Final DD Report

RP7 Price Control Engineering Support & Asset Management Advice

Utility Regulator for Northern Ireland

23 October 2023

→ **The Power of Commitment**

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Executive Summary

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.2 and the assumptions and qualifications contained throughout the Report.

GHD has been appointed by the Utility Regulator (UR) for Northern Ireland to provide Engineering Support and Asset Management advice in their determination for the expenditure allowance for the electricity network operator - Northern Ireland Electricity Networks (NIE Networks) – for the period April 2025 to March 2031 (termed the RP7 period).

The support provided by GHD covers non-load related capital expenditure under five work packages (WPs), which form part of NIE Networks' overall capex expenditure submission covering the RP7 period. Specifically, the scope of GHD's engineering support covers the following:

– WP1: Distribution Plant & Protection;
– WP2: Supervisory Control & Data Acquisition (SCADA) and Operational Telecommunications Network (OTN);
– WP3: Transmission Plant & Protection;
– WP4: Transmission Overhead Lines (OHL); and
– WP5: Transmission Underground Cables.

As part of our work, the GHD team carried out a detailed and critical analysis of NIE Networks' RP7 capex plan relating to the above five WPs, including review of additional documentation provided by NIE Networks during the analysis stage of the project. We have used our technical engineering and asset management experience to review, analyse and challenge the non-load related capital expenditure proposals.

Throughout our review and analysis we have taken due cognisance of the need to ensure that our recommended capex allowances and volumes for RP7 period represent the most efficient use of expenditure and best value for money for the customer.

The approach to the review of the capital expenditure proposals consisted of a number of strands. The first consisted of detailed review of the 46 Engineering Justification Papers (EJPs) provided by NIE Networks for RP7. This review showed that the EJPs provided some useful background to NIE Networks' RP6 strategy and presented a high-level description of the investment drivers and proposed investment (both costs and volumes) for the RP7 period. However, the EJPs generally lacked sufficient detail to support NIE Networks' proposed RP7 investment plan, with little analysis of the options considered, condition assessments undertaken and justification of the proposed costs. A query log process was used to request more information from NIE Networks, as well as several follow-up engagement sessions to clarify the information received.

Further to the review of EJPs, the GHD team undertook analysis to:

– Compare RP6 and RP7 run rates (volume analysis on an annualised basis) where appropriate to do so;
– Compare RP6 and RP7 unit costs;
– Review NIE Networks' condition assessment modelling outputs provided separately; and
– Review Cost Benefit Analysis information provided separately.

For the expenditure categories subject to this review, NIE Networks proposed a substantial increase in expenditure in RP7 compared with the RP6 outturn (increase of 63% from £132.1m to £215.3m). This corresponds to a higher percentage increase of 104% on an annual basis, given that the duration of RP7 has reduced to 6 years compared with 7.5 years for RP6.

Approximately £155m of the proposed expenditure is to manage risks relating to the transmission and distribution substation assets (WP1 & WP3) with a further £42m proposed to manage the transmission OHL and cable assets. The remaining capex (approximately £19m) relates to planned investments in the SCADA and OTN assets.

Following our review we recommend reductions to the proposed RP7 capex proposals based on the following:

– Insufficient justification for the proposed work or for the proposed volumes included within the RP7 scope. Where this has been the case, we have reduced the volume allowance and hence associated cost. In a small number of cases, we disallowed all costs for a specific sub-programme category.
– A number of NIE Networks' proposed RP7 unit cost increases relative to RP6 unit costs were not allowed as the price increases either included impact of real price effects that UR determine elsewhere within the price control, or included other uplifts that we did not agree with; and
– RP7 project cost information not provided at a suitable level of detail, thus preventing us from confirming efficiency of proposed costs.

Therefore, GHD's recommended allowances are shown in the table below:

	Programme ID	RP6+Ext. Capex £k	NIE Networks Requested RP7 Capex £k	GHD Recommended Capex £k	Variance to NIE Networks Requested	
					£k	%
WP1	Distribution (Primary & Secondary) Substation Plant	86,169	104,995	90,687	-14,308	-13.6%
WP2	SCADA & Operational Telecomms	4,173	18,759	17,882	-878	-4.7%
WP3	Transmission Plant	27,071	49,960	45,862	-4,098	-8.2%
WP4	Transmission OHL	14,210	36,901	33,800	-3,101	-8.4%
WP5	Transmission Underground Cables	514	4,702	3,714	-988	-21.0%
	TOTAL	**132,135**	**215,317**	**191,944**	**-23,373**	**-10.9%**

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1. Introduction

GHD has been appointed by Utility Regulator (UR) for Northern Ireland to provide Engineering Support and Asset Management advice in their determination for the expenditure allowance for the electricity network operator (Northern Ireland Electricity Networks (NIE Networks) in the period April 2025 to March 2031 (termed RP7 period) The support provided by GHD covers five specific work packages which form part of NIE Networks' overall capex expenditure submission covering the RP7 period.

Specifically, the scope of GHD's engineering support covers the following work packages (WP):

– WP1: Distribution Plant & Protection;
– WP2: Supervisory Control & Data Acquisition (SCADA) and Operational Telecommunications Network (OTN);
– WP3: Transmission Plant & Protection;
– WP4: Transmission Overhead Lines (OHL); and
– WP5: Transmission Underground Cables.

Our role includes the requirement to carry out a detailed and critical analysis of NIE Networks' RP7 capex plan relating to the above five WPs, including review of additional documentation provided by NIE Networks during the analysis stage of the project.

We have used our technical engineering and asset management experience to review, analyse and challenge the non-load related capital expenditure. Throughout our review and analysis we have taken due cognisance of the need to ensure that our recommended capex allowances and volumes for RP7 period represent the most efficient use of expenditure and best value for money for the customer.

1.1 Purpose of this report

This report has been prepared by GHD following the completion of our analysis of the NIE Networks RP7 business plan capex requirements relating to the five specific WPs itemised above. This draft report is intended to provide the following:

– A detailed description of the processes and techniques used to analyse and challenge the business plan submissions.
– A listing of the engagement sessions held with NIE Networks
– The outcome of the engagement sessions.
– For each of the five areas under review, a listing of:
    – the requested allowances and volumes.
    – the recommended allowance and volumes.
    – the reasons for any recommended changes; and
    – where it is the case, the reasons why no changes are recommended.

1.2 Scope and limitations

This report has been prepared by GHD for Utility Regulator for Northern Ireland and may only be used and relied on by Utility Regulator for Northern Ireland for the purpose agreed between GHD and Utility Regulator for Northern Ireland.

GHD otherwise disclaims responsibility to any person other than Utility Regulator for Northern Ireland arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.3 Assumptions

GHD has prepared this report on the basis of information provided by NIE Networks and UR, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. GHD assessment summary

Within this section of the report, we provide an explanation of the approach that we have used in undertaking our analysis of NIE Networks' capex submission for the RP7 period. We have used a multi-stranded approach to assess the capex submission for each of the five specific WPs. The following sub-sections provide an overview of the processes and techniques used.

The application of each approach is described in more detail within the report sections specific to each WP:

2.1 Assessment approaches

2.1.1 Detailed review of RP7 Engineering Justification Papers

Via UR, NIE Networks provided a suite of Engineering Justification Papers (EJPs) covering each of the five specific WPs within the scope of GHD review. Each EJP is structured in a consistent format, setting out the Investment drivers and strategy for RP7, options considered and NIE Networks' proposed capex and associated volumes for RP7.

During our analysis, we have reviewed a total of 46 EJPs.

Generally, we found the EJP's provided some useful background to NIE Networks' RP6 strategy and presented a high-level description of the investment drivers and proposed investment (both costs and volumes) for the RP7 period. However, the EJPS' lacked sufficient detail to support NIE Networks' proposed RP7 investment plan, with little analysis of options considered; we therefore sought additional clarification through the Q&A (query log) process and targeted engagement sessions.

The following points represent the key elements where the EJPs lacked detail and so clarification and / or supplementary information was requested, which is discussed in the following sub-sections relating to each WP:

– Whilst references were made to condition assessed based ranking of equipment, no evidence was provided to support the condition assessment scoring or equipment ranking that underpinned requested volumes.
– Whilst in some cases, options were identified, there was no quantified risk and cost comparison between options.
– Limited breakdown of or justification of proposed costs.
– Any commentary on assessment of options was superficial, without substantiation. In some cases it appeared as though cutting and pasting between EJPs had been extensively utilised.
– In many cases too few options have been considered and obvious options not included in some.
– Limited details regarding the basis of the proposed works were provided in most cases.

The combination of EJP sub-categories, sometimes across and sometimes which address significantly different work packages based on different source data and justifications, resulted in broad categorisations within EJP. This inevitably results in EJPs which are not as robust as could be envisaged with a more structured approach to the presentation of EJPs.

Following queries by GHD, enhanced details regarding the condition assessment process, supporting documentation and records were provided to evidence the justifications, and some expanded information was provided however, NIE Networks has not presented evidence of a robust investment appraisal of options.

For the purposes of this review a lack of robust investment appraisal has been applied in some cases as the justification to modify the allowance when there is a reasonable probability that the deficiency has materially impacted the investment proposal for the sub-programme. However, the lack of robust investment appraisal and optioneering processes has been a serious impediment to assessing the EJPs.

It should also be noted that whilst a less than robust investment appraisal of options can result in disallowances to proposed costs and volumes, it is also equally possible that the need for additional cost and volume allowances has not been identified.

2.1.2 Comparison of RP6 v RP7 run rates (volume analysis on an annualised basis)

The majority of RP7 work programmes within the scope of GHD review, relate to a continuation of existing asset replacement / refurbishment programmes from RP6 and in some cases, earlier review periods. For each asset category, we have included an assessment of the historic rates of replacement / refurbishment (termed "run-rate") v proposed RP7 forecast rates of replacement / refurbishment.

Given the relatively long-life expectancy of most asset categories, the change in run-rate between subsequent review periods would typically be relatively small, unless driven by a significant change in asset condition or the company's approach to managing asset risk.

Where appropriate, a run-rate comparison is presented in the following sections to indicate the average annual outturn volume in RP6 and the average annual volume requested by NIE Networks for RP7. It should be noted that the analysis presented considers the RP6 period including the extension year, i.e. a period of 7.5 years, compared with the annual average for the 6-year RP7 period.

Table 1 indicates the durations of the regulatory periods applicable to NIE Networks.

Table 1 Regulatory periods

Period	Dates	Duration (years)
RP5	2012/13 to 2016/17 plus 2017/18 (half year)	5.5
RP6	2017/18 (half year) plus 2018/2019 to 2023/24	6.5
RP6 Ext	2024/25	1
RP7	2025/26 to 2030/31	6

2.1.3 Unit cost comparison (RP6 v RP7)

NIE Networks' proposed costs for RP7 period have been compared on a unitised basis with their outturn costs over the RP6 period. This is a useful comparison as it allows for assessment at a detailed sub-programme level, consistent with the structure of NIE Networks investment programmes and consistent within its reporting within the "Network Investment Reporting template".

Given that the costs are all reported in 2021/22 prices, are not subject to inflation and excluding any impact of Real Price Effects (RPEs), then any significant difference between proposed unit costs has been studied to determine the main drivers for such difference and if such a driver is considered reasonable and efficient. For example, a change in technical specification of ground mounted transformers to comply with EU legislation may be a justifiable explanation for an increase in unit costs for distribution transformers.

In relation to independent unit cost benchmarking, we note that NIE Networks commissioned a benchmarking study by NERA. Within the NERA report[1], they explained their approach in using NIE Networks' outturn RIGs data for 2012/13-2021/22, and DPCR5 data for British DNOs (i.e. 2011-2015) from Ofgem's RIIO-ED1 benchmarking database. British DNOs' costs and volumes data for years beyond 2016 were not available at the required level of granularity. We also note that NERA explained that "…*In order to ensure a like-for-like comparison with British DNOs we assessed NIE Networks' capex unit cost efficiency compared to the British DNOs only for those line items for which NIE Networks reported both cost and volume data over the three-year period. As a result, we only compare NIE Networks' historic capex unit costs against British DNOs in certain non-load related cost categories: asset replacement, refurbishment, legal and safety, environmental reporting and operational IT&T expenditures*[2]*…".*

[1] BE A03 NERA Comparative Benchmarking to Support the RP7 Plan.pdf
[2] NERA Report - Section 3.2.4

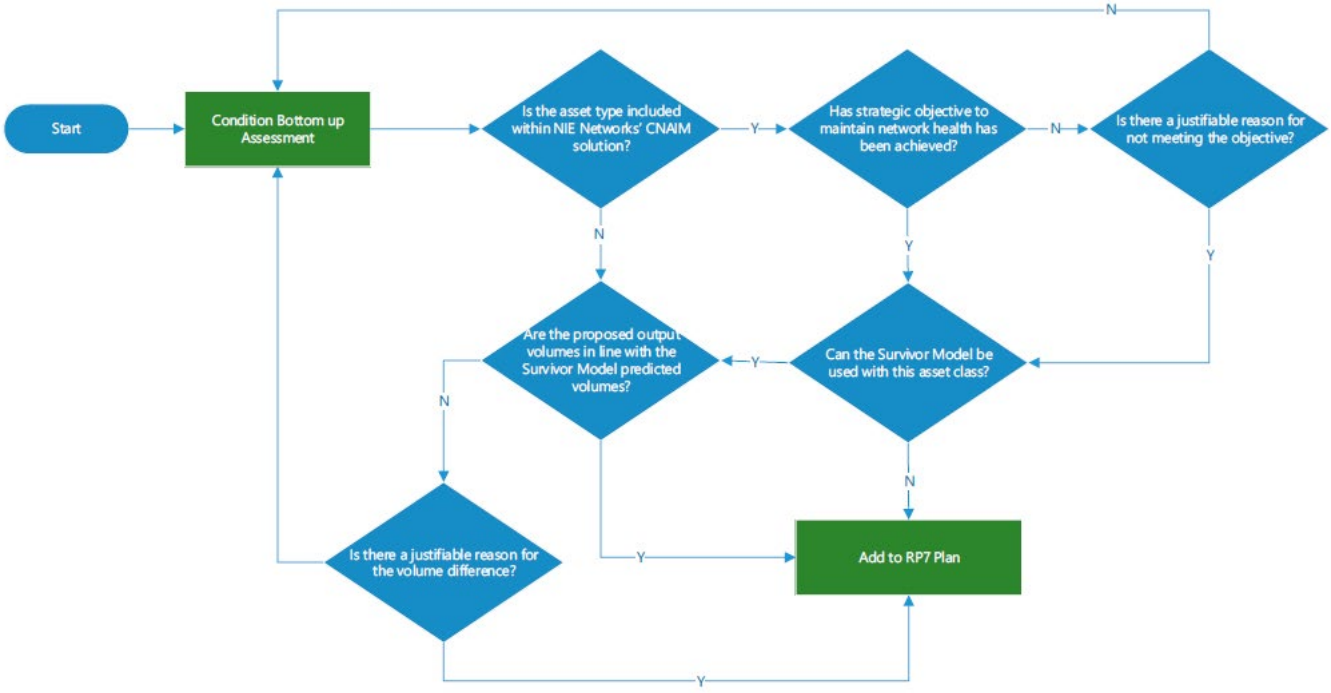
Given the limited range of suitable asset categories to be included within the benchmarking study, our focus on the cost assessment within the following sections is based on assessment of RP6 outturn unit costs benchmarked against the RP7 unit costs at a sub-programme level.

2.1.4 Detailed analysis of NIE Networks' condition assessment modelling outputs

Within the NIE Networks Business Plan, Section 7 provides details of NIE Networks' condition-based modelling approach which applies to all programmes which fall under their condition-based investment strategy.

Figure 37 of the Business Plan (Page 126) summarised the NIE Networks triangulated approach - presented in Figure 1 below:

Figure 1 NIE Networks: condition driven investment process chart



In most cases, NIE Networks has used its own condition-based models as the main driver for justifying its RP7 investment plans. Where possible, NIE Networks has benchmarked its identified RP7 volumes relative to both the Common Network Asset Indices Methodology (CNAIM) and the Survivor Age Based Replacement modelling and assessment.

The EJP's relating to each of the asset categories presents the output volumes from the three modelling approaches (where such modelling is possible), provides high level commentary on the comparable volumes and any observed differences. However, in general the EJPs provided insufficient detail to support judgements about what the model outputs are claimed to show and how resultant conclusions have been reached. As such, the detailed condition assessment models were requested for each expenditure category, which have been assessed and details presented in the relevant sections for each WP.

For each asset category, the modelled files contained a full schedule of assets by location and scoring against a range of asset condition and location factors. Our analysis of the scoring criteria and ranking / prioritisation methodology was necessary to determine the reasonableness of NIE Networks' proposed RP7 volumes.

2.1.5 Review of Cost Benefit Analysis information provided

The EJPs submitted by NIE Networks include details of the recommended approach for each expenditure category, including the options explored. On inspection, the range of options considered and details presented for

the quantitative evaluation options was found to be limited. As such, further details were requested in support of the optioneering and Cost Benefit Analysis (CBA).

The CBA spreadsheets provided make use of the Ofgem 'RIIO-ED2 Cost Benefit Analysis template', which includes calculation of the depreciation on the capitalised portion of the investment and the cost of capital associated with the investment to be expensed, based on the fixed assumptions indicated in Table 2 below.

Table 2 Ofgem CBA template – fixed assumptions

Parameter	Assumed value	Comments
Assumed asset life	45 years	-
Pre-tax WACC	5%	Spreadsheet instructions state 'enter DNO specific pre-tax WACC figure'.
Discount rate	3.5% (up to and including 30 years) 3.0% (beyond 30 years)	Fixed in spreadsheet based on 'HMRC Green Book (see Discount Factors spreadsheet 'Standard Discount Factors' tab)'
Capitalisation rate	85%	Spreadsheet instructions state 'DNOs should add their own capitalisation rate assumptions in line with Business Plans where necessary. We have set a capitalisation rate of 85% as a default assumption'.

The spreadsheet template allows for a range of options to be considered, including application of benefits in the form of 'Avoided DNO costs' and/or 'Societal benefits, i.e. costs avoided'. However, this functionality does not appear to have been used by NIE Networks and, as such, the CBA template merely presents the different costs associated with the limited options considered. The lack of detail presented on the benefits means that the justification for the choice of option in each case is limited, with no understanding of the impact of the selection compared with the alternatives (e.g. quantitative assessment of the impact of increased operating costs associated with options with lower up-front investment costs, and vice versa).

2.1.6 Use of Query Log

Throughout the analysis stage, GHD sought clarifications from NIE Networks by use of the UR query log, populated by GHD team and submitted to NIE Networks for their response. In total, GHD submitted a total of 220 queries via the query log to NIE Networks, who duly provided responses to all queries raised.

2.2 Outcomes from engagement sessions

Throughout the analysis stage, GHD held a series of engagement sessions with representatives from NIE Networks, with UR also attending each session. The engagement sessions held, together with a summary of the main outcomes, are summarised in Table 3 below.

Table 3 Summary of engagement sessions with NIE Networks

No.	Date	Location	Scope of Engagement Session	Summary of outcomes
1	6th July 2023	Virtual (Zoom) Conference	WP1 & WP3: – Transmission & Distribution Plant Condition Assessment relating to Renewals for RP7; – Drivers for Unit Cost increases in RP7 relative to RP6.	NIE Networks demonstrated on-screen an example of condition assessment model for 11kV (&6.6kV0 switchboards used to determine their proposed RP7 replacement volumes. Following the session, NIE Networks agreed to provide detailed condition assessment models for a selection of asset sub-programmes. These were provided and enabled GHD to carry out a detailed technical review of the condition-related information included within the provided files. In relation to the proposed unit costs used in the development of the RP7 forecast, NIE Networks presented detailed cost build analysis that demonstrated their methodology and assumptions used in applying various cost drivers applied to their RP6 outturn costs.
2	8th August 2023	Virtual (Zoom) Conference	WP4: Transmission OHL Review the outputs of the inspection regime and understand how this data is managed and compiled including review: The source inspection records including: – Foot patrols – Helicopter patrols – Outage and non-outage visual climbing inspections – Cyberhawk drone assessments – LiDAR surveys – Conductor sampling (summary of results noted in UR-0080 - 110kV Overhead Lines - Conductor Replacement.pdf) Systems and spreadsheets compiling the data e.g. Cyberhawk SS URQ78 Spreadsheet – Review the assessment process – Spreadsheets and systems which compare, manipulate, categorise etc. the inspection outcomes – Documentation of the assessment process and investment decisions not already provided	NIE Networks provided detailed on-screen examples of the inspection data captured through different processes in place. Following the session, NIE Networks agreed to provide detailed inspection data for a range of line inspection methodologies. These included: – LIDAR - 110 kV and 275 kV results spreadsheets. With adjustments based on detailed review and associated comments. – Cyberhawk - Excel extracts for results for all 110 kV and 275 kV circuits (110kV to be checked that previously provided is correct). – Summary spreadsheet compiling the Cyberhawk results and circuit % values used in the EJP. – Maximo - Source / s and derivation of the 75 towers inaccessible due to vegetation referenced in EJP 2.302 section 4.5. – Conductor Samples - 110 kV and 275 kV sample reports. – Tower Painting - Benchmarking carried out for RP6 for reduction to 15 year cycle (recognise this may be difficult to find). – Painting spreadsheet (with individual circuit tabs and summary page identifying circuits proposed)

No.	Date	Location	Scope of Engagement Session	Summary of outcomes
				– Foundations - 110 kV foundation assessment results (Summary spreadsheet if possible / available) and details of the source / derivation of the 5% expected repairs rate. The information was used by GHD to inform our recommended capex allowances for RP7.
3	14th August 2023	Virtual (Zoom) Conference	WP2: SCADA & OTN SCADA Network Manager and RTU Replacements – RTU Sizing / Specification; – Upgrade of Network Manager Hardware / Software – Battery replacement at Primary Substations – RP7 costs / volumes / assumptions Operational Telecoms Network Development & Replacement – Clarification of scope of works – RP7 costs & volumes DSO Operational Telecoms Network Transition – Clarification on scope and future proofing – RP7 costs & volumes	NIE Networks presented some slides that were prepared in response to the discussion points circulated prior to the meeting. By way of overview, a diagram showing the 'EJP dependencies' was presented, which illustrates 3 proposed reopener mechanisms to account for uncertainties: – SONI asset transfer (EJP 4.103): – DSO Operational Telecoms (2 stages) – 1) DSO requirements; 2) detailed design. – OTN Comms conditional investment, reflecting the dependence on the decision/approval for use of private LTE network. Detailed clarifications were provided to points raised by GHD ahead of meeting. Additional information was agreed and NIE Networks provided this after the event. The information was used by GHD to inform our recommended capex allowances relating to WP2 for RP7.

3. Review of RP7 capex requirements - Introduction

Within Table 4 below, we summarise NIE Networks' requested RP7 capex for each of the WPs within the scope of GHD's review. For comparison purposes, the table also presents the RP6[3][4] capex for each WP.

Table 4 NIE Networks' Requested RP7 Capex Summary

	Programme ID	RP6+Ext. Capex £k	RP7 Capex £k
WP1	Distribution (Primary & Secondary) Substation Plant	86,169	104,995
WP2	SCADA & Operational Telecomms	4,173	18,759
WP3	Transmission Plant	27,071	49,960
WP4	Transmission OHL	14,210	36,901
WP5	Transmission Underground Cables	514	4,702
	TOTAL	**132,135**	**215,317**

Clearly, NIE Networks is proposing a significant increase in RP7 capex compared to RP6 period. Major increases are proposed in all WP categories. Approximately £155m is proposed to manage risks relating to the transmission and distribution substation assets (WP1 & WP3) with a further £42m proposed to manage the transmission OHL and cable assets. The remaining capex (approximately £19m) relates to planned investments in the SCADA and OTN assets.

An overall increase of £83m is proposed across RP periods; accounting for the longer RP6 period (relative to RP7), then the annualised capex in RP7 is approximately double the outturn for RP6 period (£36m v £18m).

Given these significant increases across all WPs, we have undertaken a thorough and detailed assessment of NIE Networks' investment plans and the findings, conclusions and recommendations following our assessment are presented for each WP in the following sections.

[3] Within this document – unless stated otherwise, the reference to RP6 period covers the full 7.5 year period of the original RP 6 period of 6.5 years plus the one year extension to RP6

[4] RP6 capex includes outturn data to end March 2023 and forecast data to end March 2025

4. Review of RP7 capex requirements - WP1: Distribution plant – Primary plant

This section presents details of our analysis of the expenditure proposals for primary distribution plant, comprising 33kV switchgear, primary substation switchgear at 11 and 6.6kV, other investment associated with primary substations and 33/11kV or 33/6.6kV transformers.

4.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 5 for each of the sub-work programmes included within D13 and D14 programmes. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

4.1.1 RP7 Costs and volumes

Table 5 Distribution Primary plant - NIE Networks investment proposal for RP7

Sub-programme ID[5]	EJP ref	RP6. allowance		RP6 outturn[6]		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
D13 - Primary Plant (sub-total)		**33,719**	**924**	**33,387**	**916**	**29,903**	**1,196**
D13a - Replace indoor switchgear (33kV)	EJP 1.301	6,646	51	8,875	66	3,745	24
D13b - Replace outdoor switchgear - circuit breaker (33kV)	EJP 1.302	3,211	64	4,521	75	4,553	67
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	EJP 1.303	5,219	53	2,368	24	1,925	11
D13d - Replace outdoor switchgear - mesh equipment (33kV)	EJP 1.302	910	7	1,175	10	715	5.5
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	EJP 1.304	10,201	214	7,272	187	3,422	55
D13i - Civil works to primary substations	EJP 1.806	2,236	40	3,038	26	3,323	-
D13j - Primary substation lease renewal	EJP 1.807	1,184	-	383	-	4,301	-
D13K - Replace primary switchgear (11kV & 6.6kV) retro-fit	EJP 1.304	2,023	85	3,657	151	2,159	93
D13L - Refurbish primary S/S DC system	EJP 1.307	977	76	1,010	72	597	44
D13M - Rewire primary S/S (inc. AC services panel)	EJP 1.307	718	38	645	34	822	45
D13N - Plant painting (primary)	EJP 1.306	161	65	228	70	497	150
D13O - Replace earth fault indicator	EJP 1.305	235	231	215	201	565	559
D13r - 11kV Reyrolle Hadrian SMW Refurbishment	EJP 1.304	-	-	-	-	431	22

[5] Sub-programme IDs are defined by NIE Networks internally and are part of their work programme structure and relate to the main programme ID

[6] RP6 outturn costs and volumes include actual values up to end of March 2023, and forecast values for the remainder of the RP6period

Sub-programme ID[5]	EJP ref	RP6. allowance		RP6 outturn[6]		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
D13s - YMV2 Reyrolle Refurbishment	EJP 1.304	-	-	-	-	2,348	120
D13u - Asbestos Management	EJP 1.806	-	-	-	-	250	-
D13v - Primary physical security	EJP 1.805	-	-	-	-	250	-
D14 - Primary Transformers (sub-total)		**6,481**	**58**	**7,644**	**55**	**16,088**	**458**
D14b - Replace 33/11kV Transformer (up to 12.5MVA)	EJP 1.306	471	2	810	2	729	2
D14c - Replace 33/11kV or 33/6.6kV Transformer (up to 18.75MVA)	EJP 1.306	5,465	20	6,465	17	10,989	30
D14G - Transformer refurbishment	EJP 1.306	494	6	303	6	413	12
D14h - Cooler controls replacement	EJP 1.306	-	-	-	-	25	12
D14i - Sump Pumps	EJP 1.306	-	-	-	-	1,148	184
D14j - Transformer Noise Enclosures	EJP 1.308	-	-	-	-	1,679	8
D14k - Noise Surveys	EJP 1.308	51	30	66	30	365	170
D14l - 33/11kV Tx Oil Regeneration	EJP 1.306	-	-	-	-	740	40
Total		**40,201**	**982**	**41,031**	**971**	**45,991**	**1,654**

The following initial observations are made in relation to the NIE Networks RP7 investment plan associated with primary substation plant.

- RP7 requested capex of £45.9m is 12% higher than outturn / forecast RP6 capex of £41.0m;
- Noting the differing price control periods (RP6+ Extension = 7.5 years; RP7 = 6 years), the normalised difference in RP7 costs relative to RP6+E costs for these sub work programmes is an increase of 40%;
- There are eight sub-programmes for which there was either no investment in RP6 or the works were carried out within the scope of a different sub-programme. These sub-programmes account for approximately £6.9m of the proposed RP7 capex;
- It is evident that in many cases, the capex relates to ongoing replacement programmes implemented in RP6 and in some cases, RP5 also;
- More than £31m of capex (approximately 67%) of the proposed RP7 capex relates to the replacement of 33kV transformers, and the replacement or refurbishment of 33kV and 11kV switchgear.

4.1.2 Strategy for proposed investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases refurbish) aging primary distribution assets on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 6) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 6 below for each of the sub-programmes.

Table 6 Distribution Primary Plant – Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
D13a - Replace indoor switchgear (33kV)	EJP 1.301	Replacement of circuit breakers, which have been 'prioritised based on condition information, known type defects, failure and defect information, availability of spares, technical support and assigned ratings'. This programme 'is a continuation of the programme commenced in RP5 to replace the poor condition assets'. Whilst the above general statement has been used by NIE Networks, no specific type defects are cited for D13a.
D13b - Replace outdoor switchgear - circuit breaker (33kV)	EJP 1.302	The strategy 'to maintain the asset health' comprises: – Replacement of 33kV outdoor circuit breakers (D13b) as a continuation of the ongoing programme from RP6: • 'Oil units will be replaced based on condition, known type defects, failure information, availability of spares, technical support and assigned ratings'; and • 'SF6 units replaced to comply with the F-gas regulations'. – Mesh upgrades (D13d) 'to complete the programme commenced in RP4 by the end of RP7 as originally specified'. NIE Networks subsequently advised that there is a combination of full and half mesh refurbishments. 'Half meshes are sites where, for example, previous works have been carried out under various load or connections jobs, so that only half of the mesh needs refurbished'.
D13d - Replace outdoor switchgear - mesh equipment (33kV)		
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	EJP 1.303	Sites have been identified where 'mesh circuit breakers require replacement with… indoor equivalents to effectively use available space for construction work and improve the resilience of the network. The circuit breakers have been identified based on condition, known type defects, failure information, availability of spares, technical support and assigned ratings'. 'This asset class is linked to the outdoor to outdoor replacements in EJP 1.302. The combination of these two interventions improves the health of the outdoor breaker asset class, primarily due addressing gas leaks as per the F-Gas legislative requirements'. The affected sites are confirmed to be different for the D13b and D13d categories.
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	EJP 1.304	Strategy to 'maximise the life of 11kV and 6.6kV primary switchboards' through a combination of replacement and retrofit. D13e and D13k are a continuation of previous programmes and NIE Networks states that 'in RP5 and RP6, we demonstrated efficiency savings through retrofitting, and have identified further opportunities to use recovered spares post retrofitting (dependent upon condition assessment of recovered limited spares) to further manage the risk of asset failure'. In RP7, 'the overall asset health of the 11kV and 6.6kV primary switchboards will deteriorate through this programme, but the levels of risk and system reliability will be manageable, via retrofit programmes and continued inspection and maintenance processes'. In addition, the refurbishment of Hadrian SMV and YMV2 Reyrolle 11kV switchgear (D13r and D13s, respectively) is required 'to address a known defect associated with these two specific switchgear types. These defects are known to result in maloperation of the circuit breakers increasing the risk of an incident occurring, should a faulted section of the network not be isolated in a timely manner'.
D13K - Replace primary switchgear (11kV & 6.6kV) retro-fit		
D13r - 11kV Reyrolle Hadrian SMV Refurbishment		
D13s - YMV2 Reyrolle Refurbishment		
D13O - Replace earth fault indicator	EJP 1.305	Strategy to 'continue with the programme started in RP6 to replace non-operational EFIs with remote indication functionality at current strategic locations. The maintenance programme will

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
		replace other non-operational EFIs with local only indication in tandem with RMU maintenance'.
D13N - Plant painting (primary)	EJP 1.306	Strategy to replace 'units during RP7 is to control safety risk, and improve the asset health of the 33/11 kV transformer population. The decision-making methodology hierarchy is as follows; condition assessment, refurbishment where possible and once refurbishment options have been exhausted, replacement of poor condition assets' (D14b-c). In addition, various ancillary refurbishment works (D13n, D14g-i, D14l) for 'existing transformers on the network not being replaced' are stated as being 'necessary to sustain safety and asset risk at acceptable levels… This is the minimum investment is required in RP7 to provide a safe, reliable and resilient network'
D14b - Replace 33/11kV Transformer (up to 12.5MVA)		
D14c - Replace 33/11kV or 33/6.6kV Transformer (up to 18.75MVA)		
D14G - Transformer refurbishment		
D14h - Cooler controls replacement		
D14i - Sump Pumps		
D14l - 33/11kV Tx Oil Regeneration		
D13L - Refurbish primary S/S DC system	EJP 1.307	Strategy to replace/refurbish ancillary equipment based on 'review of all distribution substations to ascertain the extent of ancillary works required to resolve condition and safety issues' and 'replace existing poor condition ancillary works where possible in conjunction with planned equipment replacement'.
D13M - Rewire primary S/S (inc. AC services panel)		
D14j - Transformer Noise Enclosures	EJP 1.308	Strategy to install noise enclosures (D14j) to 'take into consideration all noise complaints received and recommendations from recent RP6 noise surveys. Sites with known noise emissions exceeding the current maximum statutory limits have been included within the RP7 programme'. In addition, proposed continuation of the programme to undertake noise surveys to 'to proactively manage noise issues'.
D14k - Noise Surveys		
D13v - Primary physical security	EJP 1.805	Security of substations must meet the requirements of the Electricity Safety, Quality and Continuity Regulations (NI) 2012, National Protective Security Authority (NPSA) guidance and provide a safe place of work in accordance with the Health and Safety at Work (NI) Order 1978. A review of current security arrangements in consideration of the above legislation and guidance has been completed at substations constructed in the 1960s up to the 1980s. This has highlighted a number of issues that require resolution. New programme is proposed for RP7 period - based on the need to commence necessary works to improve existing physical security arrangements at specific Transmission, Primary and Secondary sites. The planned upgrades will resolve a wide range of site physical security issues and ensure legislation compliance primarily at the sites being visited during the regulatory period to complete other works e.g. switchgear, transformer and ancillary equipment replacement
D13i - Civil works to primary substations	EJP 1.806	The RP7 strategy is based on the need to commence a prioritised programme of civil works that have been assessed on a site-by-site basis for the primary sites. These works will be programmed alongside other activity (i.e. replacing switchgear) to minimise disruption and maximise efficiency in delivery. NIE Networks has also identified risks relating to the presence of asbestos that will be addressed in RP7. All sites to have RP7 works completed at them have been assessed against the company's asbestos register and 145 have been identified as having asbestos present. The plan is to address the asbestos before other onsite works to ensure a safe working environment.
D13u - Asbestos Management		
D13j - Primary substation lease renewal	EJP 1.807	The primary investment driver is to ensure that there is sufficient protection of land rights (i.e., long term security of tenure) before committing to investment in a new substation. The majority of substation sites are secured by lease agreement (with a right of way for access and easements for underground

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
		cables). These lease agreements vary in terms of timescale, but the majority are 42, 99 or 999 years. Following a review of lease terms in 1999, it was decided to agree all new and renewed leases for a minimum term of 99 years on standard lease terms. Many of the leases that were for 42 years have expired or are due to expire within the next 17 years. The strategy for RP7 is the same as RP6. Where a new substation is required or where it is intended to make a significant investment in the network, a freehold or long leasehold (at least 99 years) interest in the land will be sought. If a current site lease is nearing expiry (less than 5 years remaining on the lease) NIE Networks will seek to renew the lease before investing in the site.

4.2 GHD analysis

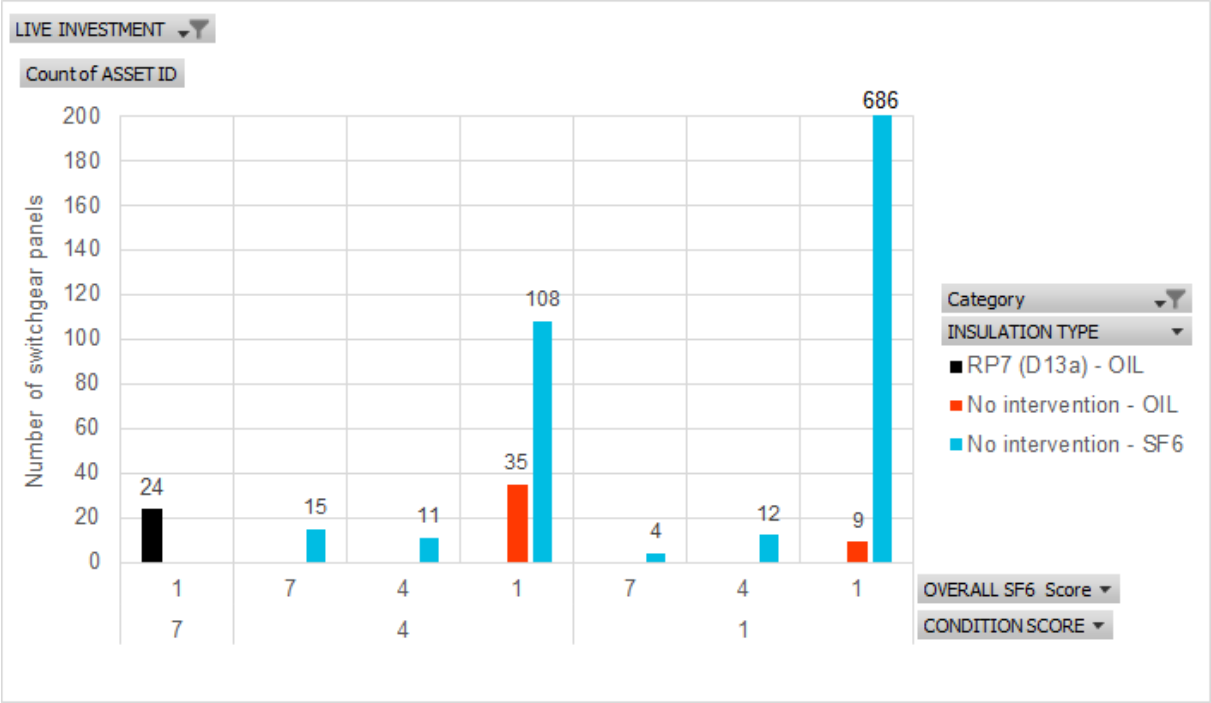
4.2.1 Condition assessment analysis

The key findings from the review of the condition assessment files submitted by NIE Networks for review are shown below in Table 7 to Table 10. It should be noted that these have been inferred from the workings presented in the condition-assessment spreadsheet files rather than any supporting narrative explanation provided by NIE Networks.

D13a - 33kV Indoor Switchboards

Table 7 33kV Indoor Switchboards (D13a) - condition assessment summary

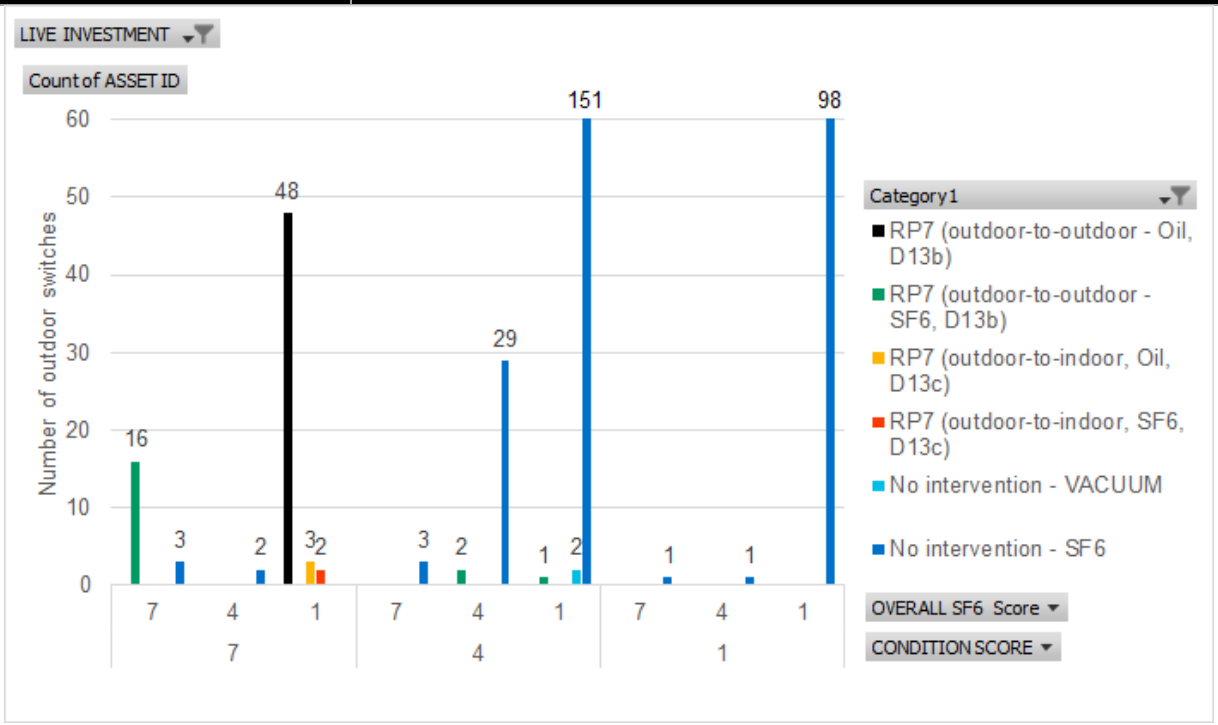
Element	Description
Condition points considered	– Switchgear remaining life – Overall SF6 score – Condition score – Spares etc score – Rating issues – Life extension score
Principal replacement driver(s)	Condition score is the principal driver, with poor condition switchboards (condition score of 7) proposed for replacement. In its EJP, NIE Networks states that the condition score 'considers condition issues such as insulation degradation, defects, oil leaks, corrosion levels and overall condition' based on 'high voltage insulation testing, site inspections'. However, no detail has been provided about how the recorded condition score has been evaluated based on these underlying criteria. All of the other condition points appear to be secondary to the condition score.
Volume / characteristics of proposed interventions	24 oil insulated switchboards (all with poor condition scores) are proposed for replacement under expenditure category D13a. In its EJP, NIE Networks states that the 'condition assessment has highlighted the need to replace the identified Reyrolle L42T switchboards as a priority due to known type defects and failures'. The 24 panels proposed for replacement are all of this type, with an additional 45 (also in poor condition) identified as having been replaced in RP6. NIE Networks stated that 'primary bus bar insulation on the L42T switchboards is provided by bitumen-based compound whilst the voltage transformers chambers are filled with insulating oil' and 'due to the extent of the insulation degradation levels replacement is the only option'.

Element	Description
The figure below shows a summary of the planned volumes for intervention in RP7 and volumes of switchboards that have not been subject to any interventions in RP6. The x-axis shows the condition score at the bottom (outer group) and the overall SF6 score above (inner group). 	
Characteristics of assets excluded from intervention	– 35 oil insulated switchboards with average condition (score of 4) are not included in the proposed interventions. 5 of these are Reyrolle L42T type switchboards (subject to type defect highlighted above in relation to the switchboards proposed for replacement). – 134 SF6 insulated switchboards with average condition are not included in the proposed interventions, of which 15 have a poor SF6 assessment (score of 7) and 11 have an average SF6 assessment (score of 4). – 9 oil filled switchboards with good condition (score of 1) and 702 SF6 insulated switchboards with good condition have also been excluded from the proposed interventions, of which 4 of the SF6 insulated switchgear have a poor SF6 assessment.
Conclusion	Based on our review of the condition assessment model, we conclude that the stated volumes for RP7 interventions in the D13a expenditure category are reasonable and recommend allowance of these volumes for RP7 period.

D13b,c,d - 33kV Outdoor Switchgear

Table 8 33kV Outdoor Switchgear (D13b,c,d) - condition assessment summary

Element	Description
Condition points considered	– Switchgear remaining life – Overall SF6 score – Condition score – Spares etc score – Rating issues – Life extension score
Principal replacement driver(s)	Condition score is the principal driver, with the majority of the poor condition switches (condition score of 7) proposed for replacement. In its EJP, NIE Networks states that the condition score 'considers condition issues such as insulation degradation, defects, oil leaks, corrosion levels, oil condition, SF6 gas leaks and overall circuit breaker condition'. However, no detail has been provided about how the recorded condition score has been evaluated based on these underlying criteria. All of the other condition points appear to be secondary to the condition score.
Volume / characteristics of proposed interventions	– 64 poor condition outdoor switches (condition score of 7; 48 oil filled and 19 SF6 insulated) are proposed for replacement with outdoor switches D13b, along with a further 3 average condition outdoor switches (condition score of 4; SF6 insulated; SF6 score of average or good), under expenditure category D13b. • 48 of the poor condition outdoor switches identified for replacement are SWS EO1 type, which NIE Networks states is subject to a defect that 'due to the age of the circuit breakers moisture ingress through degraded seals of the bushing causes paper degradation and subsequent loss of insulation. We have investigated repair options for the oil filled 33kV circuit breaker, but this has not proven to a viable option'. • A further 10 of the poor condition switches are GEC OX36 33kV circuit breakers, which NIE Networks states have 'an SF6 gas leak type defect associated with the viewing windows of each bushing. The repairs to date have found limited success with repeat repairs common. The OEM no longer supports this type of circuit breaker. In addition, the mechanism cubicle is prone to severe corrosion that cannot be replaced economically'. • The remaining 6 poor condition switches are Hawker Siddeley (Brush) Horizon 33kV SF6/vacuum circuit breakers. NIE Networks states that 'there are several known type defects associated with the bushings and SF6 seals/gaskets', comprising degradation of the main tank top access cover and main tank mid gaskets (causing SF6 leaks) and degradation of semi-conductor paint applied to the bushings (causing insulation degradation and partial discharge). – In addition, 5 poor condition outdoor switches (score of 7) are proposed for replacement with indoor switches, under expenditure category D13c, of which 3 are of the SWS EO1 type. These are located at 2 sites (Ardboe Central and Gallahers), and NIE Networks states that 'five mesh circuit breakers require replacement with 11 indoor equivalents to effectively use available space for construction work and improve the resilience of the network'.
The figure below shows a summary of the planned volumes for intervention in RP7 and volumes of outdoor switches that have not been subject to any interventions in RP6 . The x-axis shows the condition score at the bottom (outer group) and the overall SF6 score above (inner group).	

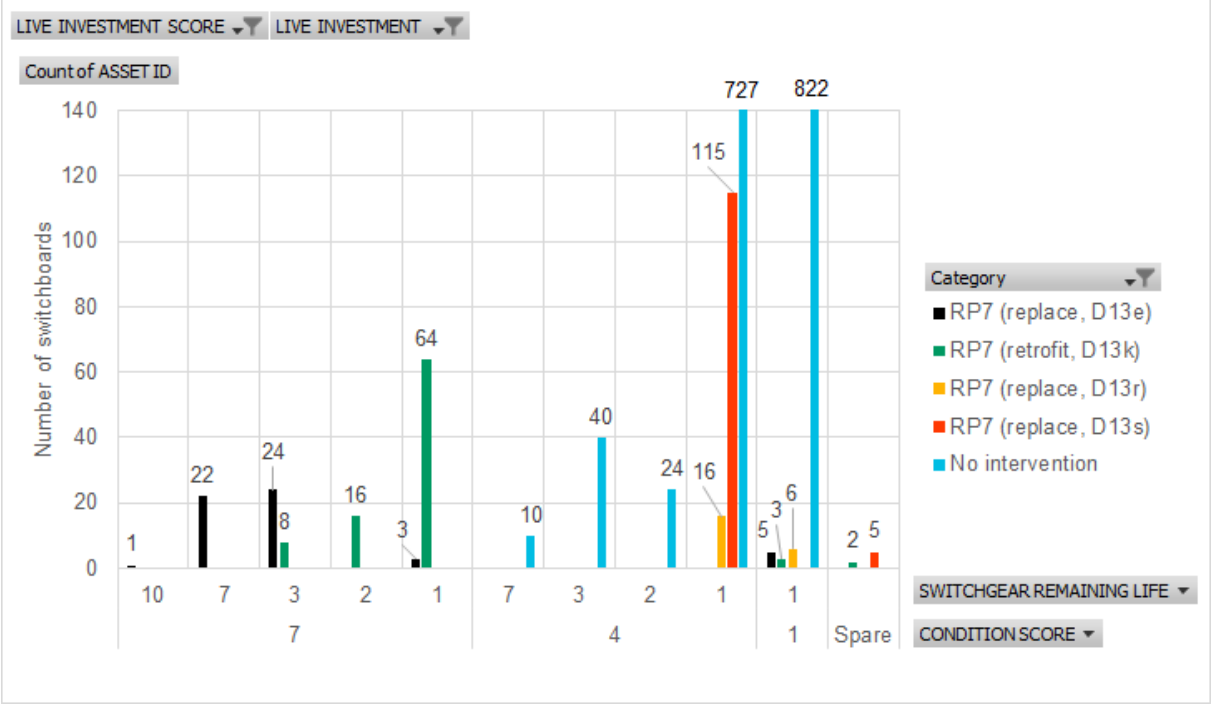
Element	Description
	
Characteristics of assets excluded from intervention	– Five poor condition outdoor switches have been excluded from the proposed interventions. It should be noted that whilst these have low remaining life scores indicating that the remaining life is in excess of 7 years in each case, they have a mixture of average and poor SF6 scores. – In addition, 185 average condition outdoor switches and 100 good condition outdoor switches have been excluded from the proposed interventions. These units also have low remaining life scores.
Conclusion	Based on our review of the condition assessment model, we conclude that the stated volumes for RP7 interventions in the D13b and c expenditure categories are reasonable, and we recommend these are allowed for RP7 period. It was challenging to reconcile the replacement volumes for SF6 circuit breakers with the statement in the EJP ('19 units have been identified for replacement as those units continue to re-leak SF6 gas shortly after remedial works have been completed'). It can be seen that 16 circuit breakers have poor condition and SF6 scores (green bar in the figure above), but the remaining three do not have a poor SF6 score. Conversely, however, there are 5 poor condition SF6 circuit breakers that have not been selected for interventions and also a further three with average condition and poor SF6 scores. As such, it is recommended that the overall volume is acceptable, but the identification of the precise circuit breakers for replacement should be confirmed by NIE Networks prior to commencing work. In addition, it has been confirmed that the stated volumes for the D13d expenditure category correspond to 5.5 mesh replacements, made up of full mesh and half mesh upgrades at different sites (full: Casterbay, Dunore Point, Limavady Main, Sion Mills; half: Castlederg South, Cushendall Central, Mobrief). NIE Networks states that 'half meshes are sites where, for example, previous works have been carried out under various load or connections jobs, so that only half of the mesh needs to be refurbished'. It is noted that there is some overlap with both mesh replacements (D13d) and circuit breaker replacements (D13b) proposed at Limavady Main and Sion Mills, but the volumes are deemed to be reasonable.

D13e,k,r,s - 11kV and 6.6kV Primary Switchboards

Table 9 11kV and 6.6kV Primary Switchboards (D13e, k, r, s) - condition assessment summary

Element	Description
Condition points considered	– Switchgear remaining life – Overall SF6 score – Condition score – Spares etc score – Rating issues – Life extension score
Principal replacement driver(s)	Condition score is the principal driver, with poor condition switchboards (condition score of 7) proposed for replacement, along with those subject to type defects. All of the other condition points appear to be secondary to the condition score.
Volume / characteristics of proposed interventions	– 50 poor condition panels of switchgear (score of 7) are proposed for replacement under expenditure category D13e, along with 5 good condition panels of switchgear. On inspection it is observed that these 5 good condition switch panels are located at Monkstown substation alongside 11 poor condition switch panels, which are proposed for replacement. As such, it is deemed reasonable that these should be replaced at the same time for practical reasons. – 88 poor condition panels of switchgear (score of 7) are proposed for retrofit under expenditure category D13k, along with 2 units with no condition score (identified as spares) and 3 good condition panels of switchgear. On inspection it is observed that these 3 good condition switch panels are located at North Foreshore (2) and Ballymena East (1) substations alongside poor condition switchgear panels (11 and 10, respectively), which are proposed for replacement. As such, it is deemed reasonable that these should also be replaced at the same time for practical reasons. – 22 Reyrolle YMV2 type switchgear panels are proposed for refurbishment (all of this type), as a result of a type defect. – 120 Reyrolle Hadrian SMV type switchgear panels are proposed for refurbishment (all of this type), as a result of a type defect, including 5 that are identified as spares.

The figure below shows a summary of the planned volumes for intervention in RP7 and volumes of switchboards that have not been subject to any interventions in RP6. The x-axis shows the condition score at the bottom (outer group) and the remaining life score above (inner group).



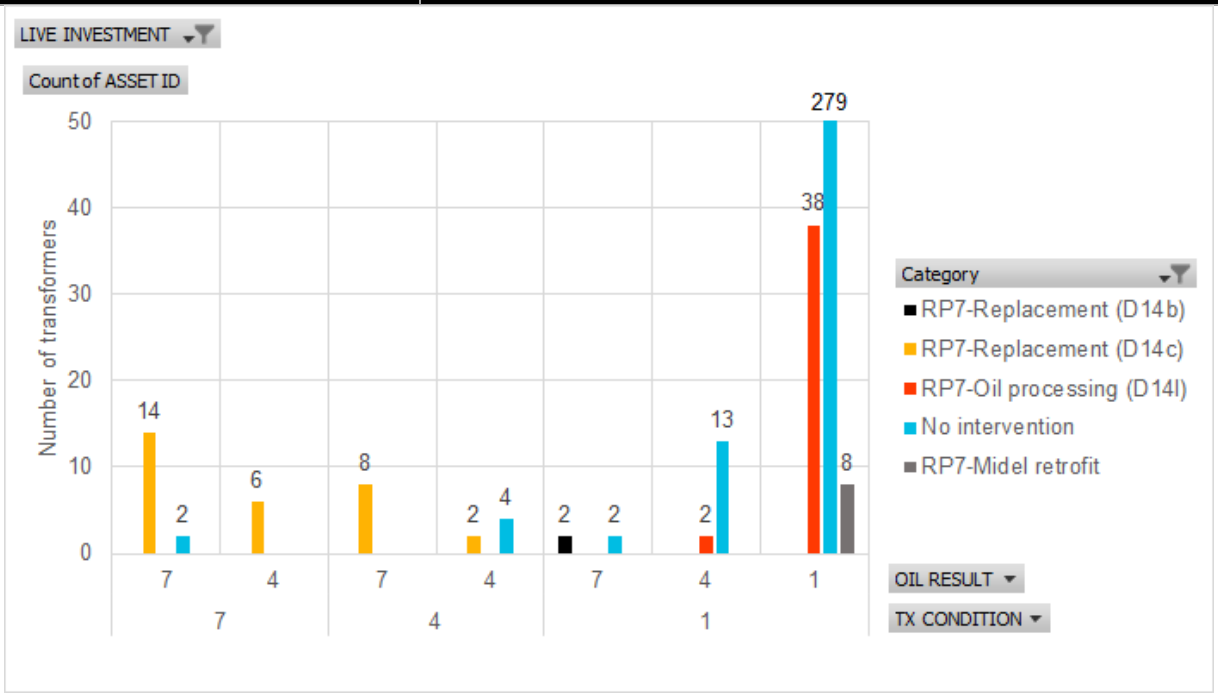
Element	Description
Characteristics of assets excluded from intervention	– 801 average condition switchgear panels (score of 4) have been excluded from the proposed interventions. – 822 good condition switchgear panels (score of 1) have been excluded from the proposed interventions.
Conclusion	Based on our review of the condition assessment model, we conclude that the stated volumes for RP7 interventions in the D13e, k, r and s expenditure categories are reasonable and we recommend allowance of these volumes for RP7 period.

D13n & D14b,c,g,h,i,l - 33-11kV Transformers

Table 10 33-11kV Transformers (D13n, D14b, c, g, h, i, l) - condition assessment summary

Element	Description
Condition points considered	– Transformer (Tx) remaining life (scored based on the remaining life at the beginning of RP7, compared with an asset life of 55 years[7]) – Oil result – Tx condition – Rating issue
Principal replacement driver(s)	Transformer condition is the principal replacement driver. All of the other condition points appear to be secondary to the condition score.
Volume / characteristics of proposed interventions	20 poor condition transformers (condition score of 7) are proposed for replacement along with 10 average condition and 2 good condition transformers[8] (D14b-c): – 8 of the 10 average condition transformers have poor oil results, and the remaining 2 have exceeded their asset life by between 2 and 4 years (remaining life score of 7). – The 2 good condition transformers have poor oil results. – It should be noted that, based on the stated continuous ratings, all of the transformer replacements have been upgraded to the size category above, i.e. 2 transformers up to 6.25 MVA replaced with transformers up to 12.5 MVA (D14b) and 30 transformers up to 12.5 MVA replaced with transformers up to 18.75 MVA. In addition, 40 good condition transformers have been selected for oil processing (D14l). The majority of these (38) correspond to transformers with good oil results, and the remaining life of these transformers vary between zero and seven years (remaining life scores of 2-5). Furthermore, 8 good condition transformers have been marked for Midel retrofit interventions in the condition assessment model, but these do not appear to align with any expenditure categories. This volume is not supported by the EJP or the condition assessment spreadsheet, which shows good “oil results” and the lowest possible condition score for these transformers accounting for all of the condition points.
The figure below shows a summary of the planned volumes for intervention in RP7 and volumes of transformers that have not been subject to any interventions in RP6. The x-axis shows the condition score at the bottom (outer group) and the oil result score above (inner group).	

[7] Some formula errors were observed in the condition assessment spreadsheet provided, such that a hardcoded value of 40 years asset life was included in some cases, rather than the reference to the input cell to use a 55 year nominal asset life for primary transformers.
[8] In addition, the condition assessment model indicates 4 transformers marked for intervention with the label ‘RP7 Load’. These do not contribute to the numbers for replacement in expenditure categories D14b-c.

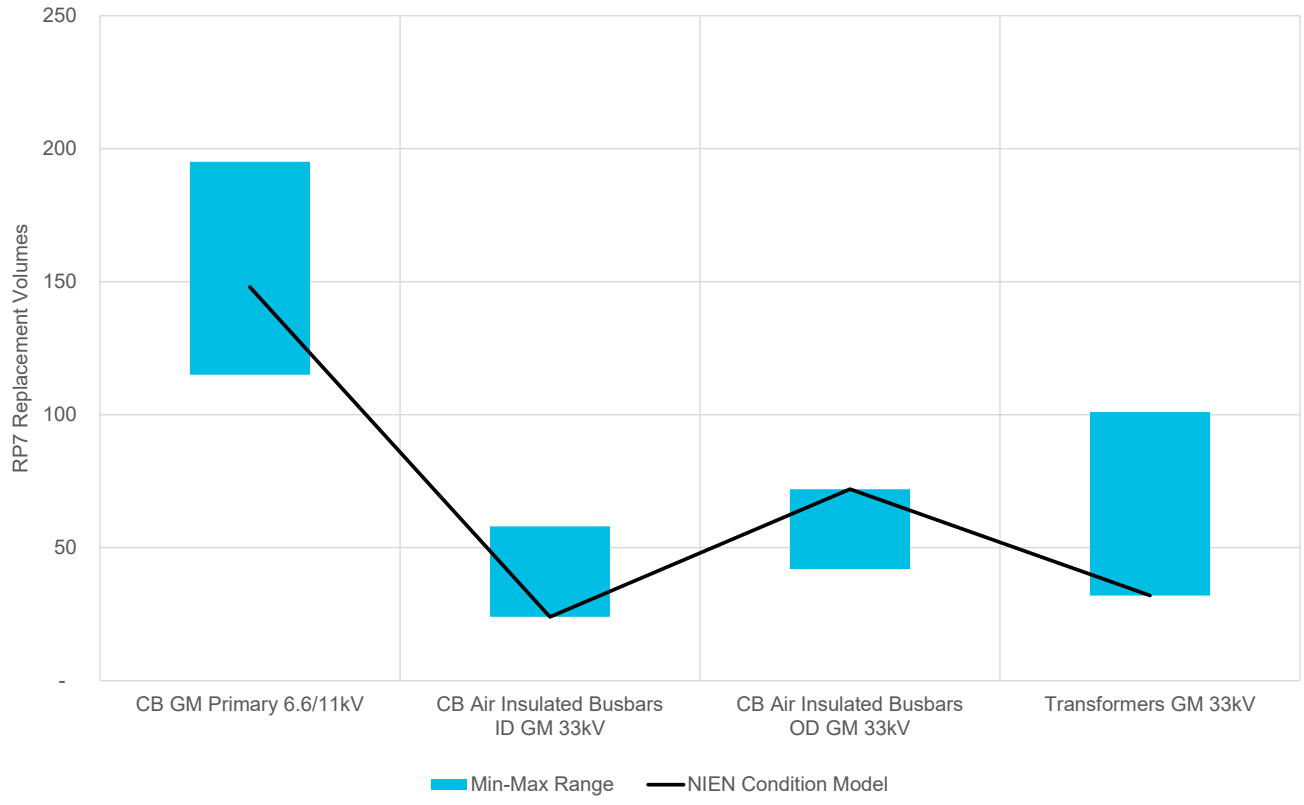
Element	Description
	
Characteristics of assets excluded from intervention	– 292 good condition transformers (score of 1) have not been included in the proposed interventions. – A further 4 average condition transformers (score of 4) have not been included in the proposed interventions. These have average oil results (score 4) and remaining lives in the range 0-4 years (scores 3-5).
Conclusion	Based on our review of the condition assessment model, we conclude that the stated volumes for RP7 interventions in the D14b-c expenditure categories are reasonable (including the approach to upgrade to the next transformer size) and recommend allowance of the volumes for RP7 period. In addition, we also conclude that the volume of 12 interventions for cooler controls replacement (D14h) is reasonable, based on the explanation from NIE Networks that these have 'been identified in poor condition, due to wiring faults, switch and contactor failures. Failures are highlighted from site alarms resulting in the need to reduce the associated transformer's assigned rating and in extreme cases this can result in the transformer being switched out'. However, no supporting condition model has been provided for these to support the statement in Appendix 2 of the EJP. However, in the absence of sufficient justification in the EJP or condition assessment model provided, it is recommended that the proposed volumes for the following interventions are modified: – Plant painting – primary (D13N) – requested volume of 150 recommended to be reduced by 50% (to 75) to enable a more manageable delivery programme. It is noted that NIE Networks states that the proposal is based on '10-years painting frequency [following initial 15 years without intervention] has been calculated to ensure all primary transformers are on a cycle to be painted in line with OEM recommendations and industry best practice'. However, insufficient evidence has been provided about the timing of painting interventions on each transformer (i.e. in RP6), and the management of this programme; – Transformer refurbishment (D14g) – requested volume of 12 recommended to be reduced to zero in the absence of clear details of the nature of the intervention (EJP refers to refurbishments in general and cooler replacements, which are distinct from cooler control replacements); – Sump Pumps (D14i) – requested volume of 184 recommended to be reduced by 50% (to 92) to enable a more manageable delivery programme for this new sub-programme. We acknowledge that NIE Networks proposes to introduce this sub-programme to address known defects, and that 'these assets have never

Element	Description
	been subject to any replacement activities and are in poor condition'. However, greater evidence is required to support this assertion about the condition. – Oil processing intervention (D14l) – requested volume of 40 transformers recommended to be reduced to zero since the condition assessment model provided indicates good or average oil scores for all of these. In addition we note that no capital allowance has been requested for the Midel retrofit interventions indicated in the condition assessment model.

In order to further verify the proposed RP7 replacement volumes, we also carried out a review of NIE Networks' replacement volumes from each of their modelling scenarios (described previously in Section 2.1.4). Figure 2 below shows the max-min range of the model outputs, in terms of RP7 for each of the three methodologies, with the NIE Networks condition-based model output also represented. It is evident that with the exception of the 33kV Outdoor CB asset category, the proposed replacement volumes are within range or the lowest of the model outputs.

For the 33kV Outdoor CB replacement volume, the NIE Network condition-based model produces the highest replacement volumes for RP7. This higher volume is driven by a specific type-defect (SWS EO1 type), described above for which NIE Networks has investigated repair options for the oil filled 33kV circuit breaker but with no viable solution being identified. We remain satisfied that the replacement volumes for these asset categories are reasonable for RP7.

Figure 2 Comparison of Model Outputs - 33kV Replacement Volumes



In addition to the above assessment, we also reviewed NIE Networks' investment proposal relating to a further number of investment categories. Our comments following this review are presented in the sub-sections below.

D13i – Civil works to primary substations

The RP7 strategy is based on the need to commence a prioritised programme of civil works that have been assessed on a site-by-site basis for the primary sites. There are 217 existing primary substations located in urban, semi-urban and rural surroundings. During RP7 NIE Networks is proposing to complete civil works at 26 sites in conjunction with planned equipment replacement or refurbishment works. This approach is intended to minimise

disruption and maximise efficiency in delivery. NIE Networks is proposing RP7 investment of £3.3m to carry out civil works at various primary substations (RP6 investment is marginally lower at £3.1m).

The RP7 programme is prioritised to target P1 (high priority) sites only. These are defined as sites that present a significant safety and reliability risk; with intervention needed to support other planned works on site during the period. The EJP provided by NIE Networks included a detailed breakdown of the civil interventions required per primary site with the justification that these have been categorised as P1. We note no consideration or supporting commentary / optioneering was included in relation to those sites classed as P2.

The estimated cost to undertake each intervention was also included within the EJP. Further clarification on the cost sources used to estimate the costs was also provided by NIE Networks[9] . It is our understanding that for each element of civil work required, similar works carried out during RP6 were identified with a detailed review and comparison of the specification of works carried out. From these actual rates, a unit cost was derived and this was uplifted to reflect changes in RPI from the date the work was carried out. Each RP7 civil task has been estimated in units and the RP6 outturn unit costs applied to these to produce an overall cost estimate for each element of work. Where this has not been possible, the contractor schedule of rates has been referenced.

Based on our review, we recommend that the prioritised programme of RP7 works and the associated costs to complete the works are allowed for within the RP7 capex allowances.

D13u – Asbestos Management

The total number of substations identified with asbestos present is 421. Of these, NIE Networks has identified works to manage asbestos present at 145 sites during RP7 with an estimated capex of £0.25m. The volume of proposed works relates only to those sites where other asset-related works will be conducted during theRP7 period.

The plan to address the asbestos at site prior to other works on site is deemed reasonable in order to ensure a safe working environment. NIE Networks' proposed interventions include complete asbestos removal if directly located in designated work area or preventative measures (to mitigate disturbing asbestos by site attendees).

As part of the Q&A process, we sought additional clarification on the cost estimate relating to asbestos management. In response, NIE Networks provided further details of actual costs incurred at a representative sample of 10 sites and based on this, we consider the RP7 forecast to be reasonable.

D13v - Primary Physical Security

NIE Networks' plan for improving primary substation security include approx. £0.25m of capex interventions. This is proposed by NIE Networks following their review of all transmission and primary substations to determine the extent of security works required to resolve issues including security fencing, access gates, security doors, floodlighting and CCTV. This has then been prioritised based on a ranked scoring system.

The works at the proposed sites are prioritised based on NIE Networks' site condition / security assessment model. We reviewed the site condition / security assessment details and observed the assessment included the following criteria:

– Site configuration score;
– ESQCR Location and History scores;
– Unauthorised access score;
– Gate / Boundary Condition scores;
– Security Door rating; and
– Floodlighting.

The model output produced aggregated site scores ranging from 9 to 20. Only sites with an aggregate score of 18 and above have been included for RP7 interventions. A relatively small number of primary substation sites are targeted during RP7, with works proposed at 11 sites, from a total population of 229 sites.

[9] NIE Networks response to UR Query No UR-0202

Following our review of the planned site interventions and related costs, and given the relatively small investment proposed, we recommend that the proposed works and capex are allowed.

D13j - Primary substation legalities

NIE Networks' approach relating to primary substation sites is a continuation of its approach during the RP6 period. A significant increase in RP7 capex is proposed relative to RP6 (£4.3m v £0.4m[10]). For primary substations, the main difference between RP6 and RP7 is the volume of leases required. NIE Networks has identified 22 sites with planned RP7 interventions that require land to be purchased or leased (including site extensions). We agree that it is prudent to obtain legal agreement for the land for these sites thereby establishing long term security of each site.

NIE Networks has also identified a further 12 primary substation leases that have expired or will expire during the RP7 period where no works are planned. Within the RP7 plan, NIE Networks has included costs to purchase these or renew leases for all 12 sites. Within the EJP, NIE Networks did consider a do-nothing option (no lease renewals) and provided general comments on this option, but no risk assessment or supporting analysis was provided to assess the impact of allowing the leases to expire for these 12 additional sites. Given the uncertainty of the impact of deferring the lease renewal for these sites, we recommend RP7 allowances are provided only for the 22 sites identified where associated works are proposed during the RP7 period. Our recommended allowance is based on NIE Networks' RP7 submission with a pro-rata reduction for lower volumes.

D14j - Transformer Noise Enclosures & D14k - Noise Surveys

NIE Networks proposed RP7 investment of approximately £1.7m for constructing of noise enclosures at primary substations and £0.4m and undertaking programme of noise surveys[11]. NIE Networks has included only sites with known noise emissions exceeding the current maximum statutory limits within their RP7 programme and plans to install 12 noise enclosures at six sites in RP7 (two 110kV Main sites and four 33kV primary sites).

Separately (but related), NIE Networks also proposes to conduct 170 noise surveys in RP7, which will cater for the proactive management of actual noise issues on their network with survey results being used to drive future investment plans.

These works represent new RP7 investment categories. In RP6 there was no investment undertaken to address noise-related issues. The main driver for the works is to comply with relevant legislation, specifically WHO Environmental Noise Guidelines for the European Region (2018) and The Environmental Noise Regulations (NI) 2006. The RP7 strategy takes into consideration all noise complaints received and recommendations from recent noise surveys. Sites with known noise emissions exceeding the current maximum statutory limits have been included within the RP7 programme. Within its EJP 1.308, NIE Networks has provided a detailed schedule of substation sites and transformer numbers where noise levels have been exceeded. 12 sites with a total of 26 transformers are identified.

One site is to be addressed in the RP6 period by installing noise enclosures.

At five of the sites, NIE Networks has proposed transformer replacements during RP7 involving installation of transformers to new specifications with lower noise output levels.

At the remaining six sites, NIE Networks is proposing to install 12 noise enclosures during the RP7 period to address identified noise-related issues. We agree with NIE Networks' approach in addressing these volumes in RP7 period.

NIE Networks is proposing RP7 unit costs of £0.22m for 110kV transformer enclosures and £0.21m for primary transformer enclosures. These unit costs are significantly higher (in range 31% to 37%) than the unit cost observed in RP6 (£0.16m) albeit the RP6 unit cost was based on a single installation project at Kells Main station. NIE Networks states the RP7 unit cost is based on supplier quotations plus experience from Kells in 2016. We recommend capex allowances for noise enclosures (D14j) based on the mid-point between the RP6 and NIE Networks' proposed RP7 rate. This addresses potential risk in relying on RP6 outturn for a single installation as

[10] NIE Networks Response to UR Query No UR-0188
[11] A further £0.4m is proposed for constructing transformer noise enclosures around 110kV transformers under the T12x investment category.

being a reasonable unit cost, but also includes for efficiency in procurement and delivery of the noise enclosures. This results in a recommended capex allowance of £1.5m.

In relation to the noise surveys (D14k) proposed for RP7, we recommend allowance in full of the requested RP7 capex of £0.36m.

D13L - Refurbish primary S/S DC system & D13M - Rewire primary S/S (inc. AC services panel)

The strategy proposed by NIE Networks is to replace/refurbish ancillary equipment based on 'review of all distribution substations to ascertain the extent of ancillary works required to resolve condition and safety issues' and 'replace existing poor condition ancillary works where possible in conjunction with planned equipment replacement'.

The refurbishment of DC systems (D13L) comprises the replacement of battery chargers and lead acid battery strings, which NIE Networks states 'is an ongoing requirement during each regulatory period based on regular inspection, condition assessment, availability of parts and reduction of ampere-hour capacity to ensure the safe and reliable operation of the distribution network'. In support of DC systems refurbishment, NIE Networks provided a condition assessment model, which identifies 44 sites where the charger and/or battery sets are in poor condition. Following our review of the provided information, we conclude that the proposed volume of 44 is reasonable and we recommend they are allowed for RP7 period.

In relation to low voltage AC systems, NIE Networks states that 'all wiring must comply with the requirements of BS 7671 and be subject to periodic inspection including insulation assessment. The condition of the LV AC system is essential to ensure the safe and reliable operation of plant and equipment within distribution substations'.

In its EJP, NIE Networks states that the 'need to replace LV AC systems and/or associated wiring is based on condition assessment and/or extension of site facilities and installation of standby generators where sufficient switched LV ways and auto-changer over facilities are not available'. However, a subsequent query response from NIE Networks states that 'there is no specific scoring for AC systems. These [sites requiring D13M AC rewiring interventions] were determined based on the sites where other RP7 interventions have been selected and that are reliant on a safe and secure AC system to function in all network configurations. These works include transformer changes that would affect the AC equipment within the building (D14b, D14c), where equipment is being replaced in the building (D13l, D13e, D13a, D13b, D13c, D13k) or where protection equipment is being replaced (D603a, D603b)'.

In view of the lack of specific evidence to support the number of sites requiring intervention, we recommend RP7 allowances based on the outturn volume from RP6, pro-rated to account for the difference in duration of the RP periods, this results in a volume of 28 sites that is recommended for AC rewiring interventions (D13M).

D13O - Replace earth fault indicator

NIE Networks' proposal for D13O is to continue with the programme to 'replace non-operational EFIs with remote indication functionality'. NIE Networks states that 1,475 EFIs have been highlighted for replacement during RP7, but 'not all of these units require remote indication functionality, so will be replaced as part of regular maintenance activities. However, 559 units have been identified as requiring smart replacement' due to their strategic location, being at a mid-point on a circuit, or being a normally open point on a circuit.

NIE Networks also states that investment to replace non-operational EFIs is proposed in addition to work 'to install substation monitors at around half of NIE Networks' secondary substation sites'.

We observed that only limited details were provided relating to the optioneering and cost benefit analysis for the replacement of EFIs, relying on differences in costs between a limited range of options. Following our review, we conclude it is reasonable to limit the assumption that more of the EFIs could be replaced with those providing local indication under the regular maintenance activities, which would represent an improvement compared with the current non-operational state. As such, we recommend a reduction in the volume of this intervention to the mid-point of the RP6 outturn and RP7 requested volume, i.e. 395 (the mid-point of 231 and 559).

4.2.2 RP6 v RP7 unit cost analysis

Table 11 presents details of the unit cost assessment that has been undertaken for distribution primary plant.

Table 11 Distribution Primary plant – unit cost assessment

	Outturn unit costs (£k)			RP7 requested unit cost (£k)	Unit cost movement (%)	
Sub-programme ID	**RP5**	**RP6.**	**RP5-RP6.**		**RP7 vs. RP6+Ext.**	**RP7 vs. RP5-RP6+Ext.**
D13 - Primary Plant						
D13a - Replace indoor switchgear (33kV)	152.6	137.4	146.2	156.1	13.5%	6.8%
D13b - Replace outdoor switchgear - circuit breaker (33kV)	87.1	61.3	67.6	68.0	11.0%	0.5%
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	122.2	87.1	116.0	175.0	100.9%	50.8%
D13d - Replace outdoor switchgear - mesh equipment (33kV)	143.5	101.5	131.6	130.0	28.1%	-1.2%
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	49.7	38.5	45.8	62.2	61.7%	35.7%
D13i - Civil works to primary substations	208.3	82.3	113.3	-	-	-
D13K - Replace primary switchgear (11kV & 6.6kV) retro-fit	-	23.5	24.2	23.2	-1.1%	-4.1%
D13L - Refurbish primary S/S DC system	-	14.0	14.0	13.6	-3.3%	-3.3%
D13M - Rewire primary S/S (inc. AC services panel)	-	18.3	18.3	18.3	-0.3%	-0.3%
D13N - Plant painting (primary)	-	3.5	3.5	3.3	-6.4%	-6.4%
D13O - Replace earth fault indicator	-	1.0	1.0	1.0	-2.1%	-2.1%
D13r - 11kV Reyrolle Hadrian SMV Refurbishment	-	-	-	19.6	-	-
D13s - YMV2 Reyrolle Refurbishment	-	-	-	19.6	-	-
D14 - Primary Transformers						
D14b - Replace 33/11kV Transformer (up to 12.5MVA)	347.2	404.9	366.4	364.3	-10.0%	-0.6%
D14c - Replace 33/11kV or 33/6.6kV Transformer (up to 18.75MVA)	475.9	808.4	697.6	366.3	-54.7%	-47.5%
D14G - Transformer refurbishment	-	50.6	50.6	34.4	-32.0%	-32.0%
D14h - Cooler controls replacement	-	-	-	2.1	-	-
D14i - Sump Pumps	-	-	-	6.2	-	-
D14j - Transformer Noise Enclosures	-	-	-	209.9	-	-
D14k - Noise Surveys	-	-	-	2.1	-	-
D14l - 33/11kV Tx Oil Regeneration	-	-	-	18.5	-	-

The percentage changes in the unit cost (RP7 request compared with RP6 outturn to 31-Mar-2023) is presented in Figure 3, along with the equivalent percentage changes in asset volumes.

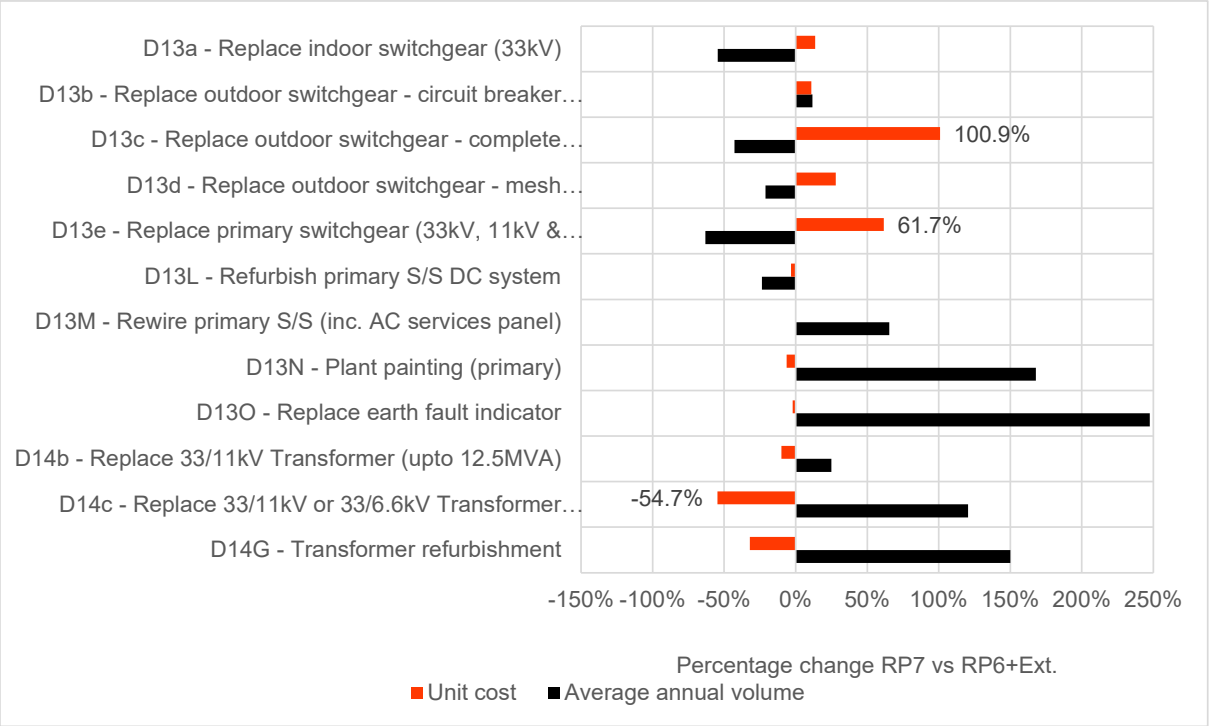


Figure 3 Distribution Primary plant – Unit cost assessment

From Figure 3 it is evident that the requested unit costs for the D13c and D13e expenditure categories correspond to the greatest percentage changes. In addition, NIE Networks' query response on unit costs[12] indicates the assessment carried out by NIE Networks to apply adjustments to the March 2022 outturn unit rates. These comprise adjustments to account for:

– 'Adjustments to reflect underlying unit rate';
– 'Transformer material prices'; and
– 'Site specific cost increases'.

A detailed review of the unit costs subject to large overall percentage changes or application of the above adjustment factors has been undertaken. The findings from this review are presented in Table 12.

Based on review of the EJP documents and supplementary information provided, and acknowledging the statement by NIE Networks that units costs incurred in RP6 are attributable to costs reported for RP5 period but with asset volumes reported in RP6[13], we propose to adopt the long term outturn unit cost (RP5-RP6) along with reasonable adjustments for changes in scope, which are listed as 'site specific cost increases'. The remaining adjustments (first two categories listed above) are recommended to be excluded as these likely constitute real price increases that the UR has advised are within the scope of the UR's real price effect adjustments, detailed in their frontier shift annex.

Table 12 Distribution Primary plant – Review of unit cost changes

Expenditure category	Commentary on unit cost increases
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	In its query response on unit costs[14], NIE Networks cites the following adjustments to the March 2022 outturn rate (£89.0k): – Adjustment to reflect true underlying rate (+£40.0k) – Adjustment for specification requirements – 'site specific costs relating to control rooms required to house the switchgear installations' (£46.1k) We recommend an allowed unit cost of £162.1k, based on the RP5/RP6 (actual to 2023) unit rate with an upwards adjustment for site specific issues.

[12] Response to queries UR-0055,58,61,90-94
[13] Which combined have the effect of artificially suppressing outturn unit costs reported over the RP6 period
[14] Response to queries UR-0055,58,61,90-94

Expenditure category	Commentary on unit cost increases
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	In its EJP, NIE Networks states that the RP7 unit cost is based on 'March '22 outturn adjusted for specification change – moving to withdrawable panels'. In its query response, NIE Networks cites the following adjustments to the March 2022 outturn rate stated as being £37.7k, with the following adjustments: – Adjustment to reflect 'underlying unit rate' (+£8.4k) – Adjustment for 'site specific cost increases' (£16.1k) We recommend an allowed unit cost of £61.9k, based on the RP5/RP6 (actual to 2023) unit rate with an upwards adjustment for site specific issues.

For the remaining asset categories that are not itemised in Table 13, we propose to apply the same approach, i.e. to adopt the long-term RP5-RP6 (actual to 2023) outturn unit costs where these are lower than NIE Networks' proposed RP7 unit rates.

4.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 13.

Table 13 Distribution plant – Primary plant recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D13 - Primary Plant	**29,903**	**1,196**	**27,211**	**946**
D13a - Replace indoor switchgear (33kV)	3,745	24	3,508	24
D13b - Replace outdoor switchgear - circuit breaker (33kV)	4,553	67	4,531	67
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	1,925	11	1,783	11
D13d - Replace outdoor switchgear - mesh equipment (33kV)	715	6	715	6
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	3,422	55	3,407	55
D13i - Civil works to primary substations	3,323	-	3,323	-
D13j - Primary substation lease renewal	4,301	-	2,783	22
D13K - Replace primary switchgear (11kV & 6.6kV) retro-fit	2,159	93	2,159	93
D13L - Refurbish primary S/S DC system	597	44	597	44
D13M - Rewire primary S/S (inc. AC services panel)	822	45	493	27
D13N - Plant painting (primary)	497	150	249	75
D13O - Replace earth fault indicator	565	559	384	380
D13r - 11kV Reyrolle Hadrian SMW Refurbishment	431	22	431	22
D13s - YMV2 Reyrolle Refurbishment	2,348	120	2,348	120
D13u - Asbestos Management	250	-	250	-
D13v - Primary physical security	250	-	250	-
D14 - Primary Transformers	**16,088**	**458**	**14,136**	**302**
D14b - Replace 33/11kV Transformer (upto 12.5MVA)	729	2	729	2
D14c - Replace 33/11kV or 33/6.6kV Transformer (upto 18.75MVA)	10,989	30	10,989	30
D14G - Transformer refurbishment	413	12	-	-

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D14h - Cooler controls replacement	25	12	-	-
D14i - Sump Pumps	1,148	184	574	92
D14j - Transformer Noise Enclosures	1,679	8	1,480	8
D14k - Noise Surveys	365	170	365	170
D14l - 33/11kV Tx Oil Regeneration	740	40	-	-
Total	**45,991**		**41,347**	

5. Review of RP7 capex requirements - WP1: Distribution plant – Secondary plant

This section relates to works carried out at NIE Networks' secondary substations and broadly consists of the replacement or refurbishment of secondary substation assets, including HV & LV switchgear, 11kV/LV (& 6.6kV/LV) transformers and combinations of these items as part of complete substation replacement works.

5.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 14 for each of the sub-work programmes included within programme D15. The table shows comparison of costs and volumes over the RP6period relative to the RP7 period.

5.1.1 RP7 Costs and volumes

Table 14 Secondary plant - NIE Networks investment proposal for RP7

		RP6 allowance		RP6 outturn[15]		RP7 proposed	
Sub-programme ID	**EJP ref**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**
D15a - Replace RMU	EJP 1.401	928		1,384	140	2,152	200
D15b - Replace complete S/S	EJP 1.401	16,813		18,491	420	18,122	288
D15c - Replace complete S/S and temporary S/S works	EJP 1.401	2,949		2,816	50	2,638	37
D15d - Secondary Switchboard Replacement	EJP 1.405	3,878		2,448	100	1,805	50
D15e - Replace OH fed GMT	EJP 1.406	1,871		3,257	74	3,199	50
D15f - Replace H pole S/S	EJP 1.407	1,119		1,304	86	1,068	49
D15g - H pole: TX change only	EJP 1.407	67		34	12	365	45
D15h - H pole: replace LV cabinet	EJP 1.407	275		262	50	248	44
D15k - Replace sectionalisers	EJP 1.404	794		1,020	110	1,468	139
D15l - Replace mini pillars	EJP 1.402	4,113		5,385	1,216	5,971	1,545
D15m - Refurbish LV plant	EJP 1.408	3,826		2,092	24,466	1,580	21,323
D15n - Replace LV wall mounted fuse board	EJP 1.409	771		725	38	464	21
D15o[16] - Secondary substation ancillary works	EJP 1.806	2,345		2,197	-	1,512	
D15q - Replace UDB	EJP 1.403			-	-	828	114
D15T - RMU substation - mini kiosk	EJP 1.410	2,847		2,125	50	3,567	56
D15x - Secondary substation legalities	EJP 1.807					1,959	
D15y - Replace LV Cabinet (GM Substation)	EJP 1.409					651	40

[15] The costs and volumes for the RP6 period are based on outturn costs to end of March 2023 plus forecast costs up to end March 2025
[16] In RP6 - sub work programme D15o was also used for allocating of costs relating to Secondary substation legalities. However, for RP7, NIE Networks has established a new sub work programme (and associated ref no - see category D15x in the table). NIE Networks advised (in EJP 1.807) that approx. £600k had been used by legalities with the remainder used for secondary civil works.

		RP6 allowance		RP6 outturn[15]		RP7 proposed	
Sub-programme ID	**EJP ref**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**
D15z - RMU substation - mini kiosk and temp	EJP 1.410					1,212	17
D15aa - Fit UDB Blanket	EJP 1.403					43	200
D15ac - Secondary substations physical	EJP 1.805					4,227	
Total		**42,595**		**43,540**	**26,812**	**53,080**	**24,218**

The following initial observations are made in relation to the NIE Networks RP7 investment plan associated with secondary substation plant.

– RP7 capex of £53.1m is 22% higher than outturn / forecast RP6 capex of £43.5m
– Noting the differing price control periods (RP6+Ext = 7.5 years; RP7 = 6 years), the normalised difference in RP7 costs relative to RP6 costs for these sub work programmes is an increase of 52%
– There are 6 sub-programmes for which there was either no investment in RP6 or the works were carried out within the scope of a different sub-programme. These total approximately £8.9m in RP7 with the most significant sub-programmes being substation legalities (lease renewals), substation physical security works and replacement of RMU mini-kiosk substations (including temp works).
– It is evident that in many cases, the capex relates to ongoing replacement programmes implemented in RP6 and in some cases, RP5 also.
– More than 53% of the proposed RP7 capex relates to distribution substation replacement (items 15a, 15b, 15c) and mini-pillar replacements (item D15l).

5.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases, refurbish) ageing secondary distribution assets on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 14) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 15 below for each of the sub-programmes.

Table 15 Distribution Secondary Plant – Investment Strategy

Asset Category (Sub-Programme)	EJP Reference	Investment Strategy
D15a - Replace RMU	EJP 1.401	– Age and condition of the equipment – several RMUs are subject to operational restriction and / or type defects, including loss of SF6 gas (insulating medium). Outdoor equipment is more susceptible to failure due to corrosion and moisture ingress. – Need also based on greater risk of injury to staff, contractors and the public. – Cannot be equipped for remote operation – must be operated locally. – Approximately 24% of equipment is more than 40 years old of which the majority are over 50 years old.
D15b - Replace complete S/S		
D15c - Replace complete S/S and temporary S/S works		
D15d - Secondary Switchboard Replacement	EJP 1.405	– Asset condition assessments have identified age and condition related deterioration and defects. – Increased maintenance burden and lack of spare parts from the original equipment manufacturers. – Increased risk to operators due to ongoing deterioration of equipment. – Continuation of the rolling programme from previous regulatory periods.

Asset Category (Sub-Programme)	EJP Reference	Investment Strategy
D15e - Replace OH fed GMT	EJP 1.406	– Transformers subject to corrosion, moisture ingress and oil leaks. These leaks result in reduced margins of insulation leading to increased risk of failure. – Operational restrictions in place relating to compound filled LV units. – Wood pole and associated equipment (including steel work and LV kiosk) is in poor condition and in some cases does not comply with current standards. – Third-party encroachments have increased during RP6.
D15f - Replace H pole S/S D15g - H pole: TX change only D15h - H pole: replace LV cabinet	EJP 1.407	– General deterioration of main components associated with the substation. – Wooden LV kiosks susceptible to acute decay. – Structures located in public areas – posing a greater risk to the public. – Condition-based assessment has identified range of interventions, including full station replacement or targeted replacement of specific assets.
D15k - Replace sectionalisers	EJP 1.404	– Asset obsolescence - oil-filled units more than 50 years old. Operating mechanisms are worn, no replacement spares and no longer supported by manufacture. – Type defect on SF6 filled units associated with the main tank of the unit resulted in the loss of SF6 gas.
D15l - Replace mini pillars	EJP 1.402	– Pillars generally located in open public areas, often adjacent to customer's premises and are subject to age-related deterioration of pillar walls and doors. – Susceptible to third party interference. – Safety risk due to possible exposure of public to live equipment and possible failure of plant resulting in explosion and risk to the safety of operational staff. – Type defect causing significant early corrosion of the exterior metalwork of the mini pillars, resulting in holes forming, presenting additional safety risk.
D15o - Secondary substation ancillary works	EJP 1.806	– Continuation of a current RP6 programme, which has been used to repair brick buildings and roofs, address subsidence, undertake kiosk repairs due to corrosion, rectify third party damage and resolve ESQCR compliance defects associated with climbing aids. – Throughout RP6 the enhanced defect information gathered has highlighted that the pace of repair must increase to keep up with the deterioration rate of these assets. – The distribution civil works programme includes only those activities on site that are not directly driven by the plant asset replacement; instead, these activities improve the surrounding civil assets that have a significant impact on the life of the electrical plant asset.
D15t - RMU substation - mini kiosk D15z - RMU substation - mini kiosk and temp	EJP 1.410	– Continuation of a current RP6 programme. – Inspection data continues to identify transformer oil leaks, leaking compound defects, corrosion type defects with both the transformer, Ring Main Units and LV cabinets, degradation of insulation associated with the HV and LV cables, and enclosure defects. – Kiosks have exposed LV connections and busbars installed inside the kiosk shell, raising the risk of injury from third party interference.

Asset Category (Sub-Programme)	EJP Reference	Investment Strategy
D15x - Secondary substation legalities	EJP 1.807	– The primary investment driver is to ensure that there is sufficient protection of land rights (i.e., long term security of tenure) before committing to investment in a new substation. – The majority of substation sites are secured by lease agreement (with a right of way for access and easements for underground cables). These lease agreements vary in terms of timescale, but the majority are 42, 99 or 999 years. – Following a review of lease terms in 1999, it was decided to agree all new and renewed leases for a minimum term of 99 years on standard lease terms. Many of the leases that were for 42 years have expired or are due to expire within the next 17 years. – The strategy for RP7 is the same as RP6. Where a new substation is required or where it is intended to make a significant investment in the network, a freehold or long leasehold (at least 99 years) interest in the land will be sought. If a current site lease is nearing expiry (less than 5 years remaining the on the lease) NIE Networks will seek to renew the lease before investing in the site.
D15n - Replace LV wall mounted fuse board D15y - Replace LV Cabinet (GM Substation)	EJP 1.409	– LV Plant work programme for RP7 focuses on the replacement of fuse boards and cabinets that are in poor condition, to comply with legislation and resolve known condition and operational issues. – Spares for the existing equipment are now obsolete, – Due to the lack of spares, and their unknown fault level ratings, extensions to existing boards for new system feeds is not possible nor recommended.
D15ac - Secondary substations physical	EJP 1.805	– Security of substations must meet the requirements of the Electricity Safety, Quality and Continuity Regulations (NI) 2012, National Protective Security Authority (NPSA) guidance1 and provide a safe place of work in accordance with the Health and Safety at Work (NI) Order 1978. – A review of current security arrangements in consideration of the above legislation and guidance has been completed at substations constructed in the 1960s up to the 1980s. This has highlighted a number of issues that require resolution. – New programme is proposed for RP7 period. - based on the need to commence necessary works to improve existing physical security arrangements at specific Transmission, Primary and Secondary sites. The planned upgrades will resolve a wide range of site physical security issues and ensure legislation compliance primarily at the sites being visited during the regulatory period to complete other works e.g. switchgear, transformer and ancillary equipment replacement.

5.2 GHD analysis

5.2.1 Run Rate comparison

The volume of asset replacement / refurbishment works proposed by NIE Networks during the RP7 period for each of the sub-programmes is presented above in Table 14. We have reviewed the proposed RP7 run rates and compared them against the NIE RP6 forecast outturn run rates. To facilitate a more meaningful comparison, the assessment has been carried out on an average annual basis over RP6 period (7.5 years) and RP7 (6 years), with the details summarised below in Table 16; asset categories that were not included in RP6 have been excluded from the table.

Table 16 Comparison of RP7 v RP6 (annualised) Run Rates

Sub-programme ID	RP6 Average Annual Run Rate	RP7 Average Annual Run Rate	Difference in Run Rate (RP6 v RP7) (%)
D15a - Replace RMU	18.7	33.3	78.6%
D15b - Replace complete S/S	56.0	48.0	-14.3%
D15c - Replace complete S/S and temporary S/S works	6.7	6.2	-7.5%
D15d - Secondary Switchboard Replacement	13.3	8.3	-37.5%
D15e - Replace OH fed GMT	9.9	8.3	-15.5%
D15f - Replace H pole S/S	11.5	8.2	-28.8%
D15g - H pole: TX change only	1.6	7.5	368.8%
D15h - H pole: replace LV cabinet	6.7	7.3	10.0%
D15k - Replace sectionalisers	14.7	23.2	58.0%
D15l - Replace mini pillars	162.1	257.5	58.8%
D15m - Refurbish LV plant	3,262.1	3,553.8	8.9%
D15n - Replace LV wall mounted fuse board	5.1	3.5	-30.9%
D15t - RMU substation - mini kiosk	6.7	9.3	40.0%

Following our assessment of run-rates, we make the following observations:

– Significant increases in run-rates are observed for a small number of asset categories, specifically RMU replacement, H-pole transformer replacement, mini-pillar replacement and sectionaliser replacement.

– Similarly we observe there are a number of asset categories where NIE Networks is proposing large % reductions in replacement volumes in RP7; although actual volume reductions are relatively small. This applies to secondary substation switchgear replacement, full H-pole replacement and the replacement of ground-mounted substations supplied from OHL

– Work programmes on these asset categories have been in place over multiple review periods with volumes driven by NIE Networks' condition assessment models.

The following sections provides comments on our analysis of NIE Networks' proposed replacement / refurbishment volumes.

5.2.2 Condition assessment analysis

The detailed condition assessment spreadsheets used by NIE Networks to determine asset volumes for replacement were provided for the following asset categories:

– 11kV and 6.6kV Ground Mounted Secondary Substations (asset categories D15a, b, c).

– 11kV and 6.6kV Secondary Switchboard Replacement (D15d).

– 11kV and 6.6kV Overhead Fed Ground Mounted Secondary Substations (asset category D15e).

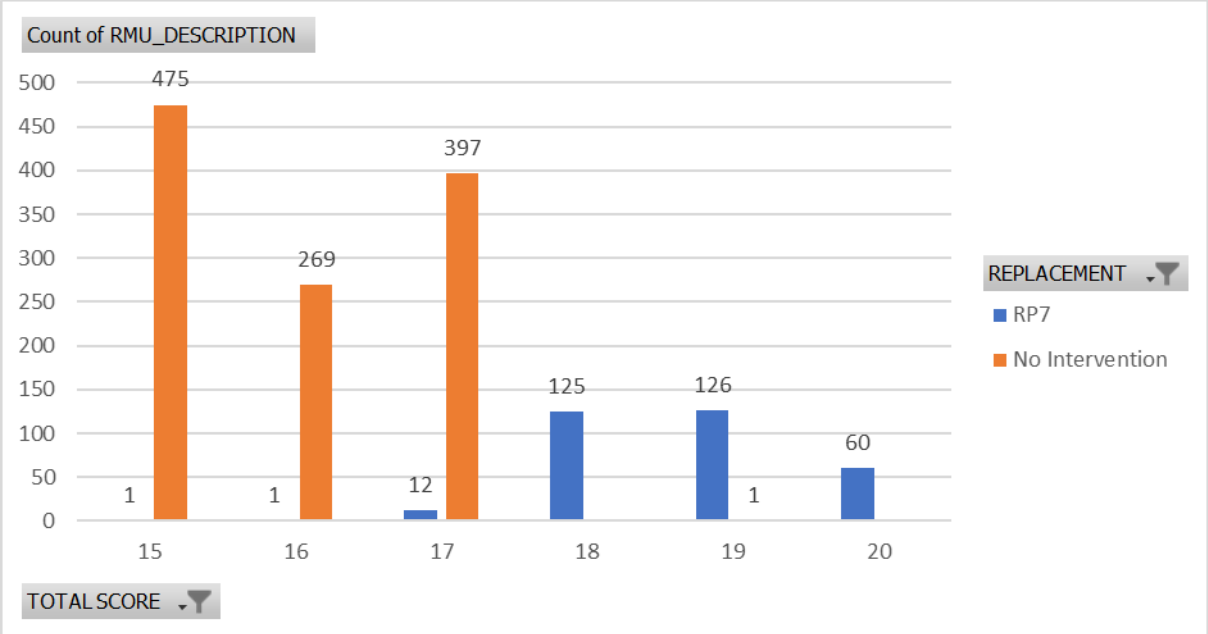
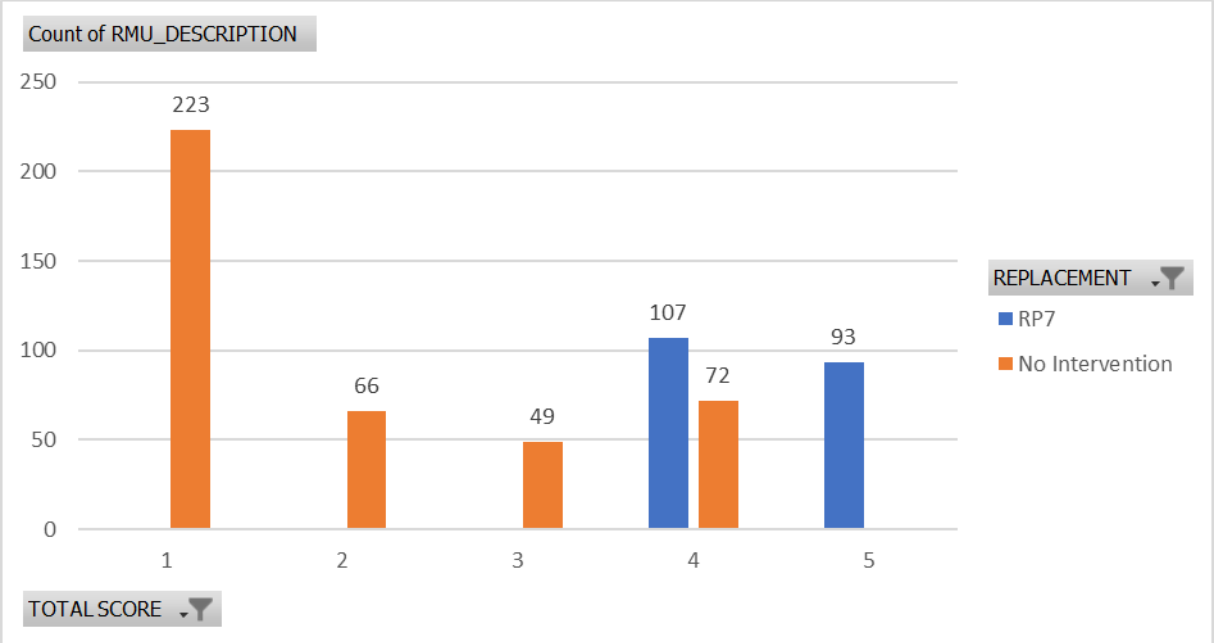
– 11kV and 6.6kV Sectionalisers (asset category D15k).

– Mini Pillars replacement / recovery (asset category D15l).
– 11kV and 6.6kV Ground Mounted Secondar Mini-Kiosk Substations (asset category D15t, z).

The key findings from the review of the condition assessment files submitted by NIE Networks for review are shown in Table 17 to Table 22. It should be noted that these have been inferred from the workings presented in the condition-assessment spreadsheet files rather than any supporting narrative explanation provided by NIE Networks.

Table 17 11kV and 6.6kV Ground Mounted Secondary Substations (D15a, b, c) - condition assessment summary

Element	Description
Condition points considered	For full substation replacements: – RMU type (made up of sub-scores based on equipment type, gas leaks, availability of spares, and operational restrictions, but these sub-scores are the same depending on the RMU type). – Substation building / enclosure type. – RMU location. – RMU age. – LV cabinet type (wood or steel). For RMU only replacements: – RMU type. – RMU location.
Principal replacement driver(s)	For complete substation replacements, the principal driver is RMU type, as the 5 sub-scores that are based on RMU type all contribute to the total overall condition score and no weighting is applied across the scores. No transformer condition assessment has been used to determine which substations to replace. For RMU only replacements, the principal drivers are RMU type and proximity to the coast – it is unclear why proximity to coast was used as a primary driver as the replacements are driven by a type issue rather than a corrosion one, and only 6 of these types of RMUs were indicated as being outdoors.
Volume / characteristics of proposed interventions	288 complete substation replacements have been proposed in RP7 under expenditure categories 15b and 37 under D15c, 325 in total were identified in the condition assessment but it is not clear which of those 325 also include temporary works. The 325 number includes all substations, bar 1, which had an overall score of 18 or higher and 14 substations that scored 15, 16, or 17. It is unclear from the assessment why certain sites were selected for replacement over others with the same total scores of 17, nor did there appear to be a cut-off point in terms of scoring to identify which sites to propose for replacement. A subset of sites were assessed for RMU only replacements, this subset consisted of RMUs which were subject to a type defect. There were 651 RMUs in the subset of data, however it is noted that there were 1,251 RMUs of these types included in the complete substation dataset – it is unclear why the assessed data did not appear to include all RMUs associated with the type defects. 200 RMU replacements were proposed, all scoring 4 or 5 in terms of proximity to coast.
The figure below shows a summary of the planned volumes for complete substation replacement in RP7 and those that would not be subject to any intervention. The x-axis shows the total score, the total scores ranged from 9 to 23, but only those with a score of 15 or higher are shown in the figure below. The RP7 intervention proposed covers replacement of 5.5% of the total population of 11kV & 6.6kV ground-mounted secondary substations.	

Element	Description
	 The figure below displays the breakdown of RMU only replacements proposed in RP7 against those with no planned intervention. It can be seen that those with higher total scores (which was made up only of the score attributed to "distance to coast") have been identified for replacement ahead of others. In total, NIE Networks propose to replace approximately 33% of the total population of RMUs with the type defects in RP7 (however as noted previously the total population of RMUs with type defects is unclear based on the information that has been provided).  It was noted that there were 9 substations with the G.E.C. SATURN RT 11KV SF6 type RMU that had been included in both the D15a and D15b plans for intervention, indicating that they had been double counted in the volumes.
Characteristics of assets excluded from intervention	– Based on the data provided there does not appear to a strict rule defining which assets to include / exclude from the assessment, other that generally those with higher total scores or distance to coast scores were prioritised. – Of the RMUs with the type defects, 9 had been identified for a full substation replacement, and 200 for RMU replacement only (however that count of 200 also included the 9 sites from the full substation replacement and appear to have been double counted). – The Network Investment Report proposed 288 substations for replacement (D15b), and 37 substations for replacement with temporary works (D15c), however the condition data provides no indication on the split between those that require temporary works and those that do not.

Element	Description
Conclusion	Based on review of the condition assessment model, the stated volumes for RP7 interventions in the D15a, b ,c expenditure category are overstated. We recommend the following volumes for the asset categories: – D15a = 200, 9 sites were also counted in the D15b, c condition sheet, however they only had a total score of 17 so it is recommended that only the RMU is replaced at those locations rather than the complete substation. – D15b = 275, as it was unclear why certain substations which scored 17 or less were identified for replacement when others were excluded. In total 312 substations scored 18 or over and it is assumed that the 37 listed as needing temporary works are included in this 312. – D15c = 37 as it seems reasonable that 13% of substations identified for replacement would also need temporary works and the run rate is similar to that in the RP6 period.

Table 18 11kV and 6.6kV Secondary Switchboard Replacement (D15d) - condition assessment summary

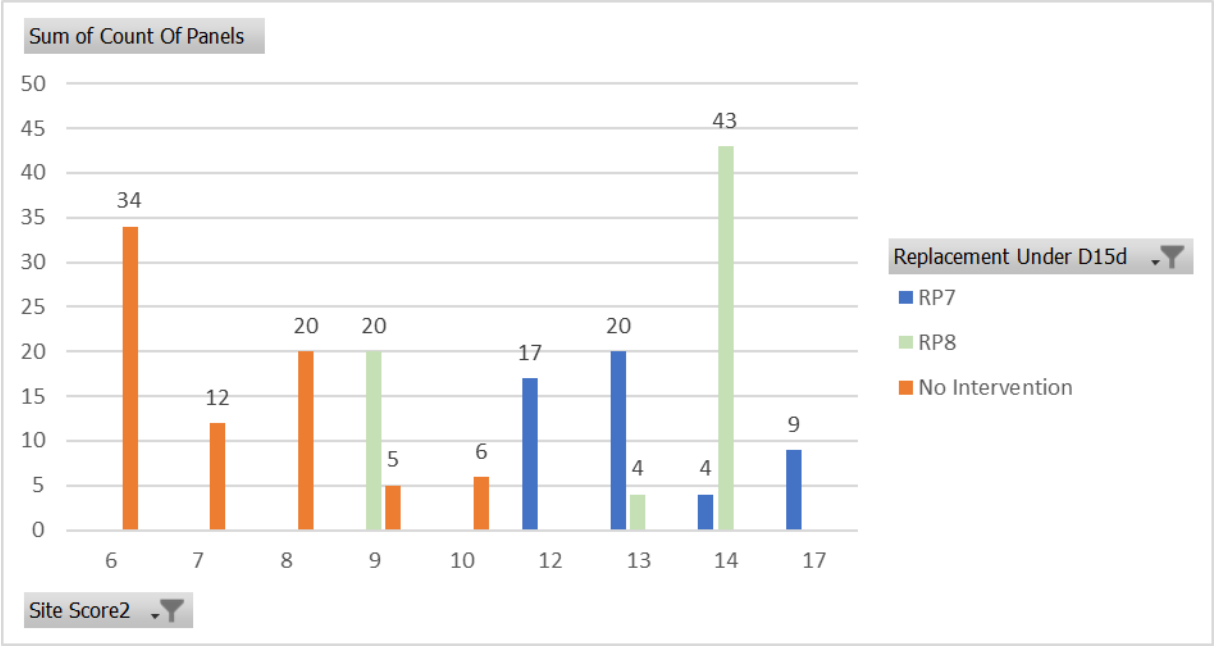
Element	Description
Condition points considered	– Circuit breaker type. – Age. – Number of customers connected.
Principal replacement driver(s)	The scores for the condition points listed above were added together (unweighted) to give a combined overall score for each panel, and these were then averaged per site. Each site was also identified with a suitability score, which indicated whether or not the site needed replacement with a primary/ secondary switchboard or standard RMU, or if it could be replaced under asset categories D15b&c. It is unclear how the suitability scores are assigned, as it is not consistent based on switchgear type, so is assumed to be site specific. Is it noted that the condition points used in the condition assessment sheet are different to those described in the EJP which were based on duty; location/environment; age; design; spares / obsolescence.
Volume / characteristics of proposed interventions	In total 11 sites, with a sum of 50 secondary panels, are proposed for replacement under expenditure category D15d. The EJPs indicate that the replacement solution is site specific, as outlined below: – 3 sites (13 panels) being replaced with new secondary switchboards. – 1 site (9 panels) being replaced with a new primary switchboard. – 7 sites (28 panels) being replaced with RMUs.
The figure below shows a summary of the planned volumes for intervention in RP7 and RP8 and volumes of secondary panels that have not been subject to any interventions in RP6 or are proposed for intervention in RP7 or RP8. The x-axis shows the average panel score for the sites, these scores ranged from 3 to 17. Sites with scores of 12 or higher have been identified for intervention in RP7 or RP8. 	
Characteristics of assets excluded from intervention	– 67 panels have been identified for intervention in RP8, all but one of these sites (4 panels) is planned for retrofit of the existing Reyrolle LMT panels. – No Reyrolle LMT panels are proposed for replacement/retrofit in RP7. – No intervention is proposed for sites with scores or 8 or lower. – No sites where the oldest panel is less than 50 years old are proposed for intervention in RP7.
Conclusion	Following our detailed assessment of the condition assessment model, its proposed outputs and comparison with historic run-rates, we conclude that the stated volumes for RP7 interventions in the D15d expenditure category are reasonable and recommend their inclusion within the RP7 programme.

Table 19 6.6kV and 11kV Overhead Fed Ground Mounted Secondary Substations (D15e) - condition assessment summary

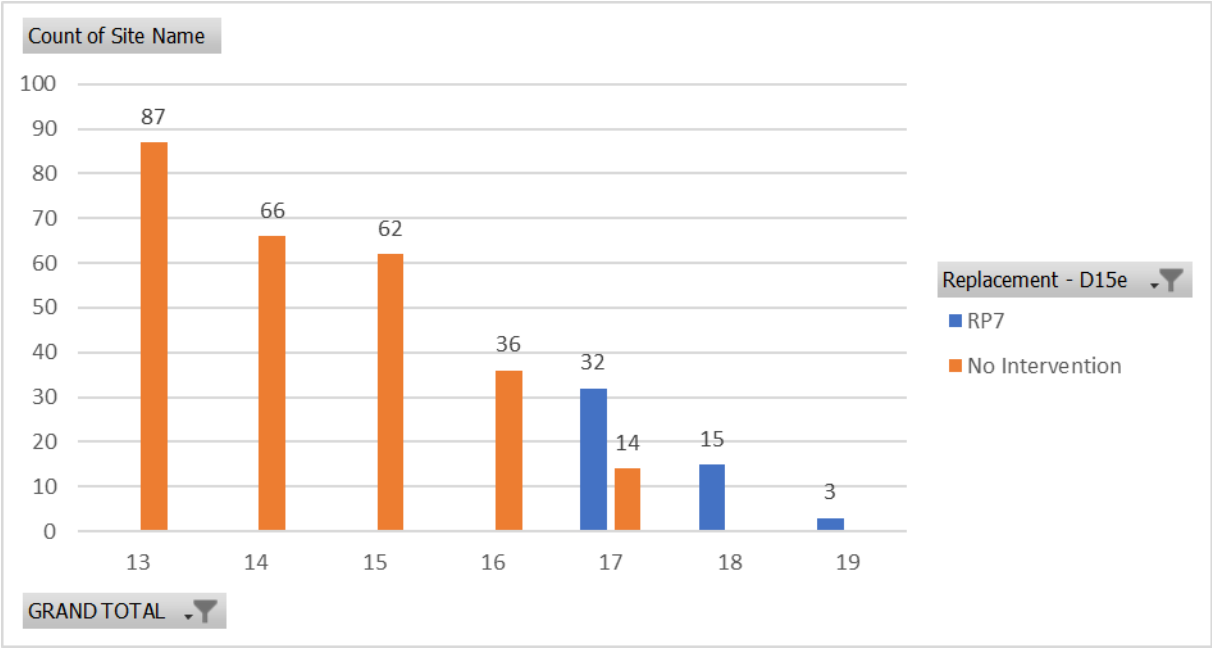
Element	Description
Condition points considered	– Number of customers connected. – Substation building / enclosure type. – Transformer age. – LV cabinet type (wood or steel). – Number of defects experienced. – Transformer condition defects. – Civil defects. – Pole condition.
Principal replacement driver(s)	The scores for the condition points listed above were added together to give a combined overall score, and the sites with the highest overall scores were selected for replacement. No weighting is applied to the condition point scores, however 78% of the assets identified for replacement did score highly on substation defects, indicating that this may be a higher priority condition point compared to others.
Volume / characteristics of proposed interventions	50 overhead fed ground mounted substations (all with poor overall condition scores) are proposed for replacement under expenditure category D15e.
The figure below shows a summary of the planned volumes for intervention in RP7 and volumes of substations that have not been subject to any interventions in RP6 or proposed for RP7. The x-axis shows overall substation score, these scores ranged from 8 to 20. 	
Characteristics of assets excluded from intervention	– 14 substations with an overall score of 17 are not included in the proposed interventions. – Substations with an overall score of 16 or lower are not included in the proposed interventions.
Conclusion	Following our detailed assessment of the condition assessment model, we conclude that the stated volumes for RP7 interventions in the D15e expenditure category are reasonable and recommend their inclusion within the RP7 programme.

Table 20 11KV and 6.6kV Sectionalisers (D15k) - condition assessment summary

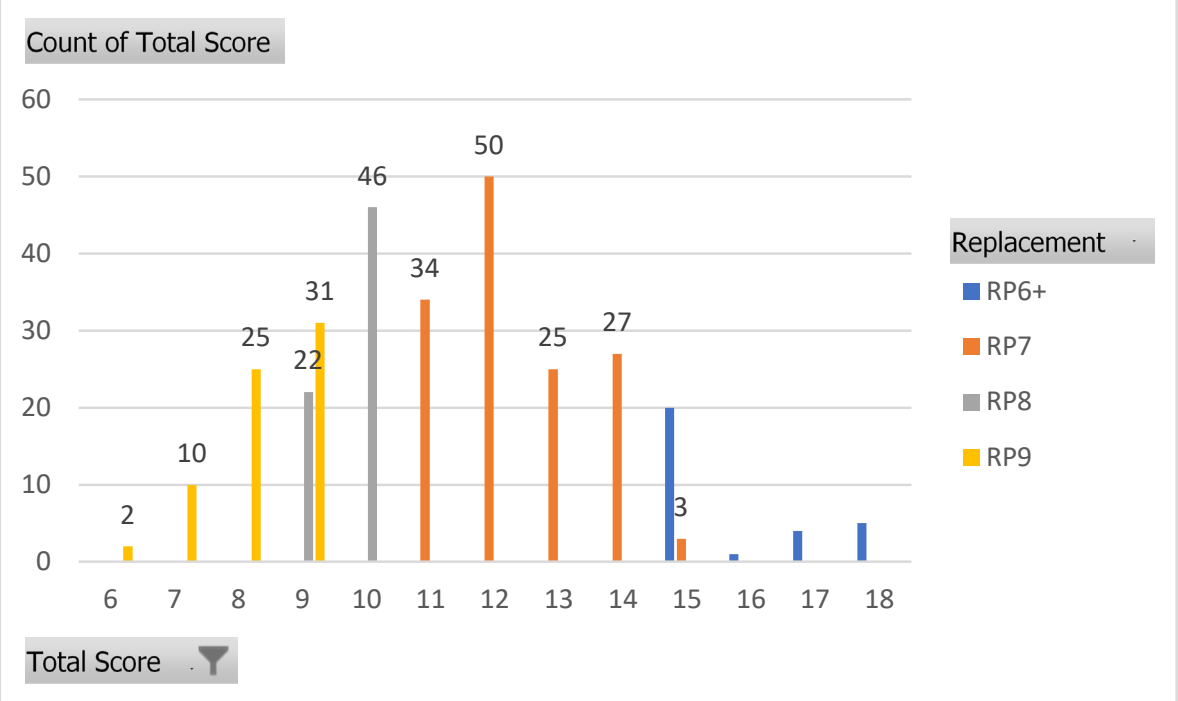
Element	Description
Condition points considered	– Number of customers connected. – Switchgear type. – On rogue circuit list. – Insulation medium.
Principal replacement driver(s)	The scores for the condition points listed above were added together to give a combined overall score, and the sites with the highest overall scores were selected for replacement. No weighting is applied to the condition point scores, although it was evident that the scores for switchgear type and customer numbers scored highly.
Volume / characteristics of proposed interventions	139 pole mounted sectionalisers are proposed for replacement under expenditure category D15k. This includes the replacement of 24 oil-filled units that are now more than 50 years old and are obsolete. A further 115 SF6 units are included - these have a known type defect in the main tank resulting in loss of SF6 gas.
The figure below shows a summary of the planned volumes for intervention in RP7 and asset quantities that NIE Networks has previously identified for RP6 intervention plus those targeted for price control periods beyond RP7. The x-axis shows overall asset score. The graph only shows 305 assets scoring 6 and above. There are a further 150 assets with lower scores, not included in graphical analysis below. 	
Characteristics of assets excluded from intervention	– 68 sectionalisers with an overall score of 9-10 identified for intervention in RP8. – 68 sectionalisers with an overall score in the range 6-9 identified for intervention in RP9. – 150 sectionalisers with an overall score less than 6 are not included in any future planned interventions.
Conclusion	Following our detailed review, we recommend that the stated volumes for RP7 interventions in the D15k expenditure category are included within the RP7 allowance.

Table 21 LV mini pillar replacements (D15l) - condition assessment summary

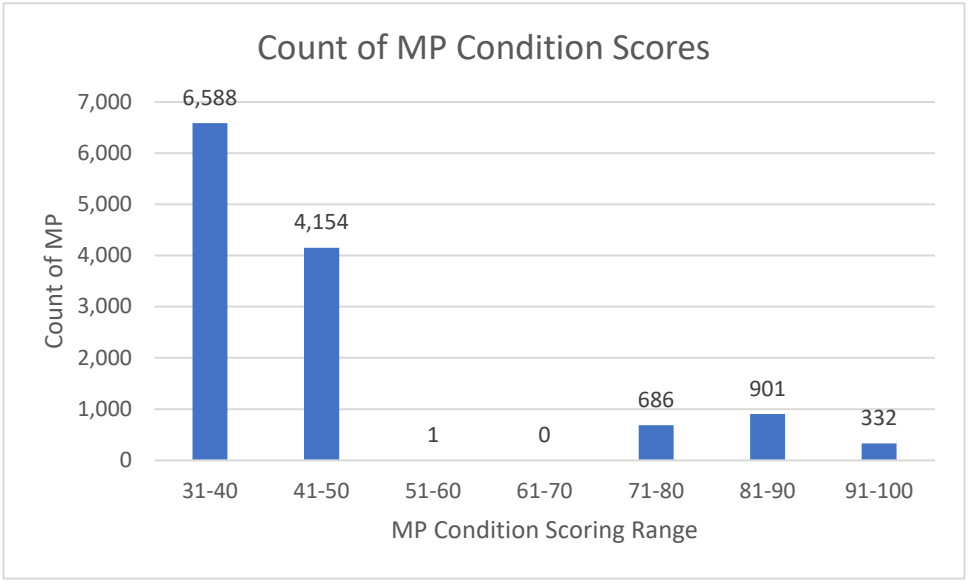
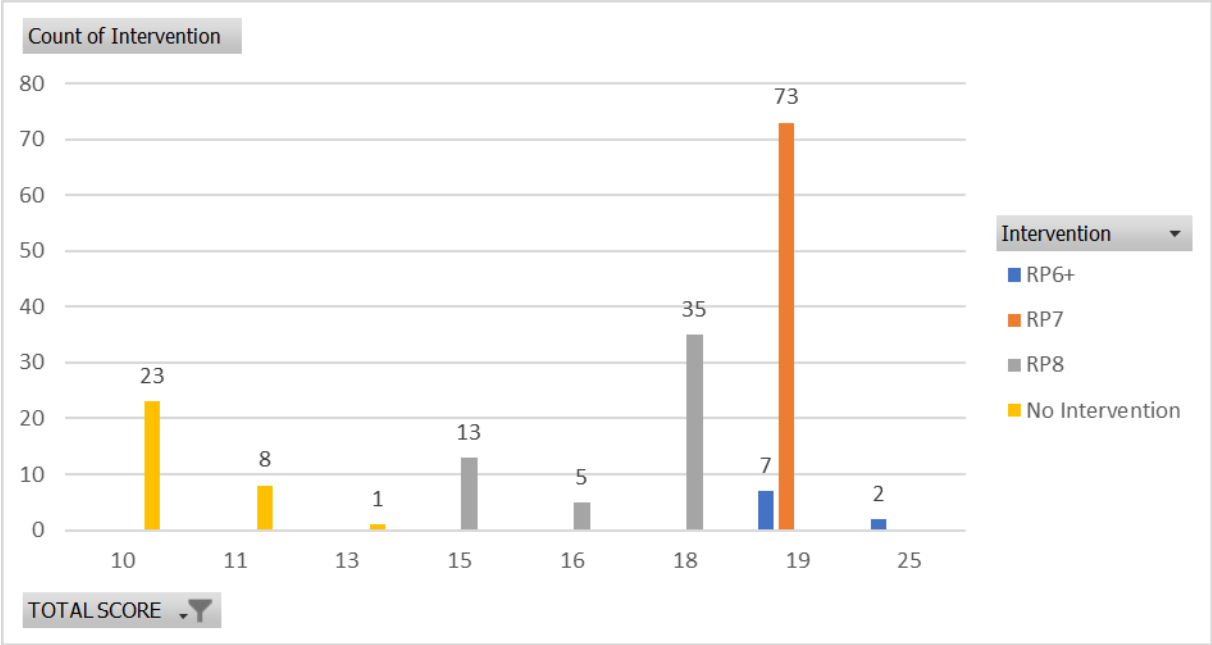
Element	Description
Condition points considered	– Age. – Corrosion index. – External / internal condition. – Compound leaks. – Signs of heating. – Phase barriers present. – Operational adequacy. – Targeted asset.
Principal replacement driver(s)	The scores for the condition points listed above are weighted and added together to give an overall score for each mini pillar. The highest weighting (45%) is applied to whether the pillar is a targeted asset (e.g. the doors are fitted with only a single locking point).
Volume / characteristics of proposed interventions	1,545 mini pillars are proposed for replacement under expenditure category D15l. The condition model does not readily identify the specific mini pillars included for intervention within RP6. It is assumed that the highest scoring units will be prioritised. It is not evident what threshold is applied above which pillars are targeted for intervention in RP7 and those which are not. Given the priority on targeted assets, there are 1,232 mini pillars identified with only a single locking point. All of these have a minimum condition score of 81 and we assume are included within RP7 volumes. Similarly, there are 687 pillars identified with type defect on the exterior metalwork and NIE Networks is proposing to replace almost 50% of these during RP7. Combined these targeted interventions total 1,545.
The figure below shows a summary of the scoring range and volumes of pillars within each band of scoring. The x-axis shows overall asset score. In total there are 12,662 mini pillars itemised within their model and NIE Networks is proposing to replace 1,545 - equivalent to 2% of the population each year.  	
Characteristics of assets excluded from intervention	– The data provided infers that a proportion of mini pillars with a condition score of 76 and below are excluded from the RP7 plans - representing approx. 88% of the asset population
Conclusion	Following our detailed review, we recommend that the stated volumes for RP7 interventions in the D15l expenditure category are included within the RP7 allowance.

Table 22 RMU substation mini-kiosks including temporary works (D15t and D15z) - condition assessment summary

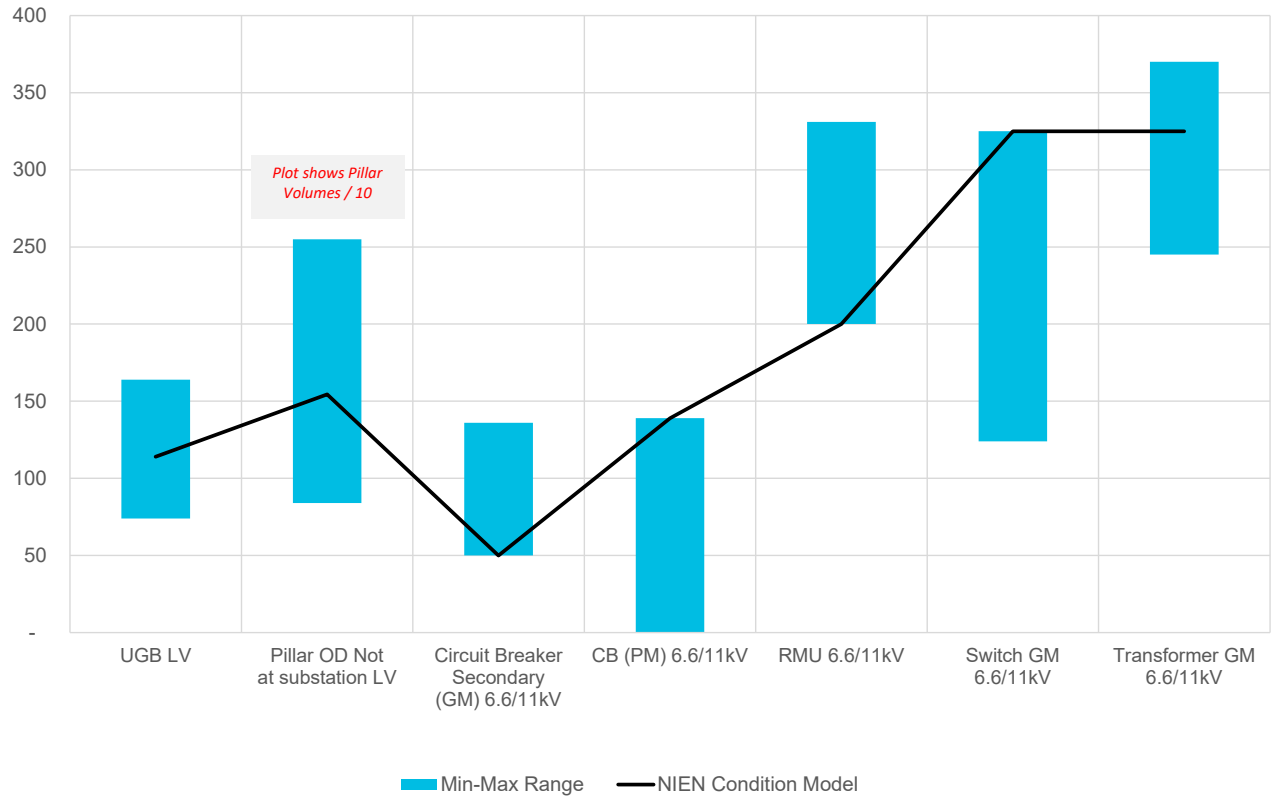
Element	Description
Condition points considered	– RMU type (made up of sub-scores based on equipment type, gas leaks, availability of spares, and operational restrictions, but these sub-scores are the same depending on the RMU type). – Substation type (modern or not). – Age.
Principal replacement driver(s)	The scores for the condition points listed above were added together to give a combined overall score, and the sites with the highest overall scores were selected for replacement. No weighting is applied to the condition point scores, though it was evident that the age scores were high on the assets identified for replacement, with all 73 assets proposed for replacement in RP7 being between 40 and 60 years old.
Volume / characteristics of proposed interventions	73 mini-kiosks are proposed for replacement under expenditure category D15t & D15z. No information is provided in the condition assessment data to indicate which mini-kiosks require temporary works. All of the proposed mini-kiosk replacements are of G.E.C. T3GF3 11KV RMU or LUCY FRMU MK2 11KV RMU types which are subject to corrosion type defects.
The figure below shows a summary of the planned volumes for intervention in RP7 and asset quantities that NIE Networks has previously identified for RP6 intervention plus those targeted for RP7 and RP8. The x-axis shows overall asset score. 	
Characteristics of assets excluded from intervention	– 53 mini-kiosks with an overall score in the range 15 to 18 identified for intervention in RP8 – 32 mini-kiosks with an overall score less than 13 are not included in any future planned interventions at present
Conclusion	Following our detailed review, we recommend that the stated volumes for RP7 interventions in the D15t and D15z expenditure category are included within the RP7 allowance.

In order to further verify the proposed RP7 replacement volumes, we also carried out a review of NIE Networks' replacement volumes from each of their modelling scenarios (described previously in Section 2.1.4). Due to the sub-programme structure of NIE Networks' Investment Plan, it is not possible to directly model replacement volumes for all asset types using all three methodologies. Where this is possible, either directly or indirectly (e.g. 11kV ground-mounted switchgear), we have included the asset type within our further review and Figure 4 below shows the max-min range of the model outputs, in terms of RP7 for each of the three methodologies, with the NIE Networks condition based model output also represented. It is evident that, with the exception of the pole mounted 11kV switchgear and ground mounted switchgear, the proposed replacement volumes are within range or the lowest of the model outputs.

For the 11kV pole mounted CB replacement volumes (Sectionaliser replacement), the recommended RP7 volumes are based on intervention required to address an identified type defect with the SF6 units resulting in loss of SF6 gas.

For the 11kV ground-mounted switch replacement volumes, the replacement volumes are included within the work programme for complete substation replacement. The prioritisation of these replacement works is based on detailed condition-based assessment for the NIE Networks distribution substation portfolio, which the age-based survivor model would not factor into the calculation of replacement volumes. We remain satisfied that the replacement volumes for these asset categories are reasonable for RP7.

Figure 4 Comparison of Model Outputs - 11kV & LV Asset Replacement Volumes



In addition to the above assessment, we also reviewed NIE Networks' investment proposal relating to a further number of investment categories. Our comments following the review are presented in the sub-sections below.

D15q & D15aa – Underground Distribution Box Replacement / Recovery

In RP6 NIE Networks replaced around 10% of the total population of mini pillars and underground distribution boxes (UDBs) combined. For RP7 NIE Networks has separated out the UDB replacements from mini pillars into its own asset category, but it is still considered a continuation of the RP6 programme. A bottom-up condition assessment was performed to determine the number of UBD replacements required, according to the EJP this was based on:

– Defects – operational or deterioration (reflected in the number of successive inspections and refurbishments recorded in NIE Networks' Maximo system)
– Locational safety risk – scored based on risk and probability

This led to 114 UDBs being identified for replacement in RP7, which is 17.1% of the total population of UDBs. This volume was between the volumes proposed by the age-based Survivor modelling and the CNAIM modelling.

In addition, a new asset category for installation of UDB protective blankets is proposed for RP7. NIE Networks is proposing to install 200 UDB protective blankets at locations which present the highest risk to members of the public. Some will be installed at sites where replacements are planned, but will be in place until such works are completed, and can then be re-implemented at other UDB locations.

Following our review, we recommend that the stated volumes for RP7 interventions in the D15q and D15aa expenditure category are included within the RP7 allowance.

D15f & D15g & D15h – 11kV and 6.6kV H-Pole Secondary Substations

Intervention is proposed at 138 H-pole secondary substations in RP7, this is a continuation from an historic replacement programme. The RP7 proposed volume is an overall decrease from the RP6 volume, but represents a small increase in the annual run-rate for these asset categories.

A condition assessment was used to identify the assets requiring intervention and the intervention solutions. No detailed condition assessment data was provided for analysis, however the EJP indicates that the condition criteria assessed included:

– Corrosion type.
– Operational safety restrictions.
– Pole decan and working at height risk.
– Location and encroachment.
– Age.
– Load growth.

In addition, there are corrosion type defects associated with Astor transformers and Renley LV 4 way cabinets manufactured between 2000 and 2004, hence these assets were prioritised for replacement.

The specific categories breakdown per asset category includes:

– 49 full H-pole replacements – including 7 sites containing Astor transformers and 6 with Renley LV cabinets. Options to install ground-mounted substations at these sites was considered but deemed to be more expensive.
– 45 H-pole transformer replacements – including the remaining 35 Astor transformers not counted in the category above.
– 44 H-pole LV cabinet replacements – including the remaining 24 Renley LV cabinets with the type defect.

Following our review, we recommend that the stated volumes for RP7 interventions in the D15f, D15g and D15h expenditure category are included within the RP7 allowance.

D15m – Refurbish LV Plant

This asset category covers NIE Networks' inspection and refurbishment investment for LV plant items including mini-pillars and UDBs. This is a continuation of an inspection programme from RP6.

NIE Networks' approach is to inspect all LV plant items at least once every 4 years. A condition assessment was performed which identified certain assets that would need more frequent inspection. In total 21,323 inspections are proposed for RP7, this is less than the RP6 volume, but a 10% increase in the annual run rate. This increase is due to a more targeted approach to inspections in RP7, with more inspections proposed for assets that had poor condition scores.

Following our review, we recommend that the stated volumes for RP7 interventions in the D15m expenditure category are included within the RP7 allowance.

D15n & D15y – Distribution Substation LV Plant

The wall mounted LV distribution boards proposed for replacement in RP7 are the last of this type on the NIE network. The LV boards are an open busbar design and present a safety risk to people entering the substation. Performing these works will result in the completion of the programme for this asset category.

Similarly, the outdoor 8-way LV cabinets included in this asset category present a safety risk due to their open frame non-insulated design. In total 40 LV cabinet replacements are proposed, this includes all 19 of the remaining wooden cabinets, and 21 others that were identified based on a condition assessment which considered:

– Age.
– Design.
– Duty.

– Spares.
– Location.

NIE Networks did consider refurbishment options, but it is not possible for the LV boards due to the lack of replacement spare parts, nor for the LV cabinets due to the severe corrosion of the units.

Following our review, we recommend that the stated volumes for RP7 interventions in the D15n and D15y expenditure category are included within the RP7 allowance.

5.2.3 RP6 v RP7 unit cost analysis

Table 23 presents details of the unit cost assessment that has been undertaken for distribution secondary plant.

Table 23 Distribution Secondary plant [17]– unit cost assessment

Sub-programme ID	Outturn unit costs (£)			RP7 requested unit cost (£)	Unit cost movement (%)
	RP5	RP6 Including 22/23[18]	RP6 Excluding 22/23[19].		RP7 vs. RP6 Excluding 2023.
D15a - Replace RMU	8,139	10,843	8,149	10,761	32.1%
D15b - Replace complete S/S	40,032	46,060	44,742	62,925	40.6%
D15c - Replace complete S/S and temporary S/S works	52,315	57,846	53,112	71,294	34.2%
D15d - Secondary Switchboard Replacement	154,555	24,550	22,389	36,110	61.3%
D15e - Replace OH fed GMT	44,990	45,951	48,411	63,981	32.2%
D15f - Replace H pole S/S	13,454	15,662	16,400	21,802	32.9%
D15h - H pole: replace LV cabinet	4,123	5,219	4,989	5,645	13.2%
D15k - Replace sectionalisers	12,312	8,700	9,159	10,563	15.3%
D15l - Replace mini pillars	3,741	4,518	4,448	3,865	-13.1%
D15m - Refurbish LV plant	-	71	74	74	0.0%
D15n - Replace LV wall mounted fuse board	18,427	21,466	22,077	22,076	0.0%
D15Tt - RMU substation - mini kiosk	-	43,540	31,104	63,689	104.8%

The percentage changes in the unit cost (RP7 request compared with RP6 Outturn) is presented in Figure 5, along with the equivalent percentage changes in asset volumes.

[17] Sub programmes with no comparable RP5/RP6/RP7 unit cost data have been removed from this analysis
[18] RP6 unit cost assessment is based on RP6 outturn costs and volumes reported by NIE Networks up to end March 2023 only - no forecast costs or volumes are included in our assessment of RP6 costs
[19] Outturn data for 2022/23 included a number of outliers due to work-in-progress (WIP) skewing the observed unit cost in the period. We have therefore analysed RP6 outturn unit costs with 22/23 costs included but also excluded to inform our recommended cost allowances.

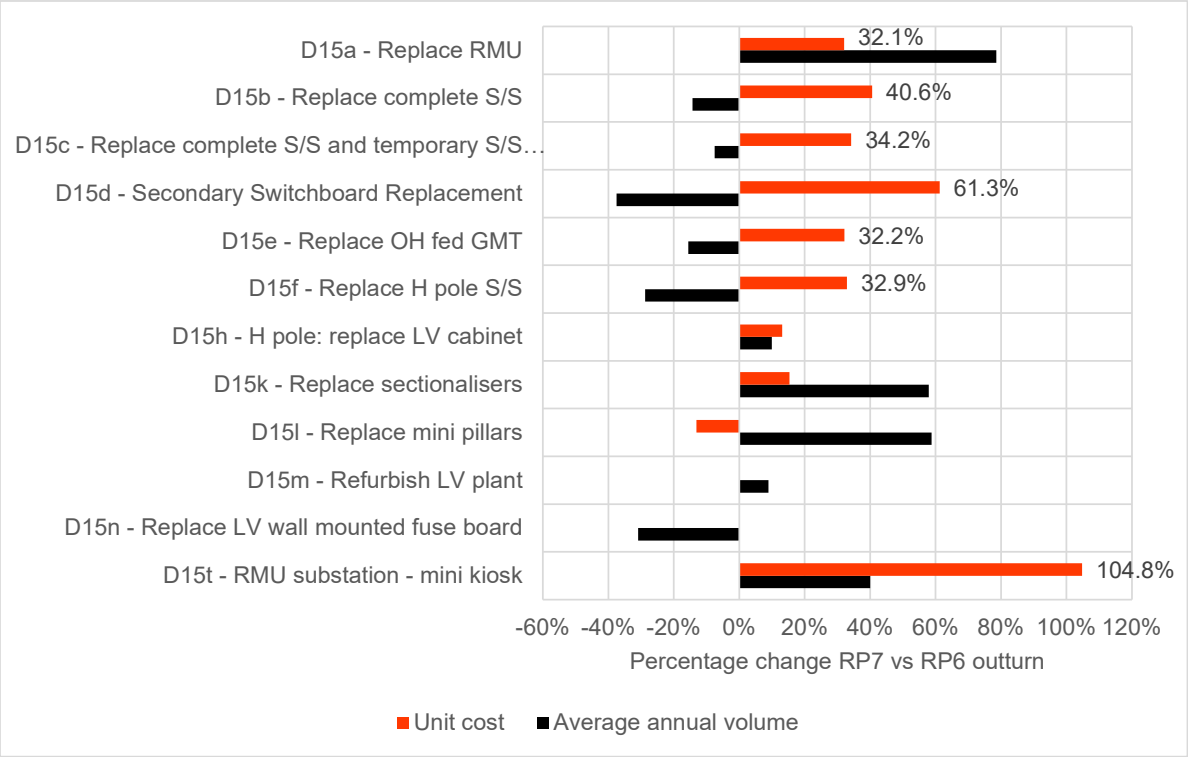


Figure 5 Distribution Secondary plant – Unit cost assessment

From Figure 5, it can be seen that 7 categories observed unit cost increases, when comparing RP6 outturn to RP7 that were greater than 20%, the largest increase being associated with RMU substation mini-kiosk replacements.

In addition, NIE Networks' query response on unit costs[20] indicates the assessment carried out by NIE Networks to apply adjustments to the March 2022 outturn unit rates. These comprise adjustments to account for:

– Adjustments to reflect underlying unit rate;
– Material prices (affecting various items of HV & LV plant);
– SF6 alternative materials; and
– Site specific cost increases.

In general terms we have used the RP6 outturn costs to inform our unit costs, together with reasonable adjustments to account for changes in technical scope (for example, the procurement of distribution transformers complying with the Tier 2 directive on maximum allowed losses). Other price increases linked to increased material and supplier costs are not included. For these, we recommend they are excluded as these likely constitute real price increases that the UR has advised are within the scope of the UR's real price effect adjustments, detailed in their frontier shift annex.

A detailed review of the unit costs subject to large overall percentage changes or application of the above adjustment factors has been undertaken. The findings from this review are presented in Table 24 below.

Table 24 Distribution Secondary plant – Review of unit cost changes

Expenditure category	Commentary on unit cost increases
D15a - Replace RMU	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate adjusted based on an SF6 alternative quote from a supplier but the price impact is uncertain. In NIE Networks' query response on unit costs[21], the additional costs were based on: – Material price increases

[20] Response to queries UR-0055,58,61,90-94
[21] NIE Networks response to UR Query No UR-0055,58,61,90-94

Expenditure category	Commentary on unit cost increases
	We recommend an allowed unit cost of £8.1k, based on the RP6 outturn up to end 2022 rate. This is broadly consistent with the RP5 outturn rate also.
D15b - Replace complete S/S	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate adjusted based on an SF6 alternative quote from a supplier. In NIE Networks' query response on unit costs[21], the additional costs were based on: – Material price increases – The transformer tier 2 eco directive For material price increases, we recommend they are excluded as these likely constitute real price increases that the UR has advised are within the scope of the UR's real price effect adjustments, detailed in their frontier shift annex. The transformer eco directive is considered a specification change and the indicated £11k unit cost increase to account for this should be included in the unit cost. We recommend an allowed unit cost of £55,740, based on the RP6 outturn rate plus uplift for change in transformer specification.
D15c - Replace complete S/S and temporary S/S works	Unit cost increase is as described above, with recommended allowed unit cost of £64,110, based on the RP6 outturn rate plus uplift for change in transformer specification.
D15d - Secondary Switchboard Replacement	The EJP indicated that the RP6 unit cost was unreflective as 50% of the works under had been switchboard to RMU replacements, this was restated in NIE Networks' query response on unit costs[6]. NIE Networks also provided some recent switchboard replacement costs[22] which were: – £6,556 for a secondary switchboard to RMU replacement – £15,195 for a secondary switchboard to secondary switchboard replacement – £36,728 for a secondary switchboard to primary switchboard replacement It is noted that the above were individual examples only, however there are more sites identified for RMU replacement solutions in RP7 (63.6%) compared to RP6 (42.9%) based on the information provided in the EJP and far fewer primary switchboard sites (9.1% in RP7 vs 38.1% in RP6), so it is expected that the unit cost should be lower than what has been proposed. We recommend an allowed unit cost of £22,390, based on the RP6 outturn rate.
D15e - Replace OH fed GMT	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate uplifted for material prices and the impact of the transformer tier 2 eco directive. The transformer eco directive is considered a specification change and the indicated £11k unit cost increase to account for this (noted against item D15b) should be included in the unit cost. We recommend an allowed unit cost of £59,410, based on the RP6 outturn rate plus uplift for change in transformer specification..
D15f - Replace H pole S/S	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate uplifted for material prices and the impact of the transformer tier 2 eco directive. The transformer eco directive is considered a specification change should be included in the unit cost. We recommend an allowed unit cost of £19,600, based on the RP6 outturn rate + a proportional uplift (based on the same proportion of the eco directive transformer uplift to the total Tx material prices used for asset D15b, and applied to the Tx material prices cost proposed by NIE Networks for this asset category[6]).
D15g - H pole: TX change only	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate uplifted for material prices and the impact of the transformer tier 2 eco directive. The transformer eco directive is considered a specification change should be included in the unit cost. We recommend an allowed unit cost of £8,610, with same assumptions as above.
D15t - RMU substation - mini kiosk	The EJP cites the basis for the RP7 unit cost as the March 2022 outturn rate uplifted for material prices, the impact of the transformer tier 2 eco directive, and due to expenditure hitting in RP5 but works occurring in RP6 thereby depressing the RP6 rate. The transformer eco directive is considered a specification change should be included in the unit cost. We recommend an allowed unit cost of £46,845, based on the RP5-RP6 outturn rate plus uplift for change in transformer specification...

[22] NIE Networks response to UR Query No UR-0311

For the other asset categories not included in the table above, we recommend the following unit costs:

– D15h - H pole: replace LV cabinet based on the RP6 outturn rate.
– D15n - Replace LV wall mounted fuse board based on the RP6 outturn rate.
– D15z - RMU substation - mini kiosk and temp based on RP5-RP6 unit rate (see comments against asset D15t in table above) + an uplift due to transformer eco directive + uplift for temporary works[23].

It is recommended to use the NIE Networks proposed RP7 unit costs for the following asset categories:

– D15k - Replace sectionalisers – unit cost increase from RP6 to RP7 was to account for specification change to improve installation safety which is deemed acceptable.
– D15l - Replace mini pillars – unit cost decrease from RP6 to RP7 was to remove unit costs associated with the UDB replacements which had been included previously in this category.
– D15m - Refurbish LV plant – unit cost decrease from RP6 to RP7 as there are lower levels of refurbishment expected due to the historic effectiveness of this programme.
– D15q - Replace UDB – this is a new asset category which had previously been included in category D15l, the units cost is higher than the mini pillar replacement unit cost which is expected due to the excavation works that required for UDBs – the combined unit costs for D15l and D15q is lower in RP7 compared to RP6 and therefore this is deemed acceptable.
– D15y - Replace LV Cabinet (GM Substation) – this is a new asset category and the EJP states that the cost is "based on a detailed cost estimate referenced back to current labour rates and material prices" so is considered acceptable.
– D15aa - Fit UDB Blanket – this is a new asset category which sits alongside category D15l, it is proposed as a safety investment and is therefore deemed acceptable.

The three remaining items in the secondary distribution work package did not have specific unit costs, however following our review of NIE Networks' proposed investment for these, we make the following comments and recommendations:

D15o - Secondary substation ancillary (civil) works

During RP6, NIE Networks has categorised its inspection data to prioritise civil defects identified. The proposed interventions are considered for the following types:

– Substation Shell Repair
– Ground Reinstatement Works
– Brick Built Building Roof Repairs
– Replacement and repairs of Boundaries and removal of climbing aids

NIE Networks has established a prioritised list of defects across its secondary substation asset portfolio. A total of 2,502 interventions are proposed in RP7. This compares with RP6 within which NIE Networks estimates that between 700 - 750 P1 and P2 sites intervened on during RP6 thus far[24].

We sought clarification on the proportion of both P1 and P2 interventions included within the RP7 programme. The works are heavily influenced by the P2 category (approximately 65%) of which the vast majority related to ground reinstatement works (almost 90%). NIE Networks' approach is to prioritise the rectification of P1 and P2 defects outside of normal maintenance schedules, whereas the rectification of lower risk P3 and P4 defects are, where possible, only completed with other maintenance and asset replacement work.

We support NIE Networks' proposal to address all P1 civil defects during RP7. There may be some scope to defer interventions beyond RP7 on a proportion of the P2 civil defects but also acknowledge that additional civil defects (previously categorised as P3) may be re-categorised at P1/P2 throughout the remainder of RP6 and within the RP7 period, requiring intervention.

Generally, the increased volumes of works proposed for RP7 are consistent with a continuing deterioration of the original building materials and potential underinvestment in previous price control periods. We therefore recommend RP7 allowances to target both P1 and P2 civil defects.

[23] equivalent to the difference between proposed RP7 costs for D15c and D15b
[24] NIE Networks response to UR Query No UR-0206

In terms of the capex required to address these interventions, NIE Networks has provided a schedule of intervention types, proposed volumes and total costs for each intervention type. It is our understanding that these costs have been built up on quotes per sq metre, or linear metre measurements bespoke to the requirements of each site.

Across the various sub-programmes relating to secondary plant, we have made adjustments to the proposed unit costs which in overall terms results in a net reduction of more than 10%. We therefore propose to make a similar adjustment to the RP7 unit costs proposed by NIE Networks and we recommend a reduction in capex allowances of 10% to the NIE Networks submitted value for this activity.

D15ac - Secondary Physical Security

NIE Networks' plans for RP7 include approximately £4.2m of capex relating to a series of interventions focusing on one or more of the following:

– Perimeter works - security fencing and access gate.
– Encroachment works - security fencing and access gate.
– High security steel door (replacement of existing rotten wooden door).

Proposed volumes are stated within the EJP (1.805) but there is no analysis, justification or commentary to support the proposed volumes. We sought supporting site survey information to gain a detailed understanding on the main driver for the proposed volumes.

For ***perimeter works***, NIE Networks Maximo system has identified 572 secondary substation sites with security issues associated with fencing. Of these, 390 sites were identified as Priority 1 and 182 sites identified as Priority 2. NIE Networks strategy is to address all P1 sites in RP7. NIE Networks has not considered any option to deal with P2 sites. There is no previous capex in RP6 to deal with security-related issues.

NIE Networks' proposed unit costs are based on 50% full replacement of fencing & 50% of partial replacement, although it is possible that some defects can be addressed with repair-type interventions rather than full / partial replacement.

We therefore propose to reduce unit costs to account for lower cost intervention.

For ***encroachment works***, the list of sites included with RP7 proposed allowances was created by extracting all the specific defects from Maximo. Priority 1 defects were determined by an assessment of photographic evidence attached to each defect. Out of a total of 127 encroachment defects, 95 were identified as Priority 1 and 32 identified as Priority 2. Again, NIE Networks strategy is to address all P1 sites in RP7. In all cases, the only intervention is to install palisade double gates and palisade security fence - no other intervention considered / presented.

In addition, NIE Networks has increased the required fence length per site by an additional 30% of fencing per site to extend fencing to include the laneway for access to substation. - It is unlikely this will be required in all cases.

For ***secondary substation door replacements,*** the list of sites included with RP7 proposed allowances was created by extracting all the relevant defects from Maximo. Out of these 509 door defects, 209 doors were identified as P1, and a further 107 doors identified as P2. P1 classification was based on reference to rot, rust, holes or corrosion within the defect report. Again, NIE Networks strategy is to address all P1 doors in RP7.

The cost build up utilised the contract pricing for the purchase and installation of 1 single & 1 double SR3 - door per site.

Following our review of the EJP and supporting information provided, the listed defects clearly identify intervention being required across many sites. We note NIE Networks has not made investment on physical site security at secondary substations during RP6 and their proposed capex for RP7 represents a significant proportion of their proposed investment at secondary substations.

There is no risk assessment of the P1 defects in terms of which sites present highest risk based on location - some form of prioritisation would target lower risk P1 defects beyond RP7 and into RP8. Even a one year extension to completing the P1 defects would reduce the RP7 volumes by more than 14%.

That said, we are mindful of the need to maintain the physical integrity of secondary substation sites and we therefore recommend that capex allowance is provided to target all P1 sites in RP7 period. However, we are not

convinced on the proposed interventions relating to fencing being applicable at all P1 sites. Or the proposed unit costs used and have therefore reduced the unit costs used by NIE Networks in preparing its forecast. We recommend a total allowance of £3.44m, equivalent to an 18% reduction compared to NIE Networks' submission.

D15x - Secondary substation legalities

NIE Networks' approach relating to secondary substation sites is a continuation of its approach during RP6 period. A significant increase in RP7 capex is proposed relative to RP6 (£1.9m v £1.0m[25]). The RP7 forecast is based on the following analysis / assumptions relating to secondary substations identified for RP7 intervention:

– 22 substations with valid lease but require site extension (e.g. to accommodate temporary works).
– 128 sites identified with expired lease requiring renewal.
– A further 57 sites identified with title unknown.
– A further 100 (representing 10%) out of an estimated 1,000 sites with expired leases where no works are planned during RP7 but the landowners will approach NIE Networks in the RP7 period with a request to renew the lease.
– A total number of site lease renewals of 307.
– Average site lease cost to increase by 47% based on a greater proportion of lease renewal on privately owned land as opposed to land owned by government bodies.

NIE Networks provided additional information to support their assumption that a further 100 sites may be subject to landowner request for lease renewal during RP7. In overall terms this assumption accounts for less than 2% of the expired assumption each year. It is not evident that similar experience was observed during RP6 period and we conclude that the assumption overstates RP7 volumes. We therefore recommend allowances based only on the proposed sites with planned intervention in RP7 - a total of 207 sites.

In relation to RP7 capex allowances, we recommend allowances based on average RP6 lease cost (plus agent and legal costs).

5.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 25.

Table 25 Distribution plant – Secondary plant recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D15a - Replace RMU	2,152	200	1,630	200
D15b - Replace complete S/S	18,122	288	15,329	275
D15c - Replace complete S/S and temporary S/S works	2,638	37	2,372	37
D15d - Secondary Switchboard Replacement	1,805	50	1,119	50
D15e - Replace OH fed GMT	3,199	50	2,971	50
D15f - Replace H pole S/S	1,068	49	961	49
D15g - H pole: TX change only	365	45	387	45
D15h - H pole: replace LV cabinet	248	44	230	44
D15k - Replace sectionalisers	1,468	139	1,468	139
D15l - Replace mini pillars	5,971	1,545	5,971	1,545

[25] NIE Networks response to UR Query No UR-0188

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D15m - Refurbish LV plant	1,580	21,323	1,580	21,323
D15n - Replace LV wall mounted fuse board	464	21	451	21
D15o - Secondary substation ancillary works	1,512	-	1,361	
D15q - Replace UDB	828	114	828	114
D15t - RMU substation - mini kiosk	3,567	56	3,054	56
D15x - Secondary substation legalities	1,959	-	1,077	
D15y - Replace LV Cabinet (GM Substation)	651	40	651	40
D15z - RMU substation - mini kiosk and temp	1,212	17	1,069	17
D15aa - Fit UDB Blanket	43	200	43	200
D15ac - Secondary substations physical	4,227	-	3,445	-
Total	**53,080**	**24,218**	**45,998**	**24,205**

6. Review of RP7 capex requirements - WP1: Distribution protection

This section relates to protection works proposed by NIE Networks to be carried out on their distribution system (predominantly at primary substations).

6.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 26 for each of the sub-work programmes included within programme D603. The table shows comparison of costs and volumes over the RP6period relative to the RP7 period.

6.1.1 RP7 Costs and volumes

Table 26 Distribution protection - NIE Networks investment proposal for RP7

		RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	**EJP ref**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**
D603A - 33kV protection retrofit	EJP 1.701	407	69	417	67	611	104
D603B - 11kV protection retrofit	EJP 1.701	1,042	175	1,158	179	2,003	304
D603e - Automatic Voltage Control replacements	EJP 1.701	-	-	-	-	375	22
D603g - 33kV Bus coupler retrofit	EJP 1.701	-	-	-	-	190	22
D603i - 33kV Transformer Protection retrofit	EJP 1.701	-	-	-	-	399	48
D603j - 33kV Distance Protection retrofit	EJP 1.701	-	-	-	-	57	4
D603k - Unit Protection retrofit - Full Diff / Pilot Box	EJP 1.701	-	-	-	-	243	15
D603k2 - Unit Protection retrofit - REF / NVD	EJP 1.701	-	-	-	-	43	10
D603l - 33kV Auto Changeover retrofit	EJP 1.701	-	-	-	-	185	9
D603m - 33kV SP Schemes	EJP 1.701	-	-	-	-	33	2
D603o - 33kV Substation Monitors	EJP 1.703	-	-	-	-	270	12
D603p - 33kV Substation Monitors retrofit	EJP 1.703	-	-	-	-	110	22
D603q - 11kV Substation Monitors	EJP 1.703	-	-	-	-	45	2
D603s - 11kV Unit Protection retrofit	EJP 1.701	-	-	-	-	265	68
D603u - Mesh VT Replacement	EJP 1.702	-	-	-	-	299	19
D603v - Switchboard VT Replacement	EJP 1.702	-	-	-	-	777	40
D603w - Protection Pilot	EJP 1.701	-	-	-	-	20	-

		RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	**EJP ref**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**
Total		**1,449**	**244**	**1,575**	**246**	**5,924**	**703**

From the above table, it is evident that NIE Networks is proposing a significant increase in protection-related capex for the RP7 period.

The two main programmes that commenced in RP6 period, relating to protection retrofits. will continue at a much increased rate compared to RP6, rising from £1.6m to £2.6m. In addition, NIE Networks is proposing investment across many new work programmes with a further capex of £3.3m identified.

6.1.2 Rationale for investment

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 27 below for each of the sub-programmes.

Table 27 Distribution Protection – Investment Strategy

Sub-programme ID	EJP ref	Investment Strategy
D603A - 33kV protection retrofit	EJP 1.701	The main investment driver for this category is the requirement to maintain and operate a safe and reliable network. Protection systems are a key component of the electricity network to help protect members of the public, employees and assets. In addition, protection systems are also an integral part of substation monitoring and this is a secondary driver for this EJP. The 33kV and 11kV protection retrofit sub-programmes (D603A and D603B) began as a trial in RP6 and RP7 looks to scale this. The other sub-programmes in this EJP are new in RP7 and aim to address specific aspects of protection and control systems. It should be noted that there is limited detail within the EJP with respect to the content and improvements the sub-programmes aim to address. For example, there is no reference to specific safety and operational aspects associated with the relay (or equipment) types that are planned to be addressed in RP7. Further detail was provided in the responses to the supplementary questions, however, this was high-level and provided only limited information.
D603B - 11kV protection retrofit		
D603e – Automatic Voltage Control replacements		
D603g – 33kV Bus coupler retrofit		
D603i – 33kV Transformer Protection retrofit		
D603j – 33kV Distance Protection retrofit		
D603k – Unit Protection retrofit – Full Diff / Pilot Box		
D603k2 – Unit Protection retrofit – REF / NVD		
D603l – 33kV Auto Changeover retrofit		
D603m – 33kV SP Schemes		
D603s – 11kV Unit Protection retrofit		
D603w – Protection Pilot		
D603u – Mesh VT Replacement	EJP 1.702	Voltage transformers (VTs) also form part of the protection system and therefore the drivers for EJP 1.702 are identical to EJP 1.701. One of the key aspects of this EJP is the intention to replace existing oil-filled VTs with more modern cast resin equivalents to mitigate fire and environmental risks. However, similar to EJP 1.701, there is limited information to that outlines why these sites have been chosen for replacement over others.
D603v - Switchboard VT Replacement		
D603o – 33kV Substation Monitors	EJP 1.703	This EJP covers both distribution substation monitors and transmission substation monitors (distribution monitors are captured here and transmission monitors are captured separately in section 10). NIE Networks state that the main driver for investment is “maintaining a safe, reliable and resilient network”. However, the main body of the EJP states that the drivers are to remove and replace “obsolete, age expired and faulty equipment” and to improve the levels of substation monitoring (including power quality).
D603p - 33kV Substation Monitors Recommissioning		
D603q – 11kV Substation Monitors		

6.2 GHD analysis

6.2.1 Run-rate comparison

Table 28 Distribution protection – run-rate comparison

	Average volume pa		
Sub-programme ID	**RP6 outturn**	**RP7 requested**	**% change RP7 vs RP6.**
D603A – 33kV protection retrofit	9.3	17.3	85.7%
D603B – 11kV protection retrofit	23.2	50.7	118.4%

Table 28 presents the volume run-rate analysis that compares annual volumes for RP6 with requested volumes for RP7. Only sub-programmes with comparable data across RP periods are included in the above table.

There is a significant increase in volumes requested for RP7 in the 33kV and 11kV protection retrofit categories (86% and 118% respectively). It should be noted that there were no separate volumes for the more “bespoke” sub-programme protection categories in RP6, it is assumed that these were included within the general protection retrofit categories in RP6.

6.2.2 Condition assessment analysis

NIE Networks has developed a scoring methodology detailed within EJP 1.701 following the protection replacement trials implemented in RP6. The methodology is based on a “condition” score which ranges from 1 (no intervention required) to 5 (immediate intervention required). The EJP provides no breakdown of asset scores, therefore, a query (UR-091) was submitted to NIE Networks to clarify the application of condition scores across protection assets. In their query response, NIE Networks clarified that a condition score of 5 is used as the intervention trigger point, but given the number of relays categorised as 5 and being cognisant of the deliverability challenge associated with this work programme, only a sub-set of relays categorised as 5 have been proposed for replacement within the RP7 period..

The following figures are taken from the response to query UR-091, which show only sites, but not the number of relays.

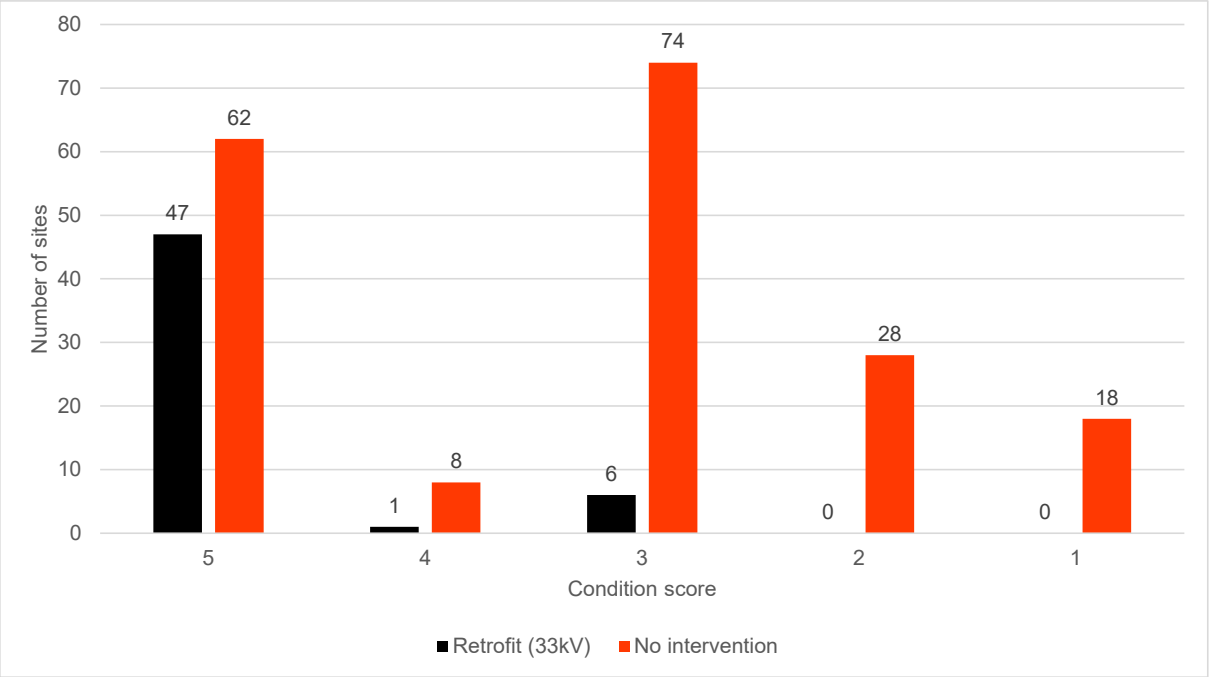


Figure 6 *Distribution protection – Condition assessment summary for 33kV sites (retrofit)*

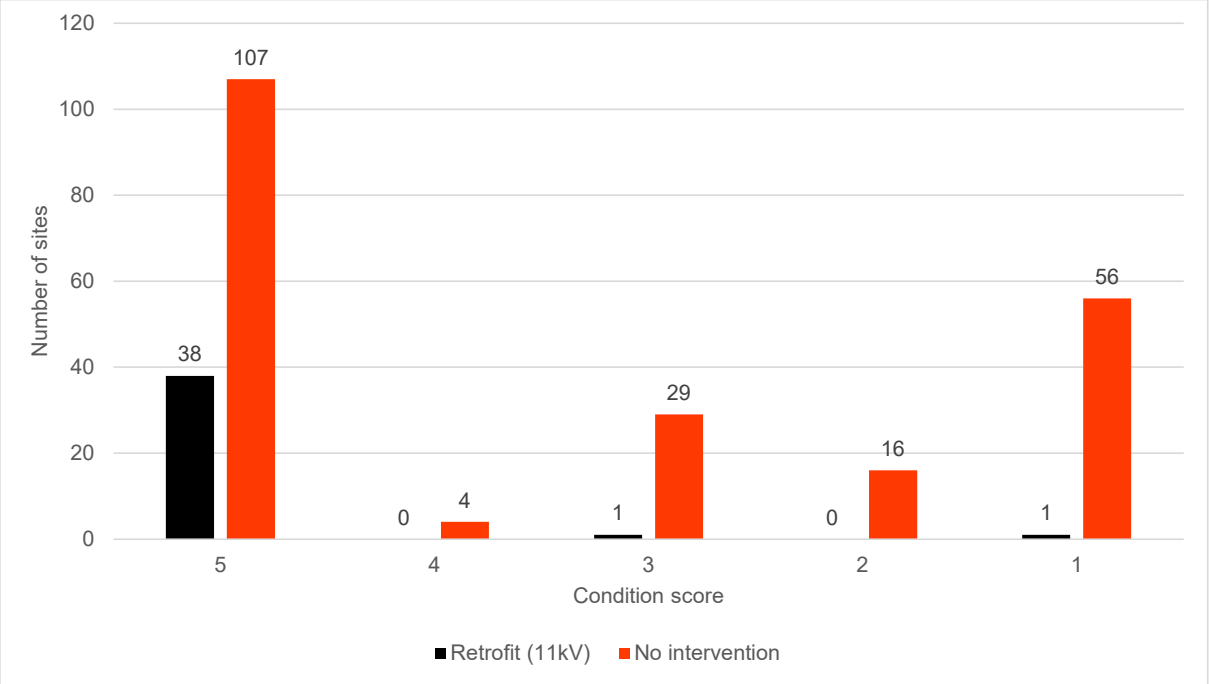


Figure 7 *Distribution protection – Condition assessment summary for 11kV sites (retrofit)*

The results shown in Figure 6 and Figure 7 indicate a high population of sites where equipment has been assigned a score of 5 (immediate intervention required).

There are gaps in the scoring methodology and resulting figures that raise questions regarding the volumes requested in RP7. The main area relates to the scoring methodology. In the EJP description, the drivers for investment relate to condition and safety, however, the scoring methodology appears to be entirely based on the age, obsolescence and support available for the protection asset. There is no information to capture the impact of the particular protection asset on safety and network reliability (i.e. CI and CML consequence), which is a primary driver for this category. It is, therefore, not possible to confirm whether the substantial increase in volumes requested for RP7 are fully justified. In addition, each of the sub-programmes will have a different impact on safety and network reliability. For example, the risk associated with an AVC failure (D603e), where voltage control is

impacted, will be different from the failure of an overcurrent and earth fault relay protecting an 11kV overhead line. The EJP does not provide any detail that confirms whether these risks have been considered when preparing the volumes for RP7.

6.2.3 RP6 v RP7 unit cost analysis

Table 29 Distribution protection – unit cost assessment

Sub-programme ID	RP6 Outturn.	RP7 requested unit cost (£k)	Unit cost movement (%)
			RP7 v RP6 outturn
D603A - 33kV protection retrofit	5.6	5.9	4.9%
D603B - 11kV protection retrofit	6.7	6.6	-1.7%

The unit costs presented in Table 29 show the outturn unit costs in RP6 compared with those proposed for RP7. Only sub-programmes with comparable data across RP periods are included in the above table.

We understand that the unit costs proposed for RP7 have been based on trials undertaken in RP6 and a high level of confidence can be placed on these. The comparison shows limited change in unit costs between RP6 and RP7 for the 33kV and 11kV protection retrofit sub-programmes. It is expected that the remaining categories, D603e to D603w, have been developed using the same methodology and these appear to be consistent and in alignment with industry standards.

6.2.4 Summary of Distribution Protection

As described above, issues have been identified in the preparation of volumes for RP7. We agree with the drivers in the main body of the EJP, “maintaining a safe, resilient and reliable network”. However, there is no evidence to demonstrate that the volumes have been justified on elements such as safety, resilience and reliability. Instead the condition assessment appears to have been justified on age, on a per site basis.

We understand from other DNOs that there are specific relays that are known to pose a higher risk compared to others (such as the legacy Alstom/Areva K-series). However, the EJP and response to the supplementary query do not provide any detail regarding the type and number of relays and their specific risks, meaning that it is not possible to confirm exactly what is being requested. In addition, Appendix 1 of EJP 1.701 only provides a list of discontinued relays, some of which are less than 10 years old with no widely known defects or issues.

EJP 1.702 covers the replacement of switchboard and mesh VTs on the distribution network. The EJP recommends replacement of VTs on switchboards where the original oil-filled circuit breakers have been retrofitted with newer oil-free alternatives. Whilst it makes practical sense to replace the last remaining fire-risk from these sites, there is no analysis to indicate that the relevant makes/models of VT are prone to failure or present a significant risk to life or the equipment (especially as these devices are not operating to break faults in the way that switchgear does). In addition, no analysis has been presented to show the impact of replacing these VTs in terms of life extension or health improvement. However, for the replacement of mesh VTs, the reasoning focuses on the need to have equipment that aligns with the new auto-changeover schemes proposed, and this is justified.

The need to install and recommission substation monitors is covered within EJP 1.703. NIE Networks intends to continue its ongoing programme from RP6 to install monitors at strategic points on the network, providing greater network visibility. The volumes proposed for RP7 are lower than RP6 as the majority of work in the programme has already been completed. In addition, there is a need to reconfigure and recommission monitors where protection and/or switchgear is being upgraded. The volumes proposed in this EJP are in alignment with the delivery programme and are justified.

In general, we have observed that there is substantial cross-over between three Distribution Protection EJPs and other Primary Plant EJPs, for example where circuit breakers are being replaced along with protection systems. However, the EJPs lack sufficient detail to determine where this cross-over is occurring. This makes it difficult to assess where NIE Networks is achieving savings by conducting work in an efficient manner (i.e. combining projects together to reduce outages and risk to the customer).

6.3 GHD recommendation

Table 30 presents the recommended allowance for Distribution Protection. The requested allowance has been adjusted based on a reduction in volumes for the majority of categories, with the exception of those included in EJP 1.703 (substation monitors) and sub-programme D603u – Mesh VT Replacement, where the volumes are justified. Unit costs were found to be justified, so these remain unchanged.

The recommendation to reduce volumes is based on the issues described earlier in this section. Primarily, the issues relate to a lack of evidence to support the allocation of condition scores and the resulting volumes. The justification presented in the EJPs is very high-level with no specific detail on how individual assets have been assigned a condition score. There is no evidence presented to demonstrate that the main drivers of safety and network resilience/reliability have been considered in the scoring and prioritisation of asset replacement. However, it is understood that there are issues with particular makes/models of assets, therefore, the volumes proposed have not been dismissed completely. Instead they have been reduced by 50%, which GHD considers to be reasonable to address specific issues and provide an efficient approach to addressing the main drivers, based on our experience in other jurisdictions and in the absence of specific evidence for individual assets.

Table 30 Distribution plant – Protection recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D603A - 33kV protection retrofit	611	104	306	52
D603B - 11kV protection retrofit	2,003	304	1,001	152
D603e - Automatic Voltage Control replacements	375	22	187	11
D603g - 33kV Bus coupler retrofit	190	22	95	11
D603i - 33kV Transformer Protection retrofit	399	48	199	24
D603j - 33kV Distance Protection retrofit	57	4	29	2
D603k - Unit Protection retrofit - Full Diff / Pilot Box	243	15	129	8
D603k2 - Unit Protection retrofit - REF / NVD	43	10	22	5
D603l - 33kV Auto Changeover retrofit	185	9	103	5
D603m - 33kV SP Schemes	33	2	16	1
D603o - 33kV Substation Monitors	270	12	270	12
D603p - 33kV Substation Monitors retrofit	110	22	110	22
D603q - 11kV Substation Monitors	45	2	45	2
D603s - 11kV Unit Protection retrofit	265	68	132	34
D603u - Mesh VT Replacement	299	19	299	19
D603v - Switchboard VT Replacement	777	40	389	20
D603w - Protection Pilot	20	-	10	-
Total	**5,924**	**703**	**3,342**	**380**

7. Review of RP7 capex requirements - WP2: SCADA & Operational Telecommunications Network (OTN)

This section includes details of NIE Networks' submission for RP7 period relating to proposed investment on their SCADA system and Operational Telecoms Network.

7.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 31 for each of the sub-work programmes included within D39 and D41. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period. There are no provided volumes in the EJPs from NIE Networks in all cases, except sub-programme D39B.

7.1.1 RP7 Costs and volumes

Table 31 SCADA & Operational Telecommunications Network (OTN) – NIE Networks investment proposal for RP7

Sub-programme ID	EJP ref	RP6 allowance		RP6 outturn		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
D39 – SCADA (sub-total)		**5,557**	**122**	**5,830**	**139**	**4,803**	**127**
D39B – Replace RTU	EJP 1.901	3,798	122	1,992	122	2,222	127
D39C – Control centre hardware & software	EJP 1.901	1,759	0	2,181	-	2,076	-
D39f – SCADA Battery Replacement	EJP 1.901	-	0	-	-	136	-
D39g – Retrofit Radios	EJP 1.901	-	0	-	-	369	-
D41 – Operational Telecoms network (sub-total)		**0**	**0**	**0**	**0**	**13,956**	**0**
D41c – PSTN Replacement	EJP 1.902	-	-	-	-	201	0
D41d – 10.5g Radio Creation	EJP 1.902	-	-	-	-	466	0
D41e – DC Asset Replacement	EJP 1.902	-	-	-	-	358	0
D41f – OIP Replacement	EJP 1.902	-	-	-	-	554	0
D41g – Comms Generators	EJP 1.902	-	-	-	-	61	0
D41h – Comms AC Services	EJP 1.902	-	-	-	-	72	0
D41j – Mast Replacements	EJP 1.902	-	-	-	-	583	0
D41k – Microwave Asset Replacement	EJP 1.902	-	-	-	-	424	0
D41l – Optical Distribution Frame Replacement	EJP 1.902	-	-	-	-	48	0
D41m – Optical Fibre Replacement	EJP 1.902	-	-	-	-	701	0
D41n – Optical Fibre New	EJP 1.902	-	-	-	-	3,619	0
D41o – Substation Comms Equipment Replacements	EJP 1.902	-	-	-	-	84	0
D41p – RAD Assets Replacements	EJP 1.902	-	-	-	-	4,098	0

Sub-programme ID	EJP ref	RP6 allowance		RP6 outturn		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
D41r – Server Asset Replacements	EJP 1.902	-	-	-	-	125	0
D41s – Sync Assets Replacement	EJP 1.902	-	-	-	-	69	0
D41u – Comms Physical Security	EJP 1.902	-	-	-	-	78	0
D41x – Comms Cyber Security	EJP 1.902	-	-	-	-	392	0
D41y – Belfast Multi-Core Network	EJP 1.902	-	-	-	-	252	0
D41z – SCADA IP Transition	EJP 1.902	-	-	-	-	802	0
D41ab – Capacity Growth	EJP 1.902	-	-	-	-	338	
D41ac – Comms Resilience	EJP 1.902	-	-	-	-	617	
D41ae – Exchange Closure – Pilot	EJP 1.902	-	-	-	-	17	
Total		**5,557**	**0**	**5,830**	**0**	**18,759**	**0**

7.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases refurbish) aging SCADA & OTN assets on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 31) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 32 below for each of the sub-programmes.

Table 32 SCADA & OTN – Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
D39B – Replace RTU	EJP 1.901	This is a continuation of existing RP6 programme of updates and end-of-life replacements to ensure the SCADA equipment will remain reliable, reduce the risk of unrecoverable failure, and meet cyber security standards for critical national infrastructure. Key drivers maintaining a safe, reliable and resilient network, compliant with regulation and legislative requirements, and allowing for capacity growth. Existing network manager system is out of support in 2029. The majority of Distributed Energy Resources (DER) and Pole Mounted Devices (PMDs) Remote Terminal Units (RTUs) require replacement with more modern units due to obsolescence and support issues. PMD RTU volumes will increase in RP7. Primary substation RTU batteries require replacement due to age, and age-related degradation. Retrofit radios to add remote control capabilities to existing PMDs, to meet Network Performance Strategy targets.
D39C – Control centre hardware & software		
D39f – SCADA Battery Replacement		
D39g – Retrofit Radios		
D41c – PSTN Replacement	EJP 1.902	Operational Telecoms Network (OTN) has previously been through one asset replacement cycle commenced in RP5. The original optical fibre is now approaching the end of its serviceable life, increasing faults primarily caused by weather damage. The proposed works are required to maintain the OTN at required standards for critical national infrastructure, maintaining security while being compatible to the development of
D41d – 10.5g Radio Creation		
D41e – DC Asset Replacement		
D41f – OIP Replacement		
D41g – Comms Generators		
D41h – Comms AC Services		

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
D41j – Mast Replacements		Distribution System Operator (DSO) capabilities supporting increasing volumes of low carbon technologies (LCTs).
D41k – Microwave Asset Replacement		
D41l – Optical Distribution Frame Replacement		
D41m – Optical Fibre Replacement		
D41n – Optical Fibre New		
D41o – Substation Comms Equipment Replacements		
D41p – RAD Assets Replacements		
D41r – Server Asset Replacements		
D41s – Sync Assets Replacement		
D41u – Comms Physical Security		
D41x – Comms Cyber Security		
D41y – Belfast Multi-Core Network		
D41z - SCADA IP Transition		
D41ab – Capacity Growth		
D41ac - Comms Resilience		
D41ae – Exchange Closure – Pilot		

7.2 GHD analysis

7.2.1 D39 SCADA

This is a continuation of existing RP6 programme of updates and end-of-life replacements to ensure the SCADA equipment will remain reliable, reduce the risk of unrecoverable failure, and meet cyber security standards for critical national infrastructure.

The specific investments identified for the SCADA system and infrastructure in RP7 are described in EJP 1.901 SCADA Network Manager and RTU Replacement and are as follows.

– D39b: Replace older technology Remote Terminal Units (RTUs) to reduce fault rates and make assets compatible with modern secure and supported Internet Protocol-based (IP) communications;
– D39c: Upgrade the operating system used by the Network Manager system and replace the server hardware infrastructure that has reached end of optimal life;
– D39f: Replace batteries that are in poor condition to mitigate high failure rates; and
– D39g: Retrofit radios to meet network performance targets.

Our analysis of each sub-category is discussed in the following sub-sections.

D39b Replace obsolete RTUs

NIE Networks has stated their investment drivers for the replacement of RTUs are the following.

– RTU has failed.
– RTU which reaching end of life or is obsolete as they are no longer supported by the Original Equipment Manufacturer (OEM).
– Provide support of IP based non-proprietary communications protocols.

These are in-line with proposals of UK DNOs and other utilities around the world in particular the move to IP based non-proprietary communications protocols.

The initial proposals for replacement of RTUs in EJP 1.901 SCADA was unclear and contradictory with differing numbers for RTU replacements stated within the document. In their response to a query[26] NIE Networks has confirmed the total number of RTUs planned to be replaced in RP7 is 127.

The units cost for these items has been based on the outturn costs for Primary Substation RTU replacement of 122 RTUs during RP6 at £29.3k. NIE Networks has advised a unit cost of £17.5k for the replacement RTU during RP7. The 40% reduction in unit cost has been explained by their focus in RP7 being on the replacements of smaller RTUs,18 DER and 109 PMD RTUs.

We note that the number of RTU planned to be replaced is similar to that achieved during RP6 and is an average of 18 replacements per year. Furthermore the RTU considered for replacement are small, therefore we consider this programme achievable.

The most recent unit costs available for comparison have a range from £13k to £50k. It must be noted that these costs are for replacement of RTUs of varying sizes up to those required for bulk supply and primary substations. The NIE Networks unit costs are at in the lower end of this range therefore we do not propose any change to the requested allowance of £2,222k.

D39c Control centre hardware & software

The major drivers for the NIE Networks upgrade to the Network Manager (NM) are as follows.

– To maintain hardware and software in manufacturer/vendor support a requirement of NIS Regulations 2018 (NIS).
– Transfer of TSO SCADA assets.
– Expansion in the number of field devices.
– Minimise operating costs.
– Increasing efficiencies.

Hitachi Energy (previously ABB) the NM SCADA software supplier will only provide vendor support for the last two major versions of the operating systems. The two operating systems in use on the NM and their end of support are:

– Windows 10 version 1607 – supported until October 2026; and
– Linux RedHat version 7 – extended life cycle support until June 2026.

After support of these operating system ceases, updates to correct software issues and cyber security vulnerabilities will no longer be available exposing the system to failures and cyber-attacks. Furthermore, it is a requirement of the UK government that all operators of essential services comply with NIS Regulations 2018 (NIS) which requires vendor support of operational systems to be maintained.

To maintain vendor support of the NM software and operating systems, NIE Networks is proposing to replace/upgrade the NM SCADA software in 2027. This will also require the upgrade of the hardware to meet the additional processing power, memory and storage capacities for the SCADA system version.

The existing hardware will be replaced, consistent with a seven-year lifespan. We agree that as these servers age, reliability can be adversely impacted with a greater risk of unplanned downtime and they become costlier to maintain.

The upgrade of the system includes expansion of the system to support communications interface to 900 new pole mounted devices (PMDs). The installation of these devices is part of the Network Performance Improvement strategy to improve reliability and resilience described in EJP 1.801(Network Performance Strategy) and considered elsewhere. However, the programme appears ambitious requiring the installation of 2-3 devices every week for the seven years of RP7.

Communications between the NM and the new PMDs is dependent on both completion of the NM upgrade to the communication interfaces (planned completion 2027) and the implementation of the proposed pLTE network discussed in EJP 4.102 (DSO Operational Telecoms Network Transition). This proposal for the implementation of a pLTE network is not being considered at this time and NIE Networks has requested an uncertainty mechanism to

[26] Clarification of RTU volumes requested in query UR-0156

deal with this issue. However, until communications between the NM and the new PMDs is established, the PMDs will be operating in local control and the full benefit of these devices will not be fully realised. At the present time it is unclear when communications infrastructure (either that described in EJP 4.102 or an as yet undefined/unfunded solution) will be available.

The SCADA infrastructure (hosts, workstations, licences, network switches, SIEM security apparatus, etc.) were competitively procured for the last upgrade and will be for the RP7 upgrade. NIE Networks' IT MSP delivered most of this previously and Microsoft OS was also supplied by NIE Networks partners / re-sellers for example.

The costs breakdown in EJP 1.901 for the NM upgrade had insufficient detail to assess their reasonability. In response to a query[27] NIE Networks provide a breakdown of the cost build shown in Table 33 below.

Table 33 NIE Networks Network Manager Upgrade Cost Breakdown

Item	Version or Type	Notes	Qty	RP6		RP7	Increase %
				Unit Cost (£k)	Project cost (£k)	Project Cost (£k)	
Network Manager	10 or 11		1	934	934	1120.8	20%
	Adaptors		1	68	68	81.6	20%
	FAT & SAT		1	20	20	24	20%
	PCU extension		6	5	30	36	20%
	RCU extension		2	13	26	31.200	20%
Hardware	DCC Servers		3	8	24	28.8	20%
	DCC Storage		1	37	37	44	19%
	ECC Servers		3	8	24	28.8	20%
	ECC Storage		1	37	37	44	19%
	Workstations		18	2	36	43.2	20%
	Optional replicated server		18	0.17	3.06	3.67	20%
Third Party Licences	Hitachi Energy/ABB	Redhat	1	4	4	4.8	20%
		ICCP	1	6	6	7.2	20%
		Arconis	1	8	8	9.6	20%
	Atos	VMWare + Oracle	1	36	36	43.2	20%
	Bytes	MS Windows + Server	1	30	30	36	20%
Infrastructure & Cyber security	Networking	Switches	1	28	28	33.6	20%
		Firewalls	1	36	36	43.2	20%
	SIEM	Darktrace & Tripwire	1	90	90	108	20%
Project Management			1	100	100	120	20%
System Integration			1	100	100	120	20%
Cyber Security	Tests		1	10	10	12	20%
Travel and Accommodation	FAT		1	6	6	10	67%
	Training		1	35	35	42	20%
				Totals	**1768.06**	**2075.67**	**20%**

The costs in Table 33 above were based on RP6 costs from 2018/19 and escalated to reflect 2021/22 prices. It is noted in the escalation for all but FAT travel and accommodation costs have been escalated by 20%. NIE Networks has advised escalation includes 9.67% for inflation and contingency.

[27] Details of cost breakdown, basis of costs and escalation factors requested in query UR-0165

We agree with the justification for the NM SCADA replacement/upgrade, however the EJP only considers the upgrade option as a single tender form Hitachi Energy. The justification for considering only one option is weak appearing to be based on assumptions rather than market engagement.

NIE Networks has not adequately considered the replacement option or undertake any optioneering of possible solutions, comparing implementation costs, risks, project duration and potential benefits such as reduced lifetime costs, maintenance costs, etc, for each option. It is our opinion the justification for the single tender procurement does not adequately demonstrate this as an efficient and cost effective solution.

In our recommendation for the allowance within Table 43 below, the allowance is reduced to remove the contingency and applying a reduction for efficiency gains from competitive tendering for the SCADA software and reduction number of PMD interfaces. The allowance for the replacement of the NM SCADA has been reduced from £2,076,000 to £1,650,000 a reduction of 20.5%.

D39f Replace primary substation RTU batteries

NIE Networks has confirmed there are 256 battery sets installed; the majority of these were originally installed in 2014 with a ten-year lifespan. Of those, condition monitoring and inspections have identified 244 are in a poor condition and are expected to require replacement during RP7.

NIE Networks is proposing to continue a rolling programme of battery replacements on a like for like basis across the asset population based on condition monitoring and inspections.

NIE Networks has stated the battery sizes can vary across the asset base depending on the RTU size and ancillary equipment being powered during power outages. Cost estimate has been based on a typical size at an average cost of £560. We do not propose any change to the requested allowance of £136,000.

D39g Retrofit Radios

To improve network performance, NIE Networks is proposing to implement remote control and monitoring of 127 existing pole mounted devices (PMDs) in the SCADA system. This requires the retrofitting of these devices with UHF aerials and radios at the site and commissioning to the SCADA front-end communications servers. NIE Networks confirmed communications with the SCADA is not dependent on completion of any other works within the communications network.

Implementation of the remote control of these PMDs is part of the Network Performance Improvement strategy to improve reliability and resilience as described in EJP 1.801(Network Performance Strategy). We note that increasing the observability of the network from the control centre and the addition of remote control will improve NIE Networks response times to faults in the areas covered by these devices.

The unit cost for the retrofitting the radios of £2,906 with the costs based on standard material item costs from the current NIE Networks managed service provider contract. We do not propose any change to the requested allowance of £369,000.

7.2.1.1 D41 Operational telecoms network

NIE Networks is proposing to continue the RP6 investment programme to address rolling asset replacement, BT21CN[28] product withdrawal and improve cyber security.

As with many UK DNOs NIE Networks has seen an increase in the number of connected Distributed Energy Resources (DERs), wind and solar generation as well as at battery storage schemes. This growth has been allowed for with the installation of equipment at the sites, communication links to the sites and the resultant core network capacity increases.

Against an ever-increasing threat landscape and the introduction of the Networks and Information Systems (NIS) regulations[29], NIE Networks has, in response, established a Security Operations Centre (SOC) and System Incident and Event Management (SIEM), complemented by automatic vulnerability scanning and secure encrypted backups.

[28] BT21CN was a move to digital only services and the withdrawal of slow speed (sub 2megabits) telecommunication services by British Telecom.
[29] Security of Network and Information Systems Regulations 2018 (update consultation 2022)

The specific investments identified for the OTN in RP7 are described in EJP 1.902 Operational Telecoms Network Development and Replacement and cover twenty-two sub-categories. Our analysis of each sub-category is discussed in the following sub-sections.

D41c PSTN Replacement

The Public Switched Telephone Network (PSTN) is being moved from a copper based switched network to an optical fibre-based IP routed network. The current Openreach target date is to withdraw all copper based PSTN services is the end of December 2025.

Where substations required under power system restoration plans require communications services NIE Networks are proposing to add telephony functionality to existing OTN nodes (50) or use third-party optical fibre-based Voice over IP (VoIP).

We agree the replacement of these BT services is essential to the operation of the NIE Networks power network. The solution and implementation costs will vary from site to site in particular critical sites required under power restoration plans. Therefore, we do not propose any change to the requested allowance of £201,000.

D41d 10.5g Radio Creation

NIE Networks has secured 10.5 GHz spectrum from The Office of Communications (Ofcom) to extend the OTN to reach to more Primary Substations and potentially third-party sites providing two-way, secure, low latency and high- bandwidth telecommunications by creating a point to multipoint 10.5 GHz network. The proposal is to install new equipment at 32 sites and implementation of a network management platform to increase capacity into Primary substations.

In response to a query[30] for details of the costs and scope of work, during the engagement session NIE Networks provided the cost breakdown in Table 34 below.

Table 34 10.5G Creation Cost Breakdown

Item description	Quantity	Unit Cost (£)	Total Cost (£)
10.5G Base	9	19,406	174,654
10.5G Remote	22	7,000	154,000
10.5G Spectrum licence	1	15,000	15,000
10.5G Management platform	1	107,500	107,500
10.5G Link planning	1	15,000	15,000
Grand Total			466,154

We note this offers greater communication connectivity possibilities to NIE Networks which will become increasingly important in the transition to low carbon technology and moving moving towards net zero energy system. Therefore, we do not propose any change to the requested allowance of £466,000.

D41e DC Asset Replacement

NIE Networks is proposing a programme of telecommunications DC systems battery replacements where condition monitoring identified that capacity has fallen to less than 80% of the capacity, or unacceptable levels of mechanical failure or obsolescence observed.

A mixture of battery chargers is installed on the NIE Networks OTN, of those the Eltek Minipack reached end of sale September 2019 with an end of support date of January 2030. All the other chargers are still supported by the OEM.

During their annual condition survey NIE Networks has identified chargers at seven sites that are starting to show performance issues and will be replaced during RP6. NIE Networks propose to continue the replacement programme during RP7 and onwards to completion during RP8 and propose to replace 21 units during RP7.

[30] Details of scope of work and cost breakdown requested in query UR-0187

Similarly, the replacement of batteries or individual cells is based on condition surveys and failure rates. These inspections monitor and identify any defective or reduced voltage cells. Battery replacement requirements can vary from site to site along with the number of battery cells that need replaced. Full replacement of DC batteries is completed when it becomes more cost effective to replace all than a few based on failure rates at that site. The expected life for the sealed lead acid batteries deployed is 8 -12 years. Based on these factors NIE Networks propose to replace batteries at 94 sites during the period of RP7.

In addition to the battery systems, there are 28 DC to DC Converters which supply power to substation routers. NIE Networks is also proposing to replace these where necessary based on condition, obsolescence or need to support replaced/upgraded routers. The expected life for the DC-DC converters is 5-7 years.

All works are undertaken by NIE Networks MSP contractor based on competitively tendered contract.

Maintenance of the DC system is essential to the communications systems supporting the SCADA and other systems required to manage the power network safely and efficiently, particularly during periods of disruption to in the network. Therefore, we do not propose any change to the requested allowance of £358,000.

D41f OIP Replacement

The EJP contained no information of this sub-category, however in response to a query[31] NIE Networks provided the following details of the proposals.

The programme is to replace core routers and switches forming part of the Operational IP (OIP) network at the core nodes within the Operational Telecoms Network (OTN). The main drivers for this programme are the obsolescence of the current hardware installed and the ceasing of support from the Original Equipment Manufacturer (OEM) this increase the risk of extended failures and cyber security risk.

NIE Networks has identified 70 routers and 8 switches across 35 sites, for which OEM support has ceased or will end during RP7. This equipment forms part of the operational system managing NIE Networks power network and as such is subject to the same NIS regulations as the NM SCADA system. NIE Networks wish to reduce the risk of non-compliance along with the threat of a Cyber Security breach through this replacement programme.

We agree with the rational for the replacement of the equipment. The average cost per unit is £7,100 is deemed reasonable and we do not propose any change to the requested allowance of £554,000.

D41g Comms Generators

NIE Networks is proposing to replace two standby generators which are obsolete and have reduced load capacity, meaning the ability to handle the full site loading is no longer possible.

We do not propose any change to the requested allowance of £61,000.

D41h Comms AC Services

This system comprises the LVAC systems powering the substation systems including the following

- Radio’s, routers and telecoms equipment;
- Battery chargers;
- Heating and lighting;
- Air Conditioning;
- Security systems; and
- On-line remote monitoring equipment.

All wiring must comply with the requirements of BS 7671 and be subject to periodic inspection including insulation assessment. Therefore, the condition of the LVAC system is essential to ensure the safe and reliable operation of plant and equipment within the OTN operational location.

NIE Networks has a responsibility to maintain the LVAC to avoid failure causing disruption to the OTN and ensure the safety of staff. Therefore, we do not propose any change to the requested allowance of £72,000.

[31] Details of OIP replacement were requested in query UR-0170

D41j Mast Replacements

NIE Networks has stated that most of the masts were installed between 1980 to 1990 while the expansion of DER sites has added additional masts in recent times. The masts are regularly inspected and a programme of painting to extend lifespan is ongoing.

In response to a query UR-0171 on the EJP, NIE Networks has provided additional detail regard the proposed works during RP7 as follows.

- Replacement of two masts which have reached design capacity (i.e. 99% of safe leg loading) and are in poor condition.
  - Molly Mountain, 48 m Lattice tower.
  - Tandragee Main, 30 m lattice tower.
- Removal of two redundant masts which are also in a poor condition.
  - Deehommed, 35 m guyed mast.
  - Pollnalagh, 24 m lattice mast.
- Replacement of two air conditioning systems at Craigavon and Molly Mountain.
- Painting of 17 masts.
- Replacement of aircraft warning lights on 5 masts in compliance with the Civil Aviation Authority (CAA) requirements on lighting/marking of obstacles within the vicinity of aerodromes.
- Replacement of 17 fall arrest systems due to their condition being assessed as poor, and not up to current industry standard of Latchway.

The cost breakdown for this sub-category in Table 35 was provided NIE Networks in their presentation during an engagement session[32].

Table 35 Sub-category D41j cost breakdown

Item description	Quantity	Unit Cost (£)	Total Cost (£)
Air conditioning	2	5,900	11,800
Mast DC aircraft warning lights	5	2,506	12,532
Mast fall arrest system	17	2,676	45,500
Mast guyed removal	1	5,000	5,000
Mast lattice removal	1	5,000	5,000
Mast lattice replacement	3	114,333	343,000
Painting	17	9,412	160,000
Grand Total			**582,832**

We note the cost breakdown includes for the replacement of three masts and not two as described in their response to query UR-0171. Therefore, we recommend a reduction of £114,000 in the allowance to £469,000.

D41k Microwave Asset Replacement

The EJP contained limited details of the proposals for this sub-category, however in response to a query[33] NIE Networks provided the following details of the proposals.

NIE Networks has identified a total of 24 systems proposed for replacement under sub-category D41k. The systems are supplied from three separate suppliers which are Nera, Ceragon and Siae Microellecttronica.

- Nera units were installed between 2007 and 2012. End of Support for these units was on 29/06/2017.

[32] SCADA_COMMS Presentation140823.pdf
[33] Details of the scope of works were requested in query UR-0172

- Ceragon units were installed between 2007 and 2012. Not all these units have yet reached End of Support, but some reached end of support on 30/11/2022.
- Siae Microellecttronica units were installed between 2007 and 2020. Not all these units have yet reached End of Support, but some reached end of support on 01/02/23.

For the Nera units, NIE Networks has confirmed there is no option to procure spares, however they are currently utilising their existing strategic spares holding along with evaluation and potential use of any recovered equipment. The programme of replacement will also be reviewed throughout to ensure that there is always sufficient spares coverage until the complete replacement of all Nera units has been achieved.

For the Ceragon and Siae Microellecttronica units, that have come end of support are managed through the same process as the Nera units. The remaining units will be part of an ongoing review in conjunction with Managed Service Provider (MSP) with additional strategic spares procured if necessary.

In responding to a query[34] NIE Networks have provided a cost breakdown for the replacement of the 24 microwave systems given in Table 36 below based on the current MSB contract.

Table 36 D41k – Microwave Replacements Cost Breakdown

Item	Quantity	Unit Cost (£)	Total Cost (£)
Antenna 0.3m Single	2	4,191	8,383
Antenna 0.6 Dual	2	4,463	8,925
Antenna 0.6m Single	2	4,192	8,385
Antenna 1.2 Single	8	4,677	37,413
Antenna 1.8 Single	4	5,485	21,940
Antenna 2.4m Single	2	6,801	13,602
Antenna Cable	24	250	6,000
Indoor Unit (IDU) Type 1	28	5,012	140,339
Indoor Unit (IDU) Type 2	20	6,140	122,800
Outdoor Unit (ODU)	104	538	55,973
		Grand Total	**423,759**

NIE Networks also confirmed they will combine the replacement with the opportunity to increase capacity to gain maximum benefit.

The replacement strategy and management of spares in our opinion is good engineering practices and we do not propose any change to the requested allowance of £424,000.

D41l Optical Distribution Frame (ODF) Replacement

NIE Networks asset condition survey has found 21 of the 201 installed ODFs are in poor condition requiring replacement.

The allowance requested of £48,000 is an average cost of £2,285 per ODF replacement, and we do not propose any change to the requested allowance.

D41m Optical Fibre Replacement

NIE Networks has identified two overhead optical fibres reaching the end of their serviceable life (40 years) with multiple breaks at mid-span locations and are exhibiting increasing fault levels, primarily caused by weather damage.

The Strabane Main to Omagh Main all dielectric self- supporting overhead cable has only 6 of the 16 fibres serviceable.

[34] Cost breakdown of works was requested in query UR-0187

The Coolkeeragh Main to Campsie West overhead wrap has only 10 of the 16 fibres serviceable.

We note that the costs for replacement of 38 km of optical fibre are approximately £18,000 /km and is in line with other project costs. We do not propose any change to the requested allowance of £701,000.

D41n Optical Fibre New

NIE Networks is proposing the installation of optical fibre on four existing transmission circuits to provide additional communication routes between key substations. It is proposed to restring the earth wire with 24 fibre Optical Ground Wire (OPGW) on the following four circuits.

Table 37 New OPGW Transmission circuits

Circuit	Length (m)
Tandragee Main to Tamnamore Main (275kV dual circuit)	25,744
Magherafelt Main to Kells Main (275kV dual circuit)	40,225
Tandragee Main to Castlereagh Main (275kV dual circuit)	56,315
Rasharkin Main to Eden Main (110kV circuit)[35]	64,360
Total	186,644

We agree with NIE Networks statements regarding the installation of OPGW on these routes will improve resilience providing a secure link between existing core network sites and reduce NIE Networks' reliance on rented circuits from BT/Openreach.

NIE Networks has stated initially it is not envisaged that there will not be any significant reduction in the use of radio and microwave circuits from the installation of the OPGW. However, this may change as the OTN evolves particularly with the development of the OTN as part of EJP4.102 (DSO Operational Telecoms Network Transition).

The total cost of restringing the 186.6 km is estimated at £3,619,000 (or £19,384 /km) and is in line with other project costs. We do not propose any change to the requested allowance of £3,619,000.

D41o Substation Comms Equipment Replacements

NIE Networks is reporting the Sec-view routers equipment will become obsolete and no longer supported by the OEM during RP7.

As part of the critical infrastructure this equipment is required to be supported by the OEM, we do not propose any change to the requested allowance of £82,000.

D41p - RAD Assets Replacements

The OTN is largely reliant on Megaplex range of multiplexers manufactured by RAD Data Communications (RAD). These support the existing IP MPLS (Multiprotocol Label Switching) network responsible for transporting SCADA, tele-protection, security and metering traffic. NIE Networks has stated the support for the Megaplex equipment will cease in 2029 and will require replacement. Furthermore, the transition to fully IP based protocol will require upgrading of the equipment to support the additional network traffic.

NIE Networks propose the first stage of the replacement programme will be carried out earlier in RP7 to ensure new projects which require OTN services are not affected by the RAD equipment replacement. This will happen following a competitive procurement process for the selection of the new provider of network interface equipment.

In NIE Networks' response to query UR-0175, the proposed expenditure of £4,907,500 is to replace 158 RAD multiplexers at 135 OTN Sites of which 113 sites have one multiplexer installed, 21 sites have two multiplexers installed and one site has three multiplexers installed.

[35] This involves restringing the 110kV lines with OPGW from Rasharkin Main to Kells Grid, Kells Grid to Ballyvallagh Main and then Ballyvallagh Main to Ballylumford Grid 110kV. The circuit will then patched through the ODF unto a spare fibre on the Ballyfurmford Grid 110kV to Eden Main OPGW strung under the ongoing D5 works.

Based on the number and types of cards that are installed within the RAD multiplexer, there are several different site classifications identified in Table 38 below.

Table 38 RAD Multiplexer Site Classification

Site Classification	Description
1	Multiplexer Located at a Control Room Location
2	Multiplexer Located at a Cluster Substation
3	Multiplexer Located at a Core OTN Node Substation
4	Multiplexer Located at a Remote OTN Node Substation

Based on these classifications, the 158 multiplexer replacement costings, based on costs from the current OTN MSP contract on a 21/22 price base, are itemised in Table 39 below.

Table 39 Replacement Multiplexers Cost Breakdown

Site Classification	No of Multiplexers	Unit Cost (£)	Total Cost (£)
1	11	33,000	363,000
2	8	28,600	228,800
3	107	27,500	2,942,500
4	32	17,600	563,200
Totals	158		4,097,500

We agree with the proposal to upgrade and replace the existing multiplexers to expand capacity and ensure support of the equipment is maintained to meet the requirement of the NIS regulations for critical infrastructure. We do not propose any change to the requested allowance of £4,097,500.

D41r - Server Asset Replacements

NIE Networks is proposing to replace seven of the servers for the management, patching and security of the radios, RAD multiplexers, routers and switches on the OTN network as these will no longer be within support. We do propose any change to the requested allowance £125,000.

D41s - Sync Assets Replacement

NIE Networks has redundant GPS clock systems installed at three locations on the network. However, two of the three systems will become obsolete during RP7 and will require to be replaced to maintain the existing level of redundancy and network stability.

We do not propose any change to the requested allowance of £69,000.

D41u - Comms Physical Security

Existing OTN hilltop mast sites are secured with Electric Fences, CCTV and alarms. NIE Networks propose to refurbish electric fences at seven sites and update the CCTV and alarm provision at nine sites.

We do not propose any change to the requested allowance of £78,000.

D41x - Comms Cyber Security

The scope of the work to be covered under subcategory D41x is to maintain NIE Networks Cyber Security resilience on the OTN. NIE Networks is seeking an allowance for the replacement of the existing SIEM and vulnerability scanning along with expansion with the addition of new assets unto the OTN.

The implementation of the Security Operation Centre (SOC) and Security Information and Event Management (SIEM) system commenced in September 2020 and was completed by January 2021. The SIEM is installed on several servers located at different locations to provide redundancy and local monitoring PCs so that in the event of loss of communication with the MSPs central SOC, staff based in Northern Ireland can continue to monitor the

network. The expected lifespan of the server and monitoring PCs is estimated at 7 years based on IT industry and OEM recommendations. Based on this, the hardware will need refreshed during the RP7 period. It is anticipated that the programme to replace the hardware will start in 2028 and will take 6 months to complete.

We do not propose any change to the requested allowance of £392,000.

D41y - Belfast Multi-Core Network

This multi-core cable network is used to support power system protection and SCADA services in the Belfast area. The condition assessment scoring of the multi-pair network, including the scoring rational is detailed in Table 40.

Table 40 Multi-pair cable assessment

Condition Score	Scoring Rational	Number of Circuits
1	Insulation levels good (>=100 Mega Ohm phase to phase, phase to earth), continuity all cores	92
2	Insulation levels good (>=100 Mega Ohm phase to phase, phase to earth), loss of continuity on 1 or more cores	19
3	Insulation levels poor (>=10 Mega Ohm < 100 Mega Ohm phase to phase, phase to earth) and or loss of continuity on 25% of cores or Asset life greater than 30yrs	15
4	Insulation levels very poor > =1 Mega Ohm and <10 Mega Ohm loss and/or loss of continuity of 30% of cores or Asset life greater than 40yrs	7
5	Insulation levels very poor or worse and / or loss of continuity of 40% of cores or Asset life greater than 50yrs	33
N/A	Abandoned Cable	41
Grand Total		207

Based on the above condition scoring and figures NIE Networks has requested a lump sum allowance to target approximately 10 of the 33 circuits that have a condition score of 5, dependent upon the criticality of the circuits during the RP7 period.

NIE Networks propose to replace existing copper cable-based services with optical fibre-based services. The scope of work for each is as follows.

- Removal of the existing communications termination cabinets.
- Decommissioning of the existing multipair cable.
- Establishment of a new optical data frame (ODF) at each end.
- Installation of the 3rd Party Circuit providers equipment.
- Installation of the fibre interface equipment.
- Modification of the existing protection equipment and intertripping to accommodate a fibre connection.
- Replacement of the hard-wired operational phone line into the site with a voice over internet protocol (VOIP) equivalent for switching.

We note that costs will vary for site to site and NIE Networks has requested flexibility in the sites to target the links replaced on a priority and needs basis. We do not propose any change to the requested allowance of £252,000.

D41z - SCADA IP Transition

NIE Networks is proposing to transition SCADA services from legacy serial protocol to modern IP based protocol, IEC60870- 5-104 based on Ethernet IP interface. In response to query UR-0181 and during the engagement session NIE Networks provided further detail of the scope of works and cost breakdown.

Table 41 SCADA IP Transition costs breakdown

Item Description	Quantity	Unit Costs (£)	Total Cost (£)
Antenna	18	1,963	35,336

Item Description	Quantity	Unit Costs (£)	Total Cost (£)
IP Front End	4	2,705	10,820
Master Station	14	9,544	133,616
Project Management	63	605	38,115
Remote Transfer Radio	608	607	369,070
PMD Aerial	349	615	214,635
Grand Total			801,592

We note the unit costs are based on MSP contract pricing and it is anticipated that it will take two years to complete this programme on a phased approach. The move to using of IP based open protocol is common throughout the UK DNOs and worldwide. We do not propose any change to the requested allowance of £802,000.

D41ab - Capacity Growth

NIE Networks has highlighted the RP7 period will be a period of significant societal change moving towards net zero energy system. They anticipate electricity distribution networks will play a pivotal role in delivering the pace of change demanded by customers as they embrace Low Carbon Technology (LCT).

NIE Networks state the increased demand for reliable communications will be met by transitioning to a more efficient MPLS IP based network, together with increasing capacity on core links and extending capacity into Primary substations.

We note that the expansion of the MPLS network, provision of 10.5G point-to-multipoint radio system, transition to IP based protocols and the provision of additional capacity in the optical fibre network as part of the OTN upgrade are all considered elsewhere in NIE Networks' proposals. Furthermore, in EJP 4.102 (DSO Operational Telecoms Network Transition) the provision of a pLTE network to expand IP based communications is proposed and will be subject to further discussion with UR. In our opinion the works described in this sub-category have been covered elsewhere or are insufficiently defined at this time to justify the allowance. Therefore it is our recommendation this allowance is disallowed.

D41ac - Comms Resilience

NIE Networks has identified areas of concern regarding the resilience of the communications systems at several substations within the network and are proposing to mitigate these during RP7. In response to query UR-0185 NIE Networks has provided details of the scope of work as follows.

- The installation and commissioning of new tele protection links to remove Single Points of Failure (SPOF).
- The transfer of existing tele protection circuits onto Ethernet Access Direct (EAD) and Fibre circuits to remove the risk associated high number of tele protection circuits on an individual communications route.
- Installation of a second fibre path using third-party rented circuits into sites that have been identified as SPOF.
- Installation of new synchronising Controlled Reception Pattern Antennas (CPRAs) for GNSS synchronisation sources which are less susceptible to cyber-attacks.
- Installation of secondary battery strings at transmission substations to improve the DC power supply resilience.
- Installation of Global Navigation Satellite System (GNSS) firewall equipment to increase security through identifying and protecting the GPS synchronising clocks from spoofing and jamming threats
- Installation of fully redundant Caesium based synchronisation clocks to mitigate against the loss of GPS signals due to geo magnetic storms from increasing coronal mass ejections. This also covers the cost for OEM support and spares services.
- Installation of second multiplexer chassis at transmission substations where the existing chassis is either at full capacity, has limitations on the number of certain types of cards that have been installed and to provide diversity by splitting the tele protection and links over the two chassis.

- Mitigation works required with the withdrawal of the BT Megastream product which was withdrawn from sale in March 2020 and is scheduled for end-of-life November 2025.

Table 42 D41ac Cost Breakdown

Item Description	Quantity	Unit Costs (£)	Total Cost (£)
BT Megastream Withdrawal	1	75,000	75,000
Comms H/W Resilience	9	18,320	164,880
Comms Route Resilience	11	17,900	196,900
Controlled Reception Pattern Antennas (CPRAs)	3	5,700	17,100
Global Navigation Satellite System (GNSS) firewall	3	17,500	52,500
Redundant Caesium based synchronisation clocks	2	55,322	110,644
Grand Total			617,024

The resilience of the communication networks particularly those for operation protection systems is critical in maintaining network performance and avoiding unnecessary outages due to their failure. Optical fibre communication networks require time synchronisation in their normal operation. Loss of synchronisation can result in degraded performance or total loss of communications. We agree with the mitigation actions proposed by NIE Networks to improve network resilience and reduce its potential vulnerability to loss of synchronisation. Therefore, we do not propose any change to the requested allowance of £617,000

D41ae - Exchange Closure - Pilot

BT are closing exchanges from 2025 which will require works at three exchange sites to move onto alternative solutions within RP7. We do not propose any change to the requested allowance of £17,000.

7.3 GHD Recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 43.

Table 43 SCADA and OTN recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D39 - SCADA	**4,803**	**127**	**4,377**	**127**
D39B - Replace RTU	2,222	127	2,222	127
D39C - Control centre hardware & software	2,076	-	1,650	-
D39f - SCADA Battery Replacement	136	-	136	-
D39g - Retrofit Radios	369	-	369	-
D41 - Operational Telecoms network	**13,956**	**--**	**13,505**	**-**
D41c - PSTN Replacement	201	-	201	-
D41d - 10.5g Radio Creation	466	-	466	-
D41e - DC Asset Replacement	358	-	358	-
D41f - OIP Replacement	554	-	554	-
D41g - Comms Generators	61	-	61	-
D41h - Comms AC Services	72	-	72	-
D41j - Mast Replacements	583	-	469	-

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
D41k - Microwave Asset Replacement	424	-	424	-
D41l - Optical Distribution Frame Replacement	48	-	48	-
D41m - Optical Fibre Replacement	701	-	701	-
D41n - Optical Fibre New	3,619	-	3,619	-
D41o - Substation Comms Equipment Replacements	84	-	84	-
D41p - RAD Assets Replacements	4,098	-	4,098	-
D41r - Server Asset Replacements	125	-	125	-
D41s - Sync Assets Replacement	69	-	69	-
D41u - Comms Physical Security	78	-	78	-
D41x - Comms Cyber Security	392	-	392	-
D41y - Belfast Multi-Core Network	252	-	252	-
D41z - SCADA IP Transition	802	-	802	-
D41ab - Capacity Growth	338	-	0	-
D41ac - Comms Resilience	617	-	617	-
D41ae - Exchange Closure - Pilot	17	-	17	-
Total	**18,759**	**127**	**17,882**	**127**

8. Review of RP7 capex requirements - WP3: Transmission plant: Switchgear & Ancillaries

We have structured our assessment of WP3 (Transmission Plant) into three separate categories, consisting of:

– Review of RP7 capex requirements - WP3: Transmission plant: Switchgear & Ancillaries;
– Review of RP7 capex requirements - WP3: Transmission Plant: Transformers, Reactors & Strategic Spares; and
– Review of RP7 capex requirements - WP3: Transmission plant: Protection.

This section relates to transmission plant switchgear and ancillary equipment, with Sections 9 and 10 covering the Transformers / Reactors and Protection assets respectively.

8.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 44 for each of the sub-work programmes included within T10, T11 and T12 programmes. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

8.1.1 RP7 Costs and volumes

Table 44 Transmission Plant: Switchgear & Ancillaries – NIE Networks investment proposal for RP7

		RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	EJP ref	Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
T10 - 110kV SWGR Total	**-**	**3,809**	**11**	**3,346**	**9**	**1,565**	**17**
T10C - Replace 22 kV shunt reactor circuit breakers	EJP 2.206	3,809	11	3,346	9	786	2
T10d - Refurbish 110kV Switchgear	EJP 2.208	-	-	-	-	168	9
T10e - Replace 110kV Circuit Breaker	EJP 2.208	-	-	-	-	611	6
T11 - 275kV Plant Ancillaries Total	**-**	**2,532**	**53**	**2,139**	**56**	**3,816**	**71**
T11g - Security systems	EJP 1.805	315	-	20	-	1,132	-
T11j - DC standby systems	EJP 2.209	315	-	497	-	7	-
T11k - Ballylumford 275kV CVT Replacement	EJP 2.203	304	12	317	12	552	24
T11m - AC rewire	EJP 2.209	88	2	117	2	90	2
T11o - Drainage	EJP 2.601	117	-	18	-	453	-
T11P - Kilroot 275kV CT Replacement	EJP 2.203	1,048	39	1,163	42	572	21
T11R - 22kV Capacitor Bank Refurbishment	EJP 2.209	29	-	7	-	50	-
T11s - Filter Bank Replacement	EJP 2.209	-	-	-	-	25	-
T11t - 275kV Surge Arrestor Replacement	EJP 2.209	-	-	-	-	116	4
T11v - Substation legalities	EJP 1.807	315	-	-	-	251	-

		RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	EJP ref	Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
T11w - Sump Pumps	EJP 2.201	-	-	-	-	96	14
T11x - Earthing Spigots/Parking bars	EJP 2.209	-	-	-	-	112	-
T11y - Replacement of Signage	EJP 2.209	-	-	-	-	23	-
T11aa - 275/110kV Tx Oil Regeneration	EJP 2.201	-	-	-	-	336	6
T12 - 110kV Plant Ancillaries Total	**-**	**2,372**	**52**	**3,045**	**46**	**11,322**	**219**
T12d - Transformer bunding	EJP 2.601	83	4	-	-	100	-
T12f - Generator	EJP 2.210	392	16	860	17	937	19
T12h - DC standby systems	EJP 2.210	318	-	337	-	318	-
T12i - AC system rewire	EJP 2.210	111	3	142	1	329	8
T12o - Civil works to primary substations	EJP 2.601	235	-	205	-	3,510	-
T12R - 110kV Disconnector replacement	EJP 2.207	959	27	1,161	26	769	17
T12S - Drainage Upgrade	EJP 2.601	29	-	20	-	283	-
T12t - 110kV CT Replacement	EJP 2.204	-	-	-	-	503	27
T12v - 110kV Surge Arrestor Replacement	EJP 2.210	-	-	-	-	88	4
T12w - 110kV Capacitor Bank Replacement	EJP 2.210	-	-	-	-	50	-
T12x - Transformer Noise Enclosures	EJP 1.308	246	2	320	2	892	4
T12y - Sump Pumps	EJP 2.202	-	-	-	-	357	52
T12z - Earthing Spigots/Parking bars	EJP 2.210	-	-	-	-	308	-
T12aa - Replacement of Signage	EJP 2.210	-	-	-	-	77	-
T12ab - 110kV Earth Switch Replacement	EJP 2.207	-	-	-	-	1,565	52
T12ac - 110/33kV Tx Oil Regeneration	EJP 2.202	-	-	-	-	1,125	30
T12ad - 110kV Coffin CTs	EJP 2.210	-	-	-	-	112	6
WP3: Transmission plant: Switchgear & Ancillaries Total	**-**	**8,713**	**116**	**8,530**	**111**	**16,703**	**307**

8.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases refurbish) aging transmission switchgear and ancillary assets on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 44) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 45 below for each of the sub-programmes. It is noted that for each of the identified sub-programmes of work, key drivers relate to maintaining a safe, reliable, and resilient network, compliant with regulation and environmental compliance.

Table 45 Transmission Plant: Switchgear and Ancillaries – Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment Strategy
T11w - Sump Pumps	EJP 2.201	Continuation of the programme commenced in RP5 to replace the poor condition 275/110kV transformers, three new transformers will be installed (See Section 9) and additional refurbishment activities will be undertaken on other units (i.e. painting, cooler replacement, cooler control refurbishment, tap changer refurbishment, bushing replacement, and oil regeneration) to extend life and control asset health risks that could lead to customer outage or safety incidents.
T11aa - 275/110kV Tx Oil Regeneration		
T12y - Sump Pumps	EJP 2.202	Proposed six new transformers will be installed in RP7 (replacing eight (See Section 9)), and additional refurbishment activities will be undertaken on other units (i.e. painting, cooler replacement, cooler control refurbishment and oil regeneration) to extend their life and control asset health risks that could lead to customer outage or safety incidents.
T12ac - 110/33kV Tx Oil Regeneration		
T11k - Ballylumford 275kV CVT Replacement	EJP 2.203	Replacement of 21 Reyrolle 275kV SF6 insulated porcelain insulator current transformers (CTs) due to SF6 leaks and insulation degradation, at one site. These issues present environmental issues associated with leaks of harmful SF6 gas and increased risk of failure which is a safety risk to staff. These CTs will be replaced by modern capacitive voltage transformers (CVTs) with composite insulators.
T11p - Kilroot 275kV CT Replacement		
T12t - 110kV CT Replacement	EJP 2.204	Proposed complete replacement of 110kV transmission Current Transformers (CTs) at one grid substation which has shown elevated levels of degradation in periodic testing. To resolve condition, safety, environmental and performance issues and associated ancillary works on the network in the RP7 period, this substation has been identified to require the replacement of CTs to mitigate the risk that the catastrophic failure of these assets would present, such as: fire, potential to cause harm to staff, contractors and public in the vicinity of this substation, and environmental incident.
T10C - Replace 110kV switchgear	EJP 2.206	Complete replacement of two 22kV shunt reactor Circuit Breakers (CBs) on the network due to failure in RP6. This replacement is required to ensure safety and network reliability, and to comply with legislation related to the use of SF6 gas. The CBs undergo regular switching during periods of lighter demand to maintain transmission voltage levels. Key drivers also include procurement risk as lead times have been increasing.
T12R - 110kV Disconnector replacement	EJP 2.207	Continuation of a programme from RP6, proposing the replacement of 17 poor condition disconnectors due to obsolescence and limited spares. Retrofitting 52 earth switches at sites where permanent earth switches are not installed, over the course of RP7. Earth Switches and disconnectors provide points of isolation and earthing, which is required for equipment maintenance or replacement, extension of equipment, isolation of faults, and to facilitate efficient operation and control of the transmission network.
T12ab - 110kV Earth Switch Replacement		
T10d - Refurbish 110kV Switchgear	EJP 2.208	In previous RPs there has been a programme to replace obsolete and poor condition CBs, however the proposed strategy for RP7 focuses specifically on the replacement and refurbishment of SF6 CBs and there is a need to resolve ongoing SF6 gas leak issues, which can be detrimental to
T10e - Replace 110kV Circuit Breaker		

Asset Category (Sub Work Programme)	EJP reference	Investment Strategy
		environment and safety, which the proposed the replacement of six 110kV CBs and refurbishment of a further nine 110kV CBs is aimed to address.
T11j - DC standby systems	EJP 2.209	Non-demand replacement of 275kV plant ancillary components, due to equipment deterioration, optional requirements and to maintain compliance with various Engineering Standards, considering the impact of failure on staff/public safety and network reliability no other alternatives have been deemed viable.
T11m - AC rewire		
T11r - 22kV Capacitor Bank Refurbishment and Studies		
T11s - Filter Bank Replacement and Studies		
T11t - 275kV Surge Arrestor Replacement		
T11x - Earthing Spigots/Parking bars		
T11y - Replacement of Signage		
T12f - Generator	EJP 2.210	Non-demand replacement of 110kV plant ancillary components, due to equipment deterioration, optional requirements and to maintain compliance with various Engineering Standards, supported by ongoing maintenance and inspection of other 110kV transmission plant ancillaries deemed less critical.
T12h - DC standby systems		
T12i - AC system rewire		
T12v - 110kV Surge Arrestor Replacement		
T12w - 110kV Capacitor Bank Replacement		
T12z - Earthing Spigots/Parking bars		
T12aa - Replacement of Signage		
T12ad - 110kV Coffin CTs		
T11g - Security Systems	EJP 1.805	Security works are proposed various transmission substation sites in RP7. This work is necessary to resolve security issues with substations constructed between the 1960s and 1980s, and includes the replacement, refurbishment and upgrade of fencing, doors, gates, cable tunnels, windows, and CCTV. The works will result in a reduction in risk to the critical infrastructure and all staff involved in the operation of the electricity network. This will also reduce the risk of third-party unauthorised access that could result in damage or injury.

8.2 GHD analysis

8.2.1 T10 – 110kV Switchgear

T10c – Replace 22 kV shunt reactor circuit breakers

NIE Networks has demonstrated a need for the replacement of shunt reactor circuit breakers, which have higher rates and more onerous switching duty than other switchgear assets in the network, this reduces the life of the switching assets, meaning replacement and/or refurbishment decisions will be more frequent than other similar assets, operating in less onerous switching functions.

The proposed controlled switch technology is supported in this application. There were some unanswered questions to NIE Networks around the justification of the use of high cost of 145kV CBs, and whether other manufacturers' CBs of different voltages might be more suitable for the required duty of these assets. Following the failure of two 22kV shunt reactor circuit breakers (CBs) in RP6, these assets are required to be replaced. However, there has been insufficient evidence provided to demonstrate that the type of equipment chosen, and associated costs are justified, particularly given the choice to replace the assets with like for like replacements, when considering the relatively poor performance achieved with these assets.

The proposed quantities in the EJPs are based on condition and supported by evaluation techniques, but unit cost value has been reduced by 33%, due to the lack of optioneering presented in EJP 2.206.

T10d – Refurbish 110kV Switchgear & T10e – Replace 110kV Circuit Breaker

Nine Circuit Breakers (CBs) have been identified to require refurbishment and a further six CBs require replacement, due to the poor condition of SF_6 assets on the network. In previous RPs there has been a programme to replace obsolete and poor condition CBs, based on a scored condition assessment ranking, the results of which have been presented. However, the proposed strategy for RP7 focuses specifically on the replacement and refurbishment of SF_6 CBs and there is a need to resolve ongoing SF_6 gas leak issues, which can be detrimental to environment and safety.

The six CBs which have been identified for replacement have had flange leakages identified caused by moisture ingress/corrosion, which impinges on the integrity of the SF_6 seals, posing significant environmental risks and non-compliance with legislation surrounding the use of SF_6.

NIE Networks suggest that repair of these leaks is not possible due to the location of the leaks. Further, NIE Networks indicate that all 110kV CBs have been maintained in a similar manner, suggesting that the maintenance of external flanges has not been suitable for the environment, emphasised by the fact that some of the CBs which have been proposed for refurbishment are less than 15 years old.

There has not been sufficient evidence provided to demonstrate why the proposed volumes of CBs are unsuitable for refurbishment. It is not clearly demonstrated in EJP 2.208, why the proposed dead tank circuit breakers to be replaced could not be refurbished. Given the lack of specific evidence to demonstrate why such refurbishment is not possible, we recommend that the volume for replacement is reduced, and instead the six CBs proposed to be replaced will be added to the total for refurbishment in sub-programme T10d.

8.2.2 T11 - 275kV Plant Ancillaries

T11j - DC standby systems

Based on battery string condition assessment and age, (battery chargers 20 to 25 years, lead acid batteries 20 years) there is an ongoing need for replacement and based on these factors there is a need to replace one of the 110V battery strings at Magherafelt Grid.

This need is consistent with experience on similar battery systems and there is no opportunity for refurbishment or other treatment options.

Whilst there is little detail provided, NIE Networks has presented a need for completion of the previous programme of work from RP6, therefore we recommend the RP7 lump sum cost is allowed.

T11k - Ballylumford 275kV CVT Replacement

NIE Networks propose to replace the remaining 24 Reyrolle 275kV oil filled porcelain insulator CVTs, installed in the late 1960's at Ballylumford Grid and in early 1970's at Kilroot Grid, due to the increased risk of failure imposed by the equipment. Additional evidence of increased levels of Tan δ measured (indicator of insulation condition) have been referenced which are consistent with the age of these units. The approach to replace these CVTs with modern CVTs with composite insulators is supported.

The EJP incorrectly labels a Ferranti CVT and overstates that failures are imminent on the Reyrolle units, where no failures have occurred. However, given the age profile of the Reyrolle units, the need for replacement is accepted. Therefore, we recommend the proposed volumes and costs for RP7 are allowed, consistent with the NIE Networks submission.

T11o – Drainage

NIE Networks has confirmed that for drainage systems that were installed during the 1960s and 1970s there are issues with site interceptors and drainage that require refurbishment and upgrade to ensure ongoing compliance with environmental legislation.

Surveys completed during RP6 and the results of the RAG assessment have been provided in EJP 2.601.

Given the unique nature of the works required, GHD requested specific works items to be selected for further details on costs.

These examples were provided and on the basis of the independent assessment justifying the works and the validated costs, we recommend the proposed volumes and costs for RP7 are allowed .

T11p - Kilroot 275kV CT Replacement

NIE Networks propose to replace the final remaining 21 Reyrolle 275kV SF_6 insulated porcelain insulator current transformers (CTs) due to SF_6 leaks, at Kilroot. These issues present environmental issues associated with leaks of strong greenhouse SF_6 gas and low, albeit increased risk of failure which could be a safety risk to staff.

Whilst SF6 units do not suffer from the same ageing effects of some oil filled equipment, it is now common practice across the limited UK Transmission Operators, with such equipment, to replace them if SF_6 leakages occur.

Successful SF6 leakage mitigation measures have not yet been successfully applied to such units. On this basis the approach to replace these units with modern voltage transformers (CTs) is supported.

Whilst the issues associated with deterioration of Tan δ measurements have been overstated for this type of SF_6 insulated CT, the need to reduce SF_6 leakage is well known and justifies the replacement programme that was commenced in RP6.

Therefore, we recommend the proposed volumes and costs for RP7 are allowed, consistent with the NIE Networks submission.

T11r - 22kV Capacitor Bank Refurbishment and Studies

NIE Networks has reported failures of capacitor cans which has highlighted poor condition of insulation and confirmed by the OEM technical information, which is that operational life can be limited to ten years.

NIE Networks propose the 22 kV capacitor bank cans will initially be replaced utilising spares purchased during RP6.

T11r is based on the outcome of studies indicating that there may be a need for additional replacement units and to upgrade the existing discharge VTs.

Whilst a ten-year operational lifetime appears extreme, this is consistent with the design of particular capacitor units and sometimes severe operational duties which can be imposed upon them.

Whilst the likely outcome of the studies and OEM guidance is accepted in principle, the specific justification of need is rather vague within the specific EJP.

Whilst the need for studies is accepted in principle, the specific justification of need is rather vague. However, given the multiple studies required (T12w, T11r, T11s) we consider it is appropriate that NIE Networks can achieve some cost efficiencies by combining studies. Therefore, we recommend a 10% economies of scale reduction in costs is applied to the NIE Networks submission. This is similar to the approach that we have observed in other jurisdictions.

T11s - Filter Bank Replacement and Studies

Studies are required to assess whether the existing 275kV filter bank at Ballylumford is still required to minimise local interference on the local telecommunications network.

Given the multiple studies required (T12w, T11r, T11s) we consider it is appropriate that NIE Networks can achieve some cost efficiencies by combining studies. Therefore, we recommend that a 10% economies of scale reduction in costs is applied to the NIE Networks submission. This is similar to the approach that we have observed in other jurisdictions..

T11t - 275kV Surge Arrestor Replacement

GHD recommends RP7 volumes and costs as per NIE Networks RP7 submission.

T11v - Substation legalities

NIE Networks' approach relating to primary substation sites is a continuation of its approach during the RP6 period. For primary substations, the main difference between RP6 and RP7 is the volume of leases required. NIE Networks has identified only one site with planned RP7 requirements that required additional land to facilitate access for replacement of transformers and underground cables. The area identified was 1000 m^2, but this is not based on site inspections or measurements. Nor was the land valued professionally, but a valuation was estimated based on residential land. Of the proposed RP7 sum, £3,700 is for fees and the remainder to purchase the land.

We agree that it is prudent to obtain legal agreement for the land access for these sites thereby establishing long term security of each site. However, the need to purchase land for transformer movements or accessing underground cables is not demonstrated.

Our recommended approach is that £25k is allowed for additional legal fees to establish appropriate easements for transformer movements and cable access, if these have not been maintained for some reason.

T11w - Sump Pumps

These assets have not been subject to previous replacement activities or programme for replacement and are reported to be in a poor condition.

Given the population of 275/110kV transformers is 17, the poor condition of the sump pumps and the importance of their function, it is not unreasonable for a programme to be undertaken.

However, given than no justification is given for the volume to be replaced, we recommend that the volume to be replaced in RP7 is eight units at the proposed RP7 unit cost of £6.6k rather than the 14 proposed at total value of £96.1k. The figure of eight replacements is based on the total population of transformers of 17 of which five are between 10 and 19 years old, and less likely to require replacement and additionally six new transformers are being installed in RP7, replacing eight transformers (ref T13a T13c).

T11x - Earthing Spigots/Parking bars

Locations where portable primary earths are fitted to facilitate work on substation plant are currently not defined by NIE Networks with specific earthing spigots and parking bays and it is left to the discretion of SAPs (Senior Authorised Persons) as to where they are fitted.

NIE Networks has indicated that spigots/parking bays will allow compliance with industry standards ESQCR, EAWR and the HASAWA.

NIE Networks further indicate that these earthing spigot/parking bays are required in addition to the installation of fixed permanent earthing switches at substations which have been included in EJP 2.207 for the installation of new permanent earth switches.

Given that no justification has been provided[36] for the requirement for further earthing spigots/parking bays in addition to the fixed earthing switches included, in EJP 2.207 the requested RP7 allowance cannot be fully accepted. On the basis that the need has not been fully justified we recommend that the requested RP7 allowance be reduced by 50% from £112k to £56k.

T11y - Replacement of Signage

Over a period of some 20 years ago, the transmission substation industry started to utilise more plastic signs on outdoor substations, that were alleged to be made from UV resistant materials and suitable to remain in place in UK weather conditions. Evidence of deterioration has taken place across the NIE Network, along with other locations in the UK and globally.

NIE Networks therefore propose a programme of work to replace substation signage.

On the basis that it has been confirmed that this is a one-off cost, given the age of the assets, we recommend the RP7 volumes and costs are allowed.

[36] A request was made for more justification UR-0273 but none provided.

T11aa - 275/110kV Tx Oil Regeneration

Oil regeneration/reprocessing is proposed by NIE Networks to remove increasing levels of moisture in the insulating oil and combustible and non-combustible gases generated in transformers and reactors due to ageing mechanisms and evolving fault conditions. NIE Networks has provided evidence of the results of condition assessment scoring and ranking of the population of assets, including oil results focused on Furanic compounds (indicator of paper insulation degradation), acidity, levels of Carbon Dioxide and Carbon Monoxide, leading to a scoring of the oil condition of individual units.

Whilst oil monitoring and regeneration does not stop the ageing processes, it is well recognised as a means of refurbishment to potentially increase asset life but more importantly to help control asset health and reduce risks of failures that could lead to customer outage or safety incidents.

Oil regeneration is therefore a helpful addition to NIE Networks RP7 work programme and we recommend that the volumes and costs are allowed as per NIE Networks submission.

8.2.3 T12 - 110kV Plant Ancillaries

T12d - Transformer bunding (oil containment systems, plinths and fire walls)

An independent environmental consultant has performed a risk and environmental compliance survey of all 275 kV and 110 kV substation sites. Based on the RAG assessment of transformer bunds, those with a status of Red will be addressed in RP7 with major works and those with an Amber rating will be subject to minor works and fully addressed in RP8.

NIE Networks has already confirmed that sites where transformer replacements are proposed are not included within the scope of these bunding works.

A full listing of the RAG assessment has been provided with identification of which works will be done in RP7 and RP8 together with more details of the specific action lists to be done at each location.

These works cover both 275 kV and 110 kV sites and a continuation of RP6 activities that will extend beyond RP7.

On the basis of the unique nature of individual bunds, we recommend the RP7 volumes and costs are allowed as per NIE Networks submission.

T12f – Generator

Standby generators are an integral part of any transmission substation infrastructure, providing back up system supplies during outage and potential black start conditions. They provide supplies for battery, communication, control, security and other substation systems.

Generators are sized on the basis of the extent of back up required which for some systems can be up to 72 hours.

A programme for generator replacement was commenced in RP5 and continued during RP6, leaving 19 remaining units to be replaced during RP7.

Based on the above volumes and the use of costs equivalent to RP6 outturn costs, we recommend the RP7 volumes and costs are allowed as per NIE Networks submission.

T12h - DC standby systems

The strategy proposed by NIE Networks is to replace/refurbish ancillary equipment based on Battery string condition assessment which includes capacity checks using load banks, impedance tests to check cell resistance and visual inspection of lead plate degradation and replace existing poor condition ancillary works, noting that the expected lifetime of a battery charger is 20 to 25 years.

The refurbishment of DC systems can be a combination of battery strings or chargers and T12h covers 13 units of both lead acid battery replacement at 50V and 110V as well as one NiCAD system at Belfast Central Main substation.

NIE Networks reference a condition assessment model, which identifies the 13 systems across 9 substation sites identifying the need for replacement of battery chargers and lead acid battery strings, which NIE Networks states 'is an ongoing requirement during each regulatory period based on regular inspection, condition assessment, availability of parts and reduction of ampere-hour capacity to ensure the safe and reliable operation of the distribution network'.

In support of DC systems refurbishment, NIE Networks has provided information on where the charger and/or battery sets are in poor condition.

Following our review of the provided information, we conclude that the proposed volume of 13 units is reasonable and we recommend they are allowed for RP7 period.

T12i - AC system rewire

As identified in T12f the LVAC supply system is critical for the ongoing operation of any transmission substation and therefore any transmission network.

NIE Networks justify the need to replace LVAC system wiring at eight sites which in particular do not have auto changeover facilities for LVAC supplies.

Whilst specific condition assessment information on the specific systems have not been provided, the costs and volumes are consistent with the works commenced in RP6.

On this basis, we recommend volumes and costs are allowed as per NIE Networks submission.

T12o - Civil works to primary substations

The works associated in this general civil works category cover a range of activities from door replacement, fence repairs, repairs to substation control building structures, rooves and rainwater fittings and are separate from the civil works associated with the replacement of primary equipment e.g. transformers.

A detailed breakdown of the RP7 requested value has been provided across 15 substations with a categorisation of the works based on:

- P1 High Priority – Significant safety and reliability risk
- P2 Medium priority – Signs of degradation that require monitoring
- P3 Low Priority – Signs of minor degradation that does not currently represent a risk

The proposed works in RP7 are based on the P1 categorisation items.

GHD selected a number of examples for a more detailed review of the condition assessment to gauge the necessity for the works and also requested further cost breakdown estimates from civil contractors for the works.

Given the unique nature of each substation and the works required, it is not feasible to undertake a detailed assessment across all items. However on the basis of the information provided and the validation of costs the volumes and costs as per NIE Networks submission and the approach taken, are considered reasonable and we recommend they are allowed for RP7.

T12R - 110kV Disconnector replacement

This is a continuation of a programme from RP6, proposing the replacement of 17 poor condition disconnectors due to obsolescence and limited spares. It involves the retrofitting of 52 earth switches at sites where permanent earth switches are not installed (see T12z), over the course of RP7. Key drivers being maintaining a safe, reliable, and resilient network, compliant with regulation.

Earth Switches and disconnectors provide points of isolation and earthing, which is required for equipment maintenance or replacement, extension of equipment, isolation of faults, and to facilitate efficient operation and control of the transmission network. They are therefore critical to the safe and reliable operation of any network. Fortunately, they are relatively straightforward and reliable devices with long asset lives, providing that replacement spare contacts can be procured as electrical contacts can deteriorate over time and dependent on operating duty.

NIE Networks report that OEM support of designs is no longer available, hence the classification as poor condition due to obsolescence., In addition, NIE Networks provided necessary additional clarifications via the query log process and we recommend RP7 volumes and costs are allowed, as per NIE Networks submission.

T12S - Drainage Upgrade

NIE Networks has confirmed that for drainage systems that were installed during the 1960s and 1970s there are issues with site interceptors and drainage that require refurbishment and upgrade to ensure ongoing compliance with environmental legislation.

Surveys completed during RP6 and the results of the RAG assessment have been provided in EJP 2.601.

There were particular issues at Castlereagh 275/110kV substation relating to drains outside of the substation fence which was subject to works in RP6. The works in T12s will also address specific issues at the same substation on the existing drains within the substation, which require upgrading.

Given the unique nature of the works required, GHD requested specific works items to be selected for further details on costs.

These examples were provided and on the basis of the independent assessment justifying the works and the validation of costs, we recommend the NIE Networks proposed RP7 volumes and costs are allowed.

T12t - 110kV CT Replacement

The proposed RP7 works involves the replacement of 27 110 kV CTs at Hannahstown Grid substation to resolve identified poor condition assessment rankings. Specific degradation of insulation condition has been identified.

The programme is a continuation of works commenced in RP6 to replace 60 CTs of older vintage (1970s) that had also been identified with elevated Tan δ levels. 36 of these units were of the same manufacturer (Emek) and whilst the 27 units to be replaced in RP7 are of the same manufacturer, they were only installed at Hannahstown Grid in 1997.

A further 51 of the total 110 kV CT population of 504 were supplied by Emek located at four further substations (Coolkeeragh 2001-2007), Drumnakelly Main (2002-2003), Strabane Main (2012) and Tandragee Grid (2003).

It is also noted that NIE Networks provided further information, to that included in the EJP 2.204 that an additional 9 Emek CTs were replaced in excess of the RP6 plan at Hannahstown as Tan δ levels between 3% and 5% had been achieved.

Given our understanding that the typical level of Tan δ measured during factory acceptance testing (FAT) was 0.7%, it is indeed of concern that levels of up to 5% have been measured on in-service units.

It is also accepted that options to refurbish are not applicable to this type of equipment. The option to provide ongoing condition monitoring has been rejected by NIE Networks on the basis of potential risks of failure. The option of on-line Tan δ monitoring through bushing tap connections, does not appear to have been considered.

On the basis of the information presented it is reasonable for the volumes of replacement CTs in RP7 to be accepted.

Regarding the RP7 unit cost, this is stated to be based on unpresented costs for unplanned replacements during RP6 and discussion with the supply chain. Given the lack of supporting evidence from NIE Networks, there is uncertainty on the efficiency of the RP7 proposed unit costs, and we therefore recommend a reduction of 10% to unit costs applied for RP7 allowances which we consider to be a more efficient cost allowance.

T12v - 110kV Surge Arrestor Replacement

The NIE Networks plan is to replace surge arresters more than 30 years old and to install new ones based on planned insulation coordination studies. Initial batch of units will be fitted to replacement transformers during RP7 which are independent of the planned insulation coordination studies.

Surge arrester technology has changed significantly over the past 40 years with the first gapless (metal oxide) devices being introduced in the early 1980s. These devices offer superior protection to the previously applied gapped surge arresters, particularly when protecting SF6 filled equipment or transformers.

Whilst the original EJP 2.210 was not clear on some of the drivers for replace (age/condition/new standards/insulation coordination studies), through the clarification process the specific justification for the four units (12 phase units) was clarified as age and poor condition.

It is recognised that based on age profile of the existing surge arresters and planned insulation coordination studies, that an increased rate of replacement/installation of new surge arresters will be required in RP8.

On the basis of the information reviewed the proposed volume of 4 units by NIE Networks is accepted. No similar programme was undertaken in RP6, so outturn costs are not applicable. However, GHD considers that the proposed unit costs of £22k per unit (NIE Networks bottom-up estimate) is reasonable based on GHD market knowledge. We therefore recommend RP7 volumes and costs are allowed, consistent with the NIE Networks submission.

T12w - 110kV Capacitor Bank Replacement and Studies

There are only two 110 kV capacitor banks on the system at Coleraine Main and Coolkeeragh.

Failures of capacitor cans has highlighted poor condition and the OEM technical information is that operational life can be limited to ten years. T12W is based on the age of capacitors at Coolkeeragh Grid (>20 years old).

Poor capacitors at Coolkeeragh Grid are planned to be initially replaced with the spare units, purchased during RP6.

Studies are also proposed to assess whether the existing capacitor banks are capable of the duties imposed at Coleraine/Coolkeeragh and determine whether additional capacitors are required.

The need for the additional studies is accepted, albeit the initial justification was rather vague. However, given the multiple studies required on capacitor banks/filters (T12w, T11r, T11s) we consider it is appropriate that NIE Networks can achieve some cost efficiencies by combining studies. Therefore, we recommend that a 10% economies of scale reduction in costs is applied to the NIE Networks submission. This is similar to the approach that we have observed in other jurisdictions...

T12x - Transformer Noise Enclosures

NIE Networks has identified in EJP 1.308 that:

"The primary driver to install noise enclosures is to ensure compliance with legislation. Failure to carry out this work would result in the Council Environmental Office servicing notice upon NIE Networks to reduce noise emissions to below statutory limits or switch transformers off (Kells Main was served with an abatement order during RP6). Switching transformers off is not an option as this would result in loss of supply to local customers. The relevant noise legislation includes: WHO Environmental Noise Guidelines for the European Region (2018) and The Environmental Noise Regulations (NI) 2006."

The justification of need as identified in EJP 1.308 is accepted.

Kells Main unit costs was £159,998 (RP6 based on EJP 1.308) with a proposed RP7 unit cost of £222,911 based on supplier budget quotations plus experience from Kells where an abatement order was served.

GHD recommend capex allowances for noise enclosures (T12x) based on the mid-point between the Kells cost and NIE Networks' proposed RP7 rate. This addresses potential risk in relying on RP6 outturn for a single installation under an abatement order as being a reasonable unit cost, but also includes for efficiency in procurement and delivery of the noise enclosures. This results in a recommended capex allowance of 4 x £191,454 = £785.8k.

T12y - Sump Pumps

Sump pumps are required within transformer bunding containment areas to drain away any excess rainwater whilst the bunding contains any potential oil spillage.

These assets have not been subject to previous replacement activities and programme for replacement introduced due to poor condition.

On the basis that there are 79 110kV/33kV transformers on the network with 31 units less than 20 years old and six new transformers to be replaced during RP7 it is not credible for a requirement to replace 52 units during RP7.

Therefore, we recommend RP7 volume should be reduced to 35 (the units more than 30 years old, less the 8 (six new plus two from RP6) to be replaced, giving an RP7 total of 27. The unit costs are accepted in line with the NIE Networks submission.

T12z - Earthing Spigots/Parking bars

Locations where portable primary earths are fitted to facilitate work on substation plant are currently not defined by NIE Networks with specific earthing spigots and parking bays and it is left to the discretion of SAPs (Senior Authorised Persons) as to where they are fitted.

It is indicated by NIE Networks that spigots/parking bays will allow compliance with industry standards ESQCR, EAWR and the HASAWA.

NIE Networks further indicate that these earthing spigot/parking bays are required in addition to the installation of fixed permanent earthing switches at substations which has been included in EJP 2.207 for the installation of new permanent earth switches.

Given that no justification has been provided for the requirement for further earthing spigots/parking bays in addition to the fixed earthing switches included in EJP 2.207, this approach cannot be accepted. On the basis that the need has not been fully justified we recommend that the RP7 allowance be reduced by 50% from £308k to £154k.

T12aa - Replacement of Signage

The drivers for the proposed works under this sub-programme are the same as described above for T11y.

On the basis that it has been confirmed that this is a one-off cost, given the age of the assets, we recommend the RP7 volumes and costs are allowed

T12ab - 110kV Earth Switch Replacement

This sub-category defines the retrofitting of 52 earth switches at sites where permanent earth switches are not installed, over the course of RP7. This includes 31 at Castlereagh Grid, 19 at Tandragee Grid and two at Drumnakelly Main.

Earth Switches and disconnectors provide points of isolation and earthing, which are required for equipment maintenance or replacement, extension of equipment, isolation of faults, and to facilitate efficient operation and control of the transmission network. Without permanent earth switches it is possible, in many cases, to fit temporary earth connections. However, such temporary/portable earth can be unwieldly, particularly when working at height, which is why most installations are equipped from design with sufficient permanent earth switches.

The key drivers of maintaining a safe, reliable, and resilient network, compliant with regulation are accepted. However, the wording of the submitted EJP was too ambiguous. Through the query log process, NIE Networks provided the additional clarifications, and we recommend RP7 volumes and costs are allowed as per NIE Networks submission.

T12ac - 110/33kV Tx Oil Regeneration

NIE Networks proposed to undertake oil regeneration/reprocessing to remove increasing levels of moisture in the insulating oil and combustible and non-combustible gases generated in transformers and reactors due to ageing mechanisms and evolving fault conditions. NIE Networks has provided evidence of the results of condition assessment scoring and ranking of the population of assets, including oil results focused on Furanic compounds (indicator of paper insulation degradation), acidity, levels of Carbon Dioxide and Carbon Monoxide, leading to a scoring of the oil condition of individual units.

Whilst oil monitoring and regeneration does not stop the ageing processes, it is well recognised as a means of refurbishment to potentially increase asset life but more importantly to help control asset health and reduce risks of failures that could lead to customer outage or safety incidents.

Whilst it is accepted that oil regeneration is necessary to address the transformer units with ongoing deterioration of oil condition, we note:

– no justification for the frequency of predicted oil regenerations;
– the replacement programme already ongoing where six units will be replaced in RP7, and
– there was no allowance in RP6,

and we conclude that NIE Networks statement that there are 30 units that would benefit from oil regeneration is not substantiated. Therefore, we recommend number of regeneration processes for RP7 be reduced from 30 to 15 with a corresponding reduction in allowed costs.

T12ad - 110kV Coffin CTs

NIE Networks is proposing the replacement of 110kV coffin current transformers associated with capacitor banks (providing network voltage support) due to poor condition (elevated dissolved gas analysis levels (DGA) at Coleraine Main and Coolkeeragh Grid.

Poor condition of the coffin CTs has been confirmed following off-line high voltage insulation tests. It is accepted that these units have a unique design and therefore long lead times for replacement spares equipment, thus accentuating the impact of an in-service failure.

On the basis of the above, we recommend the RP7 volumes and costs are allowed as per NIE Networks submission.

T11g - Security Systems

NIE Networks' plan for improving transmission substation security include approx. £1.1m of capex interventions. This is proposed by NIE Networks following their review of all transmission and primary substations to determine the extent of security works required to resolve issues including security fencing, access gates, security doors, floodlighting and CCTV. This has then been prioritised based on a RAG status.

The works at the proposed sites are prioritised based on NIE Networks' site security / condition assessment model. Although details were lacking within the EJP, we sought further detail from NIE Networks via the query log process. We subsequently reviewed the site condition / safety assessment details provided by NIE Networks and observed the security / safety assessment included the following criteria:

– Site configuration score;
– ESQCR Location and History scores;
– Unauthorised access score;
– Gate / Boundary Condition scores;
– Security Door rating; and
– Floodlighting

We note no weightings were applied to the assessment criteria with the model output producing aggregated site scores ranging from 10 to 25, with the higher score representing a higher priority for interventions. Only sites with an aggregate score of 17 and above have been included for RP7 interventions. A relatively small number of transmission substation sites are targeted during RP7, with works proposed at 12 sites, from a total population of 52 sites. There is limited optioneering presented within the EJP. For example, it is not clear why NIE Networks has set the threshold for intervention at the aggregated score of 17 (as opposed to a lower or higher number).

Within the EJP relating to security works, NIE Networks has provided a summary scope of works for each transmission site, itemising proposed works and associated costs to address identified security risks.

Following our review of the planned site interventions and related costs, we recommend that the proposed work volumes (in terms of the number of sites) are allowed. In terms of RP7 capex, we recommend some reductions to assumptions on length and unit cost of palisade fencing and gates, and security doors, similar to the approach that we recommend for cost reductions relating to secondary substation security (D15ac), detailed within Section 5.2, resulting in a recommended allowance of £879k for transmission security systems.

8.2.4 RP6 v RP7 unit cost analysis

Across WP3 Transmission Plant: Switchgear & Ancillaries there are limited opportunities to compare unit costs between RP6 and RP7 due to the significant number of sub-categories which don't appear in both RP6 and RP7. However, where unit costs can be compared, these are shown in Table 46.

Generally, we observed consistency in RP7 unit costs compared to RP6 outturn, with the exception of sub-programme T12f (generators) for which NIE Networks is proposing a reduced unit cost for RP7 period.

Table 46 Transmission plant: Switchgear and Ancillaries – unit cost assessment

Sub-programme ID	Outturn unit costs (£)			RP7 requested unit cost (£)	Unit cost movement (%)
	RP5	RP6 Including 22/23[37]	RP6 Excluding 22/23[38].		RP7 vs. RP6 Excluding 2023.
T10C - Replace 110kV switchgear	-	421,696	392,756	392,752	-0.0%
T11k - Ballylumford 275kV CVT Replacement	47,696	22,983	22,983	22,983	-0.0%
T11m - AC rewire	204,322	45,145	45,145	45,144	-0.0%
T11P - Kilroot 275kV CT Replacement	-	27,241	27,241	27,240	-0.0%
T12f - Generator	57,758	59,752	69,562	49,318	-29.1%
T12R - 110kV Disconnector replacement	-	45,464	45,238	45,238	-0.0%

[37] RP6 unit cost assessment is based on RP6 outturn costs and volumes reported by NIE Networks up to end March 2023 only - no forecast costs or volumes are included in our assessment of RP6 costs

[38] Outturn data for 2022/23 included a number of outliers due to work-in-progress (WIP) skewing the observed unit cost in the period. We have therefore analysed RP6 outturn unit costs with 22/23 costs included but also excluded to inform our recommended cost allowances.

8.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 47.

Table 47 Transmission Plant: Switchgear and Ancillaries – Recommendations summary

Sub-programme ID	Requested by NIE Networks		Recommended by GHD	
	RP7 allowance (£k)	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
T10 - 110kV SWGR Total	**1,565**	**17**	**798**	**17**
T10C - Replace 110kV switchgear	786	2	518	2
T10d - Refurbish 110kV Switchgear	168	9	280	15
T10e - Replace 110kV Circuit Breaker	611	6	0	0
T11 - 275kV Plant Ancillaries Total	**3,816**	**71**	**3,499**	**71**
T11g - Security systems	1,132	-	879	
T11j - DC standby systems	7	-	7	
T11k - Ballylumford 275kV CVT Replacement	552	24	552	24
T11m - AC rewire	90	2	90	2
T11o - Drainage	453	-	453	
T11P - Kilroot 275kV CT Replacement	572	21	572	21
T11R - 22kV Capacitor Bank Refurbishment	50	-	45	
T11s - Filter Bank Replacement	25	-	23	
T11t - 275kV Surge Arrestor Replacement	116	4	116	4
T11v - Substation legalities	251	-	251	
T11w - Sump Pumps	96	14	96	14
T11x - Earthing Spigots/Parking bars	112	-	56	
T11y - Replacement of Signage	23	-	23	
T11aa - 275/110kV Tx Oil Regeneration	336	6	336	6
T12 - 110kV Plant Ancillaries Total	**11,322**	**219**	**10,308**	**187**
T12d - Transformer bunding	100	-	100	
T12f - Generator	937	19	937	19
T12h - DC standby systems	318	-	318	
T12i - AC system rewire	329	8	329	8
T12o - Civil works to primary substations	3,510	-	3,510	
T12R - 110kV Disconnector replacement	769	17	769	17
T12S - Drainage Upgrade	283	-	283	
T12t - 110kV CT Replacement	503	27	452	27
T12v - 110kV Surge Arrestor Replacement	88	4	88	4
T12w - 110kV Capacitor Bank Replacement	50	-	45	
T12x - Transformer Noise Enclosures	892	4	766	4
T12y - Sump Pumps	357	52	240	35
T12z - Earthing Spigots/Parking bars	308	-	154	

Sub-programme ID	Requested by NIE Networks		Recommended by GHD	
	RP7 allowance (£k)	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
T12aa - Replacement of Signage	77	-	77	
T12ab - 110kV Earth Switch Replacement	1,565	52	1,565	52
T12ac - 110/33kV Tx Oil Regeneration	1,125	30	563	15
T12ad - 110kV Coffin CTs	112	6	112	6
WP3: Transmission plant: Switchgear & Ancillaries Total	**16,703**	**307**	**14,606**	**275**

9. Review of RP7 capex requirements - WP3: Transmission Plant: Transformers, Reactors & Strategic Spares

9.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 48 for each of the sub-work programmes included within T13, T15, T16 and T701 programmes. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

9.1.1 RP7 Costs and volumes

Table 48 Transmission Plant: Transformers, Reactors & Strategic Spares – NIE Networks investment proposal for RP7

Sub-programme ID	EJP ref	RP6 allowance		RP6 outturn		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
T13 - 275/110kV Transformer Replacement Total	**-**	**1,240**	**2**	**703**	**-**	**10,570**	**6**
T13a - Transformers (275/110kV) Procure only	EJP 2.201	-	-	-	-	6,626	3
T13C - Transformers (275/110 kV) Install only	EJP 2.201	1,240	2	703	-	2,077	3
T13f - Replace associated cable	EJP 2.201	-	-	-	-	1,867	-
T14 - 110/33kV Transformers Replacement Total	**-**	**10,389**	**28**	**11,938**	**31**	**9,073**	**20**
T14a - Transformers (110/33 kV)Procure only	EJP 2.202	4,769	7	5,402	8	4,748	6
T14b - Transformers (110/33 kV) Install only	EJP 2.202	3,443	9	4,322	9	2,181	6
T14c - Replace associated cable	EJP 2.202	876	-	994	-	1,532	-
T14D - Replace Earthing Transformer	EJP 2.202	284	4	556	7	265	4
T14E - Replace Transformer Cooler	EJP 2.202	1,017	8	664	7	347	4
T15 - 22kV Reactor Replacement Total	**-**	**567**	**1**	**817**	**1**	**2,087**	**4**
T15a - 22kV Reactors Procure only	EJP 2.205	567	1	817	1	1,451	2
T15e - 22kV Reactors Install only	EJP 2.205	-	-	-	-	636	2
T16 - Transmission Transformer Refurbishment Total	**-**	**591**	**40**	**609**	**43**	**1,416**	**76**
T16a - Refurbish/Replace 275kV Bushing	EJP 2.201	96	3	170	3	213	6
T16b - 275kV Plant Painting	EJP 2.201	43	4	66	6	79	4
T16d - Refurbish 275kV TX tap changer	EJP 2.201	36	2	29	2	80	4

Sub-programme ID	EJP ref	RP6 allowance		RP6 outturn		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
T16f - Replace 110kV Bushing	EJP 2.202	286	18	161	14	75	6
T16g - 110kV Plant Painting	EJP 2.202	73	9	81	13	249	21
T16i - Refurbish 110kV TX tap changer	EJP 2.202	57	4	103	5	487	22
T16k - Replace 110kV Cooler Controls	EJP 2.202	-	-	-	-	19	7
T16l - Replace PST Tap Changer Control Unit	EJP 2.202	-	-	-	-	200	2
T16m - Replace 275kV Cooler Controls	EJP 2.201	-	-	-	-	15	4
T701 - Strategic Spares Total	**-**	**-**	**-**	**-**	**-**	**4,414**	**-**
T701a - Grid Transformer	EJP 2.501	-	-	-	-	2,209	-
T701b - Main Transformer	EJP 2.501	-	-	-	-	1,583	-
T701c - Grid Plant	EJP 2.501	-	-	-	-	623	-
Total	**-**	**12,787**	**71**	**14,067**	**75**	**27,560**	**106**

9.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases refurbish) aging transmission transformers, reactors and providing strategic spares on its network. NIE Networks has provided documents (EJPs, as referenced above inTable 48) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 49 below for each of the sub-programmes. It is noted that for each of the identified sub-programmes of work, key drivers relate to maintaining a safe, reliable, and resilient network, compliant with regulation and environmental compliance.

Table 49 Transmission Plant: Transformers, Reactors & Strategic Spares – Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment Strategy
T13a - Transformers (275/110kV) Procure only	EJP 2.201	Continuation of the programme commenced in RP5 to replace the poor condition 275/110kV transformers, three new transformers will be installed and additional refurbishment activities will be undertaken on other units (i.e. painting, cooler replacement, cooler control refurbishment, tap changer refurbishment, bushing replacement, and oil regeneration) to extend life and control asset health risks that could lead to customer outage or safety incidents. The volume of replacement has been determined using the combined assessment of assets according to the NIE Networks condition Based model, Common Network Asset Indices Methodology (CNAIM), and Survivor model.
T13C - Transformers (275/110 kV) Install only		
T13f - Replace associated cable		
T16a - Refurbish/Replace 275kV Bushing		
T16b - 275kV Plant Painting		
T16d - Refurbish 275kV TX tap changer		
T16m - Replace 275kV Cooler Controls		
T14a - Transformers (110/33 kV)Procure only	EJP 2.202	Proposed six new transformers will be installed in RP7 (replacing eight), and additional refurbishment activities will be undertaken on other units (i.e. painting, cooler replacement, cooler control refurbishment and oil regeneration) to extend their life and control asset health risks that could lead to customer outage or safety incidents.
T14b - Transformers (110/33 kV) Install only		
T14c - Replace associated cable		
T14D - Replace Earthing Transformer		

Asset Category (Sub Work Programme)	EJP reference	Investment Strategy
T14E - Replace Transformer Cooler		The volume of replacement has been determined using the combined assessment of assets according to the NIE Networks condition Based model, Common Network Asset Indices Methodology (CNAIM), and Survivor model.
T16f - Replace 110kV Bushing		
T16g - 110kV Plant Painting		
T16i - Refurbish 110kV TX tap changer		
T16k - Replace 110kV Cooler Controls		
T16l - Replace PST Tap Changer Control Unit		
T15a - 22kV Reactors Procure only	EJP 2.205	Completion of a programme of 22kV reactor replacement from RP5, replacing two reactors on the network in the RP7 period to manage safety and network reliability associated with this asset class. Long-lead times (up to 24 months) for procurement have been accounted for.
T15e - 22kV Reactors Install only		
T701a - Grid Transformer	EJP 2.501	Strategy proposed for RP7 deemed necessary in response to macroeconomic conditions impacting lead times and an increasing network strain through changing consumer demands in the energy transition, increasing the importance of NIE Networks to respond more quickly to repair and replace failed assets. Similarly, the changing of operation for network assets due to distributed generation and low carbon technologies (LCTs) is increasing the demand on the equipment through increasing levels of reverse power flow, elevated loading and losses, additional network switching, increasing fault levels and network time constraints, and the need to provide reactive power compensation. This strategy is also inclusive of additional monitoring, testing, and modelling of assets and the network to manage the risk to the network. Additional key drivers relating to reducing customer impact, and mitigation of impact of global supply chains.
T701b - Main Transformer		
T701c - Grid Plant		

9.2 GHD analysis

9.2.1 T13 - 275/110kV Transformer Replacement

T13a - Transformers (275/110kV) Procure only

The overall objective in RP7 is to replace three 275/110 kV transformers during RP7 to maintain the overall asset health of the transformer population.

The volume of replacement has been determined using the combined assessment of assets according to the NIE Networks condition Based model, Common Network Asset Indices Methodology (CNAIM), and Survivor model.

Whilst it is appreciated that the NIE Networks plan is a continuation of the programme commenced in RP5 to replace the poor condition 275/110kV transformers, we observed that EJP 2.201 did not provide any specific justification, based on assessment of asset condition for the three transformers proposed, out of the population of 17, to be replaced. Nor to justify the additional refurbishment activities to be undertaken on other units (i.e. painting, cooler replacement, cooler control refurbishment, tap changer refurbishment, bushing replacement, and oil regeneration) to extend life and control asset health risks that could lead to customer outage or safety incidents.

Following the engagement process with NIE Networks further information was provided on the condition assessment process applied to the transformer assets, together with the condition scoring criteria, overall scoring for each unit and a ranking of each unit in the total population.

This ranking confirmed the selection of the units proposed for replacement during RP6 and RP7 at Castlereagh Main, Tandragee Main and Hannahstown Main.

As might be expected there was a reasonably strong correlation between the total condition score and the age of the individual units.

Options considered were to:

- Do nothing (not credible on the basis of the condition of the units identified)
- Only replace two 275/110 kV transformers (not viable due to the condition of one of the two units at Tandragee not being replaced)
- Replacement of four units (not necessary as IBTX1 at Castlereagh Grid which has a poor score, is due to be decommissioned in RP7 with the completion of the Belfast Metropolitan works)

GHD concur that the other option of refurbishment is not appropriate for such equipment taking into account age and condition of the units as indicated by condition assessment techniques.

This assessment presented is consistent with the approach expected. However, the presentation of condition assessment scoring/ranking and evaluation of potential options, was not of the standard expected.

Nevertheless, NIE Networks has demonstrated that based on the condition of the 275/110kV transformers presented, there is support for the replacement of three units as proposed in RP7.

Costs on a procurement only basis are aligned with RP6 values and are accepted, recognising that within other EJP documents there are other costs included with substation works associated with the installation of the transformers.

Therefore, GHD conclude that 275/110 kV transformer replacements (procurement only) as requested by NIE Networks are reasonable in terms of volumes and costs and we recommend their allowances for RP7 period.

T13C - Transformers (275/110 kV) Install only

The sub-category T13c covers “install only” with the scope of civil installs, auxiliary equipment relocations, new blast walls being installed and noise enclosures where required for the three units only in sub programme T13a. It does not include the work required for upgrades to drainage which is managed by the Civils upgrade EJP 2.601 – Transmission Civil Works.

Volumes are dictated by T13a and are recommended for RP7 as described above in line with the NIE Networks submission. Unit cost is based on RP6 values and on this basis, we also recommend allowances are provided for RP7.

T13f - Replace associated cable

Whilst the need to replace the cables associated with the replacement of the planned 275/110 kV transformers is accepted as necessary, no justification for the cable replacement costs has been provided.

Given that this sub-category was not included in RP6 it is not possible to conclude on the justification of the costs.

GHD consider that on the basis of the likely costs associated with replacing 275 kV, 110 kV and 22 kV cables (for connection of tertiary connected reactors), plus associated power supply and control cables, that a total cost as proposed by NIE Networks of £1.87m is high. Furthermore it appears high compared to NIE Networks own submissions in WP5 relating to Transmission Cables.

On the above basis, whilst the volumes are accepted, the total cost across the three-transformer replacement is adjusted from £1.867m to £1.25m.

9.2.2 T14 - 110/33kV Transformers Replacement

T14a - Transformers (110/33 kV) Procure only

The overall objective in RP7 is to replace six 110/33 kV transformers (replacing eight) during RP7 to maintain the overall asset health of the transformer population and control associated asset health risks that could lead to customer outage or safety incidents.

The volume of replacement has been determined using the combined assessment of assets according to the NIE Networks condition-based model, taking into account the Common Network Asset Indices Methodology (CNAIM), and Survivor models.

EJP2.201 did not provide any detailed justification, based on assessment of asset condition for the eight transformers proposed, out of the population of 79. Rather a high-level comparison of the potential impacts of relacing eight units (NIE Networks model), replacing 13 units (CNAIM) or 7 units (Survivor Model).

On the basis of the above, NIE Networks concluded that this was an efficient and cost-effective solution, compared to “doing nothing”.

Following the engagement process with NIE Networks, further information was provided on the condition assessment process applied to the transformer assets, together with the condition scoring criteria, overall scoring for each unit and a ranking of each unit in the total population.

This identified the units at Banbridge Main (two units), Logue town Main (two units) and one unit each at Donegal Main and Dungannon Main.

GHD concur that the option of refurbishment is not appropriate for such equipment, once certain activities have been exhausted e.g. oil regeneration (T12ac), tap changer refurbishment (T16i), painting (T16g), replacement of bushings (T16f) and other items which are included as ongoing activities on other transformer units in the identified sub-categories.

This assessment presented is consistent with the approach expected. However, the presentation of condition assessment scoring/ranking and evaluation of potential options, was not of the standard expected.

Nevertheless, NIE Networks has demonstrated that based on the condition of the 110/33kV transformers presented, there is support for the replacement of six units (to replace eight) as proposed in RP7.

Costs on a procurement only basis are aligned with RP6 values (procure only) and are accepted, recognising that within other EJP documents there are other costs included with substation works associated with the installation of the transformers.

Therefore, GHD conclude that 275/110 kV transformer replacements as requested by NIE Networks are reasonable in terms of volumes and costs and we recommend their allowances for RP7 period.

T14b - Transformers (110/33 kV) Install only

The sub-category T14b covers “install only” with the scope of civil installs, auxiliary equipment relocations, new blast walls being installed and noise enclosures where required for the six units only in sub-programme T14a. It does not include the work required for upgrades to drainage which is managed by the Civils upgrade EJP 2.601 – Transmission Civil Works.

Volumes are dictated by T14a and are recommended for RP7 as described above in line with the NIE Networks submission.; Unit cost are based on RP6 values and on this basis accepted we also recommend allowances are provided for RP7.

T14c - Replace associated cable

Whilst the need to replace the cables associated with the replacement of the planned 110/33 kV transformers is accepted as necessary, no justification for the cable replacement costs have been provided.

Given that this sub-category was not included in RP6 it is not possible to conclude on the justification of the costs.

GHD consider that on the basis of the likely costs associated with replacing the 110 kV and 33 kV cables, plus associated power supply and control cables, that a total cost as proposed by NIE Networks of £1.5m is high and does not align with RP6 costs. Additionally, it appears high compared to NIE Networks own submissions in WP5 relating to Transmission Cables.

On the above basis, whilst the volumes are accepted, the total cost across the three-transformer replacement is adjusted from £1.5m to £1.1m.

T14D - Replace Earthing Transformer

Earthing transformers are matched to their associated 110/33 kV transformers and therefore when a transformer is replaced, the associated earthing transformer requires replacement.

Volumes as submitted by NIE Networks are in line with the requirements of sub-category T14a and the unit costs are based on Dungannon Main outturn costs during RP6.

On the above basis GHD concludes that the replacement of earthing transformers for the 110/33 kV transformers as requested by NIE Networks are reasonable in terms of volumes and costs (four units at a unit cost of £66.3k) and we recommend their allowances for RP7 period.

T14E - Replace Transformer Cooler

Transformer coolers are an integral part of the transformer required to meet the assigned rating through operation of the fans and pumps. There are 79 transformer coolers on the 110/33kV transformer network and the condition-based assessment has highlighted four transformer coolers for replacement.

Prioritised asset works are focused on the transformer coolers at Drumnakelly (1991) and Strabane (1992) based on their poor condition.

Both transformers are over 30 years old and have not previously been subject to cooler replacement, so are suffering issues with:

– Corrosion of thin-walled coolers, leading to oil leaks.
– Corrosion of fan enclosures.
– Failures of expansion flanges.
– Heat exchanger failures due to corrosion.

Such deterioration after 30 years' service is expected.

Volumes and costs, compared to RP6 values are reasonable and we recommend RP7 volumes and costs are allowed, in line with the NIE Networks submission.

9.2.3 T15 - 22kV Reactor Replacement

T15a - 22kV Reactors Procure only

The proposed works are the completion of a programme of 22kV reactor replacement ongoing from RP5 based on ageing reactors in deteriorating condition.

The works includes Hannahstown Main T1 reactor replacement having failed catastrophically in 2021.

Condition assessment and age profile highlights that the two-remaining 50+ year old reactors require replacement.

Replacing the two reactors on the network at Kells in the RP7 period will assist in the safe management of the system and help ensure network reliability.

It is noted that there have been issues associated with the supply chain for these 22 kV reactors. The original supplier CG Power went into administration and orders were awarded to ABB for the delivery of two RP6 units in September 2021. Subsequently EIC Saudi has acquired CG Power and production has resumed at the plant in Belgium.

The market has also experienced lengthening lead times (up to 24 months) which have been accounted for by NIE Networks.

NIE Networks provided further information to support the justification for their proposed asset replacement volume in RP7 and is considered credible.

On unit costs, the high costs incurred in the ABB supply purchase order February 2022 are not accepted as reflecting the RP7 unit costs.

GHD conclude that the two units in line with the NIE Networks submission are accepted. However, we recommend allowed RP7 costs are based on unit costs as per RP5-RP6 long term rate (actual costs), taking into account the lack of clarity on the RP6 installation costs.

T15e – 22kV Reactors Install only

The volume of two reactors to be installed and covered above in T15d is recommend for RP7.

The forecast installation costs of NIE Networks for T15e are based on forecast costs taking into account forecast price increases on the D5 mechanism outturn costs for the replacement of shunt reactor T3 at Tandragee which shows a high cost for installation, but only following the exclusion of the reactor purchase cost of £484k from the total cost of £802k (resulting in a unit reactor install cost of £318k).

GHD conclude that the estimated unit rates for installation of the reactors are not sufficiently demonstrated and the justification for a >100% increase in installation costs from RP5 to RP7 is not provided.

Therefore, we recommend that the unit cost for reactor installation be reduced to £231k, representing the mid-point-between the RP5 figure of £154k and the NIE Networks requested figure of £318k.

9.2.4 T16 - Transmission Transformer Refurbishment

T16a - Refurbish/Replace 275kV Bushing

Periodic Tan δ measurements are the established approach to monitor and assess transformer bushing condition.

Failure to address bushings which are deteriorating can lead to catastrophic transformer failures, the extent and disruption to network security caused, being disproportionately high compared to the cost of an individual bushing. NIE Networks suffered a catastrophic 275/110 kV transformer fire in 1997, triggered by a bushing failure.

Each 275/110kV transformer has three 275 kV bushings, therefore there are 54 on the NIE Networks system.

Based on Tan δ measurements, replacement of six 275kV bushings in RP7 associated with GE 240MVA transformers where degradation has been found in maintenance testing is proposed by NIE Networks and this plan is supported by GHD.

Unit costs for bushing replacements are based on RP6 values and on this basis we recommend RP7 allowances consistent with the NIE Networks submission.

T16b - 275kV Plant Painting

Painting is proposed to renew existing environmental coatings to protect the main tank ancillaries from corrosion where degradation has been observed during routine inspections.

A painting programme was re-commenced in RP6 to renew the protective paint coatings on four 275/110 kV transformers based on condition assessment. Such a requirement is consistent with OEM and industry expectations that initial paint coatings will require renewal every ten years.

Unit costs are consistent with RP6 rates and on this and the above basis we recommend RP7 allowances consistent with the NIE Networks submission.

T16d - Refurbish 275kV TX tap changer

Tap changers, particularly older units without vacuum interrupters, are predominantly mechanical devices, undergoing frequent operations whilst performing an electrical duty. This combination of operational stresses leads to a pre-determined maintenance / refurbishment activity based on elapsed time and number of operations.

Four out of the Maschinenfabrik Reinhausen (MR) tap changers fitted to 8 of the 275/110kV transformers are greater than 15 years old and therefore require detailed maintenance/inspection and refurbishment.

The required work involves removal of the four tap changer diverter switches on the specific transformers. The work requires completion under the supervision of an MR site technician to ensure the appropriate work is carried out, any other issues are identified, and the work is also completed correctly.

Given the age of the tap changers, the basis for the need is accepted and given the unit cost is based on RP6 values, we recommend RP7 allowances consistent with the NIE Networks submission.

T16f - Replace 110kV Bushing

Periodic Tan δ measurements are the established approach to monitor and assess transformer bushing condition.

Failure to address bushings which are deteriorating can lead to catastrophic transformer failures, the extent and disruption to network security caused, being disproportionately high comparted to the cost of an individual bushing. NIE Networks suffered a catastrophic 275/110 kV transformer fire in 1997, triggered by a bushing failure.

Each 110/33kV transformer has three 110 kV bushings, therefore there are 237 on the NIE Networks system.

Based on Tan δ measurements, replacement of six 110kV bushings in RP7 is proposed by NIE Networks associated with GE 90MVA transformers where degradation has been found in maintenance testing and this plan is supported by GHD.

Unit costs are based on RP6 actuals and we recommend RP7 volumes and costs as per NIE Networks submission.

T16g - 110kV Plant Painting

Painting is proposed to renew existing environmental coatings to protect the main tank ancillaries from corrosion where degradation has been observed during routine inspections.

A painting programme was re-commenced in RP6 to renew/ the protective paint coatings based on condition assessment. Such a requirement is consistent with OEM and industry expectations that initial paint coatings will require renewal every ten years.

Unit costs are consistent with RP6 rates and on this and the above basis the NIE Networks RP7 proposed approach is accepted.

It is our understanding that proposed RP7 rates are based on a supplier Best and Final Offer (BAFO) of £11.9k whilst the unit rate for RP6 was only £5.4k. Based on a frequency of painting of 10 years and the population profile (79 with 8 replacements during RP7) the repainting of 21 units during RP7 is not supported and we also recommend the proposed unit cost for RP7 should be based on the mid-point between RP6 and RP7 values = £8.6k, giving a recommended allowance for 15 units of £129k.

T16i - Refurbish 110kV TX tap changer

Tap changers, particularly older units without vacuum interrupters, are predominantly mechanical devices, undergoing frequent operations whilst performing an electrical duty. This combination of operational stresses leads to a pre-determined maintenance/refurbishment activity based on elapsed time and number of operations.

The MR tap changers fitted to 22 of the 110/33kV transformers up until 05/2014 have been identified with a type defect following inspections by MR after the Newry Main failure. The OEM has issued a bulletin highlighting the defect, which recommends urgent modification of all affected units to minimise the probability of failure. The modifications involve replacement of the diverter contacts and associated flexible leads.

Therefore, the RP7 plan is to refurbish 22 110 kV tap changer units across the transformer population at a total cost of £487.4k.

On the basis of the information presented GHD recommend the acceptance of the RP7 plan to refurbish 22 of the 110 kV tap changers at the RP6 based allowance of a unit cost of £22.2k.

T16k - Replace 110kV Cooler Controls

Seven cooler control systems have been highlighted due to their poor condition due to wiring faults, switch and contactor failures and number of defective units require refurbishment. Poor internal wiring will be replaced together with switches, contactors and other suspect components.

Contractor quotations identify the cost and scope of the works.

We recommend allowances are provided for RP7 consistent with the NIE Networks costs and volume submission.

T16l - Replace PST Tap Changer Control Unit

The PST tap changer control systems at Enniskillen and Strabane were installed in 2001 and require replacement following ongoing maloperation issues.

Repairs and software modifications during RP6 have been unsuccessful in resolving the issues and NIE Networks conclude that during RP7 these two units should be replaced. The original OEM is no longer in business which will require additional control system and software design.

Supplier quotations have been received, and on this basis, we recommend the NIE Networks proposed RP7 submission of £200k is allowed.

T16m - Replace 275kV Cooler Controls

Four cooler controls systems have been highlighted due to their poor condition due to wiring faults, switch and contactor failures and number of defective units require refurbishment to ensure the ongoing reliable operation of Winding Temperature Indicators (WTI), pumps and fans. Poor internal wiring will be replaced together with switches, contactors and other suspect components.

Contractor quotations identify the cost and scope of the works.

We recommend the volume of four refurbishments/replacements is allowed along with the total RP7 cost of £14.5k.

9.2.5 T701 - Strategic Spares

NIE Networks identify that the RP7 programme highlights the need to purchase strategic spares to manage ongoing risks associated with equipment failures and minimise return to service times, whilst at the same time there is a trend towards longer delivery times for all transmission equipment and services.

Strategic spares are focused on three areas:

T701a - Grid Transformer

There are currently no spare 275/110kV transformers compared to a network population of 18.

GHD supports the need for a spare 275/110kV transformer that is proposed by NIE Networks, particularly given the likely 30+ month delivery time for a new unit.

The requested RP7 cost is aligned with T13a and we recommend it is allowed.

T701b - Main Transformer

Whilst there are currently two spare 110/33 kV transformers available as spares compared to a population of 79, these do not align with the current 90 MVA capacity required.

GHD supports the need for two spare 110/33 kV transformers that are proposed by NIE Networks, particularly given the likely >24 month delivery time for a new unit.

The requested RP7 cost is aligned with T14a and we recommend it is allowed.

T701c - Grid Plant

A need for transmission spares (excluding transformers) has been identified by NIE Networks based an assessment range of transmission asset population, spares available, anticipated deliveries and equipment supply lead times. This analysis is presented in EJP 2.501 and is extracted below as Figure 8.

Based on this review, a range of transmission spares have been identified and included in NIE Networks RP7 plan. These are listed in EJP 2.501 Table 4 and is extracted below as Figure 9.

Equipment	Voltage kV	No. on Network	Spare(s) available	Delivery time (months)	Risk (RAG)	Comments
Transformer	110/33	78	2x 60 MVA	24		Two 90MVA spares required as higher capacity units now in use.
CT	275	321	3	6+		Three unique core ratio units for Kilroot Grid. Six standard core ratio network spares required.
CT	110	504	0	6+		Six units required with additional core ratios.
CVT	275	157	0	6+		Three units required.
CVT	110	477	0	6+		Three units required.
Wound VT	22	3	0	6+		Three units required.
Circuit Breaker	275	70	1	12+		One unit required.
Circuit Breaker	110	215	1	12+		Three units required.
*Disconnectors	275	218	0	8		Two RCP and Two Pantograph units required.
*Disconnectors	110	659	0	8		Two RCP and Two Pantograph units required.
Wall Bushing	275	30	1	18		Two units required to make up a full set in case of one failing catastrophically.
Current Transformer	22	24	1	6+		One available and Two additional desired.
OPGW conductor	Comms	TBC	0	6+		To be held in stock
OPPC Lynx conductor	Comms	TBC	0	6+		To be held in stock
OPPC Upas conductor	Comms	TBC	0	6+		To be held in stock
ADSS conductor	Comms	TBC	0	6+		To be held in stock
2000mm² Cu cable	275	2 CCTs	0	6+		To be held in stock to replace 3 in² at CPS
Straight thru Joints	275	2	0	6+		To be held in stock
Terminations Joints	275	12	0	6+		To be held in stock
1000mm² Al cable	110	52 CCTs	0	6+		To be held in stock
2000mm² Al cable	110	17 CCTS	0	6+		To be held in stock
Various Protection Relays	275/110	TBC	TBC	9 - 12		To be held in stock
Shunt reactor	22	8 to increase to 11	0	18		Sufficient coverage from current Asset replacement and D5 programmes.

TABLE 1 - TRANSMISSION EQUIPMENT REVIEW

Figure 8 *Table 1 extract from EJP 2.501 Transmission Equipment Review*

Sub Cat	Equipment	Contract No.	No.	Unit Cost	Total Cost (£)
T701c	275 kV Current Transformers	C347	6	12,950	77,700
T701c	110 kV Current Transformers	C355	6	9,771	58,626
T701c	275 kV Capacitive Voltage Transformers	C362	3	11,150	33,450
T701c	110 kV Capacitive Voltage Transformers	C354	3	10,150	30,450
T701c	22 kV Wound Voltage Transformer	C362	3	4,350	13,050
T701c	275 kV Circuit Breakers	C364	1	105,294	105,294
T701c	110 kV Circuit Breakers	C359	3	35,000	105,000
T701c	275 kV Wall Bushing	TBC	2	26,000	52,000
T701c	275 kV Disconnectors (RCP[5])	C363	2	28,335	56,670
T701c	110 kV Disconnectors (RCP)	C356	2	14,187	28,374
T701c	275 kV Disconnectors (Pantograph)	C363	2	19,380	38,760
T701c	110 kV Disconnectors (Pantograph)	C356	2	11,684	23,368
				Total:	622,742

TABLE 3 - T701c – TRANSMISSION PLANT COSTS

Figure 9 NIE Networks requested spares based on EJP 2.501 analysis

GHD concurs that the unit costs are consistent with RP6 costs and that the volumes of spares to be procured are fully necessary to help secure the ongoing safety and reliability of the transmission system. We therefore recommend the RP7 allowances, consistent with the NIE Networks submission.

9.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 50.

Table 50 Transmission Plant: Transformers, Reactors & Strategic Spares – Recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
T13 - 275/110kV Transformer Replacement Total	**10,570**	**6**	**9,953**	**6**
T13a - Transformers (275/110kV) Procure only	6,626	3	6,626	3
T13C - Transformers (275/110 kV) Install only	2,077	3	2,077	3
T13f - Replace associated cable	1,867	-	1,250	-
T14 - 110/33kV Transformers Replacement Total	**9,073**	**20**	**8,640**	**20**
T14a - Transformers (110/33 kV) Procure only	4,748	6	4,748	6
T14b - Transformers (110/33 kV) Install only	2,181	6	2,181	6
T14c - Replace associated cable	1,532	-	1,100	
T14D - Replace Earthing Transformer	265	4	265	4
T14E - Replace Transformer Cooler	347	4	347	4
T15 - 22kV Reactor Replacement Total	**2,087**	**4**	**1,570**	**4**
T15a - 22kV Reactors Procure only	1,451	2	1,108	2
T15e - 22kV Reactors Install only	636	2	462	2
T16 - Transmission Transformer Refurbishment Total	**1,416**	**76**	**1,246**	**70**

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume**	**RP7 allowance (£k)**	**RP7 volume**
T16a - Refurbish/Replace 275kV Bushing	213	6	213	6
T16b - 275kV Plant Painting	79	4	79	4
T16d - Refurbish 275kV TX tap changer	80	4	80	4
T16f - Replace 110kV Bushing	75	6	75	6
T16g - 110kV Plant Painting	249	21	129	15
T16i - Refurbish 110kV TX tap changer	487	22	487	22
T16k - Replace 110kV Cooler Controls	19	7	19	7
T16l - Replace PST Tap Changer Control Unit	200	2	150	2
T16m - Replace 275kV Cooler Controls	15	4	15	4
T701 - Strategic Spares Total	**4,414**	**-**	**4,414**	-
T701a - Grid Transformer	2,209	-	2,209	
T701b - Main Transformer	1,583	-	1,583	
T701c - Grid Plant	623	-	623	
Total	**27,560**	**106**	**25,824**	**100**

10. Review of RP7 capex requirements - WP3: Transmission plant: Protection

10.1 RP7 requested allowance

NIE Networks proposed investment for the RP7 period is itemised below in Table 51for each of the sub-work programmes included within T602 programme. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

10.1.1 RP7 Costs and volumes

Table 51 Transmission Plant: Protection – NIE Networks investment proposal for RP7

		RP6allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	**EJP ref**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**
T602 - Transmission Protection Total	**-**	**3,492**	**111**	**4,473**	**84**	**5,697**	**173**
T602E - Install 275kV Interbus Transformer Protection	EJP 2.401	315	5	653	4	70	1
T602H - Install 275kV Feeder Protection	EJP 2.401	1,597	22	2,006	20	902	8
T602J - Install 275kV Circuit Breaker Fail	EJP 2.401	170	23	293	7	395	48
T602k - Install 22kV Reactors	EJP 2.401	99	4	90	3	110	4
T602N - Install 110kV Transformer Protection	EJP 2.401	193	6	327	6	1,160	17
T602O - Install 110kV Distance Protection	EJP 2.401	266	8	363	8	725	16
T602P - Install 110kV Tap Change Control	EJP 2.401	74	6	104	4	363	14
T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)	EJP 2.401	26	7	22	7	83	26
T602T - Install 110kV Unit Protection	EJP 2.401	65	2	85	2	423	10
T602U - Install 110kV Intertripping	EJP 2.401	35	2	43	4	29	2
T602w - Load Shedding Panel	EJP 2.401	19	2	10	1	42	4
T602X - Install 275kV Grid Substation Monitors	EJP 1.703	400	15	318	11	60	2
T602Y - Install 110kV Grid Substation Monitors	EJP 1.703	234	9	159	7	261	7
T602aa - Remove Protection	EJP 2.401	-	0	-	-	22	-
T602ad - Install 275kV Autoreclose	EJP 2.401	-	0	-	-	494	10
T602ae - Install 275kV Operational Intertripping	EJP 2.401	-	0	-	-	140	-
T602af - Install 110kV Bus coupler	EJP 2.401	-	0	-	-	64	2
T602ah - Install PST Protection	EJP 2.401	-	0	-	-	182	2
T602ai - 61850 Hardware Replacement	EJP 2.401	-	0	-	-	150	-
T602aj - Protection Studies	EJP 2.401	-	0	-	-	22	-

10.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace transmission protection systems on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 51) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in Table 52 below for each of the sub-programmes.

Table 52 Transmission Plant: Protection – Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment Strategy
T602E - Install 275kV Interbus Transformer Protection	EJP 2.401	Continuation of programme to replace transmission protection systems, to reduce risks of failure which could result in widespread customer outage, equipment damage and potential safety incidents. A majority of these assets are now an electronic type, where maintenance and refurbishment of these assets is not an option due to insufficient spares and withdrawal of manufacturer support, when compared with the predecessor electromechanical types. The new electronic type of equipment also has a lesser lifespan, meaning more common intervention/replacement/retrofits are required. The programme started in RP6 and continuing in RP7, will address the highest risk protection assets as part of an optimized rolling plan, replacing assets which are obsolete, unsupported by the manufacturer and approaching end of life. Key drivers to maintain a safe, reliable, and resilient network, facilitating net zero through a flexible and integrated energy system, and compliance with legislation.
T602H - Install 275kV Feeder Protection		
T602J - Install 275kV Circuit Breaker Fail		
T602k - Install 22kV Reactors		
T602N - Install 110kV Transformer Protection		
T602O - Install 110kV Distance Protection		
T602P - Install 110kV Tap Change Control		
T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)		
T602T - Install 110kV Unit Protection		
T602U - Install 110kV Intertripping		
T602w - Load Shedding Panel		
T602aa - Remove Protection		
T602ad - Install 275kV Autoreclose		
T602ae - Install 275kV Operational Intertripping		
T602af - Install 110kV Bus coupler		
T602ah - Install PST Protection		
T602ai - 61850 Hardware Replacement		
T602aj - Protection Studies		
T602X - Install 275kV Grid Substation Monitors	EJP 1.703	This EJP covers both distribution substation monitors and transmission substation monitors (transmission monitors are captured here and distribution monitors are captured separately in section 6). NIE Networks state that the main driver for investment is “maintaining a safe, reliable and resilient network”. However, the main body of the EJP states that the drivers are to remove and replace “obsolete, age expired and faulty equipment” and to improve the levels of substation monitoring (including power quality).
T602Y - Install 110kV Grid Substation Monitors		

10.2 GHD analysis

10.2.1 Condition assessment analysis

The scoring methodology shown in Table 53 below was used by NIE Networks to assess the condition of protection assets, and has been developed from previous work in RP6, considering the following factors:

– Has the switchgear already been changed to more modern type?
– Is the protection no longer supported and greater than 20 years old?
– Is there availability of spares? and if not, does the protection relay fall into the 20-year period as opposed to the 25–30-year period where failures are anticipated.
– Are the relays outside of manufacturer support?
– Have there been notable increases in failures of the specific relay type?
– Relay types and DC voltage ranges for spares.

Table 53 Transmission Plant: Protection - Scoring methodology condition risk assessment

Condition	Description
1	<10 years old no physical defects, no electrical defects
2	>=10 years or with minor physical defect e.g. cracked plastic cover plate or known defect but repairable
3	Discontinues but manufacturer repairs available or front cover missing but no exposed parts or reset facility broken
4	Obsolete but 3rd party repairs available or spares available or older than 20yrs electronic, or 35 years electromechanical
5	Obsolete – no spares nor repairs – older than 30yrs electronic or 45yrs electromechanical or known defect no repair.

Some relays in EJP 2.401 were given a score of 1, despite their description matching condition 5. Following a round of queries, NIE Networks confirmed that such relays are due to be replaced in the RP6 period but at the time of the submission they were either still in progress, or due to be completed before the end of the period. So were manually given a score of 1 to ensure that they did not affect the overall population score and NIE Networks are expecting they will be completed before the commencement of RP7.

10.2.2 T602 - Transmission Protection

The commentary provided in EJP 2.401 is supported by the NIE Networks analysis and the demonstrated need for this programme of work is clear, therefore we recommend the associated costs and volumes for the majority of sub-programmes are allowed, consistent with the submission by NIE Networks.

T602E - Install 275kV Interbus Transformer Protection

Lump sum cost accepted as per NIE Networks submission.

T602H - Install 275kV Feeder Protection

Volumes as per NIE Networks submission. However, we recommend the proposed unit cost is adjusted as per RP5/RP6 outturn to 2023.

T602J - Install 275kV Circuit Breaker Fail

Volumes and costs accepted as per NIE Networks submission.

T602k - Install 22kV Reactors

Volumes and costs accepted as per NIE Networks submission.

T602N - Install 110kV Transformer Protection

Volumes and costs accepted as per NIE Networks submission.

T602O - Install 110kV Distance Protection

Volumes and costs accepted as per NIE Networks submission.

T602P - Install 110kV Tap Change Control

Volumes and costs accepted as per NIE Networks submission.

T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)

Volumes and costs accepted as per NIE Networks submission.

T602T - Install 110kV Unit Protection

Volumes and costs accepted as per NIE Networks submission.

T602U - Install 110kV Intertripping

Volumes and costs accepted as per NIE Networks submission.

T602w - Load Shedding Panel

Volumes and costs accepted as per NIE Networks submission.

T602X - Install 275kV Grid Substation Monitors

Volumes and costs accepted as per NIE Networks submission.

T602Y - Install 110kV Grid Substation Monitors

Volumes and costs accepted as per NIE Networks submission.

T602aa - Remove Protection

Lump sum cost accepted as per NIE Networks submission.

T602ad - Install 275kV Autoreclose

Volumes and costs accepted as per NIE Networks submission.

T602ae - Install 275kV Operational Intertripping

Volumes and costs accepted as per NIE Networks submission.

T602af - Install 110kV Bus coupler

Volumes and costs accepted as per NIE Networks submission.

T602ah - Install PST Protection

Volumes and costs accepted as per NIE Networks submission.

T602ai - 61850 Hardware Replacement

The requested allowance of a lump sum for hardware replacement is not supported by the narrative in EJP 2.401 to address obsolescence in the protection systems on the transmission network. There is no justification of the relevance to requested lump sum which is categorised in this sub-programme, nor any detail as to what this subprogramme will cover, at which sites and for what purpose. Therefore, we recommend the requested allowance is disallowed.

T602aj - Protection Studies

The requested allowance of a lump sum for protection studies is not supported by the narrative in EJP 2.401, to address obsolescence in the protection systems on the transmission network by replacing protection devices. A sub-programme of protection studies is not elaborated on in the EJP and no justification is provided for the proposed cost. There is no justification of the relevance to requested lump sum which is categorised in this sub-programme, at which sites and for what purpose. Therefore, we recommend the requested allowance is disallowed.

10.2.3 RP6 v RP7 unit cost analysis

Across WP3 Transmission Plant: Protection there are limited opportunities to compare unit costs between RP6 and RP7 due to the significant number of sub-categories which don't appear in both RP6 and RP7. However, where unit costs can be compared, these are shown in Table 54.

Table 54 Transmission plant: Protection – unit cost assessment

Sub-programme ID	Outturn unit costs (£)			RP7 requested unit cost (£)	Unit cost movement (%)
	RP5	RP6 Including 22/23[39]	RP6 Excluding 22/23[40].		RP7 vs. RP6 Excluding 2023.
T602E - Install 275kV Interbus Transformer Protection	-	445,795	428,884	70,437	-83.6%
T602H - Install 275kV Feeder Protection	-	102,119	142,596	112,690	-21.0%
T602N - Install 110kV Transformer Protection	-	70,189	68,251	68,250	-0.0%
T602O - Install 110kV Distance Protection	-	45,338	45,312	45,311	-0.0%
T602P - Install 110kV Tap Change Control	-	25,960	25,960	25,960	-0.0%
T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)	-	3,180	1,857	3,174	70.9%
T602T - Install 110kV Unit Protection	-	42,325	42,325	42,325	-0.0%
T602U - Install 110kV Intertripping	-	10,787	14,485	14,485	0.0%

From the above, it is evident that proposed RP7 unit costs are either lower than or consistent with the equivalent RP6 unit costs and are deemed reasonable.

10.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 55.

[39] RP6 unit cost assessment is based on RP6 outturn costs and volumes reported by NIE Networks up to end March 2023 only - no forecast costs or volumes are included in our assessment of RP6 costs

[40] Outturn data for 2022/23 included a number of outliers due to work-in-progress (WIP) skewing the observed unit cost in the period. We have therefore analysed RP6 outturn unit costs with 22/23 costs included but also excluded to inform our recommended cost allowances.

Table 55 Transmission Plant: Protection – Recommendations summary

Sub-programme ID	Requested by NIE Networks		Recommended by GHD	
	RP7 allowance (£k)	RP7 volume	RP7 allowance (£k)	RP7 volume
T602 - Transmission Protection Total	**5,697**	**173**	**5,433**	**173**
T602E - Install 275kV Interbus Transformer Protection	70	1	70	1
T602H - Install 275kV Feeder Protection	902	8	817	8
T602J - Install 275kV Circuit Breaker Fail	395	48	395	48
T602k - Install 22kV Reactors	110	4	110	4
T602N - Install 110kV Transformer Protection	1,160	17	1,160	17
T602O - Install 110kV Distance Protection	725	16	725	16
T602P - Install 110kV Tap Change Control	363	14	363	14
T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)	83	26	83	26
T602T - Install 110kV Unit Protection	423	10	423	10
T602U - Install 110kV Intertripping	29	2	22	2
T602w - Load Shedding Panel	42	4	42	4
T602X - Install 275kV Grid Substation Monitors	60	2	60	2
T602Y - Install 110kV Grid Substation Monitors	261	7	261	7
T602aa - Remove Protection	22	-	22	
T602ad - Install 275kV Autoreclose	494	10	494	10
T602ae - Install 275kV Operational Intertripping	140	-	140	
T602af - Install 110kV Buscoupler	64	2	64	2
T602ah - Install PST Protection	182	2	182	2
T602ai - 61850 Hardware Replacement	150	-	-	-
T602aj - Protection Studies	22	-	-	-

11. Review of RP7 capex requirements - WP4: Transmission overhead lines

This section presents details of our analysis of the expenditure proposals for transmission overhead lines, comprising two sections 275kV and 110kV. The 275kV network comprising of support towers, conductors and conductor spacers, earth wire and earth wire fittings, suspension and tension insulators and fittings, colour plates, number plates, anti-climbing devices (ACDs) and foundations. The 110kV network comprising of steel towers, wood poles, conductors, suspension and tension insulators, fittings, dampers, ID and safety plates, foundations, muffs, and ACDs.

11.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 56 for each of the sub-work programmes included within T17 and T19 programmes. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

11.1.1 Costs and Volumes

Table 56 Transmission Overhead Lines - NIE Networks investment proposal for RP7

	RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes** [41]
T17 - 275kV Overhead Line Asset Replacement	**4,857**	**1,771**	**5,606**	**1,984**	**18,696**	**3,223**
T17d - Tower Painting	3,173	619	4,000	599	2,541	360
T17e - Replace Colour and Number Plates	216	358	198	358	160	300
T17f - Foundation assessment	497	165	506	165	573	208
T17g - Condition assessment	229	0	208	0	198	310
T17J - Muff Repair	527	272	509	505	139	131
T17K - Trolley Inspections	214	357	184	357	407	740 / 495
T17m - 275kV Remedial	0	0	0	0	398	-
T17n - 275kV Steel Work Replacement	0	0	0	0	100	-
T17q - 275kV Damper Replacements	0	0	0	0	37	122
T17r - 275kV Undercrossings	0	0	0	0	396	33
T17s - 275kV Tower Replacement	0	0	0	0	6,400	8
T17t - 275kV Muff Painting	0	0	0	0	214	272
T17v - 275kV Fittings	0	0	0	0	102	152
T17x - 275kV Foundation Repair	0	0	0	0	5,560	48
T17y - 275kV Tower Security	0	0	0	0	608	214
T17z - 275kV Conductor Sampling	0	0	0	0	37	25
T17aa - 275kV Stepbolt	0	0	0	0	826	300
T19 - 110kV Overhead Line Asset Replacement	**7,924**	**2,876**	**8,604**	**2,907**	**18,204**	**4,644**
T19a - Replace conductor	852	30	677	22	4,046	136

[41] Initial submission value shown first in black, followed by the revised submission (submitted as part of the query process) in red.

	RP6 allowance		RP6 outturn		RP7 proposed	
Sub-programme ID	**Costs £k**	**Volumes**	**Costs £k**	**Volumes**	**Costs £k**	**Volumes** [41]
T19b - 110kV Replace Suspension Insulator	0	0	0	0	757	376 / 378
T19c - 110kV Replace Tension Insulator	0	0	0	0	980	92
T19e - Tower Painting	1,728	892	2,251	864	1,483	525
T19f - Replace wood poles	3,778	1170	4,501	1,194	1,531	370
T19g - Replace colour and number plates	167	273	178	313	56	97 / 74
T19g1 - 110kV Replace colour and number plates	0	0	-	-	28	95
T19h - Foundation assessment	633	208	558	208	1,150	389
T19i - Condition assessment	181	0	240	-	333	487
T19N - Muff repairs	585	303	199	307	195	183
T19p - 110kV Remedial	0	0	0	0	350	0
T19r - 110kV Tower Replacement (Single)	0	0	0	0	1,400	0
T19t - 110kV Muff Painting	0	0	0	0	299	380
T19v - 110kV Tower Painting (single)	0	0	0	0	460	326
T19y - 110kV Damper Replacements	0	0	0	0	54	180
T19z - 110kV Foundation Repair	0	0	0	0	2,526	19
T19aa - 110kV Steel Work Replacement	0	0	0	0	100	0
T19ab - 110kV Tower Security	0	0	0	0	1,176	460
T19ac - 110kV Conductor Sampling	0	0	0	0	102	70
T19ad - 110kV Step bolts (Single)	0	0	0	0	94	107
T19af - Castlereagh - Rathgael ADSS recovery	0	0	0	0	108	67
T19ag - 110kV LV Undercrossings	0	0	0	0	156	13
T19ah - 110kV Clearances	0	0	0	0	500	0
T19ai - 110kV Step bolts (Double)	0	0	0	0	264	150 / 187
T19aj - 110kv Replace Fittings	0	0	0	0	54	122 / 195
Total	**12,781**	**4,647**	**14,210**	**4,892**	**36,901**	**7,867**

The following initial observations are made in relation to the NIE Networks RP7 investment plan associated with transmission OHL:

– RP7 capex of £36.9m is 160% higher than outturn / forecast RP6 capex of £14.2m;

– Noting the differing price control periods (RP6+Ext = 7.5 years; RP7 = 6 years), the normalised difference in RP7 costs relative to RP6+Ext costs for these sub work programmes is an increase of more than 200%;

– In relation to 275kV investments, the majority of costs incurred during the RP6 period relate to tower painting. It is evident this will continue into RP7 but at a lower magnitude, with significant new investment proposed for 275kV tower replacement and foundation repairs. These three sub-work programmes account for £14.5m in RP7 (78% of the total proposed by NIE Networks).

– Similarly for 110kV investments, the majority of costs incurred during the RP6 period relate to tower painting and wood pole replacement. Whilst both of these sub-programmes also continue with reduced investment in RP7, NIE Networks also proposes significant investment on conductor replacement, tower replacement and tower foundation repairs, accounting for a further £8m of RP7 investment.

11.1.2 Rationale for Investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to inspect, maintain and undertake remedial and replacement works. NIE Networks has provided documents (EJPs, as referenced below in Table 57 for each of the sub-programmes Table 56, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is also summarised in Table 57 below for each of the sub-programmes.

Table 57 Transmission Overhead Lines - Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
T17d - Tower Painting	EJP 2.301	The strategy is set out to address 275kV transmission overhead line assets in poor condition, which introduce greater risks of failure and customer complaints, and to address statutory clearance infringements detected by Light Detection and Ranging (LiDAR) surveys. Three circuits have been selected for bespoke refurbishment based on recent Cyberhawk drone surveys; The proposed works include insulator replacement where necessary, step bolt replacement, colour and number plates, safety signs, tower painting, ACD repair, fittings and damper replacement. The RP7 strategy also covers the continuation of rolling programmes from RP6 with proposed volumes at the same or increased run rates, such as tower painting, muff repair and painting. This targeted work includes steelwork replacement, tower replacements of damaged towers and to alleviate clearance issues, removal of LV crossings under 275kV lines and conductor sampling. Also proposed are additional work programmes detailing remedial works and ad hoc replacement of defective assets on the 275kV network.
T17e - Replace Colour and Number Plates		
T17f - Foundation assessment		
T17g - Condition assessment		
T17J - Muff Repair		
T17K - Trolley Inspections		
T17m - 275kV Remedial		
T17n - 275kV Steel Work Replacement		
T17q - 275kV Damper Replacements		
T17r - 275kV Undercrossings		
T17s - 275kV Tower Replacement		
T17t - 275kV Muff Painting		
T17v - 275kV Fittings		
T17x - 275kV Foundation Repair		
T17y - 275kV Tower Security		
T17z - 275kV Conductor Sampling		
T17aa - 275kV Stepbolt		
T19a - Replace conductor	EJP 2.302	The strategy is set out to replace 110kV transmission overhead line assets based on condition, known defects, design inadequacies, access issues and remaining life, rather than age. Split into four overarching programmes of work: – Circuit work based on RP6 Cyberhawk information, where circuit and component information was collected from foot and helicopter patrol and circuits identified for further assessment that have been prioritised and targeted refurbishment work identified. – Continuation of rolling programmes: replacement of wood poles, tower painting, muff painting, muff repair, foundation assessment and condition assessment. – Targeted work based on condition information from additional RP6 condition assessments. This includes steelwork replacement, pole raises and replacements to alleviate clearance issues, removal of LV crossings under 110kV lines, foundation repairs and conductor sampling.
T19b - 110kV Replace Suspension Insulator		
T19c - 110kV Replace Tension Insulator		
T19e - Tower Painting		
T19f - Replace wood poles		
T19g - Replace colour and number plates		
T19g1 - 110kV Replace colour and number plates		
T19h - Foundation assessment		
T19i - Condition assessment		
T19N - Muff repairs		
T19p - 110kV Remedial		
T19r - 110kV Tower Replacement (Single)		
T19t - 110kV Muff Painting		
T19v - 110kV Tower Painting (single)		
T19y - 110kV Damper Replacements		

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
T19z - 110kV Foundation Repair		– Remedial work and tower security, key drivers being access to towers, and safety.
T19aa - 110kV Steel Work Replacement		
T19ab - 110kV Tower Security		
T19ac - 110kV Conductor Sampling		
T19ad - 110kV Step bolts (Single)		
T19af - Castlereagh - Rathgael ADSS recovery		
T19ag - 110kV LV Undercrossings		
T19ah - 110kV Clearances		
T19ai - 110kV Step bolts (Double)		
T19aj - 110kv Replace Fittings		

11.2 GHD analysis

11.2.1 Run-rate comparison

The volume of asset replacement / refurbishment works proposed by NIE Networks during the RP7 period for each of the sub-programmes is presented above in Table 56. We have reviewed the proposed RP7 run rates and compared them against the NIE Networks RP6 run rates. To facilitate a more meaningful comparison, the assessment has been carried out on an average annual basis over RP6 (7.5 years) and RP7 (6 years), with the details summarised below in Table 58. Sub programmes that were not included in RP6 or do not have associated volumes identified have been excluded from the table.

Table 58 Comparison of RP7 v RP6

Sub-programme ID	RP6 Average Annual Run Rate	RP7 Average Annual Run Rate Initial submission / Revised submission	Difference in Run Rate (RP6 v RP7) (%) Initial submission / Revised submission
T17 - 275kV Overhead Line			
T17d - Tower Painting	79.9	60.0	-24.9%
T17e - Replace Colour and Number Plates	47.7	50.0	4.7%
T17f - Foundation assessment	22.0	34.7	57.6%
T17J - Muff Repair	67.3	21.8	-67.6%
T17K - Trolley Inspections	47.6	123.3 / 82.5	159.1% / 73.3%
T19 - 110kV Overhead Line			
T19a - Replace conductor	2.9	22.7	672.7%
T19e - Tower Painting	115.2	87.5	-24.0%
T19f - Replace wood poles	159.1	61.7	-61.2%
T19g - Replace colour and number plates	41.7	16.2 / 12.3	-61.1% / -66.2%
T19h - Foundation assessment	27.7	64.8	133.8%
T19N - Muff repairs	40.9	30.5	-25.5%

Following our assessment of run-rates, we make the following observations:

– Significant increases in run-rates are observed for a small number of asset categories, specifically 275 kV Trolley Inspections, 110 kV Foundation assessment and 110 kV and 275 kV Replace conductor.
    - The conductor replacements are particularly significant increases and are discussed further in the next section.
    - In preparing detailed breakdowns of the unit volumes at GHDs request, NIE Networks made volume changes to 8 sub-categories (out of 36 with volumes). The revised volumes are indicated in red within the above table with sub programme T17k reducing the % increase by 86%.
– There are a number of asset categories where NIE Networks is proposing a notable % reduction in replacement volumes in RP7; though the volume reductions are relatively small when compared to the largest increases more sub-categories report a decrease than report an increase.

The following sections provides comments on our analysis of NIE Networks' proposed replacement / refurbishment volumes.

11.2.2 Technical justification and options appraisal review

Quality of EJPs

Overview of condition assessment process

The OHL proposed works are largely driven by inspection and survey outputs which have been extrapolated to define the remedial works needs for the whole OHL population. This approach is generally reasonable.

The condition assessment regime developed appears to be generally robust and is proposed to be expanded on further in RP7.

While the regime utilises some strong assessment techniques and systems, such as the Cyberhawk system, LIDAR surveys, and conductor sample analysis there is no common or defined process for handling the source condition data. There are multiple spreadsheets and manual manipulation steps involved in preparing the EJP volumes from the source data which introduces significant risk of error.

Cyberhawk condition data

Cyberhawk condition assessments underpin or inform much of the condition-based works. In general Cyberhawk is a very good tool which notably retains significant data and photographs providing a resource to check condition classifications.

We note that NIE Networks has not challenged or calibrated the condition assessment thresholds (i.e. what constitutes the different levels of deterioration) but have instead chosen to use the Cyberhawk standard thresholds.

Transfer of data from Cyberhawk into the EJP volumes is via an export from Cyberhawk followed by significant manual collation and summation exercise.

GHD has carried out sample checks of the manual collation and summation and found:

– 110kV
    - Single circuit lines – 2 errors in 204 datapoints checked (≈1% error rate) or total numerical error 4/500 (≈0.8% error rate)
    - Double circuit lines – 2 errors in 120 datapoints checked (≈1.7% error rate) or total numerical error 4/500 (≈0.7% error rate)
– 275kV
    - 14 errors in 168 datapoints checked (≈8.3% error rate) or total numerical error 35/1185 (≈3% error rate)
– Manual processing of the Cyberhawk data appears to result in a number of errors.

GHD has not been able to consistently and accurately map the Cyberhawk condition data onto the EJP volumes.

It should be recognised that the Cyberhawk data processing records were provided late in the review process and as such GHD has not had the opportunity to seek clarification from NIE Networks but notes the following inconsistencies:

– 110kV
  - "Fittings" and "Earth wire fittings" do not consistently relate to the same Cyberhawk categories for dual circuit lines. In particular each may relate to either the "Earthwire" category or "Fittings" category and the reason for them swapping is not clear.
  - Earth Wire fittings are in different places assigned to T19p or T19y without obvious justification.
  - Earth Wire fittings in section 4.2.9 i.e. 67% does not appear to relate to the Cyberhawk data.
– 275kV
  - Muff repair figures in sections 4.2.1 and 4.2.2 do not align with the source spreadsheet provided (errors in the order of 20%).

Further to the above the volumes utilised for the EJP relating to the Cyberhawk data were queried by GHD resulting in NIE Networks identifying 6 x 110kV sub-categories and 3 x sub-categories which had volume errors[42].

GHD conclusion:

While the source data and condition monitoring regime are adequate and in places high quality there are multiple indications of errors in the handling of the data, inconsistencies in the application of the data in the EJP, and a number of volume errors identified by NIE Networks following query.

On the basis of the multiple incidents of confirmed or suspected errors identified in the calculated volumes, GHD does not have confidence in the accuracy of the final volumes. In view of this an allowance reduction of 10% has been applied to the sub-categories based on the Cyberhawk volume outputs, which GHD considers is commensurate with the potential residual error in the volumes and reasonable efficiencies savings that can be achieved on the combined volumes represented. The affected sub-categories are as follows:

– T17e	Note; volume error identified by NIE Networks when queried.
– T17m	
– T17v	
– T17y	
– T17aa	Note; volume error identified by NIE Networks when queried.
– T19b	Note; volume error identified by NIE Networks when queried.
– T19c	
– T19g	Note; volume error identified by NIE Networks when queried.
– T19j / g1[43]	Note; volume error identified by NIE Networks when queried.
– T19p	Note; volume error identified by NIE Networks when queried.
– T19ab	Indirectly effected as it is based on T17y
– T19ad	Note; volume error identified by NIE Networks when queried.
– T19ai	Note; volume error identified by NIE Networks when queried.
– T19aj	Note; volume error identified by NIE Networks when queried.

Tower Painting T17d, T19e, T19v

Based on the continuation of a 15 year cycle for double circuit towers and beginning a 15 year cycle for single circuit towers (50% to be addressed in RP7).

No attempt has been made at a quantification of risk, consideration of a no painting option, or comparison of option costs in the initial EJPs.

[42] UR-0082, UR-0084 & UR-0085 - 110kV Transmission OHL Volume Build Up (1).pdf
[43] Note this sub-category is referred to as both J and g1 in the EJP but are understood to be the same.

Following request by GHD comparative cost for the options considered was provided[44][45].

GHD conclusion: We recommend the proposed RP7 investment is allowed.

Tower Replacement T17s, T19r

The case for the replacement of the towers has generally been made however, the justification has not been robustly presented in the EJPs. No attempt at quantification and comparison of risk or option costs was provided.

Following query[46'47] enhanced descriptions of the options considered and justification for the proposed replacements has been provided. The justification for intervention is generally clear.

The detail provided on the options considered is variable and quantified comparison of risks has not been provided.

GHD conclusion:

The proposed works are reasonable and the needs case has been made however, the investment appraisal could have been significantly more robust and thorough.

We recommend RP7 investment is allowed on the basis that there is not a high probability that a more complete investment appraisal would affect the proposal.

Foundation Assessment T17f, T19h and Repair T17x, T19z

Foundation assessments are proposed to be increased (both for 110kV and 275kV) in frequency from 10% population to 20% per RP. This is based on a high incidence of defects identified in RP6, and that the current 10% run rate results in a 50-60 year cycle which is considered too long and represents an unreasonable level of risk.

A range of assessment frequencies have been considered however, no quantification of risk has been carried out and the initial EJPs contained no option cost comparisons. Cost comparison of the options has been provided following query[48,49].

GHD conclusion: We recommend NIE Networks' proposal to increase frequency to 20% per RP and resultant capex is allowed.

Foundation repair volumes are based on the actual % of assessments identifying a requirement for repairs in RP6.

- T17f 275kV. Section 4.3.4 for the EJP states 16% require some form of repair.
  - 16% has been corrected to 14%[50] by NIE Networks when details were requested.
- T19h 110kV.
  - 5% replacement rate which has been evidenced on request[51].

We note that despite being a large part of the cost increase in RP7 there was initially no section for Foundation Repairs in EJP 2.302 (110kV) with details provided in response to queries.

GHD conclusion: We recommend the proposed RP7 investment is allowed.

Replace Conductor T19a

T19a is the single highest cost sub-programme in T19 and is 588% of the cost in RP6.

Despite being a large part of the cost increase in RP7 there was initially no specific commentary section for Conductor Replacement within EJP 2.302 (110kV) with only vague references included and no optioneering or investment appraisal.

[44] UR-0081 110kV options.pdf
[45] UR-0069 275kV options.pdf
[46] UR-0071 & UR-0072 - 275kV Overhead Lines - Tower Replacement.pdf
[47] UR-0083 - 110kV Overhead Lines - Tower Replacement Justification.pdf
[48] UR-0081 110kV options.pdf
[49] UR-0069 275kV options.pdf
[50] UR-0073 - 275kV Overhead Lines - Foundation repair.pdf
[51] 110kV foundation assessments RP6.xlsx

Following query additional narrative has been provided[52] by NIE Networks and reviewed by GHD, with the following comments:

– The options considered are reasonable and consider the reconductoring in RP7, or to carry out the works in RP8.
– No quantification of risk has been carried out, and no argument is made on the technical risk of failure if the works are delayed until RP8. It is notable that there are three other circuits with the same residual life which have not been considered for replacement in RP7.
– Works in RP7 are considered on the basis they can co-inside with other refurbishment works to provide modest cost saving.
    - Efficiency cost savings are estimated based on assessments carried out for other circuits. There is no detail regarding the specifics of those works and as such there is no way to know if they are directly applicable. No detailed cost assessments have been carried out for the specific options presented.
    - Assuming the examples presented are applicable the potential saving is in the order of 4-12%. There is no evidence that consideration has been given to the financial benefit of delaying investment to maximise the current asset life.
– High level discussion has been provided regarding the difficulties of securing an outage during RP8 (no guarantee) and references to SONI TDPNI which NIE Networks assert will make getting outages harder.
– The deliverability of all 4 reconductoring projects in RP8 is generally questioned without providing any detailed discussion or assessment of the issues involved.

GHD conclusion:

The narrative presented is reasonable, however the specific options being considered have not been costed for comparison and there has been no attempt to quantify risk. Other apparently reasonable options such as carrying out more than one reconductoring project in RP7, or carrying out one of the other three projects (currently planned for RP8) in RP7 rather than the proposed project (for example both Tandragee - Pattersons Lake and Pattersons Lake - Lisburn A have been identified for refurbishment in RP7 and have a 10-15 year conductor residual life similar to the circuit proposed) has been discussed.

There is a reasonable argument that the scheduling of one circuit reconductoring into RP7 is the correct and prudent action however, the investment appraisal provided is not robust and does not provide confidence that the best value is being achieved.

Given the limitations in the investment appraisal, we do not consider it is appropriate to recommend allowances in full. We are not convinced that the replacement option chosen is the most efficient solution, although we do accept the general approach to schedule the conductor replacement works into RP7. We therefore recommend a 20% allowance reduction as we consider this reduced amount to be more efficient allowance based on the information presented for our review and reflects our lack of confidence in the robustness of the investment appraisal.

Tower Security T17y, T19ab

Limited optioneering has been presented[53,54]. The only options presented are carrying out a full installation and Anti Climbing Device (ACD) replacement programme in RP7, or 25% of the works in RP7. The option to not carry out the works at all or for example, to limit it to only Danger of Death (DoD) sign installation, and as required ACD repairs has not been considered. No quantification of risk and costs has been carried out.

The optioneering suggests ACDs will only be remediated if they are in poor condition however, the volume and unit cost suggest the full 25% will be replaced in the RP7 period.

No evidence has been provided to support the effectiveness of installing the proposed additional 2 DOD signs per tower.

GHD conclusion:

– 110kV T19ab

[52] UR-0080 - 110kV Overhead Lines - Conductor Replacement.pdf
[53] UR-0081 110kV options.pdf
[54] UR-0069 275kV options.pdf

- Table 2 of EJP 2.302 indicates approximately 20% of ACDs are in a condition which requires remediation and as such the programme appears to include replacing ACDs in acceptable condition.
- In view of the lack of robust optioneering and condition assessment data apparently pointing to a lower ACD replacement requirement, we recommend the allowance is reduced to reflect 370 ACD replacements (20% of population) and 460 DoD sign installations (25% population as per the request).

– 275kV T17y
  - Table 2 of EJP 2.301 indicates approximately 34% of ACDs are in a condition which requires remediation and as such the basis of replacing 25% during RP7 is accepted.

– Given the relatively low cost of installing the DoD signs and the justification of public safety this aspect has been accepted.

Replace Wood Poles T19f

The proposal is based on the replacement of all poles identified in RP6 as having decay or possibly having decay (270) with an assumed additional 100 poles expected to be identified with ongoing inspections.

No cost benefit analysis or quantified risk assessment has been carried out for the options considered.

No evidence or justification has been provided for the assumption that 100 poles will be identified in RP7.

GHD conclusion:

Replacement of decayed poles is required work however, given the lack of any presented basis or justification for the additional 100 poles GHD cannot fully support the allowance for these additional poles. GHD accepts that an allowance for additional poles beyond those already identified is reasonable however, in view of the lack of any supporting information for this volume we recommend a 50% reduction to assumed additional pole replacement volumes. GHD considers 50% a reasonable compromise between the positions of accepting unsupported volumes, and disallowing an allowance in full for which the general need is accepted. In view of the overall replacement volumes GHD considers that the 50% allowance, when combined with reasonable efficiency savings, ensure critical works are provided for.

Undercrossings T17r, T19ag

Works are planned on the basis that a Directors inquiry “recommended” all LV overhead crossings underneath 275 kV and 110 kV overhead lines[55]. On review the enquiry in-fact recommends that “Consideration should be given to removing”. Following query NIE Networks have provided further justification for delivering the recommended removal[56].

Proposal to carry out the 13 remaining 110 kV undercrossing in RP7 and split the 66 remaining 275 kV undercrossings over RP7 and RP8 is reasonable.

GHD conclusion:

We recommend the RP7 investment submitted by NIE Networks is allowed.

Trolley Inspections T17k

The existing practice is to carry out trolley inspections on an ad-hoc basis. NIE Networks propose to change this to a planned programme targeting 20% of the population annually (whole population inspected every 5 price controls) which generally aligns with spacer expected life. The reason for the change is age-based asset deterioration which is increasing the risk profile.

GHD conclusion:

We recommend the RP7 investment submitted by NIE Networks is allowed.

[55] UR-0065 - LV Undercrossing Removal.docx
[56] UR-0342 - 275kV & 110kV Overhead Lines - LV Undercrossing Removal.pdf

Condition Assessment T17g, T19i

This sub-category covers the continued use of Cyberhawk condition assessments. These have formed the basis of much of the RP7 condition based works. The proposal is to carry out Cyberhawk condition assessments of 25% of the population in RP7 and so covering the full asset base over 4 price controls.

The proposal is reasonable and the value of the data has been demonstrated in the EJPs.

However, very limited optioneering has been carried out. No quantified risk or cost based comparative assessment of options has been carried out. Only two options have been considered which are the proposed 25% of population in RP7 or to continue with the RP6 run rate. No consideration of more or less frequent assessments has been given.

GHD conclusion:

In view of the small proportion of the overall WP4 allowance (1-2%), and the value of the condition data demonstrated, we recommend the RP7 investment submitted by NIE Networks is allowed.

11.2.3 Unit cost analysis

Table 59 presents details of the unit cost assessment that has been undertaken for 275 kV and 110 kV Overhead Lines.

Table 59 275kV and 110kV Overhead Line unit cost assessment

Sub-programme ID	Outturn unit costs (£)	RP7 requested unit cost (£)	Unit cost movement (%)	Basis	GHD comments
	RP6. Actuals[57]		RP7 vs. RP6.		
T17 - 275kV Overhead Line					
T17d - Tower Painting	6,751	7,059	4.6%	RP7 requested based on March 2022 outturn rate	Unit cost based on RP6 outturn to March 2023 - Amended
T17e - Replace Colour and Number Plates	532	532	0%	RP7 requested based on March 2022 outturn rate	Confirmed to match March 2023 RP6 Actuals. Accepted
T17f - Foundation assessment	2,944	2,755	-6.4%	RP7 requested based on March 2022 outturn rate	Unit cost based on RP6 outturn to March 2023 - Amended
T17g - Condition assessment	-	639	-	Based on contractor prices	Accepted
T17J - Muff Repair	635	1,065	67.6%	RP7 requested based on contractor rate for one muff repair	Unit cost based on RP6 outturn to March 2023 - Amended
T17K - Trolley Inspections	437	550	25.9%	Based on contractor prices which have been adjusted to reflect renegotiated contractor rate.	Unit cost based on RP6 outturn to March 2023 - Amended
T17q - 275kV Damper Replacements	-	303	-	Based on contractor prices	Accepted
T17r - 275kV Undercrossings	-	12,000	-	Cost based on average of desktop designs carried	Accepted

[57] RP6 unit cost assessment is based on RP6 outturn costs and volumes reported by NIE Networks up to end March 2023 only - no forecast costs or volumes are included in our assessment of RP6 costs

Sub-programme ID	Outturn unit costs (£)	RP7 requested unit cost (£)	Unit cost movement (%)	Basis	GHD comments
	RP6. Actuals[57]		RP7 vs. RP6.		
				out by the survey department.	
T17s - 275kV Tower Replacement	-	800,000	-	Based on detailed design estimate of one tower with reference to contract rates.	Accepted
T17t - 275kV Muff Painting	-	787	-	Based on contractor prices	Accepted
T17v - 275kV Fittings	-	673	-	Based on contractor prices	Accepted
T17x - 275kV Foundation Repair	-	115,840	-	Based on actual costs at Coolkeeragh Magherafelt	Accepted
T17y - 275kV Tower Security	-	2,839	-	This sub-category was incorrectly submitted based on a volume resulting in a unit cost but when queried this has been confirmed to be an error. The submission is based on a lump sum.	See lump sum analysis.
T17z - 275kV Conductor Sampling	-	1,463	-	Based on actual costs incurred during 2022 - EA technology and internal labour	Accepted
T17aa - 275kV Stepbolt	-	2,754	-	Based on actual experience at Coolkeeragh Magherafelt	Accepted
T19 - 110kV Overhead Line					
T19a - Replace conductor	30,766	29,752	-3.3%	RP7 requested based on March 2022 outturn rate	Unit cost based on RP6 outturn to March 2023 - Amended
T19b - 110kV Replace Suspension Insulator	-	2,012	-	Based on framework contracts + (2%) for labour based on an analysis of the split on 275kV actual spend.	Accepted
T19c - 110kV Replace Tension Insulator	-	10,657	-	Based on Mar ’22 outturn rate for 275kV tension insulators (£13,124) with material cost reduced by 50% and BIS increased by 15% due to renegotiated contractor rates.	15% increase for renegotiated contractor rates removed
T19e - Tower Painting	2,663	2,825	6.1%	RP7 requested based on March 2022 outturn rate	Unit cost based on RP6 outturn to March 2023 - Amended
T19f - Replace wood poles	3,781	4,138	9.4%	Mar ’22 outturn rate plus uplift to reflect contractor cost increase of 15% due to renegotiated rates. Labour £84, materials	Unit cost based on RP6 outturn to March 2023 - Amended

Sub-programme ID	Outturn unit costs (£)	RP7 requested unit cost (£)	Unit cost movement (%)	Basis	GHD comments
	RP6. Actuals[57]		RP7 vs. RP6.		
				£1,608 and BIS £2,446 (up from £2,109)	
T19g - Replace colour and number plates	544	582	7.0%	Nov '22 outturn rate as Mar '22 rate was artificially inflated by work in progress March outturn cost of £711 included cost against units that had not yet been completed/claimed. November unit cost of £582 was deemed to be more accurate.	Unit cost based on RP6 outturn to March 2023 - Amended
T19g1 - 110kV Replace colour and number plates	-	291	-	Half of T19g	Unit cost based on RP6 outturn to March 2023 - Amended
T19h - Foundation assessment	2,555	2,956	15.7%	RP7 requested based on March 2022 outturn rate	Unit cost based on RP6 outturn to March 2023 - Amended
T19i - Condition assessment	-	684	-	Based on contractor prices	Accepted
T19N - Muff repairs	320	1,065	232.5%	Adjusted to reflect renegotiated contractor rate	Unit cost based on RP6 outturn to March 2023 - Amended
T19t - 110kV Muff Painting	-	787	-	As 275kV	Accepted
T19v - 110kV Tower Painting (single)	-	1,412	-	Half of T19e	Unit cost based on RP6 outturn to March 2023 - Amended
T19y - 110kV Damper Replacements	-	303	-	As 275 kV	Accepted
T19z - 110kV Foundation Repair	-	132,940	-	Ballylumford Eden actuals	Unit cost is greater than T17x (275kV Foundation Repair) unit cost £115,840. Amended
T19ab - 110kV Tower Security	-	2,557	-	Material costs from existing contracts and day-rates for labour.	Accepted
T19ac - 110kV Conductor Sampling	-	1,463	-	Based on an average of 15 samples collected in 2022	Accepted
T19ad - 110kV Step bolts (Single)	-	881	-	Based on half of unit cost for T19ai	Accepted
T19af - Castlereagh - Rathgael ADSS recovery	-	1,615	-	Based on rates provided for another project – mini-competition against an existing framework contract.	Accepted
T19ag - 110kV LV Undercrossings	-	12,000	-	Cost based on average of desktop designs carried	Accepted

Sub-programme ID	Outturn unit costs (£)	RP7 requested unit cost (£)	Unit cost movement (%)	Basis	GHD comments
	RP6. Actuals[57]		RP7 vs. RP6.		
				out by the survey department.	
T19ai - 110kV Step bolts (Double)	-	1,763	-	Based on outturn costs for CPS-Magherafelt	Accepted
T19aj - 110kv Replace Fittings	-	441	-	Based on existing framework contracts.	Accepted

11.2.4 Lump sum cost analysis

Table 60 presents details of the lump sum cost assessment that has been undertaken for 275 kV and 110 kV Overhead Lines.

Table 60 275kV and 110kV Overhead Line lump sum cost assessment

Sub-programme ID	Lump Sum £k	Unit cost justification	GHD Comments
T17 - 275kV Overhead Line[58]			
T17m - 275kV Remedial	398	Estimated based on the RP6 remedial category run-rate and bottom-up cost buildup.	Accepted
T17n - 275kV Steel Work Replacement	100	No justification provided by NIE Networks.	Recommended allowance reflective of average T17 variance due to lack of cost data.
T17y - 275kV Tower Security	608	Material costs are based on existing framework contracts. Labour rates are based on the cost of a man-day. Reduced by NIE Networks following GHD query to £547,412[59].	Accepted
T19 - 110kV Overhead Line[60&61]			
T19p - 110kV Remedial	350	Bottom-up cost buildup covering a range of remedial activities.	Accepted
T19r - 110kV Tower Replacement (Single)	1,400	High-level estimate by the Engineering Design team based on £800k for one tower and £600k for the second tower. Noting the uncertainties prior to detailed design.	Cost estimates consistent with GHD example. Accepted
T19aa - 110kV Steel Work Replacement	100	Bottom-up cost buildup based on Cyberhawk inspection and contractor rates. Additional 10 repairs for works identified during RP7 using the average per tower repair cost.	GHD identified errors in the calculation provided however, they resulted in an approximately net zero change. Accepted.

[58] UR-0070 & 0074 - 275kV Transmission OHL Volume Build Up.pdf
[59] UR-0343 - 275kV Overhead Lines - Volume Build-up.pdf
[60] UR-0082, UR-0084 & UR-0085 - 110kV Transmission OHL Volume Build Up.pdf
[61] UR-0345 - 110kV Overhead Lines - Lump Sum Cost Build-up.pdf

Sub-programme ID	Lump Sum £k	Unit cost justification	GHD Comments
T19ah - 110kV Clearances	500	No justification provided by NIE Networks.	Recommended allowance reflective of average T19 variance due to lack of cost data.

11.3 GHD recommendation

Table 61 presents details of the recommendations regarding the WP4 allowances.

Table 61 Transmission overhead lines recommendations summary

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume[62]**	**RP7 allowance (£k)**	**RP7 volume**
T17 - 275kV Overhead Line Asset Replacement	**18,696**	**3,223**	**18,009**	**2,627**
T17d - Tower Painting	2,541	360	2,430	360
T17e - Replace Colour and Number Plates	160	300	127	239
T17f - Foundation assessment	573	208	612	208
T17g - Condition assessment	198	310	198	310
T17J - Muff Repair	139	131	83	131
T17K - Trolley Inspections	407	740 / 495	216	495
T17m - 275kV Remedial	398	0	358	
T17n - 275kV Steel Work Replacement	100	0	96	
T17q - 275kV Damper Replacements	37	122	37	122
T17r - 275kV Undercrossings	396	33	396	33
T17s - 275kV Tower Replacement	6,400	8	6,400	8
T17t - 275kV Muff Painting	214	272	214	272
T17v - 275kV Fittings	102	152	92	137
T17x - 275kV Foundation Repair	5,560	48	5,560	48
T17y - 275kV Tower Security	608	214	493	
T17z - 275kV Conductor Sampling	37	25	37	25
T17aa - 275kV Stepbolt	826	300	658	239
T19 - 110kV Overhead Line Asset Replacement	**18,204**	**4,644**	**15,791**	**4,528**
T19a - Replace conductor	4,046	136	3,347	136
T19b - 110kV Replace Suspension Insulator	757	376 / 378	684	340
T19c - 110kV Replace Tension Insulator	980	92	769	83
T19e - Tower Painting	1,483	525	1,398	525
T19f - Replace wood poles	1,531	370	1,210	320
T19g - Replace colour and number plates (Double)	56	97 / 74	36	67
T19g1 - 110kV Replace colour and number plates (Single AKA 19j)	28	95	21	77

[62] Initial submission value shown first in black, followed by the revised submission (submitted as part of the query process) in red.

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume[62]**	**RP7 allowance (£k)**	**RP7 volume**
T19h - Foundation assessment	1,150	389	994	389
T19i - Condition assessment	333	487	333	487
T19N - Muff repairs	195	183	59	183
T19p - 110kV Remedial	350	0	315	
T19r - 110kV Tower Replacement (Single)	1,400	0	1,400	
T19t - 110kV Muff Painting	299	380	299	380
T19v - 110kV Tower Painting (single)	460	326	434	326
T19y - 110kV Damper Replacements	54	180	54	180
T19z - 110kV Foundation Repair	2,526	19	2,201	19
T19aa - 110kV Steel Work Replacement	100	0	100	
T19ab - 110kV Tower Security	1,176	460	866	414
T19ac - 110kV Conductor Sampling	102	70	102	70
T19ad - 110kV Step bolts (Single)	94	107	95	108
T19af - Castlereagh - Rathgael ADSS recovery	108	67	108	67
T19ag - 110kV LV Undercrossings	156	13	156	13
T19ah - 110kV Clearances	500	0	434	
T19ai - 110kV Step bolts (Double)	264	150 / 187	296	168
T19aj - 110kv Replace Fittings	54	122 / 195	78	176
Total	**36,901**	**7,867**	**33,800**	**7,155**

12. Review of RP7 capex requirements - WP5: Transmission Cables

This section presents details of our analysis of the expenditure proposals for transmission cables, c.112 km of 110kV and 275kV transmission underground cables, with 110kV underground FFC cables which require maintenance and replacement.

12.1 RP7 requested allowance

NIE Networks' proposed investment for the RP7 period is itemised below in Table 62 for each of the sub-work programmes included within the T20 programme. The table shows comparison of costs and volumes over the RP6 period relative to the RP7 period.

12.1.1 Costs and Volumes

Table 62 Transmission Cables - NIE Networks investment proposal for RP7

Sub-programme ID	EJP ref	RP6 allowance		RP6 outturn		RP7 proposed	
		Costs £k	Volumes	Costs £k	Volumes	Costs £k	Volumes
T20k - Refurbish 110kV Cable	EJP 2.101	321	-	127	-	436	-
T20m - Procurement of Transmission Cables Accessories and Ancillaries	EJP 2.101	478	-	386	-	1,357	-
T20n - Replacement 110kV FFC Cable	EJP 2.101	-	-	-	-	2,518	-
T20r - Decommission FFC	EJP 2.101	-	-	-	-	242	-
T20s - Leak Management Technologies	EJP 2.101	-	-	-	-	148	-
Total		**799**	-	**514**	**-**	**4,702**	**-**

The following initial observations are made in relation to the NIE Networks RP7 investment plan associated with transmission cable works:

– RP7 capex of £4.7m is significantly higher (a factor of 9) than outturn / forecast RP6 capex of £0.5m;

– The RP7 capex plan is dominated by two very significant programmes: T20m & T20n, the latter including £2.5m of capex to replace 110kV fluid filled cable (FFC).

12.1.2 Rationale for investment

This programme of investment has been included in the RP7 submission to provide funding for NIE Networks to replace (or in some cases refurbish) aging transmission cable assets on its network. NIE Networks has provided documents (EJPs, as referenced above in Table 62) for each of the sub-programmes, describing the assets and providing brief details of the condition and performance of the equipment, in support of the needs case for investment.

The proposed strategy for investment in RP7, as stated by NIE Networks, is summarised in

Table 63 below for each of the sub-programmes.

Table 63 Transmission cables - Investment strategy

Asset Category (Sub Work Programme)	EJP reference	Investment strategy
T20k - Refurbish 110kV Cable	EJP 2.101	NIE Networks' proposed capex for RP7 is focused on a small number of key areas; specifically: – a programme of replacements to address safety concerns associated with porcelain type cable sealing ends fitted to XLPE cables, – replace an oil section on two fluid-filled cables (FFC) that have historic leakage issues and are in close proximity to a watercourse, – investigate and undertake further decommissioning works on two historic circuits that were decommissioned in the late 1990s; – modernise FFC oil pressure alarms and to reduce the likelihood and environmental impact of oil leaks.
T20n - Procurement of Transmission Cables Accessories and Ancillaries		
T20n - Replacement 110kV FFC Cable		
T20r - Decommission FFC		
T20s - Leak Management Technologies		

12.2 GHD analysis

12.2.1 Technical justification and options appraisal review

T20k & T20n Refurbish & Replacement of 110 kV Fluid Filled Cables (FFC)

Methodology applied by NIE Networks

NIE Networks has not utilised the CNAIM model due to not having adequate data to populate the model.

The Survivor modelling technique has been carried out. On the basis of this technique no cable replacement would be proposed. NIE Networks assert that "the survivor model only works on age and does not consider other deterioration factors on the cables". NIE Networks has provided justification for the proposed cable replacements on the basis of a "bottom-up assessment" and significantly based on environmental impact.

In order to identify circuits requiring intervention, NIE Networks has assessed all of their transmission underground cables using the methodology in CIGRE TB B1 358[63].

– The CIGRE assessment methodology is reasonable.
  - However, NIE Networks has not provided when requested the full record of the assessment carried out, instead an overview of the methodology and the resulting scores for a selection of circuits has been presented. GHD has assessed the needs cases for these circuits as presented by NIE Networks.
– Our assessment has identified:
  - Six circuits with a score of greater than the threshold which would indicate the assets are approaching end of life and require intervention.
    – Two of these circuits are already planned for replacement under an RP6 project and a future project to replace IBTX and so are not included in the RP7 EJP.
    – Two circuits are proposed for partial replacement.
    – Two circuits are proposed for refurbishment.
  - 2 selected circuits with a score not above the end-of-life threshold but "just underneath it" and fall into the category of "needing particular attention" have also been identified for works.
    – One circuit is proposed for refurbishment.
    – One circuit is proposed to be flushed under RP6.

[63] UR-0086 &UR-0089 - Justification for circuits to be refurbished.pdf

- The assessment outcome of circuits not proposed for works has not been presented.

T20n FFC proposed for replacement

Based on the above methodology, NIE Networks propose the replacement of a 1 km stretch of the Castlereagh - Cregagh circuits (2 x circuits) with new XLPE cable. These works are costed by NIE Networks at £2.5m ≈ 54% of the total RP7 submission for Transmission Underground Cables. As such we consider it would be reasonable to expect the proposed solution and investment appraisal to be a more robust and more detailed justification than the other lower cost categories also included within this investment work programme.

The CIGRE assessment outcome and narrative description of the asset history, access restrictions and environmental concerns provided by NIE Networks adequately make the case for the necessity of intervention on this asset.

The exploration of options presented is very limited.

– Options explored are either refurbishment, a more limited replacement or the proposed option. No consideration of a more extensive replacement has been made.
– Discussion of the options is high level with little specific, quantified information regarding the asset history.
– No attempt to carry out a comparative quantitative assessment of impact on reliability or environmental risk of the different options has been made, and no direct cost comparison has been carried out with alternate options.
– A referenced risk to personnel associated with the inspection and maintenance of the “upper pumping position” is not clearly defined.

GHD conclusion:

– The case for intervention is made and reasonable. GHD accept that the continued operation of these oil filled cables in their current form is not sustainable and presents a material environmental risk.
– GHD consider that the proposed solution is likely to be well targeted. The presented alternate option of replacing a 500 m section as opposed to 1 km is not likely to provide a reduction in cost commensurate with the reduced impact on environmental risk and operational concerns.
– In view of the clearly made need case and low probability that a less extensive / costly replacement would be preferred to the proposed solution, we recommend the proposed RP7 investment is allowed.

T20k FFC proposed for refurbishment

Based on the methodology described above, NIE Networks propose the refurbishment of two circuits. These works are costed by NIE Networks at £436k ≈ 9% of the total RP7 submission for Transmission Underground Cables and an increase of 242% on RP6.

NIE Networks has not materially discussed the increase in expenditure on this category stating only “the works proposed reflect our enhanced proactive strategy and apply to different circuits to that proposed during RP6”. The proposed refurbishment works have been reviewed by GHD on their individual merits.

– Donegall-Hannahstown
  - The CIGRE assessment outcome and narrative description of the asset history and site-specific concerns provided by NIE Networks adequately make the case for the necessity of intervention on this asset.
  - GHD consider the proposed solution is likely to be well targeted.
  - Alternate options are not reasonably likely to be determined to be preferred however, there has been no attempt and quantitative comparison of options risks and costs.
– Belfast North Main to Donegall Main
  - The CIGRE assessment outcome identifies this circuit as falling just under the threshold of requiring intervention.
    – NIE Networks has made an exception for this circuit on the basis that the CIGRE methodology does not account for the severity of a potential leak.

These cables are run as a single oil section along their 6 km route, containing approximately 15,000 l per cable. The circuit experienced a significant insulation leak during RP6 of around 1,470 litres and another event with “high loss” during RP5.

  - However, we understand that this circuit is expected to be replaced with a new, higher rated circuit due to the works associated with the SONI Belfast Metropolitan plan.

    NIE Networks assert that “until this plan gains regulatory approval, there is a need to continue with refurbishment works on the Donegall Main circuits”.
  - NIE Networks has not provided a detailed and quantified comparison of options, risks or costs.
- GHD does not consider that NIE Networks has demonstrated that these works are necessary and well targeted in view of:
  - The circuit does not qualify for intervention on the basis of the CIGRE methodology.
  - The impact of the works on the health score would be a reduction of only 0.38 to 0.34 (the threshold for intervention is 0.4.
  - There is a significant probability that the cable will be replaced in the near future rendering the works unnecessary.
- We therefore recommend that the NIE Networks RP7 submission is reduced to account for the removal of the Belfast North Main to Donegall Main refurbishment project (reduction of £259.417k, see Cost Analysis).

T20m Transmission cable accessories and ancillaries

These works are costed by NIE Networks at £1.4m ≈ 29% of the total RP7 submission for Transmission Underground Cables and an increase of 232% on RP6. This sub-category is made up of five groupings:

- Replace cable sealing ends:
  - A continuation of an RP6 programme.
  - GHD considers the proposed replacement plan to be reasonable on the basis of the subjective narrative arguments presented.
    - We note that a reasonable range of options has been considered however, no attempt has been made to carry out a comparative quantitative assessment of risk compared to the cost of the options.
  - We recommend the RP7 investment submitted by NIE Networks is allowed.
- Cable sealing end cleats
  - Replacements identified via direct survey observations.
  - We recommend the RP7 investment submitted by NIE Networks is allowed.
- Refurbishment of hydraulic ancillary systems
  - A continuation of an RP6 programme.
  - Works carried out on a reactionary basis in response to leaks and defects.
  - GHD recognises the necessity for the expenditure but note that no alternative options have been considered, such as monitoring regimes which may facilitate pre-emptive replacement and which may potentially be justified.
  - We recommend the RP7 investment submitted by NIE Networks is allowed.
- Sheath refurbishment
  - A continuation of an RP6 programme.
  - Sheath faults have been identified on 12 circuits of which 10 are proposed for refurbishment. The remaining two circuits being addressed as part of other works.
  - GHD has no comments.
  - We recommend the RP7 investment submitted by NIE Networks is allowed.
- Refurbish / Replace underground cable ancillary pits.

- An enhancement of the RP6 programme which was purely reactive based on reports from DfI Roads, members of the public or NIE Networks' staff. The RP7 proposal will add an inspection programme.
- GHD considers that NIE Networks has provided no evidence or argument that the existing programme is insufficient. Further, the expected remediation rate of 20% is not supported with any source or basis.
- In view of the above we recommend the RP7 capex submitted by NIE Networks for this aspect of the sub-category be reduced by 50% (Reduction of £94.125k, see Cost Analysis). GHD considers 50% a reasonable compromise between the positions of accepting unsupported volumes, and disallowing completely an allowance for which the fundamental need has not been rejected. In view of the overall replacement volumes GHD considers that the 50% allowance is reasonable to ensure efficiency while also allowing for critical works to be delivered.

T20r Decommission FFC

We recommend the RP7 investment submitted by NIE Networks is allowed.

T20s Leak management technologies

We recommend the RP7 investment submitted by NIE Networks is allowed.

12.2.2 Cost analysis

General

As can be seen in Figure 10 below, very limited meaningful comparisons of RP6 to RP7 can be carried out due to the dominance of new sub-categories.

NIE Networks has presented minimal detail and narrative in justification for the cost difference between RP6 and RP7.

Sub-Cat	Sub-Category Name	RP6 (inc extension year) (£)	RP7 (£)	RP6 to RP7 change (%)
T20j	Replace Sheath Voltage Limiters	42,893	-	-
T20k	Refurbish 110kV FFC	127,441	436,274	242%
T20l	Cable Flushing	197,332	-	-
T20m	Transmission cable accessories and ancillaries	408,934	1,357,447	232%
T20n	Replacement 110kV FFC	-	2,518,035	-
T20r	Decommission FFC	-	242,007	-
T20s	Leak management technologies	-	148,032	-
	Total:	**776,600**	**4,701,795**	**505%**

Figure 10 Comparison of RP6 and RP7 Costs: EJP 2.101

The build-up and basis of the presented lump sum costs has been reviewed with the following comments:

– In the initial EJP submission, NIE Networks provided no breakdown or basis for lump sum costs.
– Following query NIE Networks has provided limited breakdown of the lump sum costs as shown in Table 64 below.[64]
– As can be seen no specific basis or details for the costs have been provided. Units have been provided for some items however, no unit cost with its related source has been provided.

[64] UR-0422 - Source Data for EJP2.10 Costs.pdf

– NIE Networks attribute the cost increase in part to “In addition, general unit costs have increased world-wide due to material and labour increases.”
  - GHD recommends these cost increases be excluded as these likely constitute real price increases that the UR has advised are within the scope of the UR's real price effect adjustments, detailed in their frontier shift annex.
– NIE Networks has provided no reference to out-turn costs or evidence for the “contract prices” presented. We note that certain items such as replacing cable sealing ends, sheath refurbishment, and replacing underground cable ancillary pits have all been carried out in RP6 and as such there is no reason the information could not be presented to support the RP7 lump sum costs.
– On the basis that no detail or evidence has been provided to support the ”contract prices”, and the statement in the EJP that the prices include material and labour increases, we recommend a decrease of 10% on all WP5 allowances. This is generally based on observed deductions that we applied elsewhere within our review of the WPs, where we recommended certain cost increases be excluded as they likely constitute real price increases that the UR has advised are within the scope of the UR’s real price effect adjustments, detailed within the frontier shift annex.

Table 64 Lump sum cost breakdown analysis

Sub-programme ID	Vol	Cost £	Cost justification	GHD Comments
T20k - Refurbish 110kV FFC		**436,274**		
Add new 110kV oil stop joint and tanks	1	259,417	Based on contract prices and costs included for tank works, road closure and E&R.	Works understood to be related to the Belfast North Main to Donegall refurbishment. Recommend for removal from the allowed investment. *See Technical justification and options appraisal review*
Cable 110kV tank manifold refurbishment	5	176,857	Based on contract pricing.	Works understood to be related to the Donegall-Hannahstown refurbishment.
T20m - Transmission cable accessories and ancillaries		**1,357,447**		
Replace 110kV cable sealing ends	10	975,300	Based on contract pricing.	The EJP and UR-0087 response indicate that 8 sets of cable sealing ends will be replaced compared to a volume of 10 provided in the cost breakdown. In view of this inconsistency, cost to be reduced based on 8 sets.
Cable sealing ends cleats	5	28,730	Based on contract pricing.	
Refurbishment of hydraulic ancillary systems	LS	62,697	Based on contract pricing.	No detail has been provided on the assumptions used in the compiling of the lump sum.
Sheath refurbishment	LS	102,471	Based on contract pricing.	Understood that 10 circuits will be refurbished. No detail has been provided on the assumptions used in the compiling of the lump sum.
Refurbish / replace underground cable ancillary pits	LS	188,249	Based on contract pricing.	Specific works are unknown as they will be based on the result of inspections to be carried out. No detail has been provided on the assumptions used in the compiling of the lump sum.
T20n - Replacement 110kV FFC		**2,518,035**		No detail has been provided on the basis of the lump sum (such as proposed cable route, installation, new cable details etc) making an accurate benchmarking assessment impossible.

Sub-programme ID	Vol	Cost £	Cost justification	GHD Comments
Install 110kV UG cable non pressurised (per km)	2	2,518,035	Based on contract pricing.	The cost falls at the top end of GHD benchmark comparisons for 1 km of 110 kV dual circuit cable installation. On the basis that the cost includes decommissioning of the existing oil cable the cost falls within the reasonable benchmarking range.
T20r - Decommission FFC		**242,007**		We observed an inconsistency between the cost breakdown provided and the Lump Sum amount. The sum of the cost breakdown line items is £138,249. Given the uncertainty relating to the cost information provided, and the need to propose an efficient allowance, we recommend a 10% reduction is made (in addition to the 10% general reduction proposed for all WP5 allowances)
Decommission & remove 110kV FF cable (km)	0.157	89,572	Based on contract pricing.	
Decommission & hydrogel 110kV FF cable (km)	5	48,677	Based on contract pricing.	
T20s - Leak management technologies		**148,032**		
PFT Tagging FFC (per Oil Section) - Ballyhenry Rd Tower - Glengormley A	1	24,672	Based on contract pricing.	
PFT Tagging FFC (per Oil Section) - Ballyhenry Rd Tower - Glengormley B	1	24,672	Based on contract pricing.	
PFT Tagging FFC (per Oil Section) - Castlereagh - Cregagh A	2	49,344	Based on contract pricing.	
PFT Tagging FFC (per Oil Section) - Castlereagh - Cregagh B	2	49,344	Based on contract pricing.	

12.3 GHD recommendation

Based on the above sections, the recommended RP7 allowances and volumes for each sub-programme are presented in Table 65.

Table 65 Transmission cables recommendations summary

Sub-programme ID	Requested by NIE Networks		Recommended by GHD	
	RP7 allowance (£k)	RP7 volume	RP7 allowance (£k)	RP7 volume
T20k - Refurbish 110kV Cable	436	-	159	-
T20m - Procurement of Transmission Cables Accessories and Ancillaries	1,357	-	961	-
T20n - Replacement 110kV FFC Cable	2,518	-	2,266	-
T20r - Decommission FFC	242	-	194	-
T20s - Leak Management Technologies	148	-	133	-
Total	**4,702**	**-**	**3,714**	**-**

13. Summary and conclusions

Following our review of NIE Networks' capex plans for the RP7 period, within Sections 3-12 of this report, we have presented the outcome and recommended capex allowances. The recommended allowances for each sub-programme within the WP are separately identified within Sections 3-12 and have also been consolidated into a single, complete table - this is included within Appendix A to this report. The summary of our recommended allowances for each WP is presented below in Table 66.

Table 66 GHD Recommended RP7 Capex Summary

	Programme ID	RP6. Capex £k	NIE Networks Requested RP7 Capex £k	GHD Recommended Capex £k	Variance to NIE Networks Requested	
					£k	%
WP1	**Distribution (Primary & Secondary) Substation Plant**	**86,169**	**104,995**	**90,687**	**-14,308**	**-13.6%**
	– D13 - Primary Plant	33,387	29,903	27,211	-2,692	-9.0%
	– D14 - Primary Transformers	7,644	16,088	14,136	-1,952	-12.1%
	– D15 - Secondary Substations	43,540	53,080	45,998	-7,082	-13.3%
	– D603 - Distribution Protection	1,599	5,924	3,342	-2,582	-43.6%
WP2	**SCADA & Operational Telecomms**	**4,173**	**18,759**	**17,882**	**-878**	**-4.7%**
	– D39 - SCADA	4,173	4,803	4,377	-426	-8.9%
	– D41 - Operational Telecoms network	-	13,956	13,505	-452	-3.2%
WP3	**Transmission Plant**	**27,071**	**49,960**	**45,862**	**-4,098**	**-8.2%**
	– T10 - 110kV SWGR	3,346	1,565	798	-766	-49.0%
	– T11 - 275kV Plant Ancillaries	2,139	3,816	3,499	-316	-8.3%
	– T12 - 110kV Plant Ancillaries	3,045	11,322	10,308	-1,014	-9.0%
	– T13 - 275/110kV Transformer Replacement	703	10,570	9,953	-617	-5.8%
	– T14 - 110/33kV Transformers Replacement	11,938	9,073	8,640	-432	-4.8%
	– T15 - 22kV Reactor Replacement	817	2,087	1,570	-517	-24.8%
	– T16 - Transmission Transformer Refurbishment	609	1,416	1,246	-170	-12.0%
	– T602 - Transmission Protection	4,473	5,697	5,433	-264	-4.6%
	– T701 - Strategic Spares	-	4,414	4,414	-	-
WP4	**Transmission OHL**	**14,210**	**36,901**	**33,800**	**-3,101**	**-8.4%**

	Programme ID	RP6. Capex £k	NIE Networks Requested RP7 Capex £k	GHD Recommended Capex £k	Variance to NIE Networks Requested	
					£k	%
	– T17 - 275kV Overhead Line Asset Replacement	5,606	18,696	18,009	-687	-3.7%
	– T19 - 110kV Overhead Line Asset Replacement	8,604	18,204	15,791	-2,413	-13.3%
WP5	**Transmission Underground Cables**	**514**	**4,702**	**3,714**	**-988**	**-21.0%**
	TOTAL	**132,135**	**215,317**	**191,944**	**-23,373**	**-10.9%**

In summary, GHD recommends an RP7 capex allowance of £191.9m relating to the works assessed within our scope (WP1 to WP5). This represents an overall reduction of £23.4m (10.9%) relative to NIE Network's RP7 submission for these activities.

NIE Networks provided 46 EJP's to support their RP7 programme of investment. GHD reviewed all EJPs as part of our technical support to UR. Generally, we found the EJP's provided some useful background to NIE Networks' RP6 strategy and presented a high-level description of the investment drivers and proposed investment (both costs and volumes) for the RP7 period.

However, the EJPs lacked sufficient detail to support NIE Networks' proposed RP7 investment plan, with little analysis of options considered; we therefore sought additional clarification through the Q&A (query log) process and targeted engagement sessions. From this process, NIE Networks provided enhanced details regarding the condition assessment process, supporting documentation and records to evidence the justifications. Whilst some expanded information was provided, NIE Networks has not presented evidence of a robust investment appraisal of options.

In general, we have applied reductions based on the following:

– Insufficient justification for the proposed work or for the proposed volumes included within the RP7 scope. Where this has been the case, we have reduced the volume allowance and hence associated cost. In a small number of cases, we disallowed all costs for a specific sub-programme category.
– A number of NIE Networks' proposed RP7 unit cost increases relative to RP6 unit costs were not allowed as the price increases either included impact of real price effects or included other uplifts that we did not agree with; and
– RP7 project cost information not provided at a suitable level of detail, thus preventing us from confirming efficiency of proposed costs.

The largest reduction relates to WP1 - Distribution Plant with a recommended deduction of over £14m (13.6%) proposed. This adjustment is spread across 61 sub-programmes of work divided into four groups:

– D13 - Primary Plant – reduction of £2.7m, principally resulting from reductions to the following sub-programme:
  - D13j - Primary substation lease renewal (£1.5m, 35.3% reduction);
– D14 - Primary Transformers – reduction of £2.0m, principally resulting from reductions to the following sub-programmes:
  - D14l - 33/11kV Tx Oil Regeneration (£0.7m, 100% reduction);
  - D14i – Sump Pumps (£0.5m, 50% reduction)
– D15 - Secondary Substations – reduction of £7.1m, principally resulting from reductions to the following sub-programmes:
  - D15b - Replace complete S/S (£2.8m, 15.4% reduction);
  - D15x - Secondary substation legalities (£0.9m, 45.0% reduction);
  - D15ac - Secondary substations physical (£0.8m, 18.5% reduction);
  - D15d - Secondary Switchboard Replacement (£0.7m, 38.0% reduction);

- D15a - Replace RMU (£0.5m, 24.3% reduction);
- D15t - RMU substation - mini kiosk (£0.5m, 14.4% reduction);

– D603 - Distribution Protection – reduction of £2.6m, principally resulting from reductions to the following sub-programme:
  - D603B - 11kV protection retrofit (£1.0m, 50% reduction).

The remaining work packages are proposed to be reduced, as follows:

– WP2 - SCADA & Operational Telecomms: £0.9m, 4.7% reduction;
– WP3 – Transmission Plant: £4.1m, 8.2% reduction;
– WP4 - Transmission OHL: £3.1m, 8.4% reduction; and
– WP5 – Transmission Underground Cables: £1.0m, 21.0% reduction.

Appendices

Appendix A

Detailed recommendations

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
WP1 – Distribution (Primary & Secondary) Substation Plant				
D13 - Primary Plant	**29,903**	**1,196**	**27,211**	**946**
D13a - Replace indoor switchgear (33kV)	3,745	24	3,508	24
D13b - Replace outdoor switchgear - circuit breaker (33kV)	4,553	67	4,531	67
D13c - Replace outdoor switchgear - complete mesh (with indoor switchboard)	1,925	11	1,783	11
D13d - Replace outdoor switchgear - mesh equipment (33kV)	715	6	715	6
D13e - Replace primary switchgear (33kV, 11kV & 6.6kV)	3,422	55	3,407	55
D13i - Civil works to primary substations	3,323	-	3,323	-
D13j - Primary substation lease renewal	4,301	-	2,783	22
D13K - Replace primary switchgear (11kV & 6.6kV) retro-fit	2,159	93	2,159	93
D13L - Refurbish primary S/S DC system	597	44	597	44
D13M - Rewire primary S/S (inc. AC services panel)	822	45	493	27
D13N - Plant painting (primary)	497	150	249	75
D13O - Replace earth fault indicator	565	559	384	380
D13r - 11kV Reyrolle Hadrian SMW Refurbishment	431	22	431	22
D13s - YMV2 Reyrolle Refurbishment	2,348	120	2,348	120
D13u - Asbestos Management	250	-	250	-
D13v - Primary physical security	250	-	250	-
D14 - Primary Transformers	**16,088**	**458**	**14,136**	**302**
D14b - Replace 33/11kV Transformer (upto 12.5MVA)	729	2	729	2
D14c - Replace 33/11kV or 33/6.6kV Transformer (upto 18.75MVA)	10,989	30	10,989	30
D14G - Transformer refurbishment	413	12	-	-
D14h - Cooler controls replacement	25	12	-	-
D14i - Sump Pumps	1,148	184	574	92
D14j - Transformer Noise Enclosures	1,679	8	1,480	8
D14k - Noise Surveys	365	170	365	170
D14l - 33/11kV Tx Oil Regeneration	740	40	-	-
D15 - Secondary Substations	**53,080**	**24,218**	**45,998**	**24,205**
D15a - Replace RMU	2,152	200	1,630	200
D15b - Replace complete S/S	18,122	288	15,329	275
D15c - Replace complete S/S and temporary S/S works	2,638	37	2,372	37
D15d - Secondary Switchboard Replacement	1,805	50	1,119	50
D15e - Replace OH fed GMT	3,199	50	2,971	50
D15f - Replace H pole S/S	1,068	49	961	49

[65] Initial submission value shown first in black, followed by the revised submission (submitted as part of the query process) in red.

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
D15g - H pole: TX change only	365	45	387	45
D15h - H pole: replace LV cabinet	248	44	230	44
D15k - Replace sectionalisers	1,468	139	1,468	139
D15l - Replace mini pillars	5,971	1,545	5,971	1,545
D15m - Refurbish LV plant	1,580	21,323	1,580	21,323
D15n - Replace LV wall mounted fuse board	464	21	451	21
D15o - Secondary substation ancillary works	1,512	-	1,361	
D15q - Replace UDB	828	114	828	114
D15t - RMU substation - mini kiosk	3,567	56	3,054	56
D15x - Secondary substation legalities	1,959	-	1,077	
D15y - Replace LV Cabinet (GM Substation)	651	40	651	40
D15z - RMU substation - mini kiosk and temp	1,212	17	1,069	17
D15aa - Fit UDB Blanket	43	200	43	200
D15ac - Secondary substations physical	4,227	-	3,445	-
D603 - Distribution Protection	**5,924**	**703**	**3,342**	**380**
D603A - 33kV protection retrofit	611	104	306	52
D603B - 11kV protection retrofit	2,003	304	1,001	152
D603e - Automatic Voltage Control replacements	375	22	187	11
D603g - 33kV Buscoupler retrofit	190	22	95	11
D603i - 33kV Transformer Protection retrofit	399	48	199	24
D603j - 33kV Distance Protection retrofit	57	4	29	2
D603k - Unit Protection retrofit - Full Diff / Pilot Box	243	15	129	8
D603k2 - Unit Protection retrofit - REF / NVD	43	10	22	5
D603l - 33kV Auto Changeover retrofit	185	9	103	5
D603m - 33kV SP Schemes	33	2	16	1
D603o - 33kV Substation Monitors	270	12	270	12
D603p - 33kV Substation Monitors retrofit	110	22	110	22
D603q - 11kV Substation Monitors	45	2	45	2
D603s - 11kV Unit Protection retrofit	265	68	132	34
D603u - Mesh VT Replacement	299	19	299	19
D603v - Switchboard VT Replacement	777	40	389	20
D603w - Protection Pilot	20	-	10	0
WP2 - SCADA & Operational Telecomms				
D39 - SCADA	**4,803**	**127**	**4,377**	**127**
D39B - Replace RTU	2,222	127	2,222	127
D39C - Control centre hardware & software	2,076	-	1,650	-
D39f - SCADA Battery Replacement	136	-	136	-
D39g - Retrofit Radios	369	-	369	-

	Requested by NIE Networks		Recommended by GHD	
Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
D41 - Operational Telecoms network	**13,956**	**-**	**13,505**	**-**
D41c - PSTN Replacement	201	-	201	-
D41d - 10.5g Radio Creation	466	-	466	-
D41e - DC Asset Replacement	358	-	358	-
D41f - OIP Replacement	554	-	554	-
D41g - Comms Generators	61	-	61	-
D41h - Comms AC Services	72	-	72	-
D41j - Mast Replacements	583	-	469	-
D41k - Microwave Asset Replacement	424	-	424	-
D41l - Optical Distribution Frame Replacement	48	-	48	-
D41m - Optical Fibre Replacement	701	-	701	-
D41n - Optical Fibre New	3,619	-	3,619	-
D41o - Substation Comms Equipment Replacements	84	-	84	-
D41p - RAD Assets Replacements	4,098	-	4,098	-
D41r - Server Asset Replacements	125	-	125	-
D41s - Sync Assets Replacement	69	-	69	-
D41u - Comms Physical Security	78	-	78	-
D41x - Comms Cyber Security	392	-	392	-
D41y - Belfast Multi-Core Network	252	-	252	-
D41z - SCADA IP Transition	802	-	802	-
D41ab - Capacity Growth	338	-	0	-
D41ac - Comms Resilience	617	-	617	-
D41ae - Exchange Closure - Pilot	17	-	17	-
WP3: Transmission Plant				
T10 - 110kV SWGR Total	**1,565**	**17**	**798**	**17**
T10C - Replace 110kV switchgear	786	2	518	2
T10d - Refurbish 110kV Switchgear	168	9	280	15
T10e - Replace 110kV Circuit Breaker	611	6	0	0
T11 - 275kV Plant Ancillaries Total	**3,816**	**71**	**3,499**	**71**
T11g - Security systems	1,132	-	879	
T11j - DC standby systems	7	-	7	
T11k - Ballylumford 275kV CVT Replacement	552	24	552	24
T11m - AC rewire	90	2	90	2
T11o - Drainage	453	-	453	
T11P - Kilroot 275kV CT Replacement	572	21	572	21
T11R - 22kV Capacitor Bank Refurbishment	50	-	45	
T11s - Filter Bank Replacement	25	-	23	
T11t - 275kV Surge Arrestor Replacement	116	4	116	4

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Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
T11v - Substation legalities	251	-	251	
T11w - Sump Pumps	96	14	96	14
T11x - Earthing Spigots/Parking bars	112	-	56	
T11y - Replacement of Signage	23	-	23	
T11aa - 275/110kV Tx Oil Regeneration	336	6	336	6
T12 - 110kV Plant Ancillaries Total	**11,322**	**219**	**10,308**	**187**
T12d - Transformer bunding	100	-	100	
T12f - Generator	937	19	937	19
T12h - DC standby systems	318	-	318	
T12i - AC system rewire	329	8	329	8
T12o - Civil works to primary substations	3,510	-	3,510	
T12R - 110kV Disconnector replacement	769	17	769	17
T12S - Drainage Upgrade	283	-	283	
T12t - 110kV CT Replacement	503	27	452	27
T12v - 110kV Surge Arrestor Replacement	88	4	88	4
T12w - 110kV Capacitor Bank Replacement	50	-	45	
T12x - Transformer Noise Enclosures	892	4	766	4
T12y - Sump Pumps	357	52	240	35
T12z - Earthing Spigots/Parking bars	308	-	154	
T12aa - Replacement of Signage	77	-	77	
T12ab - 110kV Earth Switch Replacement	1,565	52	1,565	52
T12ac - 110/33kV Tx Oil Regeneration	1,125	30	563	15
T12ad - 110kV Coffin CTs	112	6	112	6
T13 - 275/110kV Transformer Replacement Total	**10,570**	**6**	**9,953**	**6**
T13a - Transformers (275/110kV) Procure only	6,626	3	6,626	3
T13C - Transformers (275/110 kV) Install only	2,077	3	2,077	3
T13f - Replace associated cable	1,867	-	1,250	-
T14 - 110/33kV Transformers Replacement Total	**9,073**	**20**	**8,640**	**20**
T14a - Transformers (110/33 kV) Procure only	4,748	6	4,748	6
T14b - Transformers (110/33 kV) Install only	2,181	6	2,181	6
T14c - Replace associated cable	1,532	-	1,100	
T14D - Replace Earthing Transformer	265	4	265	4
T14E - Replace Transformer Cooler	347	4	347	4
T15 - 22kV Reactor Replacement Total	**2,087**	**4**	**1,570**	**4**
T15a - 22kV Reactors Procure only	1,451	2	1,108	2
T15e - 22kV Reactors Install only	636	2	462	2
T16 - Transmission Transformer Refurbishment Total	**1,416**	**76**	**1,246**	**70**
T16a - Refurbish/Replace 275kV Bushing	213	6	213	6

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Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
T16b - 275kV Plant Painting	79	4	79	4
T16d - Refurbish 275kV TX tap changer	80	4	80	4
T16f - Replace 110kV Bushing	75	6	75	6
T16g - 110kV Plant Painting	249	21	129	15
T16i - Refurbish 110kV TX tap changer	487	22	487	22
T16k - Replace 110kV Cooler Controls	19	7	19	7
T16l - Replace PST Tap Changer Control Unit	200	2	150	2
T16m - Replace 275kV Cooler Controls	15	4	15	4
T701 - Strategic Spares Total	**4,414**	**-**	**4,414**	-
T701a - Grid Transformer	2,209	-	2,209	
T701b - Main Transformer	1,583	-	1,583	
T701c - Grid Plant	623	-	623	
T602 - Transmission Protection Total	**5,697**	**173**	**5,433**	**173**
T602E - Install 275kV Interbus Transformer Protection	70	1	70	1
T602H - Install 275kV Feeder Protection	902	8	817	8
T602J - Install 275kV Circuit Breaker Fail	395	48	395	48
T602k - Install 22kV Reactors	110	4	110	4
T602N - Install 110kV Transformer Protection	1,160	17	1,160	17
T602O - Install 110kV Distance Protection	725	16	725	16
T602P - Install 110kV Tap Change Control	363	14	363	14
T602R - Install 110kV Load Shedding (Relay Change Only and Minor Wiring)	83	26	83	26
T602T - Install 110kV Unit Protection	423	10	423	10
T602U - Install 110kV Intertripping	29	2	22	2
T602w - Load Shedding Panel	42	4	42	4
T602X - Install 275kV Grid Substation Monitors	60	2	60	2
T602Y - Install 110kV Grid Substation Monitors	261	7	261	7
T602aa - Remove Protection	22	-	22	
T602ad - Install 275kV Autoreclose	494	10	494	10
T602ae - Install 275kV Operational Intertripping	140	-	140	
T602af - Install 110kV Buscoupler	64	2	64	2
T602ah - Install PST Protection	182	2	182	2
T602ai - 61850 Hardware Replacement	150	-	-	-
T602aj - Protection Studies	22	-	-	-
WP4: Transmission OHL				
T17 - 275kV Overhead Line Asset Replacement	**18,696**	**3,223**	**18,009**	**2,627**
T17d - Tower Painting	2,541	360	2,430	360
T17e - Replace Colour and Number Plates	160	300	127	239

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Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
T17f - Foundation assessment	573	208	612	208
T17g - Condition assessment	198	310	198	310
T17J - Muff Repair	139	131	83	131
T17K - Trolley Inspections	407	740 / 495	216	495
T17m - 275kV Remedial	398	0	358	-
T17n - 275kV Steel Work Replacement	100	0	96	-
T17q - 275kV Damper Replacements	37	122	37	122
T17r - 275kV Undercrossings	396	33	396	33
T17s - 275kV Tower Replacement	6,400	8	6,400	8
T17t - 275kV Muff Painting	214	272	214	272
T17v - 275kV Fittings	102	152	92	137
T17x - 275kV Foundation Repair	5,560	48	5,560	48
T17y - 275kV Tower Security	608	214	493	-
T17z - 275kV Conductor Sampling	37	25	37	25
T17aa - 275kV Stepbolt	826	300	658	239
T19 - 110kV Overhead Line Asset Replacement	**18,204**	**4,644**	**15,791**	**4,528**
T19a - Replace conductor	4,046	136	3,347	136
T19b - 110kV Replace Suspension Insulator	757	376 / 378	684	340
T19c - 110kV Replace Tension Insulator	980	92	769	83
T19e - Tower Painting	1,483	525	1,398	525
T19f - Replace wood poles	1,531	370	1,210	320
T19g - Replace colour and number plates (Double)	56	97 / 74	36	67
T19g1 - 110kV Replace colour and number plates (Single AKA 19j)	28	95	21	77
T19h - Foundation assessment	1,150	389	994	389
T19i - Condition assessment	333	487	333	487
T19N - Muff repairs	195	183	59	183
T19p - 110kV Remedial	350	-	315	-
T19r - 110kV Tower Replacement (Single)	1,400	-	1,400	-
T19t - 110kV Muff Painting	299	380	299	380
T19v - 110kV Tower Painting (single)	460	326	434	326
T19y - 110kV Damper Replacements	54	180	54	180
T19z - 110kV Foundation Repair	2,526	19	2,201	19
T19aa - 110kV Steel Work Replacement	100	0	100	-
T19ab - 110kV Tower Security	1,176	460	866	414
T19ac - 110kV Conductor Sampling	102	70	102	70
T19ad - 110kV Step bolts (Single)	94	107	95	108

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Sub-programme ID	**RP7 allowance (£k)**	**RP7 volume [65]**	**RP7 allowance (£k)**	**RP7 volume**
T19af - Castlereagh - Rathgael ADSS recovery	108	67	108	67
T19ag - 110kV LV Undercrossings	156	13	156	13
T19ah - 110kV Clearances	500	0	434	-
T19ai - 110kV Step bolts (Double)	264	150 / 187	296	168
T19aj - 110kv Replace Fittings	54	122 / 195	78	176
WP5 – Transmission Underground Cables				
T20 - Transmission Cables	**4,702**	**-**	**3,714**	**-**
T20k - Refurbish 110kV Cable	436	-	159	-
T20m - Procurement of Transmission Cables Accessories and Ancillaries	1,357	-	961	-
T20n - Replacement 110kV FFC Cable	2,518	-	2,266	-
T20r - Decommission FFC	242	-	194	-
T20s - Leak Management Technologies	148	-	133	-

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