

Visual Controls and Process Safety Management in the Petrochemical Industry: Safety, Knowledge Transfer, and OSHA's NEP

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The Petrochemical industry faces many unique challenges when it comes to creating and maintaining a safe, productive environment – first and foremost being the hazardous nature of the chemicals themselves. Add to this the public concern over security and terrorism, the growing demand for petrochemical products, and a more transient, less experienced workforce and it's easy to see the importance of managing every step in the process of handling petrochemical products. Failures to develop, understand, or maintain safe work practices in this industry have potentially disastrous consequences.

To address the concerns over both worker and public safety, OSHA issued the Process Safety Management (PSM) of Highly Hazardous Chemicals standard (29 CFR 1910.119), which contains requirements for the management of hazards associated with processes using highly hazardous chemicals (HHCs).¹ OSHA has since strengthened its focus, initiating the Process Safety Management National Emphasis Program for Petroleum Refineries, which specifies that OSHA will conduct 81 inspections over two years, with particular attention focused on:

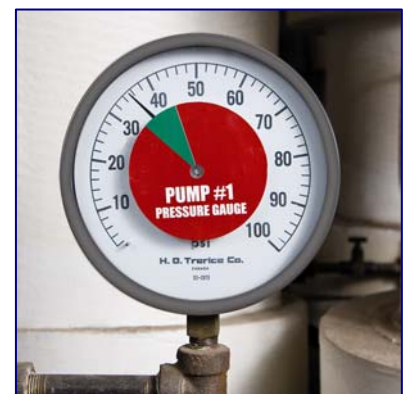
- Documentation for Safe Work Practices
- Lockout/Tagout
- Confined Space
- Pipe Marking
- Security – control over entrance/exit/presence at a facility

The current scrutiny by OSHA actually presents an opportunity for petrochemical companies to review all of their processes not only for safety, but for effectiveness and efficiency as well. A well-executed PSM program helps ensure the safety of workers and the public, but also can deliver process improvements and efficiencies that increase safety and save time and money. What is the easiest and most cost-effective way to gain all these advantages? Visual Controls.

How Visual Controls can make your facility more cost-effective and lean

The fact is that people work faster when they have the right information right in front of them. Absence of a graphical lockout/tagout procedure and point of need energy source tags for the H2 Recycle Compressor mean it will take longer to get that vital piece of equipment up and running.

Can your workers memorize the seal alignments, temperatures, and pressure settings of every circulating water pump, or the shell and tube temperatures and pressures on all heat exchangers? Probably not, and that's where adding visual controls to your PSM program will save time and money.



For instance, following a Visual Controls marking project, a large power systems company experienced a 30-minute average reduction in task completion, each time pipe tracing was required. Workers don't have to be relied on to remember everything. They just need to know where to look. This is where standardization of your markings from equipment piece to equipment piece, unit to unit, and even from plant to plant can pay off in big ways. Incremental increases in productivity add up to enormous cost savings over time. Start up, shut down, lockout/tagout, and changeover events have a tremendous impact on the bottom line with the reduction of even a few minutes of downtime. That's where Visual Controls for your PSM program can lead to improved equipment reliability ratings and decreased production costs. That's even before you factor in the advantages of improved safety throughout your plant in terms of insurance costs, workman's comp, liability claims, and equipment downtime in the event of an accident, or the cost in terms of personal tragedy if there is an employee injury or death.



BEFORE



AFTER

In fact, OSHA initiated the PSM National Emphasis program in direct response to the high number of fatal or catastrophic incidents in the petroleum refining industry. According to OSHA's IMIS database, since May 1992, 36 fatality/catastrophe (FAT/CAT) incidents related to HHC releases in the refining industry have occurred. These incidents included 52 employee deaths and 250 employee injuries, 98 of these injuries required hospitalization.²

Just one example will show how visual controls can help petrochemical facilities comply with the OSHA standard and avoid catastrophic incidents. In 2004, six refinery employees were injured, four with serious burn injuries when gasoline components were released and ignited. The incident was caused during maintenance operations when a valve that was to be closed was left open, leading to the release of flammable liquids and vapors which caused subsequent explosions.³ A simple label indicating the valve's appropriate on/off positioning, paired with clear Lockout/Tagout procedures, and use of lockout device could have helped workers avoid this incident.

That's why OSHA inspectors are now emphasizing implementation over documentation – OSHA inspectors at refineries and large chemical plants have typically found that employers have extensive written documentation related to Process Safety Management, but the implementation of the written documentation has been inadequate.⁴ This is another area where visual controls can make an enormous difference – instructions and information that are clearly posted when and where employees need them are more likely to be followed consistently.

It all starts with Visual Controls

The whole concept behind Visual Controls is to place visually instructive information at the point of need – not just in a binder or on a computer, but rather physically on or at the location of the task or hazard. This information should serve one or more of just three purposes:

- Safety Awareness, such as indicating a hazardous situation or environment
- Equipment identification and location information
- W3 + H information – What, Where, When, and How tasks are to be completed

How do Visual Controls help facilities with PSM? In recent years the demographics of the petrochemical workforce have changed dramatically. **Oil and gas industry companies are facing as much as 50% reductions in their workforce** due to retirements in the next few years, and there is a shortage of qualified, experienced workers to take their places. This has led some companies to make special allowances for non-English speaking contractors, further complicating the exchange of vital safety and procedure information. The influx of contract workers and/or much younger, less experienced employees means the transfer of knowledge simply cannot take place the way it has in the past. Workers no longer have years to get up to speed on plant layout, the whereabouts of the equipment and controls, or proper operational and maintenance procedures. The use of standardized, specific, visual, point-of-need information addresses the problem of information transfer, ensuring that all employees have the information they need, exactly when and where they need it... and that's the difference between an effective PSM program and one that exists in name only in a binder somewhere.

P-201B		
CIRCULATING WATER PUMP		
Tier 2 Limits	MINIMUM	MAXIMUM
SUCTION PRESSURE (PSIG)	N/A	350
DISCHARGE PRESS (PSIG)	N/A	345
TEMPERATURE (F)	N/A	430
FLOW RATE (BPD)	3000	9500
PUMP LUBRICATION	OIL MIST - SCH 629	
DRIVER LUBRICATION	OIL MIST - SCH 629	
SEAL BUFFER MEDIUM	COOLED BOILER FEED WATER	
DRIVER HORSEPOWER	250	
SWITCH ROOM LOCATION	CONTROL ROOM A	

SPECIAL INSTRUCTIONS:	
1. COOLING WATER SUPPLY AND RETURN MUST BE LINED UP TO SEAL FLUSH COOLER.	
2. BOILER FEED WATER SUPPLY MUST BE LINED UP TO SEAL FLUSH AT ALL TIMES.	
3. SEAL FLUSH WATER TO PUMP SHOULD BE AT 180F OR LESS.	
4. WHEN RUNNING TURBINE ON 250 PSIG STEAM, BOTH PACKING BOX STEAM EDUCATORS SHOULD BE IN OPERATION.	

BR-201B-000

The Department of Transportation (DOT) offers an excellent example of a standardized, specific marking program that most people use every day. The “Manual on Uniform Traffic Control Devices (MUTCD)” specifies the DOT's procedures and specifications for traffic signs. Anywhere you travel in the US, stop signs, yield signs, and common road markings will look the same. Imagine how confusing and dangerous it would be if this marking was haphazard or inconsistent. How much longer would Driver's Ed take if the student had to learn dozens of versions of dozens of signs? This is exactly the same problem you face if you do not have an organized program for safety signs at your facility. A clear, standardized, documented program of Visual Controls for PSM reduces the learning curve, getting your employees up to speed faster while they stay safe and productive. Dr. Gwendolyn Galsworth, a foremost authority on Visual Management, cites that some companies have reduced training time by as much as 49% through the use of Visual Controls.⁵

The logic used for consistent street signs, maps, and addresses can be applied to the detailed identification in marking pumps, compressors, exchangers, pipes, valves, panels, and other equipment. For example, when working with a refinery on a marking program, a Brady Corporation team found four side-by-side valves were related to four areas of the plant. One might logically assume the valves would be oriented 1, 2, 3 & 4, but in reality they were oriented in different order: 3, 1, 4, and 2. Long time workers at the plant probably knew that, but new employees or contractors would have no logical means of understanding such an idiosyncratic system. The chance of accident or injury increases dramatically when facility marking lacks intuitive logic or consistency. In fact, the Electric Power Research Institute (EPRI) performed a study of the utility industry and found that 54% of all operator errors were due to inadequate or missing labeling.⁶

Practical Guidelines for Effective Visual Controls

Standardization, clarity, and durability are the keys to an effective Visual Controls program. It is important to standardize markings by application, appearance, and location, so that they convey a consistent look and message in an expected location.

Elements to consider include:

- **Consistent color, header, and layout by application** – this allows employees to recognize specific messages for specific applications quickly and easily.
- **Location, location, location** – signs should be posted in same locations on each like piece of equipment. Don't make people search for needed information – the more clear and intuitive the information, the more productive your employees can be.
- **Combine information** – Instead of multiple signs crowding the work area, group information when possible. For example, include Panel ID, Voltage, Equipment Feed, and Arc Flash information onto one label with four areas, rather than four separate labels.



- **Outdoor applications** – many outdoor signs require "Danger" headers that feature text printed in red ink. Red fades more quickly than other colors, due to its reaction to UV rays. For outdoor visibility and durability, the best color choices are high contrast, dark/light color combinations. When red is needed on an outdoor sign, one way to overcome UV fading is to post information using fiberglass material designed to withstand UV rays. Look for materials guaranteed to withstand outdoor environments.

A big part of the Compliance Guidance for the OSHA directive includes consistency between the written procedure and the labeling of equipment in the field. Visual controls are essentially the link between a facility's written procedures and their successful implementation. Standardization from plant to plant and process to process ensures that all Visual Controls are quickly and universally understood. The results are OSHA compliance, faster process and procedure implementation, and a safer work environment for everyone. Clear, standardized markings will ensure that proper procedures and processes are followed, not only for normal operating procedures (NOP), but also for Emergency Shutdown Procedures (ESP) and Emergency Operations (EOP), where there is greater potential for worker panic and confusion.

Exit path markings are another area where visual controls are important to the OSHA directive. Inspectors are instructed to evaluate whether the facility identified and evaluated the visibility and clarity of emergency exit route signs. In particular, exit route signage must be "easy to read, clear, and unambiguous."⁷ This compliance guidance instruction is designed to take into consideration the potential for confusion and misunderstanding during an emergency situation.

Special Concerns for Pipe Marking

Pipe marking is a critical aspect of PSM for the petrochemical industry. While many companies have relied on painted stencils for marking pipe contents and direction, this method is both more time and labor intensive and the least "visual," because paint chips and fades quickly compared to other labeling methods. Self-adhesive and wrap style labels are brighter, easier to read, and more durable than painted stencils, and are easier to customize and update with "to/from" or "unit specific" data.

There are specific considerations to remember depending on whether you are marking insulated or non-insulated pipes. Insulated pipes benefit from the application of self-adhesive or wrap style markers that provide highly visual information without affecting the pipe.

Non-insulated pipes present different marking concerns. Do not apply vinyl, self-adhesive pipe markers directly to stainless steel or nickel pipes. Vinyl has a high halide content, which can cause fatiguing of the stainless and nickel surfaces. For these pipes, consider wrap/strap style markers, or use polyester marking materials. When using a wrap or strap style marker on non-insulated, carbon-based piping, be aware that condensation can become trapped behind the marker, thus hastening pipe corrosion. These applications may be better suited for self-adhesive markers.

Maintaining your PSM program

Too often, a Visual Controls program is thought of as a single event. Unfortunately, this view means that the benefits of the program are diminished or lost over time, due to faded signs, outdated instructions, equipment changes, and other plant updates. A program that is not maintained will not be followed consistently. However, there are many opportunities to update and maintain your Visual Controls:

- **Safety Audits and other walkthroughs** – if your company is going through any kind of inspection process, whether for OSHA, certification inspections, or other routine walkthroughs, make sure that signs and labels are in place, up-to-date, and relevant. Unclear, outdated, or damaged signs should be removed and replaced.
- **Lockout/Tagout procedures** – this is an ideal time to spot-check your Visual Controls program. Are the instructions clear enough? Can new employees understand and complete the procedure? Are Lockout/Tagout devices well maintained and easy to find?
- **Preventative Maintenance to equipment** – during any routine maintenance, ensure that pipes and valves are properly labeled, that Lockout/Tagout instructions are in place and up-to-date, and that Arc Flash or Right to Know hazard signs are in place if needed.

According to OSHA, “An effective process safety management program requires a systematic approach to evaluating the whole chemical process. Using this approach, the process design, process technology, process changes, operational and maintenance activities and procedures, non-routine activities and procedures, emergency preparedness plans and procedures, training programs, and other elements that affect the process are all considered in the evaluation.”⁸

The heart and soul of this particular OSHA directive as it applies to standardized, clear, visual controls can be summed up by this statement from the directive itself: “If operating employees cannot equate the equipment described in a procedure with equipment located in the field, employee confusion or operating errors may occur resulting in a release from the covered process. By providing unique identifiers for equipment both in written procedures and marking/labeling in the field, operators have less opportunity to be confused or error.”⁹ Developing and implementing a system of visual controls will help your facility to be more than simply OSHA compliant –petrochemical facilities that employ a PSM program using Visual Controls will gain the advantages of lean manufacturing by making it easier for employees to find the information they need, when and where they need it. The result will be an operation that is safer, more productive, and more cost-effective, every day – factors that simply cannot be ignored in today’s competitive world economy.



Citations:

1. OSHA website: www.osha.gov/SLTC/processsafetymanagement/.
2. OSHA instruction directive number: CPL 03-00-004.
3. Ibid.
4. Ibid.
5. Dr. Gwendolyn Galsworth: www.visualworkplace.com
6. The Electric Power Research Institute: EPRI-NP-6937. www.epri.com
7. Ibid.
8. OSHA website: www.osha.gov/Publications/osh3133.html.
9. OSHA instruction directive number: CPL 03-00-004.