Safety Results Mirror Expectations at Westlake Petrochemicals New Grassroots Ethylene Plant

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Introduction

Results often mirror expectations. The expectations for safety performance have evolved significantly over the past three decades. Several factors have contributed to this trend including improved process design, government regulations focusing on process safety, and increased liability related to major incidents in industry.

Safety performance has also reflected this change in expectation. For example, during the 1970's safety performance was measured by loss of life (fatalities). During the 1980's, it was measured by loss of days worked, and presently it is measured by recordable injuries. The process is still evolving with industry reviewing near miss and behavior practices in advance of recordable injuries.

The Westlake management philosophy instills a safe job performance to all organization levels. It is not enough to just blindly follow safety rules. The reasons behind the rule must be understood and questions should be ask to fully understand the work to be done and to quantify the risk involved.

At the Westlake's new grassroots ethylene plant, the safety expectations were high. Westlake had yet to have a lost time accident associated with the construction, commissioning, and start up of the first Ethylene Plant and an Ethylbenzene - Styrene plant. The results of the second Ethylene Plant were equally impressive.

Westlake Specifics

Several items contributed to the Westlake success. One factor was established Westlake safety procedures from a existing Ethylene Plant. This knowledge and experience was incorporated in the design, commissioning and start up of the second plant. A safe work site begins with an expectation that a plant will be constructed and operated with no serious injuries and a philosophy that holds personnel accountable for their own safety. However, expectations must also be accompanied by a strong commitment.

In order to standardize this approach, Westlake maintains a dynamic set of procedures to cover a variety of critical operations and issues such as Personnel Protective Equipment (PPE), hot work, audits/inspections, contractor criteria, and drug testing. Westlake also maintains procedures for all elements of OSHA 1910.119, the Process Safety Management standard.

Codes and standards consistent with regulations and Recognized And Generally Accepted Good Engineering Practices (RAGAGEP) were followed during the design stage. Consistent with regulations and good management practices, a Process Hazard Analysis (PHA) was performed on the Unit prior to construction. The PHA method that was chosen was the Hazard and Operability (HAZOP) review. As with any HAZOP, the team is the most critical factor in the success of the study. The PHA team consisted of personnel from Westlake who were familiar with the startup and operation of an existing Ethylene Unit at the Westlake Petrochemical's Site, as well as personnel familiar with the design of the proposed unit. Individuals with other expertise, such as loss prevention, were consulted as necessary.

During construction, Westlake educated contractors about Westlake Petrochemical Site requirements, and interfaced with personnel on the construction side to provide assistance, but did not "micromanage" the project. This model for interface helped the camaraderie and the morale of the entire project group, and also assisted in the team effort. Westlake provided a full time safety coordinator to act as a resource to the project group. The project group also provided continual education to personnel through vehicles such as Monthly Project Safety Meetings and periodic safety walk throughs.

As a part of the operator training, clearly written commissioning, start up and operating procedures were developed by Westlake and ABB's operations personnel. They were reviewed by the management, operations personnel and production engineering. Westlake Production Engineers and ABB

Personnel wrote operations training manuals and an eight week operator training program was conducted, supplemented by on the job training at the existing ethylene plant. Health and Safety issues were included in this training.

Procedures alone are not sufficient to ensure a safe worksite. Personnel must be educated and trained so that the procedures can be properly applied. Also, it can be very challenging to develop procedures for commissioning of a new plant. It is difficult to cover all operational situations that may occur. Even though Westlake already had commissioned a similar plant, we relied strongly on the talents and judgments of experienced personnel.

The new operators hiring criteria was first; a Bachelor Degree, the second choice was an accredited Associate Degree in Process Technology, and the third was a minimum of 5 years of ethylene experience. Westlake was fortunate that one quarter of the operations personnel had 5 or more years of ethylene experience from the existing unit. Personnel drew heavily from their experience in starting up the existing ethylene unit on site, and utilized the services of personnel in that Unit as prudent.

Design Specifics

The design specifics incorporated from the combined Westlake experience and ABB included all applicable codes and lessons learned from previous ethylene plant design and construction. Three safety design features that we will briefly mention are; 1) isolation valves, 2) triple redundant stand alone safety interlock system and 3) facility siting and equipment spacing considerations.

Present process safety guidelines from the American Petroleum Institute recommend remotely operated isolation valves (XVs) for each vessel that exceeds 10,000 gallons in inventory. In addition, the plant had hydrocarbon detectors, and standard equipment recommended by the National Fire and Protection Association (NFPA).

A triple redundant safety interlock system was designed to immediately detect the failure of any system component so that proper repair or maintenance may be taken to correct the fault. The system was designed to provide "fail-safe" protection but also designed to avoid false trips. Experience shows that false trips may cause operations to bypass interlocks, resulting in a loss of safety protection. Standard interlock logic was performed in a state-of-the-art fault-tolerant controller based on Triple-Modular Redundant architecture with 2 out of 3 voting.

Regardless of the level of redundancy, system reliability cannot be achieved unless appropriate inspection, testing and maintenance procedures are established and rigorously followed. It is vital that the plant management make a commitment to maintain the integrity of the critical safety instrumentation. The failure to do so will expose plant equipment and personnel to unacceptable risk. Westlake inspection, testing and maintenance procedures were developed.

Facility Siting considerations were critical in the design of the unit. Choices were made to have equipment arranged in such a manner as to decrease the likelihood and minimize the consequences of inadvertent releases. The control room was designed to withstand the effects of overpressure. Process equipment was arranged in an “H” configuration so that, in most cases, room was left on at least two sides. This arrangement facilitated necessary maintenance and decreased the probability of synergistic effects in the event of a release.

Lessons Learned in Design

Below is a list of some things that one should consider during design, some of which we did well, some of which presented opportunities.

- Review the facility siting to improve necessary maintenance and decreased the probability of synergistic effects in the event of a release.
- Ensure that the facility conforms to current accepted codes and standards, and up-to-date good engineering practices.
- Review selection of Instrumentation, and other key equipment for accessibility.
- Review installation of remote operated isolation valves.
- Review the interlock philosophy so that the plant safety is not compromised by unnecessary interlocks.

Results of Construction, Commissioning and Startup

Plant Safely Constructed

The safety record reflects the success of the construction, commissioning and startup of the unit. The project and operations group emphasized safety in all aspects of the job descriptions. From the ground breaking on April 10, 1996 to the first production of ethylene on November 11, 1997 the safety results were excellent.

Westlake Ethylene II Direct Statistics

Indicator	1996 Industry Avg. (1)	1996	1997
Lost Work Days Cases	2.4	0	0
OSHA Recordable Cases	4.8	0	0
First Aid Cases	Not available	6	24

Westlake Ethylene II Prime Contractor Statistics

Indicator	1996 Industry Avg. (1)	1996	1997
Lost Work Days Cases	2.4	0	0
OSHA Recordable Cases	4.8	0	0
First Aid Cases	Not Available	1	26

The Westlake and the Westlake prime contractor subcontracted some of the work. One of the requirements was a review of the subcontractors safety records, insurance modifier, and drug testing procedures. Subcontractors with a poor safety record were not allowed to bid on the contracts.

While construction was ongoing, safety procedures were reviewed to optimize construction. A safety philosophy was developed that could be updated for changing construction issues while not compromising safety. It is not enough to just blindly follow safety rules. The reason behind the rule must be understood. Questions should be ask to fully understand the work to be done and to quantify the risk involved.

Lessons Learned in Construction

Below is a list of some things that one should consider during the construction phase, some of which we did well, some of which provided opportunities.

- Review work schedule. An appropriate work schedule reduces the chances that personnel will be under undue stress.
- Keep an active interface with project construction personnel to detect and rectify problems, before commissioning and startup.
- Actively inspect construction activities while building a non confrontational relationship.

Plant Safely Commissioned

Before each system, (nitrogen header, fuel gas header, cooling water, ect.), was turned over to operations, a properly planned turn over package was developed and three independent equipment inspections were performed; One by the ABB Construction group for mechanical integrity, one by Westlake Project Group to confirm mechanical integrity, and a third by Westlake Operation Group as part of the PSSR (Pre Startup Safety Review) as required by OSHA's Process Safety Management.

Before any commissioning activities started, we spent the time to write clear procedures and planned the commissioning work. Preplanning pays dividends when the actual commissioning and start up begins. A Commissioning Coordinator was appointed to supervise the commissioning of the various systems as they were turned over. His command post was a plywood board containing a master commissioning blind / isolation list, accompanied by the master P&ID's. With the master board, the status of each system's isolation and blinding was known at all times. As a result, the unit was started with each blind in the proper position.

Lessons Learned in Commissioning

Below is a list of some things that one should consider during commissioning, some of which we did well, some of which provided opportunities.

- Construct a team with some previous commissioning experience.
- Have written procedures for turn over and commissioning.
- Train front line supervisions and operators as much as possible.
- Keep good records and maintain coordination to reduce unnecessary confusion.
- Do not attempt to gain time lost in construction at the expense of short cutting proper commissioning.

Plant Safety Placed in Service

With the team of management, engineers, operations, ABB Initial Operations, maintenance and safety personnel the plant was placed into service. At each step, the team was reminded that we were eager to produce ethylene, but not at the expense of safety.

Of course there were near misses, which we called safety non conformances. Each were properly addressed. The shift coming in was ask to arrive thirty minute early and the shift leaving was ask to stay an extra thirty minutes for a safety meeting. This is a normal safety meeting schedule, except during a start up the operations personnel work seven twelve hour days for several months.

It was emphasized during these meetings that no job needs to be rushed beyond the point of doing it safely. It was express to the operators if they were uncomfortable about a job procedure, they should stop the procedure and review the safety aspects of the job. If they still did not understand the job scope, they should get the necessary personnel involved until everyone clearly understood, not only the job, but the risk involved in the job. After several weeks of twelve hour days, concentration and attention to detail can become difficult. Personnel were encouraged to stop and review each job.

Lessons Learned in Startup

Below is a list of some things that one should consider during startup, some of which we did well, some which provided opportunities.

- Construct a team with some previous start up experience.
- Have written procedures for start up.
- Review DCS control stations and insure adequate numbers for start up. Additional control stations will be needed until instrumentation is proven.
- Ensure instrumentation reliability. Provide additional instrumentation tuning personnel.
- Evaluate near misses and if necessary conduct special meetings to emphasize safety.

Conclusions

To safely design, construct, commission and place an ethylene plant into service in thirty and one half months is a tremendous undertaking. The efforts of many different people and disciplines were required. The common goals to produce ethylene efficiently, environmentally compliant, and safely was foremost on the project team's agenda.

The pressure to start the plant up and produce useful product in an expeditious manner can sometimes compete with the goal of maintaining the highest safety standards possible. Westlake Petrochemicals understood these dynamics and therefore set forth a vision at the beginning of the design, construction and commissioning phases that the plant would be placed in service with no serious injuries. This expectation, backed up by the project team's commitment, resulted in a startup that accomplished these goals.

In essence, establishing expectations, setting standards that exceeded requirements, carefully planning tasks, working with each group instead of against it, setting high standards for education and experience for operational personnel, and ensuring inherently safer design all contributed to the a very safe startup.

References

(1) National Safety Council - SIC Code 28

Westlake Petrochemicals Safety Standards

Occupational Safety and Health Standards for General Industry, 29 CFR Part 1910

Safety and Health Regulations for Construction, 29 CFR 1926

ABB Operations Manual