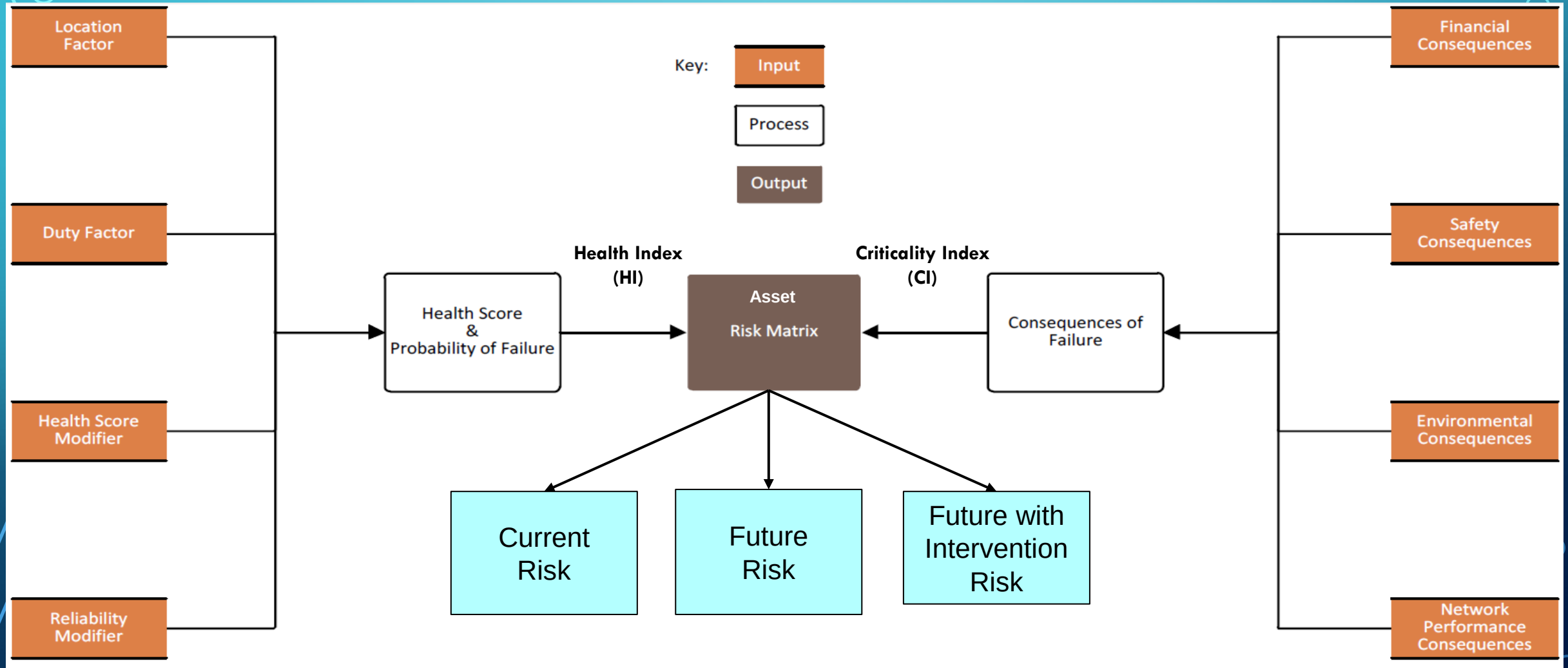
NETWORK ASSET INDICES METHODOLOGY

WESTPOWER

OBJECTIVES

- Monitor the Network Asset Performance over time.
- Determine the Asset Health and Probability of Failure.
- Assess the Asset Criticality and Consequences of Failure.
- Identify the Risk of Failure.

PROCESS OVERVIEW



NETWORK ASSET INDICES

- **Health Index** –relates to Asset Health and PoF. The Health Index groups assets into one of the five bandings (HI1 to HI5) based on their Health Score.
- **Criticality Index** – relates to Asset Criticality and CoF. The Criticality Index groups assets into one of the four bandings (C1 to C4) based on their CoF.
- **Risk Index** – is a monetised risk determined from the combination of Health Index and Criticality Index. Three Risk Matrices (Current, Future and Future with Intervention) are used to report the population of assets within a given Asset Category that have the same Health Index and Criticality Index.

PROBABILITY OF FAILURE

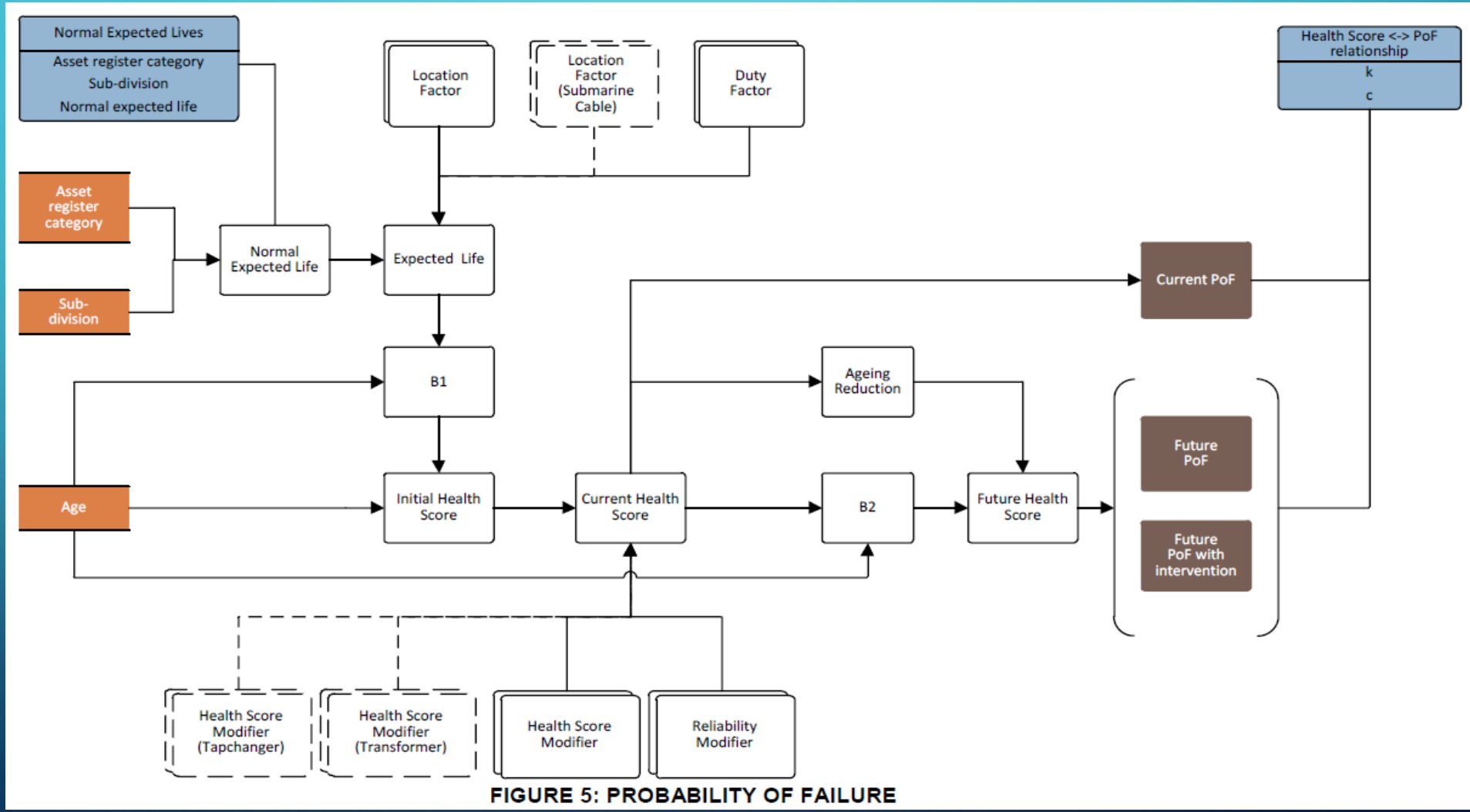
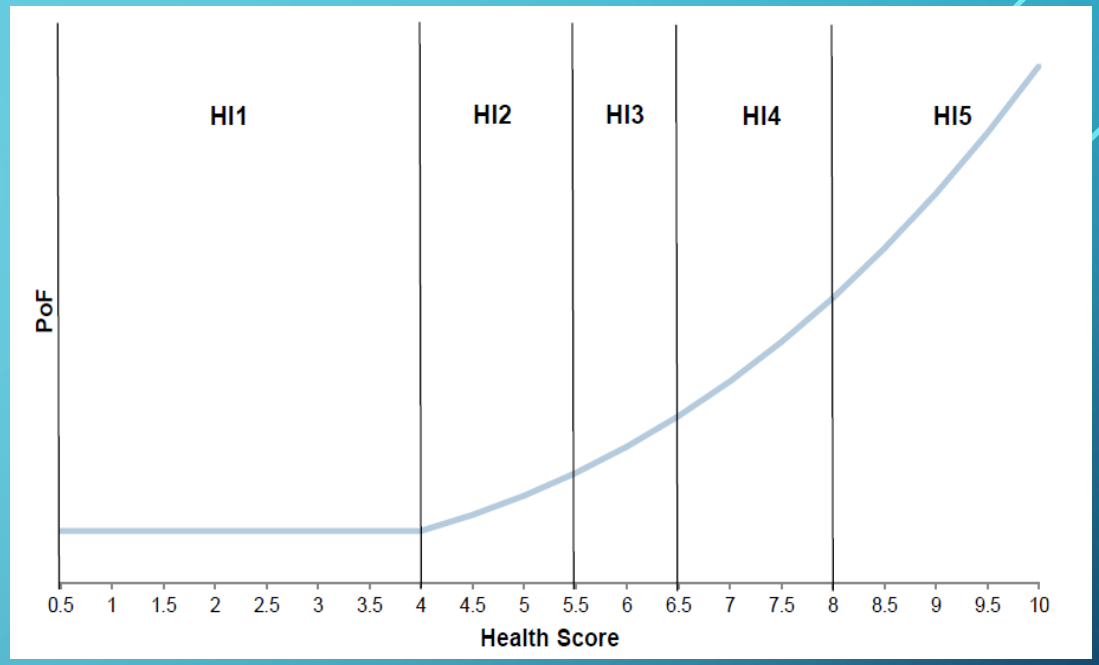


FIGURE 5: PROBABILITY OF FAILURE

PROBABILITY OF FAILURE



- PoF is a function of Asset Health Score
- There are five Health Index Bands
  - Health Indicator Level 1 (HI1) – asset in very good condition
  - Health Indicator Level 2 (HI2) – asset serviceable
  - Health Indicator Level 3 (HI3) – asset in bad condition
  - Health Indicator Level 4 (HI4) – asset in very bad condition
  - Health Indicator Level 5 (HI5) – asset replacement is recommended
- Each asset will be placed in a Health Index Band, based on their Health Score

HEALTH INDEX BANDING CRITERIA

Health Index Band	Health Index Banding Criteria	
	Lower Limit of Health Score	Upper Limit of Health Score
HI1	≥0.5	<4
HI2	≥4	<5.5
HI3	≥5.5	<6.5
HI4	≥6.5	<8
HI5	≥8	≤15

- Current Health Score → Current Health Index
- Future Health Score → Future Health Index
- Future with Intervention Health Score → Future with Intervention Health Index

CONSEQUENCES OF FAILURE - CATEGORIES

The effects of asset failure are broken down into four Consequence Categories:

- Financial
- Safety
- Environmental
- Network Performance

The overall CoF value is a sum of the monetised CoF for each Consequence Category.

The calculation of CoF is based on the same failure modes as PoF, i.e. Incipient Failure, Degraded Failure and Catastrophic Failure.

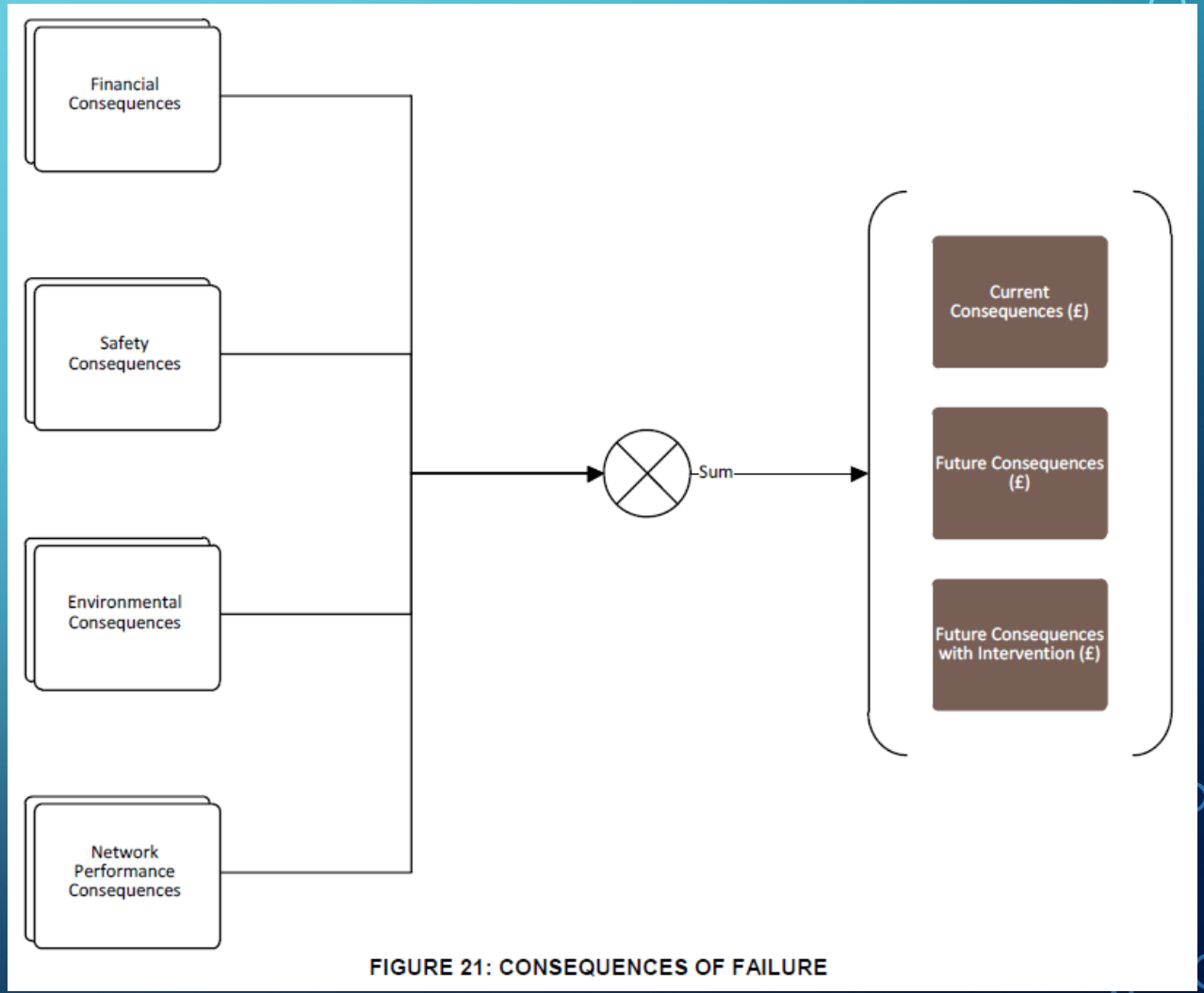


FIGURE 21: CONSEQUENCES OF FAILURE

CONSEQUENCES OF FAILURE

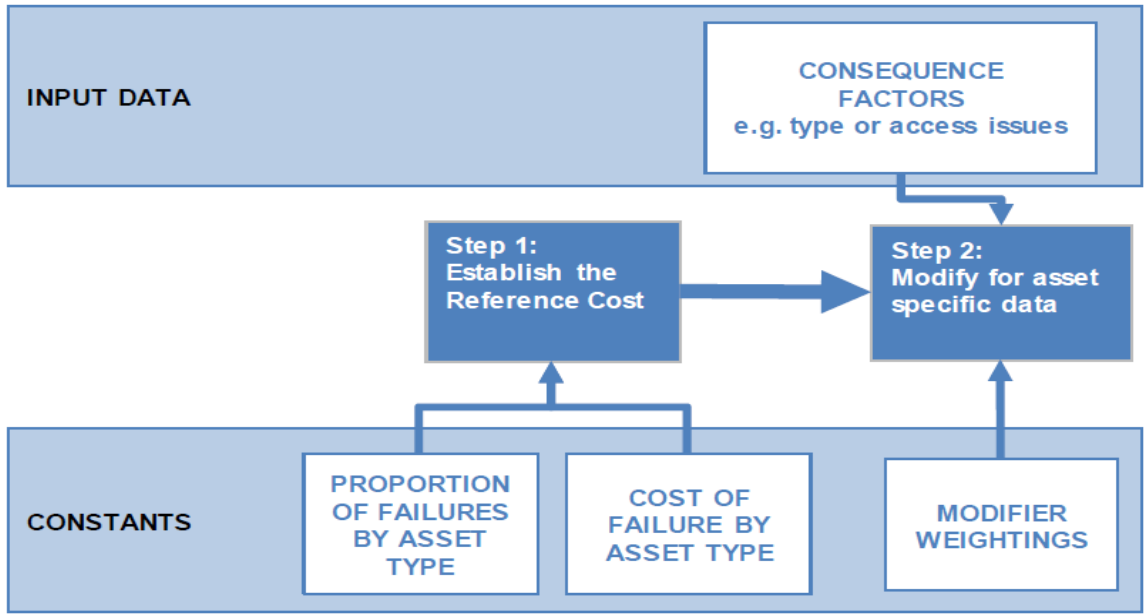
- Asset Criticality is a function of CoF.
- There are four Criticality Index Bands
  - Low Criticality (C1)
  - Average Criticality (C2)
  - High Criticality (C3)
  - Very High Criticality (C4)
- Each asset will be placed in a Criticality Index Band, based on the relative magnitude of the Overall CoF of the asset compared to the Average Overall CoF for all assets in the same Health Index Band for its Asset Category.

CRITICALITY INDEX BANDING CRITERIA

Criticality Index Band	Criticality Index Banding Criteria		Value to be used to calculate Risk Index
	Lower Limit of Overall CoF (as % of Average Overall CoF for the Asset Category)	Upper Limit of Overall CoF (as % of Average Overall CoF for the Asset Category)	
C1	-	< 75%	70%
C2	≥ 75%	< 125%	100%
C3	≥ 125%	< 200%	150%
C4	≥ 200%	-	250%

- Current Overall CoF → Current Criticality Index
- Future Overall CoF→ Future Criticality Index
- Future with Intervention Overall Cof→ Future with Intervention Criticality Index

CONSEQUENCES OF FAILURE - METHODOLOGY



$$\textit{Financial CoF} = \textit{Reference Financial CoF} \times \textit{Financial Consequences Factor}$$

$$\textit{Financial Consequences Factor} = \textit{Type Financial Factor} \times \textit{Access Financial Factor}$$

Asset Register Category	Relative Proportion of Failure Modes (as a % of total Functional Failures)			Likely Cost of Failure			Reference Financial Cost of Failure
	Incipient	Degraded	Catastrophic	Incipient	Degraded	Catastrophic	
LV Overhead Line							
LV Poles	20.0%	70.0%	10.0%	$272	$2,716	$2,716	$2,227
LV Cross-arms							
LV Fittings	80.0%	15.0%	5.0%	$226	$564	$2,252	$378
LV Conductors	0.0%	85.0%	15.0%	$0	$25,758	$51,516	$29,622
LV Switchgear							
Distribution Cabinets							
Pillar Boxes	15.0%	25.0%	60.0%	$842	$2,106	$8,426	$5,708
Link Boxes	15.0%	25.0%	60.0%	$842	$2,106	$8,426	$5,708

Asset Category	Access Factor	
	Type A Criteria - Normal Access (& Default Value)	Type B Criteria - Major Crossing (e.g. associated span crosses railway line, major road, large waterway etc.)
LV OHL Support	1	3
MV OHL Support - Poles	1	3
HV OHL Support - Poles	1	3
HV OHL Support - Towers	1	1.5
HV OHL Fittings (Poles/Tower Lines)	1	2
HV OHL Conductors (Pole/Tower Lines)	1	2
Other	1	1

Asset Register Category	Type Financial Factor Criteria	Type Financial Factor
LV Poles	Pole (excluding terminal poles)	1
	Pole (terminal poles)	1.2
	Steel Poles	2
LV Board (WM)	Non-Asbestos clad	1
	Asbestos clad	2
LV Board (X-type Network) (WM)	Non-Asbestos clad	1
	Asbestos clad	2
6.6/11kV Poles	Pole (supporting conductor only)	1
	Pole (supporting plant or equipment)	1.7
	Small footprint steel masts	2

OVERALL REFERENCE COSTS OF FAILURE

Asset Register Category	Financial	Safety	Environmental	Network Performance	Total
LV Poles	£1,113	£536	£75	£1,218	£2,942
6.6/11kV Poles	£1,592	£179	£75	£1,297	£3,143
20kV Poles	£1,910	£179	£75	£1,297	£3,461
33kV Pole	£2,053	£179	£75	£57	£2,364
66kV Pole	£3,094	£179	£75	£114	£3,462

RISK MATRIX

- The Risk Matrices shall be determined, using the Health Index (HI) and Criticality Index (C) for each asset, for the following three scenarios:
  - existing asset risk;
  - future asset risk; and
  - future asset risk taking account of planned interventions.

PoF → Health Index

CoF → Criticality Index

	HI1	HI2	HI3	HI4	HI5
C1	1	2	3	4	5
C2	2	4	6	8	10
C3	3	6	9	12	15
C4	4	8	12	16	20

UK ASSET CATEGORISATION

Asset Category (not full list)	Asset Sub-Category (not full list)
• LV OHL Support	→LV Poles
• LV UGB	→LV UGB
• LV Switchgear and Other	→LV Board (WM), LV Board (X-type Network) (WM), LV Circuit Breaker, LV Pillar (ID), LV Pillar (OD at Substation), LV Pillar (OD not at a Substation)
• HV OHL Support - Poles	→6.6/11kV Poles, 20kV Poles
• HV Switchgear (GM) - Primary	→6.6/11kV CB (GM) Primary, 20kV CB (GM) Primary
• HV Switchgear (GM) - Distribution	→6.6/11kV CB (GM) Secondary, 6.6/11kV RMU, 6.6/11kV X-type RMU, 6.6/11kV Switch (GM), 20kV CB (GM) Secondary, 20kV RMU, 20kV Switch (GM)
• HV Transformer (GM)	→6.6/11kV Transformer (GM), 20kV Transformer (GM)
• EHV OHL Support - Poles	→33kV Pole, 66kV Pole
• EHV OHL Fittings	→33kV Fittings, 66kV Fittings
• EHV Transformer	→33kV Transformer (GM), 66kV Transformer (GM)

ASSET CATEGORIES EXCLUDED FROM UK FRAMEWORK

- LV Main (OHL) Conductor
- LV Service (OHL)
- LV Main (UG)
- LV Service (UG)
- LV Transformers/Regulators
- 6.6/11kV OHL (Conventional Conductor)
- 20kV OHL (Conventional Conductor)
- Voltage 20kV OHL (BLX or similar Conductor)
- 6.6/11kV UG Cable
- 20kV UG Cable
- 6.6/11kV/20kV CB (PM)
- 6.6/11kV/20kV Switch (PM)
- 6.6/11kV/20kV Switchgear - Other (PM)
- 6.6/11kV Transformer (PM)
- 20kV Transformer (PM)
- Batteries at GM
- Substations
- 33kV/66kV/132kV OHL (Pole Line) Conductor
- 33kV/66kV/132kV Switchgear - Other
- 33kV Switch (PM)
- 33kV Transformer (PM)
- Batteries at 33kV/66kV/132kV Substations EHV
- 132kV Pole

WP ASSET CATEGORISATION

Asset Category	Asset Sub-Category
• LV Overhead Line	→ LV Poles, LV Cross-arms, LV fittings, LV Conductors
• LV Switchgear	→ Distribution Cabinets, Pillar Boxes, Link Boxes, Circuit Breakers, Fuse Disconnectors, Link Disconnectors, Capacitor Banks
• LV Underground Cables	→ LV Cables
• MV Overhead Line	→ MV Poles, MV Cross-arms, MV fittings, MV Conductors
• MV Switchgear	→ Circuit Breakers – Secondary (eg. reclosers), Circuit Breakers – Primary, Load Break Switches, Ring Main Units, Disconnectors, Surge Arrestors, Fuse Disconnectors, Link Disconnectors, Capacitor Banks
• MV Underground Cables	→ MV Cable
• MV Transformers	→ Distribution Transformer (GM), Distribution Transformer (PM), Transformer Enclosures, Regulators, Current Transformers, Voltage Transformers
• HV Overhead Line	→ HV Poles, HV Cross-arms, HV fittings, HV Conductors
• HV Switchgear	→ Circuit Breakers, Disconnectors, Surge Arrestors
• HV Underground Cables	→ HV Cable
• HV Transformers	→ Zone Substation Transformers, Current Transformers, Voltage Transformers

WORK TO BE DONE

- Discuss the proposed Asset Category and update it as required
- Discuss the proposed Health Score Modifiers and update them as required
- Discuss any Reliability Modifiers (if any)
- Discuss the proposed Condition Criteria for both Observed and Measured Condition
- Discuss the Reference Financial, Safety, Environmental and Performance Cost of Failure
- Discuss the Reporting of the Risk (Existing Asset Risk, Future Asset Risk, Future Asset Risk with Planned Interventions)

CONCLUSION

The methodology will:

- Identify the current and future Asset Health
- Identify the current and future Asset Criticality
- Determine the Risk of Failure associated with condition-based failures
- Help to develop the Asset Management Plan
- Justify the asset maintenance and replacement costs