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"Clear Knowledge in the Over Information Age"

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To: Mr. Casey LaLonde
Township Manager
West Goshen Township
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Re: Accufacts Report on the Mariner East 2X Pipeline Affecting West Goshen Township

1. Introduction.

Accufacts Inc. ("Accufacts") was asked to assist West Goshen Township ("WGT") in evaluating the Energy Transfer/Sunoco ("ET") pipeline project identified as Mariner East 2X, a newly constructed 16-inch pipeline most of which within WGT is X-70 grade steel with a wall thickness of 0.438 inches. ME 2X is rated for a maximum operating pressure, or MOP, of 1480 psig, an important pipeline parameter that I will expand on later in this report.[1] Within WGT, ME 2X approximately parallels the repurposed 8-inch ME 1 and new 20-inch ME 2 liquid transmission pipeline right-of-ways ("ROWs"). All three pipelines are intended to be operated separately moving highly volatile liquids, or HVLs, (i.e., ethane, propane, and butane), east from western Pennsylvania. There are no pipeline safety regulatory restrictions limiting what is moved in any of the three pipelines at any time. I have previously reported on the ME 1 and the ME 2 projects as they cross WGT, as well as a temporary repurposed 12-inch pipeline connecting a previously installed western segment of ME 2 to a completed eastern segment of ME 2X not within WGT.[2]

Accufacts has a long history of providing specialized neutral technical and safety expertise in such highly sensitive matters as pipeline siting, design, operation/maintenance, emergency response, control room management, integrity management, and pipeline safety regulatory

[1] 49CFR§195.2 Definitions.
[2] Accufacts public reports to WGT Township Manager, Mr. Casey LaLonde, "Accufacts Report on Mariner East Project Affecting West Goshen Township," dated March 6, 2015, "Accufacts Report on Mariner East 2 Expansion Project Affecting West Goshen Township," dated January 6, 2017, and "Accufacts report on the repurposing of an existing 12-inch Sunoco pipeline segment to interconnect with the Mariner East 2 and Mariner East 2X crossing West Goshen Township," November 8, 2018.

development, especially as it relates to HVLs. HVLs are a category of liquids given special definition in minimum federal pipeline safety regulations that are transported in pipelines as liquids, but that can eventually form vapor clouds when released to the atmosphere.

Accufacts performed a review of the 16-inch ME 2X. This report is limited to the segments of the pipeline that could affect WGT. As in the other pipeline reviews related to WGT, Accufacts was required to sign a Nondisclosure Agreement ("NDA") with ET that prevents Accufacts from disclosing certain sensitive nonpublic information. Certain additional information and equipment physically outside of WGT, such as mainline valves, metering, and an upstream pump station that serves ME 2X, required greater detail to allow me to complete an independent engineering analysis. A review of supplied information about the sole pump station outside of WGT, leads me to conclude ET's design and operational approach are reasonable to avoid pipeline overpressure.

2. Key Observations concerning ME 2X and WGT:

2a) Most of ME 2X Crossing WGT is Installed via HDD.

Similar to ME 1 and ME 2, the ME 2X crosses, based on reported station number readings, 1.14 miles of WGT in approximately the same general surface location, next to or near the earlier ME 1 pipeline ROW which has existed for decades, though the older 8-inch pipeline was repurposed for HVL service. For the ME 2X installation, the pipeline is installed as a buried new 16-inch pipeline across WGT. The vast majority of ME 2X spanning WGT (over 95%) is installed using horizontal directional drilling, or HDD, as compared to the open cut trenching method of pipeline installation. HDD involves directional drilling technology, usually from two different surface locations spanning the pipe installation, increasing various diameter bores underground in reaming passes to allow a pipe to eventually be pulled through a final bore that is larger in diameter than the pipeline.

Open cut trenching is the more widely used method of pipeline installation and involves cutting a trench at the surface into the earth and then laying the pipe into the open trench which is then buried. Open cut trenching requires disturbing the surface along the pipeline ROW. HDD tends to place the majority of the pipeline much deeper than open-cut trenching. Underground soil conditions, such as Karst, can limit the success of HDD, and not all HDDs can be successfully accomplished. While not necessarily required, it is not unusual for pipelines installed via HDD to incorporate thicker pipe and include additional coating protections to help protect the external pipe coating from possible abrasion (e.g., Powercrete©) during the HDD installation. In the case of the ME 2X spanning WGT, the pipe installed is thicker and the external coating of fusion bonded epoxy is covered with an abrasive resistant material.

One advantage of pipelines installed via HDD is that the majority of the pipeline is installed fairly deep, given the need to limit the radius at each bend of the HDD bore. The depth of the majority of the HDD limits threats from most forms of third-party damage potential to the pipeline, but not all. From a review of the provided ET alignment sheets, there appears within WGT sufficient separation distance from the other nearby ME 2 pipeline installed via HDD to avoid interactions that could impact either pipeline.

2b) <u>ME 2X Girth Weld Assessment and Pipeline Hydrotesting Exceeds Federal Minimum Pipeline Safety Regulations.</u>

Pipe steel, even pipe steel manufactured many decades ago, does not age nor wear out in the traditional sense. Other time dependent threats, however, can weaken the steel and age is not the leveraging factor, though pipe vintage can play an important role in determining which threats might exist leading to pipeline failure. No matter the age or the type of pipe steel, there is no steel pipeline invincible to threats that can result in its failure, either as leaks or the more dangerous larger opening ruptures. Ruptures are large rate pipeline releases driven by the fluid properties within the pipeline and pipe fracture mechanics. Pipe threats are evaluated utilizing such factors as the type of anomaly, its size, alignment, location, depth, interaction and growth potential in pipeline steel or welds that might eventually result in failure with time.

Federal regulations require that at least ten percent of girth welds be assessed by radiological means.[3] Radiological assessments, such as ultrasound, x-ray, or gamma ray, allow an internal inspection within the weld to determine weld quality without destroying the sample. Because of the alignment of hoop stress (circumference around the pipe), with their associated lower stress for a given pressure within a pipeline, hydrotesting cannot adequately assess a girth weld to the quality of that associated with radiological assessment. As a result, more prudent pipeline operators require one-hundred percent assessment of girth welds via nondestructive testing coupled with appropriate quality assessment and quality control ("QA/QC") measures. Proper post weld heat treatment can also remove pipe metal changes that can affect pipe at the weld heat affect zones, or HAZs, near the weld joint that can result in cracking failure at a later date. One of the important principles driving transmission integrity management federal pipeline safety regulations is to identify pipeline threats that might cause failure in certain segments, and periodically assess and, if necessary, remediate (i.e., replace or repair) such pipe well before its failure. Thicker pipe does not prevent pipeline failure from certain threats such as corrosion, but thicker pipe increases the time to failure depending on the type of threat.

One mechanism to verify integrity of mainline pipe in transmission pipelines is a hydrotest that pressure tests a pipeline with water to verify its integrity at a certain pressure. The level of

[3] 49CFR§195.234 Welds: Nondestructive testing.

hydrotest pressure is also utilized for liquid transmission pipelines to establish the maximum operating pressure, or MOP, a pressure at which a pipeline may be normally operated.[4] Federal regulations establish a minimum hydrotest pressure/testing protocol that proves a twenty-five percent safety margin above the MOP at the time of the hydrotest.

2c) Higher Pressure Hydrotesting Has Increased ME 2X Pipeline's Pressure Safety Margin Well Above That Required by Federal Regulations.

The high pressure hydrotest performed on ME 2X demonstrates that ME 2X has a pressure safety margin well in excess of minimum hydrotesting requirements for a 1480 psig MOP. There may be anomalies, or imperfections, in the pipe after such high pressure hydrotests, but such remaining imperfections will be very small, such that considerable time would be needed to grow to failure. After a hydrotest, various threats can work to reduce this hydrotest margin of safety over time, even to the point that pipelines can fail well below MOP. ET has demonstrated that, given various factors such as pipe grade, quality, thickness, and welding techniques for mainline pipe, it understands the safety benefits of a much higher pressure hydrotest incorporating not only higher test pressures, but additional prudent hydrotesting protocols beyond minimum federal pipeline safety regulations for new pipeline construction. Such higher pressure hydrotesting and additional protocols after new construction verifies the integrity of the pipeline with safety factors well above the twenty-five percent established by minimum federal pipeline safety regulation. It is important to recognize that no steel pipeline is invincible to failure, and a prudent pipeline operator should stay well informed and implement prudent periodic integrity assessment methods to identify anomalies that might go to failure on different segments of their pipeline. There are no pipelines, even new pipelines, that are anomaly free, but most anomalies do not rise to the level of a failure threat needing remediation if integrity assessments have been prudently matched to possible pipeline threats for a particular pipeline segment.

2d) The Quandary of High Pressure Hydrotesting.

While high pressure hydrotesting incorporating testing protocols well above and beyond those defined in current minimum federal regulations verifies the integrity of a pipeline at the time of hydrotesting, an interesting quandary is created from such higher-pressure testing. Depending on the pipeline system design and installation, high pressure hydrotesting permits the pipeline operator, if the opportunity presents itself, to increase MOP in the future without performing another hydrotest during the life of the pipeline. Usually other factors, such as pipe flange specification breaks, pump station design, etc., introduce financial considerations as to whether such MOP increase is a likely option.

[4] 49CFR§195.406 Maximum Operating Pressure.

Technically, the hydrotest I have reviewed would permit MOP of the mainline to be increased to approximately 2130 psig. Such high MOPs are authorized pursuant to federal pipeline safety regulations. An analysis of the Pipeline and Hazardous Material Safety Administration ("PHMSA") liquid transmission pipeline incident database will indicate some liquid transmission pipelines, even HVL pipelines, operate at these high MOP pressure levels.

The initial design of the ME 2X pipeline will involve one pump station located at Delmont, PA approximately 240 miles upstream of WGT. Based on additional information provided by ET, it would be fairly easy and cost effective to connect some existing ET pump stations along the ME 2X ROW to increase flow on ME 2X without increasing the MOP above 1480 psig. In my judgment and pipeline experience, an increase in MOP beyond 1480 psig cannot be ruled out, but in the near future is not likely.

2e) <u>Pipeline Mainline Valves and Automatic/Remote Actuation/Monitoring.</u>

The ME 2X pipeline crossing WGT contains no mainline valves within the Township. The ME 2X valve directly upstream of WGT is a remotely operated valve located at the Exton Bypass, approximately 1.3 miles from WGT's west boundary. The nearest downstream valve is also a remotely operated valve approximately 5.9 miles downstream of WGT's eastern boundary. The previous valves are powered in such a manner that they can be locally closed or remotely commanded from the control room. The ME 2X main line valves spanning WGT can also be automatically closed utilizing similar computer monitoring and pipeline system shutdown logic utilized in ME 1. ME 1 has been in HVL service approximately five years and the mainline valve automatic control logic has been generally described in my previous report.[5] The span of ME 2X pipeline segment between the two remotely operated mainline valves across WGT is approximately 8.4 miles long. For a 16-inch pipeline, product inventory is approximately 1,100 barrels/mile.

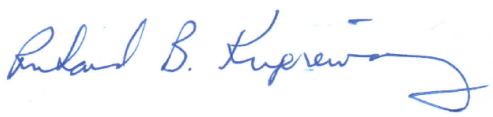
The remote monitoring, various remote release detection systems, and shutdown computer logic utilized for ME 2X are very similar to that utilized on the ME 1 and the ME 2 pipelines. As in ME 1 and ME 2 operation, and discussed in my previous reports for WGT, the control room operator overseeing, monitoring, and controlling pipeline operations plays a critical role in ME 2X pipeline emergency contact and pipeline isolation and related emergency response/communication protocols.

[5] Accufacts public report to WGT Township Manager, Mr. Casey LaLonde, "Accufacts Report on Mariner East Project Affecting West Goshen Township," dated March 6, 2015, p. 7 of 12.

3. Accufacts' Summary.

As discussed above, the important girth weld assessment and new construction high pressure hydrotesting protocols utilized by ET assure from the onset a pipeline of initial high integrity, especially for an MOP operation of 1480 psig. ET's integrity management program must be highly tuned to identify and deal with much smaller pipeline anomalies that could possibly result in pipeline failure over time. Such anomalies remaining after the initial high pressure hydrotest are not likely to grow to failure in the early years of operation though prudent periodic integrity management reassessments are warranted given the consequence of an HVL release.

My current understanding of ME 2X is that only one pump station (Delmont, PA) is providing pressure to move liquid HVL roughly 270 miles down the ME 2X pipeline for delivery to the Twin Oaks and Marcus Hook Storage facilities. This unusual one pump station setup for such a long segment of downstream pipeline results from a lower capacity/throughput need for the initial ME 2X project. ME 2X is apparently built with the ability to increase throughput via connection with some of the nearby existing pump stations along the ROW. While sufficient capacity increase can be realized from additional pump station interconnects along ME 2X, the high pressure hydrotest performed at construction gives the pipeline operator the opportunity to increase MOP over the long lifecycle of the pipeline without another hydrotest, should such a financial opportunity become available, such as a change in service.



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