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The Importance of Pipe Support Inspections for Current Operations and Future Fitness-for-Service Assessments

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Introduction

In the intricate web of industrial infrastructure, it is relatively easy for certain components to slip under the radar of routine maintenance. Pipe supports, once considered low-maintenance fixtures, have unfortunately fallen victim to this oversight in many plants. However, recent developments in standards and the evolving landscape of industrial operations are shedding light on the critical importance of regular pipe support inspections.

Historically, pipe supports may have been relegated to a lower priority status within plants. However, with the evolution of standards such as the ASME B31.1 "Power Piping," overlooking pipe supports is no longer acceptable. This oversight not only poses operational risks but could also lead to significant liabilities for plants. Moreover, as global markets witness modest increases in oil and natural gas production, the demand for in-service uprates of existing facilities has surged, amplifying the importance of thorough pipe support inspections.

The consequences of neglecting pipe support inspections can be dire. Previous experience has shown that, without proper facility pipe walkdowns to confirm current support conditions (e.g., support clamp removed/added to provide flexibility/rigidity or support rigidity change due to damage), fitness-for-service assessment results can be out of concert with reality if only as-built data is used. This disconnect can result in either under- or over-prediction of stresses, putting the asset at risk, particularly if an up-rate in operating conditions is executed. In this article, we delve into why these inspections are crucial for both current operations and future fitness for service assessments.

ASME B31.1 Power Piping Code Chapter VII: Operation and Maintenance

ASME B31.1 now addresses the operation and maintenance of power piping and its supports. While inspection and evaluation methods are acknowledged, they are not detailed. This section of the code concentrates on creep exposed piping, like main steam and hot reheat [1]. Contributing factors to the need for more robust guidance on pipe supports include the fact that deregulation has reduced funds. Furthermore, with new faces in the industry and plants being bought and sold, common industry practice was to neglect pipe supports since they were considered low-risk. Throughout this time, there were many anecdotal stories about being "lucky" and closely avoiding an incident.

The Birth of ASME B31.1 Power Piping Appendix V

Appendix V was added to B31.1 after the Mohave Power Station incident. Mohave was a 1,580 MWe coal-fired power plant located in Laughlin, NV. On June 9, 1985, a 30-in (760 mm) hot reheat line at the Mohave station, carrying steam at 600 psi (4,100 kPa) and 1,000°F (538°C) ruptured, fatally scalding six workers and injuring ten others [2]. Most of the victims were in a nearby lunchroom during shift change. The accident report stated, among several factors, that the line was not routinely inspected, even though the pipe had shifted off supports and distorted because of thermal expansion due to operating temperatures above design specifications. It is implied that if a proper walkdown was conducted and the shifted piping properly noted, a fitness-for-service assessment could have been performed, subsequently flagging that section of pipe for repair or replacement. While nonmandatory, Appendix V does provide guidance on how to maintain critical piping, as it is clearly recognized in the Foreword of this section that B31.1 prescribes minimum requirements for the construction of power piping [1]. However, it does not provide rules or requirements for the determination of optimum function or useful life of the asset (i.e., inspection and fitness for service guidance).

What Guidance Does ASME B31.1 Power Piping Code Chapter VII Provide?

While not thorough, Chapter VII does provide general guidance, saying that managing safe pipe service begins with the initial project concept and "continues throughout the service life of the system" (i.e., there shall be a monitoring and maintenance component for the piping facility) [1]. Furthermore, the code clearly states that the Operating Company shall be responsible for the safe operation and maintenance of their power piping—this assigns the responsibility squarely on the operator's shoulders and not on ancillary service providers or engineering consultants. Because of this mandate, it is important that operators not only understand the day-to-day operations but also the established inspection plan and the results of those inspections.

In Chapter VII, it is required that a condition assessment shall be performed periodically based on condition [1]. What does this seemingly recursive statement even mean? It basically means that the operator must have a periodic inspection plan in place that can trigger a fitness-for-service assessment based on established criteria (i.e., one should be actively looking for pipe support anomalies and, if something is found, something must be done about it). So, what piping systems should be inspected in these cases? In the code, they are referred to as Covered Piping Systems (CPS). For Electric Power Generating Stations, NPS 4 and larger are to be subject to condition assessments for main steam, hot reheat steam, cold reheat steam, and boiler feedwater piping systems. Other systems not mentioned above that operate above

752°F (400°C) or 1,030 psi (7,100 kPa) are also included. Of course, these are minimum requirements—the Operator may, in its judgment, include other piping systems determined to be hazardous by an engineering evaluation of probability of occurrence and consequences of failure.

How does one set this periodic inspection and assessment, and the extent of the assessment of the CPS? This evaluation requires some judgment as well, as it will consider the CPS's age, the previous documented condition, and the anticipated operating conditions. This previously documented condition assessment would include any remaining life assessments conducted in the past and update them based on any changed operating conditions. Changes in operating conditions would include any desired uprates in either temperature, pressure, or both.

What is a "Pipe Support" and Why are They Needed?

First, the term "pipe support" can be used interchangeably with the term "pipe hanger." With that in mind, a pipe support can include anything that supports the pipe's deadweight, restrains the pipe's movement (e.g., thermal expansion, shock load, vibration, etc.), and protects the pipe from structural interference. Pipe supports range from simple supports, such as wooden railroad ties, to complex engineering products, such as active vibration dampers.

Regardless of the configuration, the primary purpose of pipe supports is to safely protect equipment from overload of equipment nozzles due to pipe self-weight, thermal expansion, and shock loads. The secondary purpose of pipe supports is to safely protect piping from overstress of the pipe due to poor weight distribution or thermal expansion restraint, mechanical/chemical damage due to interference with structures (e.g., rubbing, corrosion, etc.), and shock loads such as water hammer, seismic, wind, etc.

Types of Supports

Here is a general list of different pipe supports that are currently available.

- Deadweight supports (see **Figure 1**)
  - Pipe shoe
  - Shim
  - Rod hanger
  - Spring (including any device that supports the pipe while allowing normal movement)
- Restraining supports (see **Figure 2**)
  - Anchor
  - Guide
  - Vibration control
  - Shock absorber

What to Look For?

What does the operator need to look for during visual inspections? In general, piping shall be supported and guided so that the weight is carried safely, it has sufficient flexibility for thermal expansion or contraction, and it does not vibrate excessively. Below are some examples of violations of these guidelines.

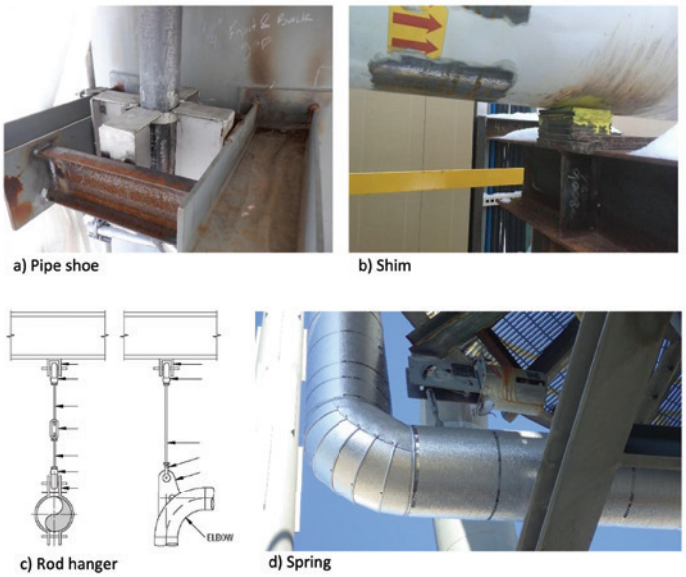


Figure 1. Deadweight supports.

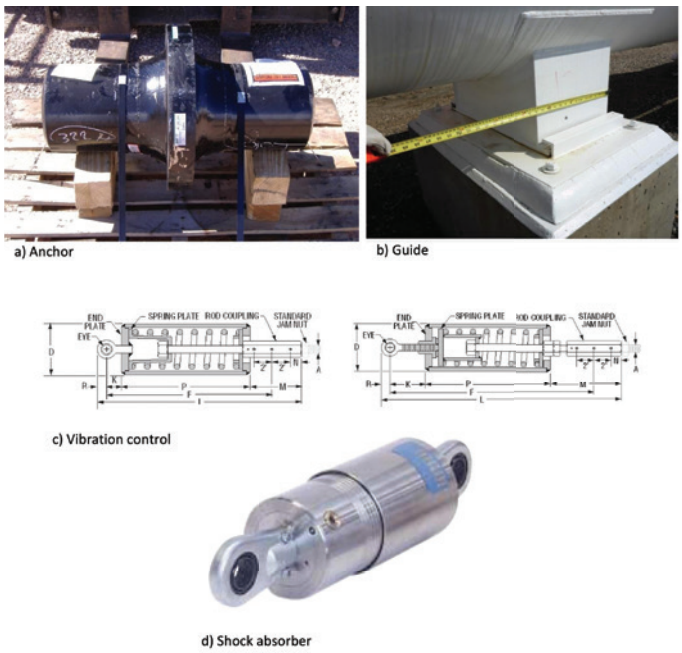


Figure 2. Different types of restraining supports.

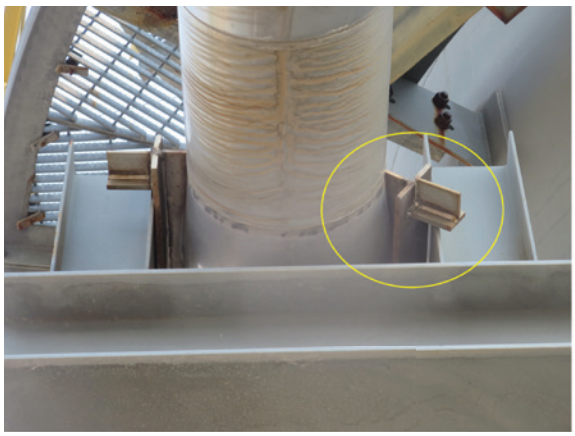


Figure 3. Deformation of a pipe guide support.



Figure 4. Excessive wear at a U-bolt support.



Figure 5. Interference between two pipe elbows.

One example of poor thermal expansion restraint is introducing too many supports that over-constrain piping. **Figure 3** shows deformation of a pipe guide support due to overload. It was later discovered that additional pipe supports were introduced that were not part of the original piping design, which most likely led to over-constraint of thermal expansion and, thus, increased loading on this pipe support not considered in the original support design.

Figure 4 shows excessive wear at a U-bolt support due to axial vibration.

The final example shows active interference (i.e., impact) between two pipe elbows due to lateral vibration (**Figure 5**).

The Role of Inspections in Uprates, with an Example

With the absence of major pipeline construction projects in the foreseeable future, the uprating of existing piping systems has become a prevalent practice. In such scenarios, inspections are pivotal in bridging the gap between historical as-built drawings and current as-found configurations. Failure to conduct thorough inspections to develop a static or dynamic "digital twin" of the asset can lead to inaccuracies in analysis results, either being under-conservative or too conservative. These resulting inaccuracies pose significant risks to operational and personnel safety and efficiency.

For example, when performing a thermal uprate of a piping

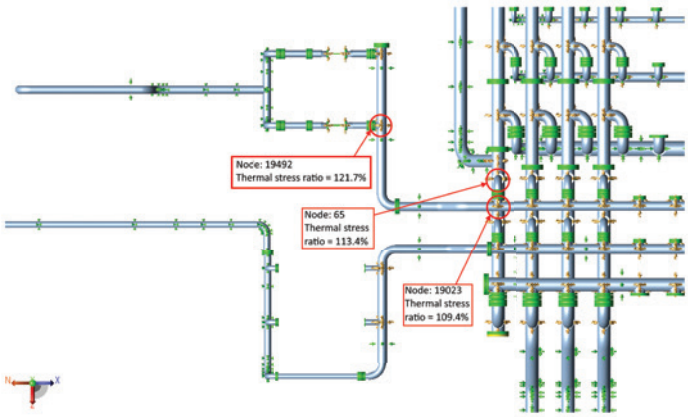
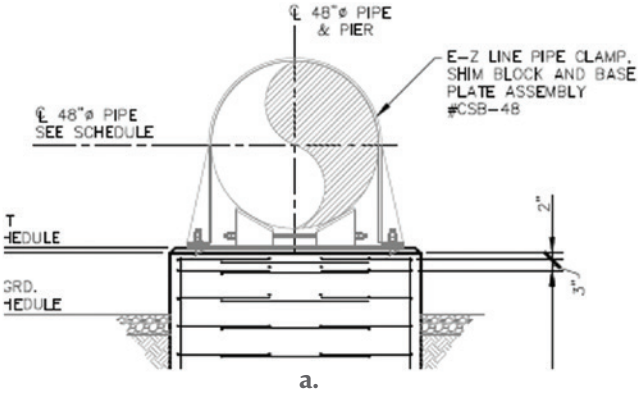


Figure 6. Piping stress analysis.



a.

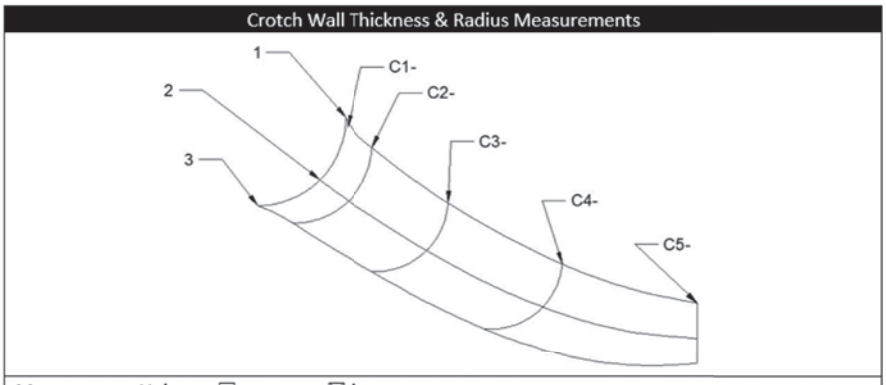


b.

Figure 7. Clamp supports **a.**) as-built vs. **b.**) walkdown.

facility using methods provided in the API 579-1/FFS-1 [3] fitness-for-service standard, one may assume that fitting wall thicknesses are equal to those of the main pipe runs coming into them. For the piping stress analysis illustrated in **Figure 6**, this assumption would lead to the conclusion that you would not be able to uprate your facility to a higher temperature unless major destructive mitigations were completed at the identified overstressed locations (i.e., fitting replacement).

However, the opportunity was taken to do a walkdown of the piping to evaluate the actual condition of pipe supports. In one case, clamp supports, as shown in **Figure 7**, were specified in the as-built. However, the walkdown revealed that these clamp supports did not exist at multiple locations.



Measurement Units:	☐ mm ☒ in		
Crotch Radius:	Little over 1"		
		Branch	Center	Run
Branch Angle		1	2	3
0°	C1	0.592	0.645	0.682
22.5°	C2	0.591	0.651	0.669
45°	C3	0.598	0.629	0.662
67.5°	C4	0.590	0.590	0.654
90°	C5	0.590	0.616	0.652

Figure 8. Crotch wall thickness and radius measurements.

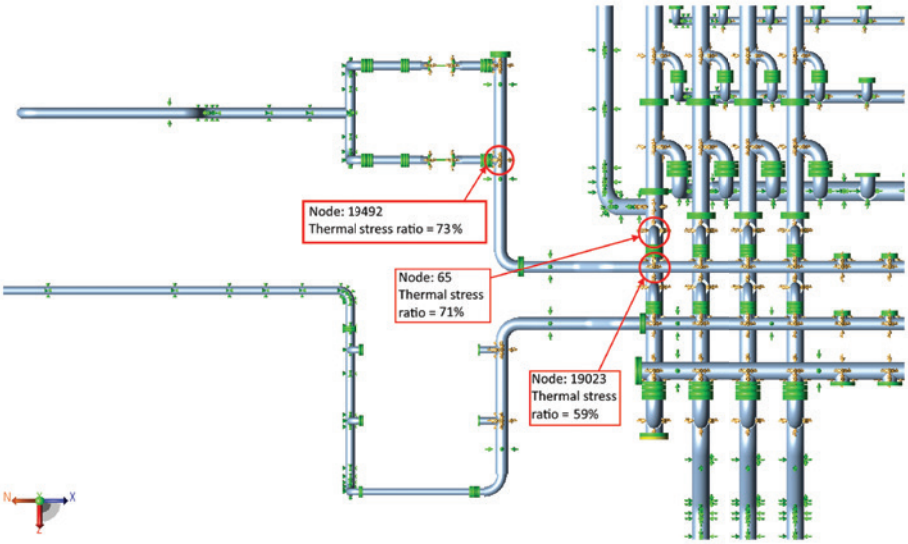


Figure 9. Updated model.

Additionally, during this walkdown, manual wall thickness measurements of the crotch at tee fitting locations identified as potentially being overstressed at a higher operating temperature were performed, revealing that the thicknesses were greater than the nominal wall thickness (see **Figure 8**).

Updating the model to reflect these actual measurements and support conditions and re-running the analysis resulted in a more favorable conclusion (i.e., stresses due to thermal expansion were not an issue at the higher temperature) (**Figure 9**).

Summary

The importance of pipe support inspections for current operations and future fitness-for-service assessments cannot be overstated. By adhering to regulatory standards, conducting regular inspections, and addressing issues promptly, plants can mitigate risks, enhance operational efficiency, and ensure the long-term integrity of their piping systems. As the industrial landscape continues to evolve, proactive maintenance practices will remain essential in safeguarding assets and maintaining operational excellence. ■

For more information on this subject or the author, please email us at inquiries@inspectioneering.com.

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