



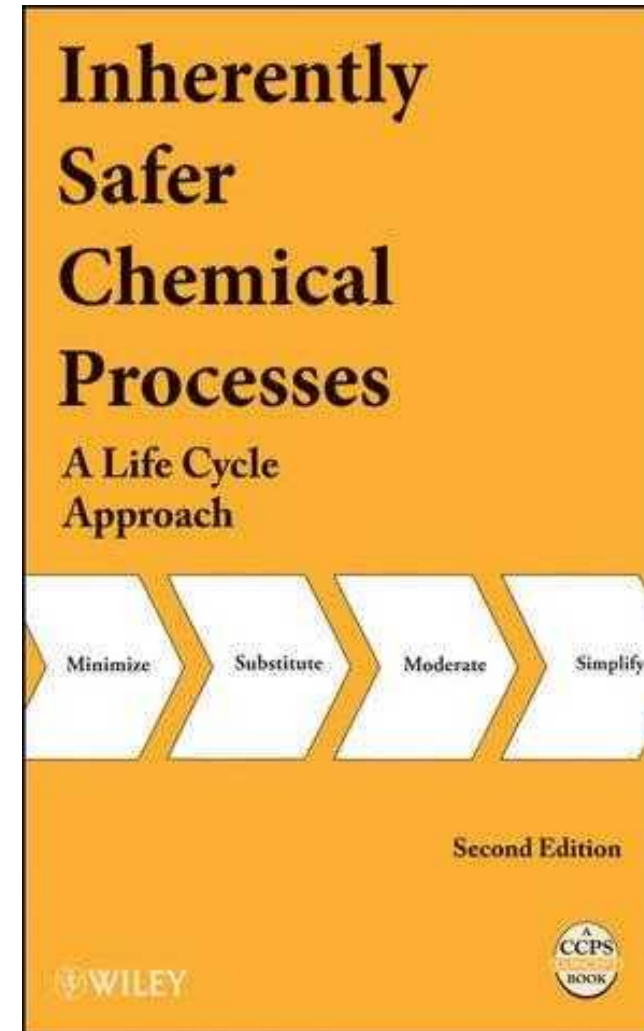
Inherent Safety's Role in Vibrant Process Safety Management Systems

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5TH GLOBAL SUMMIT ON PROCESS SAFETY
22-23 OCTOBER 2019, SINGAPORE



Inherently Safer Design (ISD)

- ISD is a key process risk management technique
- Process safety professionals have embraced the concepts voluntarily for over 50 years
- It is an established method for addressing process risks, with excellent guidance available.
- Is inherently safer design (ISD) being routinely used at all levels and opportunities to the maximum benefit?
- Unfortunately, no...



Fundamentals of ISD

- Inherently Safer Design presents a holistic approach to making the development, manufacture, and use of chemicals safer.
- Involves such practical applications as:
 - substituting more benign chemicals at the development stage,
 - minimizing risk in the transportation of chemicals,
 - using safer processing methods at the manufacturing stage,
 - and inherent safety during commissioning a manufacturing plant.
- Concept originated in UK in late 1960's from ICI. Trevor Kletz, "What You Don't Have Can't Leak"



ISD is the First Level in the Hierarchy of Controls

Control	Objective
Inherent	Eliminating or reducing the hazard
Segregate	Using of distance and barriers to reduce the effects of hazards
Passive	Minimizing the hazard through process and equipment design features
Active	Using controls, alarms, and other means to minimize the likelihood of the hazard escalating or to limit the consequences
Procedural	Using policies, procedures, training, administrative checks, emergency response, and other management approaches to prevent incidents, or to minimize the effects of an incident;

Inherently Safer Design Strategies

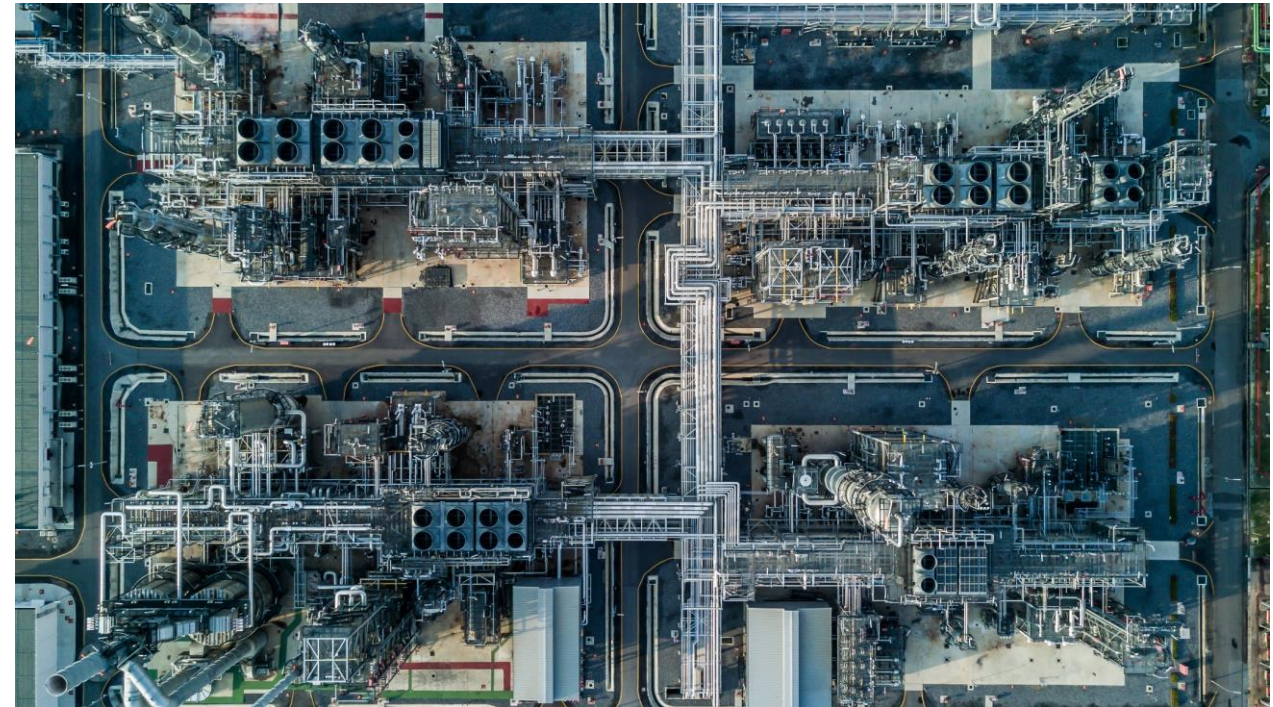
Strategy	Examples
Minimize	Use smaller quantities; eliminate unnecessary equipment; reduce size of equipment or volumes processed.
Substitute	Replace hazardous material with a less hazardous substance.
Moderate	Use less hazardous conditions, a less hazardous form of material or facilities which minimize the impact of a release.
Simplify	Design facilities which eliminate unnecessary complexity and make operating errors less likely.

Inherently Safer Viewpoints

Viewpoint	Examples
Macro (community-based & strategic)	<ul style="list-style-type: none">• Use alternative technology that has a lower operating pressure• Substitute feed stocks with less toxic substance• Substitute entire process technology
Micro (plant-based & tactical)	<ul style="list-style-type: none">• Reduce the size of a particular vessel or line in a process• Use a catalyst that is less toxic• Simplify DCS controls and/or control/operating procedures

Inherently Safer Design (ISD) First Order vs Second Order

- Use ISD “order” to set priorities for evaluation and risk control.
- **First Order**
 - A change that results in the highest degree of risk reduction possible by employing an ISD strategy
 - For example, elimination of a material from site with no need for substitution.
- **Second Order**
 - Risk reduction that is less than First Order and varies in risk reduction.
 - Substitute a less hazardous material that reduces hazard and risk levels.
 - Minimize inventory, but does not eliminate.



ISD Study Approach

- Steps to conduct an ISD study are like other PHAs but differ in that the emphasis is first on whether the process has opportunities to reduce basic hazards using inherent safety as a first strategy.
- Frequently not discussed in a typical PHA study since the team tends to focus on the basic design and determines the adequacy of the layers of protection.
- Approach:
 - Identify and understand hazards associated with a process (HAZOP, HAZID);
 - Analyze the opportunities for each of the four ISD strategies (first to second order);
 - Determine the feasibility of the potential ISD opportunity;
 - Develop recommendations to implement the ISD strategies that are feasible and justified.
 - Assess the adequacy of the layers of controls in the priority of inherent, passive, active, and administrative controls.

ISD Has Proven Value

- Recent AcuTech project to lead 5 ISD studies for a global chemical company on existing processes to demonstrate value
- Each study took on average 4 days to thoroughly review ISD opportunities
- Recommendations – $44+60+44+23+22 = 189$ total or 38 per study on average
- Benefits:
 - Different focus on directly addressing hazards v layers of protection
 - Recognition of key hazards and all options to control
 - Actual risk reduction by hazard elimination and reduction, which reduced risks, capital costs, operating expenses, ongoing risk management requirements from more complex layers of protection



Examples of Recommendations



ISD Opportunity	Benefits
<ul style="list-style-type: none"> Build a plant onsite versus using additional trucks for feedstock delivery to the process. 	<p>This will reduce the number of trucks transiting the roads to the chemical complex and within the plant and the number of offloadings; a direct feed to the plants will simplify the operation and potentially avoid multiple product movements in 3 tanks. Note: Need to evaluate the tradeoff risks.</p>
<ul style="list-style-type: none"> Eliminate one of storage tanks (500M3 each). 	<p>This will reduce the amount of chemicals stored for safety and will simplify the operation and potentially avoid multiple product movements in 3 tanks. Note: Need to evaluate if this would then cause a less stable system with less options for operational flexibility.</p>
<ul style="list-style-type: none"> Eliminate E-35201A/B preheater by enlarging the shell and tube E-15204A/B-3 heater 	<p>To reduce exposure from chemical loss of containment and reduces needless equipment.</p>
<ul style="list-style-type: none"> Locate combustible liquid containing equipment at lower levels of the process and away from personnel exposure or equipment exposure 	<p>To reduce the potential energy which may increase a leak pressure and to reduce consequences.</p>
<ul style="list-style-type: none"> Evaluate the feasibility of using an alternative technology instead of phosgene. 	<p>Reduces the toxic risks.</p>
<ul style="list-style-type: none"> Evaluate if the process N2 pressure to the unit can be reduced. 	<p>Lowers N2 pressure to reduce risk of overpressure of interfacing equipment.</p>
<ul style="list-style-type: none"> Use hot oil instead of 30 bar steam for vaporization. 	<p>Reduces high pressure steam risks. Note: evaluate the combustible hazards of hot oil v risk of tube leak and corrosion of downstream equipment.</p>

Reasons Why Companies May Not Be Getting Maximum Value From Inherent Safety?



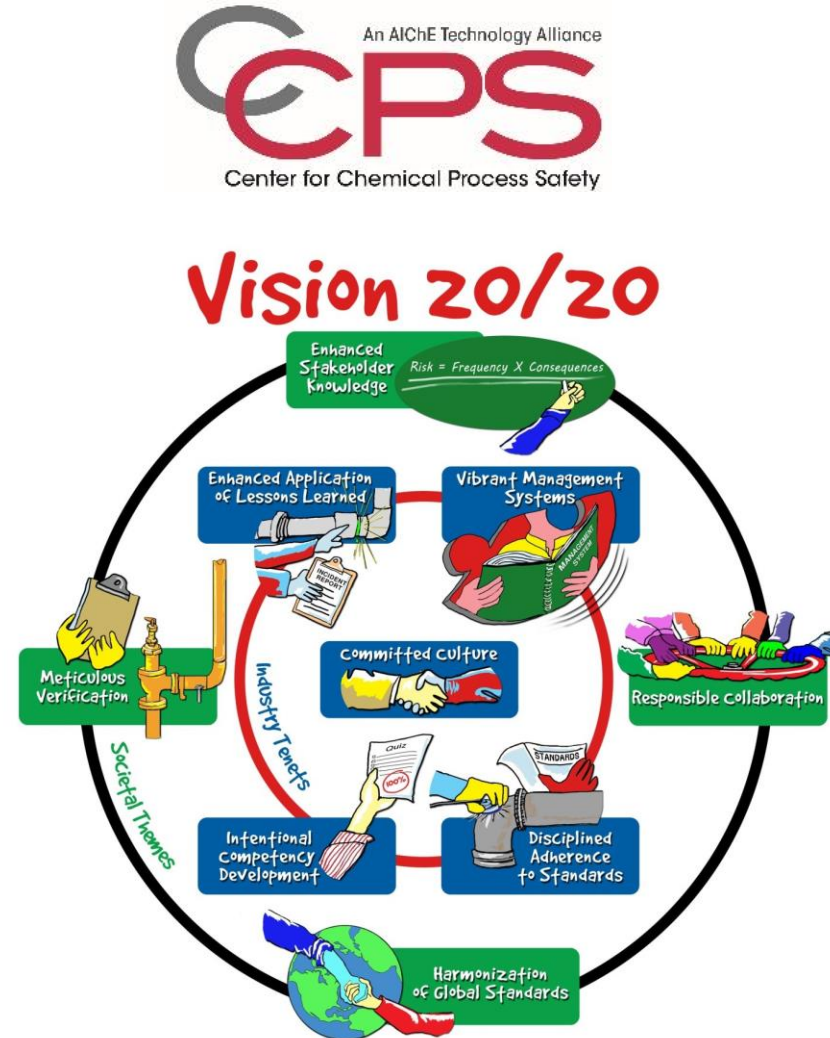
- Is there is a perception that ISD is not a suitable strategy since:
 - the core technology or chemical cannot feasibly be changed?
 - opportunity was only if new process?
 - it may be threatening to the very existence of the business if forced to do so?
- *If so, these may be misconceptions holding you back*



CCPS 20/20 Plan and Inherent Safety



- Vision 20/20, developed by the Center for Chemical Process Safety (CCPS), describes how great process safety is delivered
- It is driven by the five industry tenets and enhanced by the four global societal themes
- One tenet is Vibrant Management Systems



- CCPS explains in their 20/20 Plan that Vibrant Management Systems require clear directives and communication on a common goal and approach to process safety.
- They stated "For vibrant management systems to be effective, all employees must clearly understand their role in managing process safety.
- The management system:
 - Is documented, accessible, and easily used,
 - Defines how operations are conducted at the workplace,
 - Promotes safety in design, operations, and maintenance, and
 - Is agile and continuously improved.



VISION  N20/20

The logo for VISION 20/20, featuring the word "VISION" in black, a stylized globe icon with red and green lines, and "N20/20" in blue.

Does Your Company Have a Written Policy and Procedure for Explicit Use of Inherent Safety?



- Can you pass this test?:
 - We have a written policy to use ISD?
 - There is a written procedure on how to evaluate ISD?
 - We formally documented ISD opportunities in PHAs?
 - We have given training on ISD and how to conduct evaluations?
 - We audit our operations for use of ISD?
- *If not, you may not be fully facilitating its use*



Inherently Safer Design – It Is For Everybody

- Premise: ISD can be widely and routinely used in any facility during any stage of the process lifecycle
- Key factors limiting use:
 - Misunderstanding of what it means
 - Lack of appreciation of potential value
 - Lack of encouragement of its use
 - Lack of knowledge of how to fully apply inherent safety



Inherently Safer Design – It Is For Everybody

- Creative ideas from the employees of the company may be keys to step changes in process safety performance and hazard reduction
- These ideas may be readily implemented
- Companies that create a culture of inherent safety will be advantaged through continuous and creative risk reduction



The Keys to Taking Maximum Advantage of the ISD Concept



- Understand the real potential of ISD and commit to it
- Define a plan to encourage its use
- Ensure that it is an integral part of the safety philosophy and practice of the organization



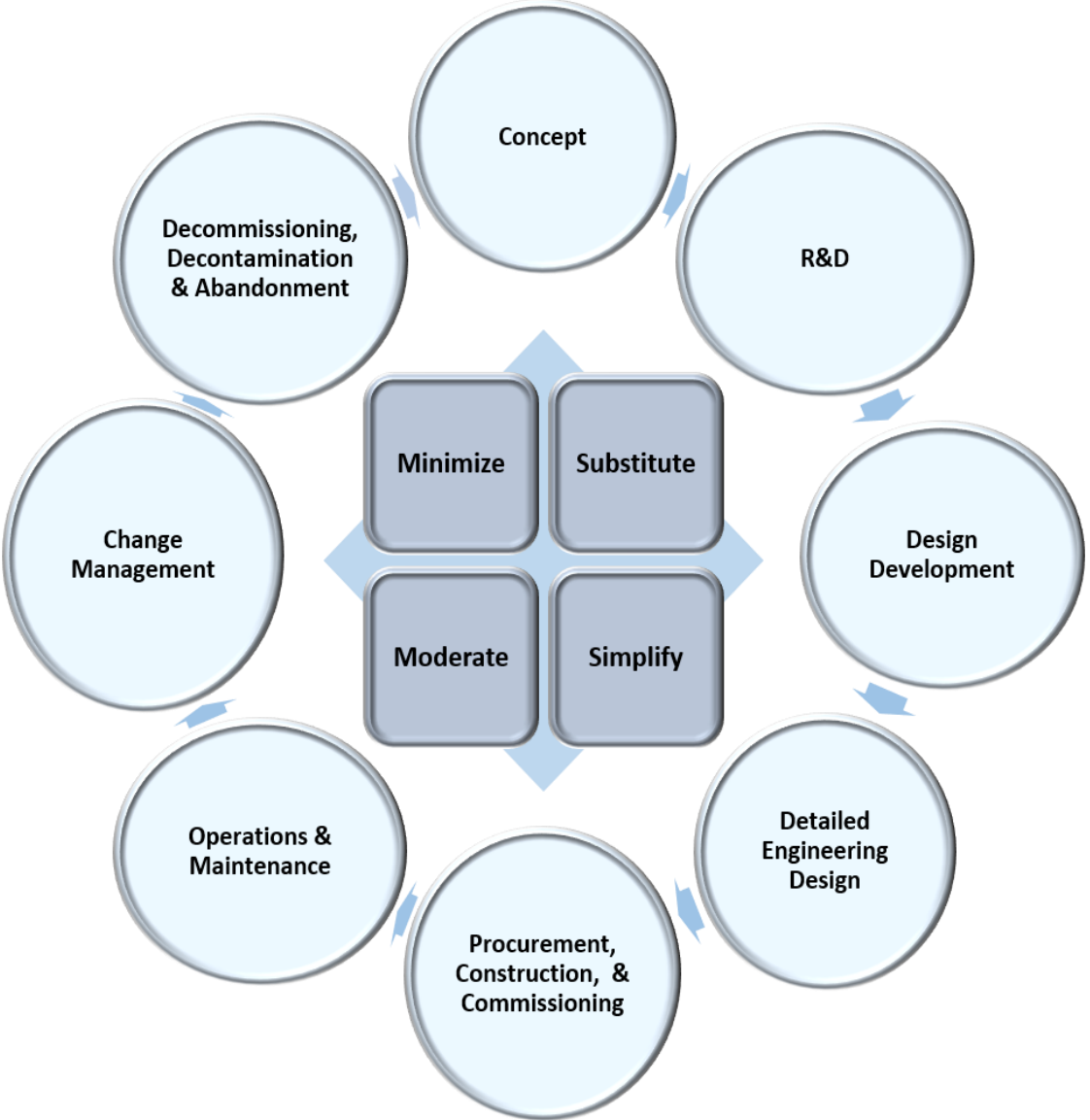
Inherent Safety Benefits and Limitations



- Inherently safer design is a fundamentally different way of thinking about the design of chemical processes and plants.
- It focuses on the elimination or reduction of the hazards, rather than on management and control.
- This approach should result in safer and more robust processes, and it is likely that these inherently safer processes will also be more economical in the long run (Kletz)
- It must be recognized, however, that applying an inherently safer concept to a plant does not necessarily mean that plant is the most safe, secure, efficient, or economical.



ISD During the Process Lifecycle



Means to Institutionalize ISD

- Implement policy and procedures
 - Management commitment and accountability
 - Policy and procedures encouraging ISD
 - Principles, goals and incentives
- Practical tools to facilitate ISD
 - Checklists and analytical methods -- independent or integrated into routine activities
 - Auditing protocols
 - Inherent Safety indices



Conclusions

- Application of ISD may not be fully utilized by most companies in the process industries.
- Formal recognition of its value is essential to encourage management to implement directives requiring its use.
- Real adoption of ISD will be with firms that engrain the concept into the culture of the organization throughout the entire lifecycle of their processes.





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