State of New Jersey
Department of Environmental Protection

Bureau of Release Prevention

Guidance on Inherently Safer Technology

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I. Introduction

On November 21, 2005, the New Jersey Domestic Security Preparedness Task Force (Task Force) signed the Best Practices Standards at TCPA/DPCC Chemical Sector Facilities (Standards). Facilities subject to the Toxic Catastrophe Prevention Act (TCPA) and Discharge Prevention, Containment and Countermeasure (DPCC) programs in the Chemical Sector and in specified Standard Industrial Classification and North America Industry Classification System codes are required to comply with the Standards.

One of these requirements is for TCPA facilities to conduct a review of the practicability and the potential for adopting inherently safer technology (IST), which must be completed within 120 days from November 21, 2005. For the purposes of the Standards, IST means the principles or techniques incorporated in covered process to minimize or eliminate the potential for an extraordinarily hazardous substance (EHS) accident that include, but are not limited to, the following:1) reducing the amount of EHS material that potentially may be released; 2) substituting less hazardous materials; 3) using EHSs in the least hazardous process conditions or form; and 4) designing equipment and processes to minimize the potential for equipment failure and human error.

The IST review must include an analysis of whether adoption of IST alternatives is practicable and the basis for any determination that implementation of IST is impractical. The IST review must be conducted by a qualified expert in chemical process safety.

The purpose of this guidance document is to provide clarification on the IST study methodology or techniques, what is a qualified expert, and recommendations for the report. For more detailed information on the concepts of inherently safer technology and how to perform an inherently safer technology review, see Inherently Safer Chemical Processes – A Life Cycle Approach, 1996, from the Center for Chemical Process Safety of the American Institute of Chemical Engineers.

II. IST Review Methodology or Technique

The Standards do not specify an IST review methodology or review technique that must be used by the owner or operator (o/o) of a covered facility. Some sources have suggested that process hazard analysis techniques such as What If, Checklist, or Hazard and Operability study can be applied. In the IST review, the o/o should evaluate the process cycle as a whole and specific sections and pieces of equipment in the process.

An analysis of IST can be done in all phases of a plant's life such as during the conceptual phase, design phase, or operational phase. However, an operating plant may have a limited option of IST application considering the practicability and cost effectiveness. For an existing facility, an application of multiple levels of engineered safeguards coupled with practicable and cost effective technological or design changes may accomplish the same degree of inherent safety in a process plant. Risk reduction measures implemented by some o/o's under the TCPA program since 1988, provided in Appendix I, as well as the publications of IST by AIChE/CCPS and a number of safety experts may provide guidance of implementing IST. The risk assessment technique in the TCPA regulation at N.J.A.C. 7:31-4.2, which lists specific criteria for consequence analysis and likelihood of releases to make risk reduction determinations, is not the same as IST analysis. IST may be applied regardless of release likelihood to reduce the hazard of an EHS.

For each of the four criteria in the IST definition described in Section I. above, the o/o should research and answer the following questions for the process cycle as a whole and specific sections and pieces of equipment in the process:

1. Are there any available IST alternatives over the current process? If so, what are they?

2.A. Is adoption of IST alternatives practicable?
The technology should have been successfully proved in commercial operation or in a pilot operation on a scale large enough to be translated into commercial operation. If an o/o wishes to implement an unproven technology, the technology should be carefully reviewed and evaluated so that additional hazards are not introduced to the process.

2.B. What is the basis for any determination that implementation of IST is impractical?

If the o/o determines that an IST alternative will not be used, the real life problems or conditions present to support this determination must be documented. For example, if an IST alternative in a reaction process provides an extremely low yield of the product, this technology may not be practical. Another example is if the IST alternative introduces a more serious hazard than the original process. Finally, the cost of the IST alternative is included in this determination. The o/o should provide cost estimates involved with the installation of each identified IST alternative and the ongoing operation of it. The technology should be available at reasonable cost commensurate with the anticipated reduction or elimination of the hazard.

3. What past IST and risk reduction measures have already been incorporated into the current process?

III. Qualified Expert

The Standards state that a qualified expert in chemical process safety must conduct the IST review. However, no definition of "qualified expert" is provided. It is suggested that a team of individuals participate in the IST review. A team leader should be established, and members of the team should have expertise in chemistry, engineering, process controls and instrumentation, maintenance, production and operations, and chemical process safety. For the specific process being reviewed, research will be required to identify available IST alternatives.

IV. IST Review Report

A report must be prepared for the IST review. The report should document all the findings of the evaluation described in section II. above. The report should include past IST and risk reduction measures that have already been incorporated into the current process. For IST alternatives that will be adopted, the o/o should provide a schedule for implementation.

Appendix 1

Examples of Inherently Safer Technology

The following are examples of inherently safer technologies that have been implemented by TCPA registrants in the past. This list is not considered to be comprehensive and all-inclusive. Also, items listed here may not be applicable or appropriate for a specific process or Extraordinarily Hazardous Substance (EHS). Each owner or operator must evaluate possible Inherently Safer Technologies that are appropriate for their process.

1. Reduction of inventory of EHS materials:
Some TCPA sources have already implemented inventory reduction by converting a batch to a continuous process and by eliminating the need of an intermediate storage tank. Some examples include onsite generation of phosgene, chlorine, sulfur dioxide, and sulfur trioxide and consuming them to make a relatively non-hazardous material without the need for storage of the EHS. The o/o should first search for a proven technology by using the same EHS but with much reduced inventory and find out if it is applicable for their process or whether it presents a new hazard in a different form. The o/o should review the hazards in a holistic approach.

2. Substituting less hazardous materials:
Some TCPA sources have already accomplished this mostly in water/waste water treatment by replacing chlorine with sodium hypochlorite, ozone, other disinfectant chemicals, or ultra violet rays. The o/o should start with a proven technology and review if is practicable for their application.

3. Using EHSs in the least hazardous process conditions or form:
Examples of technologies that are currently available include refrigerated EHSs under atmospheric pressure instead of under pressure, use of diluted materials instead of pure form, vacuum application instead of pressure application, use of hot water or steam instead of flammable oil for heating.

4. Designing equipment and processes to minimize the potential for equipment failure and human error:
This is one area where many opportunities exist for an o/o to implement IST both for a grass root design or an existing facility handling EHS materials. Numerous publications in the public domain by sources such as CCPS/AIChE, Frank Lees, Trevor Kletz, and Stanley Englund provide many practical applications of inherently safer plants. It is to be noted that the codes and practices as currently available in process industries cover only the minimum requirements for the design of a process, which may not be sufficient to be considered an inherently safer design.

The following is a list of safeguards that have been implemented by o/o's of existing TCPA facilities, which may be as effective as IST when used in combination with other independent safeguards and in consideration with other IST alternatives mentioned in paragraphs 1, 2 and 3 above:

(a) Providing a remotely operated valve at each end of a transfer hose handling an EHS and activated by an installed leak detector.
(b) Providing installed leak detectors with multiple sensors strategically located considering wind direction, location of leak, proximity to continuous attendance (storage tanks or reactors where operators are not physically stationed on a continuous basis should not be exempted from installing leak detectors.)
(c) Reducing the piping length to reduce inventory
(d) Containment of a bromine spill at a truck unloading station by maintaining a level of water which will be displaced by bromine. Bromine is 3 times heavier than water and will sink to the bottom while water will overflow to a neighboring sump. This will reduce the bromine vaporization rate significantly.
(e) Providing dikes for spill containment and deployment of materials such as foams or small hollow plastic spheres to be placed on top of a spill to suppress vapor generation.
(f) Storing cylinders/containers containing EHSs (such as chlorine, phosgene, bromine or anhydrous ammonia) inside an enclosure provided with a leak detector and vented to an emergency scrubber.
(g) Providing multiple levels of protection with relief valves as the ultimate safety venting to an emergency scrubber or flare.
(h) Installing a pencil flare or thermal oxidizer to supplement the existing flare capacity.
(i) Safe unloading of an EHS from tank wagons and rail cars in a closed system to prevent toxic release or fire and explosion.
(j) Unloading a tank wagon inside a building which vents to a scrubber.
(k) Containment of reaction mass within a process vessel by designing the vessel at the maximum pressure resulting from a runaway reaction dictated by a risk based analysis.
(l) User-friendly operating procedures and inherently safer control system including redundant detection systems, continuous monitoring system, safety alarm and interlock provided with independent elements, and grounding interlock of pumps transferring flammable materials.
(m) Providing a firewall or blast wall or bunker at strategic locations to mitigate the consequences of fire and explosion when alternate IST does not look practicable.