ISC Safety Lore

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Key lessons from incidents relating to flanges

Introduction

A flange is a way of connecting pipes, valves, pumps and other equipment to form a piping system. It provides easy access for maintenance such as cleaning, inspection or modification. Flanges are usually welded or screwed to the pipes. Flanged joints are made by bolting together two flanges with a gasket between them to provide a seal. Joints play a critical role in plant integrity, therefore the installation and assembly of them requires special attention. The correct shape, size and material of the gasket, appropriate design, material of the flange and studs and correct way of bolting are critical aspects that contribute to maintain the integrity of flanged joints.

Case 1 – Chemical plant

A spill of nitric acid occurred from a nitric acid absorber tower when a flange failed. An operator noticed a small leak from the flange bolts and proceeded to climb the tower towards the top isolating valve. At this time the flange bolts failed and sprayed acid into the absorber tower bund. The operator climbed to the next level and shut down the operation of the plant. Once the acid level had dropped to below the level of the flange, gaseous oxides of nitrogen were released. The operator then used water spray to reduce the impact of gas and acid mist. Industrial neighbours were notified of the release and the acid in the bund was neutralised with lime and sand, and later used in another onsite manufacturing process.

Key learning points

The investigation revealed that the bolts in the flange were mild steel bolts, which were not appropriate for use in nitric acid applications. These bolts were found to be corroded, which eventually led to the leak. As a follow-up, the company reviewed all the bolts used in the process. Five other flanges were identified as having mild steel bolts rather than stainless steel bolts. It was found that these bolts had not been replaced since plant commissioning. All inappropriate bolts were immediately replaced with stainless steel bolts suitable for acid applications. To prevent a recurrence the company implemented quality control procedures and inspection test plans for new projects and maintenance work. Verify that components, such as flanges and gaskets comply with the material specifications.

Case 2 –Gas plant

During recommissioning activities at a gas plant, prior to leak testing it was noticed that several flange connections had been joined without the required gasket. The gasket is vital to ensure a gas tight seal between the two metal faces of the flange. In this instance, because it was visually detected prior to leak testing, there was no loss of containment or injury.

Key learning points

Investigation determined that the flanges were bolted up by a trade's assistant and not a qualified fitter and turner. Therefore, they did not understand the importance of the gasket in the connection. Additionally, they also had no knowledge of the correct flange tightening sequence to ensure a correct seal without unnecessary pressure on the studs or flanges. Care must always be taken to ensure that equipment is only maintained or worked on by qualified and knowledgeable personnel. In this instance the contracting company did not have enough resources so had the trade's assistants performing the role of the qualified fitters. It is crucial to understand the importance of the required level of competency when primary containment systems are installed or maintained to avoid harmful impacts on plant integrity.

The ISC believes that leadership across six key functional elements is vital to achieve good process safety outcomes. These elements are:

- systems & procedures
- engineering & design
- assurance
- knowledge & competence
- human factors
- culture

In the *What can I do* section below you can see how each of these elements plays a part.

Figure 1: The ISC Framework

What can I do?	
Management	
	• Make sure that you have records about past failures of joints and the learning points are distributed within the company.
	• Ensure there are clear procedures for specifying joint components that could modify plant integrity.
	• Ensure that any contracting companies have sufficient competent resources to undertake their work
	• Make sure that procurement is competent to make purchase of joint elements based on the recommended standards.
Process Engineer/Supervisor	
	• Be aware that visual inspection is not conclusive regarding the condition of stud bolts or flanges.
	• Be aware of degrading conditions such as corrosive environment, operating outside normal operating conditions, the systems temporary taken out of service, additional stresses due to activities.
	• Make sure that operators and contract workers are provided with and install the correct size and shape of gaskets.
	• Consider keeping a joint assembly record (e.g. a logbook entry) for assembled joints, particularly the ones are in critical service. It is helpful for troubleshooting purposes or future assemblies.
	• Using temporary gaskets for tightness testing of the system that includes bolted flange joint assemblies may result in “blow out” failure. Make sure that during testing operators use the final seal for the joint instead of the substitute gaskets.
	• Provide training and qualification testing of the joint assembly personnel.
	• Make sure that operators and contract workers comply with the rules and procedures when assembling joints.
	• Ensure pre commissioning checks are carried out to prove the connection is leak tight.
Operator/Maintainer	
	• Make sure to follow bolting procedures such as the tightening sequence and the disassembly procedure.
	• When installing a gasket, make sure you wear proper personal protective equipment.
	• Make sure that proper lockout and tag-out procedures are followed.
	• Prior to installing a gasket, ensure that you check that the sealing surface is free from debris or any foreign material to avoid leakage.
	• Selecting the right gasket is imperative for safety. If a gasket is not the right size, shape or material it can result in leaks and causes injuries. Make sure that every time a new gasket is used; reuse of a gasket is not recommended.
	• Before any joint is disassembled, it is essential that pressure is removed from the system and that proper procedures are followed to ensure that joints may be safely opened. Always open a flange away from yourself.
	• Bolted joint assemblies should be tested to ensure leak tightness. If leaks cannot be stopped by tightening bolts to the required torque setting, the system needs to be depressurised and leaking gaskets replaced, or other faults corrected. Always use a torque wrench to connect flanges.
	• Prior to start-up make sure to check for leaks at all joints, manway plates, flanges, header plugs, vents and drains.
	• Be aware that, when significant numbers of bolts are loosened in rotational order, the elastic recovery of the clamped parts can result in excessive loads on the relatively few remaining bolts.