
# Bowtie Risk Assessment

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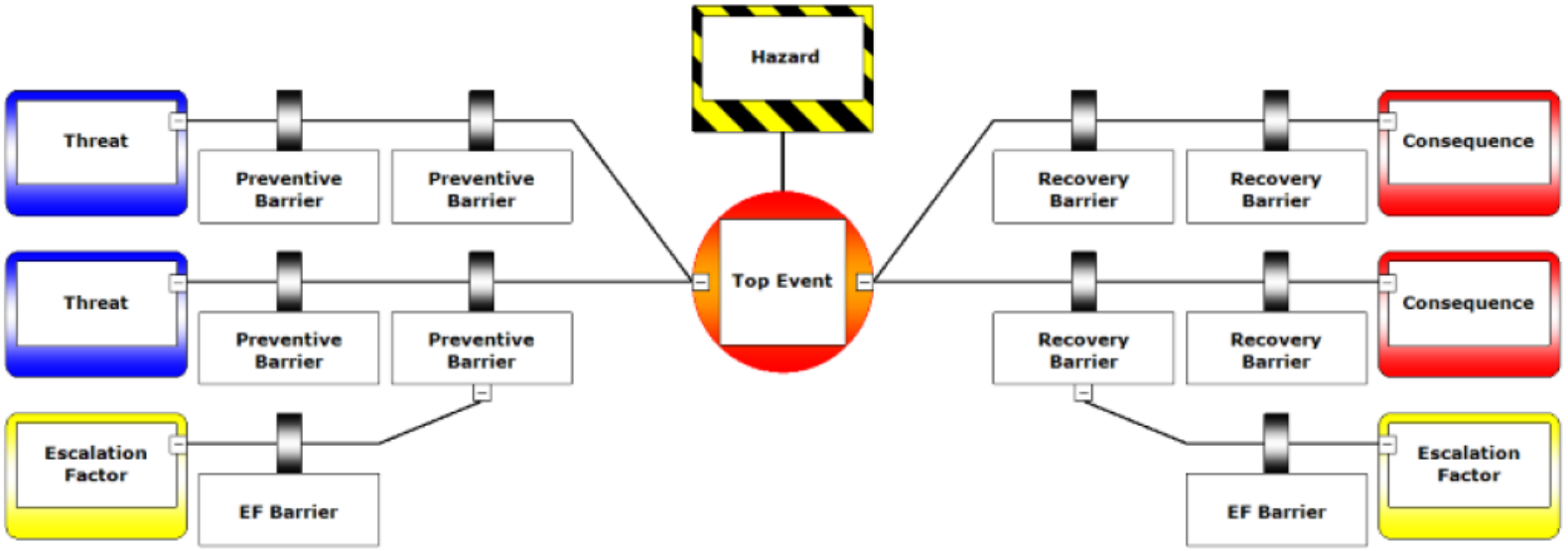
# Agenda

- *Introductions*
- *Description – what is a ‘Bowtie’*
- *Background – how and why they were developed*
- *Definitions*
- *Coffee Break #1*
- *Classification of Barriers*
- *Introduce the Worked Example*
- *Coffee Break #2*
- *Worked Example*
- *Recap*

# Description

*A 'bowtie' is a diagram that visualizes the risk you are dealing with in just one, easy to understand picture. The diagram is shaped like a bow tie, creating a clear differentiation between proactive and reactive risk management. It gives you an overview of multiple plausible scenarios, in a single picture. In short, it provides a simple, visual explanation of a risk that can be much more difficult to explain otherwise*



# Regulations and Key Events in History


1972 Robens Report

1974 Flixborough

1974 Health and Safety at Work Act

1984 Control of Major Accident Hazard Regulations

1987 Herald of Free Enterprise

1988 Piper Alpha

1990 Cullen Report

1999 Management of H&S Regulations

2006 Nimrod XV230

2008 Corporate Manslaughter Act

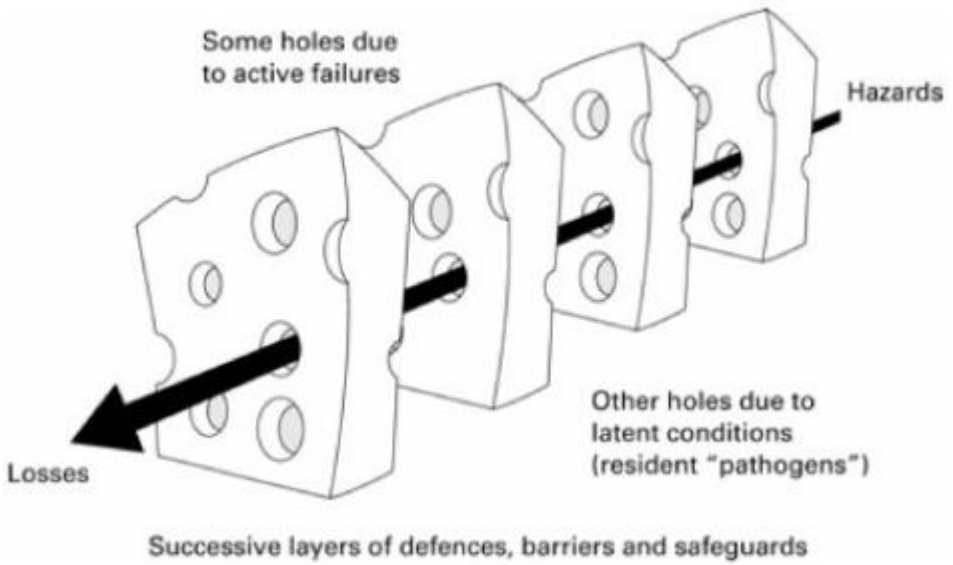
2009 Haddon-Cave Report

# Swiss Cheese?

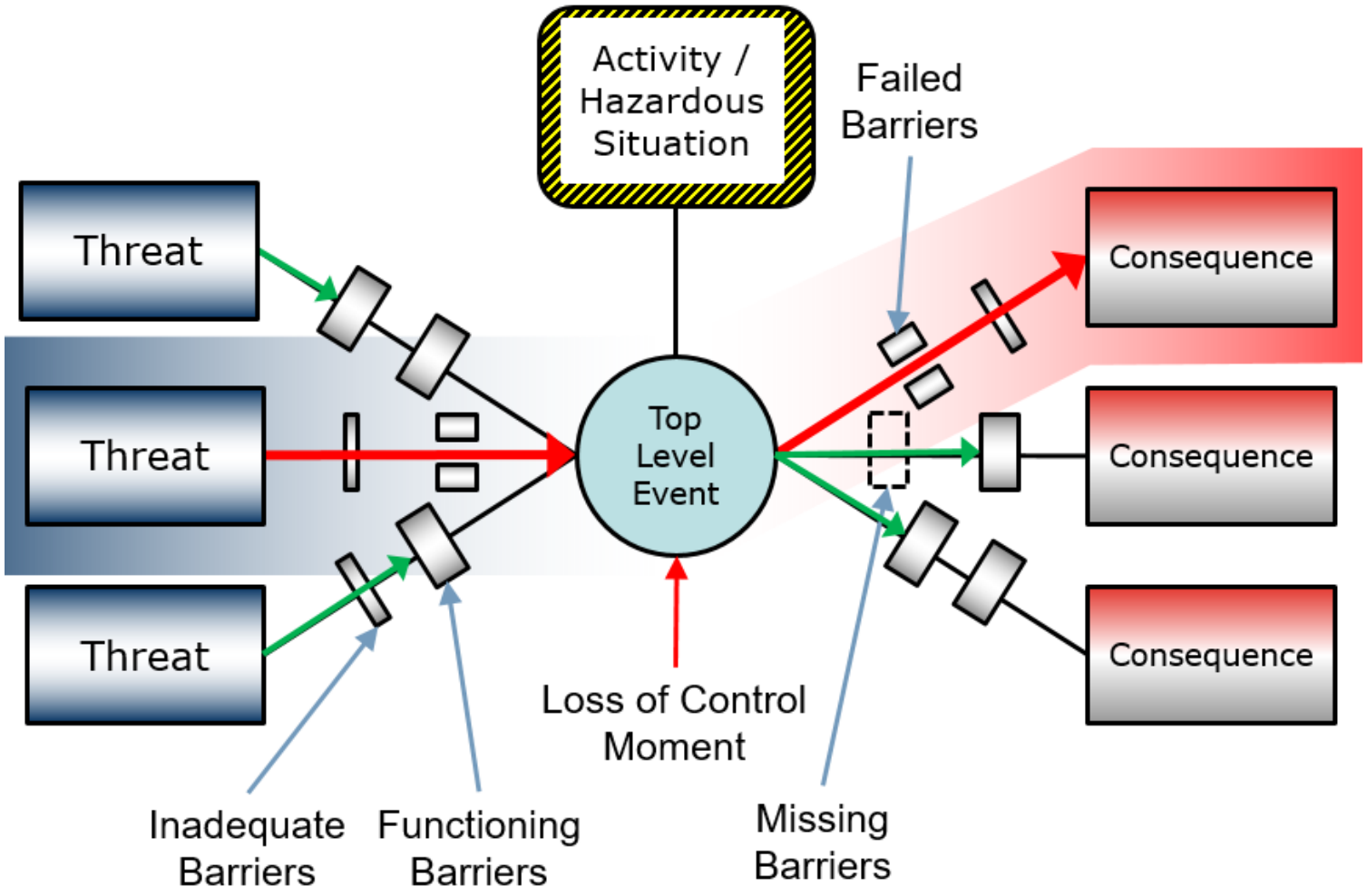
In 1990 psychologist James T. Reason proposed the Swiss Cheese metaphor as an accident causation model. Reason hypothesized that:

- Hazards are prevented from causing losses by a series of controls
- Controls however are never 100% effective as each control has unintended (inconstant) weaknesses
- Weaknesses line up as ‘holes’ enabling a hazard to be released.

In the Bowtie method these weaknesses are defined as Escalation Factors and are important features to fight the illusion of control that organisations sometime tend to have



# Mapping Causal Factors



# Definitions - Hazard

A hazard is an “intermediate state where the potential for harm exists”. It is not something undesirable, negative or unintentional; driving to work is a hazard and yet we do it every day. In the Bowtie method, a hazard is not an issue until it becomes uncontrolled.


Intermediate state where the potential for harm exists

The hazard provides structure, context and boundaries to what a bowtie may (and may not) include. It helps focus all subsequent elements of a bowtie and should be used to make its scope manageable.

# Definitions – Top Event

A top event is “A point in time that describes the release or loss of control over a Hazard”. Top events can also be described as ‘Loss of control events’. Start by looking at the hazard that the top event derives from and think of the ways that you may lose control of it.


A point in time that describes the release or loss of control over a Hazard

Top events are an important aspect of a bowtie as they represent the “pivot point” around which all subsequent elements are built. For each hazard there are often several top events, which require separate bowties to be built.

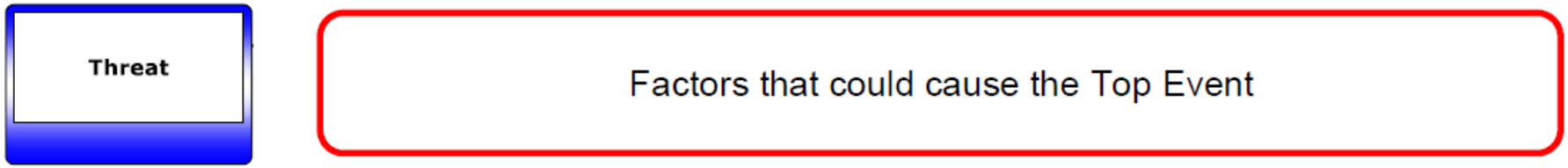
# Definitions - Consequence

Consequences are the undesirable outcomes (usually accidents) that follow on from the release of a top event if the event is not stopped by a barrier.


The undesirable events (usually accidents and safety related incidents) that may potentially result from the top event

# Definitions - Threat

Threats are “Factors that could cause the top event”

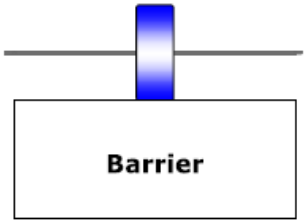



A threat should NOT describe a failed barrier (e.g. Fails to follow process X).

A threat should NOT need to be combined with other threats to cause the top event to occur (i.e. each threat on its own can conceivably cause the top event to occur).

# Definitions - Barrier

Barriers are “any measure taken that acts against some undesirable force or intention, in order to maintain a desired state”.



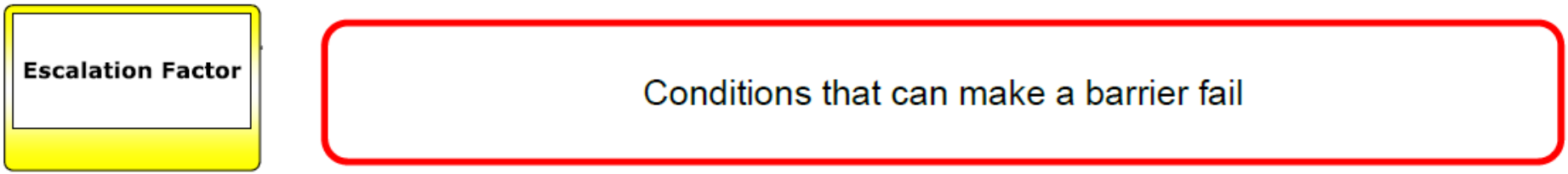

Any measure taken that acts against some undesirable force or intention, in order to maintain a desired state

Barriers in the bowtie appear on both sides of the top event. Barriers on the left side are designed to prevent threats from occurring (**Preventative Barriers**) , and if they do, prevent them from causing a loss of control (ie top event being released). Barriers on the right side make sure that if the top event is reached, they prevent a consequence from being realised or mitigate the impact if it does **(Recovery Barriers)**

- A barrier must be something that prevents an occurrence
- A barrier must be specific
- Barriers also eliminate threats and reduce the severity of consequences.

# Definitions – Escalation Factor

Escalation factors are “conditions that can make a barrier fail”. They connect to barriers and detail any condition, situation or factor that can make them fail, increasing the chance of a top event or a consequence occurring. They are a useful way of identifying specific factors that can work against the effectiveness of barriers.




Escalation factors are often misapplied and over-used, with a plethora appearing on bowties, making them hard to interpret, distorting the visualisation of risk and making them so complex that they cease to be effective. Not all potential conditions that can make a barrier fail need to be annotated, only the real weaknesses that need to be managed.

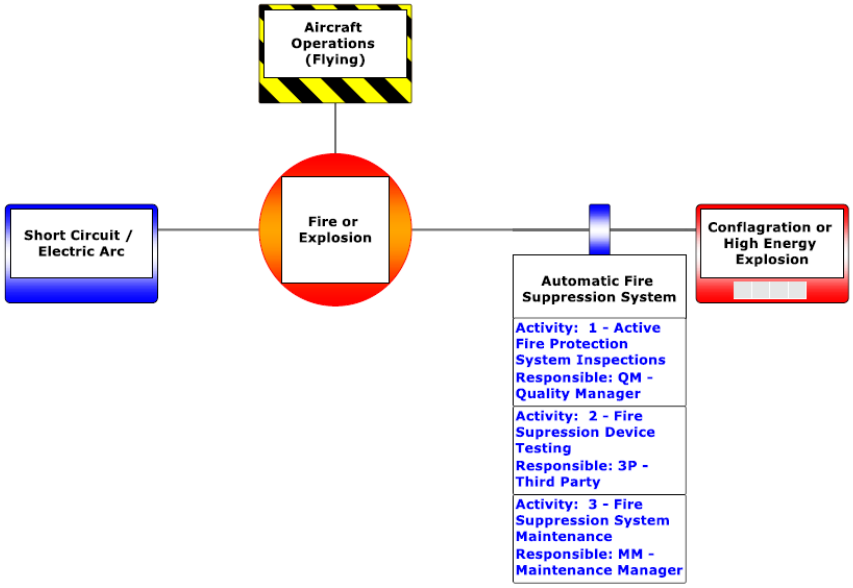
# Definitions - Activities

Activities are “detailed tasks that need to be executed in order for a barrier to be fully functional.

**Activity: 1 - Active Fire Protection System Inspections**
**Responsible: QM - Quality Manager**

Detailed tasks that need to be executed in order for a barrier to be fully functional

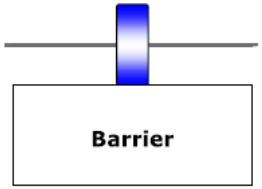
Activities can be a powerful part of the Bowtie management approach as they recognise the reality that a barrier is often not owned by one individual, rather it is made up of a number of activities delivered by different individuals or organisations



RINA

Coffee Time

# Barriers




Any measure taken that acts against some undesirable force or intention, in order to maintain a desired state

The Key benefit of using Bowtie is that it helps us to understand and manage the Barriers. For Barrier management we need to consider a number of factors including:

1. **Barrier Type**
2. **Barrier Effectiveness**
3. **Barrier Owner (who is accountable)**
4. **Barrier Basic Risk Factor**
5. **Barrier Criticality**

Whilst some organisations consider ALL of the above factors, I believe that this sometimes over complicates the overall picture – for UKHO we will jointly develop a set of criteria for Barrier management that best fits the organisation

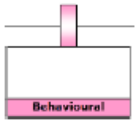
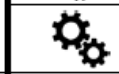
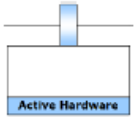
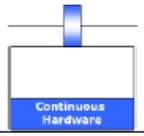
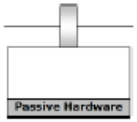
# Barrier Type

Barrier Type Illustrates whether the barriers in a threat line are over reliant on a certain type of barrier. If a particular threat is managed solely through behavioural barriers, this line may be more vulnerable than others to the impact of human performance degrading factors (fatigue, operational pressures etc.).

If a line is managed primarily through autonomous or passive barriers, it may not be sufficiently responsive to new and unexpected environmental conditions that the technical system was not designed to detect or decide upon. Barrier Types can include:

- Behavioural
- Socio-Technical
- Active Hardware
- Continuous Monitoring
- Passive Hardware

# Barrier Type

| Barrier | Description | Detect | Act |
|---|---|---|---|
|   | This type is used when a person is responsible for detecting, making a decision and performing an action. It applies if the barrier is completely represented by people (eg Lookout, Briefs). |  |  |
|   | Otherwise known as a man-machine barrier. This type is used when a combination of people and hardware work together to create a functioning barrier system. In the detect, decide, act cycle, the detection might be done by a person, while the action is an automated technical system. Vice versa is also possible (eg Radar, Aircraft Lighting). |   |   |
|   | Used if the whole system is hardware based. This type is used when the detection, decision and action are all performed by some technical system, without any direct human intervention (eg Sprinkler System). |  |  |
|   | This type is used when a technical system needs to act continuously instead of activating based on some input (eg Ventilation System). | N/A |  |
|   | This type is used when a barrier neither acts nor detects, it remains passive and is mostly there to absorb or avoid energy (eg Sense and avoid equipment, Conspicuity). | N/A | N/A |

These Barrier ‘Types’ are taken from the Production/Petro Chemical Industry. We can define our own barrier types specific to our own Organisation/Industry e.g.

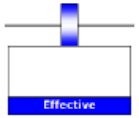
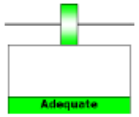
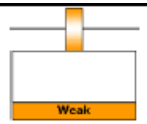
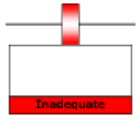
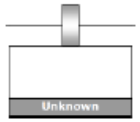
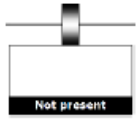
- Process/Procedure
- Certification/Regulation
- Testing

# Barrier - Effectiveness

Effectiveness. Clearly highlights the barriers that aren't effective, which helps in the identification of where to focus effort, set priorities and determine whether a risk is ALARP and tolerable. Evidence to help in assigning the correct effectiveness rating can be found from occurrence reporting, investigation findings, assurance activity, operational data and any other feedback from when a barrier has been tested, and its performance recorded. Where activities are assessed for effectiveness within Bowties, the same taxonomy should be used.

- Effective
- Adequate
- Weak
- Inadequate
- Unknown
- Not Present

# Barrier - Effectiveness

| Barrier | Description |
|---|---|
|  | • Barrier is suitable to eliminate/prevent the threat or lessen likelihood/reduce severity of the consequence.<br>• Barrier has been tested and proven to work as expected.<br>• Barrier owner informed of responsibilities and has provided feedback/ assurance on the status of the barrier.<br>• There are sufficient resources available to maintain the effectiveness of the barrier. |
|  | • Barrier is suitable to eliminate/prevent the threat or lessen likelihood/reduce severity of the consequence. SME judgement suggests the barrier will work as expected, when needed but there might not be documentary evidence to support the assumption.<br>• Description of effectiveness rating in place and barrier type selected through SQEP assessment.<br>• Barrier has an owner assigned through SQEP assessment.<br>• Procedural Barriers should always be Adequate at best (e.g. Lookout). |
|  | • The barrier is in place and offers some level of control over the threat but the adequacy and/or ability of the barrier is considered to be sub-optimal.<br>• Is the default assessment for purely HF related barriers (ie "Behavioural" but not necessarily "Socio-Technical") unless there is clear evidence to the contrary. |
|  | • A mitigation that is in place but does not operate reliably or as expected.<br>• Applies especially to technical solutions that do not deliver the intended level of control. |
|  | • The barrier has been included in the bowtie but has not been assessed by a SQEP panel for effectiveness. |
|  | • Applies to any mitigation that is known to exist and is considered appropriate in the subject bowtie. |

# Barrier - Accountability

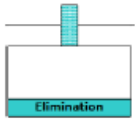
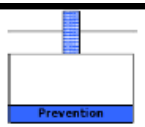
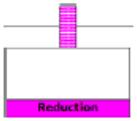
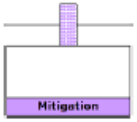
Accountability specifies the role whose incumbent is accountable for establishing and maintaining a barrier's effectiveness. Assigning barrier ownership to the correct role ensures that the right person can report on its performance and any emergent weaknesses. Ensures responsibility for mitigation measures is clearly understood and communicated across all parties.

# Barrier – Basic Risk Factor (BRF)

Basic Risk Factor (BRF). Helps ensure that bowties are constructed correctly, with barriers being placed in the order an occurrence would meet them. This facilitates more accurate risk assessment as it provides an understanding of whether the barrier prevents the threat being realised, prevents the top event from occurring, reduces the likelihood of a consequence occurring or reduces the severity of the consequence if it does occur.

- Eliminate
- Prevent
- Reduce
- Mitigate

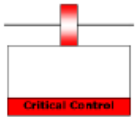
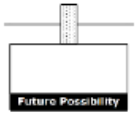
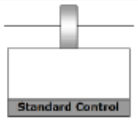
# Barrier – Basic Risk Factor (BRF)

| Barrier | Description |
|---|---|
|  | Prevents the threat occurring in the first place (effect delivered before the threat occurs). Designing out the threat should be the first priority and consideration (eg Preventative Maintenance Programme). This BRF is likely to apply to many barriers solely owned by the TAA. |
|  | If the threat occurs, it prevents the top event from happening. Where things cannot be eliminated, measures can be taken that may prevent them from creating a top event (Modify Cruise to best Engine Out Range). |
|  | If the top event occurs, it reduces the likelihood of the consequences occurring. No matter how good the prevention controls are, there will always be the potential for one or more to fail; therefore, reduction measures should be considered to reduce the likelihood of the consequences being realised. |
|  | If the consequence occurs, it mitigates against its severity (effect delivered after the consequence occurs). Measures taken to mitigate and minimise the severity of the consequences. Such measures will usually take effect after the event) eg Ventilation System). |

# Barrier – Criticality

Criticality. This assessment facilitates clear assessment of whether actions should be stopped should barrier assessed as critical to its safe conduct have a sub-standard effectiveness assessment; however, use this field with caution!

- Critical
- Standard
- Future

| Barrier | Description |
|---|---|
|  | • If the control were absent or only rated as "very poor" in terms of effectiveness, would you be thinking of stopping the operation?<br>• If the control is related to a piece of technical equipment, would its unserviceability be a "no-go" item? |
|  | • This signifies that the control is "Not Present" but may be in the process of going through a funding or development process.<br>• Also, it may not have been reviewed for consideration as a control at this juncture. |
|  | • All other controls that do not fit into Critical or Future. |


# Bowtie Workshop

# COVID-19

To start with – lets consider….

- What is the Hazard


Intermediate state where the potential for harm exists

- What is the Top Event


A point in time that describes the release or loss of control over a Hazard

# COVID-19

- What are the Threats


Factors that could cause the Top Event

- What are the Consequences

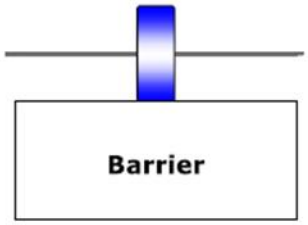

The undesirable events (usually accidents and safety related incidents) that may potentially result from the top event

RINA

**Coffee Time**

# COVID-19 - BARRIERS

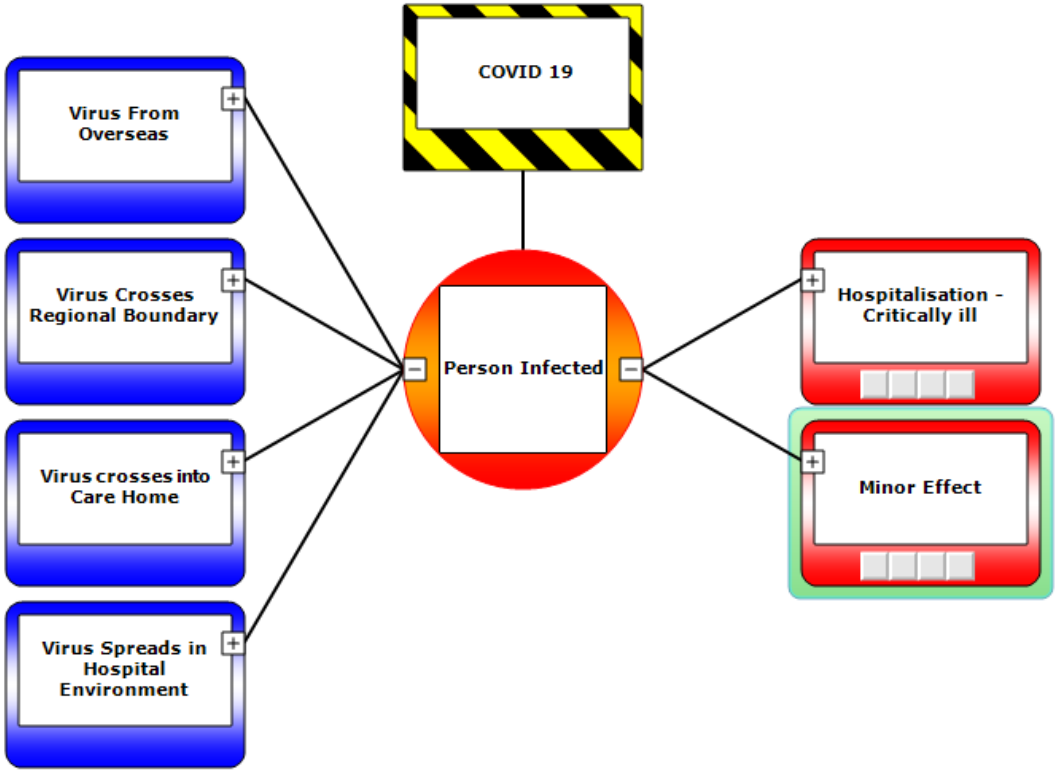
- Now lets look at the Barriers




Any measure taken that acts against some undesirable force or intention, in order to maintain a desired state

- What Barriers are currently in place
- What Barriers are ‘planned’?
- What are the Barrier Types?
- What is our assessment of Effectiveness
- What is our assessment of the Basic Risk Factor?

# Bowtie Workshop – Covid-19




# Recap

# Recap

*We've looked at the Background to the development of Bowtie as a Risk management tool*

*Considered the Threat / Hazard / Top Event / Consequence sequence of events*

*Discussed the Terminology used*

*Identified that Barrier Management is critical to managing risk*

*Used COVID-19 to understand the basic concepts used in Bowtie assessments*

***Homework***

*Within UKHO what do you consider to be the key Threats, Hazards and Consequences with respect to the delivery of your 'Products'*