PIPING NEWS

A Newsletter published by W. M. Huitt Co.
for designers and engineers involved with process piping

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FIRE PREVENTION THROUGH DESIGN

(Continued from last month)

Piping Joints

When designing piping systems containing hazardous fluids one of the key objectives for the design engineer should be in consideration of taking the necessary steps to minimize the threat of a leak; steps beyond those typically necessary in complying with the minimum requirements of a Code. There are certainly other design issues that warrant consideration, and they will be touched on much later. However, while the pipe, valves, and instrumentation all have to meet the usual criteria of material compatibility, pressure, and temperature requirements there are added concerns and cautions that need to be addressed.

Those concerns and cautions are related to the added assurance that hazardous fluids will stay contained within their piping system during normal operation and for a period of time during a fire, as expressed in such Standards as API-607, FM-7440, and BS-6755-2. Designing a system, start to finish, with the intent to minimize or eliminate altogether the potential for a hazardous chemical leak to occur will greatly help in reducing the risk of fire. If there is no fuel source there is no fire. In the design of a piping system leak prevention begins with an assessment of the piping and valve joints.

To elaborate and help clarify the previous point, let me say this: There are specified minimum requirements such as component rating, examination, inspection, and testing that are required for all fluid services. Beyond that, there is no guidance given for fire safety with regard to the piping Code other than a statement in B31.3 Para. F323.1 in which it states, in part:

The following are some general considerations that should be evaluated when selecting and applying materials in piping: (a) the possibility of exposure of the piping to fire and the melting point, degradation temperature, loss of strength at elevated temperature, and combustibility of the piping material under such exposure. (b) the susceptibility to brittle failure or failure from thermal shock of the piping material when exposed to fire or to fire-fighting measures, and possible hazards from fragmentation of the material in the event of failure (c) the ability of thermal insulation to protect piping against failure under fire exposure (e.g., its stability, fire resistance, and ability to remain in place during a fire).

The Code does not go into specifics on this matter. It is the engineer's responsibility to raise the compliance level requirements to a higher level where added safety is warranted, and to define the compliance criteria in doing so.

Joints in a piping system are its weak points. All joints, except for the full penetration buttweld, will de-rate a piping system to a pre-determined or calculated value based on the type of joint.

This applies to pipe longitudinal weld seams, circumferential welds, flange joints, and valve joints such as the body seal, stem packing, and bonnet seal, as well as the valve seat.

For manufactured longitudinal weld seams refer to ASME B31.3 Table A-1B for quality factors (*Ej*) of the various types of welds used to manufacture welded pipe. The quality factor (*Ej*) is a reduction, as a percentage, of the strength value of the longitudinal weld in welded pipe. It is used in wall thickness calculations as in the following equations for straight pipe under internal pressure, B31.3, para. 304.1.2:

$$t = \frac{PD}{2(SEW + PY)} \qquad (3a)$$

$$t = \frac{P(d + 2c)}{2[SEW - P(1 - Y)]} \qquad (3b)$$

Where:
c = sum of mechanical allowances
D = outside diameter of pipe
d = inside diameter of pipe
E = quality factor from Table A-1A and A-1B
P = internal design gage pressure
S = stress value for material from Table A-1
W = weld joint strength reduction factor
y = coefficient from Table 304.1.1

Also found in Para. 304 of B31.3 are wall thickness equations for curved and mitered pipe.

With regard to circumferential welds, the designer is responsible for assigning a weld joint reduction factor (*W*) for welds other than longitudinal welds.

What we can do, at least for this discussion, is to provide some quality ranking for the various circumferential welds based on the stress intensification factor (SIF) assigned to them by B31.3. In doing so, the full penetration buttweld is considered to be as strong as the pipe with a SIF = 1.0. The double fillet weld at a slip-on flange has a SIF = 1.2. The socket-weld joint has a SIF = 2.1. Any value in excess of 1.0 will de-rate the strength of the joint below that of the pipe. With that said, and assuming an acceptable weld, the weld joint, and in particular, the full penetration buttweld, is still the joint with the highest degree of integrity. In a fire the last joint type to fail will be the welded joint.

The threaded joint has a SIF = 2.3 and requires a thread sealant applied to the threads, upon assembly, to maintain seal integrity. With flame temperatures in a fire in the neighborhood of 2700ºF (1482ºC) to 3000ºF (1649ºC) the thread sealant will become completely useless if not vaporized leaving bare threads with no sealant to maintain a seal at the joint.

The flange joint sealing integrity, like the threaded joint, is dependent upon a sealant, which, unlike the threaded joint, is a gasket. Flange bolts act as springs and will provide a constant applied load so long as all things remain constant. Should the gasket melt or flow, due to the heat of a fire, that initial tension that was given the bolts when the joint was assembled will be lost. Once that bolt tension is lost and the gasket has lost its resilience under the heat of a fire the joint will leak.

Knowing that the mechanical type threaded and flange joints are the weak points in a piping system, and the primary source for leaks, it is suggested that they be minimized to the greatest extent possible.

Threaded joints should be limited to instrument connections and then only if the instrument is not available with a flange or welded connection. If a threaded connection is used it should be assembled without thread compound then seal-welded. This may require partial dismantling of the instrument to protect its instrumentation from the heat of the welding process. Then reassembly of the instrument after welding has been completed.

It is recommended that piping systems be welded as much as possible and flanged joints be minimized as much as possible. If flanged joints are necessary for connecting to equipment nozzles, flanged valves, in-line components, or needed for break-out joints, it is suggested that a spiral wound type gasket with graphite filler be specified. This type of material can withstand temperatures upwards of 3000ºF. There are also gasket designs that are suitable for when a fluoropolymer material is needed for contact with the chemical, while also holding up well in a fire. These are gaskets similar in design to that shown in Fig. 1. It is still preferable to make the piping system an all welded system except for equipment and instrument connections, and that includes using welded end valves and in-line components where possible.

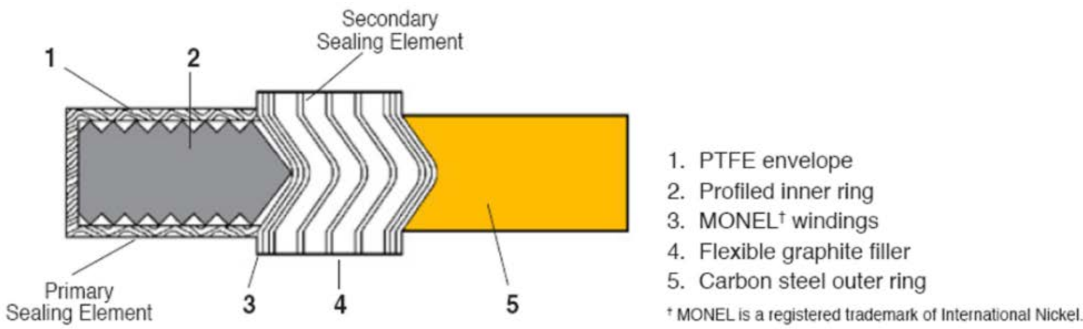

Figure 1 – Fire Safe Spiral Wound Type Gasket

Valves

A fire-safe rated valve meeting the requirements of API 607 – Fire Test for Soft Seated Quarter Turn Valves is designed and tested to assure the prevention of fluid leakage both internally along the valve's flow path, and externally through the stem packing, bonnet seal, and body seal (where a multi-piece body is specified).

Testing under API 607 subjects a valve to well defined and controlled fire conditions. It requires that after exposure to the fire-test the valve shall be in a condition that will allow it to be rotated from its closed position to its fully open position using only the manual operator fitted to the test valve.

Quarter turn describes a type of valve that goes from fully closed to fully open within the 90º rotation of its operator. It includes such valve types as ball, plug, and butterfly having a valve seat material of a fluoropolymer, elastomer, or some other soft, non-metallic material.

Standards such as FM-7440 and BS-6755-2, touched on earlier, apply to virtually any valve type that complies with their requirements. Under the FM and BS Standards valve types such as gates, globes, and piston valves with metal seats can also make excellent fire-safe valves when using a body and bonnet gasket and stem packing material similar to a graphite.

Process Systems

At the onset of a fire within an operating unit the initially unaffected process piping systems should not be a contributor to sustaining are spreading what is already a potentially volatile situation. There are basic design concepts that can be incorporated into the physical aspects of a process system that will, at the very least, provide precious time for operators and emergency responders to get the situation under control. In referring to the simplified flow diagram in Fig. 2 (next page) there are seven main points to consider:

1 Flow supply (Line A), coming from the fluid's source outside the operating unit, needs to be remotely shut off to the area that is experiencing a fire,
2 Valve (VA-1) at the pipelines termination at the vessel needs to remain open,
3 The flow path at drain valve (VA-2) needs to remain sealed,
4 The external path through stem packing and body seals needs to remain intact during a fire,
5 The bottom outlet valve (XV-2) on a vessel containing a flammable liquid should have an integral fusible link for automatic shut-off, with its valve seat, stem packing, and body seals remaining intact during a fire, and

6 Pipeline A should be sloped to allow all remaining liquid to drain into the vessel.
7 The liquid in the vessel should be pumped out to a safe location until the fusible link activates, closing the valve. There should be an interlock to notify the control room and to shut down the pump when the fusible link valve closes.

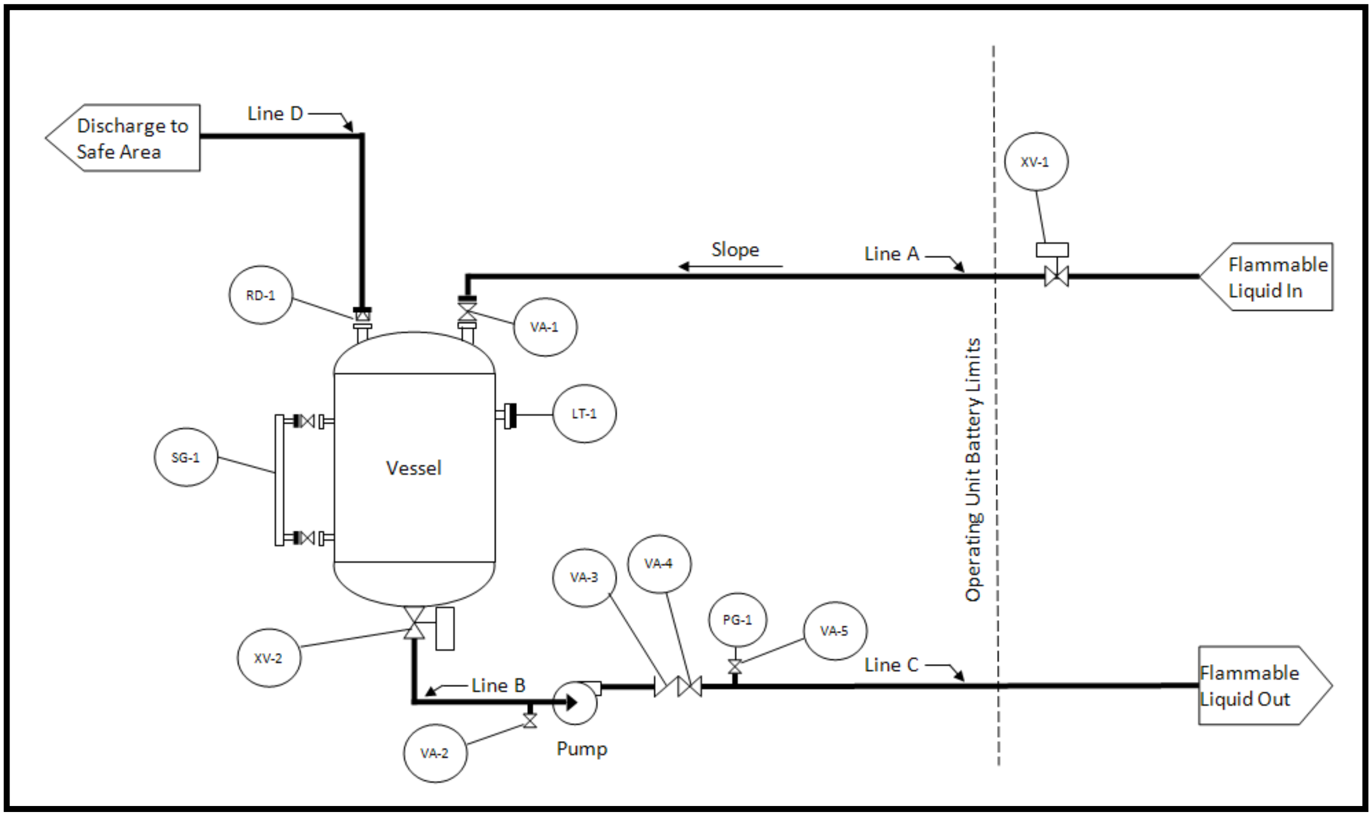

Figure 2 – Simplified P&ID

Those seven points, with the help of the flow diagram in Fig. 2, are explained as follows:

Point 1: The supply source, or any pipeline supplying the operating unit with a flammable liquid, should have an automated, fire-safe isolation valve (XV-1) located outside the building or operating unit area and linked to the unit's alarm system with remote outside on/off operation (From a safe location) at a minimum.

Point 2: Any block valve (VA-1) at a vessel should remain open during a fire. The area or unit isolation valve (XV-1) will stop further flow to the system, but any retained or residual fluid down-stream of the automatic shut-off valve needs to drain to the vessel where the increasing overpressure will be relieved to a safe location, such as a flare stack, through RD-1. If the Valves VA-1 and XV-1 are closed in a fire situation the blocked in fluid in a heated pipeline will expand and potentially rupture the pipeline; first at the mechanical joints such as seals and packing glands on valves and equipment, as well as flange joints, and then ultimately the pipe itself will rupture (catastrophic failure). During a fire expanding liquids and gases should have an unobstructed path through the pipeline to a vessel that is safely vented.

Point 3: Valves at vents and drains (VA-2) need to be fire-safe and remain closed with seals and seats intact for as long as possible during a fire.

Point 4: During a fire another source for valve leakage is by way of stem packing and body seal, as mentioned earlier. Leakage, at these seal points, can be prevented with valves that are not necessarily fire-safe rated, but contain stem packing and body seal gasket material specified as some acceptable form of graphite (flexible graphite, graphoil, etc.). This is a fire-safe material which is readily available in non-fire-safe rated valves.

Point 5: The valve on the bottom of the vessel should be fire-rated with a fusible link or a Fail Closed position. Relying on an air or electric operated valve actuator may not be practical. A fusible link is most certainly needed on a manually operated valve. The content of a vessel containing a hazardous liquid needs to get pumped to a safe location during a fire until such time as the fusible link is activated, closing the tank bottom valve. All valved gage and instrument connections (SG-1) mounted on a vessel should have a graphite type stem packing and body seal gasket material at a minimum. Flange gaskets at these gage and instrument connections should be spiral wound fire-safe type gaskets similar to those mentioned earlier. Specialty tank-bottom valves (XV-2) should be given special consideration in their design by considering a metal-to-metal seat, or a piston valve design along with fire rated seal material.

Point 6: As mentioned in Point 2, the residual fluid in Line A, after flow has been stopped, should be drained to the vessel. To help the liquid drain, the pipeline should be sloped toward the vessel. The intent, as mentioned above, is to prevent sections of any pipeline, not containing a relief device, from being blocked and isolated during a fire. If the piping system for a flammable fluid service is designed properly the contents will be able to drain or expand into a vessel where over-pressurization can be relieved and safely vented.

Point 7: It will be necessary to evacuate as much of the hazardous fluid as possible from tanks and vessels in the fire area to a safe location. The pump-out should continue until there is insufficient pump suction head, or until the fusible link on XV-2 is activated. At that time the pump interlocks would shut down the pump.

With regard to tank farms, the following is a suggested minimum: Drain valves should be a fire-safe type valve. Outlet valves should be a fire-safe type valve with a fusible link. Tank nozzles used for gages or instrument connections should have, at a minimum, valves containing stem packing and seal gasket material specified as some acceptable form of graphite, as mentioned above, or some other fire rated material. Gaskets used at nozzle flange joints should be a fire-safe gasket similar to the spiral wound gaskets mentioned earlier or the gasket shown in Fig. 1.

In-line valves downstream of the tank outlet valve, such as pump transfer lines and recirculation lines, do not necessarily need to be fire-rated, but should have stem packing and seal gasket material that is fire-safe as mentioned earlier.

To reiterate the specific Points made above, they include the following:

1. Use welded connections to the maximum extent possible, and minimize flange joints throughout the piping system for flammable fluids.
2. Where flange joints are required use a fire-safe spiral wound type gasket.
3. Threaded joints should be relegated to instrument connections, and then only when a flanged or welded instrument is not available,
4. In making a threaded connection, do so without thread compound, then seal-weld,
5. The supply line of a flammable fluid should have an automated on/off fire-rated valve installed prior to entering the building or operating unit battery limits. The valve should have an interlock with the fire alarm system and have remote, on/off, operation from a safe location.
6. All valves in a flammable fluid service inside a building or operating unit should be either:

a. A fire-rated valve used at the following locations:
   i. Vents and drains
   ii. Tank bottom
   iii. Any location where the valve is required to be in a closed position during a fire to maintain a blocked flow path
b. A non-fire-safe valve with fire-safe type stem packing and body seal gasket material used at the following locations:
   i. Any location other than those described in a. above.

7. All hazardous service valves inside a building or operating area should either have welded ends (preferred) or flanged ends with a fire-safe, spiral wound type gasket at the flange joint.
8. There may be exceptions, but generally all in-line valves (not vents, drains or source shut-off) should be in the open position during a fire with all residual fluid able to drain freely toward a vessel with a relief device that is vented to a safe location.
9. For a vessel containing a flammable liquid a fire-safe tank-bottom valve with a fusible link, when possible, should be used.
10. The liquid inside vessels and tanks, at the onset of a fire, should be pumped to a safe location until the fusible link is activated, closing the valve.
11. Valved gage and instrument connections should have valves with a fire-safe type stem packing and body seal gasket material, at a minimum.
12. Each flange joint for flanged gage and instrument connections should use a fire-safe spiral wound type gasket.
13. Outside tank farms should have a fire-safe valve connected directly to each nozzle located below normal liquid level with the exception of gage or instrument connections.
14. Each tank outlet valve (does not include drain valves) should have a fusible link.
15. Gage and instrument nozzles should have, at a minimum, valves that have stem packing and body seal material made of a fire-safe type material.
16. Fire-safe spiral wound type flange gaskets should be used at all flange nozzles, gage and instrument connections.
17. All other valves installed in tank farm piping should, at a minimum, have a fire-safe type material specified for stem packing and seal gasket material.

And Finally

Situations will arise that do not fall neatly into those described above. If there is any doubt with regard to valving, default to a fire-rated valve. Each piping system identified as needing to be fire-safe should be designated as such.

Where individual fire-safe valves are to be strategically located in a system, they should be designated on their respective P&ID's either by notation or through the assigned pipe material specification.

With the pipe material specification indicated on each pipeline of the P&ID, the specification itself should be descriptive enough for the designer to know when a fire-safe valve is called out. And further, if a fire-safe valve should be called out on the P&ID, but is not, it needs to be pointed out to the proper individual.■

ASME B31.3 and BPE MEETINGS

The ASME B31.3 Process Piping Committee meets two times each year and the BPE Committee meets three time each year. This year their Meetings, which are open to the public, will be held as follows:

B31.3 Process Piping Committee Meetings

Fall 2019

September 16-18, 2019 – Monday-Wednesday, with B31 Code Week

Venue & Location: (cont.)

B31.3 Process Piping Committee Meetings

Venue & Location:

Lord Baltimore Hotel
http://www.lordbaltimorehotel.com
20 West Baltimore Street
Baltimore, MD, United States

Spring 2020

April 06 2020 08:30 AM - April 08 2020 05:00 PM, Monday - Wednesday

Venue & Location:

Royal Sonesta New Orleans
https://www.reservationcounter.com/hotels/show/6123778/royal-sonesta-new-orleans-new-orleans-la/
300 Bourbon Street
New Orleans LA, United States

Bioprocessing Equipment (BPE) Committee Meetings

Fall 2019

September 09 2019 08:00 AM to September 12 2019 12:00 PM, Monday - Thursday

Venue & Location:

Lord Baltimore Hotel
http://www.lordbaltimorehotel.com
20 West Baltimore Street
Baltimore, MD, United States **Winter 2020**

January (Dates TBD)

Venue & Location:

Caribe' Hilton
https://www.caribehilton.com/
1 San Geronimo Street
San Juan, Puerto Rico 00901

Spring 2020
May 18, 2020 08:00 AM to May 21, 2020 12:00 PM, Monday - Thursday

Venue & Location:

Royal Sonesta New Orleans
https://www.reservationcounter.com/hotels/show/6123778/royal-sonesta-new-orleans-new-orleans-la/

Venue & Location:

Lord Baltimore Hotel
http://www.lordbaltimorehotel.com
20 West Baltimore Street
Baltimore, MD, United States **Winter 2020**

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1 San Geronimo Street
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Venue & Location:

Royal Sonesta New Orleans
https://www.reservationcounter.com/hotels/show/6123778/royal-sonesta-new-orleans-new-orleans-la/
300 Bourbon Street
New Orleans, Louisiana, USA

DRONES: AN EVOLVING INDUSTRIAL ASSET?

Stuttgart, September 2019, INTERAERIAL EXPO

Seeing the above advertisement for an expo on UAV's (Unmanned Aerial Vehicles) and UAS's (Unmanned Aerial Systems) put me on notice that the practical and essential use of drones in the chemical process industry (CPI) has not only arrived, it's arrived like a freight train. It now becomes a matter of industry, not just the FAA (Federal Aviation Administration), getting a handle on this quickly evolving asset.

UAV's, better known as drones, are being used for plant security, stockpile inventory estimates, unmanned access into tanks and pressure vessels, thermal inspections, corrosion inspections, inspection of pipe supports, inspection of building support steel on open air structures, pipeline inspections, and so much more. Drones are now being lumped in with robotics when we talk about applying robotics to high risk conditions for inspecting equipment. Work in performing inspections in precarious elevated conditions such as atop a 200 foot plus tall wind turbine.

OSHA (Occupational Safety and Health Administration) is already taking advantage of this relatively new technology in writing an 8 page memorandum dated May 18, 2018.that states in its first paragraph under the Subject line: OSHA's use of Unmanned Aircraft Systems in Inspections, that, “This memorandum addresses the use of Unmanned Aircraft Systems ("UAS" or "drones") by OSHA. UAS may be used to collect evidence during inspections in certain workplace settings, including in areas that are inaccessible or pose a safety risk to inspection personnel. UAS may also be used for technical assistance in emergencies, during compliance assistance activities, and for training. As a Federal agency, there are currently two legal frameworks available to OSHA under Federal Aviation Administration (FAA) rules for the use of UAS, either as a Public Aircraft Operator (PAO) flying missions that meet the governmental functions listed in the Public Aircraft Statute [Qualifications for public aircraft status] (49 U.S.C. §§ 40102(a)(41) & 40125), or as a Civil Operator under the civil rules [for Small Unmanned Aircraft Systems] (14 CFR part 107).”

Under 14CFR part 107 the following terminology is defined as follows:

- **Control station:** an interface used by the remote pilot to control the flight path of the small unmanned aircraft.
- **Corrective lenses:** spectacles or contact lenses.
- **Small unmanned aircraft:** an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.
- **Small unmanned aircraft system (small UAS):** a small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system.
- **Unmanned aircraft:** an aircraft operated without the possibility of direct human intervention from within or on the aircraft.
- **Visual observer:** a person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground.

With such prolific use of drones by the government, the military being at the forefront in the use of this technology, and their acceptance as an advanced technological tool by companies in the oil & gas industries, the chemical processing industries, mining industries, and the geotech industry, standards developers such as the American Petroleum Institute (API) and the American Society of Mechanical Engineers (ASME) are making a full throated effort at trying to catch up and get ahead of this technology in its application for inspection purposes.

It has become obvious that this method of visual inspection can greatly reduce the risk to inspection personnel. By eliminating, to the extent possible, the need for personnel to enter closed spaces or climb to perilous heights in an effort to perform an inspection is, on its own merits, worth the investment.

This past June API published the “API Guide to Developing an Unmanned Aircraft Systems Program." This guide is written from the view point of the 30,000 foot level. Meaning that it does not get into the “how-to” weeds of the discussion, but instead provides points of consideration for anyone preparing to get into the weeds of developing processes and procedures for a drone program. And there is much to consider. The FAA rules being the most obvious considerations, as pointed out in the OSHA memorandum presented earlier.

ASME has created a Special Working Group (SWG) under Sect. V titled "Special Working Group on the Use of Unmanned Aerial Vehicles/Systems for Inspection (BPV V)." Its Charter reads as follows: “Develop, review and maintain guidelines, standards for requirements and methods for industrial plant (e.g. power, petrochemical, manufacturing, etc) inspection using safe and reliably operating unmanned aerial systems/unmanned aerial vehicles (UAS/UAVs).” It is intended that this SWG will eventually evolve into its own standard once it has a fully developed program.

City governments typically kick the can down the road when it comes to putting traffic lights in the budget for at an intersection. That is, until a fatal accident finally lights a fire under someone’s posterior to do something. But, as you can see, unlike such city governments, American Standards Developers (ASD), like ASME and API, make every attempt to stay ahead of the curve as it relates to personnel safety, the ever changing world of industry, and its fast-paced changes in technology.

Volunteer groups within these ASD’s are already positioning themselves to do a deep dive into ways in which we can utilize drones in the best, most efficient, and safest way possible.■

IN THE SEPTEMBER 2019 ISSUE

The Philosophical Intent of Codes

In making an earnest attempt at complying with code or standard requirements, whether it’s B31.3, B31.1, BPE, NFPA, or any of the other myriad codes & standards that are published, there will be times when a circumstance skirt specific rules and recommendations in the code you are attempting to comply with. And this does happen, more often than not. So what are you supposed to do?

In reading through the rules and recommendations that make up the 382 pages of the B31.1 code, or the 546 pages of the B31.3 code, or the 381 pages of the BPE standard, you should get a sense of an overall theme, or philosophical intent, if you will. Gaining an understanding of this running theme or philosophy of the code or standard will help the user fill in the blanks when a situation does not correspond with specific code or standard requirements or rules. So let’s see how we might discern the philosophical intent of a code or standard from within its rules and recommendations. (Cont. next month)

QUESTION OR COMMENTS

If you would like us to address a specific topic or simply answer a question, related or unrelated to the content of this Newsletter, please contact us at: staff@wmhuittco.com. In the subject line of the email please enter “Newsletter Question/Comment.”