APPENDIX: NETWORK OUTPUT MEASURES METHDOLOGY
Author: National Grid

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1.0 PURPOSE AND SCOPE

1.1 Document Purpose

1. A Network Output Measures Methodology Statement has been produced in accordance with standard Electricity Transmission Licence Condition B17 which is applicable to the three Transmission Licensees (Electricity) (National Grid, Scottish Power (SPTL) and Scottish Hydro-Electricity (SHETL)).

2. The Methodology Statement describes the common framework (concepts and principles) which will be followed by the three Transmission Licensees in producing the Network Output Measures in each of the following areas:
   a. The requirements in the Licence Condition
   b. The Transmission Licensees' collective understanding of the Licence Condition requirements
   c. The process the Transmission Licensees have followed in developing the Network Output Measures
   d. The common framework (concepts and principles) behind the Network Output Measures
   e. The proposed Network Output Measures
   f. Comparisons of the Network Output Measures with measures produced by other Asset Management organisations
   g. Further development requirements which the Transmission Licensees have identified
   h. Confidentiality issues surrounding publishing the content of this Methodology Statement to external (outside The Authority) parties

3. In addition to the Methodology Statement, each individual Transmission Licensee has produced a specific appendix to describe how each will produce the Network Output Measures using the common framework described in the Methodology Statement.

4. This Appendix is referred to from this point as National Grid's Implementation Document. This Implementation Document includes the supporting data and models used to generate the Network Output Measures.

5. This Implementation Document references internal business documentation (attached) which describes:
   a. The data (including the data categories) used to produce the Network Output Measures
   b. The methods, calculations and models used to transform this data into the Network Output Measures
   c. Analysis and reports used to develop the Network Output Measures, including supporting data and models
   d. Availability of historical data
   e. National Grid's use of the Network Output Measures
   f. Developments National Grid intends to make in implementing the Network Output Measures

[redacted]

7. As outlined in the Methodology Statement further work is required to develop the framework around Network Risk and Network Performance. The framework is still evolving and development work is ongoing within National Grid to implement this framework. With feedback expected from The Authority and others through the Network Output Measures consultation and approval process, it can be expected that this Implementation Document and all associated documentation will undergo review and revision. A stable set of Network Output Measures is to be agreed by 31 March 2009 and first reported to The Authority by 31 July 2010.

8. In addition, it can be expected that this Implementation Document and all associated documentation will continue to undergo review and revision as part of continuous improvement of National Grid's Asset Management processes and practices and as the Network Output Measures are regularly reviewed and updated to ensure they continue to meet the objectives of the Licence Condition.

2.0 USING NETWORK OUTPUT MEASURES WTHIN NATIONAL GRID

9. This section of the document provides an explanation of how the Network Output Measures are embedded in National Grid's Asset Management System in the following areas:
    a. Using technical asset lives to assess longer term network expenditure requirements
    b. Using Asset Health Priorities and Replacement Priorities to understand medium to shorter term network expenditure requirements
    c. Using volume modelling to assess Network Risk
    d. Using performance metrics in the form of losses of supply, defects, faults, failures and Average Circuit Unreliability to understand and monitor Network Performance
    e. Using boundary information within its system design decision making process

2.1 Long term Asset Replacement Planning

10. Long-term asset replacement forecasts are developed for lead assets using a probabilistic (Monte Carlo simulation) asset replacement model called ALERT. ALERT models asset deterioration, the rate of asset deterioration being encoded in the technical asset lives forming a primary input to ALERT. In the short to medium term (within a 10 year period) National Grid uses the asset replacement volume outputs from ALERT to understand how the capital plan compares with expected volumes from the technical asset lives. In the longer term the need for asset replacement is considered over a 20-year time horizon to ensure that decisions in the short term maintain network sustainability, thus protecting both current and future stakeholder interests.

11. Given the above, in the longer term (greater than a ten year period), the need for asset replacement investment is based on equipment specific technical asset lives, which represent the probability the lead assets need to be replaced. These technical asset lives have been developed over a long period of time and are based on an in-depth understanding of asset condition and asset deterioration. The technical lives incorporate a significant body of asset health information including outputs from research and development, condition monitoring, condition assessment, forensic examinations, fault and failure investigations and knowledge of equipment design. Depending on the equipment type, condition information may be available for specific assets (where condition information is collected as part of routine processes) and/or based on known asset family deterioration mechanisms.

12. The Asset Health Review process collates and assesses asset data, information and knowledge from across the Electricity Transmission business to ensure a full understanding of asset performance, asset condition and criticality. A review of asset lives will also be triggered based on analysis of performance and condition information undertaken as part of the Asset Health Review process.

2.2 Short to Medium Term Asset Replacement Planning

13. Each lead asset is assessed and categorised with an Asset Health Index (Asset Health Priorities). Asset Health Indices describe the condition and performance of the lead assets and are assigned against a common set of definitions. The criteria used to define the Asset Health Indices include asset condition (specific and family), design weaknesses and asset performance.

14. Each lead asset is also assigned a Replacement Priority. The Replacement Priorities are assessed using the Asset Health Indices, System Criticality, Safety and/or Environmental Criticality as appropriate. The distinction between Asset Health Indices and Replacement Priorities recognises that two assets, both with the same Asset Health Index can have a different Replacement Priority because of the consequences of failure.

15. Asset Health Priorities and Replacement Priorities are reviewed annually or as part of the Asset Health Review process.

16. Replacement Priorities provide a set of priority ranked asset replacement candidates which are used to initiate and develop schemes which form the capital plan. This process will involve either asset replacement being brought forward or deferred to:
    a. bundle asset replacement into economic packages of work
    b. align asset replacement with load related network requirements
    c. recognise the practicalities of delivering schemes in terms of outages, resources, lead time to achieve asset replacement and interaction with other schemes

17. Condition assessments acquire specific asset related condition information (i.e. detailed condition information on the particular asset being considered for replacement) to inform the Asset Health Indices and Replacement Priorities and to understand the required scope of works (e.g. scope of civil work required) and options associated with asset replacement (e.g. refurbish, replace).

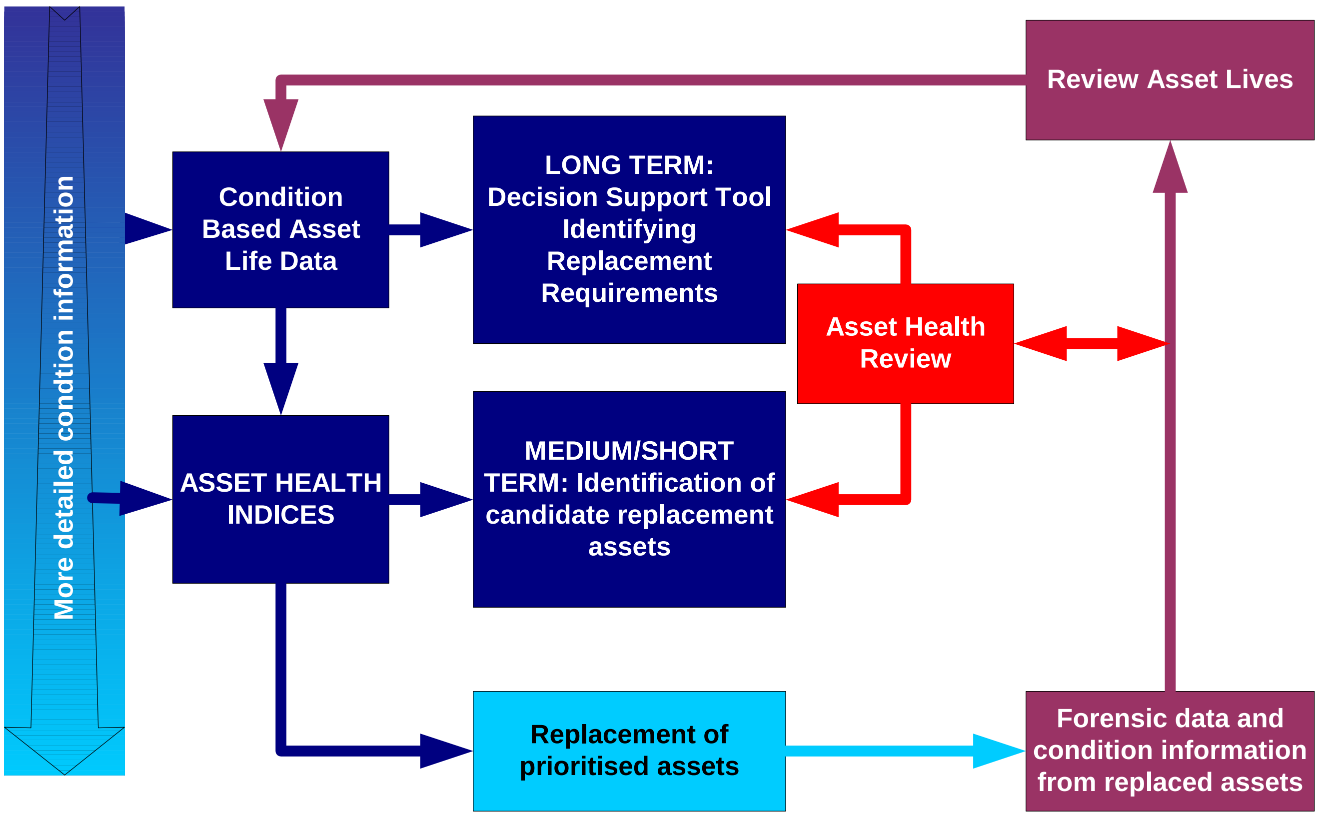
18. Updated information received from condition assessments and asset failures, performance trends are monitored through the Asset Health Review process. This may result in changes to the Asset Health Indices and Replacement Priorities leading to either asset replacement being brought forward or asset

replacement being deferred. Figure 1 in the Joint Methodology Statement shows how Asset Health Priorities and Replacement Priorities inform the capital plan.

19. As schemes are completed, opportunities are taken to gather forensic evidence. This forensic evidence is used to validate the technical asset lives used in long term modelling and to inform the Asset Health Priorities and Replacement Priorities as part of the Asset Health Review.

20. Figure 1 below summarises National Grid's approach to identifying the requirements for asset replacement network expenditure, progressing from long term modelling based on statistical models and technical asset life data, through to condition, performance and criticality based identification of asset replacement candidates.

Figure 1: Asset Replacement: High Level Process



2.3 Understanding Network Risk Using Asset Replacement Volumes

21. The asset replacement volumes generated from the ALERT model are used in conjunction with the volumes from the capital plan to understand Network Risk.

22. For the period under consideration, cumulative capital plan asset replacement volumes are calculated by summating the asset replacement volumes from the first year (e.g. 2000/1) to each year in the period under consideration. This gives a set of cumulative capital plan asset replacement volumes for each year under consideration. A set of cumulative ALERT asset replacement volumes is calculated using the same method.

23. For each year the difference between the cumulative capital plan volumes and cumulative ALERT volumes is calculated and plotted on a graph. For each year this volume difference can be sub-categorised using the Replacement Priorities of assets yet to be replaced.

24. The resultant volume is sub-categorised by assessing Replacement Priorities in the following order:

    a. 0-2 Years – Red
    b. 2-5 Years – Orange
    c. 5-10 Years – Yellow
    d. > 10 Years - Green

25. Not all the sub-categories may be shown for any particular year if only a few of the sub-categories are required to reach the volume (difference between cumulative capital plan volumes & ALERT volumes) on the graph (see example graph in Figure 2).

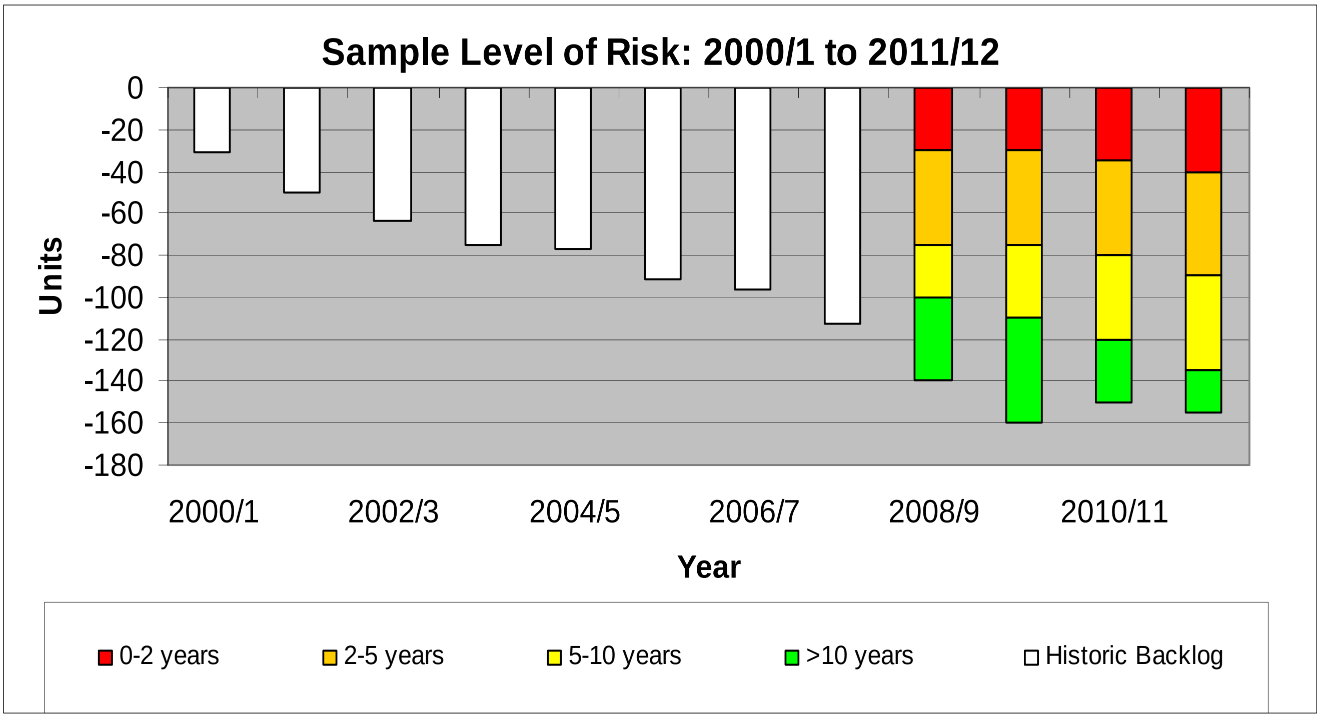
26. The forward Replacement Priorities were calculated by projecting forward each of the categories other than 0-2 years as explained in the following table.

Table 1: Projecting Replacement Priorities Forward

Year into the future	Movement from 2-5 yrs into 0-2 yrs category	Movement from 5-10 yrs into 2-5 yrs category	Movement from >10 yrs to 5-10 yrs category
1	0	20%	Same as 5-10 to 2-5 yrs movement
2	0	20%	
3	33.3%	20%	
4	33.3%	20%	
5	33.3%	20%	

27. If the backlog volumes have not been reached for each year, then the balance is made up from the > 10 Years category.

Figure 2: Backlog volumes by Replacement Priority (Example)



28. These graphs allow the business to understand the level of Network Risk associated with any capital plan scenario. This is achieved by assessing the individual assets yet to be replaced and assessing the volume at risk (shown on the graph) against historic volumes. This enables National Grid to assess the reliability risk compared to historic levels (this is key because our Asset Management approach is designed to maintain historic levels of reliability performance) and to understand areas of the network at risk.

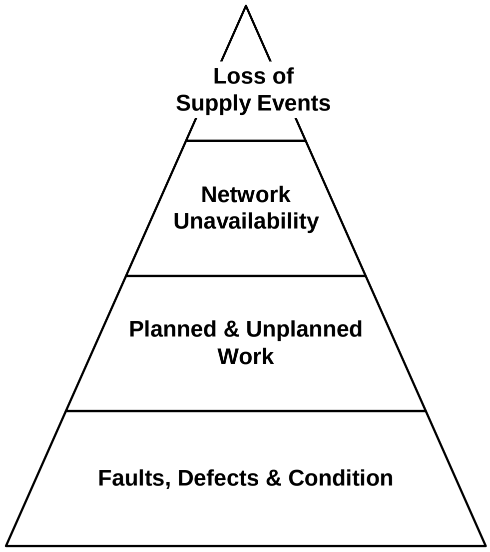
2.4 Understanding Asset and Network Performance

29. National Grid undertakes a wide variety of asset and network performance monitoring activities with particular emphasis placed on monitoring 'leading' measures to provide advance warning of key issues.

30. It is possible to show the relationship between loss of supply events and other network performance metrics in a 'Network Performance Triangle' (Figure 3). This 'Network Performance Triangle' is analogous to Heinrich's Safety

Triangle[1] widely used to describe the relationship between fatalities and near misses.

Figure 3: Performance Triangle



31. A mathematical relationship between the elements in the triangle cannot be demonstrated in the same way as the safety triangle, rather the relationship is purely conceptual.

32. The key metrics National Grid uses to understand asset and network performance are:
    a. Losses of supply
    b. Average Circuit Unreliability including Unplanned Unavailability
    c. Failures
    d. Faults
    e. Defects

[1] Heinrich, H.W., “Industrial Accident Prevention: A Scientific Approach”, 1959, McGraw-Hill, New York

33. Asset and network performance monitoring is a key activity for National Grid as changes in performance influence the costs of the services that National Grid provides. This information is used in conjunction with other data, information and knowledge to determine the appropriate proactive and reactive Asset Management actions.

2.4.1 Losses of Supply

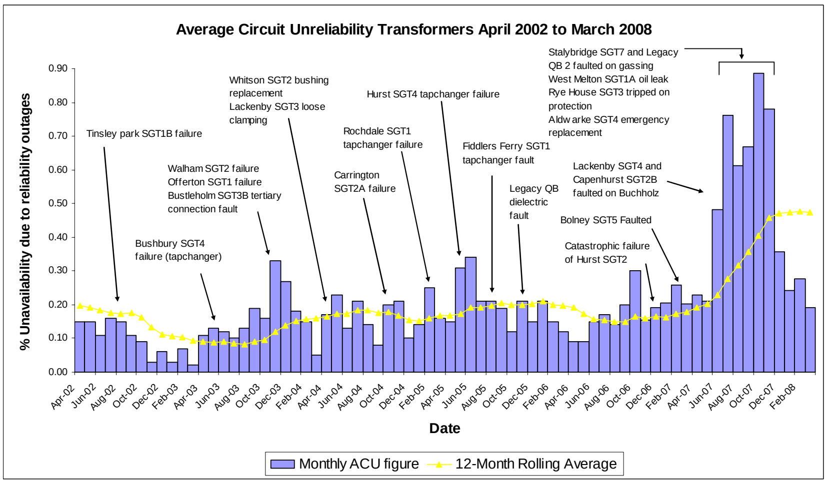
34. All loss of supply events are investigated to ensure the root cause of the loss of supply is understood and to identify any learning points which could avoid further events. Losses of supply are reported, investigated and analysed but due to the very small number of loss supply events each year (average of 10 incidents in total with an average of 5 incidents where more than 3 customers are affected) this provides very sparse information to enable identification of any emerging trends.

2.4.2 Average Circuit Unreliability

35. Average Circuit Unreliability is used within National Grid to understand the impact that asset unreliability has on the network. Average Circuit Unreliability has been reported monthly as a Key Performance Indicator (KPI) within National Grid since autumn 2001. This KPI is used to identify trends in asset and network unreliability and in depth analysis is undertaken to understand the causes of these trends and identify appropriate Asset Management actions to manage asset and network performance. Unplanned Unavailability (fault and enforced outages taken within 24 hours) is a subset of Average Circuit Unreliability and is reported as part of the KPI for information purposes.

36. To aid this in depth analysis Average Circuit Unreliability is reported at an equipment level for the equipment types which make a major contribution, namely transformers, cables, switchgear and overhead lines. An example graph is shown in Figure 4.

Figure 4: Average Circuit Unreliability Split into Equipment Types (Example)



2.4.3 Failures

37. Within National Grid failures are defined for each equipment type but essentially a failure is a disruptive event that results in either a major sub-component or the whole asset being replaced.

38. The number of failures experienced each year is very small (e.g. a few in each equipment category). As failures are often disruptive in nature they may often result in risk of significant safety and/or environmental impact. In addition failures can have significant system impact as they can either cause more than one asset to be out of service at any one time or result in long periods when the assets are out of service (e.g. months for transformer and cable failures).

2.4.4 Faults

39. Within National Grid a fault is defined as ‘an event which causes plant to be automatically disconnected from the HV system for investigation and further action if required’.

40. National Grid typically has a small number of faults (200-300) per annum where the number is highly dependent on weather conditions. Given this, faults are not a good measure for tracking overall network performance or benchmarking but fault analysis is routinely undertaken as part of the Asset Health Review to identify issues with particular assets or asset families.

2.4.5 Defects

41. Within National Grid a defect is defined as ‘a non-conformance from specified requirements, which is identified from maintenance, inspection, observation or alarm and requires investigation, possibly involving planned disconnection of plant, and/or further remedial action’.

42. Typically 17000 – 18000 defects are identified on National Grid’s network each year. Defects are used to track asset performance at a detailed equipment design level. Defects in isolation are not a good measure for tracking overall network performance, as aggregating the total number of defects is not sensible as the severity and impact of defects may vary greatly. Defects can only be sensibly benchmarked at a detailed equipment level taking account of equipment design, defect severity and defect impact.

3.0 IMPLEMENTATION

3.1 Network Asset Condition

3.1.1 Required Individual Documentation

43. Additional to the Methodology Statement the following items are included within this Implementation Document:
    a. A description of the information used to determine the Asset Health Indices and technical asset lives including availability of historical information
    b. An explanation of how National Grid determines Asset Health Indices
    c. An explanation of how National Grid determines technical asset lives

[redacted]

[redacted]

f. [redacted]--

45. [redacted]

[redacted]

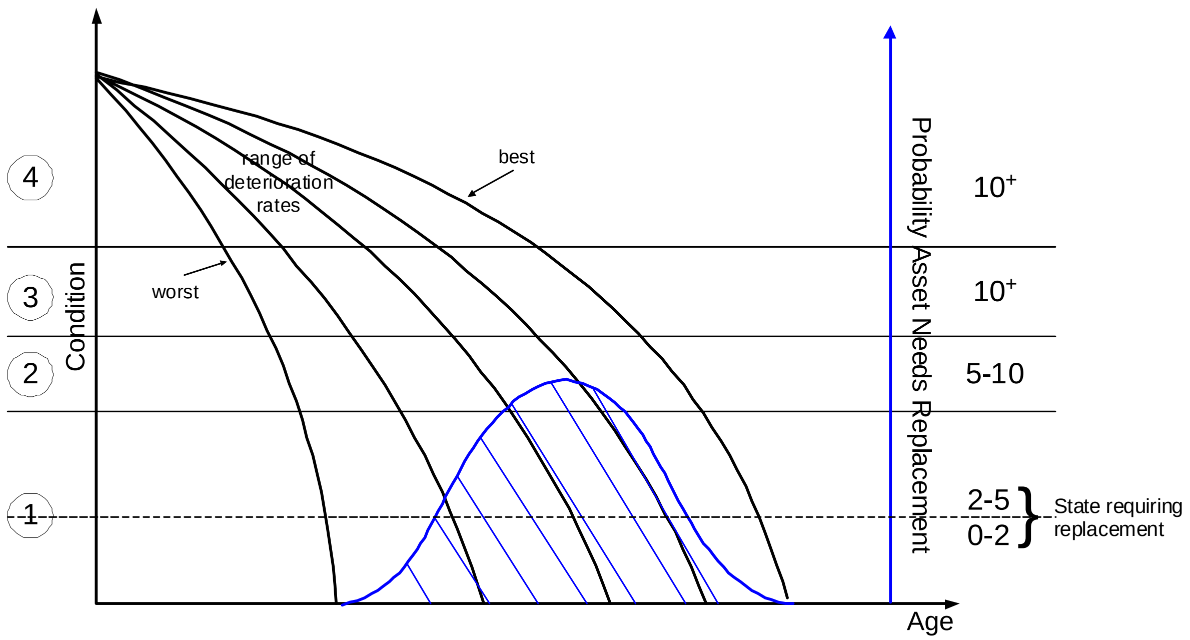
3.1.3 Framework for Developing Asset Health Indices (Short to Medium Term Assessment)

[redacted]

47. Within National Grid the generic Asset Health Index categories are defined over a numeric scale. This Implementation Document will include a description of the mapping from the numeric equipment specific Asset Health Index to the Network Output Measures Asset Health Index categories:
    a. Remaining Useful Life 0-2 Years
    b. Remaining Useful Life 2-5 Years
    c. Remaining Useful Life 5-10 Years
    d. Remaining Useful Life > 10 Years

48. Figure 6 shows the relationship between Asset Health Indices and technical asset lives.

Figure 6: Link between Asset Health Indices and Asset Lives



3.1.4 Overhead Lines Asset Health Indices

[redacted]

51. Asset Health Indices for overhead lines were developed in 2007. Route refurbishment prioritisation was carried in the past on a different basis therefore there is not enough information available to back-calculate historic Asset Health Indices.

3.1.5 Cables Asset Health Indices

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

55. Asset Health Indices for cables were developed in 2007. There is not enough information available to back-calculate the historic Asset Health Indices on the same basis.

[redacted] Circuit Breakers Asset Health Indices

[redacted]

58. Asset Health Indices for circuit breakers were developed in 2008. There is not enough information available to back-calculate the historic Asset Health Indices on the same basis.

3.1.7 Transformers Asset Health Indices

[redacted]

61. [redacted]

62. Historical data for transformer Asset Health Indices is available from 2000/1. From 2000/1 to 2002/3 there was no subdivision of Category 2 into a, b and c.

3.1.8 Framework For Developing Technical Asset Lives (Longer Term Assessment)

63. [redacted]

64. [redacted]

3.1.9 Overhead Lines Technical Asset Lives

[redacted]

[redacted]

3.1.10 Cables Technical Asset Lives

[redacted]

68. [redacted] Since August 1999 further categorisation has been added into the technical asset lives table so not all current technical asset lives will be comparable with historic information. Technical asset lives do exist before August 1999 but the definitions used do not align with the current definition.

3.1.11 Circuit Breakers Technical Asset Lives

[redacted]

70. [redacted]

3.1.12 Transformers Technical Asset Lives

[redacted]

72. [redacted] Since August 1999 additional asset families and further categorisation has been added into the asset lives table so not all current asset lives will be comparable with historic information. Technical asset lives do exist before August 1999 but the definitions used do not align with the current definition.

3.1.13 Future Development

73. Asset Health Indices and technical asset lives are continuously being developed using information (e.g. condition, performance) collected during Asset Management activities and specific activities to develop further understanding of asset health (e.g. forensics, research and development). These developments will be incorporated in National Grid Policy Statements and Technical Guidance Notes and will be reflected in the regular review of the Transmission Licensees Methodology Statement and National Grid's Implementation Document.

3.2 Network Risk

3.2.1 Required Individual Documentation

74. Additional to the Methodology Statement the following items are included within this Implementation Document:
    a. Short term developments of the Network Risk methodology - work undertaken by the National Grid in developing the thinking for System Criticality, bringing System, Safety and Environmental Criticality onto a common scale and mapping Criticality and Asset Health Indices against each other to produce Replacement Priority
    b. Longer term developments once the Network Risk methodology is developed - descriptions of Safety and Environmental Criticality scoring criteria by equipment type
    c. Detailed explanation of determination of Criticality information by equipment type
    d. Detailed explanation of determination of Replacement Priority by equipment type

3.2.2 Understanding Network Risk

75. For many years National Grid has prioritised schemes in the capital plan based on lead assets. This prioritisation process included Criticality factors for System, Safety and Environmental. Recent changes in the development of the Replacement Priorities have combined System, Safety and Environmental Criticality with the Asset Health Indices. This has led to developments in the methods used to determine the priorities for asset replacement.

3.2.3 System Criticality

76. National Grid has worked jointly with the GB System Operator to develop a consolidated overall view on System Criticality. This overall view of System Criticality includes a number of key data items which have been available for some considerable time but until very recently these key data items have not been combined together to form an overall System Criticality score. The overall System Criticality score is being applied consistently across all the asset types.

[redacted]

78. A high, medium or low categorisation is derived from application of this process.

[redacted]

3.2.4 Overhead Lines Replacement Priorities

[redacted]

81. [redacted]

82. Replacement Priorities for overhead lines were developed in 2008. Route refurbishment prioritisation was performed in the past on a different basis therefore there is not enough information available to back-calculate the historic Replacement Priorities on the same basis.

3.2.5 Cables Replacement Priorities

[redacted]

84. [redacted]

85. Replacement Priorities for cables were developed in 2008. There is not enough information available to back-calculate the historic Replacement

Priorities on the same basis.

3.2.6 Circuit Breakers Replacement Priorities

[redacted]

87. [redacted]

88. Replacement Priorities for circuit breakers were developed in 2008. There is not enough information available to back-calculate the historic Replacement Priorities on the same basis.

3.2.7 Transformers Replacement Priorities

89. [redacted]

[redacted]

91. Replacement Priorities for transformers were developed in 2008. There is not enough information to back-calculate the historic Replacement Priorities on the same basis.

3.2.8 Future Development

92. Replacement Priorities are continuously being developed using information (e.g. Asset Health Indices, Criticality information) collected during Asset Management activities and specific activities to develop understanding of replacement requirements. These developments will be incorporated into the National Grid Policy Statements and Technical Guidance Notes and will be reflected in the regular review of the Network Output Measures Methodology Statement and Implementation Documents.

3.3 Network Performance

3.3.1 Required Individual Documentation

93. Additional to the Methodology Statement the following items are included within this Implementation Document:
    a. In the short term - rule set for defining the outages included within the definition of Average Circuit Unreliability. In the long term – this will be a common agreed definition across the three Transmission Licensees
    b. Explanation of process undertaken to capture and analyse information for reporting purposes
    c. Availability of historic information

3.3.2 Production of Network Performance Measures

94. National Grid calculates Unavailability and Unreliability statistics from National Grid's outage planning database TOPAM (Transmission Outage Planning and Monitoring), as this records the reasons for outages taken.

95. Outages in TOPAM are assigned codes when the outage is entered in the system. An example of a TOPAM code is Ad Hoc Repair (unplanned reliability related outage).

96. The process for producing Average Circuit Unreliability is as follows:
    a. A general report of all outages in TOPAM for the time period is downloaded
    b. This report is then queried to search for outages assigned ADR (ad hoc repair) codes
    c. Outages not assigned ADR codes are also queried to search for reliability related keywords in the job description
    d. All reliability related outages are then analysed to determine whether they are actually reliability related outages, which equipment item requires repair and an equipment marker is placed in TOPAM to indicate that the outage is reliability related

97. A report which queries all outages containing equipment marker codes for the specified time period is then calculated in TOPAM. Reliability related outage durations are extracted from TOPAM for each plant type, according to the marker allocated to the outage.

98. The total reliability related outage duration for the period is determined for each equipment type and is converted into a % unavailability (for reliability related reasons) figure based on the number of circuits on the Main Interconnected System (MIS). The equation for calculating Average Circuit Unreliability is:

$$\frac{\text{Total number of repair days for equipment type}}{\text{No of circuits} \ \ x \ \ \text{No of days in reported period}} x100$$

99. The MIS comprises all 400kV and 275kV circuits plus all Supergrid Transformer feeder circuits, connections to Generators and those parts of lower voltage systems that are controlled by National Grid as defined in the substation Site Responsibility Schedules.

3.3.3 Rule Set for outages included within Average Circuit Unreliability

100. It is not always obvious from TOPAM what constitutes a repair outage. Sometimes repairs can be synchronised with other planned work on the circuit. If, under these circumstances, the repair is not the work element that governs the outage placement or duration, then the outage is not regarded as a repair outage. If, however, the repair governs the outage pattern duration, then the outage is regarded as a repair outage.

101. Outages **not** included in Average Circuit Unreliability:
    a. Outages with Pier codes (indicating capital work), MAJOR/BASIC/IMED codes (indicating maintenance activity), WSE (written scheme examination), Inspections, Refurbishment connected with asset replacement and third party outages (whether they affect our equipment or not)

102. Outages included in reliability statistics:
    a. Fault and defect outages, weather trips, overhead line clearance, third party effects, proximity outages (if the outage is related to National Grid 's unreliable equipment) and theft are included in the Average Circuit Unreliability

103. Search terms include:
    a. Defect, Leak, Fault, Repair, Problem, Fail, Damage, Broken, Mend, Emergency, Urgent, Top Up, Tree and Fix.
    b. Some search terms are designed to capture multiple forms of a word that may be reported: 'Rectif' captures rectify/rectification, 'Invest' captures investigate/investigation, 'Remed' captures remedy/remedial, 'Tripp' captures tripping/tripped, 'Sampl' captures sampling/sample, 'Inspect' captures inspection/inspection ('Inspect' is often used for investigating unreliable equipment. If the outage is purely inspection it is excluded).

104. Equipment codes marked in TOPAM comprise the following equipment groups:
    a. Substations
    b. Compensation
    c. Overhead Lines
    d. Cables
    e. Switchgear
    f. Transformers, Quad Boosters and Reactors
    g. Protection
    h. Telecoms

105. It should be noted Average Circuit Unreliability for Compensation equipment is very small because Reactive Compensation equipment rarely causes outages on the MIS. In addition Average Circuit unreliability for Substations, Protection and Telecoms is minor compared with the main plant types and makes a very small contribution to the overall unavailability statistics. For reporting purposes these are grouped into an Other Equipment category.

3.3.4 Availability of Historical Information

106. Average Circuit Unreliability has been produced since April 1998. In 2001/02 the number of search criteria was expanded from 4 keywords to 20. For this reason historical data produced on the same basis is available from 2001/02.

107. It will not be possible to report historical data from TOGA (Transmission Outage and Generator Availability) because a limited amount of historical data will be imported into TOGA.

3.3.5 Reporting of Other Asset and Network Performance Metrics

108. Losses of supply are captured by the GB System Operator and are recorded according to ‘TP167 – Reporting of Loss of Supply Events and Application of the Transmission Network Reliability Incentive Scheme within National Grid’.

109. Faults are recorded in the MIMS work management system by the GB System Operator. Faults are analysed through the Asset Health Review process.

110. Defects are recorded in the MIMS work management system by the Network Operators Centre (if generated from an alarm), by field staff via Office in the Hand (handheld device) if identified on site. Defects are analysed as part of the Asset Health Review process.

111. Failures are identified from a subset of faults and in rare cases from defects through the Asset Health Review process.

112. The above metrics of asset and network performance are reported annually to The Authority in the Transmission Regulatory Reporting Pack in Tables 4.4, 4.5 and 4.6.

3.3.6 Future Development

113. National Grid is continuously developing its ability to report and analyse asset and network performance information collected during Asset Management activities. In particular since 2003 National Grid has introduced a number of process changes to improve the capture of defects. This has led to a marked increase in the number of defects reported. As further developments are undertaken these will be incorporated into Asset Management activities and will be reflected in the regular review of the Network Output Measures Methodology Statement and Implementation Documents.

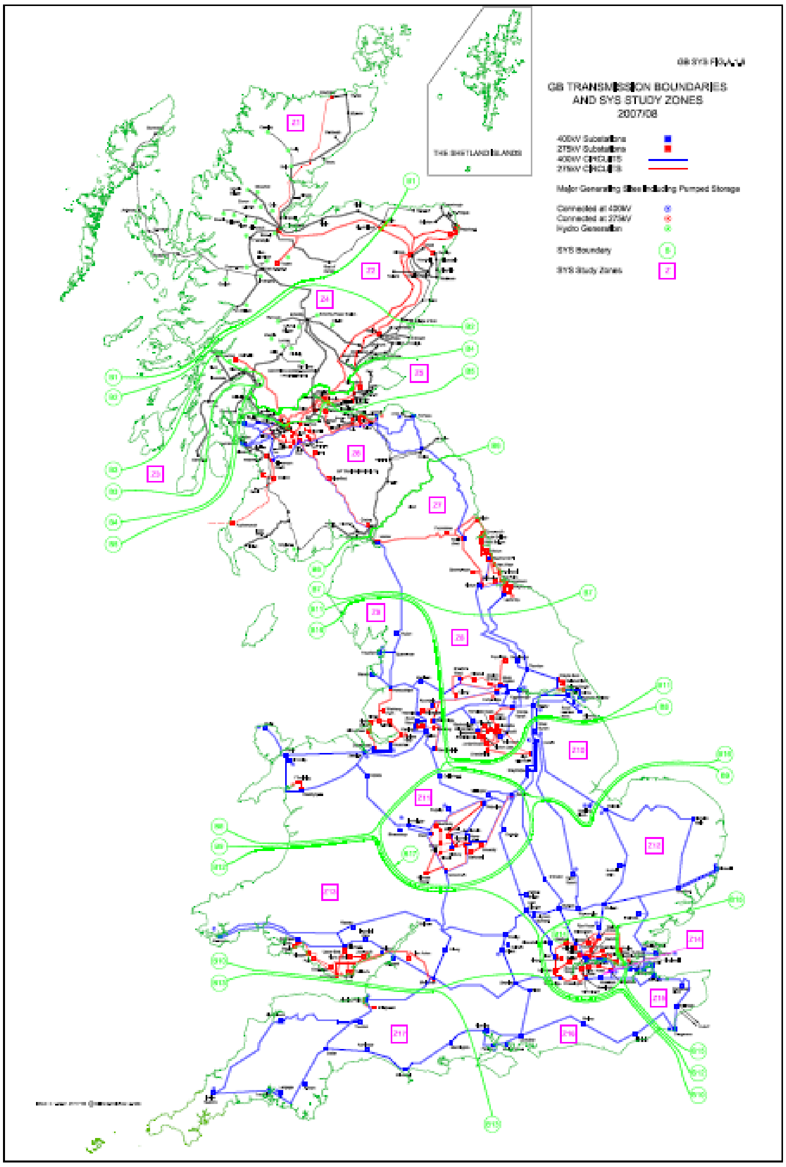
3.4 Network Capability

114. Additionally to the Methodology Statement the areas covered in this section are:
    a. A description of the data used to determine the inputs in Table 4.8 and Table 4.9 in Regulatory Reporting Pack

3.4.1 Network Capability

115. Figure 7 shows the transmission network split into zones which define boundaries across which transfer capabilities are assessed. The capabilities of these boundaries are calculated using DC and AC analysis (FLOP and OPFLO packages) and are tabulated in Table 4.8 in the Regulatory Reporting Pack.

Figure 7: The Transmission Network Split Into Zones



116. The actual capability of a boundary is the current and predicted GW power transfer capability, based on a best view background.

117. The required capability is the current and future requirement to transfer power in GW, based on a best view background.

118. The best view background is made up of the following:
    a. Demand Background: The demand backgrounds are based upon user submissions as governed by the Grid Code. Demands are corrected for the average cold spell and modified to consider demand usage seen and predicted by National Grid
    b. Generation Background: A best view of the generation pattern is based upon market behaviour and contracted positions
    c. Network Background: The existing network and those future transmission developments, which are considered ‘firm’ in that they are least likely to be varied or cancelled as the needs of the evolving system change

119. The required power transfer values must satisfy the GB Security & Quality of Supply Standards (GB SQSS). An interconnection allowance, as defined in Appendix D of the GB SQSS, is included in the capability calculations. The interconnection allowance is an additional margin to take into account non-average conditions such as severe winters as well as variations in generator availability.

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120. If the forecast for required capability is greater than the ability of the network to transfer the power (required capability > actual capability) then mitigating action is required. Identified shortfalls allow National Grid to plan solutions for ensuring continuing compliance with the SQSS. The solutions may take the form of capital reinforcement or action such as intertripping contracts.

3.4.2 Network Utilisation

121. Table 4.9 in the Regulatory Reporting Pack shows the number of sites within % bands of utilisation at demand exit points.

122. Capacity is defined as ‘non supergrid transformer (SGT) capacity’ and takes into account:
    a. SGT capacity, utilising cyclic rating for post fault conditions
    b. Low voltage interconnection capacity as provided by the DNO (Distribution Network Operator)
    c. Embedded generation where it is appropriate to consider a contribution

123. Table 4.9 considers substation utilisation for three network conditions:
    a. Winter peak, intact system compared with intact SGT capacity

b. Seasonal Peak demand (most onerous of summer, winter or autumn demand) compared against n-1 capacity, typically loss of one SGT at the site
c. Demand at maintenance period (summer demand), compared against n-2 capacity, typically one SGT on maintenance and loss of a second SGT. This comparison is only valid for substations where the demand is greater than 300MW, as defined in Table 3.1 of the GB SQSS.

124. Table 4.9 in the Regulatory Reporting Pack identifies sites where present or future demand (in MVA) is close to or greater than the capacity of the substation. Together with the DNO companies, National Grid uses this type of information to identify where there is a need for future infrastructure investment or other mitigating action.

125. Substation utilisation can be limited by complex issues which it is difficult to tabulate. These factors still require consideration by the appropriate companies and can be summarised as follows:
   a. Insufficient low voltage switchgear fault rating means that the site must be operated split, restricting the way the transformers are able to supply the load
   b. Uneven transformer sharing due to differences in impedance, restricting the ability of the site to utilise the full capacity of an SGT
   c. Heavy loaded sites that have been split to manage fault levels can experience high voltage step changes following the loss of a transformer

126. Entry point utilisation and capability is a function of the generators connection requirements and operating regime and as such is not reported.

3.4.3 Historical Information

127. National Grid has historic information for Network Capability Output (Table 4.8 in Regulatory Reporting Pack) from 2000/01. This was reported to The Authority in 2007.

128. National Grid has historic information for Network Utilisation Output (Table 4.9 in Regulatory Reporting Pack) from 2001/02. This was reported to The Authority in 2007.

3.4.4 Future Development

129. Currently there are no developments identified in either of Network Capability or Network Utilisation.

[redacted]

130. [redacted]

[redacted]