



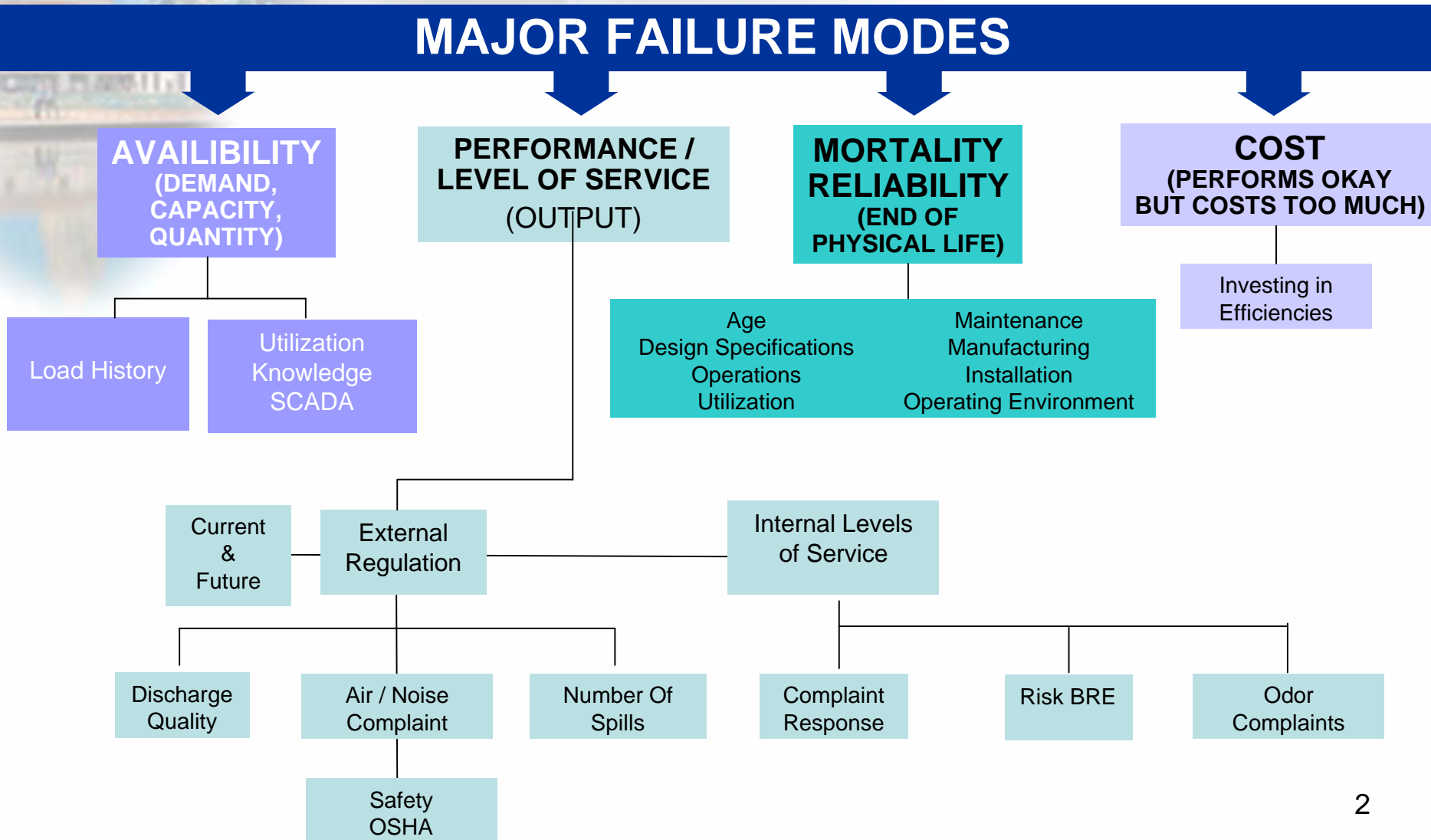
***Q3 Given My System,
Which Assets Are Critical
To Sustained
Performance?***

AMPLE

**Asset Management Program
Learning Environment**

The Concept of "Failure Mode": The Four Core "Failure Modes"

MAJOR FAILURE MODES



The “FMECA” Structure

(“Failure Mode, Effects and Criticality Analysis”)

MAJOR FAILURE MODE/S IDENTIFIED

AVAILABILITY

**DEMAND
CAPACITY
QUANTITY**

PERFORMANCE / LEVEL OF SERVICE

RELIABILITY

MORTALITY

**END OF
PHYSICAL LIFE**

COST

**PERFORMS OKAY
BUT COSTS TOO MUCH**

MODES EFFECTS TREATMENT	<p>DEMAND EXCEEDS CAPACITY (SUPPLY)</p>	<p>DEMAND INADEQUATE UTILISATION OF ASSET IS POOR</p>	<p>ASSET IS UNRELIABLE AND INTERRUPTS SERVICE DELIVERY TO UNACCEPTABLE LEVELS</p>	<p>ASSET STILL PERFORMING ADEQUATELY BUT FAILURE LIKELY</p>	<p>NON PERFORMING FINANCIALLY TECHNICALLY INEFFICIENT OR OBSOLETE.HAS POOR UTILISATION AND DERIVES LOW INCOME / INCOME</p>
	<p>FAILS TO MEET LEVEL OF SERVICE OR STANDARDS REQUIRED</p>	<p>HIGH COST OF SERVICE NON PERFORMING ASSET (FINANCIALLY)</p>	<p>HIGH NUMBER OF FAILURES IMPACTS ON CUSTOMERS. POOR LEVEL OF SERVICE</p>	<p>LOSS OF SERVICE IMPACT DEPENDENT ON DIRECT / INDIRECT CONSEQUENCES OF FAILURE</p>	<ul style="list-style-type: none"> • HIGH MAINTENANCE AND / OR OPERATING COSTS • HIGH DEPRECIATION • FUTURE LIABILITIES ETC
	<ul style="list-style-type: none"> • ASSET AUGMENTATION • NEW ASSET • DEMAND MANAGEMENT 	<ul style="list-style-type: none"> • ASSET DISPOSAL • RATIONALISATION • INCREASE INCOME • CONTINUE SUBSIDY 	<ul style="list-style-type: none"> • IMPROVE MAINTENANCE • REDESIGN • REHABILITATE • REPLACE / DISPOSE • LOWER SERVICE LEVEL 	<ul style="list-style-type: none"> • COMPLETE RISK ASSESSMENT • COMPLETE ORDM • IDENTIFY OPTIMISED RENEWAL 	<ul style="list-style-type: none"> • RATIONALISATION • DISPOSAL • OPTIMISED RENEWAL • LOWER LEVELS OF SERVICE • RESPONSE TIMES etc

Modes ➔ Effects ➔ Treatment (Management) Alternatives

CMOM – Failure Modes

Capacity

Storm Event

Availability/
Reliability

Blockage

Collapse

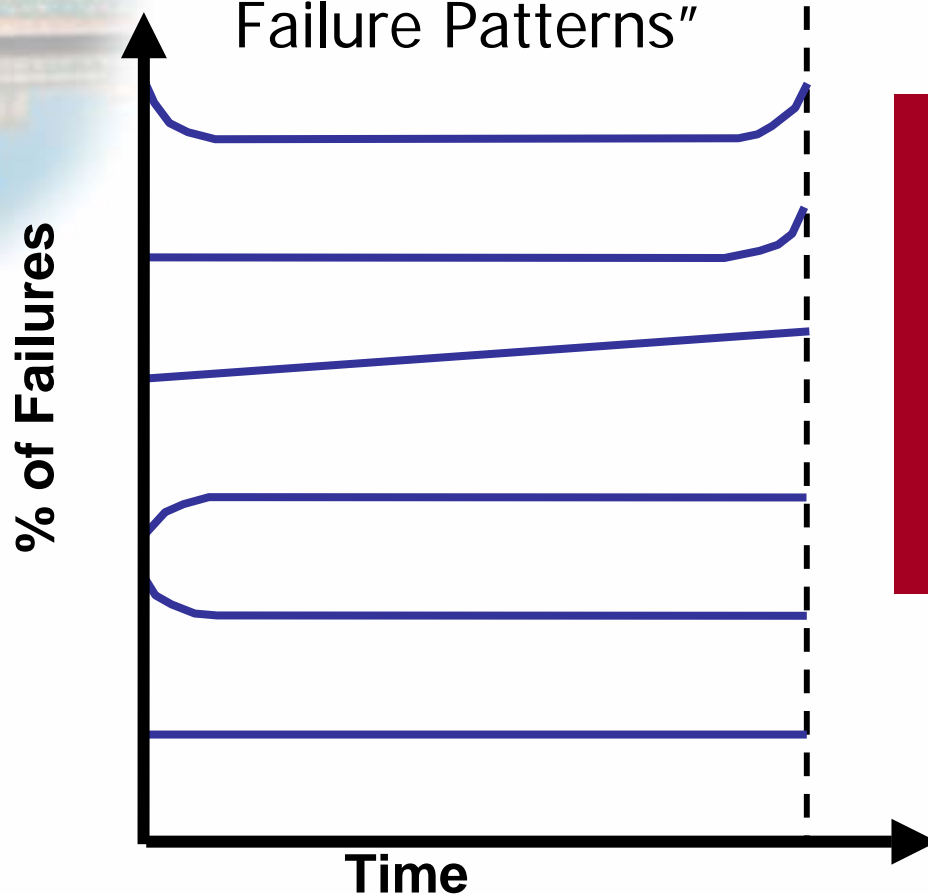
Asset Breakdown

- Physical capacity inadequate
 - exceeds LOS
- Physical asset not available due to:

Operations
Management

All Failure Modes – All Assets - Have a “Probability of Failure”

The Six “Generic Failure Patterns”



Reliability Analysis

“The probability that a component or system will perform its specified function for the specified period under specified operating conditions”

A scenic view of a river with a suspension bridge and a building in the background. The bridge has a prominent tower and is reflected in the water. The building is a large, classical-style structure with a dome. The scene is set in a city, likely San Francisco, with a bay and hills visible in the distance.

Definition of Risk

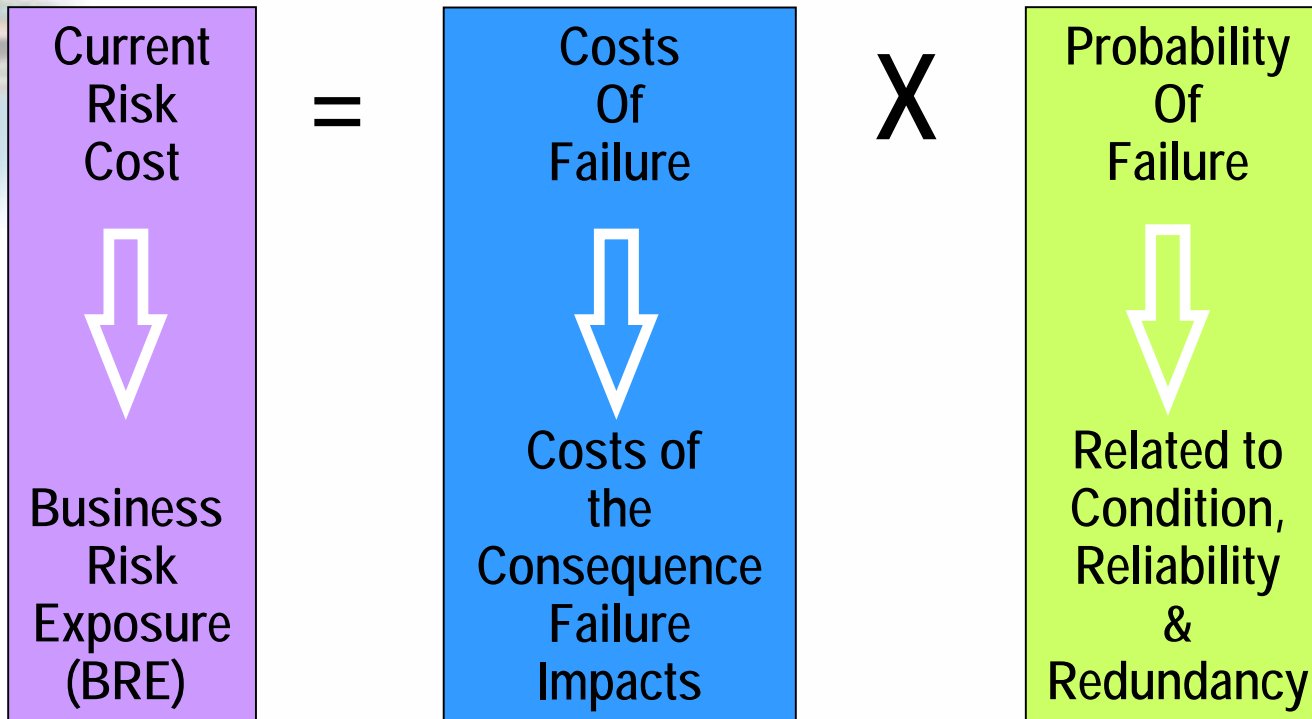
Risk is the consequence of uncertainty

Variables:

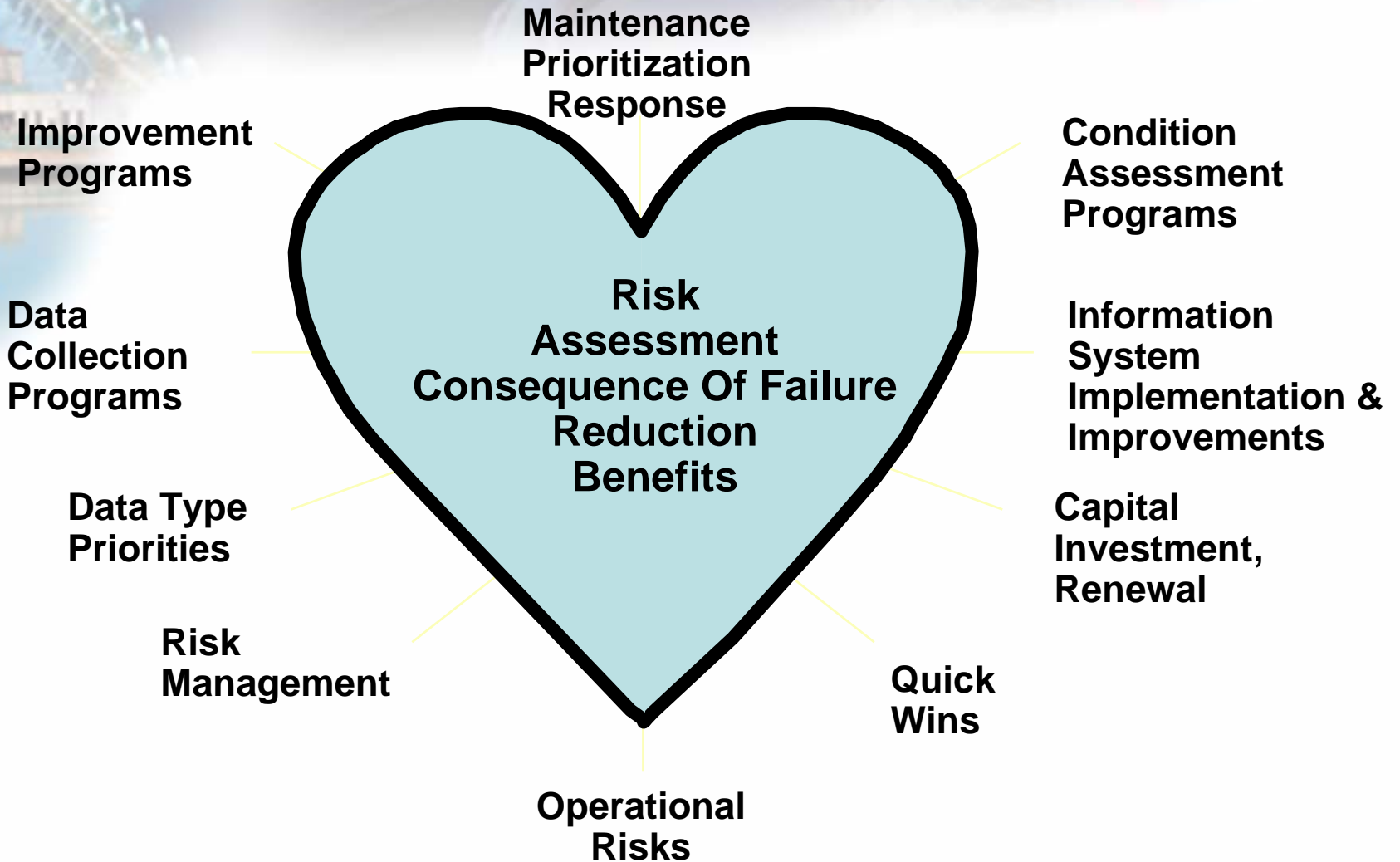
The consequence or impact of the event (CoF)

The potential or likelihood of the event (PoF)

The Risk (Criticality) Metric



Risk - The Heart Of A.A.M.



Risk - Inputs / Relationships

- Cause of failure
- Mode of failure
- Consequence of failure
- Probability of failure
- Risk cost exposure
- Risk cost reduction options
- Economic evaluation of options

“FMECA”

RISK

“ORDM”

FMECA – Failure Mode, Effects & Criticality Analysis
ORDM – Optimal Renewal Decision Making

Probability of Failure (PoF)

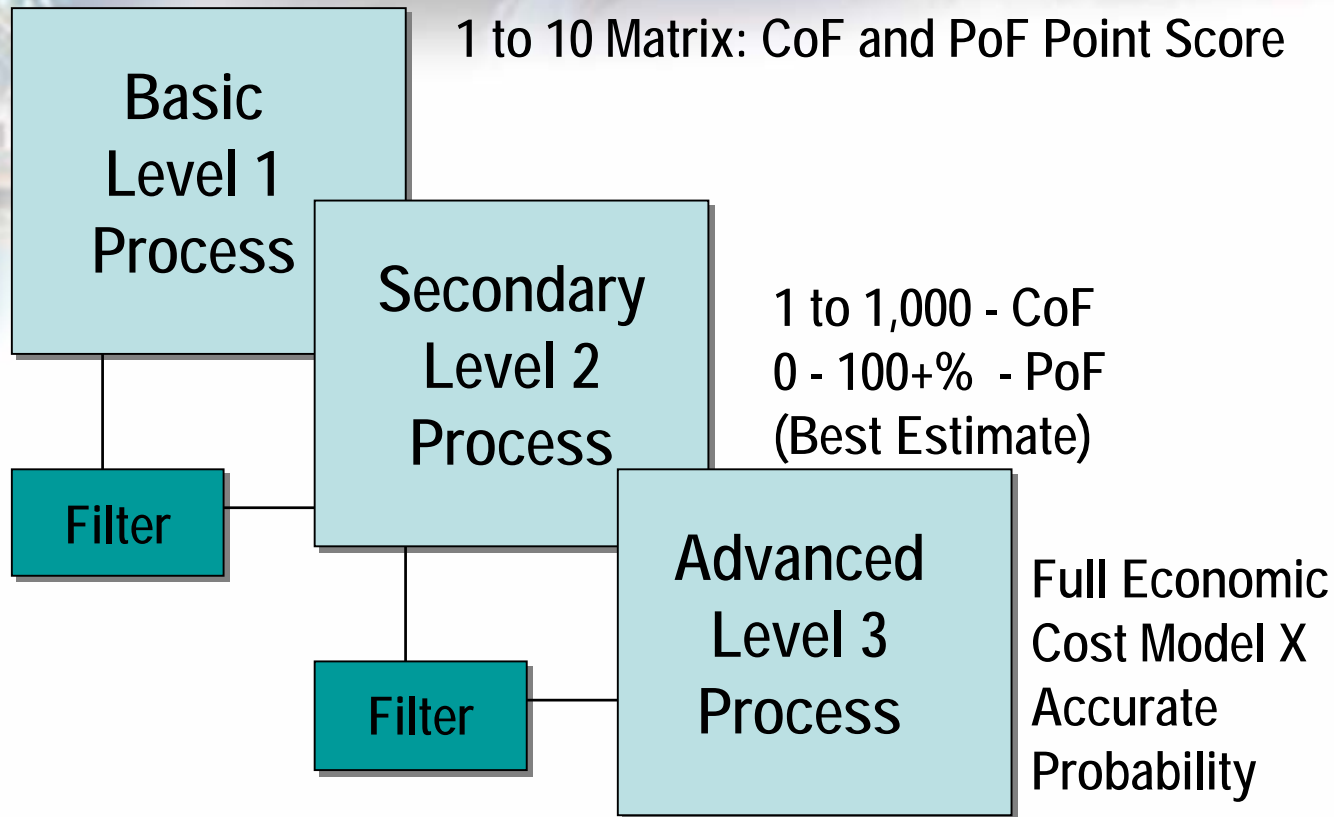
- The PoF is directly related to the “mode of failure” (MoF)
- We cannot be absolutely sure of the PoF.
- Sometimes we have good data, sometimes we do not.
- We can estimate a range of failure - how early (pessimistic) and how late (optimistic).

What are the Sources of PoF?

- CMMS – “Mean Time Between Failure” (MTBF)
- Vendor / industry information
- Other failure records (hard copies)
- Our “Brilliant Memories” (Staff)
- Our SCADA System (if we have one and it records this asset).

PoF – Potential of Failure

The Evolving BRE Methodology



CoF – Consequence of Failure
PoF – Potential of Failure

Stage One - Simple

EXAMPLE: Not all sewers are the same..

Risk Rating = Probability X Consequence


ASSET No.	PROBAB.	CONSEQ.	RISK RATING
1	.60	4	2.4
2	.70	2	1.4
3	.40	5	2.0
4	.85	8	6.8 *
5	.75	9	6.8 *
6	.10	10	1.0

*** THESE REQUIRE FURTHER INVESTIGATION**

Stage Two – Intermediate

Multiple Elements

ENHANCED FMECA ANALYSIS TECHNIQUES

ELEMENT	RATING	WEIGHTING	MAX. SCORE
Safety	1 - 5	10	50
Environment	1 - 5	6	30
Functionality	1 - 5	5	25
Cost	1 - 5	8	40
			145

Assets Review - Record No. 1

Main

Assets Review - Record No. 1

<u>C.o.F. Effects</u>		<u>Score</u>	<u>Weighting</u>	<u>C.o.F.</u>
Environmental Impacts	3 ?	20.0	1.0	20.00
Repair Cost	3 ?	20.0	1.2	24.00
Loss of Service	0 ?	0	1.0	0.00
Time off Supply	2 ?	3.0	1.5	4.50
Area off Supply	0 ?	0	2.5	0.00
Public Image	3 ?	20.0	1.5	30.00
Property Damage	0 ?	0	1.0	0.00
System Disturbance	4 ?	5.0	0.5	2.50
Production Loss	0 ?	0	1.0	0.00
Potential Injury or Fatality	1 ?	10.0	3.0	30.00

Prob. of Failure = 0.90 ?

Total C.o.F. Rating = 111.00

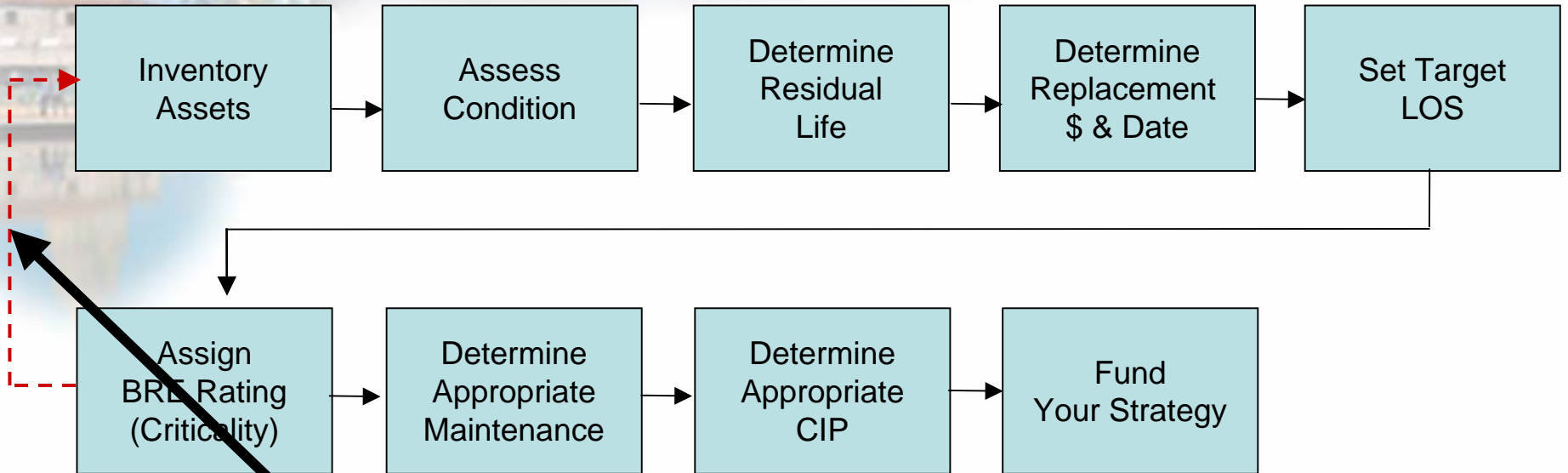
Risk Rating = 99.90

Asset does not comply with
Statutory Regulations or
Industry Standards

Return

Find New Edit Delete Return

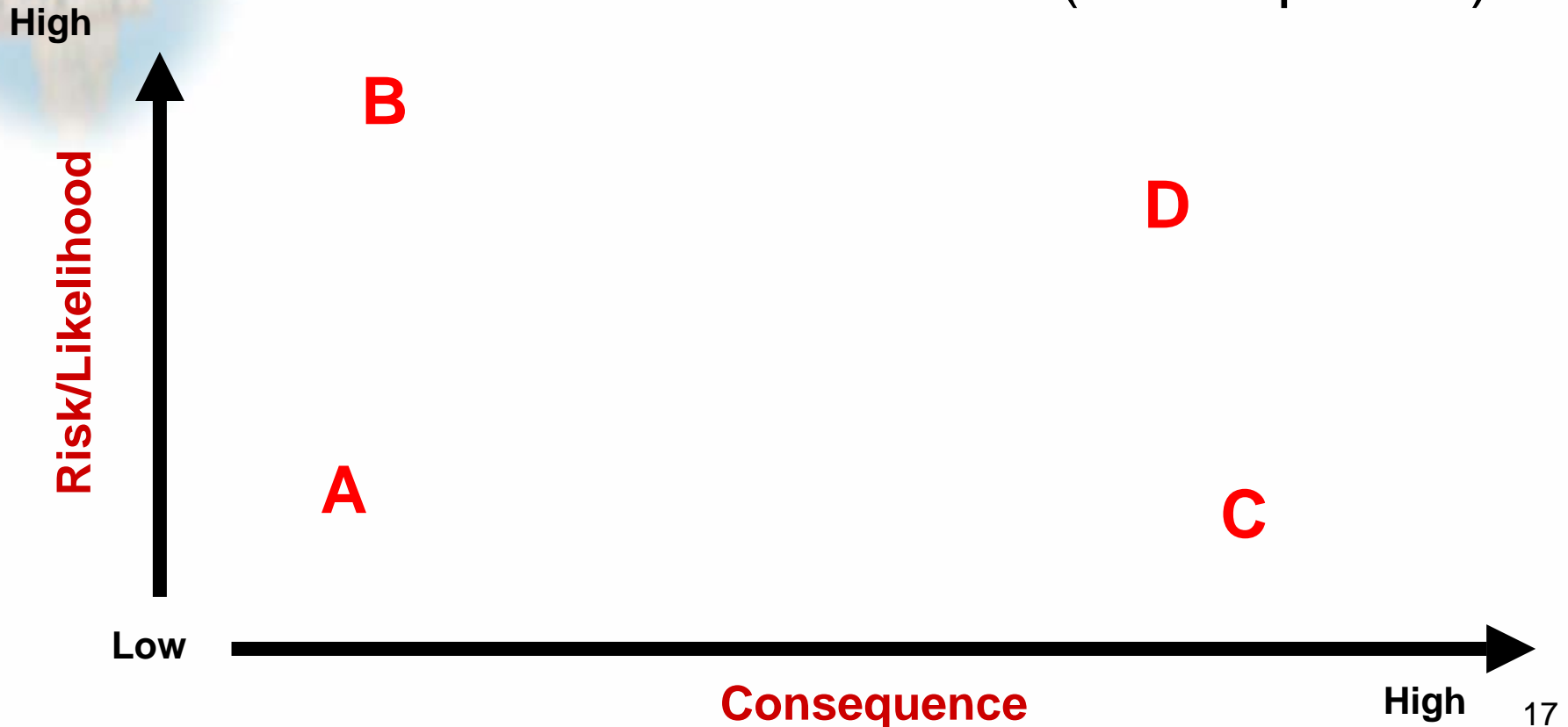
AAM Program Process - Modified



Use risk/consequence weighting to guide inventory and condition assessment efforts!

Determining "Significant" Failures: The Risk – Consequence Trade-off

- What is the likelihood of failure ? (risk)
- What is the cost of failure? (consequence)



Failure Risk/Consequence Drives Work Program

High

Risk/Likelihood

B "Poor"

D "Fair"

~~Worst First?~~

A "Good"

C "Good"

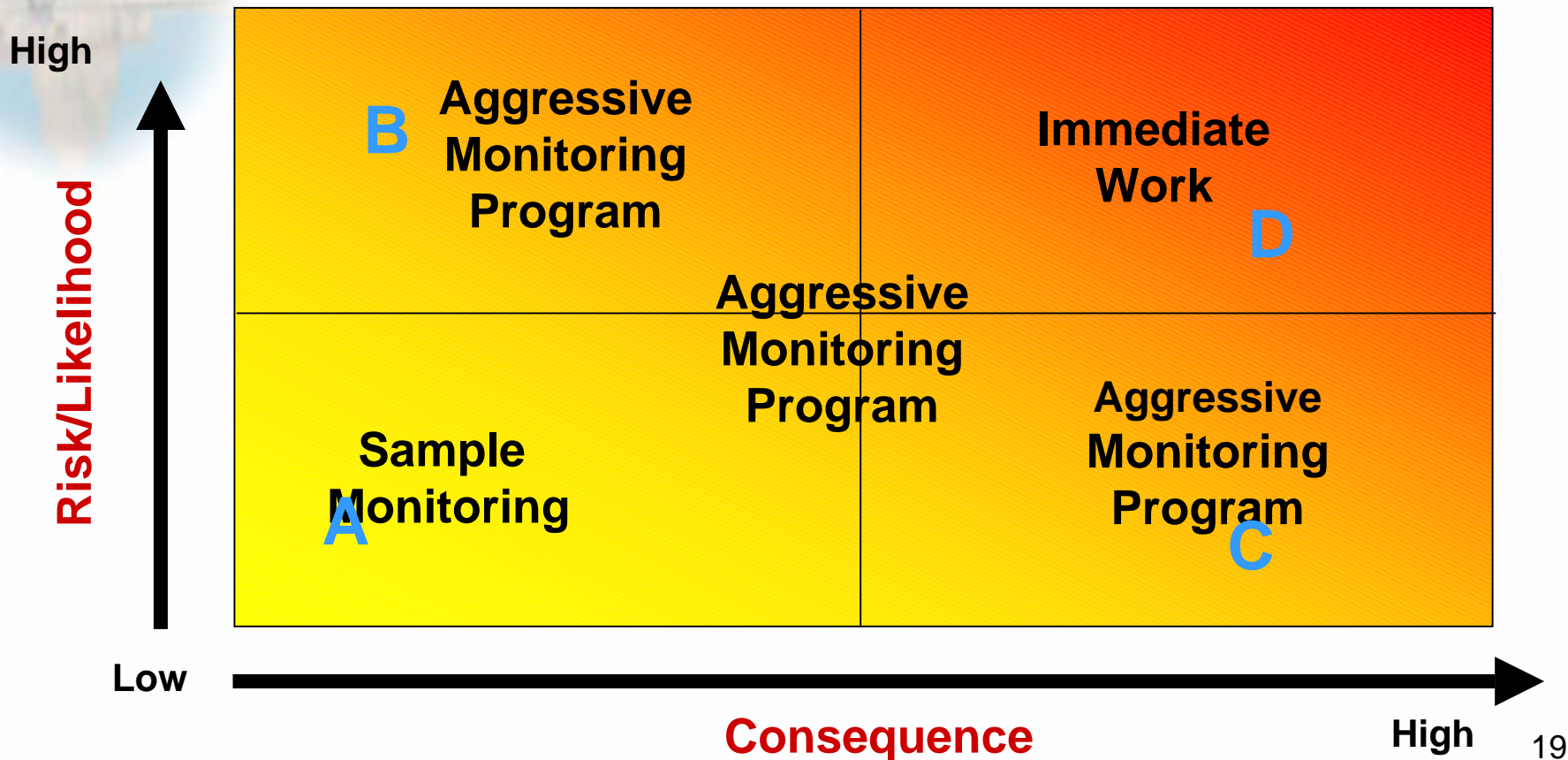
Low

Consequence

High

18

Failure Risk/Consequence Drives Work Program



BRE* 1 - Simple Approach

* Business Risk Exposure

High

1

2

3

3

3

6

9

2

2

4

6

1

1

2

3

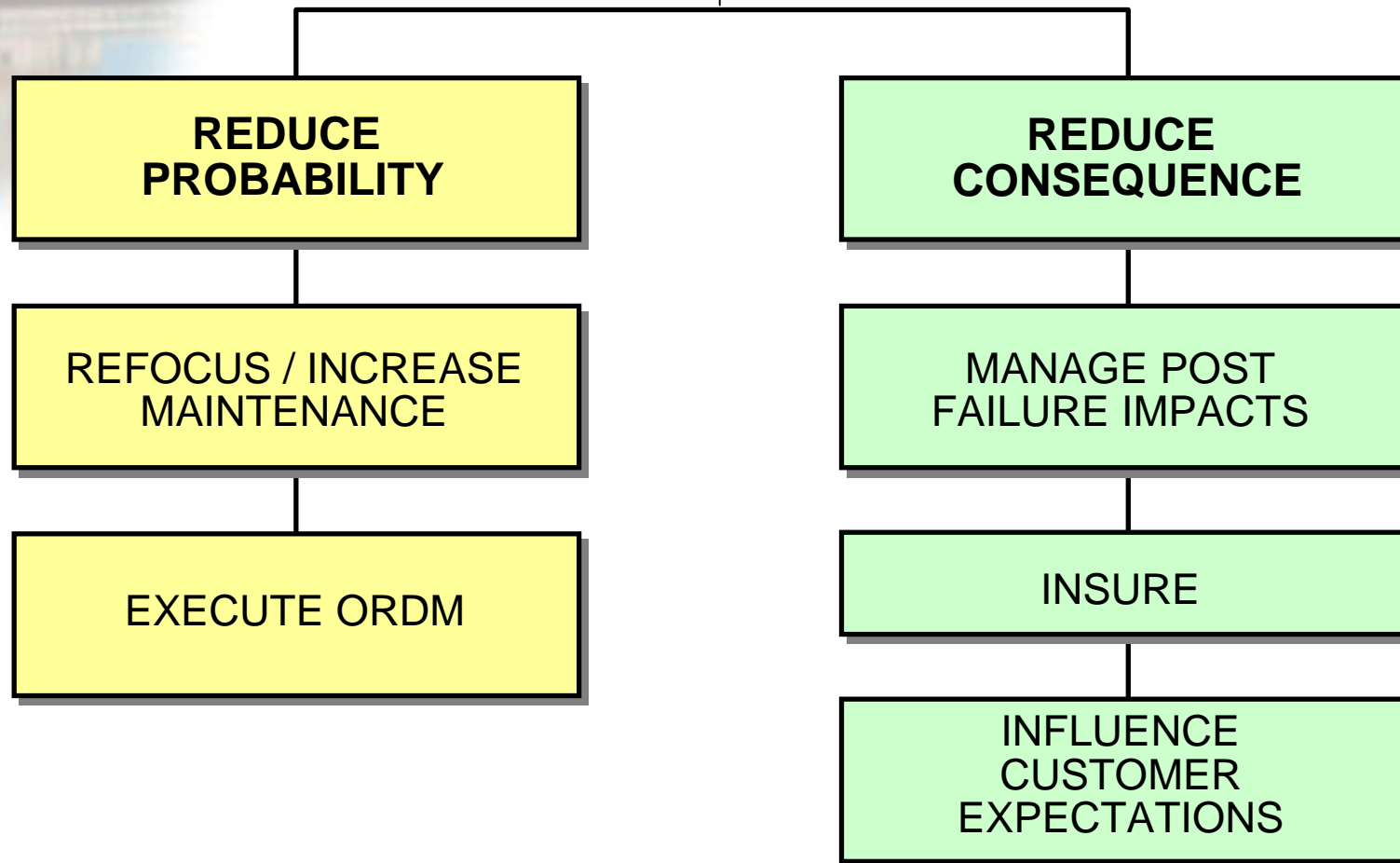
Low

CoF / Consequence of Failure

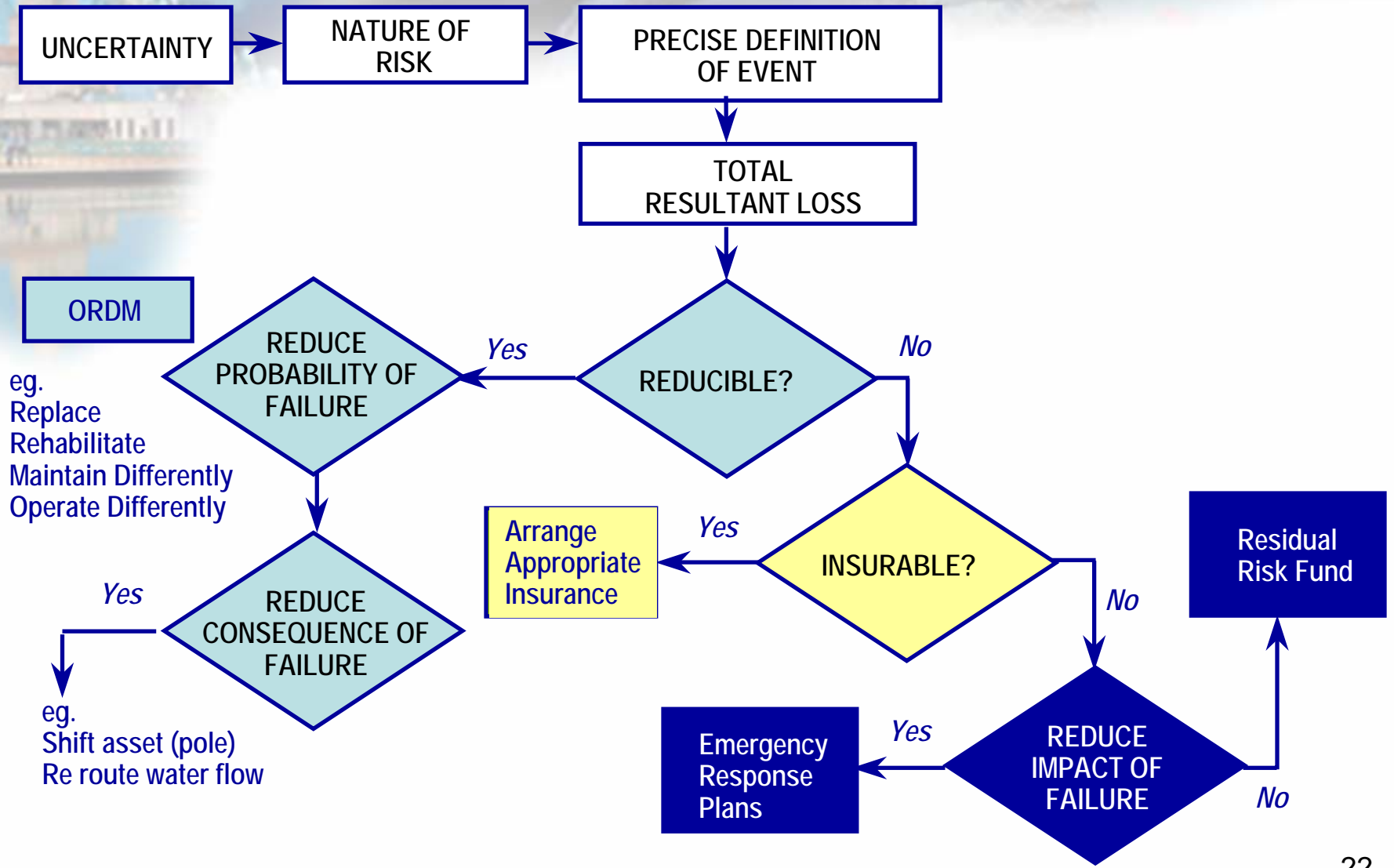
High

Managing Risk: Risk Reduction Options

Treatment Options



Risk Management – Flow Chart



Some Failures Will Happen



Educate Our
Customers To
Expect
Acceptable Or
Unavoidable
Failures

Exercise Number 3

Help Tom develop an understanding of the criticality (BRE) of the components of the pump station

Using the data provided, determine:

- The consequence of failure using the 1 to 10 score table in the exercise spreadsheet
- Apply these to all the components you have in your asset register

Exercise Number 3

- The probability of failure will be calculated by the spreadsheet using the residual life (but in future you need to use real data)
- Have a look at the BREs. Are they what you expected ?
- What is the total BRE for the pump station?

BRE – Business Risk Exposure

Sheet C on the exercise spreadsheet

Probability of Failure

% of Effective Life Consumed	PoF Rating
0%	1
10%	2
20%	3
30%	4
40%	5
50%	6
60%	7
70%	8
80%	9
90%	10

Don't Forget Redundancy??

Level of Redundancy	Reduce PoF by:
50% Backup	50%
100% Backup	90%
200% Secondary Backup	98%

This is calculated based on condition rating

Key Lessons Learned

- ⇒ BRE is the heart of all good Advanced AM.
- ⇒ It helps us make better decisions by far ...
- ⇒ BRE comes in different levels of sophistication.
- ⇒ You can start very easily – as shown.
- ⇒ PoF data is hard to get and is individual asset related.
- ⇒ So start completing your work orders now.

BRE – Business Risk Exposure
PoF – Potential of Failure

Take home messages

- Get 'cracking'(aussie for started)
- Develop a simple 1 to 10 criticality for all assets under your control
- Encourage others to do it...but,
- Don't try and change the world overnight,
- Change your world first...