NORTHERN IRELAND ELECTRICITY plc
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CONNECTION OF GENERATING STATIONS DOCUMENT (PLM-SP-1 SEPT 1975)

1. General Use

Document PLM-SP-1 is a guide to the planning of connection of generating stations to the NIE System, each scheme being individually assessed by NIE in the light of economic and technical factors obtaining.

2. Particular Modifications in Respect of Generating Station Busbar Arrangements

Sufficient busbar sections shall be provided at any generating station such that it is possible with maintenance outage of one bus-section and all generating sets available to connect no more generation than twice the rating of the largest generating unit on the system to any one section of busbar.

This is a reduction to the Standard given in PLM-SP-1 in respect of busbar faults and is due to economic considerations.

3. Particular Modification in Respect of Number and Capacity of Circuits Connecting Generating Stations to the NIE System

Stations with a sent out capacity in excess of 550MW will normally be connected via at least four circuits. The configuration and line rating shall be decided on by NIE following the completion of rigorous system load flow security studies considering outage of any two circuits.

This enhancement of the Standard given in PLM-SP-1 is due to the NIE Transmission System being relatively small so that all generator connection points in fact become an integral part of the system. Consequently account must be taken of the through flow of power obtaining.

Central Electricity Generating Board

Planning Department

PLANNING MEMORANDUM PLM—SP—1

PLANNING STANDARD OF SECURITY FOR THE CONNECTION OF GENERATING STATIONS TO THE SYSTEM

Issue 1 September 1975

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PLANNING STANDARD OF SECURITY FOR THE CONNECTION OF GENERATING STATIONS TO THE SYSTEM

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Issuing Branch: System Planning

Approved by:

Director of Planning

PLANNING STANDARD OF SECURITY FOR THE CONNECTION OF GENERATING STATIONS TO THE SYSTEM

FOREWORD

This Memorandum is provided for the guidance of CEGB staff involved in the planning and design of connections between generating stations and the system. It sets out the present planning standards for the security of the connections between generating stations and the transmission system. The standards are not to be applied retrospectively.

The standards are largely empirical, being based on past experience and have not been the subject of a quantitative risk/economic worth assessment. It is envisaged that the standard may be modified as a result of future work in this area.

Any variation from the recommended standard must be the subject of technical and economic appraisal.

This Memorandum should be applied in conjunction with:

(i) CEGB Operation Memorandum No. 3, 'Operational Standards of Security of Supply'.
(ii) Electricity Council Engineering Recommendation P.2/4, 'Security of Supply'.

1. SCOPE

This Memorandum recommends the connection security requirements at the planning stage for individual generating stations connected to the 400, 275, 132 kV and lower voltage systems. It also defines credible transmission outages in relation to station size.

2. OBJECTIVES

2.1 The CEGB system shall be planned so that it may continue to operate satisfactorily with a maximum instantaneous loss of the two largest generators on the system. The transmission connections to a generating station shall be planned to minimize the effect of a sustained loss of that order. To meet these requirements, it is necessary to ensure that with maintenance and fault outages:

2.1.1 It shall be possible to operate a generating station, whose maximum output does not exceed the two largest sets on the system, at maximum output during a prolonged outage of one of the connecting circuits. For larger stations, it shall be possible to operate at maximum output with a prolonged outage of two of the connecting circuits.

2.1.2 No single fault (other than a bus section or bus coupler circuit-breaker fault) shall cause the instantaneous loss of generation greater than the sent out capacity of the largest authorized generator, boiler or nuclear reactor on the system.

2.1.3 No bus section or bus coupler circuit-breaker fault, double circuit fault on an overhead line or two simultaneous circuit faults shall cause the instantaneous loss of generation greater than the sent out capacity of the two largest authorized generators, boilers or nuclear reactors on the system.

2.1.4 System frequency and voltage shall be maintained within statutory and equipment design limits under normal and credible outage conditions.

2.1.5 The generators shall remain stable following credible faults under normal conditions and credible outage conditions at all times when the generators are running in accordance with the planned operating regime of the station.

3. STANDARD FOR THE DESIGN OF GENERATING STATION CONNECTIONS

The following paragraphs define the standard to be used in determining the number, rating and disposition of the connecting circuits to achieve the recommended standard of connection.

It is permissible to provide more or less than the recommended standard of connection but ANY variation from the recommended standard must be the subject of technical and economic appraisal.

Examples of cases where such appraisals would be appropriate could be:

(i) Where additional transmission is needed to prevent restriction of generation or operation out of merit at off-peak times, or
(ii) Where a lower standard of connection imposes only a small risk of restricting generation.

The order in which the following criteria are listed has no special significance: all criteria must be taken into account when planning the transmission connections for a generating station.

3.1 Largest Authorized Generating Unit

The sent out capacity of the largest authorized generator, boiler or nuclear reactor, referred to in objectives 2.1, 2.1.1 and 2.1.2 is assumed to be 660 MW. Accordingly, all references to maximum generation are expressed in multiples of 660 MW.

If the size of the largest generating unit is increased, unless an amendment to this Memorandum is issued to the contrary, then maximum generation figures should be deemed to be re-cast in multiples of the size of the new unit.

3.2 Number and Rating of Circuits

3.2.1 The maximum output capacity on column 1 must be connected by at least the number of circuits in column 2 and must be capable of being transmitted with the credible outages stated in column 3.

(1) Maximum Output Plant Connected MW	(2) Minimum Number of Circuits Required	(3) Credible Outage Contingency
Up to 1320	2	Any one circuit
Above 1320	3	Any two circuits

The voltages of the connecting circuits are not significant provided that the requirements of number and rating are met.

3.2.2 The seasonal circuit ratings to be assumed will depend on the load factor of the generating stations as follows:

Annual Load Factor		Circuit Rating (Weather Conditions Appropriate to Overhead Line Circuits)
High	above 65%	Normal
Medium	20–65%	Winter
Low	below 20%	Winter
Frequency Regulating Plant[1]		Normal

[1] Gas Turbines and Pumped Storage

3.2.3 The generator load factor assumed should be the planned load factor for the year under consideration. This means that the transmission connections provided for a new high load factor generating station may be considered excessive some years later when its load factor has dropped. Consequently, any system rearrangement undertaken at this later time would recognize the reduced requirement and, where possible, take advantage of it. Equally, a generating station whose load factor has increased might require reinforcement of transmission connections.

3.3 Switching Arrangements

3.3.1 The recommended switching arrangements are detailed below and the relevant reference documents are listed in 4. 'References'. They are subject to the overriding proviso that where CEGB circuits are routed across land not owned by the Supply Industry, circuit-breaker switching facilities must be provided at both ends of the circuit.

3.4 Supergrid Connected Generators

3.4.1 The preferred busbar switching arrangements for the connection of generators at 400 and 275 kV are laid down in Design Memorandum 099/55 (TDM 13/6), 'Supergrid Switching Facilities', which is presently under review. These arrangements are appropriate to high load factor plant which should be connected to busbars in a switching station located within 5 km of the generating station.

3.4.2 Medium, low load factor and regulatory plant may be bussed at a remote substation subject to the circuit requirements of 3.2.1, and provided that:

(i) The circuit length does not exceed 20 km.

(ii) A circuit-breaker is provided on the HV or LV side of the generator transformer to clear the generator infeed for a fault on the circuit connected to the remote busbar.

Note: The distances 5 km and 20 km referred to above are empirical and are based on experience.

3.5 Generators Connected at 132 kV and Lower Voltages

3.5.1 As with supergrid generators, connection to a local busbar is preferred for high load factor plant while medium/low load factor plant may be bussed at remote substations if this proves more economic.

3.5.2 The switching arrangements preferred for 132 kV connected generating stations are described in Design Memorandum 099/55.

3.6 Circuit Complexity

All outlet circuits from generating stations should comply with CEGB Standard 9943/2 (TPS 13/1), 'Complexity of CEGB Transmission Circuits' at all voltage levels.

3.7 Generator Stability and Voltage

It may be necessary to consider supplementing the standard circuitry and switching arrangements if, under normal or credible transmission outage conditions, the generators are subject to instability or the voltage (or its step change) lies outside the planning limits. Planning criteria for generator stability and voltage control are given in PLM–ST–4 and Design Memorandum 099/32 (TDM 13/9).

4. REFERENCES

This Memorandum makes reference to the following documents:

Electricity Council Engineering Recommendation P.2/4, 'Security of Supply'.
Electricity Council Engineering Recommendation P.14, 'Preferred Switchgear Ratings'.
ESI Standard 41–3, 'Switchgear Current Ratings at Reduced Ambient Temperatures (Excluding Fuses)'.
CEGB Standard 99312 (TPS 1/96), 'Current Ratings for 175 mm^2 and 400 mm^2 Aluminium Conductors – Steel – Reinforced (ACSR)'.
CEGB Standard 9943/2 (TPS 13/1), 'Complexity of CEGB Transmission Circuits'.
CEGB Design Memorandum 099/32 (TDM 13/9), 'Criteria for System Voltage Control and Reactive Compensation Studies'.
CEGB Design Memorandum 099/55 (TDM 13/6), 'Supergrid Switching Facilities'.
CEGB Operation Memorandum No. 3, 'Operational Standards of Security of Supply'.
CEGB Planning Memorandum PLM–ST–4, 'CEGB Criteria for System Transient Stability Studies (Supergrid System)'.

5. DEFINITIONS

For the purposes of this document the following definitions shall apply:

Circuit – The part of an electricity supply system between two or more circuit-breakers. It may include transformers, reactors, cables, overhead lines, series capacitors, or quadrature boosters excluding busbars.

Busbar – The common connection point of two or more transmission circuits.

System – The system for the purpose of this Memorandum, is the switching station in the interconnected network at the receiving end of the transmission connections from the generating station busbar. Hence, transformer feeder connections from a generating station busbar to an isolated local network are not considered to be part of the connections from the station to the system.

Credible Transmission Outage (Fault) – That single or multiple transmission circuit or busbar outage (fault) combination which the system is planned to withstand and against which contingency transmission equipment shall be installed.

Maximum Output – The generating station's maximum output is the maximum station sent out capacity as given in the annual O.R.1 returns or current development plan.

Circuit Ratings

(i) **Circuit-breakers** – Continuous rating (see Engineering Recommendation P14 and ESI Standard 41–3).

(ii) **Transformers** – The appropriate cyclic rating based on a 24 hour load cycle.

(iii) **Underground Cables** – The cyclic rating based on a 24 hour load cycle.

(iv) **Overhead Lines** – Continuous rating (see CEGB Standard 99312 (TPS 1/96)).

CIRCULATION LIST FOR PLANNING MEMORANDUM PLM–SP–1

Regions

All Directors-General (1)
Director of Transmission – N.W., Midlands, S.W. Regions (6 each)
Director of Resource Planning – S.E. Region (6)
System Operation and Development Engineer – N.E. Region (6)

TDCD

Director of Design – (2)
Director of Construction – (2)

Operations Department HQ

Director of Operations (1)
System Operation Engineer (12)

Planning Department HQ

Director of Planning (1)
Generation & Transmission Development Engineer (12)
Generation Studies Engineer (2)
Resources Planning Engineer (2)
System Technical Engineer (10)
System Planning Engineer (12)