

SELECTIVE PROTECTION ASSET REPLACEMENT (SPAR)

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PURPOSE AND SCOPE

This Technical Guidance Note (TGN), in conjunction with related functional specifications, details the requirements for Selective Protection Asset Replacement (SPAR) within TPS 5/33 and hard-wired feeder bay protection panels/cubicles on feeder bays at double busbar and mesh substations on National Grid's 400 and 275 kV transmission system.

Selective Protection Asset Replacement (SPAR) projects in TPS 5/33 and hard-wired protection panels/cubicles comprise the replacement of existing obsolete feeder main protection relays with modern numeric protection relays, whilst retaining the existing bay infrastructure as far as possible and necessary.

In terms of primary protection functionality, in all but exceptional cases, the new feeder main protection relays shall be a like-for like replacement of the existing feeder main protection relays, whilst at the same time enabling in the relay as many of the requirements of relevant current National Grid Technical Specifications as practicable.

This TGN defines what the functional requirements for SPAR projects are and in particular those areas where deviations from current technical specifications and policy are required and permitted.

PART 1 –PROCEDURAL

1 GENERAL PRINCIPLES AND OVERVIEW

Existing equipment in TPS 5/33 cubicles would have been installed in the 1990's and the equipment in hard-wired cubicles would have been installed considerably earlier. The feeder bay protection panels/cubicles nominated for selective protection asset replacement shall be visually inspected and subjected to an assessment process (as described in section 1) to determine whether or not the SPAR principle can be effectively applied.

An important criterion of the assessment process is the determination that retained existing ancillary equipment would provide reliable service for a further 20 years; thereby ensuring that the asset life (20 years) of any new numeric protection relays installed as part of a SPAR project and the asset life of retained ancillary equipment is aligned.

Policy Statement PS(T) EPS 12.08 - "Protection, Control & Automation System Replacement and Refurbishment" gives guidance on end-of-life criteria and the anticipated life in years for protection and control equipment. This document shall be referenced as part of the assessment process to determine the remaining useful life of equipment considered for retention. E.g. the useful life of electromechanical relays is indicated as between 60 to 80 years. Provided that electromechanical relays and equipment installed in the 1990's or even the 1970's are reviewed and considered to be acceptable for a further 20 years with a low risk to on-going reliable operation, then retention and reuse of such equipment is a reasonable expectation, i.e. the expectation is that ancillary equipment such as trip relays, test blocks, fuses, links, MCBs, check/system synchronising equipment, delayed auto reclose equipment, CB Fail, etc. will in general be retained.

For retained existing equipment, it is expected that an ample supply of "Grey Spares" (reclaimed light current spares) will be available to keep the protection system in reliable operation for a further 20 years. Where necessary; remedial action may be undertaken to ensure this capability. This may include mitigating actions such as consideration to include CB Fail replacement as part of a SPAR project or another on-going strategy.

The interfacing point between the new feeder main protection relays and the retained existing ancillary equipment will be within the protection cubicles. As much of the existing interface wiring as practicable should be reused. Some new cables and minor remedial works may inevitably be required, but appropriate design should keep this to a minimum.

For TPS 5/33 installations, the umbilical cables which incorporate the wiring from the relay terminals to the "Harting" multipin plugs shall be prepared off-site prior to the Factory Acceptance Tests. The multipin plugs shall be appropriately coded to ensure that only the correct plug can be inserted into the specific existing corresponding socket of the Secondary Marshalling Field. The coding arrangement used shall ensure alignment of the pins when mating a plug and socket. "Harting" multipin plugs and sockets and associated components and wires are available from multiple suppliers.

For hardwired installations, new umbilical cables required for connection to the relay terminals shall be prepared off-site prior to the FAT. In this case however, instead terminating on a multipin plug, the free end of the umbilical cables shall be prepared for connection to the terminal blocks in the existing protection cubicle. Where no terminal block(s) exists within the protection cubicle, if possible the existing wiring shall be used or a suitable intermediary terminal block(s) provided to terminate the existing wiring interface.

2 ASSESSMENT CRITERIA

Prior to selecting a TPS 5/33 or hard-wired protection panel/cubicle for Selective Protection Asset Replacement (SPAR), the feeder main protection relays would have been identified as obsolete and listed for asset replacement based on their Asset Health Indices.

A survey of the feeder protection panel/cubicles on a per circuit basis (see Appendix A) is undertaken and an assessment is carried out to determine whether or not selective replacement of only the feeder main protections and signalling equipment whilst retaining the existing supporting auxiliary relays and associated infrastructure should be undertaken or if full replacement with a NICAP standard bay solution (SBS) is required.

2.1 Factors Considered for the Assessment

Factors to be considered as part of the assessment are listed below

- Equipment Condition/Performance
 - Are there any ancillary relays or equipment e.g. DAR, Check Synch, CBF or other relays/equipment/wiring that would not potentially last another 20 years?
 - Are the retained items within the asset life guidance of PS(T) EPS 12.08? – Y/N
 - Are there any known operational or maintenance issues which indicate performance/reliability would be unacceptable or unmanageable (e.g. Maintenance records identifying deteriorating relay performance)? – Y/N
 - Are there any retained items for which spares, replacements, repairs would be difficult to source or alternative mitigating actions be unavailable? – Y/N
- Equipment Installation/Project Management
 - Does the current equipment installation present any problems in undertaking SPAR or managing equipment for an additional 20 year period?
 - Is equipment 19" Rack/19" rack mounting - enabling ease of replacement?
 - Is equipment Swing Frame mounting - enabling ease of replacement?
 - Is equipment panel/front sheet mounted - can the sheets be converted easily to mount new relays (are suitable mounting options available for new IEDS)?
 - Does cutting/drilling into the relay panel or disturbing any Trip/Aux Relays, links, wiring make SPAR impractical? – Y/N
 - Are any other works required to the bay circuitry to ensure that it is potentially fit for another 20 years and can the work be undertaken? – Y/N
 - Does the location of any equipment or panel make application of SPAR impractical e.g. remote location of synchronising or circuit breaker fail protection relays/panels?
 - Is a shared GPS time signal available for the synchronisation of internal clocks for fault recording or does it need to be installed? - Y/N
 - Is there any obvious reason that would prevent the SPAR process from being successfully applied? - Y/N

The survey is an opportunity to assess whether or not the supporting relays, hardware and wiring can provide reliable service for the 20 year expected life of the replacement feeder main protection relays and to identify specific items that need to be addressed with the protection replacement.

A flow chart for the assessment process is shown in Figure 1.

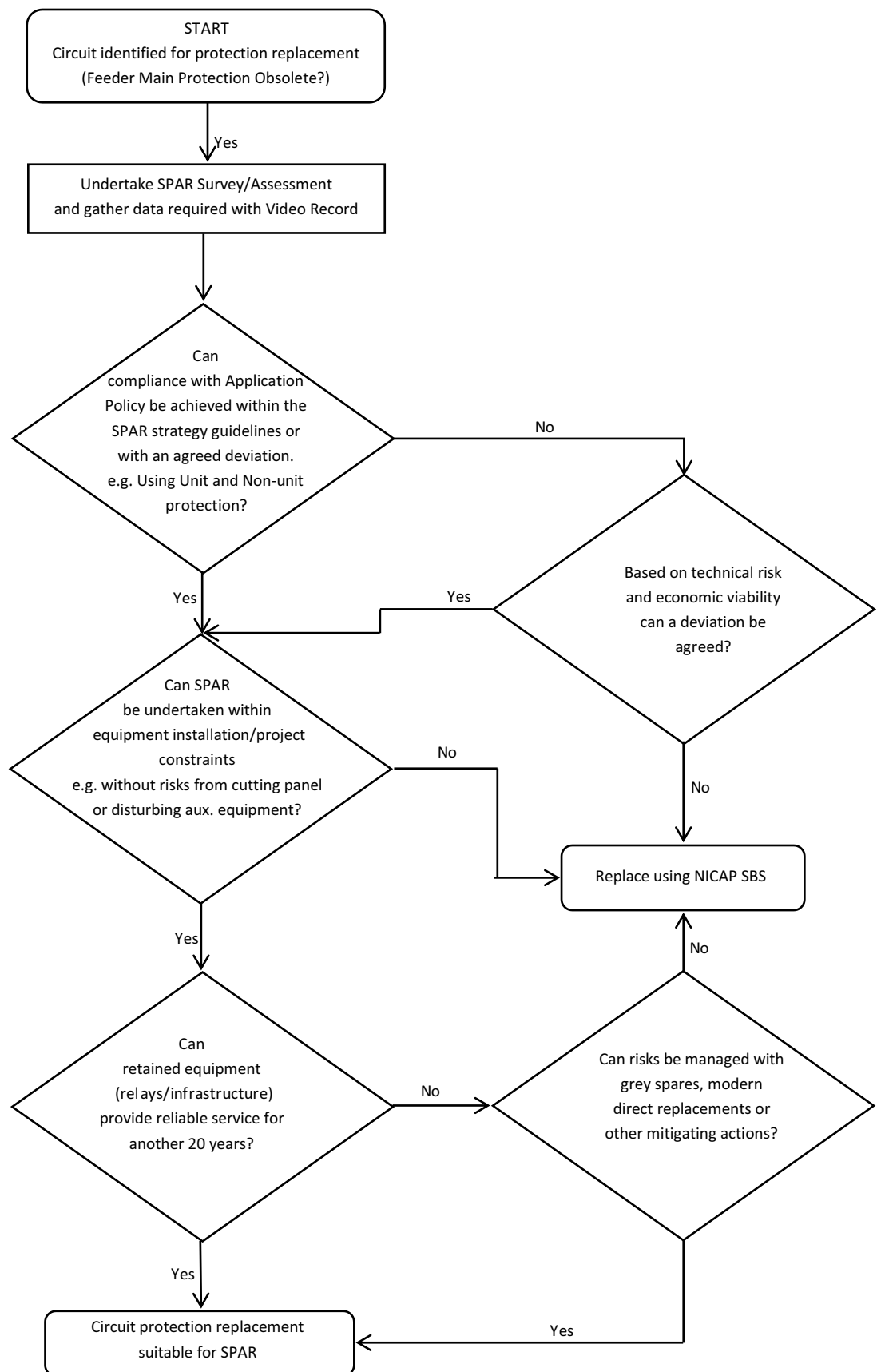


Figure 1 – SPAR Assessment Process

2.2 Identification and Management of Retained Equipment

The SPAR survey and SPAR application process will identify any relays or equipment that will be retained as part of the SPAR project. This equipment should be considered with reference to the latest catalogue of reclaimed light current spares to ascertain if in case of potential defects or failure in the future, the items concerned can be managed by either:

- Replacement with an identical item held as a spare
- Replacement with an equivalent item which is held as a spare and can be utilised
- Effecting a repair with a similar item or parts held as a spares
- Installation of a modern equivalent like-for-like replacement available either from stores or from a supplier (this includes actions to obtain items to hold in the stores together with application guidance where required).

Based on current equipment holdings and usage it is expected that the majority of retained items can be managed in this manner with existing stocks.

Where items are identified as unavailable, either the SPAR project shall put actions in place to provide a solution in acceptable timescales or full replacement should be undertaken using a NICAP standard bay solution.

2.3 Reclaimed Light Current Spare Requirements

While it is considered that the majority of retained items can be managed by the options listed in section 2.2 above, it is important to ensure stock levels are maintained and the required expertise to repair and maintain the equipment is available (currently this is undertaken by ETO Field Support in conjunction with Asset Integrity).

Current stock usage of ancillary relays and equipment is low. However, as SPAR projects require ancillary equipment to be retained for a further 20 years, in accordance with TP112, all light current equipment being removed from the network shall be listed by the project undertaking its removal and a list identifying the same provided to the Reclaimed Light Current store. This list will enable identification of items that should be recovered and sent to the Reclaimed Light Current stores for retention when replacement works are undertaken i.e. all light current equipment becoming redundant from any project should be offered to the Reclaimed Light Current stores for retention as spares.

3 EXISTING PROTECTION APPLICATION ISSUES

Consideration shall be given to the existing protection installation and its compliance to the latest issue of Application and Protection Setting Policy PS(T) 010.

The intention of the SPAR strategy is for like-for-like replacement¹ of the existing feeder main protection relays, whilst at the same time enabling in the relay as many of the requirements of relevant current National Grid Technical Specifications as practicable. Where Technical Policy non-compliances arise which are not accounted for in this TGN, they should be duly considered, and a technical deviation agreed as required. Where a technical deviation cannot be agreed, replacement with a NICAP standard bay solution should be undertaken.

¹ Note: Unit protection based on the low impedance biased differential principle may be replaced with Type Registered unit protection based on the alpha plane principle – see Appendix B for further information.

3.1 Current Transformers in Transformer HV Bushings

TGN (E) 286 provides Technical Guidance and Technical Deviations to NGET Technical Specifications as Applied to Single Asset Replacement/Refurbishment/Recondition Investments. The guidance given in TGN (E) 286, Clause D3.3 regarding current transformers in transformer HV bushings is applicable:

“Clause 1.2 (t) of PS(T) 010 states that it is not permissible to use SGT turret CT’s for feeder protection purposes. This statement is intended for application to new build primary arrangements. For the feeder protection replacement it is permissible to re-use the existing transformer bushing CT, provided there are no known safety concerns on the associated transformer and bushings such as oil leakage etc. The CT connections will be relocated to a post type CT following projects that involve primary reconfiguration of the system (i.e. transformer replacement)”

For SPAR the feeder protection replacement it is always permissible to re-use the existing transformer bushing CT, provided there are no known safety concerns on the associated transformer and bushings such as oil leakage etc.

3.2 Both Feeder Main Protections based on a Unit Protection Principle or Both Feeder Main Protections based on a Non-Unit Protection Principle

In exceptional cases, feeder circuit protection comprising two unit protections or two non-unit protections may be encountered. In these cases to determine whether the new replacement relays should be a like for like replacement or whether the feeder bay protection should be changed to have one working on the unit protection principle and the other on the non-unit protection principle the assessment will consider the following:

- Technical risk
- Circuit criticality
- Resource/outage requirements
- Any required additional works
- Economic viability
- The certainty around the future requirement for the circuit.

It is not anticipated that double unit protections will require to be changed to a unit and non-unit protection.

SPAR which requires changing double non-unit feeder main protections to a unit and non-unit protection should nevertheless follow the basic principles of like for like replacement. The wiring modifications required in these cases are not anticipated to be significant as the interfaces to the unit protection relay should be reduced.

3.3 Short Two Ended Feeders with Unit and Non-unit Feeder Main Protections

There are a some short feeder circuits which are equipped with Unit and Non-Unit feeder main protections, but which do not comply with the requirements for PS(T) 010 clause 1.2.1 (c) with regard to the type of distance protection scheme to be applied when taking circuit length into consideration E.g. the existing Non-unit protection may be a plain distance scheme whereas based on the length of the circuit (greater than 4 km but less than 10 km) it should be a blocked distance scheme.

SPAR projects on such circuits should ensure that the new feeder main protections comply with the requirements of PS(T) 010. For the example given above, the plain distance protection scheme should be replaced with a blocked distance protection scheme.

3.4 Fault Recording

Existing fault recording facilities (standalone or integral to Integrated Monitoring facilities) will normally be retained, however the fault recording facility integral to each new feeder main protection relay will also be enabled.

Fault recording facilities integral to each main protection shall be configured for cross-triggering if there is an IEC 61850 link between the relays.

The new feeder protection relays shall have binary inputs configured to accept fault recorder triggers from any associated trip outputs from adjacent protections to the feeder bay (e.g. coupler, section or transformer) such that future transfer of inputs does not require modification to the relay configuration.

Where the existing fault recorder is replaced by fault recording facilities integral to each main protection, time synchronisation via a GPS signal shall be provided.

4 TYPE REGISTRATION REQUIREMENTS

Use of feeder main protection relays that are not already type registered as a tier; or which require updating of an existing type registration shall be subject to the National Grid type registration process (TP183) and shall successfully achieve appropriate Type Registration before entering service on the National Grid System.

Type Registration shall be for the full functionality of the relay such that the relay can be used for all credible scheme configurations and applications without the need for further type registration activity for future SPAR projects.

The Type Registration process comprises two phases.

The first phase requires the vendor/contractor to self-certify the relay for use on the National Grid system against the relevant clauses of applicable National Grid Technical Specifications, International Electrotechnical Commission (IEC) or other relevant specifications. To this end the vendor/contractor shall provide test evidence in the form of type test reports and calculations which demonstrate compliance with the relevant specifications. Compliance check sheets which confirm compliance/non-compliance with the individual clauses of the relevant Technical Specifications and Application and Protection Setting Policy document PS(T) 010 shall be provided.

The second phase requires that the vendor/contractor undertakes a type registration FAT to validate by means of functional testing that the relay meets the relevant requirements of PS(T)-010 and other National Grid Technical Specifications and Policies and is suitable for integration into existing TPS 5/33 or hardwired panels/cubicles.

The following type registration supporting documentation shall be provided:

- Self-Certification Statement
- Test evidence in the form of type test reports and calculations
- Non-compliance Statement for all applicable specifications
- Standard Application Diagrams
- General Arrangement Drawings

- Site Commissioning & Test Schedules (SCT)
- Setting Calculation Guidance Documents
- Generic Equipment Models (GEM)
- Functional Design Specifications (FDS)
- Relay Manuals
- Type Registration FAT test plan and test results

5 FEEDER MAIN PROTECTION FUNCTIONAL REQUIREMENTS

Informative: This section describes the functional requirements of the new replacement feeder main protection relays for use with selective protection asset replacement (SPAR) within TPS 5/33 and hard-wired feeder bay protection panels/cubicles.

The new replacement feeder main protection relays shall provide like-for-like functionality with regard to the existing feeder main protection (i.e. unit or non-unit protection) whilst retaining and reusing as much of the existing ancillary equipment as possible.

They shall comply with the requirements the Technical Specifications for “Hardware Platform” and “Environmental and Test Requirements for Electronic Equipment”, TS 3.24 04 and TS 3.24.15 respectively.

The functional and performance requirements for unit and non-unit protection shall be in accordance with TS 3.24.18 and TS 3.24.35 respectively.

The back-up overcurrent and earth fault protection functional and performance requirements shall be in accordance with TS 3.24.38.

Depending on the vintage of the TPS 5/33 and hardwired protection panels/cubicles, all bay level functional protection requirements of current National Grid Technical Specifications and policies may not have been provided in the existing feeder bay protection system.

The new feeder main protection relays however, shall have enabled within the relay all functional protection requirements specified in the relevant current National Grid technical specifications and policies. This is irrespective of whether or not a specific function is required for a particular application. Functions which are not required for a specific application shall be available but disabled.

5.1 Unit Protection IED

Feeder main protection working on a unit protection principle shall in addition to the differential main protection function have available the following additional functions:

- Differential Supervision Alarm (in accordance with Addendum No. 2 , Addition A1 of TS 3.24.18)
- Group Setting Change facility (*for non-unit (distance) protection settings when used as back-up protection in double unit applications*)
- CT Supervision – based on differential measurement
- Back-up earth fault
- Back-up overcurrent (*required where both main protections are based on a unit protection principle and no VT's are available for back-up distance*)

- Integral distance protection to be used for back-up protection when required. Zone 1 disabled, Zone 2, Zone 3, Zone 3 Offset, Switch-onto-Fault and Zone 2 Override
- Phase Unbalance alarm
- Stub bus protection (*required if feeder protection CTs are situated on line side of line disconnector – TS 3.24.7*)
- Direct Transfer Trip (DTT) Intertripping
- Permissive Intertripping
- Fault Recording
- GPS/IRIG B (*Time synchronisation for fault recording - where existing GPS connections exist on site*)

Unless advised otherwise the Unit protection shall operate in conventional telegram mode without the requirement for GPS synchronising.

5.2 Non-unit Protection IED

Feeder main protection working on a non-unit protection principle, shall in addition to the distance main protection function (Z1, Z2, Z3, Z3R, Z2 Override, blocked and permissive scheme options) have available the following additional functions:

- Switch on to Fault
- Group Setting Change facility (*to facilitate Zone 2 Override and Reverse Zone for busbar contingency plan*)
- VT Supervision
- Power Swing Blocking (*this function shall be available in the relay but unless specifically instructed otherwise shall be disabled*)
- Back-up earth fault
- Phase Unbalance alarm
- Stub bus protection (*required if feeder protection CTs are situated on line side of line disconnector – TS 3.24.7*)
- Direct Transfer Trip (DTT) Intertripping
- Fault Recording
- Fault Locator
- GPS/IRIG B (*Time synchronisation for fault recording - where existing GPS connections exist on site*)

6 BAY LEVEL INTEGRATION

The internal back-up protection in both main protections shall be interfaced into the existing back-up protection trip system and ancillary equipment.

Existing fault recording facilities (standalone or integral to Integrated Monitoring facilities) will normally be retained, however the fault recording facilities integral to each main protection will also be enabled. Analogue current and voltage (*where voltage inputs to the new replacement feeder main protections are already existing*) shall be recorded in addition to other existing relevant event information.

The existing intertrip relays/panels/tiers of protection will be retained but the integral intertrip functionalities of the new replacement feeder main protection relays will be utilised in place of any existing signalling equipment.

The communications interface of the main protection relays to the OPTTEL network shall be via C37.94 direct fibre.

The functional requirements and integration options for the first and second main feeder protections as detailed in TS 3.24.7 shall be complied with.

In particular, functions such as back-up overcurrent protection, back-up earth fault protection voltage transformer supervision and phase-unbalance alarm will be integrated into the new feeder main protection relays and the existing relays performing these functions will be removed.

Stub bus protection, where existing, shall be retained. In some instances stub protection will need to be added, in which case the function shall be provided in the new main protection relays. NG TA will clarify the requirement on an individual contract basis.

TS 3.24.7 - Appendix B "Acceptable Integration Options" has been modified to show the integration of Fault Recording in the Feeder Main Protections as detailed in TS 3.24.71 and is included as Table 1 below for convenience.