



August 24, 2016

Mr. R.M. Seeley
Director PHMSA Southwest Region
Pipeline and Hazardous Materials Safety Administration
8701 S. Gessner, Suite 630
Houston, TX 77074

Re: ONEOK NGL Pipeline, L.L.C., Notice of Proposed Safety Order
CPF 4-2016-5014S

Dear Mr. Seeley:

As a result of the informal consultation held at the PHMSA SW Region offices on July 28, 2016, ONEOK NGL Pipeline, L.L.C. is submitting its proposal to address items 1, 4 and 5 of the Proposed Safety Order CPF 4-2016-5014S.

Also included is an email correspondence from our proposed vendor we wish to perform the vibration analysis at the Sterling III pump stations, Energy Dynamics Incorporated (EDI). This was a request during our consultation asking ONEOK to provide their hazardous liquids (Part 195) experience. This is included as Exhibit A.

If there are further questions you can contact me at 918-924-0158 or gary.numedahl@oneok.com.

Sincerely,

A handwritten signature in blue ink that reads "Gary Numedahl".

Gary Numedahl
Director DOT Compliance
ONEOK Partners, L.P.

ONEOK Response to Items One, Four and Five of PHMSA's Notice of Proposed Safety Order CAF-4-2016-5014S

ONEOK NGL Pipeline, L.P. (ONEOK) respectfully submits the Response and Plan of Action detailed below to Items 1, 4 and 5 contained in PHMSA SW Region's Notice of Proposed Safety Order CAF-4-2016-5014S (Notice).

PHMSA Notice Item #1:

ONEOK must make, at a minimum, an immediate 20% pressure reduction on their Sterling III Pipeline as required by §195.55 and implement operational constraints on the pump units to reduce the vibration and threat of failure. The pressure reduction and operational constraints must remain in place until approval to resume normal operations is given by the PHMSA Southwest Region Director.

ONEOK submits the following discussion

ONEOK requests that the 20% pressure reduction stipulated in Item #1 of the Safety Order be withdrawn. This request is based on the risk of harmonic fatigue being minimally impacted by the operating pressure of the pipeline.

ONEOK has engaged technical experts and performed testing in an effort to understand the risk to our piping exposed to harmonic frequencies generated by our pumping units. These discussions occurred both prior to and after the Notice was received on May 20, 2016. Through these discussions, it has been concluded that small diameter branch connections are a key focus area because these connections can have a natural frequency which has the potential to be excited by the pump's vane pass frequency under certain operating conditions.

In an effort to minimize risk associated with the small diameter branch connections until an analysis could be performed, ONEOK installed temporary supports in early 2016. To date, we have not observed any signs of failure at these locations.

Additionally, in order to perform a complete harmonic analysis that is both desired by ONEOK and required under Item #4 of the Notice; ONEOK requests the ability to continue operating Sterling III Pipeline under its full range of available operating parameters.

In conclusion, based on both ONEOK's and our technical experts' current understanding of the risk, the proactive steps taken to manage the risk, and the need to operate the pipeline in all operating scenarios to complete the analysis, ONEOK requests that the 20% pressure reduction stipulated in Item #1 of the Safety Order be withdrawn.

PHMSA Notice Item #4:

Within 30 days of receipt of the Order, ONEOK must submit a plan to the PHMSA Southwest Region Director for approval, to perform a complete, systematic analysis of the vibration problem, determine the specific operational conditions where the vibration occurs, and propose mitigation measures to prevent damage to the pipeline from the vibrations. The proposed plan must be performed by an independent third party, including a means to verify the effectiveness of the mitigation measures, and perform periodic monitoring of the effectiveness after the mitigation measures are implemented. The independent third party must also be approved by the PHMSA Southwest Region Director prior to the commencement of work.

Operator's Proposed Choice of the Independent Third Party

ONEOK respectfully submits Energy Dynamics Incorporated (EDI), headquartered in San Antonio, TX, for approval as our independent third party to perform the vibration analysis inspections detailed below.

EDI has extensive experience with vibration and pulsation issues in NGL pipeline systems. Some relevant examples include:

1. Assisted Enterprise Products in design stage of their Western Pipeline Expansion Project (Wyoming, Utah, Colorado, New Mexico).
2. Numerous field tests to troubleshoot vibration issues for Enterprise pump stations (nationwide).
3. Field testing and design work for NuStar in their Eagle Ford pipeline systems.
4. Field testing and design work for Targa Resources - North Dakota pipeline (Johnson's Corner).
5. Field testing for Valero Logistics (formerly Diamond Shamrock) - Adrian, Cuervo and Moriarity pump stations.
6. Field testing at various locations on behalf of pump vendors including Sulzer-Bingham, Best PumpWorks and Flowserve.
7. Extensive field testing and design work for Alyeska (Alaska Pipeline - Pump Station Electrification Project).

EDI also has several staff members that are involved in industry standards groups, including:

1. API 688 - Pulsation and Vibration Control for Positive Displacement Machinery
2. Several other API Standards (618, 619, 674)

3. ASME O&M Subgroup on Piping Systems (Nuclear Power Plant Operations and Maintenance Standard)
4. Gas Machinery Research Council
5. Texas A&M Turbomachinery Advisory Committee

An additional document summarizing EDI's capabilities is included as Exhibit A.

Vibration Analysis Inspection Pump Station Sites

The Sterling III pump stations are similar in design and operational characteristics. The primary variable is the number of pumps available for service at each station. Of the 13 pump stations on Sterling III, 1 is equipped with 3 pumps (maximum of two units in operation), 4 are equipped with 2 pumps, and the remaining eight are equipped with single units. ONEOK proposes to initially conduct a vibration study at one single unit site and one dual unit site. The specific sites proposed are Blue River, OK (single unit) and Goodrich, TX (dual units).

Harmonic Testing Background and Procedure

Pump induced vibration is the result of vane pass frequency (VPF) and amplitude. Vane pass frequency is calculated by multiplying the rotations per minute by the number of impeller vanes and then dividing by the operating frequency of the pump. For example a pump with a 7 vane impeller operating at 3000 rotations per minute on a 60 Hz pump would have a $VPF = (3000 \times 7) / 60 = 350 \text{ Hz}$. Vane pass frequency occurs in all centrifugal pumps and is a result of the pulsation caused by the impeller passing the cutwater, or discharge, of each of the stages. When the natural frequency of the piping components of a pump station are at the same frequency as the VPF, there is potential for vibration to become an issue. Determining the natural frequency of the piping components is determined using testing in the field. If the VPF and the natural frequency of the piping component are the same, the amplitude of the vibration must be below acceptable levels to prevent fatigue failures. Amplitude can be thought of as the strength or intensity of the vibration wave. The higher the amplitude, the more the vibration will excite the piping component that shares its frequency. The impact of vibration on the pump station will be determined by employing Engineering Dynamics Incorporated to utilize the following procedure.

1. Pressure transducers, accelerometers and sound levels meters will be installed in and around the pump(s) and station piping in the following orientation:
 - a. Accelerometers will be glued to the vent valves in the proximity of at least one pump at the station.
 - b. Accelerometers will be glued to the bearing housings of one of the pumps.
 - c. Pressure transducers (both dynamic and static) will be installed at available taps upstream and downstream of the pumps (as well as in the crossover, if available) to determine pulsation levels and static pressure levels in the system.
 - d. One or more sound level meters will be placed at appropriate locations in and around the pumps and piping to evaluate the noise levels at the station.
2. Various process parameters that are monitored by permanently installed transmitters (pressures, motor currents, etc.) will be measured and recorded during testing.
3. If the station has multiple pumps, it is sufficient to attach most of the transducers to one pump.
4. Station flow will be measured using an ultrasonic (transit-time) type flow meter.
5. Running speed of the pump(s) will be measured using a laser tachometer aimed at reflective tape attached to the motor shaft(s).
6. Up to 32 channels of data will be continuously recorded for the duration of the testing. The data will be recorded at a sample rate of 10,000 samples per second, which is sufficient to capture the dynamic content of interest in the signals. The recorded data can later be analyzed in different ways to further evaluate the system.
7. The pressure, horsepower and flow will be used to determine the operating point of each pump on the performance curve during the testing periods.
8. If there is only one pump at a station, it will be operated over the full operating speed range while all data is recorded. If multiple pumps are present at the station, and two of these pumps can run simultaneously, then various combinations of pump operation will be performed:
 - a. Speed sweep of Pump 1 with all other pumps shutdown.
 - b. Speed sweep of Pump 2 with all other pumps shutdown.
 - c. Start Pump 1 while Pump 2 is running at maximum speed (bypass mode).
 - d. Start Pump 2 while Pump 1 is running at maximum speed (bypass mode).
 - e. Run both pumps at maximum speed (bypass mode) while the pressure drop across the pressure control valve is varied.

9. Impact tests will be performed on piping and pump bearing housings (all pumps must be shut down for this testing). This testing will help identify natural frequencies in the system. The results of this testing will identify if there are any areas of concern at the station (vibration, sound, etc.), as well as help identify the cause(s) (pulsation, mechanical excitation, etc.)
10. If the testing indicates that one of more of the branch connections has vibration levels that exceed the screening criteria of 1.4 inches per second (see Figure 1), it may be necessary to install strain gages at the location(s) of concern to evaluate the dynamic strain caused by the vibration. Additional operational testing with the strain gage(s) would then be performed. The procedure that EDI uses for qualification of strain measurements is from the ASME Boiler and Pressure Vessel Code 2010 (with 2011 Addendum), Section III – Division 1. If significant strain is identified, based on criteria supplied by EDI (pipe size and material dependent), ONEOK will initiate further non-destructive testing and repairs, if necessary.

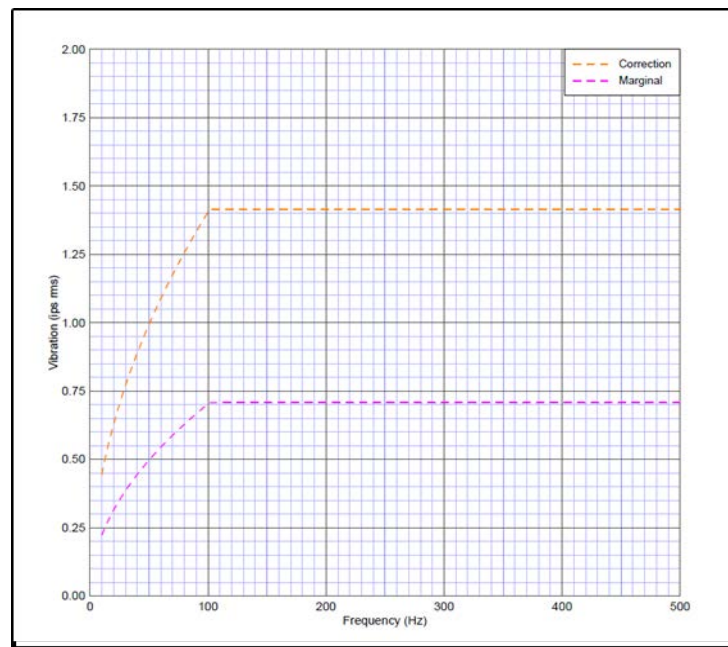


Figure 1

11. Areas of high vibration (if any are identified in the testing) will be evaluated to determine if additional supports are necessary to limit vibration below the screening criteria.
12. After testing is complete, Engineering Dynamics Incorporated will assist in responding to the Item #5 of the Notice by:
 - a. Recommending several potential courses of action to mitigate any identified problem areas.

- b. After any mitigating procedures have been implemented, Engineering Dynamics Incorporated will assist ONEOK in confirming the effectiveness of the changes. This step may involve review of new support designs proposed by ONEOK, as well as performing additional operational testing to confirm that the changes were effective.

PHMSA Notice Item #5:

Based on the results of Item 4, ONEOK must submit to the PHMSA Southwest Region Director a written plan and schedule to implement the specific measures selected by the Operator to mitigate the integrity threat caused by the vibration. The plan must be approved by the PHMSA Southwest Region Director prior to the commencement of work. The plan may propose a limited implementation followed by monitoring and testing to ensure the effectiveness of the measures. However, ONEOK must complete testing and implementation of the selected mitigative measures at all affected locations within one year of the Order. If a limited implementation is first proposed to confirm the effectiveness, subsequent required implementation plans must be submitted to the Southwest Region for approval within 30 days after the confirmation period.

Upon completion of the testing at the selected locations outlined in Item #4, ONEOK will evaluate the findings with its independent consultants and submit to the Region Director any subsequent plans that may be necessary.

Summary

ONEOK hopes that PHMSA will find our response satisfactory in addressing Items #1, #4 and #5 of the Notice.