best practices

Inspecting Pressure Vessels

Entering and inspecting pressure vessels must be done carefully to comply with the required safety procedures as well as to find any damage. Prior to entering the vessel, the following steps — at the minimum — must be completed.

1. Obtain a management-authorized vessel-entry form.
2. Clean and decontaminate the vessel.
3. Blank out the vessel from all piping.
4. Check the vessel for explosive tendencies and flammability.
5. Check the vessel for oxygen content; 21% is required.
6. Lock, tag, and try agitators or other mechanical devices.
7. Remove all radioactive monitoring equipment if they present a personnel hazard.
8. Ventilate the vessel mechanically if required by permit.
9. Obtain a management-authorized flame permit if welding is to be done.
10. Wear appropriate safety equipment such as gloves, hard hat, goggles, safety shoes, safety harness, or wristlets.
11. Have standby personnel on hand with radio, air horn, etc.
12. Have the appropriate ladders on hand to facilitate entry (scaffolding may be required).
13. Have self-contained breathing apparatus (SCBA) available at the vessel entry site.

Once all safety considerations have been satisfied, you must check your inspection equipment to make sure the necessary tools are on hand. The following are personal items each inspector should have to aid the visual inspection:

- Good flashlight, with fresh batteries, and the capability to be focused to a spot.
- Small scraper such as a stiff putty knife.
- Sharp scribe — a tungsten-pointed one is excellent — or a stainless steel dental pick, or both.
- 10× magnifier. Lighted ones are available.
- Pencil magnet.
- 10- to 12-ft tape.
- 6-in. machinist's scale.
- Note pad and pen for notes and sketches.
- Small tape recorder for dictation of conditions. This is optional but very helpful.
- A belt pack to contain everything.

Most of the items listed are readily available, but the more specialty items can be purchased from inspection supply firms. Additional visual inspection tools such as borescopes, cameras, video cameras, and video probes can also be useful, especially for recording the inspection results for comparison in the future.

Once you've gathered your tools, the next step is to check the equipment's identification; it must be confirmed by checking its ID plate. Some operating functions in a manufacturing plant are such that more than one identical unit is available for a particular function. Examples include equipment duplicates that fill the need to take an equipment piece offline for cleaning and replace it in kind, or there may be spare pumps for a particular location to permit replacement of seals. In that case, a space unit having

its own ID is put into place and operations continue; therefore, it is imperative that each unit's ID be confirmed before the inspection begins.

Starting the Inspection

Careful examination of the vessel entry access port prior to you entering the vessel ensures it is not forgotten as you exit the vessel later. (In one case, the entry nozzle was not inspected, and the corrosion damage that was overlooked caused a leak and an expensive and unscheduled shutdown on startup.) Typically, flange faces, nozzle necks, and nozzle attachment welds are inspected for mechanical or corrosion damage as the inspector makes the initial entry.

Once you are inside the vessel, carefully and thoroughly inspect it for mechanical and corrosion damage. Vessel inspections may require removal of internal manways between different levels, or baffling that may obstruct the view of portions of the vessel. Ladders or scaffolding are often required to gain access to all of the interior surfaces. Surface inspections usually require accessibility within an arm's length; visual inspection at longer distances is usually inadequate since damage may be overlooked. Some inspectors take the position that if they cannot touch a surface, they cannot adequately inspect it.

When you find damage, note and describe it in some manner so you can accurately report it later. Legibly mark any damaged surfaces if further action will be required during a shutdown. A soapstone marker is good for marking carbon steels; a paint marker may be required for stainless steels and other bright alloys. When using paint markers, make sure they do not contain high sulfur, chlorides, zinc, lead, or other elements that would leave a residue that could cause damage to the metals during subsequent cutting or welding operations.

Inspecting the Exterior

After the vessel's interior has been inspected, the exterior must also be examined for deterioration. This can be difficult and costly if the vessel is insulated; however, damaged insulation is often the first indication that insulation removal and inspection may be required. If water can find its way into the insulation via damaged vapor barriers, the resulting moist, hot conditions can cause severe corrosion of the external surfaces. Radiography and ultrasonic testing are often used to inspect for equipment damage without the need for complete insulation removal.

When the Inspection Is Complete

Once you complete the equipment inspection, document your results and discuss them with the appropriate management and maintenance personnel. Any needed repairs should be planned and discussed with the welding and mechanical supervisors to ensure that all damaged areas are well understood as to their location, extent of damage, and required repairs. Often, you will revisit the equipment location or even reenter the vessel with the repair personnel to show them exactly what is required. Once all repairs are completed, they must be reinspected.❖

Excerpted from AWS PRGVT, The Practical Reference Guide for Welding Inspection Management — Visual Inspection of Pressure Vessels and Pressure Piping.