

TECHNICAL GUIDANCE AND TECHNICAL DEVIATIONS TO NGET TECHNICAL SPECIFICATIONS AS APPLIED TO SINGLE ASSET REPLACEMENT/REFURBISHMENT/RECONDITION INVESTMENTS

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PURPOSE AND SCOPE

This document provides technical guidance and agreed technical deviations to NGET Technical Specifications (TS) as applied to the delivery of Electricity Transmission single asset replacement/ refurbishment/recondition investments. The technical guidance and agreed technical deviations are grouped together for each type of investment and presented as separate appendices in TGN (E) 286. e.g. Appendix A CB Replacement (without CT's) & (with CT's).

This document shall be read in conjunction with UKBP/TP236 which defines key Transmission Procedure (TP) minimum requirements as applied to the delivery of Electricity Transmission single asset replacement /refurbishment/recondition investments. These key TP minimum requirements are grouped together for each type of investment and presented as separate appendices in UKBP/TP236. e.g. Appendix A CB Replacement (without CT's) & (with CT's)

Note: UKBP/TP236 Appendices and TGN(E) 286 Appendices shall correspond to each other when applied to the same type of single asset replacement/refurbishment/recondition investment. See Figure 1 below.

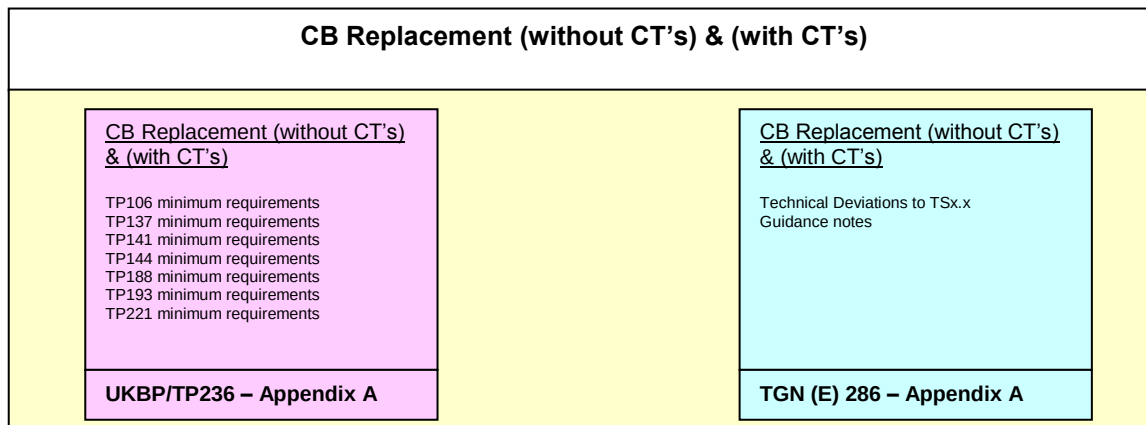


Figure 1 The diagram above illustrates the relationship between key TP minimum requirements (as identified by appendix) and the associated Technical Guidance and Technical Deviations (as identified by appendix) for CB Replacement (without CT's) & (with CT's).

Note: The technical guidance and Technical Deviations (identified by appendix in this procedure) as applied to the delivery of single asset replacement/refurbishment/ recondition investments SHALL NOT be utilised on any other investments without the agreement of ETAM Asset Policy Manager.

PART 1 –PROCEDURAL

1 SUMMARY OF KEY TP MINIMUM REQUIRMENTS, TECHNICAL GUIDANCE AND TECHNICAL DEVIATIONS FOR SINGLE ASSET REPLACEMENT/REFURBISHMENT/RECONDITION INVESTMENTS.

				Key TP Minimum Requirements (x denotes - Key TP Minimum Requirements, blank denotes – TP fully applies if applicable A denotes – TGN(E) 286 Appendix A)										
Single Asset Replacement/ Refurbishment/ Reconditioning Investment	UKBP_ TP236 Appendix	Project Management Organisation	Work Delivery	UKBP_ TP106	UKBP_ TP137	UKBP_ TP141	UKBP_ TP144	UKBP_ TP163/BP221	UKBP_ TP184	UKBP_ TP188	UKBP_ TP193/TP193.1	UKBP_ TP211	UKBP_ TP221	TGN(E) 286 Appendix
CB Replacement (without CT's) & (with CT's)	A	CD	Contractor	X	X	X	X			X	X	N/A	X	A
CB Refurbishment (with or without bay refurbishments)	B	ETAM PMO	ETAM/ Contractor	X	X Use AMB P051	X	X Use AMB P051	Use AMB P310 AMB P311	Use AMB P051	X	N/A	N/A	X	B
CB Recondition (with or without bay refurbishments)														
Bay Refurbishment	C To Be Produced	CD	Contractor								X	N/A		C To Be Produced
NICAP	D	CD	Contractor								X	N/A		D
SCS Upgrade	E	CD	Contractor								X	N/A		E
Supergrid Transformers & Reactors (In-situ Replacement Only)	F	CD	Contractor	X	X	X	X			X	X		X	F
OHL fittings replacement only	G	CD	Contractor									N/A		G
Asbestos removal (with & without replacement materials)	H	CD	Contractor								X	N/A		H
Flood defence	I	CD	Contractor									N/A		I
ISS (Electric)	J	CD	Contractor											J

2 RESPONSIBILITIES & PROCESS

As defined in UKBP/TP236 section 1

3 FORMS AND RECORDS

Not applicable.

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

4 DEFINITIONS

Not applicable.

5 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	April 2016	New TGN (E) to support the delivery of single asset replacement/refurbishment/recondition investments.	Josh Banks Richard Stone Ian Price Andrew Chapman Capital Delivery Technical Assurance	Shaun Hughes CD TA Technical Manager Stewart Whyte ETAM Asset Policy Manager
2	June 2016	Appendix A CB replacement added Appendix B CB Refurb/Reconn added Appendix F SGT Replacement added	Rob Everitt Peter Holliday Peter Holliday Paul Jarman Gibson Bhunu Nick Tart Mark Gomersall	Shaun Hughes CD TA Technical Manager Stewart Whyte ETAM Asset Policy Manager
3	July 2016	Appendix H Asbestos removal added Appendix I Flood defence added Appendix J ISS addedd	John Fieldhouse Rob Everitt Stuart Baillie	Shaun Hughes CD TA Technical Manager Stewart Whyte ETAM Asset Policy Manager

6 IMPLEMENTATION

6.1 Audience Awareness

Audience	Purpose Compliance (C) / Awareness (A)	Notification Method Memo / letter / fax / email / team brief / other (specify)
Principal Contractors/Contractors	C	Normal issue email & Engineering Bulletin
ETAM Investment Management and designers	C	Normal issue email & Engineering Bulletin
ETAM Operations	C	Normal issue email & Engineering Bulletin
ETAM PMO	C	Normal issue email & Engineering Bulletin
Capital Delivery – Development	C	Normal issue email & Engineering Bulletin
Capital Delivery – Delivery Unit	C	Normal issue email & Engineering Bulletin
Capital Delivery – Technical Assurance	C	Normal issue email & Engineering Bulletin

6.2 Training Requirements

Training Needs N/A / Informal / Workshop / Formal Course	Training Target Date	Implementation Manager
N/A	N/A	N/A

6.3 Compliance

Compliance will be monitored by Capital Delivery Technical Assurance.

6.4 Procedure Review Date

8 years from publication date.

PART 3 - GUIDANCE NOTES AND APPENDICES

7 REFERENCES

This document shall be read in conjunction with:-

UKBP/TP236 Key Transmission Procedure minimum requirements as applied to the delivery of Electricity Transmission single asset replacement/refurbishment/recondition investments.

APPENDIX A - CB REPLACEMENT (WITHOUT CT'S) & (WITH CT'S) TECHNICAL GUIDANCE AND TECHNICAL DEVIATIONS

A1 INTRODUCTION

The technical guidance detailed in this appendix is applicable to circuit breaker replacement schemes only. The following sections cover the reuse of civil assets and guidance on primary and P&C aspects.

A2 CIVIL ASPECTS

Many of the 400kV circuit breakers on the National Grid network, which are due to be replaced under the circuit breaker programme, are supported by structures which are of standard design. The vintage of these structures means that in most cases they will have exceeded (or will soon exceed) their 40 year design life. However, many of them appear to be in good condition with significant reserves of strength.

The use of standard designs, together with a limited supplier base for replacement circuit breakers allows potential economies to be made by carrying out an upfront study of a finite number of breaker/structure permutations. This will facilitate a reduced duration of the NDP4.3 development stage as calculations will have already been carried out to determine the adequacy of the structure for numerous failure modes. This will feed into a DH15 report along with site specific data (condition assessments etc.) to inform the decision on whether to reuse or replace the supporting structure and foundations.

The purpose of this section is to outline a standard approach to the assessment of the supporting structures, both in terms of structural analysis and condition assessment.

This section also covers the reuse of structures for 275kV, 132kV and 13kV circuit breakers.

A2.0 Structural assessment

The structural assessment required shall comprise:

- a) A numerical analysis;
- b) A condition assessment

The following clauses outline the requirements for both parts of the assessment, over numerous system voltages.

A2.1 400kV

Many of the air blast circuit breakers being replaced as part of the asset replacement works are supported on structures which collectively form a 'family' of standard structures. This family of standard structures, designed and constructed by the former CEGB, are of similar form and are identified by the prefix "K.A.C.B.". The particular variant is then defined by a numerical reference e.g. "7/6".

Where adequate records exist, the K.A.C.B. structures have been assessed against the loading imposed by typical 400kV circuit breakers from three suppliers. Table A1.1 shows the type of circuit breakers used in the assessment:

Supplier	Type
ABB	HPL 420 B2
Alstom	GL316X
Siemens	3AP2FI

Table A1.1

Where circuit breakers other than those listed in Table A1.1 are used, this shall be outside of the scope of this appendix.

The structure types listed in Table A1.2 have been assessed against the loads associated with each circuit breaker, as defined in the suppliers' drawings and TS 3.01.04

A2.1.1 Failure mode and location key

A number of failure modes have been considered which have been categorised below, for clarity. Each possible failure mode has been assigned a letter, and each location a number. For example, a critical failure mode of (V)(3) refers to a shear failure in the top slab. The full key is listed below:

Failure modes

- Bending (M)
- Shear (V)
- Axial (F)

Locations

- Base (1),
- Stem (2),
- Top slab (3)

A2.1.2 Results

The structures listed below in Table A1.2 have been assessed on the basis that the new equipment will be mounted on a modified baseplate, using the existing boltholes.

In the majority of cases, the critical failure mode is shear in the top slab due to the coexistent moment and uplift caused by circuit breaker operation.

Note: Code rules regarding enhanced shear strength close to supports are not considered to be applicable in this instance as the uplift will act away from the support, hence a compressive strut will not be formed in the slab.

All structures analysed have a factor of safety > 1.0 for the critical failure mode. The exception to this is the KACB 1.9 structure, which was designed for use with the AT4 air blast circuit breaker. The column fails in bending for all three equipment types, therefore should not be considered for reuse.

			New Equipment		
			ABB	Alstom	Siemens
			HPL 420 B2	GL316X	3AP2FI
Existing Structure	KACB 3/7	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.52	3.28	2.89
	KACB 4/0	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.25	2.68	2.36
	KACB 5/1R	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	2.14	4.64	4.20
	KACB 5/6R	Critical Failure mode	(V)(4)	(M)(3)	(M)(3)
		FOS	1.64	3.31	2.71
	KACB 7/6	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.25	2.69	2.37
	KACB 8/1	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.52	3.28	2.89
	KACB 8/6	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.25	2.69	2.37
	KACB 9/1	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.52	3.28	2.89
	KACB 9/6	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.25	2.69	2.37
	KACB 10/1R	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	2.23	4.84	4.45
	KACB 11/6R	Critical Failure mode	(V)(4)	(M)(3)	(M)(3)
		FOS	1.64	3.35	2.62
	KACB 12/1R	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	2.14	4.64	4.20
	KACB 12/6R	Critical Failure mode	(V)(4)	(M)(3)	(M)(3)
		FOS	1.64	3.34	2.60
	KACB 2.4	Critical Failure mode	(V)(4)	(V)(4)	(V)(4)
		FOS	1.47	3.17	2.79
	KACB 1.9G	Critical Failure mode	(M)(3)	(M)(3)	(M)(3)
		FOS	0.37	0.68	0.55

Table A1.2 - 400kV Circuit Breaker Combinations

The above table shows the worst case failure mode for each combination and should be used in conjunction with the site specific inspection (see A2.1.3) to determine the suitability of the structures for reuse. All other failure modes are deemed to have a factor of safety in excess of the critical failure mode listed above.

In some cases e.g. overturning of large “grillage” foundations, the structure may be deemed to comply “by inspection” rather than by calculation of a numerical safety factor. Where there is no evidence of settlement or known poor ground, foundations will be deemed to be adequate for bearing checks.

Many of the existing structures in Table A1.2 have a similar form and reinforcement detailing and were designed to carry similar items of plant. National Grid Technical Assurance may decide to reuse members of the K.A.C.B. family which are not listed above and for which no as built records can be found. This is considered reasonable on the basis that:

- The external dimensions can be checked to ensure that they are of similar proportions to the assessed structures
- The factors of safety on the majority of assessed structures is relatively large

- c) The structures were designed over the same period to carry similar plant arrangements.

It is expected that where a structure is listed in the table above or is a similar KACB variant, a decision can be made without further analysis e.g. where a high factor of safety is noted and the critical element of the structure shows few defects (or can readily be repaired). This decision shall be recorded in the form of an assessment report following the guidance in DH15.

Where a factor of safety close to unity is noted and the element is question is in poor condition, closer scrutiny may be required. In this instance, advice shall be sought from National Grid, Technical Assurance.

A2.1.3 Condition Assessment

In addition to ascertaining the condition of the structures, site investigations shall also confirm that the structure is constructed as per standard design assumed in Table A1.2

Where the structure deviates from the standard design, the designer shall (in conjunction with National Grid, Technical Assurance) assess whether this is a substantive change that invalidates the original structural assessment, or not. Where the original assessment is not invalidated, the differences shall be recorded in the DH15 report. Where the original assessment is invalidated, then further calculations may be required.

A2.1.4 Suite of testing

A standard suite of testing is required to determine the condition of the structure, this shall comprise of the tests listed below:

- a) Cover survey
- b) Visual inspection including 1no. trial pit per bay if feasible
- c) Delamination survey
- d) Chloride content
- e) Depth of carbonation
- f) Half cell potential
- g) Cores and petrographic examination, only where ASR is suspected (1 per concrete “type”) or where concrete is of questionable quality
- h) Sulphate content of ground (not required where covered by previous GI)

A2.2 275kV

As part of the CB replacement programme a small number of 275kV circuit breakers are due to be replaced. The decision to whether to reuse these structures shall follow the same process as described above for 400kV circuit breakers. However, the initial study of structure/breaker permutations has not been carried out, so bespoke assessments will be required to inform the decision making process.

A2.3 132kV

132kV circuit breakers are predominantly supported at ground level by a large concrete foundation (ACBR type).

These foundations are considered to present a low risk of failure, hence it shall be acceptable to carry out a numerical analysis of the load carrying capacity, post installation. The assessment shall be submitted to Technical Assurance within 12 weeks of the installation.

A condition assessment shall be carried out in NDP4.3 to determine whether or not to proceed with reuse of the foundations.

Because of the low risk, this may be limited to:

- a) Visual inspection by a suitably qualified Civil Engineer;
- b) Desk study of previous ground investigations (to check for presence of sulphates);
- c) Limited number of carbonation and chloride tests.

Outages may be required to perform the carbonation and chloride testing. If the programme is put at risk by the availability of outages, it shall be acceptable to carry out this testing at the time of installation (subject to the visual inspection indicating that corrosion is unlikely).

Where 132kV circuit breakers are currently supported on structures i.e. above ground, the approach for reuse described above in A2.2 shall be adopted.

A2.4 13kV

The approach for 13kV circuit breakers on rails shall be based on the assumption that the supporting slab and rails are structurally adequate, unless found to be in poor condition. 13kV circuit breakers are predominantly located indoors in bays with exposed low level equipment, hence an outage and permit would be required to carry out a detailed condition inspection.

Due to the low risk, it is not considered necessary to carry out a detailed inspection prior to the replacement works going ahead. Works shall proceed on the basis that the supporting structure is in adequate condition, with this being confirmed by visual inspection at the time of installation.

However, an assessment of the surrounding building, considering methods of removal and installation of equipment should be undertaken. This assessment should also look at general condition of the building to identify any immediate remedial works that are required.

A2.5 Civil Design

During the NDP4.4 Execute Project phase, the only aspect of civil design anticipated is the design of modified baseplates and holding down arrangements for the equipment, to enable the reuse of existing boltholes in the structures.

Where the designer feels that revised bolt positions invalidate the assessment made in NDP4.3, then additional calculations may have to be prepared. Note: this is not a preferred option, and baseplates shall be designed to avoid this problem wherever practicable.

Where resin fixings are used, a 100% testing regime shall be implemented. The test procedure shall be in accordance with guidance from the Construction Fixing Association.

Note: the assessment of the existing structure undertaken in NDP4.3 does not include a check of pull out failure for resin anchors.

If bespoke support frames are proposed to raise the circuit breaker to the correct height, these designs are considered to be civil/structural/building engineering and shall go through the contractor design approval and assurance process.

A3 PRIMARY / P&C ASPECTS

A3.1 Scope

This section relates only to the Circuit Breakers replacement technical requirements. It outlines a standard approach to both the physical installation and the interconnection of the replacement circuit breaker into existing substation systems.

A3.2 SCS Alarms

To add new circuit breaker alarms to the existing SCS a Data Set Switch (DSS) will be required. This may be used to incorporate alarms changes from a number of different schemes and may be planned before or after the CB replacement.

For CB replacements after the DSS the alarms shall be cabled to the SCS cubicle and connected to the new SCS alarms terminals

For CB replacements before the DSS the alarms shall be cabled to the SCS cubicle, grouped as required and connected to existing SCS alarm terminals. This enables the alarms to be separated after the DSS without the requirement for a circuit breaker outage.

Typical alarm grouping for circuit breaker replacement are shown in table A3.1 below.

Note – Alarms will vary with circuit breaker type and supplier

New Alarm	Grouped to Existing Alarm
SF6 Gas Density Close Lockout	Low Air Pressure Close Lockout
SF6 Gas Density Trip Lockout	Low Air Pressure Close Lockout
CB Motor Circuit Faulty	Low Air Pressure Close Lockout
Spring Charge Close Lockout	Low Air Pressure Close Lockout
Spring Discharged	Low Air Pressure Close Lockout
Spring Charge Motor Excess Running	Low Air Pressure Close Lockout
SF6 Gas Density Falling	Low Air Pressure Close Lockout
CB Cubicle Heater Faulty	Low Air Pressure Close Lockout
Phases Not Together	Circuit Breaker Fail Protection

Table A3.1 - Typical alarm grouping for circuit breaker replacements

Alarms shall be presented to the SCS as 'voltage applied in alarm state' / fail safe and require no inversion within the SCS.

'Circuit Breaker Faulty' alarms shall not be initiated from the circuit breaker to the SCS during normal operation of the circuit breaker (e.g. 'Spring Discharged' during normal recharging of the spring)

A3.3 Spring Charge Supplies

The National Grid preferred voltage for replacement circuit breaker spring charge supplies is 230V AC. This may be varied depending on availability of existing substation supplies and the supply to existing circuit breakers.

A3.4 Heater Supplies

The National Grid preferred voltage for replacement circuit breaker heater supplies is 110V AC. This may be varied depending on availability of existing substation supplies and the supply to existing circuit breakers.

A3.5 Trip and Close Supplies

Some new circuit breakers have +ve supplies for closing from remote (relay room) and local (ring main) supplies segregated by contacts on the circuit breaker local/remote switch. The –ve supply is commoned after the local/remote switch to the local supply. As the local and remote supplies may be from different battery systems all trip and closing supplies to a circuit breaker of this type shall be from the remote supply.

A3.6 Trip and Close Coil Ccts

Any existing trip circuit supervision resistors shall be checked for suitability with new trip coils and changed if necessary.

If the burden of the new trip and close coils is less than existing trip close coils (See DH01 App 4) then there is no requirement for a burden / volt drop calculation. During commissioning of the circuit breaker a reduced voltage test shall be done to prove operation of trip and close coils.

A3.7 Maintenance and Control

The majority of circuit breakers to be replaced will be installed on top of the existing circuit breaker structures. The Local Control Cubicle (LCC) and any SF6 Gas Filling point shall be accessible from ground level (1m – 1.8m from ground as TS2.1). The opening of the LCC shall not be restricted by the proximity of other equipment. .

A3.8 Insulation

The Pollution Class of insulation shall be as existing equipment on the substation.

A3.9 Electrical Clearances / Equipment Height

Electrical clearances and height for replacement circuit breakers shall be as TS2.1

A3.10 CTs

TGN(E) 251 shall be used as the primary process for post CT replacement. All Current transformers (including spare/unused) shall be cabled to local termination point (marshalling kiosk, relay panel) and terminated on stud terminals.

A3.11 Circuit Breaker Fail

The settings of existing circuit breaker fail protection shall be checked for replacement circuit breakers. There may be a requirement to either reset or change the existing current check relay to align with policy. Very low primary settings of 50A used on OIBR 140 shall be changed to align with current policy. Circuit Breaker Fail timer settings shall also be reviewed and wherever possible standardised with the current policy of 150ms.

A3.12 Phases Not Together

The replacement circuit breaker may include detection of phases not together during opening or closing cycles, this shall initiate a latched alarm to the SCS and trip upon closing.

A3.13 Air System

If the existing circuit breaker is an Air Circuit Breaker, the air system shall be removed from the LCC and any existing air ring main reinstated. The LCC shall also be removed.

A3.14 Busbar Protection Pre Close

Where circuit breaker positional information affects the selection of CTs to the algorithm of busbar protection, a means of ensuring advance selection prior the circuit breaker closure shall be provided as per TS3.24.34 Clause 1.2.3.

Pre-close repeat relay contacts can be used to give advanced information of circuit breaker closing for slow circuit breaker auxiliary switches.

A3.15 Busbar Loadings

There is no requirement for busbar loading calculations provided the busbar length is less than the standard maximum busbar length for which the maximum loading has been calculated. Confirmation of this will require evidence of standard busbar calculation, new equipment maximum loadings and lengths and types of new busbars.

A3.16 Other design considerations

Other items that shall be reviewed as part of the overall design are listed below but not limited to:-

- Auxiliary contact provision on the new equipment
- Requirements for point on wave switching (shunt reactors and/or MSC's)
- Mechanical interlocking requirements for castel or fortress key.
- Where a live tank circuit breaker is replaced by a dead tank circuit breaker CT positions and protection zones shall be reviewed (modification of interlocked overcurrent arrangements)
- Existing Low Air Pressure Interlocks
- Existing Sequential Isolation schemes
- Force Tripping on Bus Sections and Bus Couplers

A3.17 Division of Responsibility

Circuit Breaker replacement may be included in a circuit outage for NICAP protection replacement carried out by a separate contractor. It may be also split between a contractor for the supply of the circuit breaker and the installation of the circuit breaker.

The following tables show responsibilities of the contractors involved. Any changes to these responsibilities shall be agreed by all contractors involved before work commences.

Contractor	Contract for
CBSO	Circuit Breaker Supply Only (LOT 1 Switchgear 2017-20)
CBSI	Circuit Breaker Supply & Install (LOT 2 Switchgear 2017-20)
CBIO	Circuit Breaker Install Only (LOT 3 Switchgear 2017-20)
NICAP	Protection Replacement

Table A3.2 Contractors