OFGEM

INFORMATION AND INCENTIVES PROJECT

REPORT ON

MEDIUM TERM NETWORK PERFORMANCE MONITORING

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PB Power

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1. INTRODUCTION

Ofgem has initiated a number of workstreams associated with the Information and Incentives Project (IIP). Ofgem published initial proposals on output measures in June 2000 and an associated report by PB Power on the Review of the PES Measurement Systems was published in July 2000. The PB Power Report considered the accuracy and consistency of network performance data reported to Ofgem under Licence Condition 9 (England and Wales) and 6 (Scotland) based on a questionnaire and visits to distribution companies. It concluded that there were significant inaccuracies and inconsistencies in reporting associated with definitions of terms and company systems of reporting. PB Power produced a further report which proposed definitions for two of the output measures proposed by Ofgem and a workshop was held in August to debate these issues. Ofgem published its final proposals on defining output measures in September 2000 along with a final PB Power report on the definitions of output measures (which took account of written comments made by companies after the August workshop). All these documents are available on the Ofgem website www.ofgem.gov.uk.

Ofgem is concerned that distribution businesses may be able to achieve short-term improvements in performance on output measures at the expense of medium-term performance (MTP). Ofgem is also concerned that, in the future, as cost savings become harder to achieve and companies take different approaches to maintaining their networks, the risk of a decline in MTP increases.

Ofgem's preferred approach is to develop a set of reliability output measures or indicators based on an analysis of faults by asset type and cause and to monitor trends in performance of assets over time. It would also be desirable to develop indicators which have within them a predictive quality, i.e. that are able to indicate the possibility of a decline in future performance.

Some companies have suggested that accreditation of asset management systems would be an appropriate basis for monitoring medium-term performance. Ofgem's view is that this may not give sufficient comfort that MTP is being maintained. It may also inhibit developments in best practice and focus on regulatory inputs.

Ofgem has indicated that in monitoring MTP, it is seeking to provide additional comfort to consumers and their representatives that the plans submitted by the distribution businesses and any action they take between price reviews, and the final price control settlement proposed by the regulator, is consistent with ensuring the overall integrity of the distribution network for the medium and long term (i.e. for the period of the next price control period and beyond).

Ofgem has initiated further work to further develop its thinking in this area and this PB Power report considers the issues. Ofgem's requirements for monitoring medium term performance are outlined in the draft Regulatory Instructions and Guidance (RIGs) document which has been published on the Ofgem website.

The main objectives are to:

a. Develop a framework for monitoring MTP by monitoring performance of asset type and fault cause;

and in general terms to consider:

b. whether it is possible to develop indicators with a predictive quality;

c. the relationship between indicators and output measures and the extent to which deterioration in short-term performance is an indication of medium-term performance;

d. whether a combination of indicators trending in the same direction is of more concern than a single indicator moving by a large amount;

e. the level of detail required for effective monitoring of performance;

f. what supporting narrative would be required from companies; and

g. what, if any, special arrangements are required for poorly performing assets e.g. of particular design or manufacture.

The reporting systems used by companies produce outputs for both the National Fault and Interruption Reporting Scheme (NaFIRS) and Ofgem reports (Condition 6/9 reports). A description of NaFIRS equipment performance monitoring is provided in Appendices A and B. This report therefore refers to NaFIRS and associated Electricity Association Engineering Recommendation G43/2. This is in order to identify current industry and Ofgem reporting requirements and to identify how these might be developed for reporting on MTP to Ofgem. It would appear to be desirable to keep industry and Ofgem reporting procedures in step as far as possible. References in this report to G43/2 are for illustrative purposes only and are in no way an attempt to modify Electricity Association standards.

2. SUMMARY AND PROPOSED METHODOLOGY FOR MONITORING MEDIUM TERM PERFORMANCE

The main recommendations and findings of this report are as follows:

a. In the current Licence Condition 6/9 reports to Ofgem on network performance, the distribution companies are only required to report reliability of the network as a figure for the network as a whole (faults per 100 km), with no disaggregation by voltage, asset class, or fault cause. This reliability index is not a useful indicator of MTP, as it does not reveal trends in performance at each voltage level or for particular poorly performing assets. For example higher voltage networks are by design more reliable than lower voltage networks and a combined index masks potential problems at different voltage levels and possibly also between asset classes and fault causes – information which Ofgem does not presently collect under the existing reporting arrangements.

b. It is recommended that a framework for reliability monitoring is adopted based on existing NaFIRS (or equivalent) information, disaggregated to an appropriate level, i.e. by voltage, asset class and high level fault cause as set out in Section 4. This more detailed disaggregation of reliability data will assist in the identification of adverse trends in network reliability.

c. Reliability monitoring may prove useful for identifying adverse trends for most asset types but adverse trends in minority asset sub-groups may not be revealed in high level figures. Routine monitoring of asset sub-groups is not recommended but companies will be required to report separately on the performance of sub-groups of assets where adverse trends are detected by the Companies' own asset management processes. Such reports will be included in the accompanying narrative that will be required as part of MTP monitoring. (See below).

d. It is also unlikely that adverse trends in 132 kV and 33 kV assets will be detected as fault rates are low and therefore it may not be possible to identify a deterioration in MTP. It is therefore recommended that companies provide as part of the narrative an explanation of how they monitor reliability of these assets, including both fault performance and condition monitoring and predicted performance.

e. The monitoring of reliability will be most useful for identifying trends for each company and inter-Company comparisons are not considered a primary input for MTP. It is not therefore recommended that reliability indices, at this stage, are normalised for inter company comparisons. However, it is important that the definitions are consistent over time, or that where any changes are made they are fully understood.

f. The reporting of fault causes is not consistent across companies and over time and tends to under-report deteriorating assets, in preference to more clear-cut and immediate causes such as weather. Around 30% of incidents are reported as cause unknown, mainly because there is insufficient evidence of fault cause, in many cases no evidence. Fault cause reporting may be improved by issuing further guidance but

is not likely to improve sufficiently to be useful for monitoring fault causes at a very detailed level. Disaggregation by fault cause is therefore only recommended at a high level, highlighting the main causes such as weather and environment, third party damage, company causes and unknown classifications.

g. Companies currently disaggregate reliability indices in NaFIRS reporting by damage and non-damage faults, but this is not recommended for Ofgem reporting as both types of fault can be indicative of asset management practices and of MTP.

h. The relationship between reliability indices and the output measures that Ofgem has indicated will be subject to direct financial incentives under the incentive regime (i.e. the number and duration of interruptions to supply) is not straightforward. Incentivised outputs could move more favourably than reliability indices but this could mask a deterioration in network reliability which MTP is designed to detect. However there may be diminishing returns in improving incentivised outputs and in the longer term there may be a closer relationship between incentivised outputs and MTP measures.

i. In addition to quantitative information on reliability, companies should also submit a supporting narrative, to include:

   i. A commentary on broad philosophy and the overall approach the company adopts with respect to asset management. This would include a statement on the methodology for monitoring condition and performance of assets and for predicting future condition and performance and hence deriving replacement and improvement programmes;

   ii. An explanation of trends in reliability figures in MTP reporting (and IIP Outputs) and actions taken to improve reliability or replace deteriorating assets, together with a prediction of future performance;

   iii. An explanation of adverse trends in reliability of sub-asset groups not revealed in the MTP reports but detected from the Company's own asset management processes, and actions taken to improve reliability or replace deteriorating assets together with a prediction of future performance;

   iv. The additional condition monitoring and post fault investigations carried out by the company to identify the condition of assets, and the prognosis for future condition and performance MTP and replacement and improvement programmes;

   v. To report on the actions to be taken to control any adverse trends in the reported figures or sub groups of under-performing assets identified, including maintenance, remedial work and replacement. Companies should also provide some activity based information such as on the number of different asset types replaced, repaired, refurbished or maintained. It is recommended that initially this should focus on where a company has

identified a poorly performing asset type and has put in place a replacement or refurbishment programme. The company should identify the number and proportion of the poorly performing assets replaced each year and how this compares with the normal programme; and

vi. In addition, for 132 kV and EHV assets, a supporting narrative is required which explains the asset management approach for these assets, together with details of condition monitoring or condition assessment (rating systems) with a more detailed report on problem assets or sub groups.

j. It is recommended that the framework for monitoring MTP is developed over time by Ofgem and the companies and that in particular that a better understanding is gained of the relationship between expenditure (both capital and operating) and MTP.

3. EXISTING NAFIRS DATA RELATING TO EQUIPMENT RELIABILITY

3.1 Current NaFIRS and Ofgem Equipment Reliability Reporting

NaFIRS is designed to collect information relating to both network performance and equipment performance. Network performance indices relate mainly to customer effects such as Average Minutes Lost per Connected Customer and Number of Customers Interrupted per 100 Connected Customers, (IIP incentivised outputs). Equipment performance is measured by a reliability index defined as the number of faults leading to forced outages of plant and equipment expressed as:

a. Number of faults per unit length of circuit classification; and

b. Number of faults per unit of equipment classification.

NaFIRS expresses reliability in terms of fault incidents per 100 km, for circuits (overhead lines and underground cables) and the number of fault incidents per 1000 units of equipment for plant and equipment items, such as switchgear. The index reported under NaFIRS and in Condition 6/9 reports to Ofgem currently excludes pre-arranged outages and faults on service equipment and also excludes incidents on external networks such as NGC and generator networks.

Reporting of reliability under NAFIRS is described in more detail in Appendices A and C, including a description of the current disaggregation of reliability measures by voltage, asset, fault cause and between damage and non-damage faults.

Reliability is currently reported by distribution companies in Licence Condition 9 (England and Wales) and 6 (Scotland) as a single overall figure based on faults per 100 km for the whole network.

The average reliability for England and Wales reported in NaFIRS varies across the voltage levels as follows for 1997/98:

132 kV:	2.2 faults per 100km
EHV:	4.9 faults per 100 km
HV:	10.3 faults per 100 km
LV:	19.3 faults per 100 km

This shows that networks at higher voltage are inherently more reliable than those at lower voltages and reporting a single figure for the network as a whole may mask a deterioration in reliability at different voltage levels.

The overall reliability figure reported to Ofgem is improving marginally. One reason for this is that companies have over time targeted worst performing assets. The reliability index may however vary significantly from year to year due to many factors including severe weather incidents and third party cable damage.

There are a number of measurement issues associated with the accuracy and consistency of reliability reporting, particularly the reporting of fault causes and the extent to which companies segregate LV service incidents from LV mains incidents. However, it is likely to be the case that the trend in performance over time for a particular company would be more important than the trend between companies. It would be important to establish that companies have been reporting

consistently over time. There would be benefits for achieving consistency where possible in the definitions of indicators used to monitor MTP.

There appears to be different practices in reporting low voltage mains and service faults which impact on both the NaFIRS and the Ofgem overall reports on reliability. Services represent a significant part of the asset base and are in general one of the less reliable elements of the distribution system. It is recommended that in future service faults, (defined in the PB Power report on Definition of Input and Output Measures) should be separately monitored for MTP as LV service faults per 1000 customers.

3.2 Damage and Non-Damage Incidents

The NaFIRS disaggregates “damage” and “non-damage” faults for overhead lines. This is because many faults on overhead lines are not permanent and no damage is found. Such faults can arise due to weather, trees, birds and some types of deterioration. In most cases such incidents will be automatically restored and give rise to Short Interruptions (currently defined as being less than one minute, although Ofgem has proposed to move the definition to less than three minutes). However, a proportion of these faults are not restored automatically by auto-reclose but are subsequently successfully reclosed by local or remote control. In most cases no evidence of the fault can be found and hence the fault is reported as a “non-damage” fault with cause unknown.

Non damage faults can also arise on low voltage underground cables where a developing fault causes a fuse to operate and the fuse is subsequently successfully replaced and the circuit restored without the need for repairs. This is often reported as a “non-damage” fault as any damage remains undiscovered. Supplies may be interrupted on further occasions as the fault develops until the fault becomes permanent at which time it would be classified as a “damage” fault. This is common with the premature failure of "consac" cables (a type of LV cable) and therefore both “damage” and “non-damage” faults may indicate a deterioration in reliability.

There does not appear to be a sound reason for disaggregating reliability measures between damage and non-damage incidents for the purposes of monitoring MTP as both types of incident may be indicative of deterioration and MTP. It is therefore recommended that reliability monitoring for Ofgem reports should not disaggregate between damage and non-damage incidents.

3.3 Fault Causes

NaFIRS adopts 55 classifications of fault cause as set out in Appendix A. Fault causes include a category “deterioration due to age and wear” which could be reflective of a deterioration in MTP. However this classification does not identify all those faults where deterioration may be involved. For example, approximately 50% of HV overhead line faults are attributed to weather, 10% due to "deterioration due to age and wear" and 20% due to unknown cause. However for overhead lines many faults arise due to a combination of weather and age and wear and the "direct cause" (i.e. first degree of importance) is likely to be attributed to weather, even though the underlying cause was a deterioration in age and wear. It is not therefore sufficient to monitor “age and wear” incidents in order to monitor MTP.

Many faults are coded as cause "unknown" due to genuine difficulty in identifying a "direct cause", particularly where there is no damage and the circuit is restored without the fault being found. In some cases the extent of the damage caused by short circuit current masks the cause. It is not

practical to examine all faults in detail and companies reserve such analysis for situations where they have detected a developing generic problem.

Between 10% and 30% of cable faults are caused by third party damage, mainly during roadworks, and are not reflective of equipment deterioration. Third party incidents vary significantly from year to year due to levels of economic activity and work programmes of other companies, particularly cable TV. Third party faults are not indicative of MTP and it is important that third party damage faults are monitored separately to understand the impact that these may have on the overall trend.

NaFIRS has the facility for recording a contributory cause, except for LV incidents. However checks in one company found that "contributory cause" was recorded for less than 1% of HV faults. A "contributory cause" of "age and wear" is not often recorded as this is often a subjective judgement. It is not considered appropriate to recommend disaggregation of reliability figures by "contributory causes" as well as "direct causes.

At higher voltages of 33 kV and above, equipment is designed to be very reliable and fault rates due to deterioration are very low. A sample of fifteen 132 kV incidents in one company revealed six auto-reclose operations (mainly due to lightning), and eight deliberate disconnection which include actions following alarms such as cable oil pressure and loss of protection telecommunications circuits, and objects on overhead lines and substations.In these circumstances companies proactively monitor the condition of equipment rather than react to failures. Ofgem will therefore need to be more dependent on the proposed company narrative to understand what companies are doing to maintain MTP for equipment operating at 33 kV and above.

4. PROPOSED DISAGGREGATION FOR RELIABILITY MONITORING

Section 3 indicates the extent and complexity of equipment performance monitoring carried out by companies using NaFIRS or similar systems. Most fault classifications except third party damage are likely to reflect deterioration due to age and wear or other aspects of MTP to some extent. Significant variations can also occur from year to year due to weather and third party damage. In monitoring trends in reliability, it will therefore be necessary for Ofgem to have visibility of the reliability trends for asset classes at each voltage level and for the most significant fault causes.

The disaggregation of reliability for MTP reporting set out below is recommended.

Note:

1. Reliability to be reported as faults per 100 km for lines and cables, faults per 1000 units for equipment and faults per 1000 customers for services.
2. Equivalent classifications will need to be identified for those companies which do not report exactly to NaFIRS fault cause classifications.
3. No distinction is made between damage and non damage faults.
4. Volumes of circuits and plant items used for standardising data should be provided, based on a count at 30 September in the reporting year.
5. Numbered references below refer to NaFIRS equipment and fault cause codes (See Appendix A).

4.1 132 kV, 66kV and 33 kV Circuits and Equipment

Disaggregate by voltage and by:

a. Total (all faults)

b. Overhead Lines

c. Underground cables

Total number of trend lines: 3 per voltage classification.

4.2 HV (including 22 kV)

Aggregate all voltages from 1 kV to 22 kV.

4.2.1 Overhead Lines

Include existing NaFIRS overhead line equipment classification plus pole mounted isolators and switch-disconnectors, i.e.:

Overhead Lines	Prefix 0
plus	
Switchgear	Prefix 2 (Situation 3 - Pole or Structure Mounted Only)

Disaggregated by cause as follows:

a. Total (all causes)

b. Weather & Environment – Birds, Animals & Insects combined (Codes 01 - 33)

c. Company Causes (60 – 87) and faulty manufacture (90)

d. Unknown or unclassified causes (98 – 99)

e. Third party and other network faults (39 – 58) combined with (88 - 89)

Total number of trend lines: 5

4.2.2 Underground Cables

To include existing NaFIRS underground cable classification, i.e.:

Power Cables	Prefix 1

Disaggregated by cause as for Section 4.2.1:

Total number of trend lines: 5

4.2.3 Switchgear and protection systems

Include existing NaFIRS pole mounted automatic circuit breakers and sectionalisers and all ground mounted switchgear and protection and control equipment classifications, i.e.:

Switchgear etc	Prefix 2 (All Situations except Pole or Structure Mounted)
plus	
Protection Equipment	Prefix 4 (Include all faults but include switchgear numbers only in the index denominator)

Total number of trend lines: 1

4.2.4 Transformers, Reactors etc

Include existing NaFIRS classification, i.e.:

Transformers, Reactors, etc	Prefix 3

Disaggregated by ground mounted / pole – mounted.

Total number of trend lines: 2

4.3 LV

4.3.1 Overhead Mains

Include existing NaFIRS overhead mains and equipment classifications, i.e.:

Overhead mains	Prefix 00
plus	
Surface wiring mains	Prefix 20
Plus	
Switchgear/fusegear	Prefix 60 (Subset 62)

Disaggregated by cause as for Section 4.2.1.

Total number of trend lines: 5

4.3.2 Underground Mains

Include existing NaFIRS overhead mains and equipment classifications, i.e.:

Underground mains	Prefix 41 to 49
Plus	
Switchgear/fusegear	Prefix 60 (Subsets 61, 63 to 69)

Disaggregated by cause as for Section 4.2.1.

Total number of trend lines: 5

4.3.3 Services – overhead and underground

Include existing NaFIRS overhead and underground service classifications, i.e.:

Overhead service	Prefix 10
plus	
Surface wiring service	Prefix 30
Plus	
Underground service	Prefix 51 to 59
Plus	
Other	Prefix 90 (excluding unmetered services Subsets)

Total number of trend lines: 1

5. OTHER ISSUES RAISED BY OFGEM

5.1 Whether it is possible to develop indicators with predictive quality

A decline in future performance might be predicted by analysis of fault rates if the deterioration process is known and the age profile is known for a homogeneous set of assets. Such trends may only be apparent in specific subsets of assets and are not likely to be apparent in the high level indicators proposed for MTP reporting to Ofgem. However where a downward trend in reliability is apparent in the high level figures, this will need to be explained in the proposed MTP narrative as it may indicate a deterioration across an asset group, which may become worse if remedial action is not taken.

Companies are investigating predictive techniques by condition monitoring. As equipment ages and companies develop their asset management techniques, it may be possible for them to predict future failure rates and report as part of the MTP narrative. Where companies have developed predictive indicators these should be reported to Ofgem as part of the narrative.

Companies with deteriorating asset subsets such as "consac" cables (A type of LV cable which is failing prematurely) have difficulty in predicting future failure rates. One company has experienced a "consac" failure rate which has been increasing steadily at 10% per year and then in one year the failure rate doubled. Classically failure mechanisms follow a "bath tub curve", i.e. early life failures due to a small proportion of manufacturing and installation problems, followed by a long period of stable service with low fault rate, followed by a period of increasing fault rate. The rate of increase in deterioration and the time period of the increase is not predictable statistically on current knowledge, particularly with a non homogeneous asset base which is made up of equipment from different manufacturers and installed by different contractors and company staff and subject to varying environmental and electrical conditions.

When looking at overall figures there will be a mix of uncontrollable faults, faults due to deterioration of certain asset groups and improvements caused by replacing the poorly performing assets with new assets. Reliability monitoring at an asset level, even disaggregating by fault cause, will only show an overall trend. Companies need to monitor failure rates and condition of of sub-asset groups to explain reliability trends and to predict likely future performance.

5.2 The relationship between MTP indicators and IIP output measures

The Ofgem Annual Report on Distribution and Transmission System Performance which is available on the Ofgem website www.ofgem.gov.uk gives information on some proposed MTP and IIP indicators.

MTP measures the underlying reliability of the network in terms of the number of failures per unit of equipment. Deterioration of the network by ageing and improvement of the network by replacement of poorly performing assets to improve overall network performance is a gradual process and for most companies the figure has remained static or slightly improving over the past 10 years.

Over the same period companies have shown an improvement in Average Minutes Lost Per Customer (CMLs), one of the output measures proposed for incentives, of around 20%. It should be noted that as part of the work that has already been undertaken significant measurement inaccuracies and changes in definitions were identified over time. However, it is probably the case that quality of supply has at least been maintained if not improved to some extent. One company has halved CMLs

whilst reliability has remained virtually static. This has been achieved by targeting improvements to give the greatest benefit to customers. Recent improvements in performance have also been achieved by better network operation to reduce fault duration, including remote control automation and use of mobile generators.

The number of Customer Interrupted per Connected 100 Customers (CIs) is the second of the proposed Ofgem incentivised measures and is more reflective of network reliability, since it is more closely linked with the number of incidents causing interruptions. (The historic measure of CIs is defined rather differently and has been subject to measurement inconsistencies). Companies have also been able to improve the CI performance, again by targeting improvements to maximise benefits to customers and by design improvements that reduce the number of customers affected by individual faults.

Over the recent past therefore, there has been little correlation between the proposed incentivised outputs and the proposed MTP reliability measures. This demonstrates that it may be possible for companies to offset a deterioration in the underlying asset base by other means and it is this concern which is one of the drivers behind MTP.

Over time improvement of incentivised measures may become less economic and the system design and operating characteristics may become more static. With a static system the number and duration of interruptions that customers experience can be expected to correlate more closely with overall number of incidents and overall reliability.

There are particular issues in relating the reliability of 132 kV and EHV networks and output measures. These networks are duplicated and mainly operated "automatic firm" where supplies are not interrupted for a single circuit fault, i.e. there tends to be more than one circuit. There is little correlation between MTP and incentivised measures for these networks and in any event current fault rates are low. 132kV and EHV systems are therefore inherently more reliable by design but because of duplication there may be an incentive to allow these assets to deteriorate or to neglect maintenance.

An unexpected fault, coincident with other faults or outages, at 132 kV or EHV may lead a large number of customers being off supply for a long period. This is to some extent limited in the UK by the limits set by the P2/5 Security Standard embodied in the Licence, which specifies the requirements for alternative supplies in these circumstances. However most companies have a small number of large outages each year on the 132 kV and EHV network. Companies do not rely on monitoring fault trends for this equipment and instead increasingly carry out regular inspections and condition monitoring in an attempt to identify remaining life and replace before failure. Monitoring reliability of 132kV and EHV equipment can therefore only be a backstop measure and it is important for companies to monitor the condition of these assets. It is recommended therefore that the reliability monitoring that is required by Ofgem is carried out at a high level only and companies provide reports on what they are doing to monitor the condition of these assets and actions taken to maintain service levels as indicated in Section 5.6 below. Companies should also be expected to provide, as part of the overall narrative, a report on the performance of higher voltage assets and the actions taken to monitor and predict performance, including any action taken in response to a particular incident.

5.3 The extent to which deterioration in short-term performance is an indication of the medium-term performance

When companies are incentivised to achieve short-term improvements in key quality of supply outputs, a deterioration in performance may well indicate that all opportunities for short-term improvements have been realised and the deterioration of the network is the dominant force at work. Deterioration in short-term performance may also reflect abnormal weather but this would not be expected to occur every year on a downward trend. However an increasing vulnerability to weather may also indicate deterioration in overhead line assets. Overhead lines are generally stressed more in abnormal weather but are designed to resist all but the most severe weather and most weather-related faults reflect to some extent aspects of MTP. With a more static system a downward trend in incentivised measures is likely to reflect MTP.

5.4 Whether a combination of indicators trending in the same direction is of more concern than a single indicator moving by a large amount

As discussed above changes can be expected from year to year, often quite large changes due to adverse weather and this can alter the apparent trend from year to year even when measured over a five year period. Analysis of data therefore needs to recognise the natural variation of reliability figures. There are a number of reasons why reliability figures will vary from year to year:

a. Bad weather is likely to affect a number of asset classes including overhead lines at all voltages, and pole mounted switchgear, fusegear, and transformers. This may not be of great concern in one year as it may not be indicative of deterioration in MTP.

b. Third party damage affecting lines and cables also fluctuates with economic activity.

c. Tree incidents can rise across all voltage classes if tree-trimming is neglected.

d. Cable systems in the UK still have significant remaining life on average but these will start to fail as they reach the end of their technical lives. Cable failure rates related to deterioration are very low and are partly masked by third party damage failures. Cable failure rates will need to increase significantly before companies are able to target an effective replacement regime (except for rogue assets such as consac and small quantities of other rogue cables, e.g. some cables uprated from 6 kV to 11 kV working, small section HV cables).

A decrease in reliability due to an increase in age and wear would be of more concern. However a consistently increasing failure rates across a broad class of assets does not necessarily mean neglect or that there has been deterioration in MTP. Apart from overhead lines which are capable of refurbishment, most cables and substation equipment might be expected to have an increasing failure rate as the average age of assets increases and becomes closer to the technical life. The underlying reason for abnormal trends are likely to require further detailed investigating and reporting by companies.

5.5 The level of detail required for effective monitoring of performance

The factors which are likely to cause a decrease in reliability are diverse and could vary between companies and over time. The level of disaggregation of reliability indices proposed above are designed to allow Ofgem to understand the broad movements in reliability and to have sufficient information to ask companies to explain trend for particular assets. In particular for overhead lines and cables, disaggregation is designed to reveal trends in those aspects of reliability which are subject to variation, such as weather/environment or not reflective of MTP such as third party causes. Company explanations in the narrative are likely to involve more detailed analysis and disaggregation

of data. It is considered that companies should report on the reasons for any adverse trends based on their own disaggregation of the problem and not for Ofgem to ask for disaggregation of reliability at lower levels which may not be relevant. The process of company reporting should stimulate companies to carry out more detailed analysis and report problems by exception.

5.6 What supporting narrative is required from companies

Reliability monitoring has many limitations and is mainly to be regarded as a backstop measure to identify poorly performing networks before there is a significant impact on customers, bearing in mind the other measures that companies can take to maintain short-term performance. However in present circumstances of relatively low fault rates, adverse trends on sub groups of assets may not be readily identified and this is particularly so at 132 kV and EHV. It is therefore recommended that reliability reporting is supplemented by a detailed narrative from companies that should cover the following:

a. A commentary on broad philosophy and overall approach the company adopts with respect to asset management. This would include a statement on the methodology for monitoring condition and performance of assets and for predicting future condition and performance and hence deriving replacement and improvement programmes;

b. An explanation of trends in reliability figures in MTP reporting (and IIP Outputs) and actions taken to improve reliability or replace deteriorating assets, together with a prediction of future performance;

c. An explanation of adverse trends in reliability of sub-asset groups, not revealed in the MTP reports, but detected from the Company's own asset management processes, and actions taken improve reliability or replace deteriorating assets, together with a prediction of future performance;

d. The additional condition monitoring and post fault investigations carried out by the company to identify the condition of assets, and the prognosis for future condition and performance MTP and replacement and improvement programmes;

e. To report on the actions to be taken to control any adverse trends in the reported figures or sub groups of under-performing assets identified, including maintenance, remedial work and replacement. Companies should also provide some activity-based information such as on the number of different asset types replaced, repaired, refurbished or maintained. It is recommended that initially this should focus on where a company has identified a poorly performing asset type and has put in place a replacement or refurbishment programme. The company should identify the number and proportion of the poorly performing asset replaced each year and how this compares with the normal programme; and

f. In addition for 132 kV and EHV assets, the supporting narrative should explain the asset management approach for these assets, together with details of condition monitoring or condition assessment (rating systems) with a more detailed report on problem assets or sub groups.

It is recommended that there is a form of the narrative that can be made publicly available to aid the spread of best practice of asset management.

5.7 What, if any, special arrangements are required for poorly performing assets from particular manufacturers

It is not envisaged that Ofgem monitoring will be carried out at the level of sub asset groups and companies will be expected to report on problem assets as part of their narrative, regardless of whether it is revealed in the trend data submitted as part of MTP monitoring.

If in time certain assets are found to be under-performing it may be appropriate to disaggregate to identify national trends but this may be envisaged only where deterioration is likely to have a significant impact on network performance or the capital required for asset replacements.

However, if a company does identify a group of particularly poorly performing assets and puts in place a replacement programme it is recommended that the company reports against this plan on an annual basis, including any reasons for divergence from the original replacement programme.

5.8 Future Development of MTP

The approach to MTP may evolve over time. It may be appropriate to allow this reporting to develop for a period of two to three years and then to specify the reporting requirements more rigorously based on best practice. It may also become apparent that there are particular sub-asset groups or fault causes which require more close monitoring for all companies. It may be necessary to standardise further the level of detail provided.

At the next price control review it may be appropriate for distribution businesses to submit an assessment of the impact on MTP which their capital expenditure forecasts can be expected to deliver. The narrative distribution businesses submit each year would explain any differences between their expectations and outturns, along with the quantitative information outlined above.

The framework for MTP would provide the regulator with a way of evaluating (and subsequently monitoring) capital expenditure requirements by looking at the outputs that the distribution business is expected to deliver. In monitoring MTP, Ofgem is seeking to provide additional comfort to consumers and their representatives that the plans submitted by the distribution businesses and any action that they take between reviews, and the final price control settlement proposed by the regulator, is consistent with ensuring the overall integrity of the distribution network for the medium and long term (i.e. for the period of the next price control and beyond).

APPENDIX A

NaFIRS EQUIPMENT PERFORMANCE REPORTING AND FAULT CAUSE CLASSIFICATION

This Appendix sets out, for information purposes, the existing arrangements for reliability monitoring under NaFIRS. As explained in the main body of the report it is recommended that Ofgem collects data at a more aggregated level than under NaFIRS.

NaFIRS is designed to collect comprehensive information about equipment performance by identifying assets and components involved in an incident and the fault cause. It is then possible to identify problems at a company and national level relating to specific classes of asset or components, manufacturer, and attributable to particular fault causes.

Figures 1, 2 and 3 included in Appendix B show the data collected in NaFIRS and the list of fault cause classifications adopted by most companies is attached to this Appendix A. The main categories of NaFIRS reporting are summarised below:

a. **Main equipment involved**: This includes main asset classes of cables, overhead lines, switchgear, transformers etc and types of asset, e.g. waveform LV cable, as appropriate for different voltage levels.

b. **Main component involved**: The particular component affected, e.g. overhead line conductor, insulation, etc.

c. **Manufacturer and type or reference**

d. **Damaged component**: Damaged components are defined as “Components which once de-energised would not be re-energised permanently without replacement or repair”. NaFIRS therefore is able to distinguish between damage faults and non damage faults and the EA NaFIRS Report includes reliability trends which for overhead lines distinguishes between damage and non damage faults.

c. **Direct Cause and Contributory Cause**: Direct cause is that, which in the opinion of the reporter, is the prime reason (i.e. first degree of importance) for the occurrence of the incident. Contributory cause entries are discretionary at 132 kV EHV and HV and not included in NaFIRS for LV incidents. There are fifty-five fault cause codes, which are used for all assets, although each asset and voltage level has characteristic fault causes. Fault causes are grouped as follows:

    i. **Weather and Environment** – including lightning, snow, ice, rain, wind, trees and windborne material;

    ii. **Birds Animals and Insects**;

    iii. **Third Party** - including wilful damage and theft, dissagregating by the various utilities that may damage equipment when working near cables and lines;

iv. **Company Related** – related to work, switching or testing, deterioration due to age and wear, maintenance, and electrical causes;

v. **Non Company** – other electricity systems, manufacture, design or assembly; and

vi. **Unknown and Unclassified** - one company uses the term “no cause found”.

All companies monitor equipment reliability in line with NaFIRS or in a similar format. London has no overhead lines and adopts a simplified list of fault causes, which can be accommodated in the NaFIRS annual report. Eastern currently does not report to NaFIRS but its network performance reporting is based on Electricity Association (EA) Engineering Recommendation G43/2 Instructions for Reporting to NaFIRS.

NaFIRS Reliability Reports

The NaFIRS annual report (for all companies except Eastern) includes tables giving an analysis of all incidents and fault causes, disaggregated by voltage and asset class, (overhead lines, power cables, switchgear/fusegear and other). The format of this report indicates what companies find useful in monitoring trends in equipment performance and MTP.

NaFIRS annual reports also provide more detailed tables of the five-year trend of equipment reliability for different types of EHV, HV and LV asset class, e.g. cables and overhead lines. Reliability is expressed as faults per 100 km for circuits and faults per 1000 units of equipment, e.g. for classes of switchgear and transformers. In the case of overhead lines the faults are segregated between damage and non-damage faults. For other types of equipment only damage faults are reported.

The NaFIRS Annual Report includes tables of reliability trends over a five-year period, disaggregated by voltage, asset class as follows:

a. total faults, damage and non-damage, per 100 km;

b. overhead lines, damage and non-damage faults, per 100 km;

c. underground cables faults, damage only, per 100 km;

d. circuit breakers, damage only, but disaggregated by reclosing and non-reclosing breakers, per 1000 units;

e. automatic switch-fuses, damage only, per 1000 units;

f. other ground mounted switchgear, damage only, per 1000 units;

g. pole mounted switch / isolators, damage only, per 1000 units;

h. fusegear, damage only, disaggregated by pole mounted and non-pole mounted, per 1000 units;

i. transformers, damage only, pole mounted and non pole-mounted, per 1000 units; and

j. protection equipment, incident count only.

This top-level data may highlight areas for further investigation which companies may do by "drilling down" into the NaFIRS data to investigate fault causes for sub-groups of assets.

Some companies are developing asset management systems outside NaFIRS where sub-groups are identified for condition monitoring especially at EHV and 132 kV where fault rates are low and it is more important to predict future performance and replace assets before failure occurs.

ATTACHMENT TO APPENDIX A
NaFIRS FAULT CAUSE CLASSIFICATIONS

CAUSES OF INCIDENTS			
	Weather and Environment		Public Electricity Supply Company
01	Lightning	60	Accidental Contact, Damage or Interference by PESC or their Contractors (INCLUDING Live Line Work)
02	Rain		
03	Snow, Sleet and Blizzard	61	Switching Error by PESC Personnel
04	Ice	62	Testing or Commissioning Error by PESC Personnel
05	Freezing Fog and Frost	63	Incorrect or Inadequate System Records, Circuit Labelling or Identification
06	Wind and Gale (excluding Windborne Material)		
07	Solar Heat	65	Incorrect Application of PESC Equipment
10	Airborne Deposits (excluding Windborne Material)	66	Faulty Installation or Construction
		67	Load Current above Previous Assessment
14	Condensation	68	Incorrect Protection Settings or Fuse Rating
15	Corrosion	69	Unsuitable Protection Characteristics
16	Mechanical Shock or Vibration	70	Inadequate Rupturing or Short Circuit Capacity
17	Ground Subsidence	71	Deterioration due to Ageing or Wear (excluding corrosion)
18	Flooding	72	Fault on PESC Equipment Faulting Adjacent Equipment
19	Fire not due to Faults	73	Unsuitable Paralleling Conditions
20	Growing or Falling Trees (not felled)	75	Operational or Safety Restriction
21	Windborne Materials	77	Inadequate or Faulty Maintenance
22	Disruption of Intended Indoor Environment	87	Local Generation Failure (isolated System
	Birds, Animals and Insects		National Grid Company
30	Birds (including Swans and Geese)	88	PESC Equipment Affected by National Grid Company Personnel or Equipment
32	Vermin, Wild Animals and Insects		
33	Farms and Domestic Animals		
	Third Party		Private Generator or Authorised Electricity Operator
39	Wilful Damage, Interference or Theft, Accidental Contact, Damage or Interference:	89	PESC Equipment affected by Private Generator or Authorised Electricity Operator (other than National Grid Company
42	by Public Telecommunications Operator (e.g. BT or Mercury) or their Contractors		
43	by Gas Company or their Contractors		
44	by Water/Sewage Companies or their Contractors		Manufacturer
45	by Highway Authorities or their Contractors	90	Faulty Manufacturing, Design, Assembly or Materials
48	involving Farm Workers or Farm Implements		
49	involving Aircraft or Unmanned Balloons		
50	by Private Individuals (excluding 49 and 56)		Other
53	by Unknown Third Parties	98	Causes Unclassified in this Table
54	by Local Building Authorities or their Contractors	99	Cause Unknown
55	by Private Developers or their Contractors		
56	involving Leisure Pursuits		
57	by Other Third Parties		

APPENDIX B

FLOW CHARTS OF NaFIRS INPUT DATA

Figure 1: Flowchart of 132kV NaFIRS Input Data

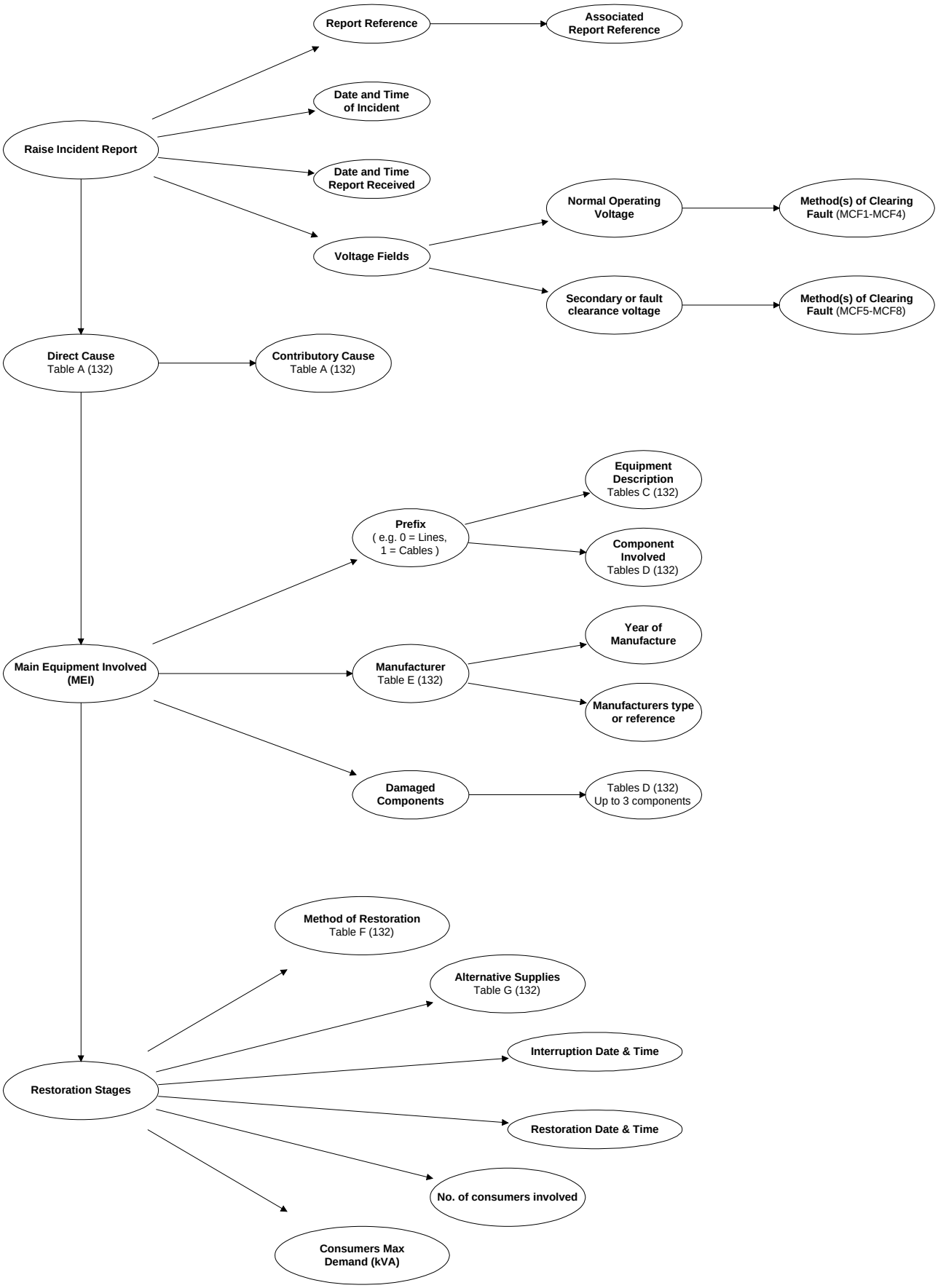

Figure 2: Flowchart of EHV/HV NaFIRS Input Data

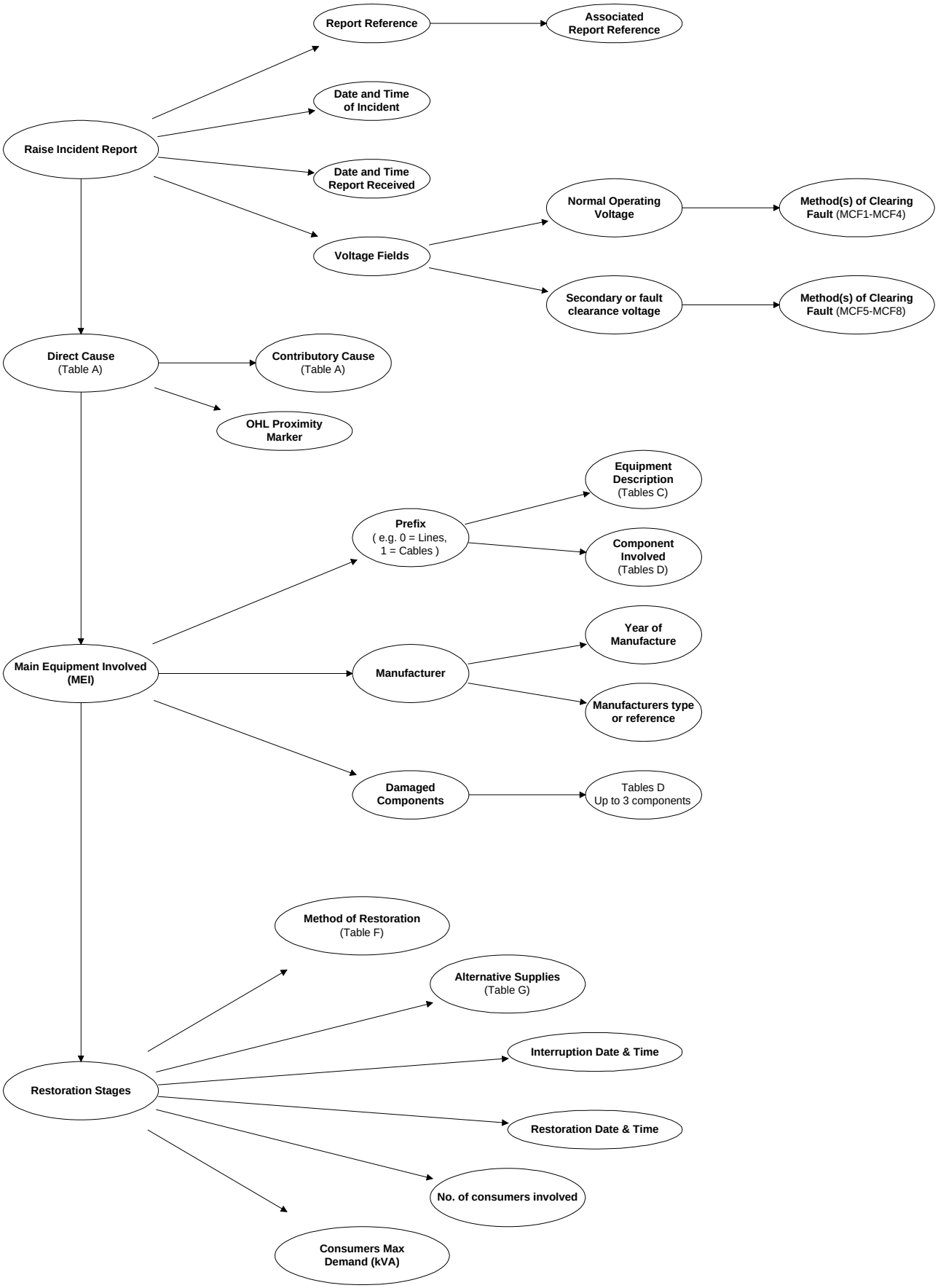

Figure 3: Flowchart of LV NaFIRS Input Data