



**Used, Classic, or Antique; Solving the Enigma of Disciplined  
Adherence to Standards for Existing Equipment**

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### **Abstract**

What do you consider when buying a used car? Do you have minimum safety requirements for your used car? Similarly, do you have minimum safety requirements for existing equipment in your plant?

One of the CCPS Vision 20/20 Industry Tenets is Disciplined Adherence to Standards. In this tenet, Vision 20/20 puts special emphasis on application of standards for existing equipment. Companies with great process safety performance recognize that having minimum standards for existing equipment is as important as having them for new projects. However, identifying and applying relevant standards to equipment that may have been installed decades ago can be challenging. This paper will describe how to establish minimum standards for existing equipment and will provide a suggested approach for the implementation of these internal or common industry standards.

## **1 Introduction**

The emphasis in the CCPS Vision 20/20 tenet, Disciplined Adherence to Standards, is creating and following standards for existing equipment.[1] Normally when Vision 20/20 is discussed, standards for existing equipment is briefly mentioned, but not thoroughly described. The authors felt a need to describe in detail what is meant by standards for existing equipment and provide a suggested approach for the creation and implementation of a management system for standards for existing equipment. Our intention is not to bring existing equipment to look like new equipment. It is to bring existing equipment to meet predetermined minimum expectations.

### **2.1 Why is it important to have standards for existing equipment?**

When buying a used car, one subconsciously develops minimum expectations. Those minimum expectations will vary depending on the perceived risk. The requirements for a used vehicle will be vastly different depending on the driver and use of the car. If the car is for a college freshman who is driving 500 miles to a university in a city, there is a risk of car trouble a long way from home and an increased likelihood of an accident given traffic density and unfamiliar surroundings. For a pickup that is going to be driven in a small town close to home, the favorite repair shop is close by and the driving conditions are much less challenging. The potential consequences for the college freshman are such that the frequency of failure needs to be relatively low compared to the hometown pickup.

How might this be reflected in the design of the car or pickup? Both must meet a minimum expectation. They will both have seat belts, functioning lights, and brakes, for example. Beyond that minimum level, the desire for a lower frequency of failure may prompt a vehicle with a higher reliability rating or additional airbags. These are options that are above the minimum.

The same concept is true in the processing industries. As the risk (i.e., the likelihood of the consequence severity) associated with equipment failure or malfunction increases, the more important it is for that equipment to meet predetermined minimum expectations. For equipment that is in a certain level risk service, there should be minimum expectations no matter how new or old the equipment. Even though equipment was built to codes or the best practice of the time of installation, it is not necessarily good forever. Equally, just because it is not the newest model, does not mean that it is not fit for service.

As an industry and a society, we are continually expanding our knowledge base and enhancing our understanding of hazards and the means to address those hazards. Back to the car analogy, if the car does not have seat belts, brakes, or working lights, it is probably not good judgement to send your college student away in that car or even to drive a pickup around town. If a vehicle is

to be operated, there are minimum standards it must meet. Similar circumstances apply to existing process equipment, especially equipment in high consequence service:

- Existing equipment that does not have the equivalent of “seat belts” for its relevant hazards perhaps should no longer be operated...or, alternatively, it should be assessed against minimum standards and upgraded as appropriate.
- Existing equipment that is not routinely inspected, tested, and maintained may have unknown integrity and reliability issues.
- Equipment may be in a current process service different than the original intended service but did not undergo an effective management of change review. It may not be clear if this equipment is “fit” for the new service?
- A company that has acquired facilities may find that the existing equipment and technologies are based on different standards than the company uses. Minimum standards may need to be developed to address these new facilities.

## **2.2 Most of our equipment is existing, not new**

When Disciplined Adherence to Standards is discussed, the discussion normally centers on standards for new equipment. Most of our equipment, however, is not new and in fact has been in place for years; sometimes for decades.

Many companies have standards for new equipment, but do not have standards for existing equipment. Establishing such standards has significant potential to improve process safety results. There are not many untapped opportunities in process safety, but this is one for many companies. Unfortunately, companies often only establish minimum expectations for existing equipment after a series of incidents. For example, if a company has several incidents with fired heaters over a relatively few years, the company is likely to generate a mandate that all fired heaters must meet specific requirements. Vision 20/20 promotes development of standards and equipment modification before the incidents occur rather than after they occur; the goal is to prevent those initial incidents.

Process safety is a team sport. Engineers in an operating plant design changes to equipment. PHA teams are expected to recognize the need for protection. Similarly, asset integrity and maintenance personnel are expected to perform the appropriate inspections and maintenance on equipment based on the hazards and risks. All of these personnel can be supported by standards for the existing equipment.

## **2.3 What existing equipment should have a standard?**

Standards for existing equipment generally come in one of two categories: 1) equipment type or, 2) technology. Both categories are important and it may be appropriate to have standards for

both. Standards for equipment often do not address technology specific issues and technology standards do not address process safety critical equipment that is outside the technology.

Standards organized by equipment type are for equipment such as fired heaters, flares, compressors, relief devices, turbines, and pressure vessels. The standard developed for fired heaters would be applied to every fired heater, no matter how old the fired heater. Most companies already have standards for a new furnace, but often there are no minimum requirements for furnaces that were built decades ago. Standards for existing equipment would fill that gap.

Standards organized by technology are for technologies such as fluid catalytic crackers, pressure let down systems, ammonia plants, or storage systems for ammonium nitrate or high concentration oxygen. There have been numerous instances in which two similar processes to produce the same material have had significantly different equipment in place. For example, one may be a swing unit that operates infrequently and the other operates continuously, or the facilities are in different plant sites or different regions of the world. Incidents could have been prevented if minimum process safety system standards had been defined and implemented.

Regardless of whether a standard is for equipment or technology, specific required details should be clearly defined. The detailed requirements are the items that must be included every time that type of equipment or technology is in service. For example, suppose a standard for monomer storage tanks requires that there shall be two independent temperature measurements that are always submerged in the liquid and alarms shall activate if the temperature reaches 45 degrees centigrade. This then applies to all storage tanks that contain that monomer. Examples of items that could be included in the storage of monomer XXXX follow.

1. Tanks in XXXX service must be constructed of stainless steel or aluminum.
2. A floating roof tank must never be used for XXXX storage.
3. Three independent layers of protection are required to verify that a container carries XXXX before it can be offloaded into the XXXX storage vessel. One of these must be a positive verification of the container contents by sampling the container at the receiving site.
4. To decrease the likelihood of contamination, there must be a written procedure for returning a XXXX tank to service after internal tank inspection/maintenance is performed.
5. There must be a written procedure before changing an existing tank into XXXX service.
6. XXXX must be stored at a temperature between 60<sup>0</sup>F and 80<sup>0</sup>F.
7. Never use the direct application of live steam, steam tracing, or steam coils to heat or thaw XXXX.
8. XXXX must be stored under a blanket atmosphere containing 8 to 21 volume % oxygen.
9. In case of inadvertent purging of XXXX with an inert gas, the XXXX must be sparged with air as soon as possible.

## 2.4 How to develop a management system for standards for existing equipment

Developing and implementing standards for existing equipment and for technologies can be a significant and complex undertaking that can take years to complete. For many companies it is also one of the most important things they can do to reduce risk and improve process safety performance. Because it takes time and money, it is critical to get executive support before significant work is started. Executives will need to be convinced that there is real benefit to defining minimum expectations for existing equipment and then spending the money to bring the equipment up to those expectations. Though it does take time and costs money, having existing equipment that meets minimum expectations is much more cost effective than experiencing a process safety accident. Establishing standards also can result in improved quality and productivity results due to reduced downtime and more consistent operation of the existing equipment. To make visible the support from executives, a representative of senior management should be directly involved in the project to develop and implement the standards.

The challenge is how to start. Do not be overwhelmed by the size of the topic. Use a risk-informed approach.[2] Start with equipment or technology that causes the greatest concern. Alternatively, start small. Consider starting with equipment or technology that offers an opportunity for a “quick win” or noticeable process safety improvements. Taking a risk-informed approach may consider multiple factors including the following.

- Consequences – These are the immediate effects of failure of the equipment or technology, such as flammable release, toxic cloud, corrosive spray, or environmental impacts. The consequences could also be “downstream” effects of the equipment or technology failure. For example, release of cooling water may not be a high consequence event but loss of cooling to an exothermic reaction with runaway potential could be catastrophic.
- Usage – Equipment or technology that is widespread through a facility or company or that is in use continuously will present a greater risk due to the increased frequency.
- Integrity – Equipment with known or suspected integrity or reliability issues may present a greater risk.

Following this logic, refinery fired heaters might be a good place to start since there are many fired heaters and some of them are decades old without modern burner management systems. In a chemical plant, it might be a high oxygen concentration handling system or an ammonia handling system due to broad use and consequences.

Do not forget the suggestion to start small. If the company finds that fired heaters or high oxygen handling systems are too complex for a new team, then consider starting with simpler equipment or technology to enable the team to make effective progress and learn the process of developing standards. An example could be storage tanks for highly hazardous materials. The point is, pick something that is a relatively high risk item and start.

Developing the initial standard(s) is an important step because once the standard is finalized; the company is committed to meet the standard. If the standard is unnecessarily burdensome, money and energy will be spent without corresponding risk reduction. If the standard is not sufficiently demanding, risk will not be reduced appropriately even after conformance with the standard. For these reasons, in addition to technical, operations, and maintenance personnel, the team to develop the standards should be the experts within the company and possibly experts from outside the company. One recognized characteristic of a positive process safety culture is deference to expertise.[2][3] Using company and industry experts to establish standards for existing equipment takes advantage of the knowledge of a broad range of experts. Decisions made by experts and then applied to existing equipment throughout the company assure consistency from unit to unit and site to site that cannot be achieved by a series of process hazard analyses. The standard may also need to be vetted across several sites to ensure that it is appropriate for all locations.

There are three ways to develop a standard for existing equipment.

1. Develop a standard for existing equipment by starting with a standard for new equipment and selecting specific items to also apply to all existing equipment. This may be done starting with industry standards for new equipment or starting with company standards for new equipment. This technique can also be used for some technology standards if there are published consortium documents with which to start. This approach may be appropriate for equipment such as fired heaters.
2. Use a published standard developed by a credible organization. For example, for pressure vessels, companies in the U.S. often use API standards. It would not make sense to write a new standard when the API standards are widely recognized in the industry. Applying an existing standard is not only the most direct approach, it also is an approach that promotes consistent safety practices across the industry and it is generally supported by regulatory authorities.
3. Develop a new standard that is company specific. It is appropriate to develop a new standard for a specific technology unique to a site or company, although there may be useful supporting documents from industry consortiums.

Industry standards often include several “shoulds” indicating that a specification is suggested but not required. Engineering judgment is required in considering the “should” statements. Differences in approach and in local conditions may result in inconsistent application of the “should” statements across a company. Where consistency is desired, standards for existing equipment specify which of the “shoulds” in the industry standards “shall” be applied for their company.

Re-emphasizing, no matter which of the three methods above is used, it is critical that subject matter experts develop the standards. If not available within the company, then outside expertise will need to be involved.

## 2.5 What requirements should standards for existing equipment include?

The standards for existing equipment should focus not only on the design and specifications of equipment or technology, they also may need focus on maintaining the integrity of the equipment and the reliability of the safety systems for that equipment.

Standards for existing equipment might require specific sensors, interlocks, shutoff valves, etc. It might also include integrity inspections of appropriate components. The testing and inspection frequencies may vary with the age and service of the equipment.

A standard for existing equipment may address any or all of the following topics, depending on the equipment type, technology, and service (examples provided below each topic):

- Design/integrity Requirements
  - Wall thickness
  - Material of construction
  - Allowance for pitting, nicks, cracks
  - Design configuration (usually applicable for individual components, such as sight glasses, valves, etc.)
- Safety System Requirements
  - Pressure/temperature/level interlocks and alarms
  - Ignition sensor interlocks
  - Redundant or back-up systems
  - Overflow protection
  - Venting
- Inspection and Testing Requirements
  - Monthly test of critical interlocks
  - Annual visual inspection for evidence of corrosion
  - Wall thickness measurements every three years
  - Annual maintenance and integrity testing of critical interlocks by experts
- Operational Requirements
  - Maximum temperature/pressure/level
  - Type of fluid service (e.g. use allowed only in non-corrosive, non-abrasive service)
  - Allowed ambient conditions (e.g., do not operate below 0C)
  - Maximum length of service (replace gaskets every year)
  - Daily check of E-Stop functionality

As mentioned previously, the intent is not for existing equipment to meet all the design specifications of new equipment, including items like instrumentation or process control system



requirements. However, there should be some minimum expectations that must be met no matter how old the equipment is.

Once a standard for existing equipment is written, the next step is to compare equipment to the standard and identify gaps. This gap analysis needs to be a meticulous, line-by-line comparison of the standard to existing equipment with gaps clearly identified.

As with any activity such as this, when the gap analysis is completed, an action plan needs to be developed with due dates and responsible parties defined. Finally the equipment is modified to meet the standard. Because there may be human or financial resource constraints, modifications may need to be made in a risk-based manner. Though all of the preliminary steps may take several months, completing the modifications of the equipment to conform to the standard is the only step that actually reduces risk.

While the underlying premise of standards for existing equipment is for equipment to remain in operation with modifications as necessary to meet minimum requirements, some equipment simply might not be able to meet the standards. If such equipment is identified, management must remove the equipment from service as soon as practicable, implementing interim safety measures where needed.

## **2.6 Standards for existing equipment are part of a robust process safety management system**

As stated in the introduction, establishing minimum requirements through standards for existing equipment represents a potential step-change improvement in process safety performance. Establishing and adhering to such standards will reduce risk and reduce the number of incidents, the goal any process safety management system.

Developing the standards and modifying equipment as required to meet the standards is a large undertaking for any company or facility and will take years to complete. The journey does not end with the establishment of standards. As industry and company knowledge continually evolves, those standards need to be upgraded to incorporate new learnings. Subsequently, equipment may need to be modified in the future to meet the upgraded standards and maintenance and operational requirements similarly modified.

The standards for existing equipment should be supported by the process safety management system. Throughout the development of the standards and closing identified gaps, it is important that a culture of conformance be maintained. With respect to standards, the management system should:

- Include the involvement of a senior leader
- Establish the governance for standards (e.g. who develops and approves)
- Specify standards for both existing equipment and for technologies

- Clearly require conformance to the standards and specify timing of that conformance
- Define a protocol, including approval requirements, for deviating from the standards
- Define the scope to which the standards apply (e.g., part of or the entire company)
- Define the frequency with which facilities are expected to verify conformance with the standard (e.g., some companies conduct a gap analysis every five years during the revalidation process hazard analysis)
- Include performance monitoring of conformance to the standards

To continually improve process safety performance, a fundamental goal of Vision 20/20, companies must continue “working down the list” of existing equipment, developing standards for moderate and then lower risk equipment. Companies should not neglect items such as sight glasses, piping, pumps, and utility systems.

The Vision 20/20 tenet of Disciplined Adherence to Standards obviously requires an on-going commitment by any company. Achieving this tenet is a never-ending journey; facilities, companies, and industry organizations mutually focus on adhering to standards for existing equipment and pushing the process safety frontier ever onward.

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