# SECTION D: PROCESS HAZARD ANALYSIS/ACTION ITEMS

County Ordinance Code Chapter 450-8, Section 450-8.016(d) as amended by County Ordinance 2006-22[1] requires Stationary Sources to conduct a process hazard analysis (PHAs) on each covered process at their Stationary Source. The PHAs and PHA revalidations should be conducted in conformance with Section 2760.2 of the CalARP program regulations and Section 7.3 of the *Contra Costa County CalARP Program Guidance Document,* except in assessing whether seismic events must be considered. Stationary Source must complete recommended actions from PHA's and from PHA revalidations within one year. If a process shutdown is required, then the recommended actions must be completed during the first regularly scheduled turnaround of the applicable process subsequent to the 1-year completion time frame. With the exception of Security and Vulnerability Assessments, other studies and analyses related to the PHA (external events such as seismic, facility siting for a process unit, and other studies such as evaluations for latent conditions, human factors, inherently safer systems, etc.), are subject to the same 1-year completion time frame for any action items/recommendations developed as a result of these studies or analyses, unless a turnaround is required. Stationary Sources must send CCHMP a request for extension before PHA actions (including other studies and analysis related to the PHA) become overdue when they cannot be addressed within 1 year and a turnaround is not required.

As part of an external events analysis of PHAs, the risks from seismic events must be evaluated (i.e., a seismic assessment must be conducted) if the covered process (as defined in Section 450-8.014(a) of County Ordinance Code Chapter 450-8) contains a regulated substance (as defined in Section 2735.3(qq) of the CalARP program regulations) and the distance to the nearest public receptor for a worst case release scenario[2] is within the distance to the toxic or flammable endpoint (i.e., Program 3 covered process).[3] The seismic assessment should be conducted in accordance with Section 7.3.4 and Appendix B of the *Contra Costa County CalARP Program Guidance Document.*

Also as part of PHAs, and as required in Section 450-8.016(g), Stationary Sources shall perform and document a Security and Vulnerability Assessment (SVA) as defined in Section 7.3.4 of the *Contra Costa County CalARP Program Guidance Document*, by June 30, 2007, and at least once every five years after the initial assessment, or as prescribed by federal regulation. For Stationary Sources that are not required to perform an SVA or revalidations at least every five years as required by the Department of Home Land Security (DHS) or the U.S. Coast Guard (USCG), the SVA shall include:

- SVA methodology; consult with CCHMP if using any methodology not listed in this section;
- Intent to perform a 5 year SVA revalidation, and description of the method used to perform a revalidation;
- Indication of what mechanism is in place to track and ensure that recommendations are addressed; and
- Indication of the criteria for rejecting recommendations.
- Documentation for assuring that recommendations are properly addressed.

The following SVA assessment methodologies are acceptable to CCHMP:

- American Institute of Chemical Engineers Center for Chemical Process Safety: Guidelines For Analyzing And Managing The Security Vulnerabilities Of Fixed Chemical Sites;
- Department of Justice – Sandia Labs: Chemical Facility Vulnerability Assessment Methodology;
- Department of Justice – Sandia Labs: Risk Assessment Methodology for Water Systems (RAM-W);
- Synthetic Organic Chemical Manufacturers Association, Inc. ("SOCMA"): Manual on Chemical Site Security Vulnerability Analysis Methodology and Model;
- Air Products: APCI Security Vulnerability Assessment;
- BASF Security Vulnerability Assessment (SVA) Methodology & Enhanced Security Implementation Management;
- ExxonMobil: Chemical Facilities Safeguards and Security Risk Assessment Methodology;
- Georgia Pacific: Security and Vulnerability Assessment;
- American Petroleum Institute/National Petroleum Refiners Association Security Vulnerability Assessment method. [Contra Costa CalARP Guidance Document Appendix I]; and
- The workshop sponsored by the Water Environment Federation that covers "Vulnerability Assessment and Security Planning for Medium Drinking Water Utilities" that includes training on how to apply the EPA approved software titled "VSAT" for developing an SVA for a medium size water treatment plant.

For those Stationary Sources that are required to submit their SVA to the DHS via Chemical Facility Anti Terrorism Standards (CFATS), or to the USCG, the responsibility for regulatory oversight will remain with these organizations. CCHMP will not include the audit questionnaire for this subject as part of the CalARP/ISO safety audit. However, as described in Section E.9, the Safety Plan shall include a discussion of the SVA performed and the process for resolution of identified issues. Preparation and submittal of DHS Chemical Security Assessment Tool TOP-Screen does not constitute an SVA revalidation.

Additionally, County Ordinance Code Chapter 450-8, Section 450-8.016(d) requires the following for conducting PHAs.

## D.1 INHERENTLY SAFER SYSTEMS

The intent of the Inherently Safer Systems (ISS) requirements is that each Stationary Source, using good engineering practices and sound engineering judgment will incorporate the highest level of reliable hazard reduction to the greatest extent feasible, to prevent Major Chemical Accidents and Releases.

*"Inherently safer systems" means "inherently safer design strategies" as discussed in the latest edition of the Center for Chemical Process Safety Publication "Inherently Safer Chemical Processes," and means feasible alternative equipment, processes, materials, lay-outs, and procedures meant to eliminate, minimize, or reduce the risk of a major chemical accident or release by modifying a process rather than adding external layers of protection. Examples include, but are not limited to, substitution of materials with lower vapor pressure,*

*lower flammability, or lower toxicity; isolation of hazardous processes; and use of processes which operate at lower temperatures and/or pressures."* County Ordinance Code Chapter 450-8, Section 450-8.014(g).

As discussed in the 2009 Center for Chemical Process Safety Publication Inherently Safer Chemical Processes, a Life Cycle Approach*, "Inherent safety is a concept, an approach to safety that focuses on eliminating or reducing the hazards associated with a set of conditions. A chemical manufacturing process is inherently safer if it reduces or eliminates the hazards associated with materials and operations used in the process and this reduction or elimination is permanent and inseparable."* An Inherently Safer Process is then defined as,"*One which reduces or eliminates the hazards associated with materials and operations in a manner that is permanent and inseparable from the process itself". "For all covered processes, the Stationary Source shall consider the use of inherently safer systems in the development and analysis of mitigation items resulting from a process hazard analysis and in the design and review of new processes and facilities."* County Ordinance Code Chapter 450-8, Section 450-8.016(d)(3). The term inherently safer implies that the process is safer because of its very nature and not because equipment has been added to make it safer.[4]

The 2009 Center for Chemical Process Safety Publication Inherently Safer Chemical Processes, a Life Cycle Approach has defined four categories for risk reduction:

- Inherent - Eliminating the hazard by using materials and process conditions which are nonhazardous; e.g., substituting water for a flammable solvent.
- Passive - Minimizing the hazard by process and equipment design features which reduce either the frequency or consequence of the hazard without the active functioning of any device; e.g., providing a diked wall around the storage tank of flammable liquids.
- Active – Using controls, alarms, safety instrumented systems and mitigation systems to detect and respond to process deviations; e.g., a pump that is shut off by a high level switch in the downstream tank when the tank is 90% full. These systems are commonly referred to as engineering controls, although human intervention is also an active layer.
- Procedural – Using policies, operating procedures, training, administrative checks, emergency response, and other management approaches to prevent incidents, or to minimize the effects of an incident; e.g., hot-work procedures and permits. These approaches are commonly referred to as administrative controls.

These risk reduction strategies may contribute to the overall safety of a process; however only the first category, inherent, does so in a way which seeks to remove the hazard while the other three accept the hazard and attempt to mitigate the effects. While a Stationary Source may use any of the four categories of risk reduction, it is preferred that the inherent option be chosen over the other three whenever possible. The inherent and passive categories should be implemented when feasible for new processes and facilities and used during the review of Inherently Safer Systems for existing processes if these processes could cause incidents that that could result in a Major Chemical Accident or Release. Active and procedural

applications of risk reduction strategies should be used in developing recommendations and mitigations from process hazard analyses along with the inherent and passive categories. CCHMP encourages the use of inherent options to the greatest extent feasible.

Approaches to consider Inherently Safer Systems include the following[4]:

- Minimization – Use smaller quantities of hazardous substances (also called *Intensification*)
- Substitute – Replace a material with a less hazardous substance
- Moderate – Use less hazardous conditions, a less hazardous form of a material, or facilities that minimize the impact of release of hazardous material or energy (also called *Attenuation* or *Limitation of Effects*)
- Simplify– Design facilities that eliminate unnecessary complexity and make operating errors less likely, and that are forgiving of errors that are made (also called *Error Tolerance*)

The following guidance on the review of ISS is broken down into seven separate sections. The first section addresses new processes, the second section addresses existing processes; the third section addresses mitigations resulting from PHA; the fourth section defines feasibility; the fifth section addresses recommendations from PHAs; the sixth section addresses ISS Reports; and the last section contains definitions. As discussed in the following sections, the ISS analyses must be performed for situations where a major chemical accident or release could reasonably occur[5] with the exception of ISS for new processes which should begin the ISS considerations at the conception phase.

References on the approaches to ISS to consider are listed at the end of this section.

## D.1.1 INHERENTLY SAFER SYSTEMS ANALYSIS FOR NEW PROCESSES

For the intent of this Section, a new process is defined as: *the addition of a process that did not previously exist or a major revamp of an existing process resulting in a substantial change in the process configuration or process chemistry.*

The Industrial Safety Ordinance requires a Stationary Source to consider Inherently Safer Systems " . . . in the design and review of new processes and facilities." (§450-8.016(d)(3)). CCHMP expects Stationary Sources to develop criteria when a new process would require ISS considerations. This section describes the different phases in the development of a new process that an Inherently Safer Systems analysis should be applied. Inherently Safer Systems approaches should be reviewed early in the development phase of a new process and then revisited throughout the different process design phases. The objectives for an inherent safety review are to employ synergistic teams[6] to:

- *Understand the hazards*
- *Find ways to reduce or eliminate the hazards*

*"The first major objective for the inherent safety review is the development of a good understanding of the hazards involved in the process. Reducing and eliminating hazards and their associated risks is the second major objective. Applying inherent safety principles early in the product/process development effort provides the greatest opportunity to achieve the objectives of the inherent safety review process for the project at hand."*[7]

The Stationary Source should use a review process for new processes that includes an Inherently Safer Systems review at different phases of the design process. For new processes the following different phases for reviewing ISS may be applicable:

- During the chemistry forming (synthesis) phase for product/process research and development to focus on the chemistry and process
- During the facilities design scoping and development prior to completion of the design basis to focus on equipment and configuration
- During the basic design phase of the project

CCHMP understands that for different Stationary Sources and different processes that the above phases, timing and sequencing, may not always be applicable. For some processes, the chemistry may be complete and the chemistry-forming phase is not applicable. For some Stationary Sources it may be more appropriate to do ISS analyses at phases that are not entirely the same as described above, but occurs at the same approximate timing in a project development and design phases. The intent is that a Stationary Source conducts ISS analysis early in the project development and throughout the various phases of the design to capture the opportunity of incorporating ISS strategies. Stationary Sources should recognize that the earlier in a project development and design the easier and most likely less costly it is to make a choice to implement Inherently Safer Systems than it is to change design and specifications later in the project.

#### D.1.1.1 APPLYING INHERENTLY SAFER SYSTEMS REVIEW – CHEMISTRY-FORMING PHASE

Inherently Safer Systems should be evaluated early in the assessment of the project. When applicable, this assessment should be done in the chemistry-forming phase during the product and process research and development. A team with a diverse background would best perform the assessment. The team assessment should address topics such as:

- An understanding of the hazards
- The best route to produce a given chemical or product
- Process improvement
  - Reactor types and conditions
  - Intermediate storage optimization
  - Waste minimization
- Identify requirements for additional information
- Worker Safety
- Inventory needs

Some of the information that may need to be available prior to this review includes the following[8]:

- Simplified process flow diagrams
  - Include alternative processes
- Defined chemical reactions
  - Desired and undesired
  - Develop potential for runaway reactions/decompositions
- A list of all chemicals and materials employed
  - Develop compatibility matrix
  - Obtain MSDSs
  - Include air, water, rust, etc.
- Defined physical, chemical, and toxic properties
- Defined process conditions (pressure, temperature, etc.)
- Estimated quantities used in each process system (tanks, reactors, etc.)
  - Estimate quantities of wastes/emissions

The review team should examine the following questions:

- Can safer chemicals be used?
- Can quantities be reduced?
- Is the overall risk increased by implementing an ISS?
- Can waste be reduced? (Regenerable catalyst or recyclable.)
- What additional information is required? (Toxicology information, heats of reaction, or reactive chemicals data.)

Documentation that should be kept for this phase of the project, when applicable, includes, but is not limited to:

- How the decision was made to perform an ISS Review at this phase
- How and when the assessment was performed
- The assessment team leader, including the relevant experience of the team leader
- The makeup of the assessment team by discipline, experience, and name of the participants
- The information that was prepared and available during the assessment
- How the hazards were understood, including flammability, toxicity, and reactivity
- The different routes to produce a given chemical or product and how the best route was determined, including the criteria and method used for this determination
- How process improvements were reviewed and the determination of the process that was determined to be the inherently safest process
- The answers to such questions as those listed above
- The identification of requirements for additional information

### D.1.1.2 APPLYING INHERENTLY SAFER SYSTEMS REVIEW – FACILITIES DESIGN SCOPING AND DEVELOPMENT

Inherently safer systems should then be evaluated during the design-scoping phase of the project when applicable. The evaluation should concentrate on the following:

- Minimizing equipment
- Reducing inventories
- Simplifying the process
- Reducing wastes
- Moderating process conditions

The preliminary information that should be available prior to the development phase of the project ISS review may include the following:

- Process flow diagram or simplified process flow diagram
- Preliminary P&IDs
- Material and Energy Balance
- Defined chemical reactions
- Defined physical, chemical, and toxic properties

During the review the team should examine questions such as:

- Previously unanswered questions
- Can potential releases be reduced via lower temperatures or pressures, or elimination of equipment?
- Can quantities be reduced?
- Can waste be reduced? (Regenerable or recyclable catalyst.)
- Can different equipment be used resulting in safer conditions?
- What sequencing is necessary for material additions?
- Is the reaction exothermic, endothermic, or adiabatic?

Documentation that should be kept for this phase of the project includes, but is not limited to:

- How the decision was made to do an Inherently Safer Systems Review at this phase
- How and when the assessment was performed
- The assessment team leader, including the relevant experience of the team leader
- The makeup of the assessment team by discipline, experience, and name of participants
- The information that was prepared and available during the assessment

- The process used to determine that the equipment sizes are minimized and the results of this determination
- The process used to determine the minimum inventories needed and the results of this determination
- The process used to simplify the project, if applicable, and the results of this process
- The process used to reduce the waste made from the project and the results of the determination
- How the moderation of the process was done – the checklist in Attachment C could be used in this determination
- The answers to such questions as those listed above
- The identification of requirements for additional information

### D.1.1.3 APPLYING INHERENTLY SAFER SYSTEMS REVIEW – DURING THE BASIC DESIGN OF THE PROJECT

During this assessment phase, use of ISS should be reviewed and documented. This may be achieved using a checklist that incorporates ISS considerations such as those listed in Attachment C. Another method that may be used is the incorporation of additional parameters and guidewords such as those used in a Hazard and Operability Study. An example of guidewords or parameters that could be used is shown in Attachment D. These analyses would review the processes for ways to eliminate or reduce hazards that are present in the process. The CCPS book, Inherently Safer Chemical Processes (2009) also has additional checklists including those geared towards Stationary Sources taking a risk based process safety approach. Preliminary safety critical devices and procedures should be examined to determine if there is a way to eliminate the need for the device or procedure by applying principles of inherently safer systems. The information prepared prior to the design phase of the project should include the process safety information that is required under the Industrial Safety Ordinance and CalARP Program. Some of the information to be included with the process safety information is the following:

- Process Flow Diagrams (PFD's)
- Piping and Instrument Diagrams (P&ID's)
- Material and Energy Balance
- Equipment specifications
- Designing equipment for isolation when applicable – (P&ID's may be sufficient to address this requirement)
- Preliminary safety critical procedures or guidelines
- Instrumentation logic information – (P&ID's may be sufficient to address this requirement)

During the ISS Study the team should consider such questions as:

- Can potential releases be reduced via lower temperatures or pressures, lower concentrations, elimination of equipment?
- Can quantities be reduced?
- Can waste be reduced?

The documentation that should be included for the checklist analysis includes the items that are applicable from the checklist in Attachment C, what items were considered, how they were considered, and the results of the consideration. For items that were applicable and not considered, document why each item was not considered.

Note: Corporate and/or engineering teams are likely involved in the basic design of the more significant new processes/projects and these may involve licensed technologies. In any case, Stationary Sources should not use the proprietary technology to by-pass needing to apply ISS or avoid conducting an ISS analysis on non-licensed portions such as connected equipment, storage or other parts of the process. Corporate and/or local engineering teams must be well versed in the application of ISS and need to be involved in the ISS analysis. This analysis needs to be documented.

The documentation for incorporating the guidewords for inherently safer systems into a Hazard and Operability Study should be consistent with the documentation used during any Hazard and Operability Study.

Other methods for performing an ISS Analysis may be appropriate. If another method is used, the Stationary Source must work with CCHMP in determining that this other method is appropriate for analyzing for ISS prior to implementation.

The documentation must include the makeup of the review team by discipline, relevant experience, dates of the ISS review and the names of the review leader and participants.

### D.1.2 INHERENTLY SAFER SYSTEMS ANALYSIS FOR EXISTING PROCESS UNITS

The Industrial Safety Ordinance requires that Stationary Sources consider hazards as part of the process hazard analyses.

*"The process hazard analysis shall be appropriate to the complexity of the Covered Process and shall identify, evaluate, and control the hazards involved in the Covered Process. The process hazard analysis shall address: the hazards of the process; the identification of any previous incident which had a likely potential for catastrophic consequences; engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases."* Chapter 450-8 §450-8.016(d)(1)

**NOTE:** ISS need only be considered for scenarios where a Major Chemical Accident or Release could reasonably occur. This could include a process or parts of a process. The Stationary Source needs to establish a method to make the determination of a potential occurrence of a Major Chemical Accident or Release. This could include examining each consequence of a deviation, including the severity of each consequence.

Stationary Sources should perform one of the following methods to ensure that ISS (inherent and passive categories) are considered and documented for the covered processes:

- An independent ISS analyses that is done in addition to a PHA[9]. These analyses should review the covered processes for ways to eliminate or reduce hazards that are present in the covered process. This may be achieved by using a checklist (Attachment C) or guideword analysis (Attachment D) that incorporates ISS. If the Stationary Source decides to use some other ISS checklist or other methods to evaluate ISS, these must be approved by CCHMP prior to their use.
- An ISS analyses that is incorporated into the existing PHA review process. This would require that each covered process in its entirety have an initial ISS analyses conducted. (Incorporating inherently safer systems into a revalidated process hazard analysis may not be sufficient to satisfy the initial ISS review if the whole process is not evaluated.) This may be achieved using a checklist (Attachment C) or guideword (Attachment D) that incorporates ISS considerations into a Hazard and Operability Study where a Major Chemical Accident or Release could reasonably occur. These analyses would review the covered processes for ways to eliminate or reduce hazards as well as risks that are present in the covered process.

Whichever type of ISS analysis is implemented by the Stationary Source the following will need to be done:

- The Stationary Source will document the qualifications of the team facilitator/leader and team makeup, including positions, names, and any relevant experience or training.
- The Stationary Source will document the ISS's considered as well as those implemented. Implementing only one option to address identified hazards may not be adequate to address the greatest hazard reduction or elimination. However, it is not necessary to implement more than one ISS if the implementation of a second ISS does not add any significant hazard reduction or has been documented as infeasible.
- If the Stationary Source chooses to do an independent ISS analysis, the Stationary Source should document the method used for the analysis, what ISS were considered, and the results of each consideration. If the checklist for ISS was used, for items that were not considered, document why those items were not considered, i.e., not applicable or were already considered in previous consideration.
- The Stationary Source will document for the ISS considered and not implemented, the grounds that were used to make the feasibility determination (See D.1.4 Feasibility).

- The documentation for incorporating the guidewords for ISS into a Hazard and Operability Study should be consistent with the documentation used during any Hazard and Operability Study.
- For any other ISS analysis, the Stationary Source should document the ISS considered, the ISS implemented, and the ISS not implemented.
- The ISS analyses should be revalidated at least once every five years. The revalidation should include and document the following:
    - Incorporate improvements made in method since the last review was conducted or select a new method to perform the ISS analyses.
    - ISS review for all changes that have been made since the last ISS analysis.
    - Review of all major chemical accidents or releases or potential major chemical accidents or releases that occurred at the process under review.
    - Review for any new and existing technologies not previously reviewed that can be incorporated that will make the process under review inherently safer.

### D.1.3 PROCESS HAZARD ANALYSIS RECOMMENDATIONS AND MITIGATIONS

The concepts as addressed in the CCPS book Inherently Safer Chemical Processes a Life Cycle Approach for looking at all four categories of risk reduction (Inherent, Passive, Active, and Procedural) should be used in the development and mitigation of recommendations from process hazard analysis as well as for considering Human Factors.[10] Chapter 4 of the CCPS book Inherently Safer Chemical Processes a Life Cycle Approach discusses many inherently safer system strategies that can be incorporated in the development of mitigations to address the recommendations from process hazard analysis.

The Stationary Sources should provide guidance to personnel responsible for developing and analyzing recommendations and mitigation items resulting from the unit PHA. The guidance should include the concepts of inherently safer systems including:

- The different categories of risk reductions
- Moving up the different levels from procedural to active to passive to inherent levels
- Approaches to apply inherently safer systems including minimization, substitution, moderation, and simplification

The Stationary Source should document how they used the inherently safer system strategies for risk reduction in developing and analyzing mitigations to address the recommendations from a process hazard analysis. There should be sufficient detailed documentation satisfactory to CCHMP and should at least include the following for the Stationary Sources ISS program description:

- The facility has a program in place to ensure that risk reduction actions taken to address PHA recommendations incorporate inherently safer systems.

- The program incorporates at a minimum; the four levels of risk reductions described beginning on page D-3 of this document.
- How the Stationary Source encourages moving up the levels from procedural to inherent in the implementation of the inherently safer system strategies.

The Stationary Source should also document the implementation of ISS strategies and should include the following:

- At least one risk reduction action was taken using inherently safer system strategy for each PHA mitigation item for scenarios that have the potential for a Major Chemical Accident or Release.
- A description of the risk reduction method selected and the inherently safer system strategy used.
- Details of risk reduction mitigation considered using the inherently safer system strategy that was not implemented.
- Reasons the rejected risk reduction mitigation was determined to be infeasible using the inherently safer system strategies.

### D.1.4 FEASIBILITY

The Industrial Safety Ordinance requires the Stationary Source to select and implement ISS to the greatest extent feasible (Section 450-8.016 (D)(3)). The Industrial Safety Ordinance also defines feasible " . . . capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors." To assist in the determination of feasible, CCHMP is using a modification of the following guidance from OSHA (Federal OSHA provided guidance for justifiably declining recommendations from incident investigations in the September 1994, OSHA Instruction CPL 2-2.45A CH-1. These criteria have since been applied to recommendations formulated during PHA's.) And the U.S. EPA:

- The analysis upon which the recommendations are based contains factual errors.
- The recommendation is not necessary, i.e., the safeguards may be inadequate, but the consequences are operational or the consequence or severity of the scenario would not result in a Major Chemical Accident or Release.
- An alternative ISS would provide a sufficient level of hazard reduction (NOTE: Implementing only one option to address identified hazards may not be adequate to address the greatest hazard reduction or elimination. However, it is not necessary to implement more than one ISS if the implementation of a second ISS does not add any significant hazard reduction or has been documented as infeasible.)
- The recommendation is in conflict with existing federal, state, or local laws.
- The recommendation is in conflict with Recognized and Generally Accepted Good Engineering Practices (RAGAGEP).
- The recommendation is economically impractical, such that the process unit can no longer be financially operated. This can include the following factors:
    - Capital investment

  - Product quality
  - Total direct manufacturing costs
  - Operability of the plant
  - Demolition and future clean-up and disposal cost
- The recommendation would have a negative social impact such that the project should not be implemented. Some examples of social impact include the recommendation would have a visual or noise impact on the community that is not acceptable and the recommendation would cause or increase the traffic congestion.
- The recommendation may violate a license agreement and the license agreement cannot be modified and must remain in effect.
- The recommendation may decrease the hazard, but would increase the overall risk.
- An alternative measure would provide more risk reduction than the ISS
- If the ISS recommended is determined not to be implemented because it will create more risk, or if other modifications that are not ISS are made such that the overall risk is less than if the ISS were implemented, the Stationary Source will need to document how this determination was made. A qualitative risk assessment/analysis could be used as a basis for the risk analysis. The Stationary Source needs to document how they determined the qualitative severity and likelihood for the existing or modified conditions and for the conditions if the ISS is implemented. If the qualitative risk analysis shows the same level of risk, then a quantitative risk assessment/analysis should be performed to compare the risk of the existing or modified conditions to the risk if the ISS is implemented. The documentation should include the background information that was used to do the comparison of the existing or modified conditions to the conditions if the ISS is implemented. Another method may be used by the Stationary Source, such as a weighted scoring decision matrix as shown on page 223 of CCPS book Inherently Safer Chemical Process a Life Cycle Approach, if that method is approved by CCHMP prior to the use of the method.

County Ordinance Code Chapter 450-8, §450-8.016(d)(4) requires the following: "For recommended actions not selected for implementation, the Stationary Source shall include the justification for not implementing the recommended action. For all covered processes, the Stationary Source shall retain documentation of closure, and any associated justifications, of actions identified by the process hazard analysis." The documentation should include the applicable background information, calculations, and the reasons that an inherently safer system was not implemented. If there is any concern that the reasons for not implementing an inherently safer system would not satisfy CCHMP, the Stationary Source should consult with CCHMP to determine if the justification is satisfactory. The Stationary Source should then receive in writing from CCHMP their decision and how they came to their decision including background information, calculations, and alternatives considered.

### D.1.5 COMPLETION OF RECOMMENDED ACTION ITEMS

Stationary Sources must document the decision made to implement or not implement all process hazard analysis recommended action items and the results of recommendations for

additional study. This documentation must include the justification for not implementing any recommended actions. Federal OSHA provided guidance for justifiably declining recommendations from incident investigations in the September 1994, OSHA Instruction CPL 2-2.45A CH-1. These criteria have since been applied to recommendations formulated during PHA's. **NOTE:** Additionally, CCHMP encourages Stationary Sources to consider the impact on surrounding communities when declining recommendations.

- The analysis upon which the recommendation is based contains material factual errors
- The recommendation is not necessary to protect the health and safety of the employer's own employees, or the employees of contractors
- An alternative measure would provide a sufficient level of protection
- The recommendation is infeasible

Cal/OSHA issued the following clarification in Part 4 of the June 1994 Process Safety Management Guidelines. "…Cal/OSHA's intent is that an employer is required to implement the teams' findings and recommendations except to the extent that an employer can document that an alternative will be at least as effective or efficient in addressing the safety concerns that are the subject of those findings and recommendations".

The Stationary Source must complete the recommended actions selected for implementation, including those formulated during PHA, as follows:

- All actions not requiring a process shutdown must be completed within one year after submittal of the original Safety Plan or after completion of the PHA revalidation unless the Stationary Source demonstrates to the satisfaction of CCHMP that within one year is infeasible
- All actions requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process subsequent to one year after submittal of the Safety Plan or after completion of the PHA unless the Stationary Source demonstrates to the satisfaction of CCHMP that such a schedule is infeasible
- Stationary Sources must send CCHMP a request for extension before PHA actions (including other studies and analysis related to the PHA) become overdue when they cannot be addressed within 1 year and a turnaround is not applicable.

ISS Study and ISS Revalidation recommendations should be resolved in a timely manner. CCHMP Staff may request that the Stationary Source make the plans for completing these recommendations available during facility audits.

Examples of situations where the schedule may be infeasible include procuring customized equipment requiring a long lead time for fabrication and delivery, complex projects requiring significant front-end engineering, facilities that require substantial time to construct, or implementing a recommended action that requires the application of a local air district permit to construct or county land use permit and its requirements (a CEQA analysis may be

conducted.) **NOTE:** the Stationary Source must demonstrate that they initiated the land use permit process in a timely manner.

The Stationary Source must retain documentation of closure and any associated justification of actions identified by the process hazard analysis. CCHMP interprets "actions" to include, but not be limited to, all recommendations made for changes to physical equipment and procedures, and for additional studies and information. The Stationary Source must also retain documentation of communication to operating, maintenance, and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.

### D.1.6 INHERENTLY SAFER SYSTEM REPORTS

An Annual report on the Industrial Safety Ordinance is made to the Board of Supervisors in October each year. Each June, CCHMP will request information from the Stationary Sources for this report. Part of this information includes information on the inherently safer systems already implemented. The information on inherently safer systems should include a brief description of each inherently safer system that was implemented from June 1 of the previous year through May 31 of the current year. Each description is to meet the definitions of the inherent or passive levels for processes where a Major Chemical Accident or Release could reasonably occur. The description should include the level of risk reduction (inherent or passive), and the basis for the inherently safer system implemented (e.g., PHA, Inherently Safer System Analysis, Review of Inherently Safer Systems for new processes or facilities).

### D.1.7 DEFINITIONS

1. *"Active – Using controls, alarms, safety instrumented systems, and mitigation systems to detect and correct process deviations; i.e., a pump that is shut off by a high level switch in the downstream tank when the tank is 90% full. These systems are commonly referred to as engineering controls, although human intervention is also an active layer"*[7]

2. Could Reasonably Occur[11] – is a relative term that depends on the severity of the incident that qualifies a scenario as a Major Chemical Accident or Release. A scenario resulting in a Major Chemical Accident or Release could reasonably occur if:

    *a.* For a scenario resulting a Level 2 incident, or on-site property damage (including clean-up and restoration activities) initially estimated at $500,000 or more, the likelihood can be described by "has happen in unit, or at least at location"

    *b.* For a scenario resulting a Level 3 incident, the likelihood can be described by "has happened at location, but very rare"

*c.* For a scenario resulting in one or more fatalities, or greater than 24 hours of hospital treatment of three or more persons, or off-site property damage (including clean-up and restoration activities) initially estimated at $500,000 or more, or a vapor cloud of flammable and/or combustibles that is more than 5,000 pounds, the likelihood is greater than "has not happened at location, and very remote"

The shaded cells in the table below indicate what should be considered reasonable for the different severities

| | Severity (a) | Severity (b) | Severity (c) |
|---|---|---|---|
| Has occurred at process unit | | | |
| Has occurred at Stationary Source | | | |
| Has not occurred at Stationary Source, but could occur during process unit's lifetime or has occurred within industry | | | |
| Has not occurred at Stationary Source or within the industry and occurrence is remote over process unit's lifetime | | | |

3. Inherently Safer Systems –*Feasible alternative equipment, processes, materials, lay-outs, and procedures meant to eliminate, minimize, or reduce the risk of a Major Chemical Accident or Release by modifying a process rather than adding external layers of protection. Examples include, but are not limited to, substitution of materials with lower vapor pressure, lower flammability, or lower toxicity; isolation of hazardous processes; and use of processes, which operate at lower temperatures and/or pressures."* (County Ordinance Code Chapter 450, §450-8.014(g)

4. *"Inherent - Eliminating the hazard by using materials and process conditions which are nonhazardous; i.e., substituting water for a flammable solvent."*[7]

5. Inherently Safer Systems Analysis – Performing a study to incorporate concepts of inherently safer systems. The analysis will include recommendations on incorporating inherently safer systems into a process. The analysis will include the documentation on how the study was performed, the recommendations from the study, and how the recommendations were formulated.

6. Less Hazardous Form – Materials being handled under conditions that is considered less hazardous. Less hazardous conditions can be accomplished by strategies that are either physical (lower temperatures, and/or pressures, dilution) or chemical

(development of reaction chemistry that operates less severe conditions). Examples include: dilution, refrigerated liquids that are gases at standard temperatures and pressures, and operating at lower temperatures and pressures.

7. Major Chemical Accident or Release - is defined by the ordinance (§450-8.014(h)) as *" . . . means an incident that meets the definition of a Level 3 or Level 2 Incident in the Community Warning System incident level classification system defined in the hazardous materials incident notification policy, as determined by the Department; or results in the release of a Regulated Substance and meets one or more of the following criteria:*
   *(1) Results in one or more fatalities;*
   *(2) Results in greater than 24 hours of hospital treatment of three or more persons;*
   *(3) Causes on and/or off-site property damage (including clean-up and restoration activities) initially estimated at $500,000 or more. On-site estimates shall be performed by the Stationary Source. Off-site estimates shall be performed by appropriate agencies and compiled by the Department.;*
   *(4) Results in a vapor cloud of flammable and/or combustibles that is more than 5000 pounds."*

8. *"Minimization – The reduction of the quantity of material or energy contained in a manufacturing process or plant(also called Intensification)"*[7]

9. *"Moderation – Use of materials under less hazardous conditions, use of a less hazardous form of a material, or use of materials in a manner that minimizes the impact of release of hazardous material or energy. (also called Attenuation or Limitation of Effects)"*[7]

10. New Process - *The addition of a process that did not previously exist or a major revamp of an existing process resulting in a substantial change in the process configuration or process chemistry.*

11. *"Passive – Not active but acted upon. In the case of inherent safety, minimizing the hazard by process and equipment design features which reduce either the frequency or consequence of the hazard without the active functioning of any device."*[7]

12. *"Procedural – An established series of steps; a prescribed or traditional set of forms, or requirements to be followed. In the case of inherent safety, the use of operating procedures, administrative checks, emergency response, and other management approaches to prevent incidents, or to minimize the effects of an incident; administrative controls."*[7]

13. Process - Any activity involving a regulated substance including any use, storage, manufacturing, handling, or on-site movement of such substances, or combination of these activities. For the purposes of this definition, any group of vessels that are

interconnected, or separate vessels that are located such that a regulated substance could be involved in a potential release, shall be considered a single process. (CCR Title 19, Section 2735.3(kk)

14. *"Process Flow Diagram – A diagram that shows the material flow from one piece of equipment to the other in a process. It usually provides information about the pressure, temperature, composition, and flow rate of the various streams, heat duties of exchangers, and other such information pertaining to understanding and conceptualizing the process."*[12]

15. *"Quantitative Risk Analysis – The systematic development of numerical estimates of the expected frequency and/or consequence of potential accidents associated with a facility or operation based on engineering evaluation and mathematical techniques*."[13]

16. Safer Chemicals – Chemicals where the acute and chronic toxicity, flammability, reactivity, and instability are lower. A chemical may be safer in some of these hazard categories and higher in others. The facility needs to determine the impact from a release of a chemical based on the above hazards. The chemical with the least impact should be safer.

17. *"Simplification– The design of facilities or processes in a manner to reduce or eliminate unnecessary complexity and make operating errors less likely (also called Error Tolerance)"*[7]

18. *"Substitute – To replace a material with a less hazardous substance, or with an alternative that reduces or eliminates the hazard"*[7]

19. Sufficient Level of Hazard Reduction - The level where the accidental release scenario being considered is not likely to occur.

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[1] Modifications were made to the Contra Costa County's Industrial Safety Ordinance (ISO) in 2006. Major changes made to the human factors program requirements included: requiring changes to maintenance and emergency response staffing to undergo a Management of Organizational Change evaluation; and requiring human factors evaluations of maintenance safe work practice procedures and maintenance procedures for specialized equipment, piping, and instruments. Since the corresponding City of Richmond's Industrial Safety Ordinance has not been amended, Stationary Sources subject to the City of Richmond's ISO are encouraged to comply with the County ISO amendments.

[2] As specified in California Code of Regulations, Title 19, Chapter 4.5, Section 2750.3

[3] As specified in California Code of Regulations, Title 19, Chapter 4.5, Section 2750.2(a)

[4] Process Plants: A Handbook for Safer Design, 1998, Trevor Kletz

[5] Process Hazard Analysis methods determine the risk of a deviation or potential incident. The risk determination is based on a combination of the hazard (severity) of the potential incident and likelihood (probability) of an incident occurring. If the potential hazard (severity) of consequence of a deviation meets the definition of a Major Chemical Accident or Release an ISS Analysis should be done for those that could reasonably occur.

[6] Composition of the review teams will vary at different phases of the development cycle of the project and with the nature of the process. In product development and design scope, the team may comprise of chemist, process design engineers, industrial hygienist, safety engineer, environmental, and control engineer etc. In the hazard and operations

review phase, the team may include operations and maintenance personnel as well. A Stationary Source may choose not to use an ISS review team at a particular phase. If this does occur, the Stationary Source should document the reasons for not using a team for performing an ISS review during this particular phase. A multi-disciplined group should be used throughout the various phases of development, implementation, and operation.

[7] CCPS, Inherently Safer Chemical Processes, A Life Cycle Approach, Second Edition, 2009

[8] Early review often will not have all of the information listed, as it may not be developed yet. Do not wait for the undeveloped information to complete the reviews. Later reviews should cover the information that was not available in the earlier reviews.

[9] If the Stationary Source decides to do an independent inherently safer systems analysis, CCHMP suggests that this be done in conjunction with the process hazard analysis, but it may be appropriate for a Stationary Source to perform an inherently safer systems analysis that is done at a different time than the process hazard analysis. Either approach meets the guidance from this document, as long as the inherently safer systems analysis is revalidated at least once every five years.

[10] County Ordinance Code Chapter 450-8, §450-8.016(D)(3) *"For all Covered Processes, the Stationary Source shall consider the use of Inherently safer Systems in the development and analysis of mitigation items resulting from a process hazard analysis . . .*" and County Ordinance Code Chapter 450-8, §450-8.016(D)(4) *"For all Covered Processes, the Stationary Source shall document the decision made to implement or not implement all process hazard analysis recommended action items and the results of recommendations for additional study. . ."*

[11] Shell Canadian Study

[12] CCPS, Guidelines for Process Safety in Batch Reaction Systems, 1999

[13] CCPS Guidelines for Hazard Evaluation Procedures, Second Edition,1992

[14] CCPS, Guidelines for Engineering Design for Process Safety, 1993

[15] CCPS, Guidelines for Design Solutions for Process Equipment Failures, 1998.

[16] CCPS, Guidelines for Analyzing and Managing the Security Vulnerabilities of Fixed Chemical Sites, 2003.

[17] Process Plants: A Handbook for Inherently Safer Design, Kletz, 1998