Ammonia Plant Design Safety Procedure

Program of formal reviews during design phase makes certain that hazard and risk reduction is built into a new plant before actual construction starts

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A formal safety and loss prevention review procedure during the design phase of a new project will go a long way toward making sure that the ammonia plant, for example, will have no built-in booby traps when it is turned over to operations at Monsanto Co.

This mechanism is just one more part, though an extremely important part, of our company's attitude: we want to cause no injuries to employees or the public and we want to minimize accidental losses to property and to production.

The safety review procedure is only a supplement, however, to the most important feature in a plant design, the designers themselves. There is no substitute for a team of capable and experienced design engineers using good engineering judgement and standards, and availing themselves of the additional knowledge and experience of plant personnel.

The reviews are handled by engineers in the safety and property protection branch of the corporate engineering department. The "S&PP" engineers average approximately 25 years of experience in several engineering disciplines, personnel safety, and chemical plant operation. These people have no direct authority over the design of a plant. Instead, it is their function to advise, review, and assist design engineers. Our purpose in this mode of operation is that we do not want to relieve project engineers of their responsibility to design a safe plant.

The Safety and Loss Prevention Review Procedure is handled in several steps, some required and some optional, the latter depending upon the size of a project, its hazard potentials, and other factors. The procedure is used for all types of new chemical plant projects; however, the details in this discussion of the various steps are related to an actual ammonia plant project.

First consultation is on major project areas

During the preparation of the preliminary project scope, project engineers usually consult with S&PP for comments and recommendations on the following items:

1. Location of the new ammonia plant and its separation from other process units.
2. General layout and spacing within battery limits.
3. Location of the control house.
4. General in-battery fire protection requirements.
5. The possible need to increase the overall plant fire pump capacity.

Any subsequent changes in these areas usually involve significant changes in scope and capital costs, and it is to the project manager's advantage to avoid late surprises.

The review is scheduled when the preliminary scope and plot plan have been issued, and before the preparation of the appropriation request and capital estimate. In addition to several project and S&PP engineers, plant personnel representing the operating, maintenance, and safety functions participate in the meeting.

The depth of the subject matter covered in the pre-project review meeting is based on the amount of design information available at that time. However, the major purpose is to cover those items that will have a significant effect on the project estimate that is yet to be completed, and will usually include:

1. Plant siting and spacing.
2. Area electrical classifications.
3. Fire protection.
4. Location and integrity of the control house.
5. Storage tanks and dikes.
6. Potential noise problems and control.
7. Major, expensive spare parts to be supplied by the project, including spare turbine and compressor rotors.
8. Instrumentation and safety interlock concepts, including vibration monitoring of major machinery and normally energized versus normally de-energized shutdown circuits.
9. Emergency instrument power.
10. Requirements for inert blanketing of equipment and tankage.
11. OSHA, ASME Code, and legal safety requirements.

Following this meeting, S&PP issues a report with recommendations to the project manager. The report also contains a statement of hazards and of risks to personnel, property and production.

It is highly significant that this safety and loss prevention review must be held before the appropriation request and capital estimate can be submitted to the Board of Directors. The appropriation request contains the statement that the project has been reviewed with S&PP and that they concur with statements of hazards and risks contained in the appropriation request.

Safety manager is named

Following the pre-project safety review, one of the

S&PP members is designated as safety manager for the project. He serves as the primary safety liaison and consultant to the project team during the design of the project.

When piping and instrumentation diagrams are nearing completion and while changes still are only drawing paper changes, hopefully, the design safety and loss prevention review is held. It also is attended by plant personnel as well as project and S&PP engineers.

The scope of this review includes the following:

1. Disposition of earlier S&PP recommendations.
2. Detailed review of piping and instrumentation diagrams relative to critical controls, safety interlocks, overpressure relief venting, inerting, explosion venting or containment, spill potential and control and similar features.
3. Material handling.
4. Loading and unloading docks and systems.
5. Personnel access and egress from structures.
6. Safety equipment such as safety showers and eye wash stations.
7. A review of a model of the project.

A somewhat different format was used during a recent design safety review of a new ammonia plant project being designed by an outside engineering firm.

Because most of the design details have been standardized and proved out in plants furnished to other clients, it would not have been a necessary nor a productive exercise to review piping and instrument diagrams in detail. Instead, a list of specific items or areas was compiled to serve as the main agenda for the safety review.

The list includes a number of areas of major loss potential, potentials that have been too amply realized in a number of existing ammonia plants. In fact, as listed below, much of it resembles an outline of subjects covered in past AIChE symposia on safety in ammonia plants and related facilities:

Primary Reformer—Tube materials; firing safeguards and interlocks; steam failure interlock.

Transfer Line and Secondary Reformer—Insulation; cooling.

Auxiliary Boiler and Startup Heater Controls and Interlocks.

Waste Heat Boilers—Tube materials and provisions for tube bundle removal.

Steam Drum—Level controls and alarms.

Boiler Feed Pumps—Emergency controls and steam supply.

Boiler Feedwater and Make-up Quality Monitoring.

Interlock System—List of interlocks; emergency power supply; provision for on-stream testing.

Compressors and Drives—Bearing temperature and vibration monitoring; lube oil systems.

Fire Protection—Turbine and compressor lube oil systems; cooling tower; fire pumps, mains and hydrants.

Cooling Tower—Materials of construction.

Safety Showers and Eye Wash Stations.

Platforms, Stairs and Railings—OSHA Standards.

Following the design safety review meeting, a report with any resulting recommendations is sent to the project manager by S&PP. This review meeting is the last formal step in the procedure; however, informal safety consultation continues throughout the remainder of project design.

Conclusion

We have been working with our formal design safety and loss prevention review procedure for ten years. I wish I could say that we have had no accidents resulting from deficient design of plants that passed through the safety review procedure during their design stage. That is not the case. Our experience does indicate, however, a reduction in the incidence of major problems in new operating plants, and we think that the safety review procedure has made a significant contribution. #

G. Ostroot, Jr.

DISCUSSION

Q. In your presentation you stated that part of your review includes a check of auxiliary boiler interlocks and startup procedures. Now this seems to imply that many or perhaps all of your designs do include an auxiliary fired boiler to supplement your waste heat boiler. Is this true—do many or all of your designs include an auxiliary fired steam generator? To supplement your waste heat boiler?

OSTROOT: I do not know if all our ammonia plants have auxiliary-fired steam generators. I would like to ask Guy LeGendre to answer this question.

GUY LEGENDRE: I think that depends on who the engineering contractor is. Some do provide auxiliary boilers. I think there are some ammonia plants, particularly the older types, which don't have auxiliary boilers. So it's not a normal thing that you would provide it. It depends on the type of plant that you are buying from the engineering firm.

Q. In the audit that you mentioned, you mentioned that you considered emergency situations, yet you acknowledged that you really can't consider every conceivable emergency situation. In fact there are some that you never

do conceive of. I wonder if you could tell us how you draw the line, or where you draw the line. For example, do you consider double contingencies, or triple contingencies?

GERALD NEAL: We've been through, as I am sure many of you have, many emergency conditions, and we learn from the ones we have experienced, but we depend on operator training and knowledge to take care of the emergency situation.

KEN WRIGHT, CAMEX: We follow an audit practice similar to what you describe, with one point in addition. We use what we call a hot flange leak check, which is based upon a technique described in a paper presented by R. A. Watkins of DuPont, and published in the March, 1969 edition of Chemical Engineering Progress. Once a week operators go around the plant checking all the flanges, packings, etc., with an explosive test meter, and we have found several hundred leaks that we didn't know existed by following this practice.

Q. Monsanto has had considerable experience with the process computer for their ammonia plant facilities , and I was wondering if either one of you gentlemen had comments on the applicability of this data information system for improving reliability or safety aspects of ammonia plant. Is information provided by the process computer or control systems from the computer that have helped?

LEGENDRE: Yes, I would say that we have used the computer for not only control but also for information which may be helpful in preventing some severe damage to equipment. For example, all of the bearing temperatures on the major compressors are monitored by the computer, and we have an alarm system which will immediately alarm should any bearing temperature get out of the limits we have set. There have been several occasions where high bearing temperatures have been noted by the computer, and we've been able to get the machinery shut down without doing any severe damage.

Q. You said, I think, that when a plant is on line, your operators do stroke and emergency strip valves on an approximately two weekly basis. I wonder if you could expand that a little bit, and tell us whether you do anything special to allow that to happen?

LEGENDRE: Would you repeat the question. I didn't get all of it.

Q. I think you said that you stroked your emergency trip valves every two weeks, and if you did say that, you confirm that, could you tell us whether you do anything special to allow that?

LEGENDRE: We've installed block valve arrangements on certain emergency valves so that we can block these valves in and stroke the valves to verify they are working properly such as steam let down valves, and pressure control valves.

MAX APPL, BASF, Germany: I want to make a comment on the paper of Mr. Ostroot. You mentioned that in the early design stage you have a proper look also in the design of the control room. What does it mean in a more concrete way of speaking—do you intend to build a more conventional type of controlroom with windows, or to go more for a bunker type with no windows, as safety measurement What's your philosophy?

OSTROOT: We tailor the control house to the hazard of the operation. As a general rule we don't have any windows facing the process area, or even not facing the process area. We say that if we must have windows we limit their size to 80 square inches, made of safety glass and anchored sufficiently so that its integrity is equal to that of the wall that it's in. Where we have potential explosion overpressures we look at the materials we are handling, the quantities, the temperatures, the boiling points, and if this comes up as a hazard high enough to warrant a high integrity control house, then we design the walls and roof to withstand a certain over-pressure, calculated on the bases of distances and potential release quantities.

In general, we are beefing up our control house integrity and spacing. Our nominal spacing is no operation closer than 50 feet, but in some operations we are looking at greater distances.

Q. Has Monsanto looked into or used safety drilling on piping, supplemented with ultrasonics, or on its own, to any extent.

I'm interested in the concept of safety drilling on piping where you drill through up until the corrosion allowance. This is done by some people to check their corrosion rate, and if it goes through, you've got a leak.

OSTROOT: We have used the safety drilling concept on several pressure vessels, but not on piping. On piping we use ultrasonics to check corrosion rate.

Q. Could you perhaps expand a little bit on Monsanto's philosophy opposite energize or de-energize trip systems—deenergize *only* in regard to trip, also, possibly enlighten us a little bit on the philosophy opposite protection of the trip device, particularly the instrument from the electrical side of the business, in the event of fire to main machines, the part of the plant now regarded as the most vulnerable in the situation.

OSTROOT: We have no firm company philosophy on this point. Safety and Property Protection would like to have a normally energized system, deenergized to trip—we think that fundamentally it's the safest. However, it is also a very nice thing to keep your plant running, and this is a great safety feature. So, in spite of the Safety Department's general recommendations for a normally energized system we will listen to the project manager if he proposes a normally deenergized system, energized to trip and is providing this normally deenergized system with standby power, capability to switch without missing a beat, and on-stream testing capability; also if the plant has convinced us that they have the orgainzation and the procedures to perform on-stream tests of the normally energized system.