

Company Directive

STANDARD TECHNIQUE: SD11B/1

Requirements for Category B Load Management Schemes that utilise Full Pre-event Curtailment

Summary

This document specifies the requirements for Category B Load Management Schemes (LMSs) including the network design requirements. These schemes are designed to Curtail customer demand or generation in anticipation of Operational Secured Next Faults, operational switching/dispatch and credible changes in Load.

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Implementation Date: June 2023

Approved by



Carl Ketley-Lowe
Engineering Policy Manager

Date: 12th June 2023

Target Staff Group	Staff involved with the analysis, design, construction, maintenance, replacement, operation and control of National Grid Electricity Distribution's network
Impact of Change	Amber – The requirements for state estimation and load flow contingency analysis have been relaxed for less complex networks/schemes.
Planned Assurance checks	Six months after the issue of this document Engineering Policy will audit at least one Category B LMSs in each Licence Area to confirm compliance with this ST

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IMPLEMENTATION PLAN

Introduction

This document specifies the detailed requirements for Category B Load Management Schemes (LMSs). These schemes curtail Load (i.e. demand, generation or electrical energy storage) in the anticipation of Operational Secured Next Faults, operational switching / dispatch and credible changes in Load.

Main Changes

The document has been reformatted and restructured to reflect changes in POL: SD11. Two LMS scheme approaches have been specifically recognised, one utilising real time load flow analysis and another utilising pre-determined values/formula based on the network topology, to determine Curtailment requirements. Requirements for state estimation and load flow contingency analysis have been relaxed, to some extent, where networks are less complex.

Impact of Changes

Target Staff Group	Staff involved with the analysis, design, construction, maintenance, replacement, operation and control of National Grid Electricity Distribution's network
Impact of Change	Amber – The requirements for state estimation and load flow contingency analysis have been relaxed for less complex networks/schemes.

Implementation Actions

Managers shall ensure that staff involved in the design, installation, maintenance, operation and control of load management schemes are aware of and follow the requirements of this document. POL: SD11 requires all existing LMSs to be assessed and any deficiencies addressed.

[<SD11B/1 Presentation>](#)

Implementation Timetable

This document is implemented on issue for new and substantially modified Category B LMSs. LMSs commissioned prior to the issue of this document may be reassessed and/or upgraded to comply with this document with agreement of the Primary System Design Manager.

REVISION HISTORY

DOCUMENT REVISION & REVIEW TABLE		
Date	Comments	Author
June 2023	<ul style="list-style-type: none"> Documents has been re-structured and re-formatted to specifically include requirements for detection, calculation, instruction actuation and recording Requirements for connections to Other Authorised Distributors (including IDNOs) have been included Two LMS scheme approaches have been specifically recognised, one utilising real time load flow analysis and another utilising pre-determined values/formulae based on the network topology, to determine Curtailment requirements. Where the LMS is unable to automatically determine the required set points it shall initially apply curtailment using worst case configuration settings, issue a high priority alarm to Control via ADMS and after a time progress to fail safe mode Requirements for state estimation and load flow contingency analysis have been relaxed, to some extent, where networks are less complex. 	Andy Hood
October 2020	<ul style="list-style-type: none"> This is a new document but the requirements have been taken from the first issue of POL: SD11. The maximum 132kV voltage specified in Table 1 has been reduced from 132kV + 12% to 132kV +10%. References to overhead lines ratings have been updated to align with ST: SD8A. 	Andy Hood

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1.0 SCOPE

This document specifies the requirements for Category B Load Management Schemes. These schemes are designed to Curtail customer demand or generation in anticipation of Secured Outages, Operational Secured Next Faults, operational switching/dispatch and credible changes in Load in order to prevent overloads or unacceptable network voltages.

Category B LMSs utilise Active Network Management (ANM) systems which may either may be separate from NGED's Advanced Distribution Management System (ADMS) or embedded within it.

Category B LMSs may be used to Curtail customer load connected directly to NGED's network or connected to Other Authorised Distributor (OAD) networks. Where the customer is connected to an OAD network NGED will issue Curtailment instructions to, and receive relevant information from the OAD at the OAD Connection Point. The OAD will implement the requirements of this document within their network and with their customers.

Where any difficulty is encountered with the application of this policy, the author shall be notified, who will consider if a variation is appropriate.

2.0 DEFINITIONS

Name/Phase	Definition
Advanced Distribution Management System (ADMS)	A NGED system that provides Supervisory Control and Data Acquisition (SCADA), Distribution Management System (DMS) and Outage Management System (OMS) functionality.
Category B	A category of LMS that utilises full pre-event curtailment and that satisfies the prerequisites specified in ST: SD11B.
Category Z	A category of Load Management Scheme that does not satisfy the prerequisites associated with any other category of Load Management Scheme. <i>Definition taken from ST: SD11Z</i>
Controllable Load	Load that shall be Curtailed by a customer in accordance with the terms of the NGED/customer connection agreement or the NGED/OAD bilateral agreement.
Connection Point	An entry point or exit point of the distribution system to a customer or OAD where power flows into or out of the Distribution Network Operator's system under normal circumstances. <i>Definition derived from the Distribution Code</i>
Curtail, Curtailment, Curtailing	Any action taken by NGED to restrict the flow of electricity at the customer's Connection Point (including a Connection Point within an IDNO or OAD network) <i>Definition derived from POL: FD3</i>
Customer Security	The requirement for Demand Security and Generation Security. <i>Definition taken from POL: SD11</i>

Name/Phase	Definition
Demand Security	<p>The ability to meet customer demand under Intact Network and outage conditions.</p> <p><i>Definition taken from POL: SD11</i></p>
Generation Security	<p>The ability to accept customer export under Intact Network and outage conditions.</p> <p><i>Definition taken from POL: SD11</i></p>
Independent Distribution Network Operator (IDNO)	<p>A DNO that does not have a distribution services obligation area in its distribution licence and is not an ex public electricity supplier</p> <p><i>Definition taken from the Distribution Code</i></p>
Intact Network	<p>A network operating with open points in their normal position and without any outages that are material to the condition being considered or studied.</p> <p><i>Definition taken from POL: SD11</i></p>
Load	<p>The apparent power (e.g. kVA or MVA) associated with demand, generation and/or electrical energy storage.</p> <p><i>Definition taken from POL: SD11</i></p>
Load Management Scheme (LMS)	<p>Plant, equipment and software systems that together manage network loading and voltages by either controlling demand and/or generation connected to the network, operating switchgear to change the topology of the network and/or controlling the settings of tap-change controllers, reactive compensation equipment and flexible power links. Examples of Load Management Schemes include but are not limited to:</p> <ul style="list-style-type: none"> • Operational Intertripping • Active Network Management (ANM) • Soft-intertripping • Overload protection • Auto-changeover • Voltage constraint systems • Remote control of switchgear or other plant and equipment <p>The following are not considered to be Load Management Schemes:</p> <ul style="list-style-type: none"> • Customer-owned limitation schemes • Conventional independent tap-change control schemes • Network protection for fault clearance

Name/Phase	Definition
	<ul style="list-style-type: none"> • Loss-of-mains protection, including loss-of-mains intertripping • Timed connections <p><i>Definition taken from POL: SD11</i></p>
Network Integrity	<p>The ability of a network to operate within thermal, voltage and other technical limits, excluding frequency-related limits, under both Intact Network and outage conditions.</p> <p><i>Definition taken from POL: SD11</i></p>
Operational Secured Next Fault	<p>A fault outage after which Customer Security, Network Integrity and System Frequency Integrity requirements must be satisfied when operating the network. The following fault conditions starting from the prevailing running arrangement are applicable:</p> <ul style="list-style-type: none"> • Each Circuit fault • Each busbar fault <p>Outages at all voltage levels in question shall be considered, including outages on the transmission system and other third party networks, where applicable.</p> <p><i>Definition taken from POL: SD11</i></p>
Other Authorised Distributor (OAD)	<p>A user of NGED's distribution system authorised by licence or exemption to distribute electricity and having a user distribution system connected to NGED's distribution system.</p> <p><i>Definition taken from POL: SD11</i></p> <p><i>Note, an IDNO is a type of OAD</i></p>
Secured Outage	<p>An outage or combination of outages after which Customer Security, Network Integrity and System Frequency Integrity requirements must be satisfied in design studies.</p> <p><i>Further guidance on this definition is provided in POL: SD11.</i></p>
System Frequency Integrity	<p>The ability of the GB system to operate within acceptable frequency-related technical limits under both Intact Network and outage conditions.</p> <p>System Frequency Integrity is primarily managed by NGESO, but it can be affected by the operation of NGED's network and customers. This includes but is not limited to:</p> <ul style="list-style-type: none"> • Low Frequency Demand Disconnection • Interface Protection associated with Power Generating Modules • Changes in net Load caused by protection operation, manual intervention or the operation of Load Management Schemes. <p><i>Definition taken from POL: SD11</i></p>

3.0 REQUIREMENTS

3.1 Scheme Description

3.1.1 Basic Functionality

3.1.1.1 Category B LMSs shall use Active Network Management systems to:

- Monitor the network
- Determine when Curtailment is required in order to prevent overloads or unacceptable network voltages in anticipation of Secured Outages, Operational Secured Next Faults, operational switching / dispatch, and credible changes in Load
- Implement the required Curtailment
- Check that the Curtailment is sufficient

3.1.2 Operating Modes

3.1.2.1 Category B LMSs include a number of modes of operation, including:

- ANM mode, which enables the Category B LMS and allows it to automatically issue set points to customers and OADs.
- SCADA (Supervisory Control and Data Acquisition) mode, which allows Control to manually issue set points to customer and OADs
- Hold mode, which applies set points that prevent customers/OADs from increasing their Load from their current (i.e. existing) level.
- Fail-safe mode, which applies pre-determined customer/OAD set points that are deemed to satisfy Network Integrity requirements.

3.1.2.2 Modes may be set/initiated independently at each customer/OAD site, i.e. via each Connection Control Panel. All operating modes are manually selectable by Control via ADMS. Hold mode and fail-safe mode may be initiated automatically, for example following equipment or communication link failures.

3.1.3 Planned Outages

3.1.3.1 Curtailment may be required before operational switching or dispatch is carried out that affect an LMS. Examples include:

- Where an interconnected circuit is to be fed from a single end (i.e. a circuit breaker is to be opened)
- Load transfers are to be carried out (e.g. on lower voltage networks)
- Telephone or email dispatch of customer's or other Network Operator's load.

3.1.3.2 The means by which curtailment is carried out in advance of operational switching and dispatch should be determined as part of the scheme design. Options include:

- Integration with PowerOn switching schedules so that the scheme is automatically informed of imminent switching actions
- A user interface is provided for control engineers to manually inform the LMS of imminent switching actions
- Control engineers manually curtail demand or generation to prevent potential overload or voltage issues in anticipation of further operational switching and dispatch.

3.1.4 Other Authorised Distributor (OAD) Networks

3.1.4.1 Where Curtailment is required from customers connected to an OAD network, the OAD is required to install their own LMS that i) passes on NGED's Curtailment instructions to their customer and ii) provides confirmation signals back to NGED. OAD curtailment systems used to implement a NGED Category B LMS shall be designed, installed and maintained to satisfy the requirements of this document.

3.1.4.2 Further details/requirements are provided in the following sections.

3.2 **Security and Integrity**

LMSs shall be designed and implemented to satisfy the requirements of POL: SD2, POL: SD3, POL: SD4, POL: SD5 and POL: SD11 as applicable. These documents include high level requirements for:

- Customer Security
- Network Integrity
- System Frequency Integrity
- Failure Mitigation
- Scheme Interaction
- Thermal Ratings

3.3 **Principles of Operation**

Every Category B LMS shall address/perform each of the following basic functions:

- Detection
- Calculation
- Instruction
- Actuation
- Recording

3.3.1 Detection

3.3.1.1 Category B LMSs shall use one or more of the following input types to determine when Curtailment is required:

- Breaker status (e.g. open, closed etc.)
- Isolator status
- Current measurements
- Voltage measurements
- Directional power flow measurements
- Weather measurements/forecasts
- Load forecasts

3.3.1.2 In addition, knowledge of the customer's load characteristics (e.g. ramp rates, profiles etc.) may be used to influence the Curtailment.

3.3.1.3 Depending on the complexity of the network and the LMS it may be necessary to use state estimation to determine/verify network derived statuses and measurements.

3.3.2 Calculation

3.3.2.1 The calculation engine may utilise real time load flow analysis or, for less complex networks, pre-determined values/formula based on network topology, to determine the Curtailment requirements.

3.3.2.2 Whichever method is used the LMS shall, in real time, determine the curtailment necessary to prevent overloads and unacceptable voltage conditions for:

- The prevailing Load assessed against the current network running arrangement. In the case of overhead lines the Sustained Load Pre-fault ratings are used for this assessment.^[1]
- The prevailing Load assessed against all Operational Secured Next Faults. For overhead lines the post-fault ratings are used for this condition.^[1]
- The Load following credible changes in Load assessed against the current network running arrangement. For overhead lines Variable Load Pre-Fault ratings apply, unless the line has been assigned the Sustained-Load Pre-Fault rating.^[1]

Note [1], POL: SD11 and ST: SD8A provide further guidance on thermal ratings.

3.3.2.3 The scheme shall apply curtailment that meets the requirements of all of the calculated states within five minutes of a change in:

- The prevailing Load
- The current network running arrangement

3.3.2.4 Once the proposed curtailment has been applied the scheme shall check that this is sufficient to prevent overloads and unacceptable voltages under the conditions described above. The system used to carry out these checks may require state estimation and load-flow contingency analysis functionality, depending on the complexity of the network. Where required, the LMS initiate further Curtailment.

3.3.2.5 Where the LMS is unable to determine the required set points, for example, where the real time load flow analysis fails or where the network topology is not anticipated the LMS shall:

- Initially apply curtailment using the highest sensitivity factors with the lowest pre-event limits and issue a high priority alarm to Control.
- After an appropriate time delay^[2] progress to fail safe mode.

Note [2], This time delay should take account of operational switching timescales and also consider impact of the resulting Load changes on System Frequency Integrity.

3.3.2.6 Where the LMS does not automatically anticipate operational switching and dispatch Control may utilise SCADA mode to apply manual set points to customer/OAD connections in advance.

3.3.3 Instruction

3.3.3.1 NGED shall install one or more Connection Control Panels (CCPs) and associated interface panels at the required customer and/or OAD Connection Points. These instruct the customer or OAD, as applicable, to initiate Curtailment. Each CCP uses up to 4 analogue outputs (e.g. 4 to 20mA DC outputs) to specify maximum and minimum levels of active power and reactive power. In addition each CCP provides two binary outputs (normally open contacts) to provide Stage 1 Operate and Stage 2 Operate Curtailment instructions.

3.3.3.2 The Stage 1 Curtailment instruction is initiated where the customer does not respond to the analogue signals within the proscribed time. The Stage 2 Curtailment instruction, which is normally configured to trip the customers controllable load, is initiated where the customer does not respond to the Stage 1 instruction.

3.3.3.3 The connection agreement / bilateral agreement shall include clauses that require customer/OAD to interface with and respond to NGED's analogue signals and Stage 1 Operate and Stage 2 Operate binary outputs.

3.3.4 Actuation

3.3.4.1 The customer/OAD shall respond to NGED's analogue outputs, ensuring the Load at the Connection Point adheres to the NGED's requirements within the agreed response time. For customer schemes a maximum response time of either 10s or 30s is typically agreed depending on the nature of the customer's Load. Longer response times may be required at OAD connections to accommodate the operating time of the OAD's LMS system.

3.3.4.2 When a customer or OAD receives a Stage 1 Operate signal from a NGED's CCP they shall immediately respond to this signal taking steps to reduce the customer's Controllable Load in order to satisfy the pre-determined (and agreed) level of active power at the Connection Point. The customer or OAD, as applicable shall also send a Stage 1 Operated confirmation to NGED using a normally open binary contact. The response time from receiving the Stage 1 Operate signal to completing the Curtailment and sending the confirmation signal shall be stated in the connection agreement / bilateral agreement. For customer connections a maximum response time of either 10s or 30s is typically agreed, depending on the nature of the Controllable Load. For OAD connections a longer response time may be required to cater for the operating time of the OAD's LMS.

3.3.4.3 When a customer or OAD receives a Stage 2 Operate signal from a NGED's CCP they shall immediately trip the customer's Controllable Load. The customer or OAD, as applicable shall also send a Stage 2 Operated confirmation to NGED using a normally open binary contact. The response time from receiving the Stage 2 Operate signal to completing the Curtailment and sending the confirmation signal shall be stated in the connection agreement / bilateral agreement. For customer connections a maximum response time of 1s is typically agreed. For OAD connections a longer response time will be required to cater for the operating time of the OAD's LMS.

3.3.5 Recording

3.3.5.1 ANM schemes and their CCPs shall report their statuses, alarms, analogue set points and measured analogues to ADMS. In addition, the reason for the LMS triggering curtailment should be identified. This information shall be recorded within NGED's Data and Digitalisation systems.

3.4 **Additional Considerations**

The following aspects must also be considered and addressed when designing the network and offering a Category B LMS:

- Connection agreements and bilateral agreements
- Provision of ADMS functionality
- Components
- Communication paths
- Prevention of over-commitment of networks
- Ensuring sufficiency of the LMS

3.4.1 Connection Agreements and Bilateral Agreements

3.4.1.1 NGED shall agree their Curtailment requirements with their customers and with OADs, as applicable. Details shall be included within customer connection agreements and OAD bilateral agreements. It is the OAD's responsibility to agree the relevant requirements with their customers.

3.4.2 Components

3.4.2.1 Customer and OAD components/equipment, including their communication systems are the responsibility of the Customer and OAD, respectively.

3.4.2.2 It is recommended that these Customer/OAD systems utilise protection class equipment suitable for use in the environment it is installed (typically a substation environment). These systems, including the associated communication systems shall be designed, as far as possible, to be fail-safe, i.e. to automatically Curtail the Controllable Load where a failure occurs.

3.4.2.3 NGED CCPs and customer interface boxes shall comply with EE SPEC: 143, and satisfy the TP18 series of company directives.

3.4.3 Provision of ADMS Functionality

3.4.3.1 Category B LMS (i.e. ANM system) functionality, Connection Control Panel functionality and, where applicable, additional measurements points need to be included within NGEDs ADMS system to provide visibility and control to NGED's Control Engineers. The relevant PSD Engineer shall discuss and agree the requirements with Control at least 6 weeks before the ANM scheme and/or CCPs etc. are commissioned. This allows sufficient time for the ADMS system to be updated.

3.4.3.2 The following email addresses should be used for this purpose:

- nged.controlsqc@nationalgrid.co.uk – for South West and South Wales
- nged.midlandssqc@nationalgrid.co.uk – For East Midlands and East Midlands

3.4.4 Communication Paths

3.4.4.1 NGED Communication paths shall be designed to have an availability of 99.9% or higher. Options for these paths include:

- Fibre optic cable
- Microwave link
- Pilot cable
- UHF/VHF licensed radio
- BT EAD (Ethernet Access Direct) or other equivalent 3rd party service, where the previous options are not reasonable practicable
- Satellite communication

3.4.4.2 Where protection class communication links are used these shall comply with POL: TP20.

3.4.4.3 It is recommended that OAD communication systems use the same approach.

3.4.4.4 THE NGED Telecoms Enquiry form should be used for all telecommunications enquiries and requests. This is available from the NGED Telecommunications intranet page, which is available from [here](#).

3.4.5 Failure Mitigation

3.4.5.1 Detectable NGED LMS failures including, but not limited to, communication failure alarms, ANM alarms, CCP alarms, battery system alarms etc. shall be presented to Control as high priority alarms.

3.4.5.2 In addition, at least one of the following measures shall be used to mitigate scheme failure:

- Ramped or delayed 'fail-safe' Curtailment in the event of a detectable scheme failure. See also section 3.3.2.5
- Backup overload protection satisfying the requirements of ST: SD11D
- Full duplication of the LMS

3.4.5.3 When mitigation measures are selected the wider System Frequency Integrity risks, for example, widespread tripping due to communication network failures and cascade tripping due to overload, shall be considered and controlled. Further guidance is included in POL: SD11.

3.4.6 Preventing Over-commitment of Networks

3.4.6.1 Under intact network conditions, neglecting the behaviour of the LMS and its failure-mitigation measures:

- The maximum load on any overhead circuit shall not exceed 110% of its normally assigned Pre-Fault rating (ST: SD8A refers)
- The maximum load on any item of plant or equipment, excluding overhead lines, shall not exceed 125% of its rating
- The voltage on the network shall remain within the limits given in Table 1

Network Nominal Voltage	Maximum Voltage	Minimum Voltage
132kV	Nominal + 10%	Nominal -12%
All other voltages	Nominal + 10%	Nominal -10%

Table 1: Voltage Limits When Assessing a Network Under Intact Conditions with Category B LMS Disabled

3.4.7 Ensuring Sufficiency of the LMS

3.4.7.1 When the network is modelled with the LMS enabled, for Intact Network conditions and for Secured Outage conditions no overloads and no unacceptable network voltages shall occur.

3.5 **Scheme Records**

LMS scheme records shall include:

- A description of the scheme operation including:
 - Details of the version of ST:SD11B that the scheme complies with (e.g. ST:SD11B Issue 0 or Issue 1)

- Whether the scheme uses real time load flow analysis or pre-calculated scenarios to determine the curtailment requirements
- CCP firmware reference
- CROWN asset records
- Drawings and diagrams
- Test records
- Settings

These records and settings shall be produced and recorded in accordance with POL:TP10.

A copy of the scheme description and settings shall also be sent to Control using the email addresses, provided above.

3.6 **Design Assessment**

As part of the network design process all Category B LMSs shall be assessed to ensure they satisfy the requirements of POL: SD11 and this Standard Technique. The results of this assessment shall be recorded by the Primary System Design Engineer or Planner responsible for the LMS design and kept with the associated scheme records, in accordance with POL: TP10.

Where significant changes are made to a LMS, the network or to associated customer or OAD connections the scheme records and the design assessment shall be reviewed and updated.

A Type B Assessment Form is available via the following link:

[Assessment Information Link](#)

APPENDIX A: SUPERSEDED DOCUMENTATION

This document supersedes ST: SD11B dated October 2020 which has now been withdrawn.

APPENDIX B: RECORD OF COMMENT DURING CONSULTATION

[ST: SD11B/1 – Comments](#)

APPENDIX C: ANCILLARY DOCUMENTATION

POL: FD3 Managing processes for Curtailable and Flexible Connections

POL: SD2 132kV Network System Design

POL: SD3 66kV and 33kV Network System Design

POL: SD4 11kV and 6.6kV Network System Design

POL: SD5 LV Network Design

POL: SD11 Requirements for Load Management Schemes

POL: TP10 Protection, Alarm, Control Scheme and Load management Scheme Records

EE SPEC: 98 Approved Protection, Voltage Control and Alarm Relays and Test Access Blocks

EE SPEC: 136 Ancillary Electrical Equipment for Use in Conjunction with Switchgear and Protection/Control Panels

EE SPEC: 147 Functional Specification for Western Power distribution's Connection Control Panels (CCPs)

ST: SD11D Requirements for Type D Load Management Schemes - Overload Protection

ST: SD11Z Requirements for Type Z Load Management Schemes that do not comply with the prerequisites for other Load Management Scheme categories

ST: TP10E Requesting, Issuing and Recording Settings for Connection Control Panels

ST:TP18A Application of Connection Control Panels for Soft Intertrip and/or Voltage Constraint Schemes

POL: TP20 Protection Class Communication Links

APPENDIX D: KEYWORDS

ANM, Category A, Category B, Category D, Category Z, design, intertrip, soft intertrip, Load Management Scheme, network, system, planning, network analysis