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CSI Engineering Report: Analysis of Jumper Hose Leaks

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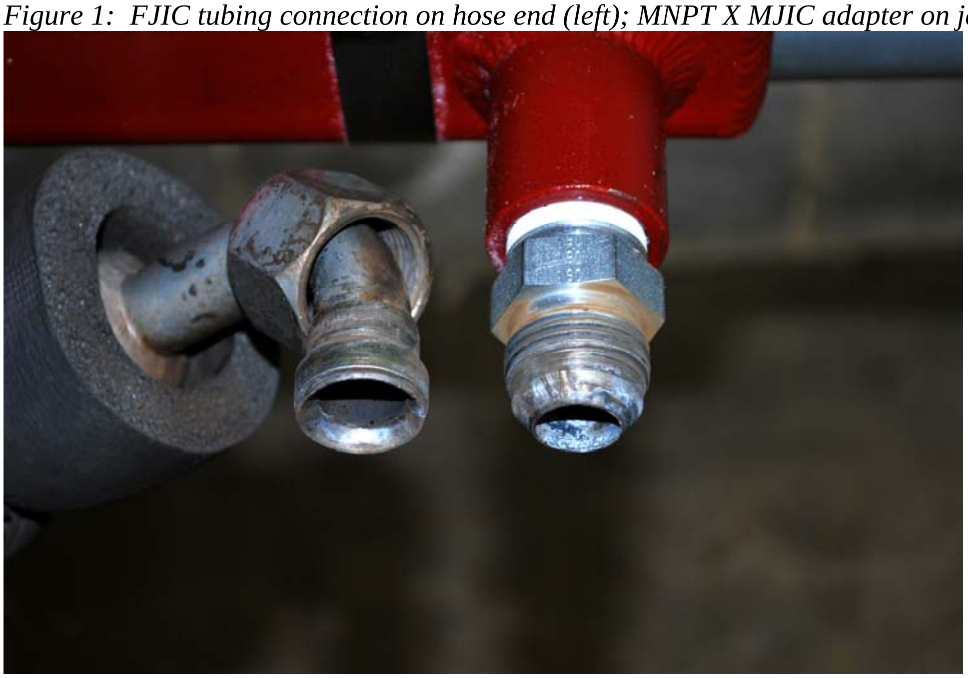
Background

Flexible metal hoses are commonly used to interconnect jacketed pipe spools or bolt-on heating elements in a jacketed heating system. These hoses are referred to as jumper hoses because they allow the heating medium to jump from one spool/element to the next spool/element in circuit. Each hose features stainless steel corrugated metal tubing surrounded by a stainless steel braid. The corrugated tubing provides flexibility while the braid provides pressure containment capability. Each end of the hose is fitted with a female 37.5° JIC hydraulic fitting. During installation, the jumper hose is connected to a male JIC fitting on the jacketing spool/element. The male and female JIC surfaces are brought into contact with one another via a threaded connection. Figure 1 shows an example of the female and male JIC fittings.

Figure 1: FJIC tubing connection on hose end (left); MNPT X MJIC adapter on jacketing (right)



There are two main categories of jumper hose leaks: (1) failure of the hose and (2) failure of the JIC sealing surface. Hose failures can be caused by a weld failure at the braid/tubing/collar weld at the hose end. A weld failure can result from poor welding quality or improper installation. Jumper hoses are not designed to accommodate torsion, overbending, or compression. If subjected to any of these loads during installation or operation, the hose can fail. These same loads can also result in failure of the corrugated tubing at locations other than the hose end. If a jumper hose leaks due to hose failure, it cannot be field repaired and must be replaced.

The purpose of this analysis was to study the root causes of the second category of hose leaks (i.e., failure of the JIC sealing surface). It was hypothesized that JIC sealing failures could be caused by: (1) under-tightening the JIC connection and (2) damage to the JIC sealing surface. These hypotheses were evaluated using a lab setup which featured five ControTrace bolt-on heating elements for a total of ten JIC connections. All elements were interconnected with ¾" jumper hoses. The inlet/outlet connections on the ControTrace featured ¾" FNPT couplings that were fitted with ¾" MNPT X MJIC adapters. The ControTrace circuit was supplied with 40 psig saturated steam using a 30 kW steam boiler. An inverted-bucket steam trap was used at the end of the circuit allowed the condensate to escape. The experimental setup is shown in Figure 2.

Figure 2: Experiment set-up featuring boiler, ControTrace, and ten JIC connections.

Experiment Overview

A total of eleven experiments were run. A brief description of each experiment follows:

Expt.	*Description*
1	The system was run for 24 hours with all connections tightened to industry- recommended minimum torque value for a ¾" JIC connection of 36 ft-lb. No leaks were observed.
2-5	The system was run for a total of 2 hours at progressively lower torque values (20, 15, and 10 ft-lb as well as hand-tight) to induce leaking. The highest torque value at which a leak was first observed was recorded for each JIC connection.
6	The system was run for 25 minutes with all JIC connections returned to 36 ft-lb. The leak status of each connection after returning to 36 ft-lb was documented.
7-8	Four leaking connections from Expts. 2-5 were run for 1 hour at a low torque which produced leaks followed by another 20 minutes at a higher torque which stopped the leaks. The torque value required to stop the leaks was recorded for each connection.
9	Expt. 7 was repeated for 12 hours with several stops and starts in an attempt to evaluate whether leaks would worsen over time. At the end of 12 hours, all connections were torqued to 90 ft-lb to evaluate if the impact of a higher-than-recommended torque on stopping leaks.

10-11	Four previously un-tested MJIC adapters (one undamaged and three damaged) were run for 4 hours at 36 ft-lb. The leak status of each adapter was documented. Following the 4-hour run, the torque was increased to 56 ft-lb to see if the leaks could be stopped. Next, the three damaged surfaces were fitted with a JIC gasket to evaluate its effectiveness.

Summary of Findings

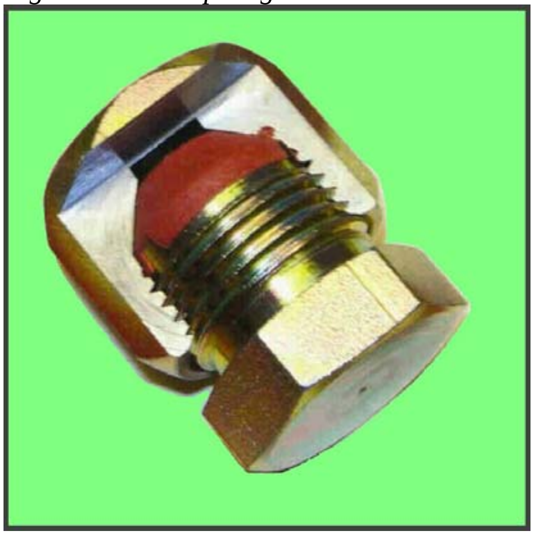
A summary of the experimental results and observations is as follows:

1. No leaks were observed at JIC minimum recommended torque values during any testing. This supports the original hypothesis that proper installation (adequate tightening) can prevent leaks.
2. Dirt and debris in the mating threads can cause misleading torque values. The presence of dirt and/or debris in the mating threads requires greater torque to correctly seat the JIC sealing surfaces. This is because torque that would otherwise be spent sealing the JIC surfaces must be spent overcoming the dirt/debris. Thus, dirt/debris can result in the JIC surfaces not being well sealed even though the minimum torque has been achieved.
3. Leaks tend to worsen over time. Figure 3 shows the leak damage caused by inadequate torque during the 12-hour test. It can be seen that the leaking steam created erosion of the sealing surface. Depending upon how long the leaking has persisted, additional torque may be sufficient to stop the leaking. However, if the erosion is significant enough, even over-tightening beyond minimum torque may not be adequate to prevent stop leaking from a damaged JIC surface.
4. Extremely damaged surfaces can be sealed using a JIC repair gasket. A range of JIC surface degradation was tested, as shown in Figure 4. The JIC repair gasket (shown in Figure 5) was effective in eliminating leaks for all surfaces. This implies that failed JIC surfaces in the field can be addressed via replacing the adapter or applying a JIC repair gasket. It should be noted that the repair gasket is a one-time use gasket and would need to be replaced if the hose was disconnected.

Figure 3: JIC sealing surface damage caused during 12-hour leak test.

Figure 4: Damage inflicted to JIC adapters for Expts 10-11.

Figure 5: JIC repair gasket.



Summary

The following proper installation techniques are needed to prevent jumper hose leaks:

1. Verify the mating threads are clean of dirt/debris.
2. Verify the JIC sealing surfaces are clean of dirt/debris and damage.
3. Install jumper hose without subjecting the hose to torsion, overbending, or compression.
4. Tighten the connection to industry-recommended minimum torque values.

Jumper hose leaks due to hose weld and/or tubing failure cannot be field repaired and must be replaced. Leaks due to poor JIC connection and/or JIC surface damage may be addressed via replacing the JIC adapter or using a JIC repair gasket.

End of report

Respectfully submitted,

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