PROJECT HALE

DNV Independent Asset Audit - Executive Summary

National Grid Electricity Transmission plc

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Objective:

An independent audit to review and assess NGET's asset management practices against industry best practice, conducted through a desk-based data review and on-site inspections at 20 substations across the network.

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FR	2025-12-08	Final Report	VARIOUS	ES	RV
FR-ES	2025-12-08	Final Report – Executive Summary	VARIOUS	ES	RV

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EXECUTIVE SUMMARY

Audit background

This audit has been commissioned on Ofgem's initiative following the failure of a transformer at North Hyde substation In March 2025 which led to largescale disruption to Heathrow airport. Ofgem's aim is to understand whether this was a one-off event, or whether there is the risk of other assets failing at critical substations with the ability to cause similar, widespread disruption.

Audit objectives

Ofgem identified the following four objectives for the audit:

1. To assess whether NGET's maintenance policies and procedures in respect of the defined assets and asset types align with good industry practice and internationally recognised standards.
2. To assess whether the assets at the sites chosen for this audit are being monitored, maintained and managed in line with relevant NGET policies and procedures.
3. To assess whether the monitoring, maintenance and any other relevant interventions carried out by NGET on these assets are being accurately recorded in NGET's asset management systems.
4. To assess whether the asset health data feeding into the calculation of the End-of-Life Modifiers and Probability of Failure metrics under NARMs is accurate, and whether the calculation of these metrics aligns with NGET's approved methodology.

DNV's approach

DNV completed three tasks to meet the objectives laid out above:

1. A desk-based comparison of NGET asset maintenance policies against international guidelines and DNV's Good Utility Practices (GUP),
2. A desk-based review of NGET asset management and work order (WO) data to evaluate whether policies and maintenance activities are carried out and recorded as expected,
3. Visual site inspections covering each of the in-scope assets.

The outcomes of DNV's tasks are outlined further on in this executive summary.

Overview of NGET Substation Maintenance Workflow

NGET substation lead equipment maintenance planning starts with the Maintenance Scheduled Tasks (MST) file. MST lists the maintenance activities that are required by individual assets and the interval at which they should be conducted. It is the basis for the batch process that issues periodic inspection (PI) and periodic maintenance (PM) WOs according to defined activity intervals. Tasks are either scheduled or deferred; the inspections and/or maintenance activities are performed, reported and closed out; condition-based maintenance (CBM) WOs are raised based on the findings from PIs or PMs. As CBM WOs do not have an activity interval, they receive a priority status (dependent on the type of issue) that is assigned in the Work and Outage Requests Tracking System (WORTS) by asset engineers. This priority status is then matched with a certain urgency (related to the maintenance tasks) and/or criticality (related to the importance of the asset).

There are two ways to trigger follow-up CBM WOs based on visual inspection findings or asset health data. One is an automatic process in which the inspection data is entered into a script linked to the work management system (WMS) which automatically generates these CBM WOs. The other process is through engineering asset health assessments throughout the year. This is an involved process that results in manual CBM WO creation. Finally, there is an annual EoL assessment process that supports asset replacement planning.

Task 1: NGET asset management policy benchmarking

DNV's benchmarking of NGET asset maintenance and inspection policies against international guidelines and GUP found the following:

- 6.7% of activities exceed benchmark intervals (i.e. activities are completed at shorter intervals than guidelines suggest),
- 65.3% of activities align fully with benchmark intervals,
- 26.9% of activities align partially with benchmark intervals, meaning that although the intervals for these activities as stated within NGET's policies do not fully align, DNV considers them to be within a reasonable level of tolerance,
- 1.1% of activities are not aligned with benchmark intervals (i.e. activities are completed at longer intervals than guidelines suggest, and outside of what DNV would consider a reasonable level of tolerance).

Thus, DNV concludes that NGET policies are broadly aligned with good industry practice and guidelines. Although there are examples of NGET completing activities more and less frequently than guidelines suggest, DNV is cognisant that variations from these guidelines is to be expected. Utilities adapt intervals and activities based on a balance between equipment criticality, asset condition, past performance versus objectives, as well as constraints including financial and human resources. As such, this exercise is useful to consider practices at a high-level across the asset portfolio and not for a like-for-like comparison between individual assets. Review of the underlying reasons for variations, objectives and constraints, is not part of this gap analysis.

Many maintenance policy activities, such as oil analysis, comprise a combination of time-based and condition-based tasks according to previous oil analysis results (or other condition indicators). Whilst DNV encourages condition-based intervals, establishing these intervals requires a rigorous process, which has been investigated in Task 2.

Task 2: NGET asset management process and data management assessment

DNV completed three sub-tasks to understand whether NGET's data and data management processes support an effective asset management routine as laid out in NGET policy:

1. An assessment of WO and asset data management processes to understand whether data is accurately recorded and managed,
2. An assessment of WO data to understand whether WOs are being created and completed in conformance with NGET policies,
3. An assessment of NGET end-of-life (EoL) scoring to understand whether scores are correctly assigned, the input data is accurate, and the resulting interventions are appropriate.

For the purposes of this assessment, DNV has assessed activity interval compliance for WOs across different categories defined by NGET which are summarised below:

- '**Routine maintenance**' **–** a wide range of inspection and maintenance activities which are scheduled at regular intervals.
    - '**Basic', 'intermediate' and 'major' maintenance** – a subset of the 'routine maintenance' category. They are the routine activities scheduled on assets and cover the physical maintenance and intrusive inspection activities required on assets. The requirements are often set by OEMs.[1]
- **Statutory inspections** – the written scheme of examinations (WSE) required on assets by law.

[1] 'Major' maintenance often covers a wide range of activities covered under WOs (e.g. 'basic' and 'intermediate' activities) and therefore the completion of 'major' maintenance can remove the need for other WOs.

- **Non-statutory inspections** – non-intrusive inspection activities that are not required by law.
- **Oil sampling** – the sampling of oil from bushings and main tanks.

In addition to these categories, DNV has conducted some analysis using very high-level terms which incorporate the above, to provide a high-level overview:

- **Periodic inspection (PI) –** all scheduled **/** routine inspection activities,
- **Periodic maintenance (PM) –** all **scheduled / routine maintenance activities, and**
- **Condition-based maintenance (CBM)** – all activities (inspections or maintenance) conducted on an asset as a result of the observed condition of an asset following PI or PM WOs.

Assessment of WO and asset data management processes

NGET's asset management process is data intensive. The process for managing WOs is partly automated and partly manual. Examples of such manual processes include the registering of visual inspection script results and the raising of CBM WOs based on asset health data. This introduces a degree of potential risk related to human error in manual processes, especially where engineering judgement is applied.' However, from a review of the assets with the highest risk health indicators, DNV has not identified any instances where interventions were missed because of human error in manual processes. Where DNV did identify potential defects with assets, NGET was able to demonstrate an appropriate asset management response had been undertaken.

DNV finds, with 95% confidence, that the accuracy of NGET's asset data collection for quantified visual inspection metrics exceeds 93%. The data collection for qualitative metrics was less accurate due to a desire to avoid unnecessary duplicate WOs. DNV considers this is an area of improvement but also considers the risk of adverse impacts from this issue to be low. DNV considers some deferral of activity is generally reasonable and sometimes unavoidable for a range of reasons (e.g. practical, operational, resourcing). For each individual utility the incidence of deferrals will be highly specific and different. DNV does not have more detailed data to compare NGET's deferral policy with that of other utilities.

In DNV's experience, NGET's data quality and speed of delivery for this engagement was very good for assignments of this type. Because of this and other factors observed during the audits, DNV considers NGET's management of asset data (from the point of data collection onwards) to be of a good standard.

Assessment of WO data

DNV's WO analysis showed that the volume of WOs raised is consistent with NGET policies. Additionally, there is a large number of CBM WOs, which is a good indicator that NGET proactively inspects and maintains its assets.

With exception of routine maintenance and bushing oil sampling, the compliance rates for these WOs (measured by whether WO closed dates are within defined intervals) exceed 90% (Table 0-1). However, there are some examples where conformance rates are lower, indicating that WOs are completed later than defined activity intervals require. WO activity interval compliance is 99.8% for basic, intermediate, major maintenance, 93.8% for transformer main tank oil sampling. WO activity interval compliance is 77.4% for routine maintenance and inspection and 72.8% for transformer bushing oil sampling. DNV notes that lower compliance rates for bushing oil samples, compared to main tank oil samples, are to be expected given that bushing oil samples require outages to be taken. DNV notes that 96.3% of statutory inspection activities are completed within defined intervals. Statutory inspections cover the Written Scheme of Examinations (WSE) for pressure systems in compliance with Pressure System Safety Regulations (PSSR). Statutory inspections and oil sampling are independent of 'routine'

maintenance, while 'basic', 'intermediate' and 'major' maintenance are a subset of 'routine' maintenance activities.

Table 0-1 summary of WO compliance figures for different activities

Maintenance Type	Count of WOs with Activity Interval Met	Count of WOs with Activity Interval Not Met	Activity Interval Compliance (%)
Basic, Intermediate and Major Maintenance	592	1	**99.8**
Routine Maintenance	1595	466	**77.4**
Transformer Main Tank Oil Sampling	2916	192	**93.8**
Bushing Oil Sampling	67	25	**72.8**
Statutory Inspections	597	22	**96.3**

Plant status and maintenance performance are tracked continuously. The maintenance performance dashboard (Tableau) tracks maintenance compliance by asset type. There is an opportunity to explicitly track PI, CBM and Oil-Sampling and WOs 'Not Done.' Plant status tickets are raised for assets which require specialist support or interventions (e.g. repairs or replacement) above a £10,000 threshold.

Of all required WOs, 10.8% are deferred. Therefore, NGET complies with its internal policy of not allowing more than 15% of all inspection and maintenance activities to be deferred. Included in the deferred WOs, ca. 8% of WOs are deferred because of outage (system access) constraints. A further 11.1% of WOs are not done because they are duplicated WOs or are superseded by other WOs. These are not considered to be deferred WOs as they are not required. The figures presented in this paragraph are not included in the analysis of activity interval conformance rates summarised above and should be considered separately, given that they assess different points. It is not possible for DNV to comment on the length of time that it takes to complete 'Not Done' WOs that are replanned, based on the data available. DNV understands that NGET has a process for managing deferred work orders and that NGET's overall compliance figures track activity completion, taking deferrals into account. However, DNV has not independently validated these processes and figures as part of this audit.

Compliance rates for CBM activities cannot be tracked as there are no required-by dates or defined activity intervals for CBM WOs. Therefore, DNV cannot assess whether they are completed according to policy. Introducing CBM required-by dates / activity intervals would help NGET conform to best practice across the industry, but DNV notes that NGET is not an outlier in not having such intervals defined.

Assessment of NGET EoL scoring

Finally, DNV finds that NGET's calculation of EI modifiers is in line with NGET policies and the data used in these calculations is accurate and corresponds to the data held in NGET's asset management systems. DNV's top-down assessment shows that the approach for calculating EoL scores for wound plant is more subjective than that used for calculating circuit breaker EoL scores. This is reflected in the fact that the EoL scores for wound plant are not fully tabulated in a Microsoft Excel spreadsheet, whereas it is tabulated in a spreadsheet for circuit breakers. The dielectric scores (DS) and thermal scores (TS) for wound plant are not automatically calculated

from underlying data. Instead, they are assigned by engineers based on the guidance provided in NGET's documented methodology (TGN(E) 306) for assigning EoL scores to wound plant, approved by Ofgem. Across both plant types, the EoL scores assigned by NGET align with scores calculated by DNV with one exception within the circuit breakers. In this instance, by exception, an EoL score was assigned to a circuit breaker due to a known issue for the Asset Family, resulting in a value exceeding the limit allowed in NGET's policy. DNV has confirmed with NGET that the use of this EoL score, by exception, was reviewed and approved by NGET's internal governance procedures.

Task 3: Site inspections

DNV has conducted visual inspections across 20 selected substations to obtain an independent view of visual asset condition and to compare this against NGET's recorded data and asset management practices. DNV finds that site conditions broadly align with NGET's asset management records (as reported above), and that issues observed by DNV have been consistently met with appropriate asset interventions by NGET.

Across the inspected substations, DNV observed good compliance with essential operational practices, including well-documented oil top-up histories, clear evidence of ongoing maintenance activity, and awareness among site teams of asset issues. In general, sites were well-kept and demonstrated good stewardship, with staff showing ownership of local asset condition and maintenance actions. NGET's recent introduction of an at least five-yearly visual inspection process provides a structured approach for capturing non-quantified condition information.

However, the inspections also revealed some areas for future improvement. At some sites, DNV observed corrosion, paintwork degradation and dirt / oil build-up on transformer tanks, radiator pipework and bunded areas. While these issues do not always constitute immediate defects or asset health issues, they can hinder leak detection, complicate maintenance activities and introduce safety risks and, in extreme cases, lead to the need for replacement of assets or parts of assets. DNV finds that oil leaks are recorded and actioned (where they potentially impact asset safety or functionality), but that the process that is followed leaves room for human error.

DNV's review found instances where visible corrosion did not have corresponding WOs or plant status flags, or had deteriorated to such an extent that the replacement of parts was required. This indicates inconsistent recording and follow-up of paintwork and corrosion issues across sites. This issue should now be addressed by the introduction of NGET's five-yearly visual inspection and recording regime.

DNV also noted that at a number of sites the auxiliary systems such as marshalling kiosks and low-power supply housings showed visible deterioration. Whilst NGET's new visual inspection process should improve the long-term capture of this information, DNV observed cases where corrosion on auxiliary systems lacked corresponding WOs. However, DNV does note that these assets are inspected every three months providing a frequent opportunity for NGET to identify issues and raise defects, should they be required.

Conclusion

Based on the outcomes of our assessment, in relation to the specific objectives of this audit, DNV finds that in general:

1. NGET's maintenance policies and procedures align with good industry practice and internationally recognised guidelines, with the exception of condition-based maintenance (CBM) WOs not having defined intervals or required-by dates.
2. The assets at the sites chosen for this audit are being monitored, maintained and managed in line with relevant NGET policies and procedures across the portfolio of assets. There are some exceptions for specific activities, but compliance figures are tracked at a portfolio level. At this level NGET complies with its policy.

3. The monitoring, maintenance and any other relevant interventions carried out by NGET on these assets are being accurately recorded in NGET's asset management systems.
4. NGET's calculation of end-of-life scores is accurate according to defined methodologies and is supported by accurate input data.

However, there are also areas where NGET could improve its practices in relation to the above for example through the automation of CBM WO creation, consolidation of policy documents, and providing clear and unambiguous thresholds for CBM WOs including their 'required-by' dates. DNV recognises the importance of engineering judgement alongside good policy but considers policy should be leading.

DNV has observed a general tendency for prudent capital requests stemming from a desire to minimise interruption of the core functionalities of substation lead equipment by minimising repairs and bundling where appropriate. Additionally, DNV notes that ca. 8% of WOs are deferred due to system access constraints, which is a factor largely beyond NGET's control. These factors may adversely impact asset maintenance and pose risk as asset condition can impact asset health, increasing capital requests over the long term. Noting these areas of improvement, throughout this audit, DNV has not identified any instances where interventions were missed because of human error in manual processes, from a review of the assets with the highest risk health indicators.

Overall, from this audit DNV finds that NGET adheres to good asset-condition, health-data management and general asset management practices.