Working Document of the NPC Study
Dynamic Delivery –
America's Evolving Oil and Natural Gas Transportation Infrastructure
Made Available December 12, 2019

Topic Paper #3-7

LNG PRESSURE RELIEF DEVICE TESTING

Prepared for the
Permitting, Siting, and Community Engagement for Infrastructure Development Task Group

On December 12, 2019 the National Petroleum Council (NPC) in approving its report, *Dynamic Delivery – America's Evolving Oil and Natural Gas Transportation Infrastructure*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Permitting, Siting, and Community Engagement for Infrastructure Development Task Group. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 26 such working documents used in the study analyses. Appendix C of the final NPC report provides a complete list of the 26 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Topic Paper (Prepared for the National Petroleum Council Study on Oil and Natural Gas Transportation Infrastructure)	
3-7	**LNG Pressure Relief Device Testing**
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Reviewers	
Date: August 26, 2019	**Revision:** Final
SUMMARY This paper provides background on testing of LNG pressure relief devices.	

Pressure Relief Device Testing

Concern:

49 CFR Part 193.2619 currently requires that control systems (e.g., relief valves) "must be inspected and tested once each calendar year…" This regulatory requirement does not follow industry standards, either refinery, process safety management nor the most recent version of NFPA 59A. Having regulation with a prescriptive time interval for testing, especially as short as one year, over-exposes the facility and personnel to elevated risk and hazards and reduces safety and reliability. Said another way, removing and testing these devices will increase the potential for failure and therefore will reduce safety and reliability.

Objective:

The objective of this paper is to demonstrate the technical justification for Operators to follow risk-based industry standards that are fit-for-purpose as they relate to set pressure testing of pressure relieving devices (PRDs).

Background:

The LNG industry has an exemplary safety record that spans decades. Part of the reason for this is that the design of an LNG facility includes multiple safety assessments that focus on Hazardous Operations (HAZOP), Safety Integrity Levels (SIL), Layers of Protection Analysis (LOPA), and vapor dispersion and hazard modeling. These assessments are lengthy, regimented review of the hazards and their mitigation associated with LNG designs. These comprehensive risk assessments assure that there are multiple layers of protection implemented and functioning at all times so that there are no means of a single point of failure for plant systems.

These mechanical, passive pressure relief devices are typically the last of multiple safety layers that prevent overpressure in the system. The failure of one device, would likely not cause a failure of the entire system since multiple safety devices are available for any area in the system. Furthermore, process systems incorporate a control system-based alarm and control action as well as a SIS based shutdown interlock - all of which act to prevent overpressure before the pressure relief device is called upon to act and reduce the demand rate on the pressure relief device.

LNG is a clean noncorrosive process for these devices which are common to refining and chemical process systems where the process environment is significantly more severe. The clean LNG process environment means that corrosion and degradation of the devices is virtually nonexistent and expected reliability and service life meet or exceed design expectations.

The current regulation for the LNG industry were developed and intended for an industry that was smaller in scale than the current scale of LNG export facilities that are under construction along the U.S. Gulf Coast and elsewhere. Small-scale LNG facilities (peak shavers) are more simplistic in design and although they are designed with safeguards, their operational complexity is significantly lower than LNG export facilities and the amount of PRDs numbers in the low 100's. Furthermore, since the operation of these smaller peak shaving facilities is seasonal, the requirement for testing is more easily accomplished when the facility is shut down, in many instances for months at a time.

For large scale liquefication facilities, utilization rates are 90% or higher. In the large-scale LNG facilities; complex process systems usually require 500-1000 PRDs per train depending on their design and each facility has multiple trains. The sheer scale of testing thousands of pressure relieving devices annually unnecessarily increases risk to the precision tolerance equipment and the personnel performing the work. For companies around the world using PRD's in refining, chemical and/or LNG service, a risk-based approach to maintenance and integrity management has become the norm, including health checks for PRD's. The testing intervals that have been adopted range from one to ten years based on the type of fluid, vessel, piping, system and associated operating condition. Moreover, industry standards allow for screening PRD's as part of a risk-based approach to inspection and testing.

Industry Standards:

American Petroleum Institute (API) is a trade organization that has developed hundreds of recognized and generally accepted codes, standards and recommended practices. API 576*, Inspection of Pressure Relieving Devices* states that the frequency of inspection could vary widely depending on the various operating conditions, with less frequent inspection required when operations are satisfactory and more frequent when corrosion, fouling, operational upsets and leakage occur. API 510, *Pressure Vessel Inspection Code; In-service Inspection, Rating, Repair, and Alteration*, recommends that intervals for testing not exceed 5 years for typical process services and 10 years for clean (non-fouling), noncorrosive services. The 2019 version of NFPA 59A has incorporated the following requirement: **18.10.10.7.2** Set-point testing intervals shall be in accordance with either of the following:

(1) At intervals not exceeding five years, plus three months
(2) At a frequency in accordance with API RP 576, *Inspection of Pressure-Relieving Devices*

Testing Risks:

The diagram in Attachment A illustrates the pressure relief valve and the associated risks involved with inspection and testing of the device. API 576 also recommends that *Pressure-relief valve parts are precision items manufactured to extremely close tolerances. Improper handling can degrade these tolerances destroying the basic valve alignment on which the fine, exacting performance characteristics of the device primarily depend.* The actual testing and handling of the device could precipitate premature failure. Furthermore, as these devices are located throughout the facility, those in elevated locations expose personnel to the safety concerns of working at heights, rigging, crane and scaffolding operations, and falling objects. Inspection and testing of the devices expose personnel to unnecessary risks during purging and isolation, pressurizing/depressurizing systems, hand

and eye injury, and over-pressurization/rupture. Attachment B lists the work activities involved in testing these devices.

Conclusion/recommendation:

1. Testing of PRDs expose personnel to risks
2. Testing PRDs exposes the facility to risk of damage to a functioning PRD with the inspection and testing and as a consequence introducing risk by not returning the system to safe and reliable service
3. The current regulatory requirement of yearly testing is not an industry standard
4. Industry standard of longer testing intervals has not impacted (reduced) safety

The most appropriate and safest route for addressing inspection and testing of pressure relieving devices is a recommendation to adopt API 576 and 510 by reference for PRD testing and/or the adoption of in the requirements in the 2019 NFPA 59A (18.10.10.7.2).

Attachment A

Risk and other issues associated with set pressure testing

ISOLATION

PURGING

RIGGING

BREAKING FLANGED CONNECTIONS

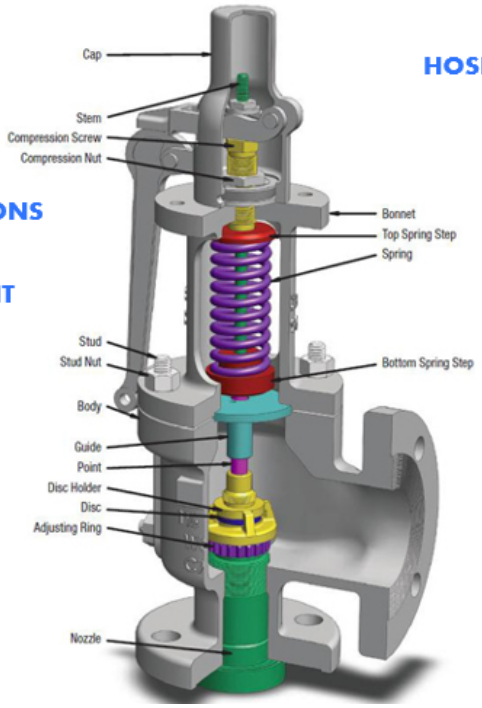
WORKING AT ELEVATED HEIGHT

PHYSICAL HANDLING OF THE VALVE

HAND INJURY

PINCH POINTS

EYE INJURY



BOLT TENSIONING

HOSE CONNECTIONS - DISCONNECTIONS

PRESSURIZED HOSES/PIPING

DAMAGE TO SEATING SURFACES

DEVIATIONS IN PRECISION TOLERANCES

HOSE CONNECTIONS

FALLING OBJECTS

FOOT INJURY

OVER-PRESSURIZATION/RUPTURE

Attachment B

Work Activities for Testing Pressure Relief Devices

- **Work Preparation (administrative)**

Permit to work, job safety analysis (risk assessment), site review (to determine access)

BORA (bypass override risk analysis), engineering review of each test and any impact to production, isolation review

- **Work Preparation (operations)**

*Scaffolding**
Rope off test area for test "in situ"
*Personnel lift**
*Crane operation**
*Staging/placement of Nitrogen cylinder and associated equipment**
Running pressure hoses

- **Work Activity**

*Isolate equipment, block in the line, running nitrogen line**
Verify equipment identification/functional location
*Unbolt from parent asset**
*manual handling**
*crane handling**
Perform actual set pressure test (connect to pressure test equipment, run test, verify test)

- **Post Work Activity**

Return to normal operation
Reinstallation (alignment, gaskets, bolting, torqueing)
*Removal of scaffolding/other safety equipment**
Removal of pressure testing equipment

- **Work Close Out**

Control of work (close permit to work, job evaluation)
Documentation (test reports)
Data population into inspection data management system/maintenance management system
Engineering review

when required