Costain Energy & Process

The Buncefield Enquiry Findings and Costain's Approach to Best Practice in Integrity Level Assessment

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Contents

- Overview of Buncefield
- The Buncefield Incident
- Human and Financial Costs
- The Buncefield Enquiry and Recommendations

- Integrity Level Assessment
- Risk Graph
- LoPA
- Review of Integrity Level Assessments from Bulk Hydrocarbon Storage Sites

- Overall Lifecycle Approach and Application

Overview of Buncefield Operations

COSTAIN

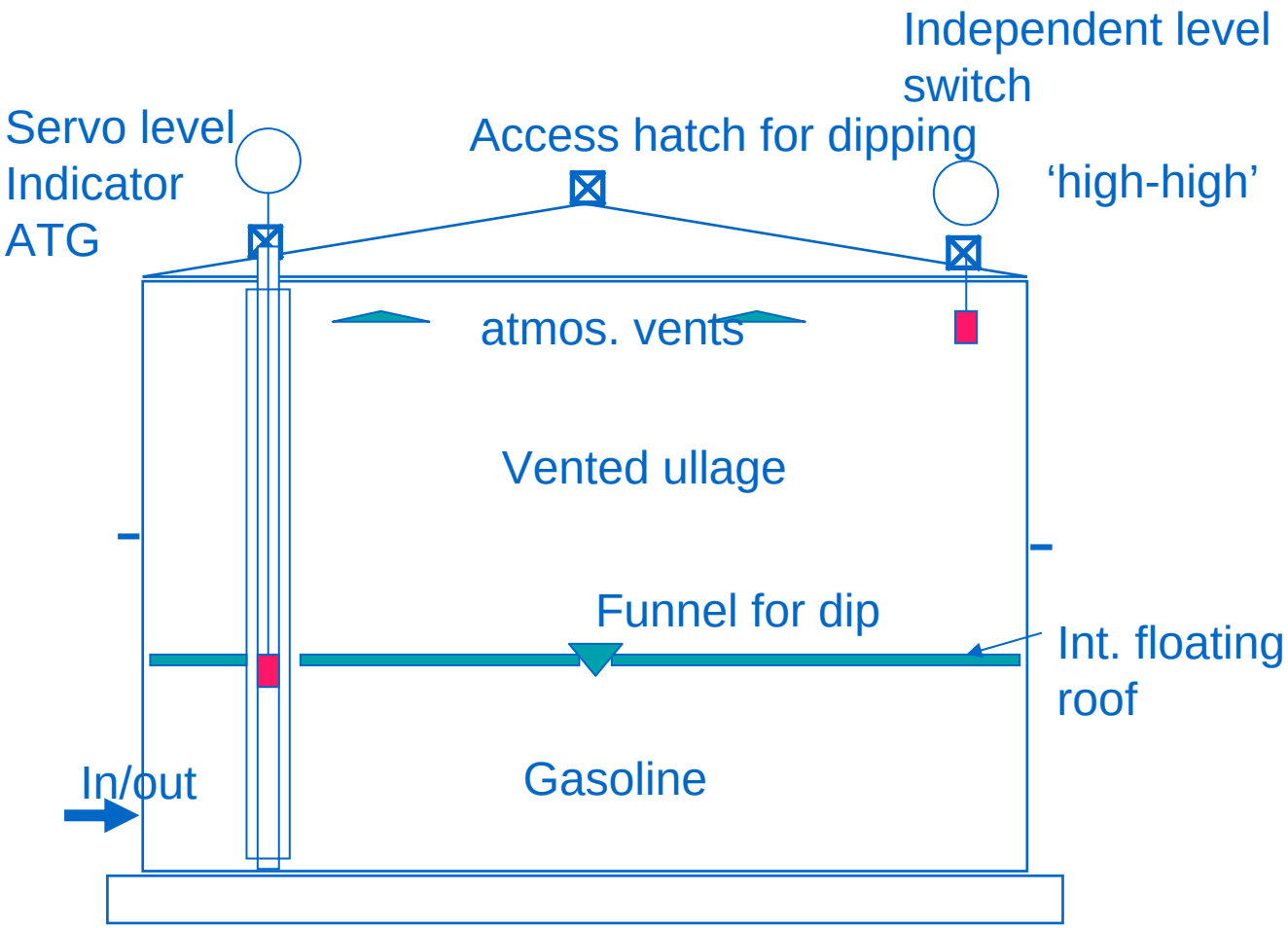
5th largest fuel depot in the UK

60 million gallon capacity

2.37 million tonnes/year turnover

The Buncefield Incident

The Buncefield Incident



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The Buncefield Incident

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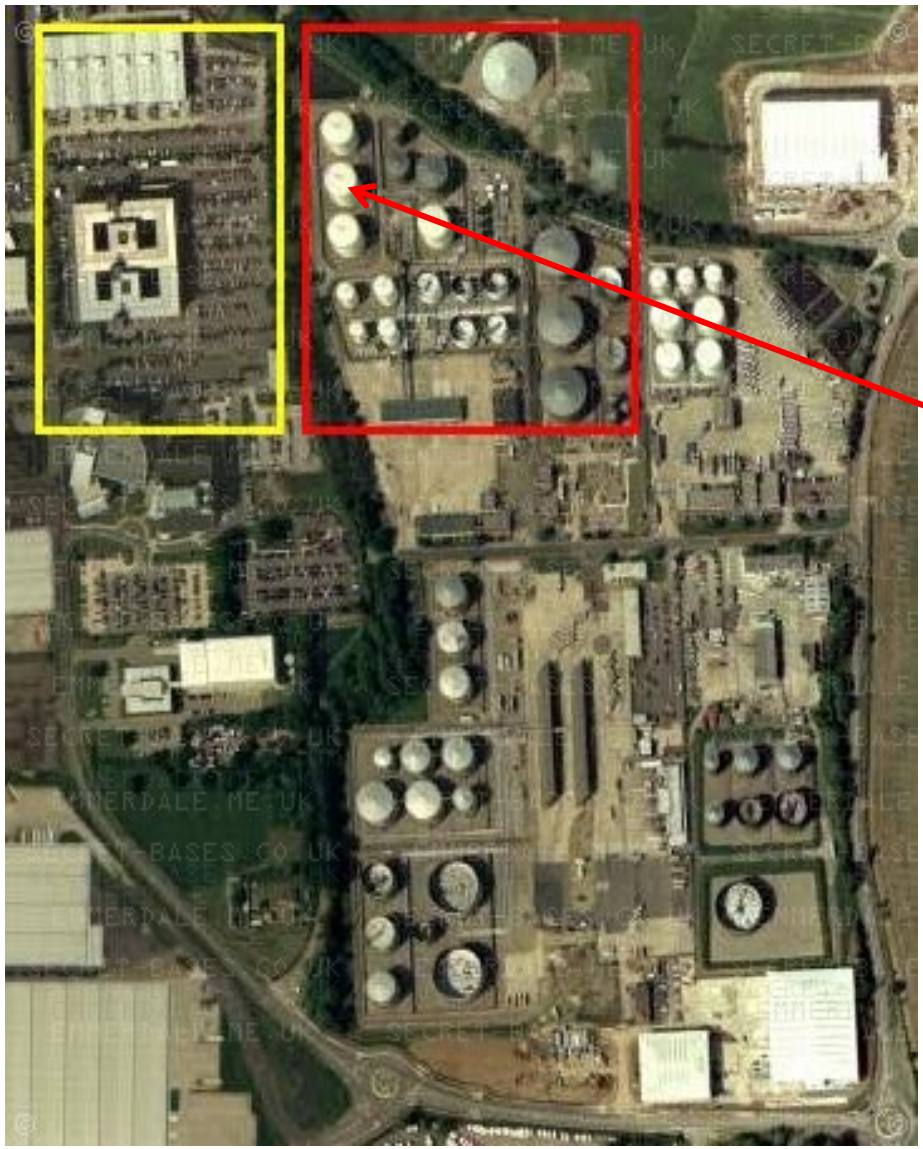

The Buncefield Incident

The Buncefield Incident
Human and Finanical Costs

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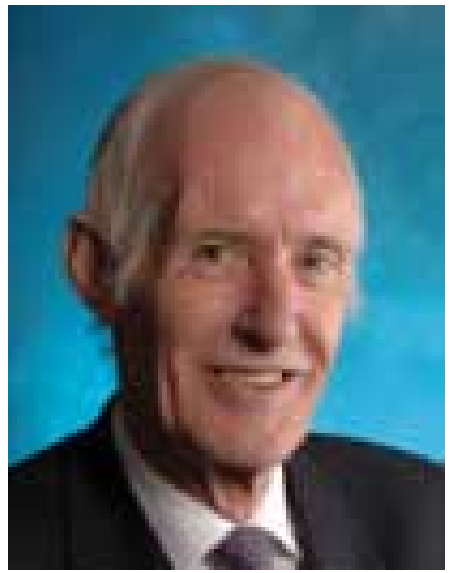
Initial Fine	9.6 Million dollars
Subsequent Claims	1.2 Billion dollars
Loss of operation Loss of business Loss of reputation	>0.4 Billion dollars
Human loss	42 Serious injuries (2 operator, 40 public)
Total Losses	**> 1.6 Billion dollars**

The Buncefield Enquiry

- Chaired by Lord Newton of Braintree
  - Instigated by the Health and Safety Executive, independent of the operator and government
  - Members taken from
    - Industry
    - Academia
    - The Regulator
    - Professional Bodies



The Buncefield Enquiry

Inherent Safety	Reduce inventory, location of new plant, using less hazardous materials
High Integrity Systems	Correct assignment and implementation of Integrity Levels
Escalation	Bunding, emergency response, communication
Hardware supply, equipment supply and OEM's	Use of high reliability organisations
Culture	SMS's (Safety Management Systems), leadership, reporting incidents, Corporate Social Responsibility

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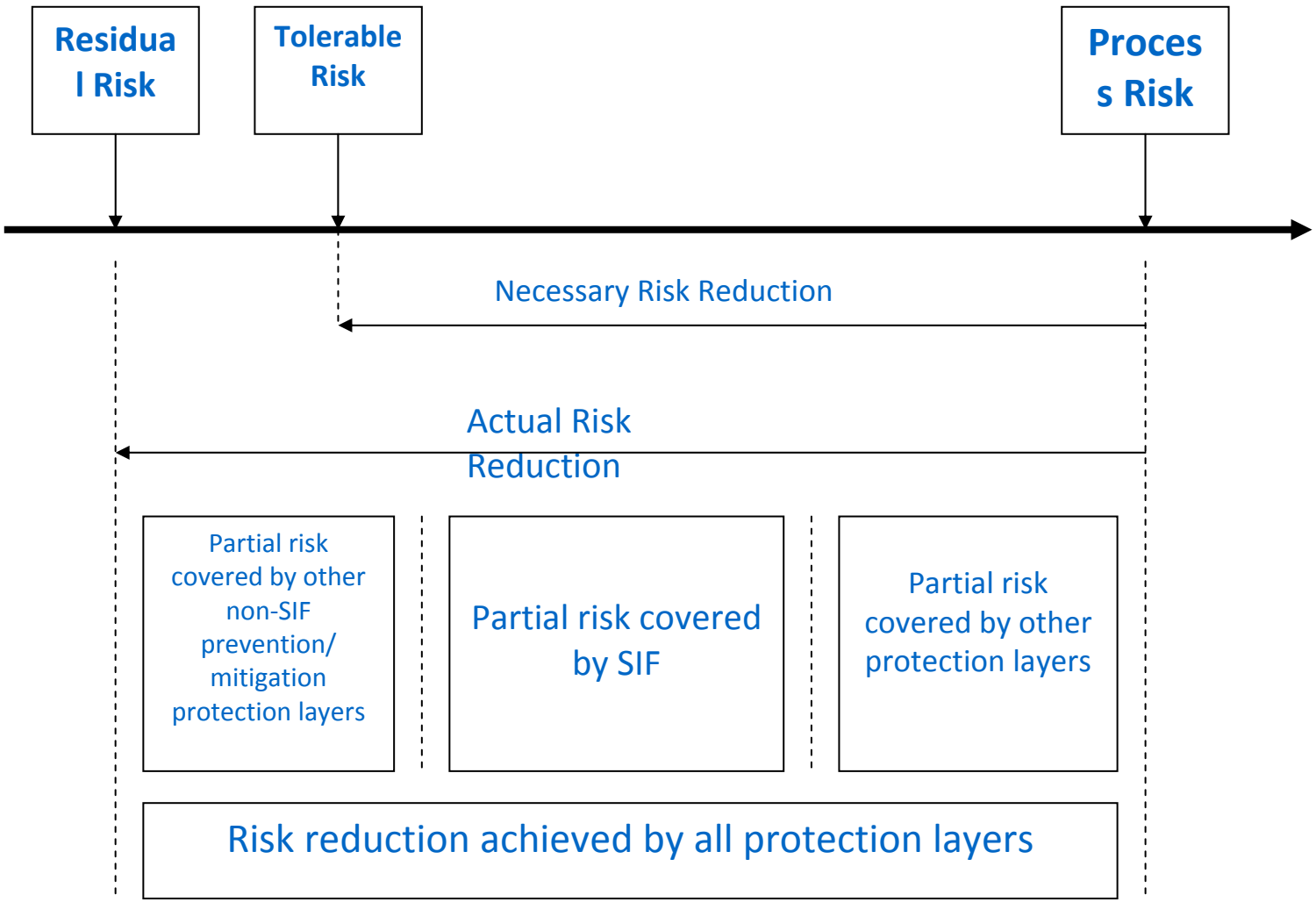
Integrity Level Assessment



Integrity Level Assessment

- Integrity Level Assessments, regardless of technique, attempt:
  - To identify the consequences of an event
  - To identify the frequency of that event
  - To define the capabilities of non-SIF protective measures (eg.PSVs)
  - To compare the mitigated likelihood with a target frequency based on the operating company's criteria

Integrity Level Assessment

- The severity of each consequence –
    - fires,
    - injuries,
    - fatalities,
    - environmental damage,
    - asset damage,
    - business interruption, etc.

Integrity Level Assessment

- The likelihood, or frequency, of each initiating cause of the undesired event –
  - requirement to operate, or ‘demand rate’ is ‘x’ times per year

Integrity Level Assessment

- The capability of non-SIF layers of protection.
    - No layer of protection is perfect; for example, a pressure relief valve may fail to open 1 out of 100 times it is required to operate,

Integrity Level Assessment

- The frequency of the mitigated event compared to a target frequency –
  - If the frequency of the mitigated event is low enough, the risk is viewed as tolerable. The more severe the consequences, the lower the target frequency.

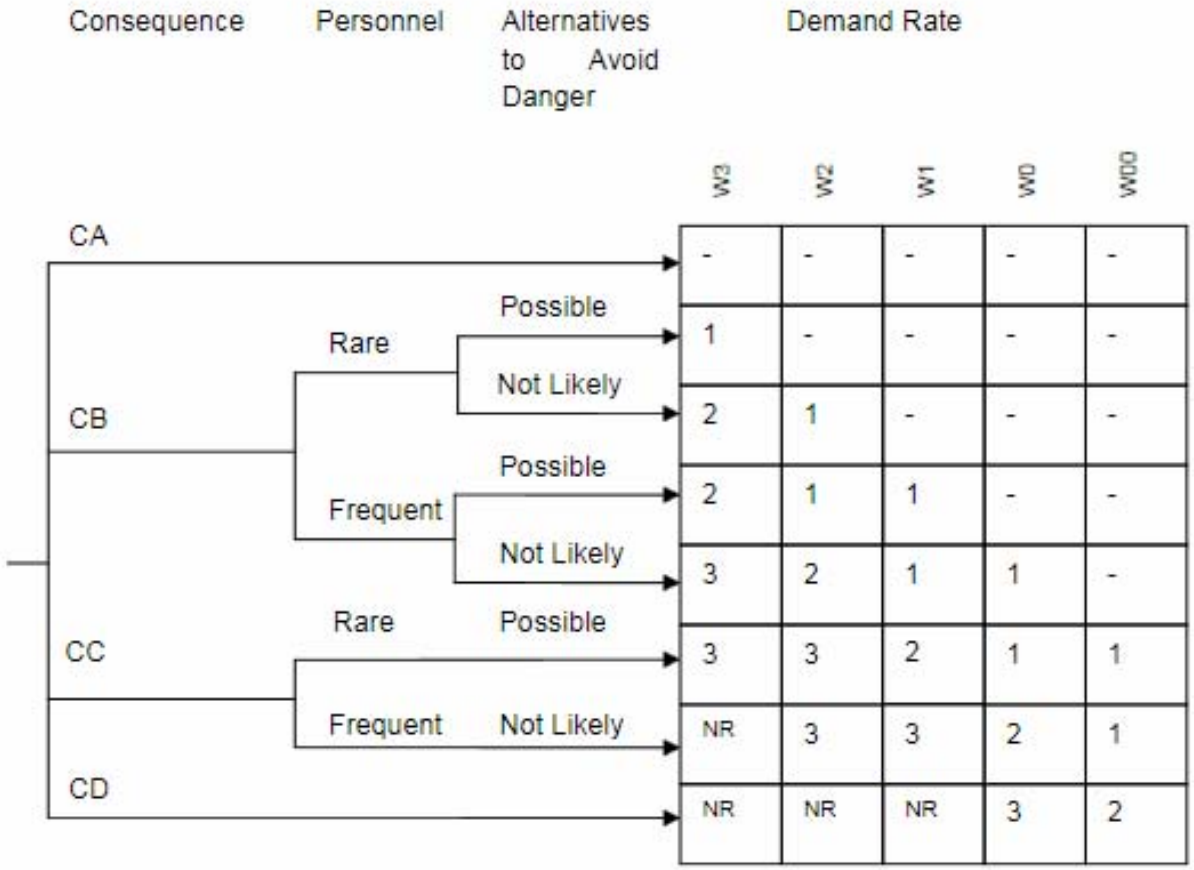
Integrity Level Assessment

- Two commonly used methods for establishing the Integrity Level of a Safety Instrumented Function as described here
  - Risk Graph
  - Layers of Protection Analysis

Risk Graph

- Uses ‘Orders of Magnitude’ Values
  - Consequences are assigned to a ‘Consequence’ band
  - Occupancy is assigned to an ‘Occupancy’ band
  - Demand Rate is assigned to a ‘Demand Rate’ band
- The values that determine the extents of the bands are determined in a ‘Calibration’ exercise, which reflects the operating company’s values, subject to any legal minimum

Risk Graph



- = No special safety features required

NR = Not recommended. Consider alternatives

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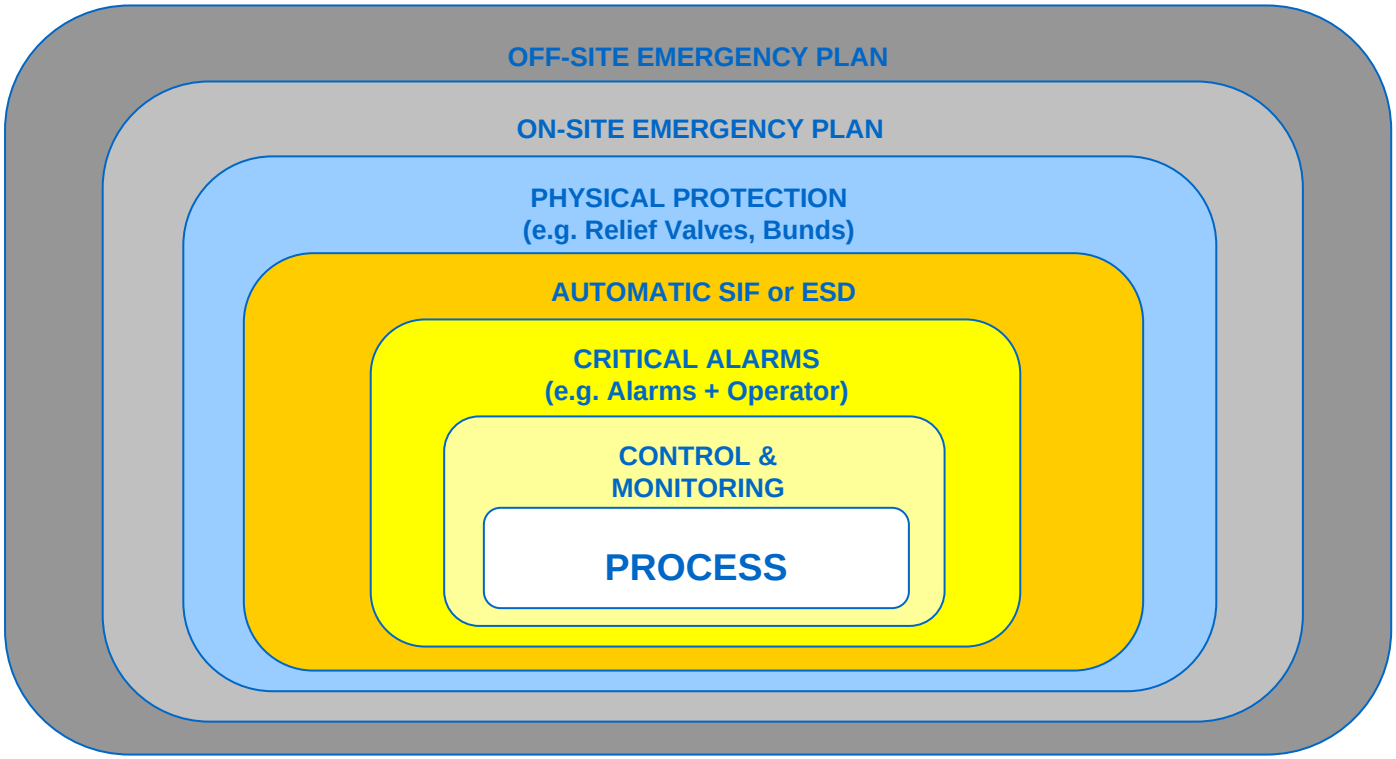
Layers of Protection Analysis (LoPA)

- A semi-quantitative method
  - Can use orders of magnitude or more precise values
  - Better data input from precision means a more accurate, less conservative result
- The method ‘preferred’ by the UK regulator
  - More rigorous
    - Consequentially, better understanding of hazards
- Uses substantially more resources than Risk Graph – Costain’s experience is that resources are doubled

Layers of Protection Analysis



Review of Integrity Level Assessments

- The Buncefield Enquiry instigated a review of Integrity Level Assessments that had used the Layers of Protection Analysis technique
- Review looked at bulk liquid hydrocarbon storage only
- Objectives of review:
  - To ascertain the current practice, quality and application of assessments
  - To identify any areas of good practice
  - To report on the findings and to make recommendations of value to industry

Review of Integrity Level Assessments

Quality	Data sources should be current and auditable e.g. OKOOA or OREDA guidance. Errors included using site only historical data rather than industry wide
Rigour	Team approach – relevant team members, experienced, knowledgeable
Consistency	Errors in the estimation of failure rates and initiating event rates
Human Factors	Too much credit taken for HF as a mitigation, underestimating HF as initiating event
Sensitivity	Is the Integrity Level close to the next level up?

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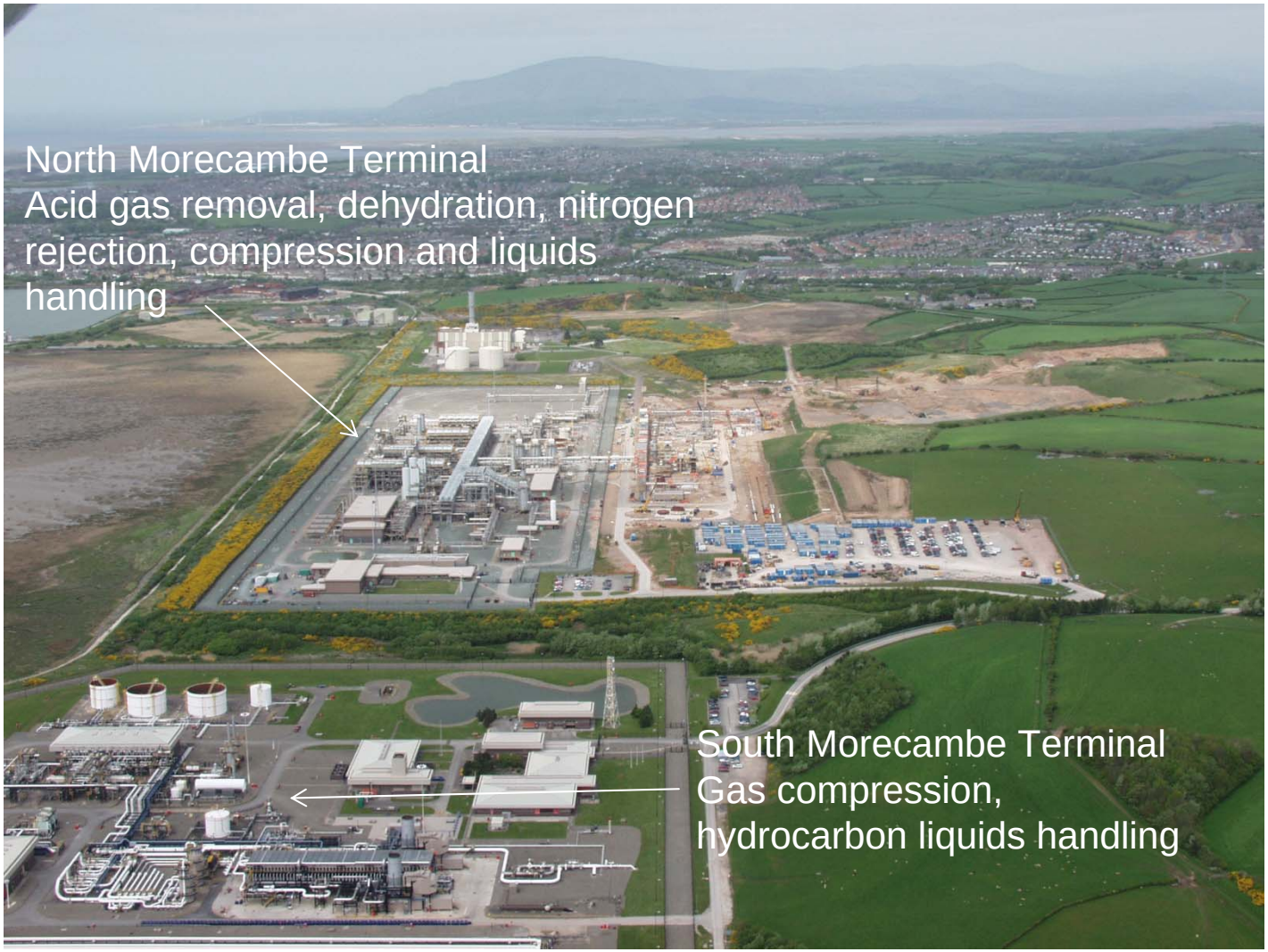
- Overall Lifecycle Approach and Application
- Costain Address Buncefield Enquiry Recommendations for key clients

Client Onshore Facilities

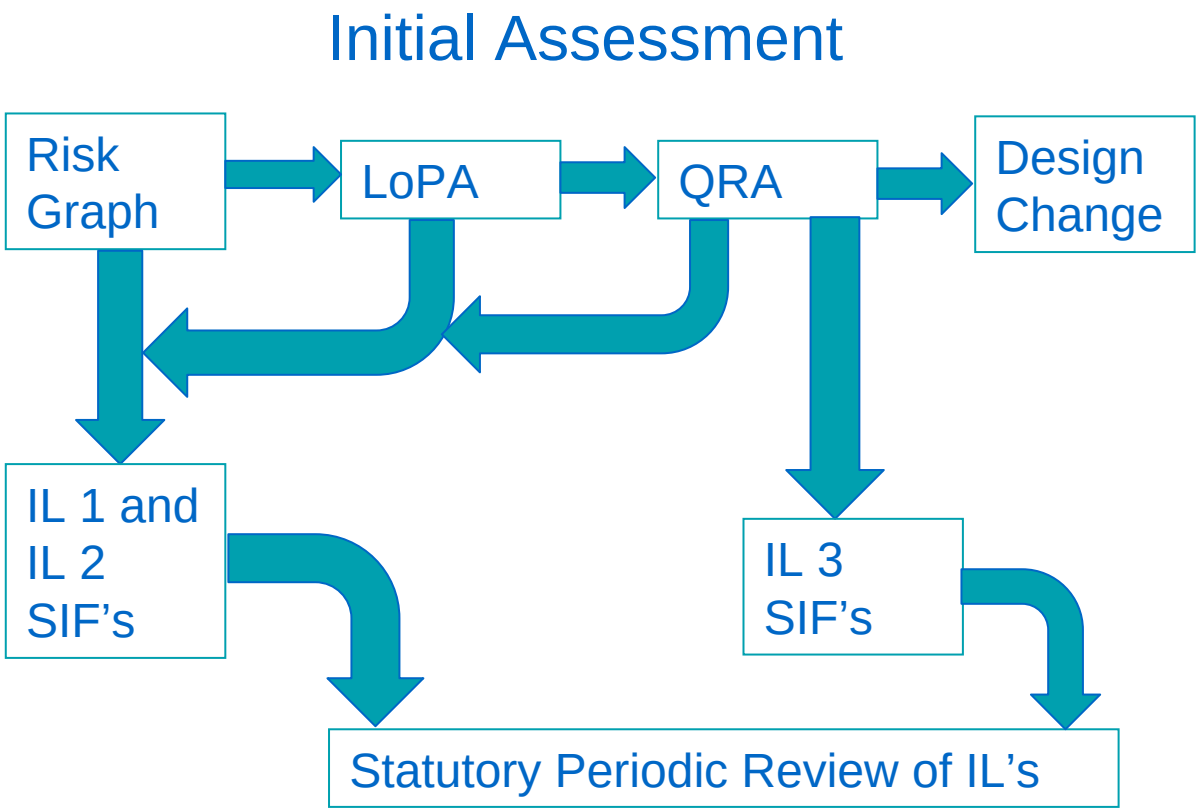


The Lifecycle Approach Model

- Background
  - Extensive study consisting of 2 gas processing facilities and multiple offshore assets
  - 864 SIF's (Safety Instrumented Functions)

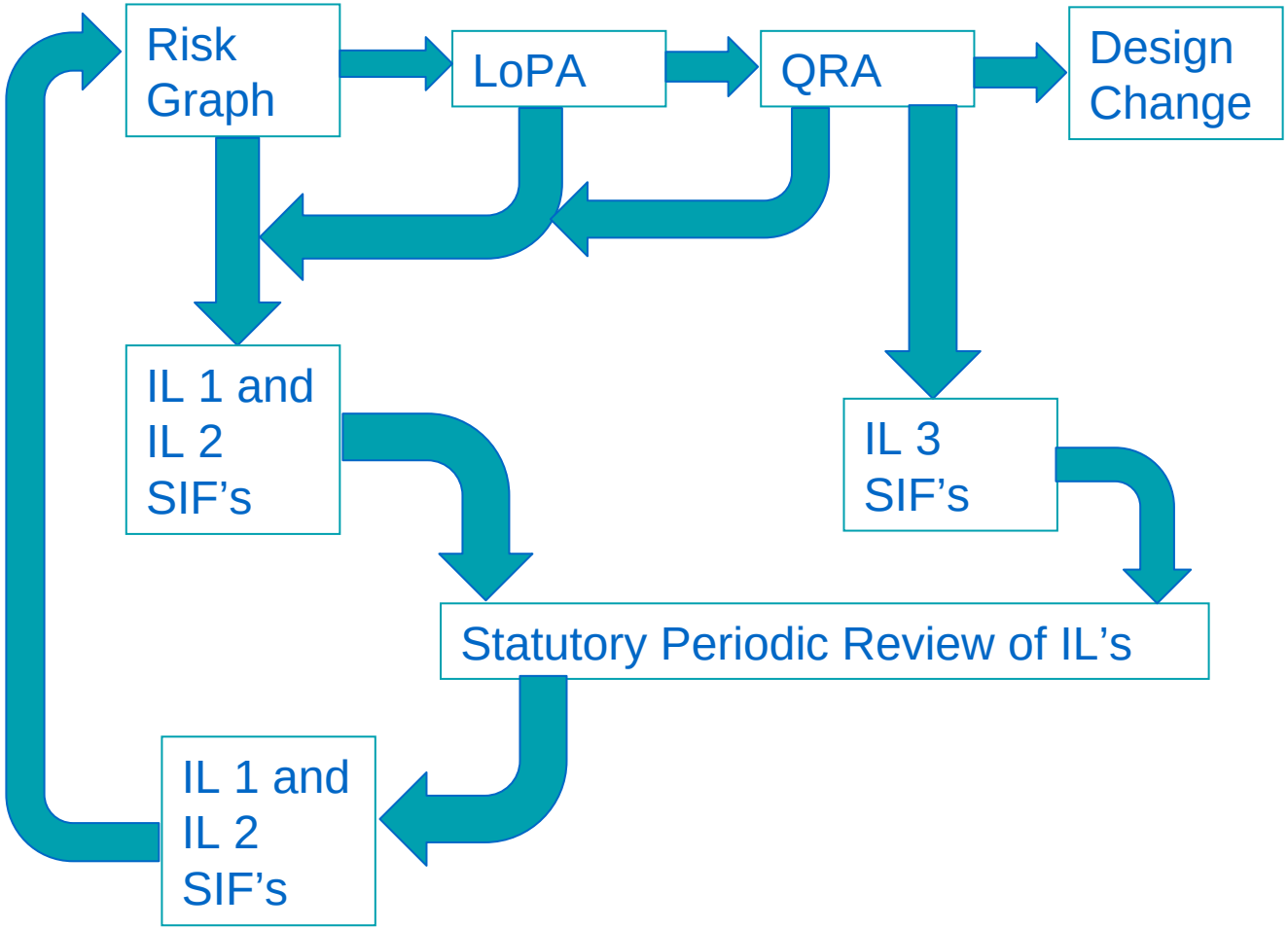
- Client objective
  - Reduce resource usage
  - Maintain rigour
    - Greatest hazards receive greatest consideration
    - Use best available data
  - Produce a formal procedure for use 'corporate-wide' in compliance with IEC 61508

The Lifecycle Approach Model



The Lifecycle Approach Model

Periodic Review Assessment



The Lifecycle Approach Model

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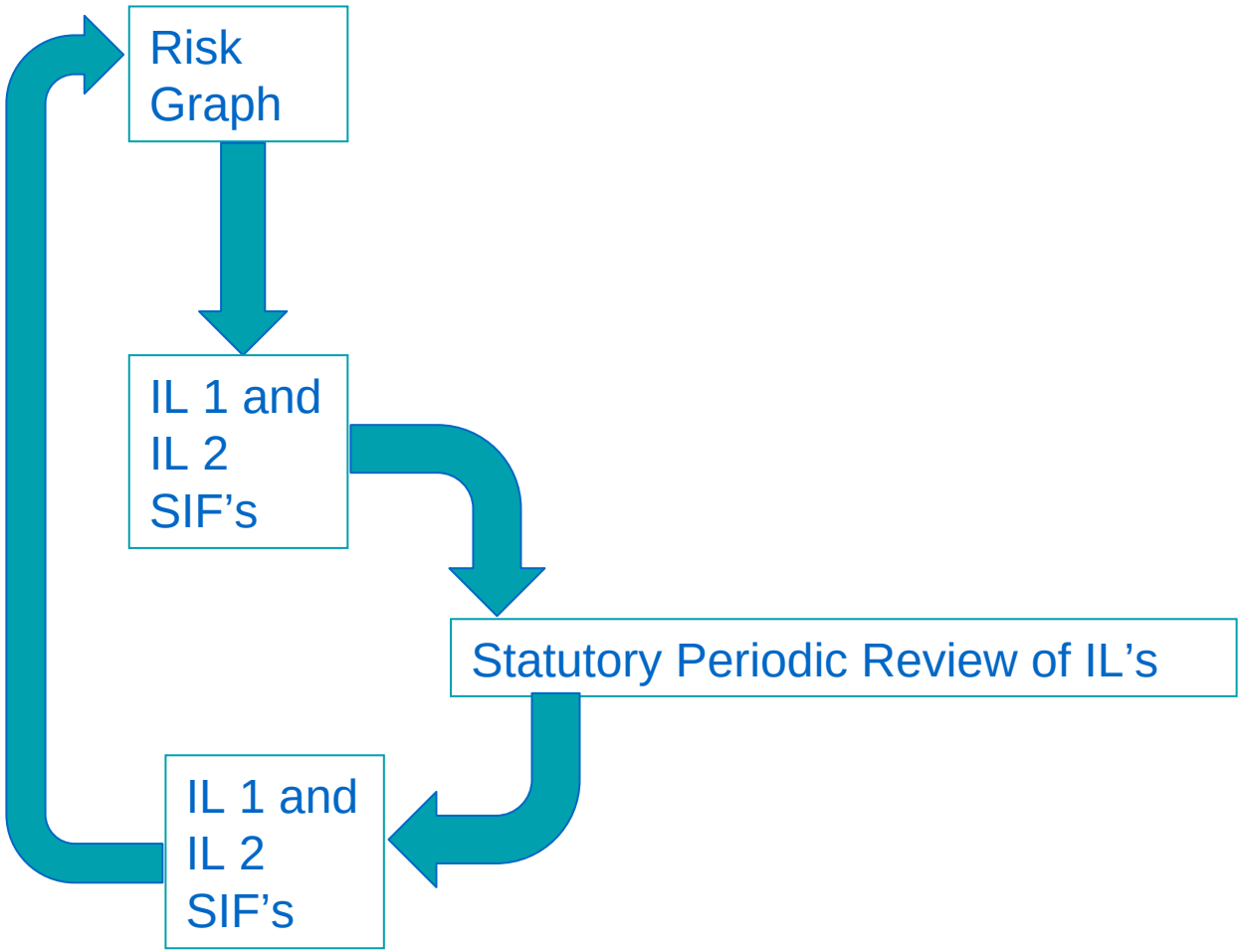
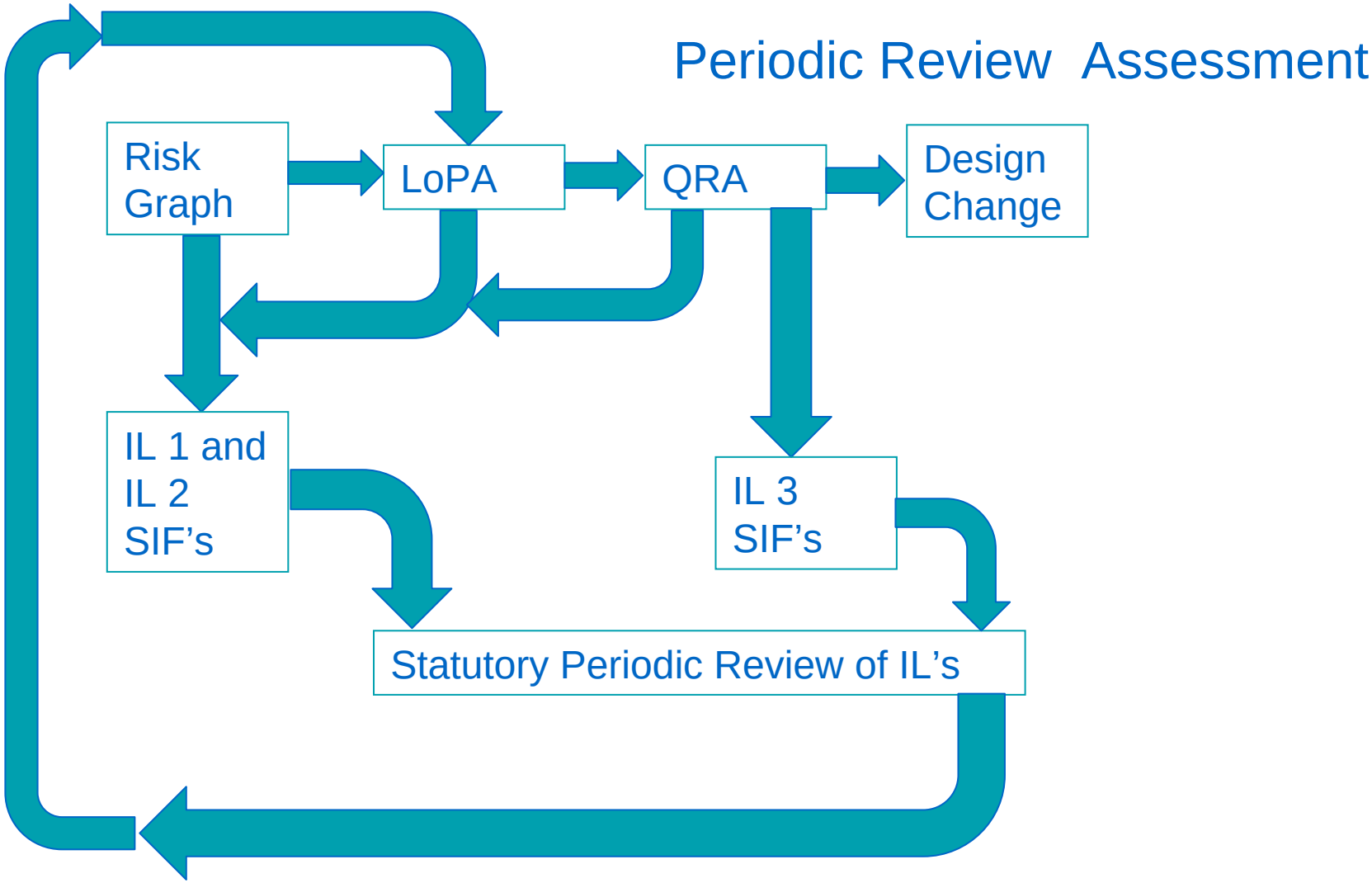


The Lifecycle Approach Model



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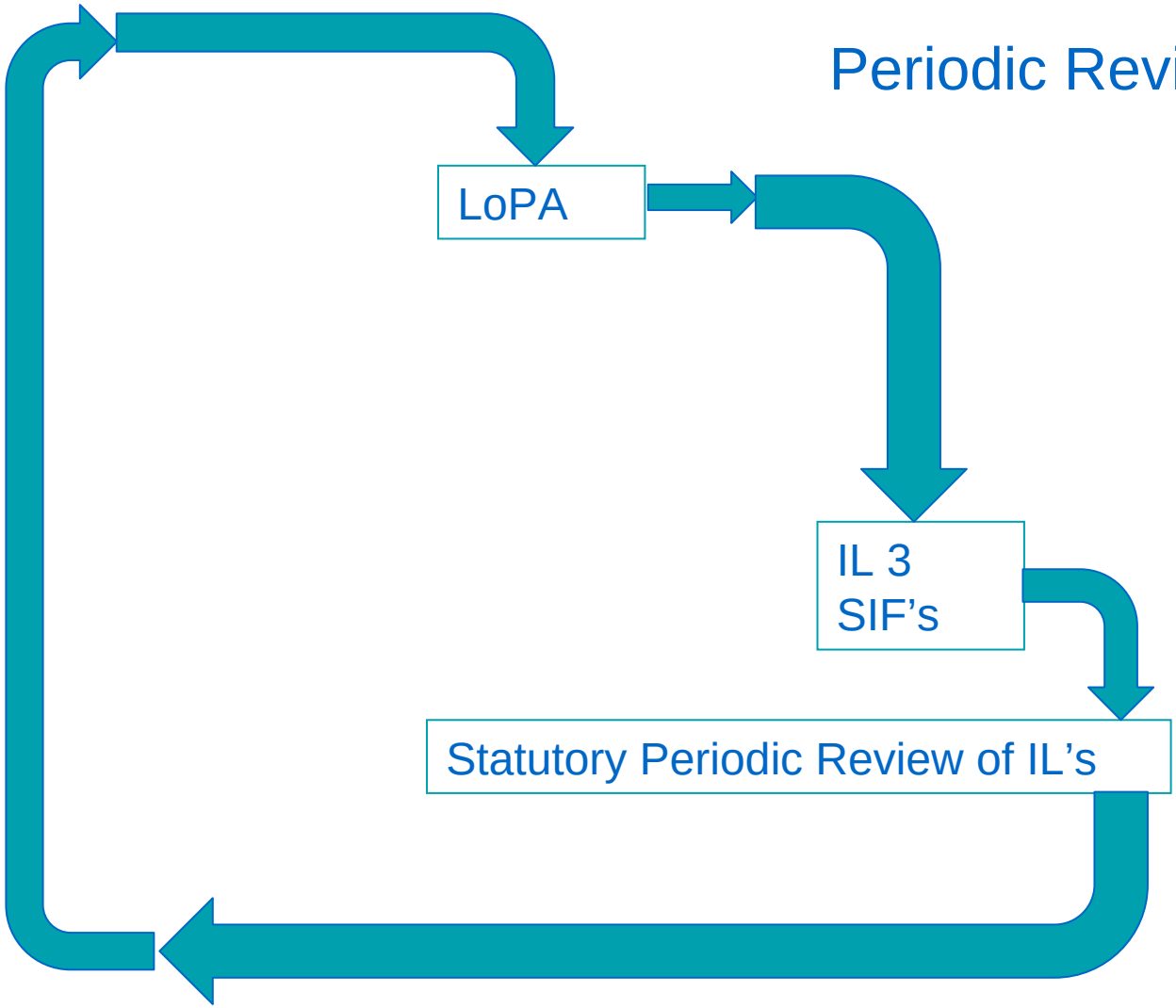

Benefits to client

- Short term - The time/resource saving is between 15 and 25% representing cost reduction of approximately USD20K.
- Long term - Subsequent reviews will see even greater savings since they will be completed using the appropriate techniques
- Overall – Rigour is maintained
- Methodology ensures greatest hazards receive greatest consideration
- Used best available data (eg. UKOOA, OREDA)
- Produced a formal procedure for this methodology in compliance with IEC 61508, which will be implemented imminently

Summary

- The Buncefield Incident and the subsequent public enquiry fundamentally questioned the approach to the assessment of Integrity Levels.

- The recommendations from the Enquiry introduced new levels of rigour and assurance, particularly since the review of a sample of assessments on similar facilities showed shortcomings.

Summary (Continued)

- Clients have been concerned about the additional costs.
- The challenge has been to achieve best value for clients while meeting the rigour required by the regulator and standards.
- Principal of targeting greatest resource at the greatest hazard.

Summary (Continued)

- Robust Procedures
  - Monitoring the Standards. Constant evolution to meet IEC 61508

- Lifecycle Approach
  - Reviews ensure assessments remain ‘current’
  - Training of assessment chairs
  - CASS certification – assurance
  - Supply chain management – no weakest link
  - Current, precise and appropriate data
  - Audit trail – Buncefield (1968), no documentation
  - 25% reduced costs over purely LoPA treatment

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Thank you for your attention