent</td>
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<tr>
<td></td>
<td>2 years sporadic</td>
</tr>
<tr>
<td>Qualified Senior Bolting Specialist</td>
<td>2 years continuous</td>
</tr>
<tr>
<td></td>
<td>4 years infrequent</td>
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<tr>
<td></td>
<td>8 years sporadic</td>
</tr>
<tr>
<td>Qualified Senior Bolting Instructor</td>
<td>4 years continuous</td>
</tr>
<tr>
<td></td>
<td>8 years infrequent</td>
</tr>
<tr>
<td></td>
<td>16 years sporadic</td>
</tr>
</tbody>
</table>
Note that ASME defines “continuous” experience as relevant bolting work conducted on a daily basis with all-time worked on bolting assemblies. “Infrequent” is defined as intense periods of work time as frequent as one week per month and one-third of each year spent on bolted assemblies. “Sporadic” is defined as less frequent than that, but at least one-quarter of each year spent on bolted assemblies.

To qualify as a qualified senior bolting specialist, training modules 1 through 7 must be completed, coupled with at least two years of practical, theoretical, constant, and continuous workplace experience.

Candidates also need documented workplace experience references from supervisors and clients, so they should keep a log book to validate their work experience when requested by asset owners. The log book should include details of the various types of joints worked on.

According to ASME guidelines, there are different routes to qualification. Specifically, workplace experience can gained as follows:

- before training and assessment
- after training and assessment
- after training and after assessment

In other words, if candidates have been working historically in the sector, they can capture that experience and then do the training. Conversely, a new technician coming into the industry can do their training first, before obtaining assessments and experience.

After certification, bolted joint specialists and instructors should carry competency cards that can be presented to quality inspectors at any given time. Also included in the PCC-1 guidelines are expectations about quality assurance processes to be conducted by joint-integrity inspectors.

Industry case study on competency

Recently, a major oil and gas operator [4] conducted a case study on human interventions on BFJAs. The operator owns and operates both onshore and offshore assets, and was very keen to reduce leaks and improve safety, so the operator conducted a series of BFJA tightening procedures using a variety of methods.

- BFJA – tightened using uncontrolled wrenches and new studs
- BFJA – tightened using uncontrolled wrenches and used studs
- BFJA - tightened by Air Impact guns
- BFJA – tightened by controlled torque wrenches
- BFJA – tightened by controlled hydraulic bolt tensioners

In Figure 1 [4], a quantity (see X-axis) of bolts were tightened with hand wrenches and new studs. The operator targeted a bolt stress of 70,000 psi. As is clearly shown, most of the hand-tightening procedures resulted in the bolts being under-tightened and falling dangerously short of the required load specification. In other cases, bolts were over tightened, which can cause the bolt to yield, break, or be destroyed. This section of the case study determined that using hand wrenches and new bolts were not appropriate as a controlled method of tightening bolted joints.
In Figure 2, the operator targeted a bolt stress to be set at 33,500 psi. The operator asked technicians to tighten the bolts again and as can been seen the results show wide variances and the average bolt stress with this method was 28,000 psi, 15% lower than required and can be concluded to also be unacceptable as a controlled bolting process.
The case study also found that re-used studs introduce a significant amount of variation in the final stud loads that are obtained due to friction increases from galling and corrosion in the threads, which can only be corrected by running taps and dies over the threads.

In Figure 3 [4], the operator targeted bolt stress to be set at 45,000 psi. The operator asked technicians to tighten the bolts using impact guns. The results showed that nearly every joint was over tightened and potentially yielded.

As a result of this method, the average bolt stress was 72,000 psi or 60% over the targeted value, demonstrating using air guns to tighten bolts is unacceptable as a controlled bolting process.

In Figure 4, [4] the operator targeted bolt stress to be set at 29,500 psi. The operator asked technicians to tighten the bolts using a hydraulic torque method.
This method was much better than the previous methods, although the average bolt stress was 29,500 psi. Using the calibrated torque wrench with a gauge resulted in much more controlled bolting process with minimal variation.

In Figure 5, the operator targeted bolt stress was to be 45,000 psi. The operator asked technicians to tighten the bolts with hydraulic tensioning. Although the average bolt stress was 47,300 psi, this method proved to be the best and most accurate method of tightening with minimal variation.

Clearly, using hydraulic tensioning for tightening studs provides the highest level of accuracy.

These case study results show the initial effects and results of various methods of tightening BFJAs. Yet, technicians know (or should know) that the initial tightening process results in relaxation.
effects and therefore further work might be required, particularly if the joint functions at elevated temperatures.

Specifically, after bolts are tightened or loaded to the designated calibrated tightness, the BFJAs immediately begin to relax, embed and settle. The bolt load begins to reduce. In this case study, during the next six months, about 47% of the initial load in the joint was lost. Therefore, technicians should re-tighten the joint generally after 24 hours, although ASME states a minimum of 4 hours is required, so that the bolted joint does not relax below its sealing point over the longer term.

In Figure 6, the case study’s results show that an average stud loaded to 98,000 psi dropped to 69,000 psi within about a month. The bolt was re-torqued but within one month it fell again to 95,000 psi and then continued to decline through operation before fully settling after 18 months.

Obviously, without a second pass, the joint could begin to leak within a short period of time if it falls below the required load to seal the gasket. In Figures 1 and 2, where the bolts were significantly under tightened at the outset, these observations demonstrate the criticality of proper BFJAs tightening methods and tools.

In conclusion and simply stated, only with BFJA-technician training, experience, and assessments can competency be achieved, safe operations be ensured, and ASME PCC-1 compliance be achieved.
References

[1] ASME, PCC-1-2013
[3] Norwegian Oil and Gas Industry project to reduce Hydrocarbon leaks
[4] AIPM Reliability and Maintenance Conference and Exhibition Sealing and Bolting, Mark Ruffin, Chevron, David Reeve, Consultant