INHERENT SAFETY IMPLEMENTATION THROUGHOUT THE PROCESS DESIGN LIFECYCLE

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OUTLINE

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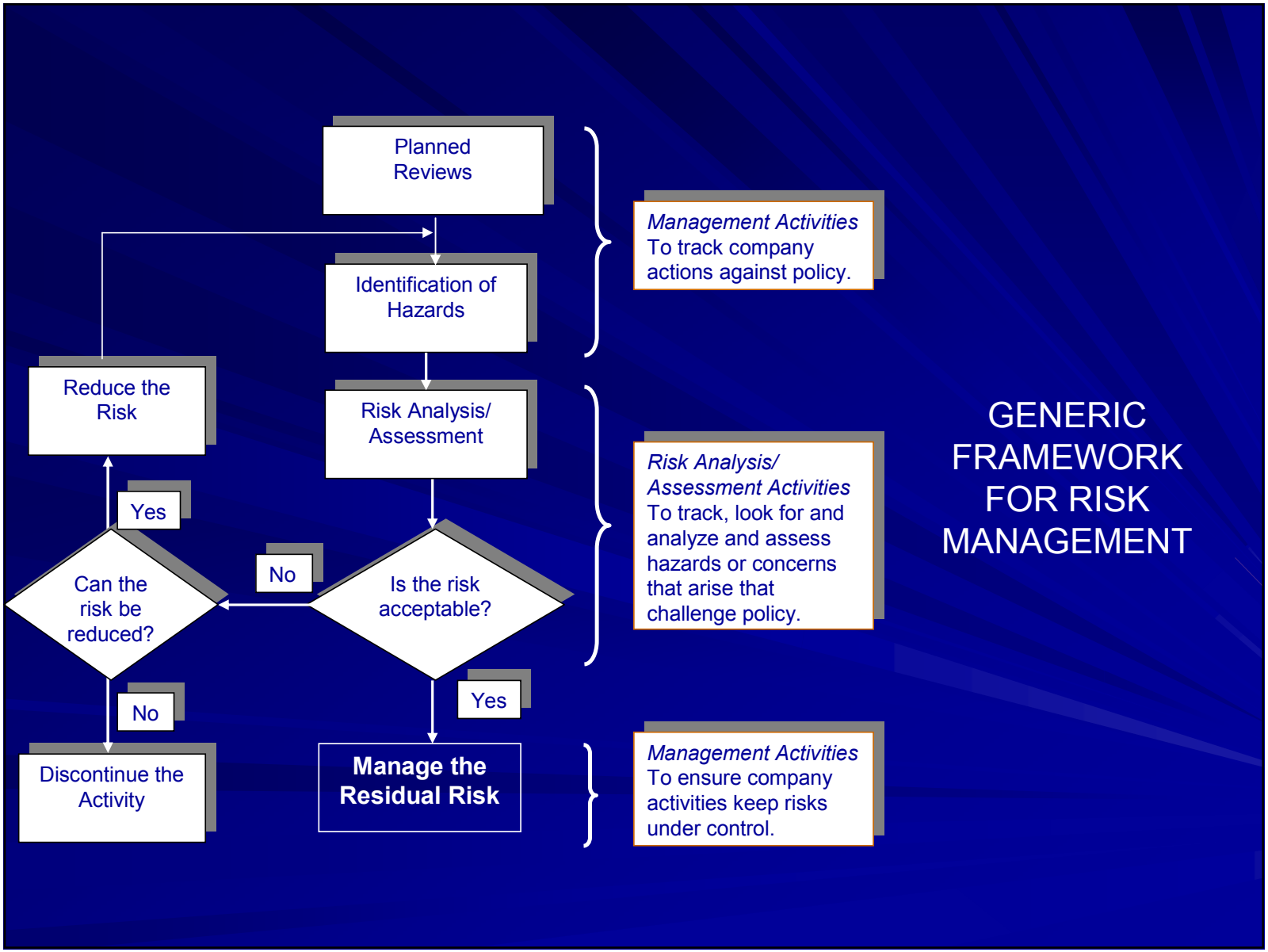
  - Process Design Lifecycle
  - Hierarchy of Risk Control Strategies
  - Inherent Safety
- Design Assistance Method for Inherent Safety Implementation
  - Design Space
  - Methodology
  - Application
- Concluding Remarks

INTRODUCTION

- Scope
  - Enhancement of industrial safety through recognition of the applicability of inherent safety to other risk control strategies and to stages later in the design lifecycle
- Motivation
  - Protection of people, environment, assets and production
  - Provision of a methodology for consideration of inherent safety principles throughout all levels of the hierarchy of risk controls and all stages of the process design lifecycle

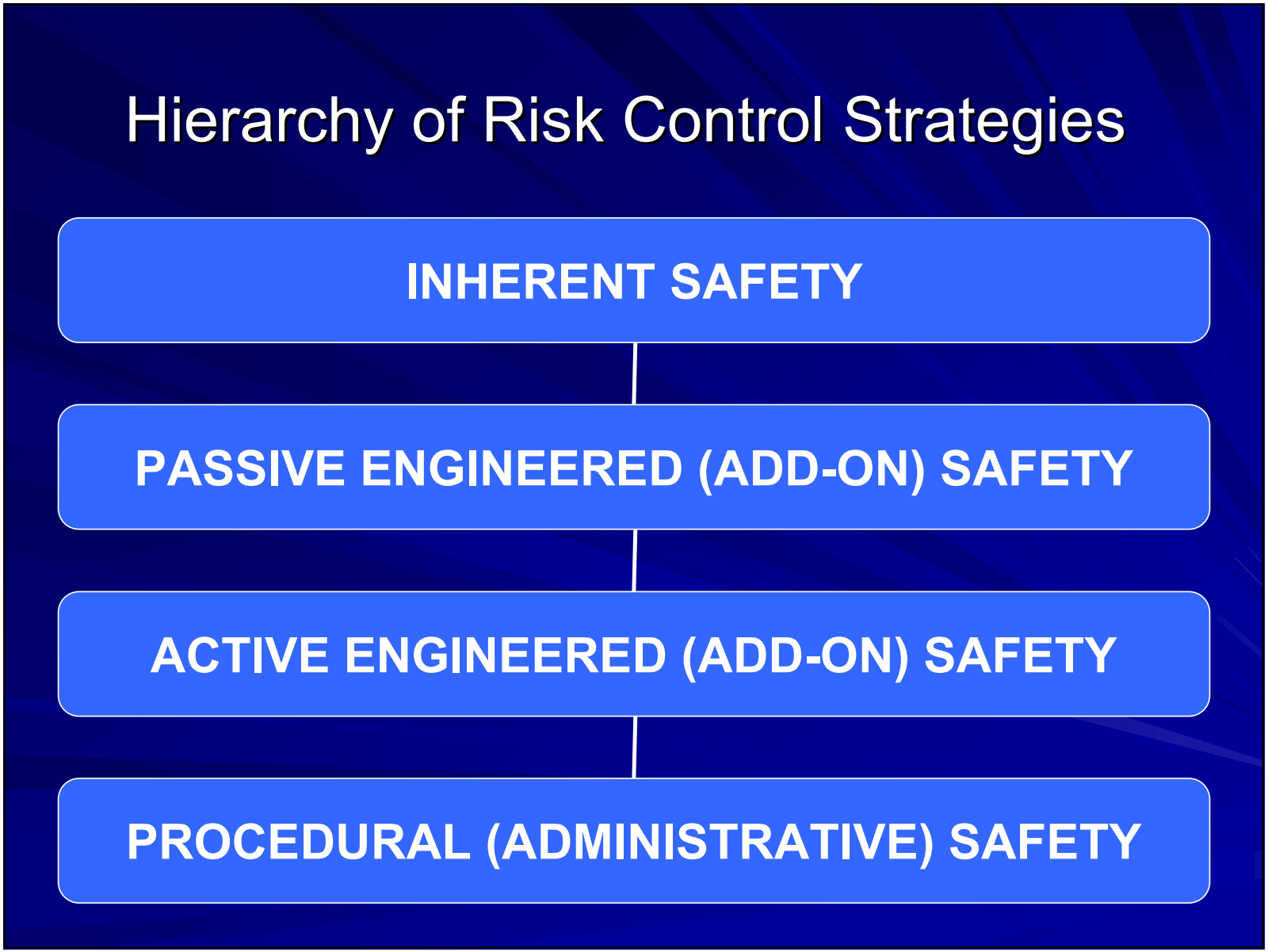
GENERIC FRAMEWORK FOR RISK MANAGEMENT



Process Design Lifecycle

- Process Research and Development
- Conceptual Design
- Basic Design
- Detailed Design
- Procedure Design
  - Operation
  - Emergency

Hierarchy of Risk Control Strategies



Inherent Safety

- From dictionary – *inherent*
  - Belonging to the very nature of a person or a thing
  - Stresses the inseparability of a part, element or quality
- Characteristics of a design which prevent hazards or mitigate consequences
  - Utilize underlying physics and chemistry
- Trevor Kletz:
  - *What you don't have, can't leak*

Principles of Inherent Safety

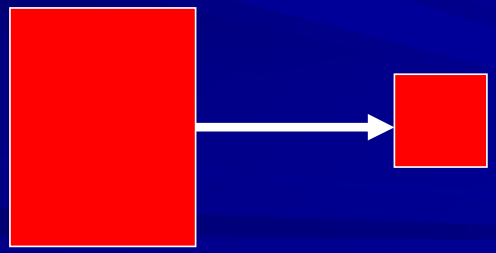
Four main principles of inherent safety are:

- Minimization
- Substitution
- Moderation
- Simplification

Principles of Inherent Safety

- Minimization:

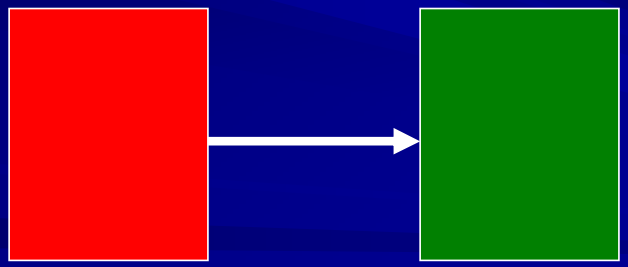
  Minimize amount of hazardous material in use (when use of such materials cannot be avoided – i.e. elimination)



Principles of Inherent Safety

- Substitution:

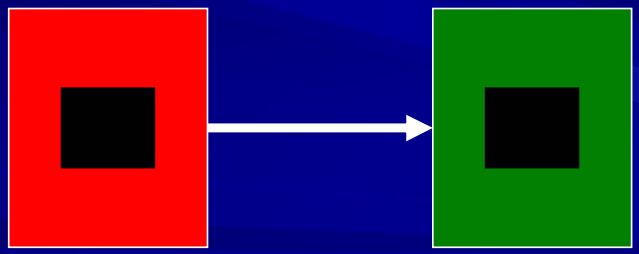
  Replace substance with less hazardous material; replace process route with one involving less hazardous materials



Principles of Inherent Safety

- Moderation:

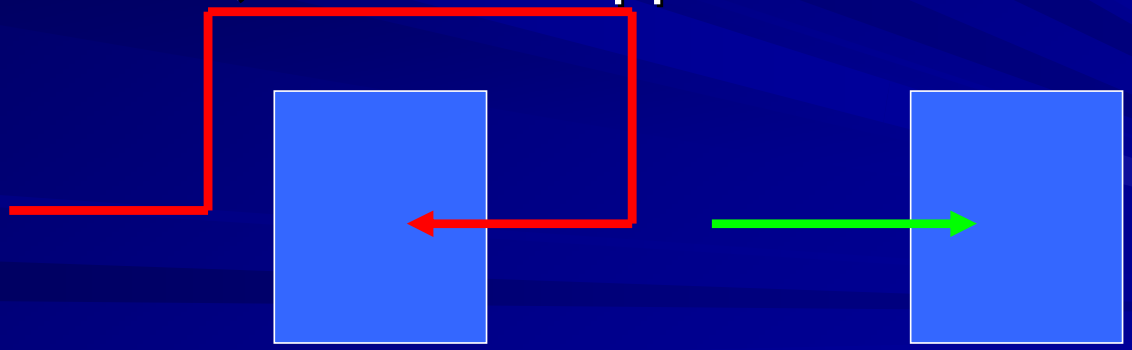
  Use hazardous materials in least hazardous forms; run process equipment with less severe operating conditions (e.g. T and P)



Principles of Inherent Safety

- Simplification:

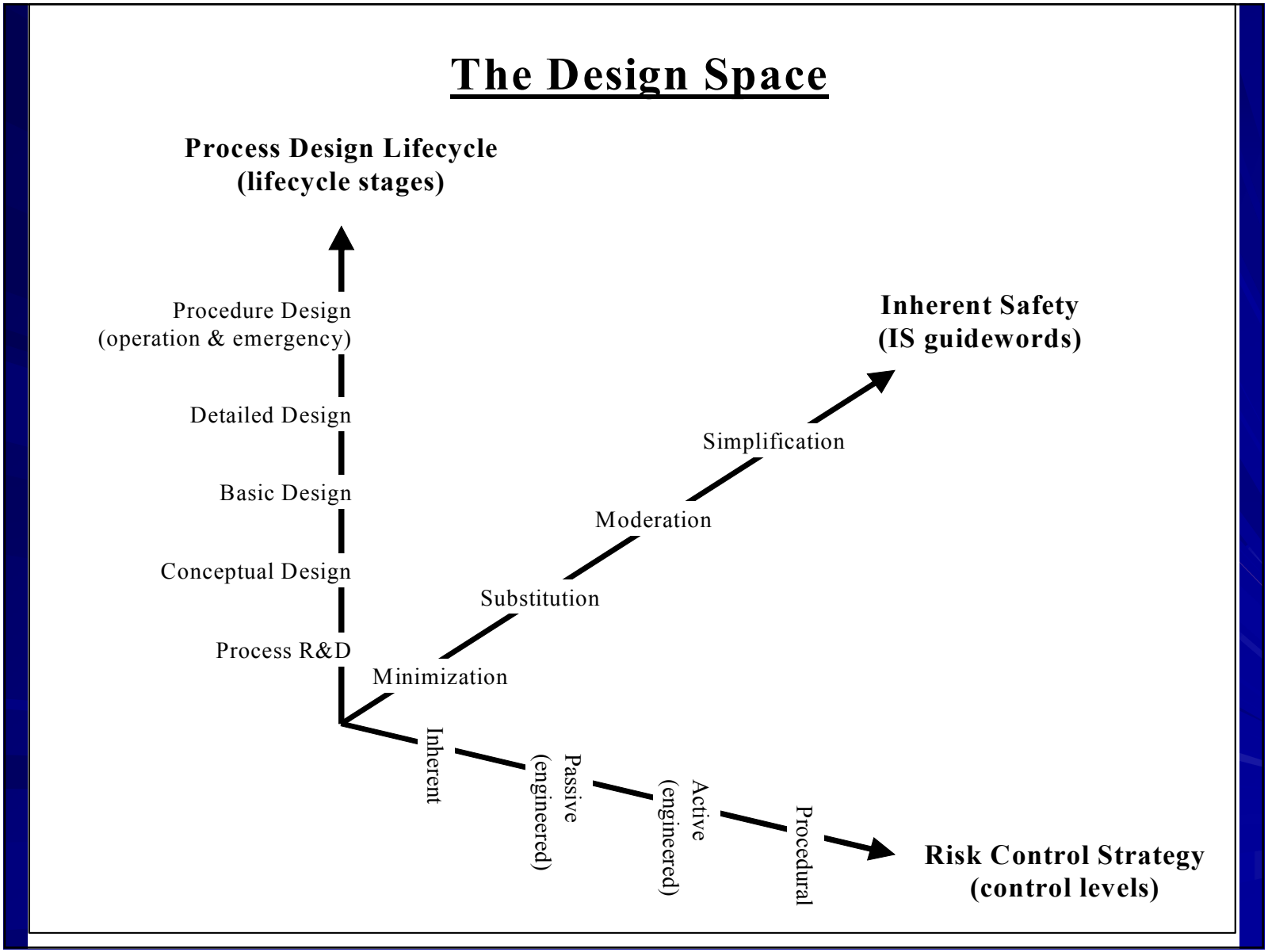
  Simplify equipment and processes that are used; avoid complexities; make equipment robust; eliminate opportunities for error

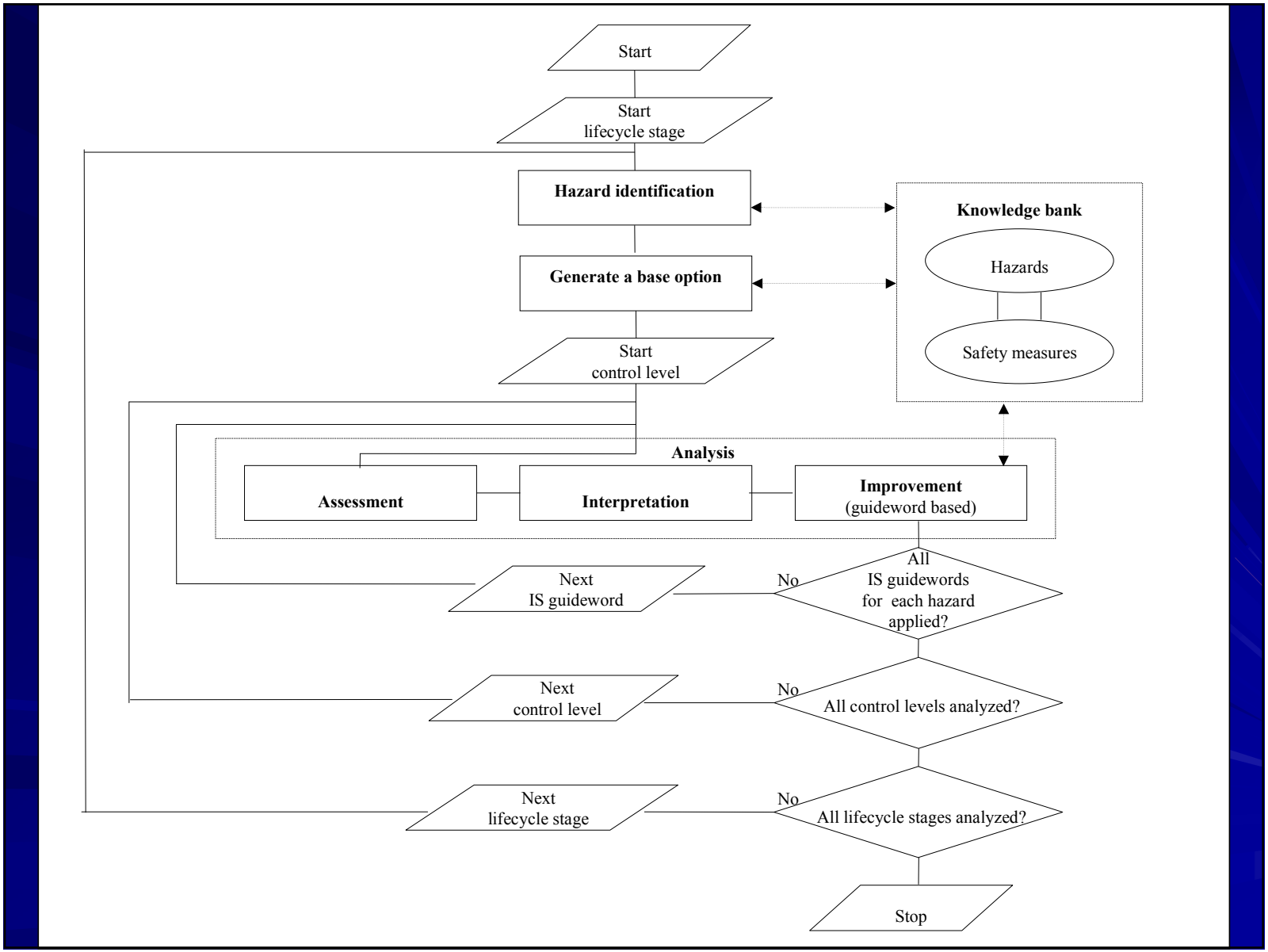


DESIGN ASSISTANCE METHOD FOR INHERENT SAFETY IMPLEMENTATION

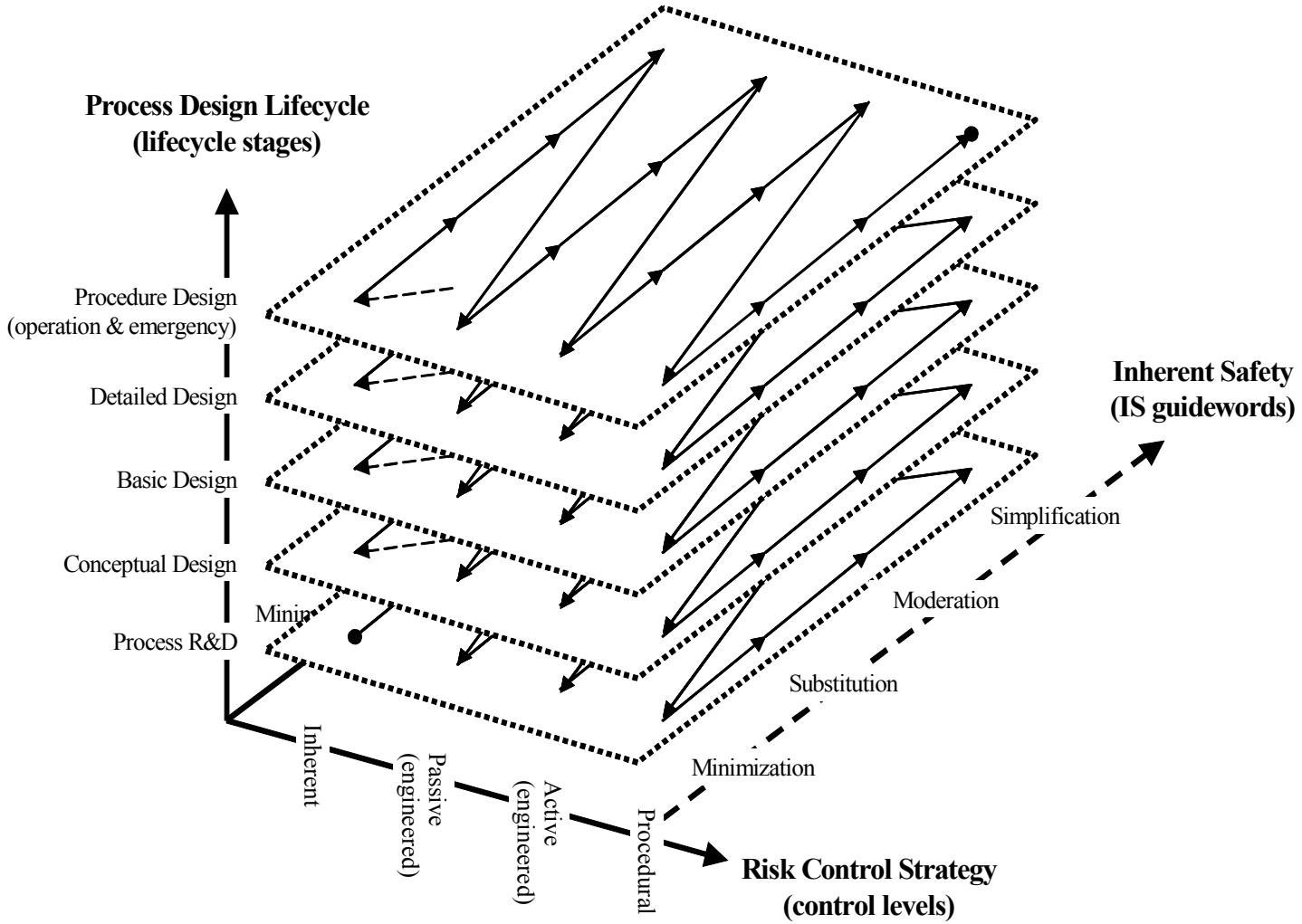
- Basic concept is rigorous exploration of inherent safety applicability within the Design Space
- Methodology involves series of nested cycles to facilitate systematic analysis through design lifecycle stages, risk control levels, and inherent safety guidewords (principles)
- Application should result in an inherent safety-optimized design for each lifecycle stage

The Design Space

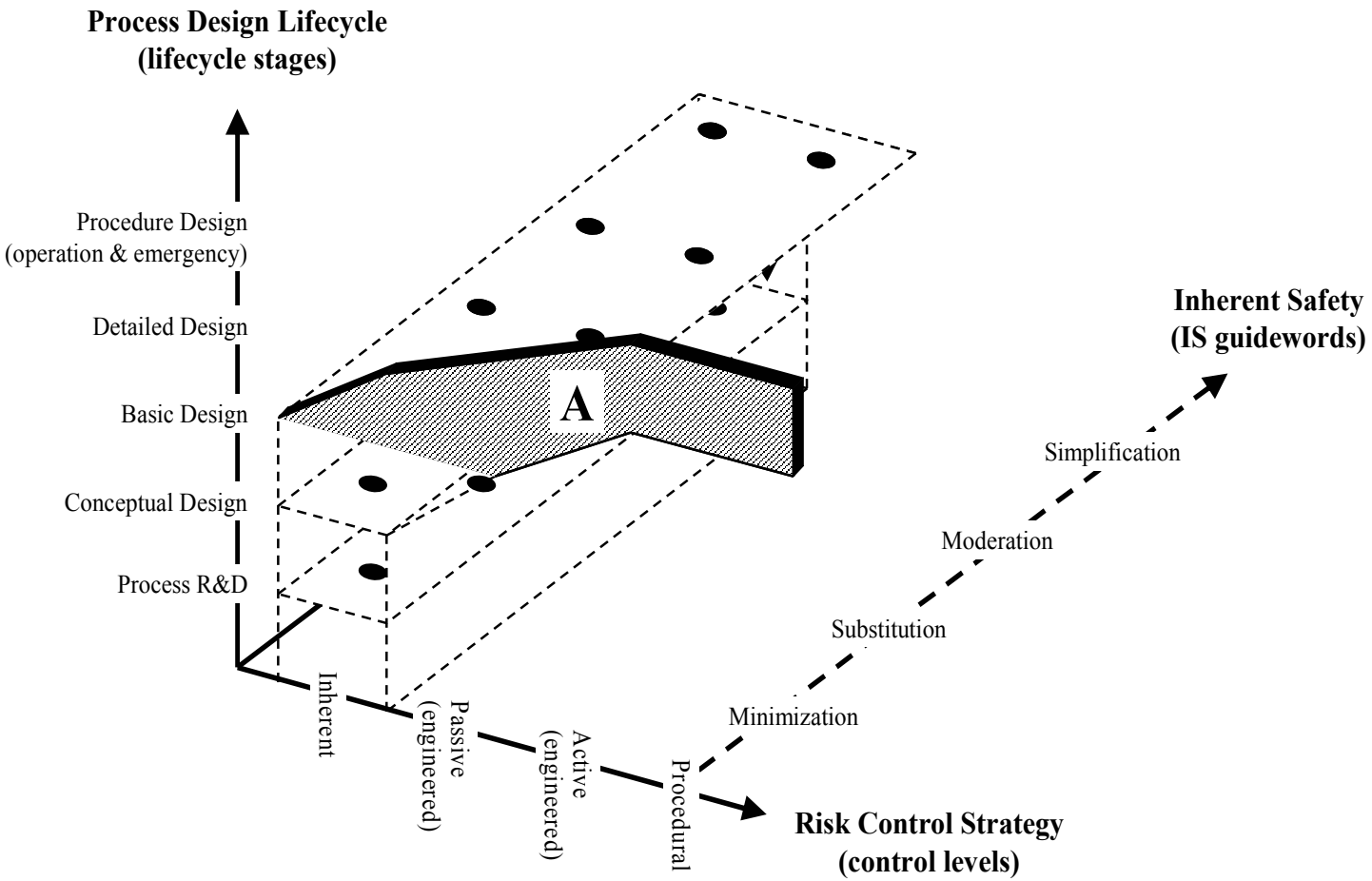



Start
Start
lifecycle stage
Hazard identification
Knowledge bank
Hazards
Safety measures
Generate a base option
Start
control level
Analysis
Assessment
Interpretation
Improvement
(guideword based)
All
IS guidewords
for each hazard
applied?
No
Next
IS guideword
All control levels analyzed?
No
Next
control level
All lifecycle stages analyzed?
No
Next
lifecycle stage
Stop

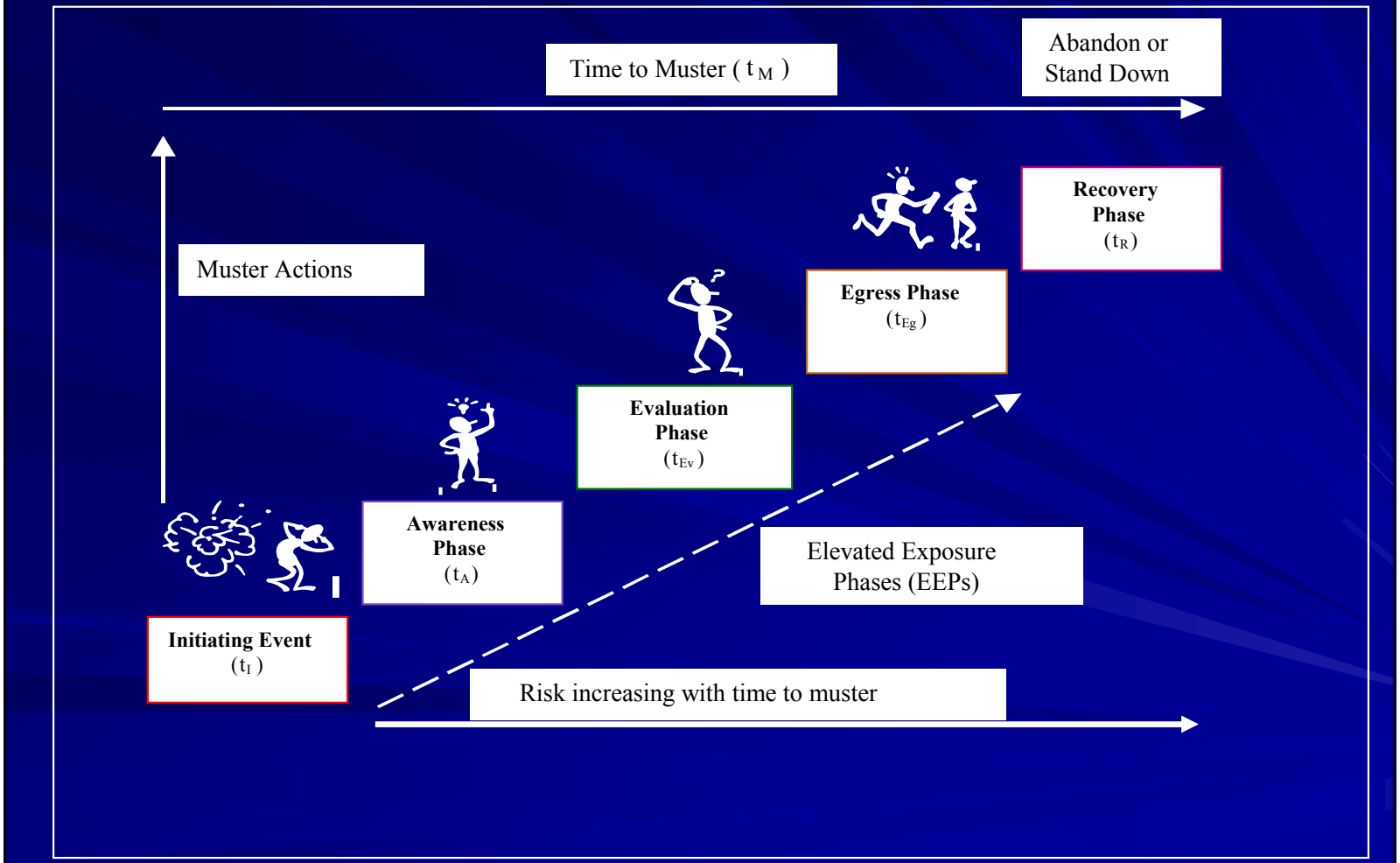
The Design Space



The Design Space



Muster Sequence



Muster Actions

Awareness Phase	
1	Detect alarm
2	Identify alarm
3	Act accordingly
Evaluation Phase	
4	Ascertain if danger is imminent
5	Muster if in imminent danger
6	Return process equipment to safe state
7	Make work place as safe as possible in limited time
Egress Phase	
8	Listen and follow PA announcements
9	Evaluate potential egress paths and choose route
10	Move along egress route
11	Assess quality of egress route while moving to TSR
12	Choose alternate route if egress path is not tenable
13	Collect personal survival suit if in room at time of muster
14	Assist others if needed or as directed
Recovery Phase	
15	Register at TSR
16	Provide pertinent feedback, if any, attained while enroute to TSR
17	Don personal survival suit or TSR survival suit if instructed to abandon
18	Follow OIM's instructions

Awareness Phase Action 1: Alarm Detection for Given Scenario

- Lifecycle Stage: Detailed Design (for alarm specification)
  - Note that choice will impact muster process during procedure design stage
- Hazard Identification: Errors in alarm detection
  - Knowledge bank must include human error
  - Knowledge bank must include safety measures such as training, procedures, equipment, etc.
- Base Option: Industry-standard or previously installed alarm type

Awareness Phase Action 1: Alarm Detection for Given Scenario

- Initial Control Strategy Level: Inherent Safety
- Assessment: Expert judgment indexing technique to estimate likelihood of alarm detection errors and resultant consequences
- Interpretation: Relative importance of alarm detection in overall muster sequence

Awareness Phase Action 1: Alarm Detection for Given Scenario

- Improvements: Application of IS guidewords
  - e.g. *Minimization* (of obstructions near alarms)
  - e.g. *Substitution* (recognizable tone)
- Other Control Levels: Passive engineered, active engineered, and procedural (with application of IS guidewords)
  - e.g. *Simplification* of emergency procedures
- Other design lifecycle stages: Goal is to evaluate relevant hazards and safety measures before procedure design stage

CONCLUDING REMARKS

- Presented a concept and some thoughts on a design assistance method
- Key objective is to systematically consider the application of all inherent safety principles to all risk control strategies and all process design lifecycle stages
- Essence of our argument – inherent safety is not just a stand-alone strategy that applies only at early design stages
- Considerable further work needed to develop methodology (mathematical rigor and ease of use)

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