

# Incorporating Inherent Safety Principles in Process Safety Management

*by*

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# Outline

- Objectives
- Process Safety Management
- Elements of PSM
- Inherent safety
- Principles of inherent safety
- The need for incorporating IS in PSM
- Methodology
- Example: Incident Investigation
- Example: Management of Change
- Future work

# Objectives

Incorporate inherent safety principles in process safety management both qualitatively and quantitatively.

# Process Safety Management

- Process Safety Management is the application of management systems to the identification, understanding and control of process hazards to prevent process related injuries and incidents (CCPS, 1989).
- The Center for Chemical Process Safety (CCPS) was formed by the American Institute of Chemical Engineers (AIChE) in 1985 to promote the improvement of process safety among those who handle, use, process, and store hazardous materials

# Elements of Process Safety Management

1. Accountability
2. Process Knowledge and Documentation
3. Capital Project Review and Design Procedures
4. Process Risk Management
5. Management of Change
6. Process and Equipment Integrity
7. Human Factors
8. Training and Performance
9. Incident Investigation
10. Company Standards, Codes and Regulations
11. Audits and Corrective Action
12. Enhancement of Process Safety Knowledge

# How we deal with hazards

- Engineered: Engineering features which reduce the frequency or mitigate consequences of the existing hazards.
- Procedural: Use of safe work practices or procedures to reduce the risk.

# Inherent Safety

From dictionary – inherent

- Belonging to the very nature of a person or a thing.

Characteristic of a design which prevents hazard or mitigate consequences

# Principles of Inherent Safety

The four main principles are

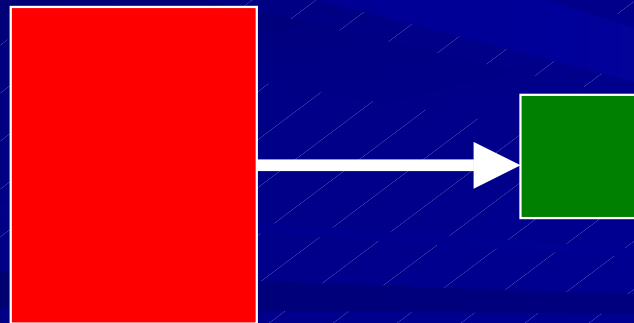
- Minimization
- Substitution
- Moderation
- Simplification



# Inherent Safety

- Minimization:

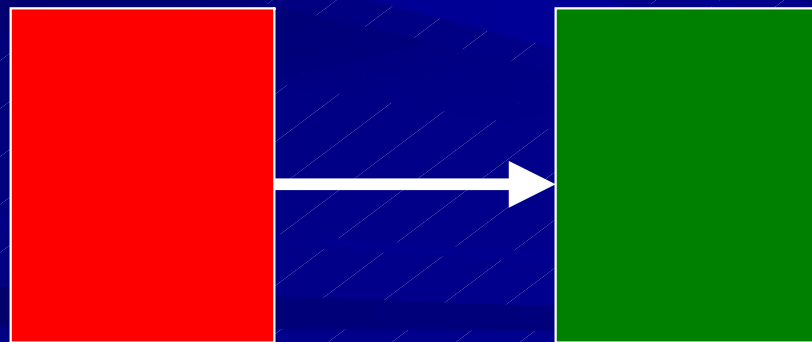
Minimize the hazard by reducing the quantity of the hazardous material.



# Inherent Safety

- Substitution:

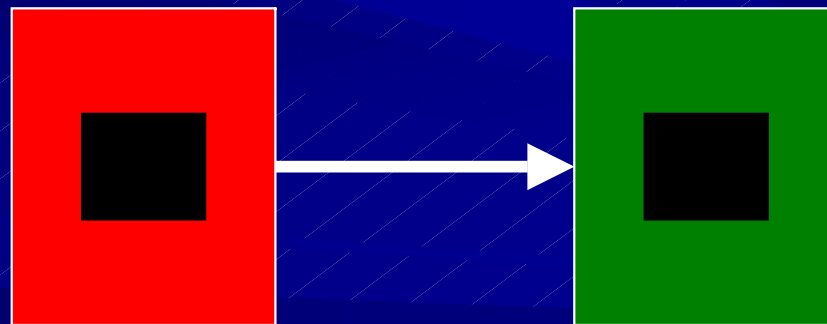
Replacement of hazardous material or process with one that is less hazardous.



# Inherent Safety

- Moderation:

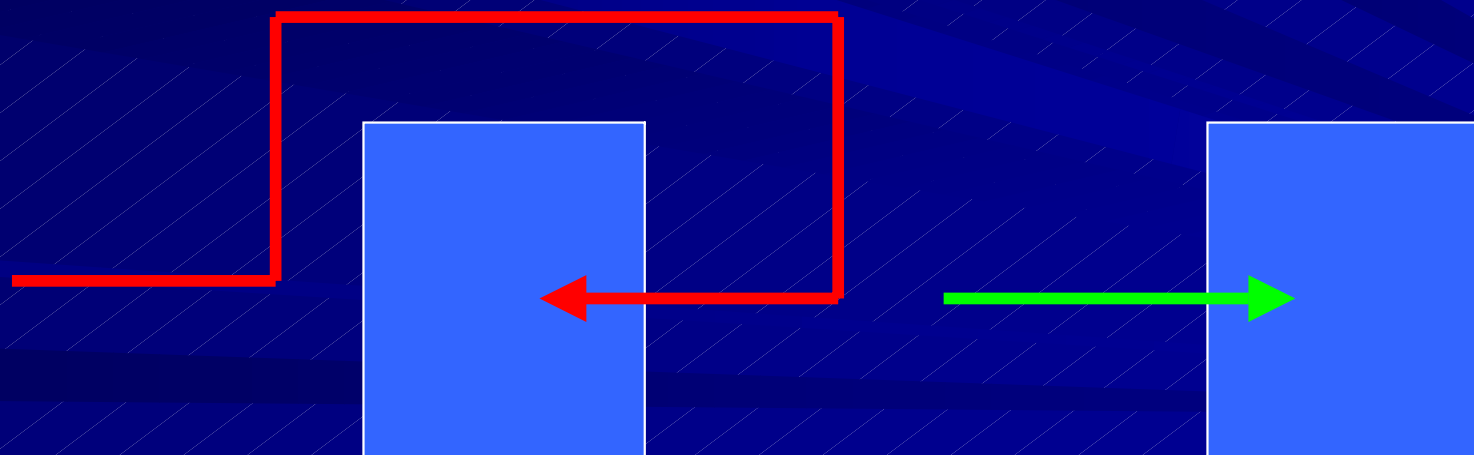
Moderation means using materials under less hazardous conditions.



# Inherent Safety

## ■ Simplification:

Simplification means designing to avoid unnecessary complexity, thus reducing the opportunities for error and mis-operation.



# The need for incorporating IS in PSM

- Although most companies that handle hazardous material have implemented process safety management, they are still having incidents
  - ✓ Incorporation of inherent safety principles in the basic definitions of PSM elements, can improve the quality of PSM to a great extent.

# PSM Elements Selected for IS Incorporation

- Process Risk Management
- Management of Change
- Process and Equipment Integrity
- Human Factors
- Training and Performance
- Incident Investigation
- Standards, Codes and Regulations

# Methodology

## Qualitative:

- Identifying protocol
- Work-in Inherent Safety Checklist and Guidewords at both front and back end of the protocol.

## Quantitative:

- For quantitative part, the plan is to incorporate I2SI into one of the elements and also developing a new tool for one the elements.

# Methodology

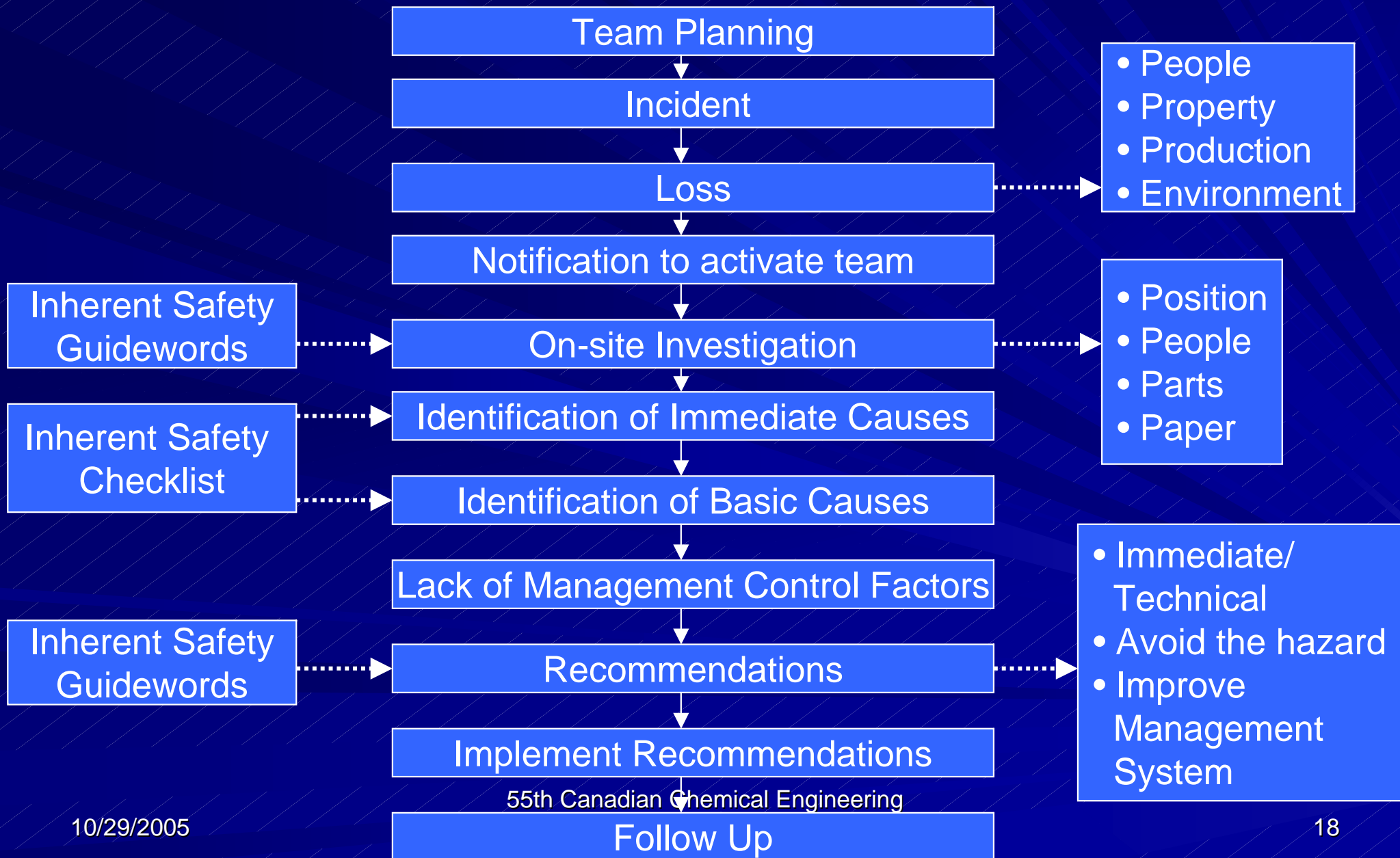
- Qualitative:
  - Management of Change
  - Human Factors
  - Training and Performance
  - Incident Investigation
  - Standards, Codes and Regulations
- Quantitative:
  - Process Risk Management
  - Process and Equipment Integrity



# I2SI: Integrated Inherent Safety Index

- I2SI is guideword based indexing approach to measure inherent safety
- $I2SI = ISPI/HI$ 
  - HI is hazard index; ranges values from 1 to 200
  - ISPI is measures of the applicability of inherent safety principles; values ranges from 1 to 200

# Investigation Methodology



# Inherent Safety Guidewords

- Minimize:** Use smaller quantities of hazardous materials when the use of such materials cannot be avoided. Perform a hazardous procedure as few times as possible when the procedure is unavoidable.
- Substitute:** Replace a substance with a less hazardous material or processing route with one that does not involve hazardous material. Replace a hazardous procedure with one that is less hazardous.
- Moderate:** Use hazardous materials in their least hazardous forms or identify processing options that involve less severe processing conditions.
- Simplify:** Design processes, processing equipment, and procedures to eliminate opportunities for errors by eliminating excessive use of add-on (engineered) safety features and protective devices.

# Inherent Safety Checklist

Guideword	Checklist question
<b>Minimize</b>	<ul style="list-style-type: none"><li>■ Is the storage of all hazardous gases, liquids and solids minimized?</li><li>■ Are just in time deliveries used when dealing with hazardous materials?</li><li>■ Is shift rotation optimized to avoid fatigue?</li></ul>
<b>Substitute</b>	<ul style="list-style-type: none"><li>■ Can a less toxic, flammable or reactive material be substituted for use?</li><li>■ Can a water based product be used in place of a solvent or oil based product?</li><li>■ Is there an alternate way of moving product or equipment as to eliminate human strain?</li></ul>

# Inherent Safety Checklist Contd.

Guideword	Checklist question
Moderate	<ul style="list-style-type: none"><li>■ Can potential releases be reduced via lower temperatures or pressures, or elimination of equipment?</li><li>■ Are all power tools de-energized when not in use for extended periods?</li></ul>
Simplify	<ul style="list-style-type: none"><li>■ Are all manuals, guides and instructional material clear and easy to understand, especially those that are used in an emergency situation?</li><li>■ Are equipments or procedures designed such that they cannot be operated incorrectly or carried out incorrectly?</li></ul>

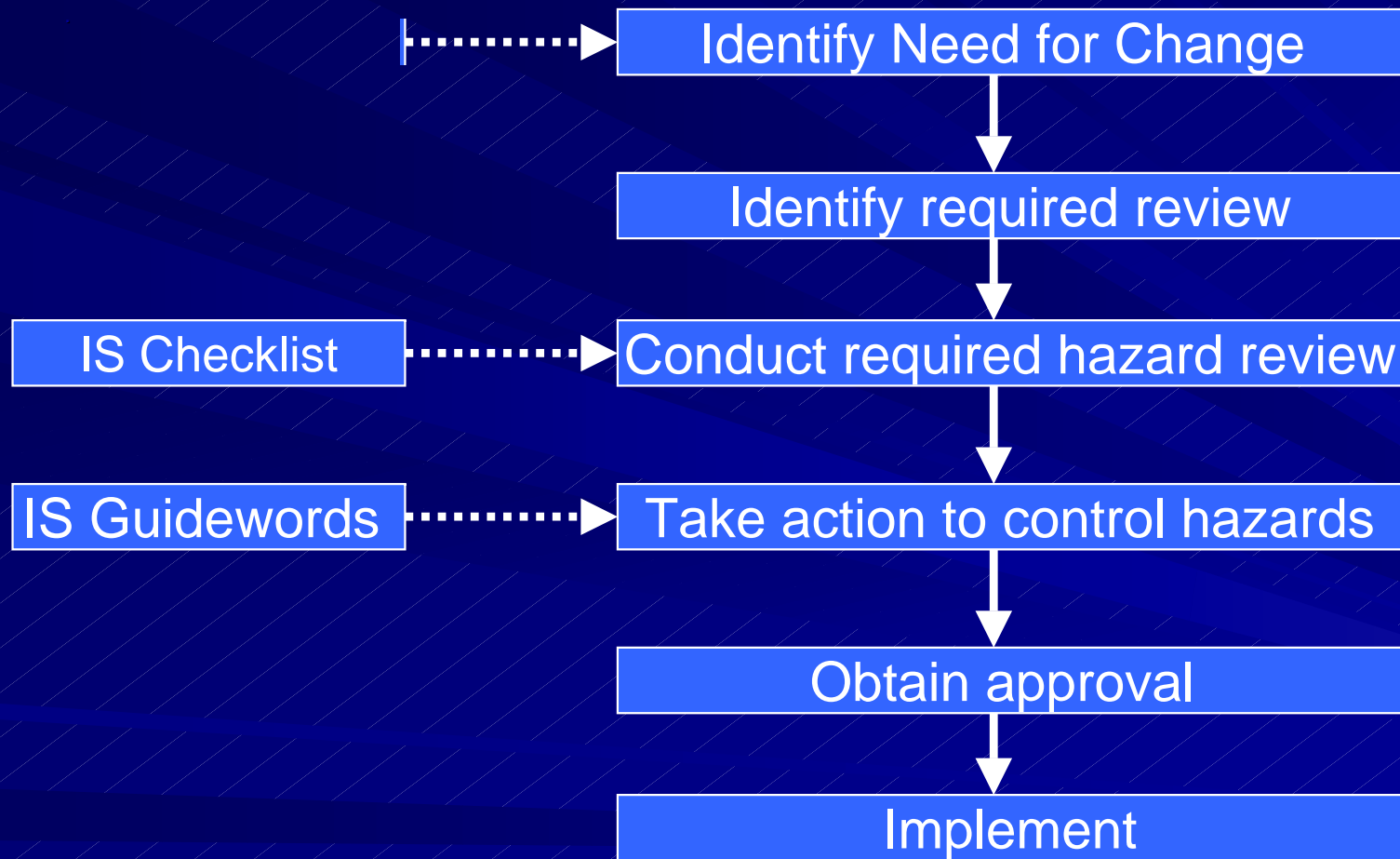
# Management of Change

- Policies and procedures which ensure that change do not result in operations outside of established safety parameters
- Essential element is a plant's process safety system
- Managing change can mean managing potential incidents

# Main Types of Changes

- Change of Process Technology
- Change of Facility
- Organization Change
- Variance Procedures

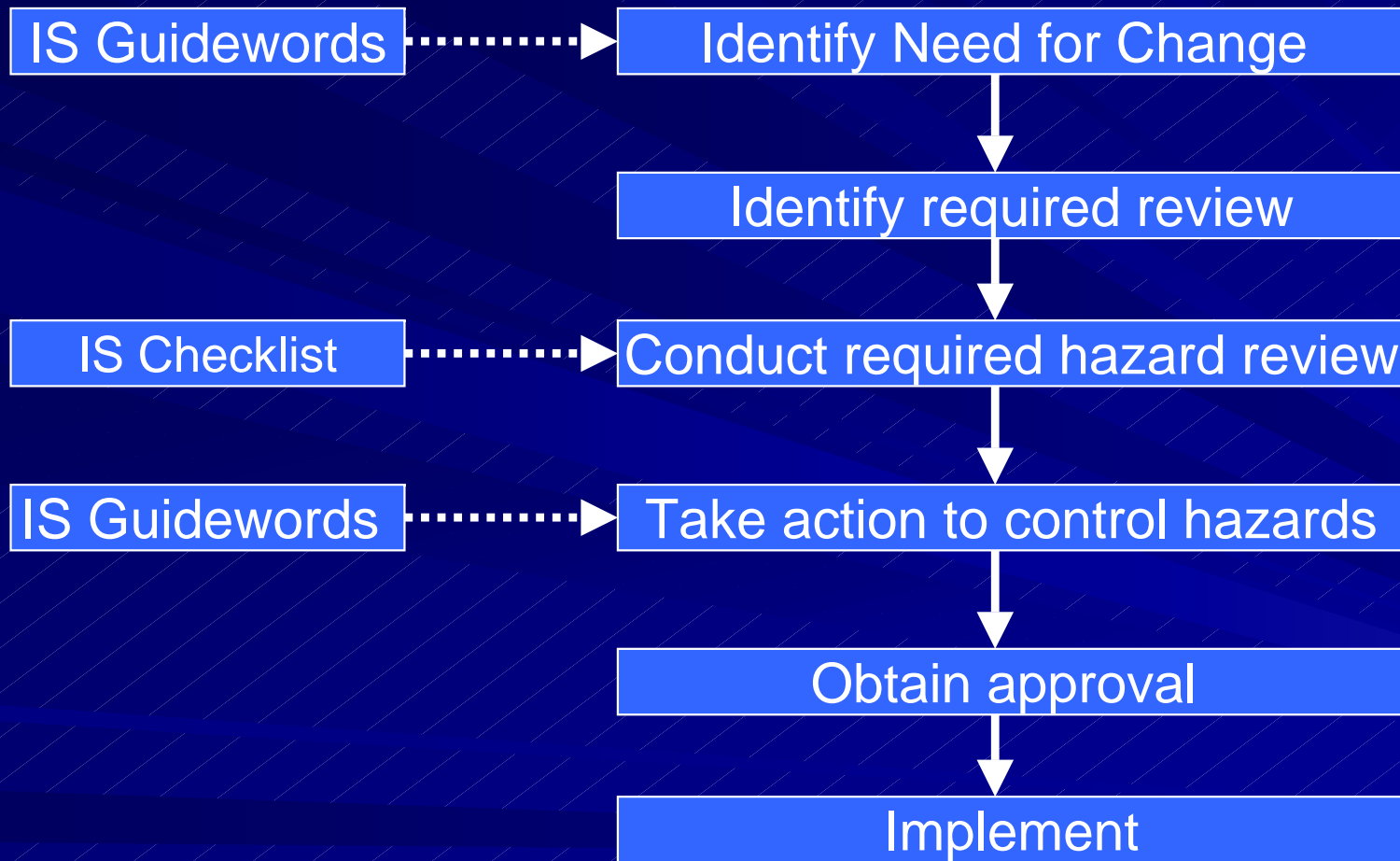
# Flowchart for Management of Change



*Kelly (1996)*



# Flowchart for Management of Change



*Kelly (1996)*

# Future Work

## Case Study: Flixborough

- Vapor Cloud Explosion- fueled by release of 30 tons of cyclohexane
- Largest single loss by fire or explosion in the UK
  - Killed 28 people
  - Injured 89 others
  - \$63 million in the property damage

# Acknowledgements

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- Dr. Faisal Khan
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# Questions and Suggestions