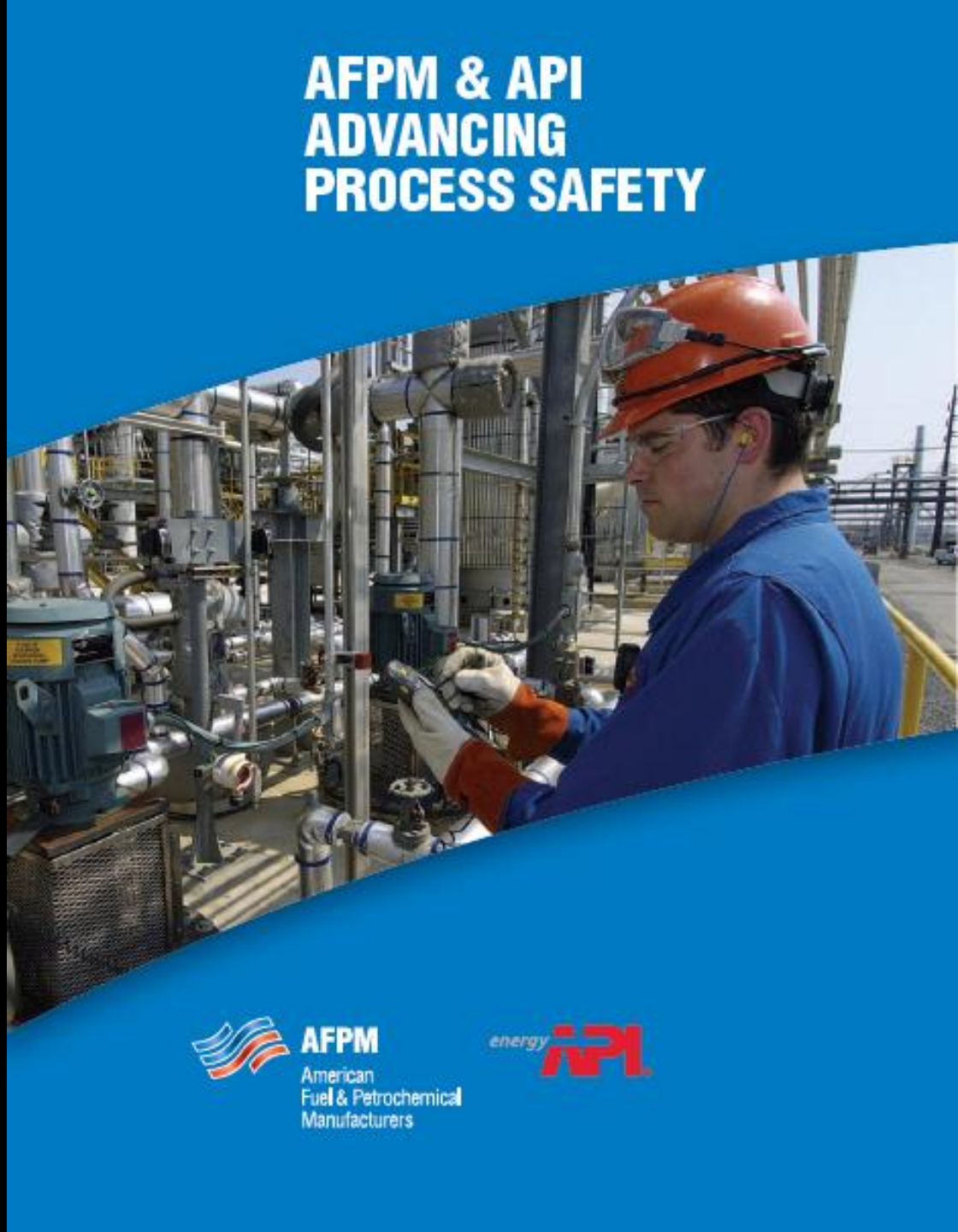
ANSI API RP-754

Quarterly Webinar

June 6, 2017

Process Safety Performance Indicators for the Refining and Petrochemical Industries



Purpose of Industry Learning & Outreach Quarterly Webinars

- To support broad adoption of RP-754 (2nd Edition) throughout the Refining and Petrochemical industries
- To ensure consistency in Tier 1 and 2 metrics reporting in order to establish credibility and validity
- To share learnings regarding the effective implementation of Tier 1-4 lagging/leading metrics
- To communicate changes or improvements in other aspects of the Advancing Process Safety programs

Today's Agenda

1. New AFPM/API Advancing Process Safety Subgroup: Industry Learning & Outreach.
2. Learnings from 2016 PSE Submittals
3. PSE Example Discussion
4. Event Sharing Database & Outreach Information
5. Q & A

New AFPM/API Advancing Process Safety Subgroup: Industry Learning & Outreach

- Combined two existing subgroups: Metrics & Analysis and Event Sharing.
- Goal of eliminating redundant / near redundant work efforts, (e.g., event submittal).
- Single group with the objective to learn and share.

Learnings from 2016 PSE Submittals

- 729 PSEs submitted. 190 PSE Tier 1s, 639 PSE Tier 2s.
- Approximately 50% of PSE Tier 1s included severity values.

Clarifications-

- If release material is burned completely – no release amount. Tier determination based on other factors: cost, injury.
- PRD releases must have: 1) >TQ, and 2) One of the other 4 consequences, (e.g., rainout, unsafe location, on-site SIP, public protective measure).

Data gaps noted-

- Release category not filled out or different from information in the event description.
- No causal factors listed.
- Causal factors tied to TapRoot vs API-754 wording.
- Missing normal mode subcategory, (e.g, sampling, loading / unloading).

PSE Interpretations / Queries

Heat Exchanger – Gas Migration

Question:
There was an incident involving a potential failure of multiple tubes in a heat exchanger resulting in gas migrating from the tube side to the shell side. Although the quantity of gas that migrated from the tube side to the shell side is more than the threshold quantity for a Tier 2 or a Tier 1, the gas was all directed to the flare.

The natural gas migrating from the tube side to the shell side (the mixed refrigerant system) was all contained and sent to the flare (where a pressure controller on the top of the vessel [see the red line on the drawing] acted to send excess inventory to the Cold Dry Flare system). There was no release to the atmosphere except the flaring.

A sketch is given to help to clarify the discussion. The heat exchanger shell side fluid is the Mixed Refrigerant (MR) at around 3-6 bara (bar absolute). The pressure on the tube side is higher, for the natural gas (NG) circuit (shown in green) around 60 bara. In case of a NG tube leak, high pressure natural gas will flow into the shell side and start pressurizing the MR circuit.

The heat exchanger shell side is protected by RVs (in the bottom outlet, not shown), but before that a pressure controller on the top of the vessel (red line) will act to send excess inventory to the Cold Dry Flare system. This gives the flaring of leaked natural gas via the mixed refrigerant system that we're currently seeing.

Heat Exchanger – Gas Migration

Additional Background:

The incident did not result in any of the following:

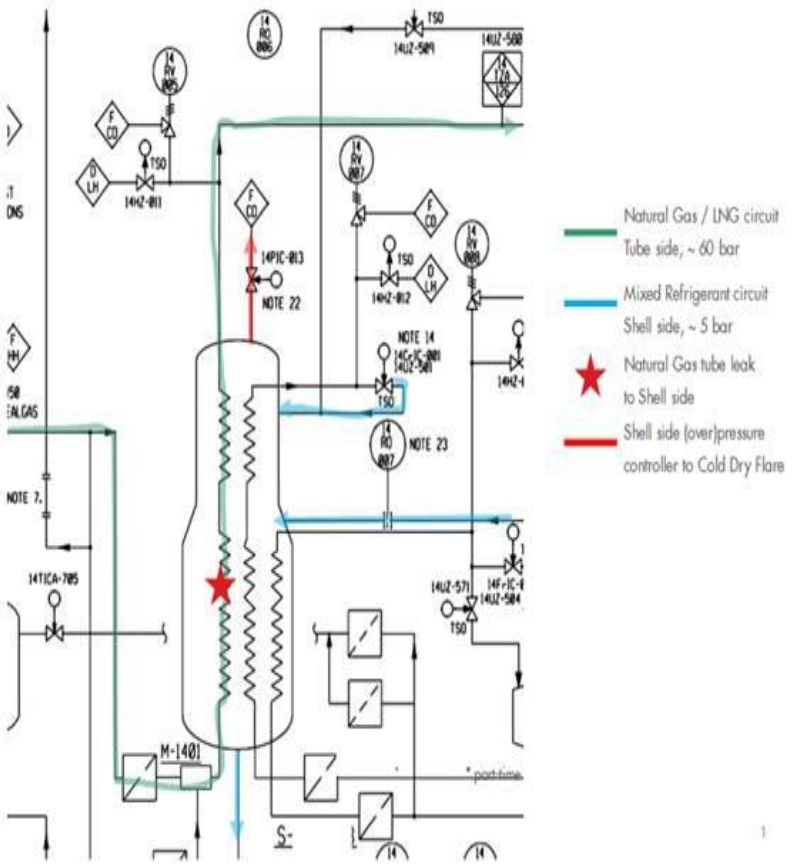
Tier 1

— an employee, contractor or subcontractor “days away from work” injury and/or fatality;
— a hospital admission and/or fatality of a third-party;
— an officially declared community evacuation or community shelter-in-place;
— a fire or explosion resulting in greater than or equal to 100,000 of direct cost to the Company;
— a pressure relief device (PRD) discharge to atmosphere whether directly or via a downstream destructive device (such as the flare) that results in one or more of the following four consequences:

- — rainout;
- — discharge to a potentially unsafe location;
- — an on-site shelter-in-place;
- — public protective measures (e.g. road closure);

Tier 2

— an employee, contractor or subcontractor recordable injury;
— a fire or explosion resulting in greater than or equal to $2,500 of direct cost to the Company;
— a pressure relief device (PRD) discharge to atmosphere whether directly or via a downstream destructive device (like the flare) that results in one or more of the “four consequences”.



78) An upset causes a PRD to open and release fuel gas to the facility flare system. The flare system works properly and combusts the vapor release that came from the PRD. This is not a Tier 1 or Tier 2 PSE since the PRD release was routed to a downstream destructive device that functioned as intended (i.e. did not cause one of the four listed consequences). A company may record this as a Tier 3 challenge to the safety system.	Not a Tier 1 or Tier 2 PSE §5.2, Tier 1 Definition and Table 1 §6.2, Tier 2 Definition and Table 2
79) If a relief valve releases a Tier 1 or 2 threshold quantity and liquid is carried over to the flare drum knockout, but no release to atmosphere in the form of rainout occurs, would you count it as Tier event? The four consequences associated with a release to a downstream destructive device are assessed at the discharge point of the downstream destructive device. In this case, there was no rainout from the flare stack, and assuming none of the other three consequences was realized, then this event would not be a PSE. A company may choose to record this event as a Tier 3 challenge to a safety system.	Not a Tier 1 or Tier 2 PSE §5.2, Definition

Heat Exchanger – Gas Migration

Tiering Proposed by Questioner:
We consider this as an LOPC (which is a Tier 3 – Other LOPC) due to the unplanned event (tube failure causing a migration of gas from tube side to the shell side), but we think that it is neither a Tier 1 nor a Tier 2 as the gas migrating from the tube side to the shell side all went to the flare which did not result to any of the four listed consequences. See attached Examples 78 and 79 from API RP 754 where releases to the flare are neither T1 nor T2 as it did not result to any of the four listed consequences.

Answer Given by M&A Group:
Since "primary containment" is defined as, "A tank, vessel, pipe, truck rail car, or other equipment designed to keep material within it, typically for the purposes of storage, separation, processing, or transfer of material.", the tube failure that results in gas migrating from the tube side to the shell side is an LOPC. However, in reviewing the LOPC, the release did not cross the process boundary since the gas was contained within the shell side of the exchanger, therefore it was not a release "from a process" (as required to be a Tier 1 or a Tier 2), and therefore is not a PSE 1 or PSE 2. A company may choose to take this LOPC as a PSE Tier 3 – Other LOPC.

Important Thoughts:
- M&A response follows definitions given in API 754. The job of the M&A Group is to give answers that are consistent with what API 754 states. (M&A Group went through "LOPC or not" discussions.)
- Highlights the importance for Companies to define their Tier 3 – Other LOPCs.

Total Work Hours

Question:

Do you exclude hours from major construction projects from your exposure hours when figuring out your PSE Rates? We do not, we use all employee and contractor hours for work within the refinery fence line. Our thought behind this is that construction work within a refinery can, and has, caused process safety events. Wondering what others do?

3.1.51

total work hours

Total employee, contractor, and subcontractor hours worked minus the hours associated with major construction projects. This is the same number typically used to calculate occupational injury and illness rates.

3.1.24

major construction

Large scale investments with specific, one-time project organizations created for design, engineering, and construction of new or significant expansion to existing process facilities.

Answer Given by M&A Group:

By the definition of "total work hours", the hours associated with major construction projects, (see definition for "major construction"), are to be excluded. Typically major construction projects within existing process facilities are done in an area that does not present an opportunity to cause a process safety event, even if they are done within the fence line of the facility. Some major construction project work, like tie-ins to existing process units, may present an opportunity to cause a process a safety event. However, these hours are typically small compared to a facility's total work hours. Note: Many times the hours for major construction projects are tracked separately and therefore it is rather simple to exclude them.

Table 2 - Tier 2 Material Release Threshold Quantities

Background Associated with Question:

In reference to threshold category 2-7, threshold category 2-8, and the notation under table 2 which states: “In determining the Threshold Release Category for a material, one should first use the toxic (TIH Zone) or flammability (Flash Point and Boiling Point) or corrosiveness (Strong Acid or Base vs. Moderate Acid or Base) characteristics. Only when the hazard of the material is not expressed by those simple characteristics (e.g. reacts violently with water) is the UNDGL Packing Group used.”

T1-7	Strong acids/bases (see definition 3.1.2) or UNDG Class 2, Division 2.2 (non-flammable, non-toxic gases) excluding air or Other Packing Group III Materials	or ≥14 bbl	or ≥1.4 bbl

It is recognized that threshold quantities given in kg and lb or in lb and bbl are not exactly equivalent. Companies should select one of the pair and use it consistently for all recordkeeping activities.

In determining the Threshold Release Category for a material, one should first use the toxic (TIH Zone) or flammability (Flash Point and Boiling Point) or corrosiveness (Strong Acid or Base vs. Moderate Acid or Base) characteristics. Only when the hazard of the material is not expressed by those simple characteristics (e.g. reacts violently with water) is the UNDGL Packing Group used.

Table 2 - Tier 2 Material Release Threshold Quantities

Question:
If the incident involves a release of about 900 kg sulfur with a flash point of 392F and released at 275F, will this fall under Threshold Category 2-8 with at TQ of 2,000 kg, and therefore NOT a Tier 2 PSE, or should it fall under Threshold Category 2-7 because sulfur has a Packing Group III material and therefore an API Tier 2 PSE because 900 kg release is higher than the TQ of 200 kg? The notation says, one should first use the TIH Zone for which sulfur is not applicable, or flammability (Flash Point is 392F and although it is released at 275F, both temperatures are above 200F). Since the hazard of the material is already expressed under flammability, is this then the criterion to use instead of the packing group and therefore NOT a Tier 2 PSE?

A similar question is raised if the release is bitumen (asphalt) of about 800 kg with a flash point of 446F and released at 250F, will this fall under Threshold Category 2-8 with at TQ of 2,000 kg, and therefore NOT a Tier 2 PSE, or should it fall under Threshold Category 2-7 because bitumen (asphalt) has a Packing Group III material and would therefore be an API Tier 2 PSE because the 800 kg release is higher than the TQ of 200 kg? The notation says, one should first use the TIH Zone for which bitumen is not applicable, or flammability (Flash Point is 446F and although it is released at 250F, both temperatures are above 200F). Since the hazard of the material is already expressed under flammability, is this then the criterion to use instead of the packing group and therefore NOT a Tier 2 PSE?

Table 2 - Tier 2 Material Release Threshold Quantities

Answer Given by M&A Group:
Using the flash point and the release temperature of the molten sulfur and bitumen (asphalt), the flammability of both materials is outside of the criteria described in T1/2-5, T1/2-6, T1/2-7 and T2-8, and therefore there is no threshold quantity for these two materials. Boiling points, flash points and release temperature describe the flammability of the material of concern, therefore it is appropriate to use these criteria identify the release category. Since the flammability for molten sulfur and bitumen are described, and are outside of the PSE 1 and PSE 2 criteria, it is not necessary to consider other criteria, such as Packing Group. Neither of these releases would be a Tier 1 or 2 PSE. A company may choose to categorize these releases as a Tier 3 PSE – Other LOPC.

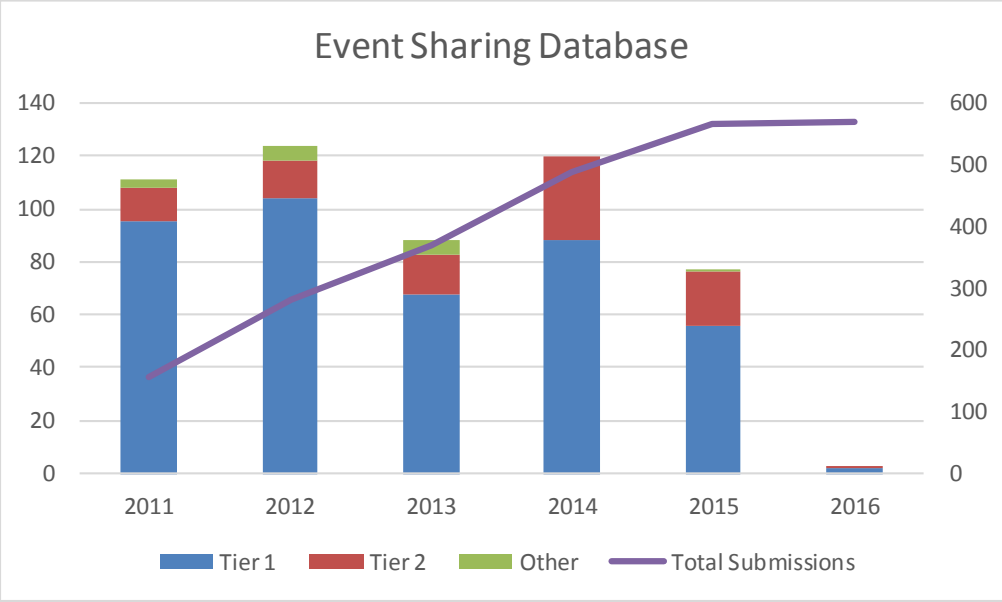
Important Thoughts:
- Highlights importance of reviewing and adhering to “Notes” associated with the Tables in API 754.
- M&A response is consistent with what is written within API 754.
- Question ultimately highlighted awareness of M&A Group to ensure consistency between other groups (e.g. CCPS [e.g. CCPS Process Safety Incident Evaluation Tool] and IOGP [International Association of Oil and Gas Producers]) regarding Tiering. (M&A Group is reaching out to these other groups to help facilitate consistency.)

Event Sharing

- Update on Event Sharing Database
- Industry Bulletin: Hazards of Piping Vibration

Event Sharing

Update on Event Sharing Database



Based on submissions as of May 31, 2017

- Improved web interface for tracking your submissions
- Next year expect automatic initialization of event database submittals based on API-754 reporting (if selected) to reduce redundant data entry
- Continued improvement in ability to extract and share event information

Event Sharing

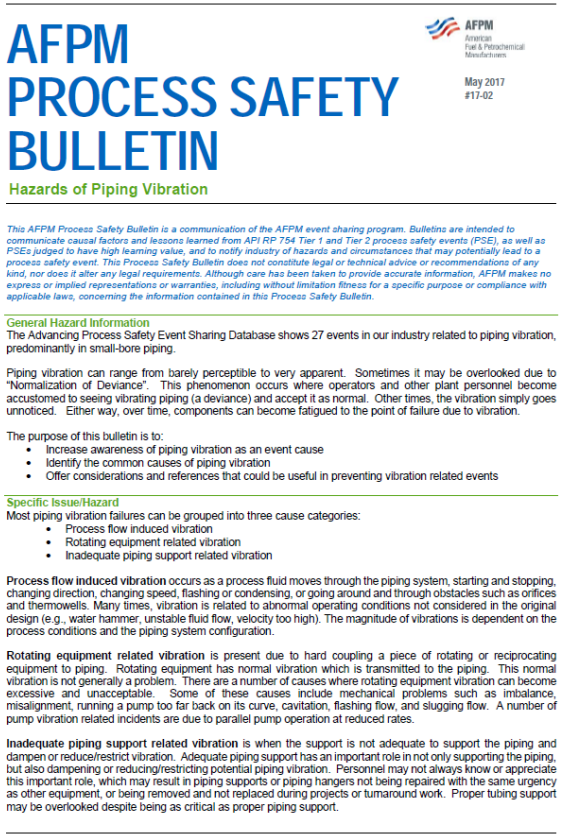
Industry Bulletin:

Hazards of Piping Vibration

- Event Database - 27 events
- Piping vibration - small-bore piping.

- Increase awareness of vibration as event cause
- Identify the common causes of vibration events
- Considerations and references useful in preventing vibration related events

- Bulletin emailed on May 23
  Available on APS Safety Portal



AFPM
American Fuel & Petrochemical Manufacturers

May 2017
#17-02

AFPM PROCESS SAFETY BULLETIN

Hazards of Piping Vibration

This AFPM Process Safety Bulletin is a communication of the AFPM event sharing program. Bulletins are intended to communicate causal factors and lessons learned from API RP 754 Tier 1 and Tier 2 process safety events (PSE), as well as PSEs judged to have high learning value, and to notify industry of hazards and circumstances that may potentially lead to a process safety event. This Process Safety Bulletin does not constitute legal or technical advice or recommendations of any kind, nor does it alter any legal requirements. Although care has been taken to provide accurate information, AFPM makes no express or implied representations or warranties, including without limitation fitness for a specific purpose or compliance with applicable laws, concerning the information contained in this Process Safety Bulletin.

General Hazard Information

The Advancing Process Safety Event Sharing Database shows 27 events in our industry related to piping vibration, predominantly in small-bore piping.

Piping vibration can range from barely perceptible to very apparent. Sometimes it may be overlooked due to "Normalization of Deviance". This phenomenon occurs where operators and other plant personnel become accustomed to seeing vibrating piping (a deviance) and accept it as normal. Other times, the vibration simply goes unnoticed. Either way, over time, components can become fatigued to the point of failure due to vibration.

The purpose of this bulletin is to:

- Increase awareness of piping vibration as an event cause
- Identify the common causes of piping vibration
- Offer considerations and references that could be useful in preventing vibration related events

Specific Issue/Hazard

Most piping vibration failures can be grouped into three cause categories:

- Process flow induced vibration
- Rotating equipment related vibration
- Inadequate piping support related vibration

Process flow induced vibration occurs as a process fluid moves through the piping system, starting and stopping, changing direction, changing speed, flashing or condensing, or going around and through obstacles such as orifices and thermowells. Many times, vibration is related to abnormal operating conditions not considered in the original design (e.g., water hammer, unstable fluid flow, velocity too high). The magnitude of vibrations is dependent on the process conditions and the piping system configuration.

Rotating equipment related vibration is present due to hard coupling a piece of rotating or reciprocating equipment to piping. Rotating equipment has normal vibration which is transmitted to the piping. This normal vibration is not generally a problem. There are a number of causes where rotating equipment vibration can become excessive and unacceptable. Some of these causes include mechanical problems such as imbalance, misalignment, running a pump too far back on its curve, cavitation, flashing flow, and slugging flow. A number of pump vibration related incidents are due to parallel pump operation at reduced rates.

Inadequate piping support related vibration is when the support is not adequate to support the piping and dampen or reduce/restrict vibration. Adequate piping support has an important role in not only supporting the piping, but also dampening or reducing/restricting potential piping vibration. Personnel may not always know or appreciate this important role, which may result in piping supports or piping hangers not being repaired with the same urgency as other equipment, or being removed and not replaced during projects or turnaround work. Proper tubing support may be overlooked despite being as critical as proper piping support.

2017 Webinar Dates

- February 28 – 10:00 am Eastern (Complete)
- June 6 – 11:00 am Eastern (Complete)
- September 19 – 11:00 am Eastern
  - Deep Dive Observations
  - Interpretations
- December 5 – 11:00 am Eastern
  - M&A/Event Sharing Collaboration
  - Interpretations

Questions? / Discussion!