The Electrical Standards for SHE Transmission's area are non-maintained versions of National Grid Technical Specifications that are applicable to the SHE Transmission System only. These specific versions are not subject to National Grid change control and all queries about their applicability and content should be directed to SHE Transmission in the first instance. (Should Users require the change controlled versions of the GB Transmission System National Grid Technical Specifications please see the National Grid Extranet or Livelink system where applicable).

Master Art work

National Grid

National Grid Technical Specifications have been issued as listed below

Number	Title	Issue No	Date
NGTS 2.6	Protection	2	June 1994
NGTS 3.6.1	Unit Feeder Main Protection	2	February 1995
NGTS 3.6.2	Protection for Auto-Transformers	2	February 1995
NGTS 3.6.3	Busbar Protection for 400 kV and 275 kV Double Busbar Switching Stations	3	December 1996
NGTS 3.6.4	Non-Unit Feeder Main Protection	2	February 1995
NGTS 3.6.5	Intertripping and Protection Signalling Systems	2	October 1995
NGTS 3.6.6	Protection for Static VAR Compensators	2	March 1996
NGTS 3.6.7	Backup Protection	2	January 1995
NGTS 3.6.8	Circuit Breaker Fail Protection	2	June 1995
NGTS 3.6.9	Cross Site Communication Links for Teleprotection	1	June 1997
NGTS 3.6.10	PLC Coupling Equipment	3	January 1995
NGTS 3.6.11	Communications for Teleprotection	2	April 1995
NGTS 3.6.12	Fault Recorders	2	March 1995
NGTS 3.6.13	Circuit-Breaker Trip Circuit Supervision Systems	1	December 1992
NGTS 3.6.14	Copperwork Protection	2	May 1995
NGTS 3.6.15	Trip Relays & Trip Relay Resetting	2	March 1996
NGTS 3.6.16	Protection for Double-Wound Transfomers	1	June 1995
NGTS 3.6.17	Protection for Quadrature Boosters	1	November 1994
NGTS 3.6.18	Protection for Shunt Reactors	1	February 1995
NGTS 3.6.19	Protection for Series Reactors	1	February 1995

10 July 1997

NGTS 3.6.20	Protection for Bus Sections and Bus Couplers	1	March 1995
NGTS 3.6.21	Protection for Mechanically Switched Capacitors	1	March 1996
NGTS 3.6.22	Protection for Transformer Tertiary or LV Connections to Static Compensation Equipment	1	June 1997
NGTS 3.6.23	Protection for 400 kV and 275 kV Mechanically Switched Capacitors	2	March 1997

National Grid
Technical
Specifications

NGTS 2.6
Protection

and associated
Level 3 Specifications

National Grid Technical Specifications

NGTS 2.6 Protection

and associated Level 3 Specifications

National Grid Technical Specifications

NGTS 2.6 Protection

RECORD OF REVISION

NGTS 2.6 PROTECTION

This issue (Issue 1) has been revised and amended as follows:

REV	DATE	DETAILS OF REVISION	AUTHORISATION
Issue 2	June 1994	Interim Update to 3.1.4, 3.2.4, 3.3 and 4.4	MBA Murphy

National Grid
Technical
Specification

NGTS 2.6
Issue 2
June 1994

Protection

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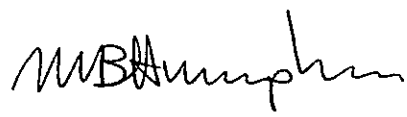

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CONTENTS

PROTECTION

FOREWORD

This Specification defines the requirements for protection systems and associated connections at the National Grid Company plc (NGC) owned substations. This Specification is part of a hierarchical structure of documentation comprising three levels of functional specifications. This document is a Level 2 Specification.

1 SCOPE

This Specification describes the overall functional and performance requirements for protection systems, outlines the common systems required, and the extent to which they should be applied to transmission plant and apparatus for typical substation configurations.

It applies to all the 400 and 275 kV transmission network which includes any transformer LV connections to the busbar at 132 kV or below.

Detailed requirements relating to the individual protection relays and systems are specified in the NGTS Level 3 documents.

2 REFERENCES

This Specification makes reference to, or should be read in conjunction with, the following documents.

2.1 IEC, CENELEC or BS Standards

Compliance is required with the following:

2.1.1 Design Standards

IEC 56 (1987)	High Voltage alternating-current circuit-breakers (BS 5311)
IEC 255-0-20	Contact Performance of Electrical Relays
IEC 255-1-00 (1975)	Electrical relays - all-or-nothing electrical relays.
IEC 255-6 (1988)	Electrical relays - measuring relays and protection equipment.
IEC 391 (1972)	Marking of insulated conductors.
BS 142	Specification for electrical protective relays.

2.1.2 Environmental Standards

IEC 68-2-1 (1974)	Basic environmental testing procedures-tests-cold.
IEC 68-2-2 (1974)	Basic environmental testing procedures-tests-dry heat.
IEC 68-2-3 (1969)	Basic environmental testing procedures-tests-damp heat, steady state.
IEC 529 (1976)	Classification of degrees of protection provided by enclosures.
IEC 255-21-1 (1988)	Electrical relays - vibration, shock, bump and seismic tests on measuring relays and protection equipment - vibration tests (sinusoidal).

IEC 255-21-2 (1988)	Electrical relays - vibration, shock, bump and seismic tests on measuring relays and protection equipment - shock and bump tests.
IEC 255-11 (1979)	Electrical relays - interruptions to and alternating component (ripple) in D.C. auxiliary energising quantity of measuring relays.
IEC 255-5 (1977)	Electrical relays - insulation tests for electrical relays.
IEC 255-7 (1978)	Electrical relays - test and measurement procedures for electromechanical all-or-nothing relays.
IEC 255-22-1 (1988)	Electrical relays - electrical disturbance tests for measuring relays and protection equipment - 1 MHz burst disturbance tests.
IEC 255-22-2 (1989)	Electrical relays - electrical disturbance tests for measuring relays and protection equipment - electrostatic discharge tests.
IEC 255-22-3 (1989)	Electrical relays - electrical disturbance tests for measuring relays and protection equipment - radiated electromagnetic field disturbance tests. (Technical Report).
IEC 255-22-4 (1992)	Electrical relays - electrical disturbance tests for measuring relays and protection equipment - fast transient disturbance test

2.2 NGC Level 1 Specification

All protection equipment must comply with the relevant parts of:

NGTS 1	Overview - National Grid System

2.3 List of Associated Level 2 Specifications

NGTS 2.1	Substations
NGTS 2.2	Switchgear for the National Grid System
NGTS 2.3	Transformers and Reactors for use on 132 kV, 275 kV and 400 kV Systems
NGTS 2.7	Sub-station Control Systems
NGTS 2.12	Auxiliary Supplies
NGTS 2.13	Electronic Equipment
NGTS 2.15	Automatic Switching Requirements

2.4 List of Associated Level 3 Specifications

NGTS 3.2.4	Current Transformers for Protection and General Use on the 132 kV, 275 kV and 400 kV Systems
NGTS 3.2.5	Voltage Transformers for use on the 132 kV, 275 kV and 400 kV Systems
NGTS 3.2.6	Current and Voltage Measurement Transformers for Settlement Metering of the 33 kV, 66 kV, 132 kV, 275 kV and 400 kV Systems
NGTS 3.2.8	Line Traps for use on 275 kV and 400 kV Systems
NGTS 3.6.1	Unit Feeder Main Protection

NGTS 3.6.2	Protection for Auto Transformers
NGTS 3.6.3	Busbar Protection for 400 kV and 275 kV Double Busbar Switching Stations
NGTS 3.6.4	Non Unit Protection for Feeders
NGTS 3.6.5	Intertripping and Protection Signalling Systems
NGTS 3.6.6	SVC and MSC Protection
NGTS 3.6.7	Back-up Protection
NGTS 3.6.8	Circuit-Breaker Fail Protection
NGTS 3.6.10	Power Line Carrier Coupling Equipment
NGTS 3.6.11	Communication Systems for Teleprotection
NGTS 3.6.12	Fault Recorders
NGTS 3.6.13	Circuit-Breaker Trip Circuit Supervision Systems
NGTS 3.6.14	Copperwork Protection
NGTS 3.6.15	Trip Relays and Trip Relay Resetting
NGTS 3.12.1	48 V D.C. Supplies
NGTS 3.12.2	110 V D.C. Supplies
NGTS 3.15.1	DAR and Plant Isolation

2.5 List of National Grid Transmission Plant Specifications

TPS 5/6	400, 275, 132, 66 and 33 kV Electromagnetic Wound Type Oil Filled Voltage Transformers, Alarm and Tripping Arrangements Applicable to Gas Detection Devices (GDDS)
TPS 5/33	Accommodation and Connection of Protection and Control Equipment in 19 inch Racks of Transmission Substations (Issue 1 July 1989)
TPS 12	Series diagrams are available from NGC as examples of approved ways in which protection relays can be interconnected

3 GENERAL REQUIREMENTS

3.1 General

3.1.1 Protection Philosophy

In order to achieve the necessary performance requirements at 400 and 275 kV, protection of the transmission systems shall follow the philosophy whereby no single failure of protection devices or systems shall permit a fault to remain connected to the primary system. In this context failure shall mean failure to operate, or failure to operate within a specified maximum operating time, or in a time whereby other protection, which should not normally have operated, has sufficient time to perform a correct back-up function.

In order to implement this philosophy, it is necessary to ensure that all faults are detected by at least two independent high speed devices or systems which have their output contacts selectively allocated to entirely independent tripping systems with separate D.C. supplies. In addition, these two devices or systems should preferably operate on different principles and be of different manufacture. Independent back-up and circuit-breaker fail protection shall also be provided.

At 132 kV, only a single independent high speed device is required unless otherwise specified by NGC, together with an independent back-up protection.

3.1.2 Protection Discrimination

When a system fault occurs, main protection equipment is required to detect the fault rapidly and initiate the opening of only those circuit-breakers which are necessary to disconnect the faulted Apparatus from the network. Protection equipment associated with adjacent Apparatus may detect the fault, but must be able to discriminate between an external fault and a fault occurring on the specific Apparatus which it is designed to protect.

3.1.3 Protection Sensitivity

Unless otherwise specified in the contract, the settings to be applied to individual types of protection and protection relays shall be specified by the Contractor and the calculations shall be submitted to NGC for approval. The settings for feeder protection shall be such as to permit correct operation of the protection for earth faults with up to 100 ohms impedance in the fault itself. Any limitation, such as the maximum permissible load current shall be declared by the Contractor.

NGC will provide specific system data on request from the Contractor.

3.1.4 Fault Current Interruption Time and Fault Clearance Time Requirements

The protection equipment shall be installed such that the total fault current interruption and fault clearance times are in accordance with the times specified in NGTS 1, para 4.4. The operating time between fault inception and initiation of tripping shall not be less than 10 ms as required by IEC 56 Test Duty 5 for circuit-breakers.

Details of operating times of protection shall be supplied to NGC by the Contractor. Any limitation in operating time performance shall be declared by the Contractor, for instance end of zone faults where distance protection is applied, high resistance faults, faults at high X/R with significant D.C. component and time constant, communication channel noise etc. The Contractor shall specify the increase in operating time which could occur under such conditions.

3.2 Functional Requirements

3.2.1 Feeder Main Protection

At 400 and 275 kV, two independent feeder protection systems shall be provided. Wherever practicable one of the two systems shall operate on a non unit principle eg distance protection. The other system shall ideally operate on a unit protection principle (preferably a current differential protection). The two protection systems shall avoid the use of common hardware or software to minimise the risk of common mode failure. Each system shall be operated from separate CTs. Where two distance schemes are employed, the VT secondary wiring shall be segregated.

The feeder main protections shall trip in a one-out of two tripping logic.

Each feeder protection system shall be provided with local in/out switching facilities. Where equipment or communications channel failure may cause the protection to be unstable then remote in/out switching shall also be provided.

Where blocked distance protection is employed it shall be possible to switch out the communication channel leaving the distance protection operating in the plain mode.

At least one main protection on a given feeder shall have the facility to pass a permissive or direct trip signal to the remote end via its associated communication link. If communication channels are provided for both the feeder protections then they shall employ different or separately routed media.

Failure of a communication channel shall preferably cause the associated protection to be secure from tripping for external faults. If the communication channel becomes degraded, reduced dependability is permissible provided that security is maintained (see 4.2). When the communication channel is degraded, a longer operating time will be accepted. The Contractor shall state such limitations as required under Clause 3.1.4.

Where appropriate NGC will provide details of planned or existing equipment(s) at the remote feeder end(s) and any associated communication media.

Each main protection system shall be provided with adequate test facilities to enable testing of the main protection relay both on and off load. Any signalling channel, associated with a non-unit protection, shall have a test/normal switch and a facility to send a test signal both on and off load. When selected to test, the associated protection shall be rendered secure from tripping for external faults other than in a back-up mode.

3.2.2 Feeder Back-up Protection

In the event of a failure of the main protection equipment, back-up protection is required. Under these conditions tripping of circuit-breakers may be delayed but shall be limited to the minimum time necessary to clear the fault.

An IDMT earth fault protection device independent of feeder main protection shall be provided at each circuit end. Where distance protection is provided as a feeder main protection, a measure of back-up protection for phase to phase faults, would normally be achieved by the time delayed Zone 2 and 3 elements. Where distance protection is not installed, however, a two or three pole IDMT overcurrent protection device shall be provided in addition to the earth fault IDMT protection device. (See NGTS 3.6.7 Back-up Protection).

3.2.3 Feeder Intertripping

For a plain 400 and 275 kV feeder, a single intertripping facility shall be provided. This shall operate via dedicated signalling equipment and not via a feeder main protection direct transfer trip facility.

Where transformers, reactors, capacitors or other plant are directly connected to a feeder, then completely duplicated intertripping facilities shall be provided. In this case they shall either operate via separate dedicated signalling equipment, or alternatively one or both may operate via the respective feeder main protection direct transfer trip facilities where available.

Where two intertripping systems are provided, they shall be of different type and employ different or diversely routed communication media.

Where appropriate, NGC will provide details of planned or existing equipment(s) at the remote feeder end(s) and any associated communication media.

Each intertripping system shall have a test/normal switch and a facility to send a test signal both on and off load.

3.2.4 Plant Protection

Plant protection includes the protection of all 400 and 275 kV main and auxiliary transformers, reactors, capacitors, and associated HV and LV connections etc. Where practicable, the electrical protection provided should meet the requirements as specified previously under Protection Philosophy Clause 3.1.1. Mechanical protection devices (eg gas operated relays and winding temperature devices) shall also be provided as specified in the appropriate NGTS documents. For example NGTS 2.3 Transformers.

Wound VTs and combined CT/VT units shall be provided with electronic or mechanical gas detection devices as specified in NGTS 3.2.5 and NGTS 3.2.6. These devices shall be connected to provide intertrip, alarm and/or DAR lockout facilities, according to NGC requirements for the particular installation and to ensure the VT is made dead automatically using local tripping and remote intertripping facilities where fitted or as a minimum to initiate an alarm to ensure remote manual disconnection within 5 minutes. For further details please refer to TPS 5/6.

3.2.5 Busbar Protection

At 400 and 275 kV, two independent, fully discriminative fault detecting systems operated from separate CTs shall be provided for each busbar zone being protected, both of which must operate in a 2 out of 2 logic before circuit-breaker tripping is initiated. One detecting system shall act as a Check System common to the whole substation, although at large substations multiple check zones may be required. The other detecting system shall act as a discriminating system dedicated to the particular busbar zone being protected.

Each fault detecting system shall itself have duplicated fault measuring elements, the outputs of which shall operate into separate D.C. tripping systems, to trip the associated circuit-breakers in a duplicated 2 out of 2 tripping logic, (ie 2 x (check + discrim)).

The resultant tripping logic shall be such that the failure of any one fault measuring element or its associated tripping system shall not result in a failure to initiate circuit-breaker tripping via the other tripping system. Conversely, circuit-breaker tripping shall be secure against false operation of any single detecting system.

NGC will normally specify the number of separate zones of protection to be provided.

Signalling to disconnect the remote infeed to a feeder short zone fault within the busbar zone, shall normally be achieved via the circuit-breaker fail protection. NGC may specify direct signalling from busbar protection in cases where the delay of circuit-breaker fail protection may cause system instability.

3.2.6 Circuit-breaker Fail Protection

Circuit-breaker Fail Protection shall be provided for all 400 and 275 kV circuit-breakers.

In the event of a circuit-breaker failing to trip following receipt of a trip command, Circuit-breaker Fail Protection shall trip all necessary contiguous circuit-breakers in order to isolate the faulty circuit-breaker.

Current check and timing facilities shall operate in a 2 out of 2 tripping logic to trip all adjacent circuit-breakers both locally, via the busbar protection tripping systems, and remotely via intertripping or protection signalling channels.

Circuit-breaker Fail Protection is not required at 132 kV, however an Interlocked Current Protection shall be provided on the Transformer 132 kV LV Circuit-breaker to cover the short zone fault if appropriate.

3.2.7 System Back-up Protection

Over reaching zones of distance protection shall provide a measure of system back-up protection. IDMT earth fault devices shall be provided for each Bus Section and Bus Coupler at busbar substations. In addition to feeder back-up protection (Section 3.2.2), additional back-up protection associated with the plant protection shall be provided as specified in the appropriate NGTS Level 3 document.

Bus Sections and Bus Couplers shall also be fitted with an instantaneous three phase overcurrent device for commissioning purposes, that can be selected into service when energising a new circuit via a Bus Section or Bus Coupler circuit-breaker.

3.2.8 Interconnectivity of Protection and Associated Equipment at Substations

Appendix B contains functional diagrams showing the extent to which protection systems are applied by NGC to transmission plant and apparatus for typical substation circuit configurations.

The interconnectivity between various protection systems is shown, together with the protection interfaces to external equipment and plant, such as switchgear, substation control, DAR, etc.

NOTE: The arrangements given in the functional diagrams are typical and only for guidance. The actual requirements may vary in detail according to the requirements of a particular circuit as specified under the contract with NGC.

Detailed examples of particular equipment interconnections that meet NGC's requirements contained within these functional diagrams, are given in NGC's TPS 12 series diagrams.

3.2.9 Fault Recorders

Each feeder end shall be provided with a fault recorder to provide printed records of three phase current, residual current, three phase voltage and protection relay event signals during system fault conditions. Fault recorder requirements are given in NGTS 3.6.12.

The Contractor shall also provide fault recording equipment, as necessary, to monitor the performance of other plant protection. Refer to relevant NGTS 3 series specifications.

The Contractor shall also offer a remote interrogation and analysis package so that fault recorders at the substation can be remotely interrogated and their records automatically transferred via a communications link to the local Transmission Area Office and other locations for subsequent analysis.

3.2.10 Alarms/Indications

The protection equipment shall provide alarm and indication outputs as detailed in the appropriate NGTS 3 series documents, to control and event logging systems as outlined in NGTS 2.7 Substation Control Systems.

3.2.11 Auto-Reclose

Delayed 3 pole auto reclose (DAR) shall be provided to operate for line faults on all overhead line feeders, or mixed overhead line and cable feeders unless otherwise specified by NGC.

DAR shall be initiated from both feeder main protections and intertripping systems.

DAR shall be locked out following operation of busbar protection, circuit-breaker fail protection, plant protection (when plant is connected to the line) Zones 2 or 3 of distance protection and for persistent receipt of an intertrip signal.

For full details of DAR requirements refer to NGTS 2.15 Automatic Switching Requirements and NGTS 3.15.1 DAR and Plant Isolation.

3.2.12 Trip Relays and Trip Relay Resetting

Electrically reset trip relays shall be provided for interlocking and co-ordination of local and remote end automatic switching. The requirements for Trip Relays and Trip Relay Resetting are given in NGTS 3.6.15.

Other means of achieving scheme functionality as typified in the scheme functional diagrams will be considered.

3.3 Accommodation and Connection

The accommodation and connection of relays should be in a 19 inch rack or hinged rack cubicles and be of modular construction with factory assembled and tested wiring. It shall offer the benefits of minimum site construction times and circuit outage requirements. NGC Specification TPS 5/33 details an existing accommodation system that meets NGC's requirements, although other accommodation systems will be considered.

Electrical interconnection between protection equipments and with the site should be at a marshalling rack or cubicle. Where jumper fields are used, they should be factory assembled and tested to minimise site construction and testing.

Interconnections shall be identified in line with the requirements for dependant local end marking as specified in IEC 391 Sections 3.4.1.a.1 and 5.1.2, Marking of Insulated Conductors. The interconnections are to be recorded on an appropriate schedule or diagram.

3.4 Test and Isolation Facilities

Adequate test and isolation facilities shall be provided within the protection system, to enable NGC or Manufacturer's recommended commissioning and maintenance procedures to be carried out safely.

3.4.1 Test Facilities

The test points shall be clearly identified and labelled and be readily accessible to enable the majority of commissioning and all maintenance to be carried out from the panel front.

3.4.2 Isolation Facilities

The isolation points shall preferably be securable, and accessible from the panel front. They shall be clearly identified and labelled. These labels shall either describe the function or be uniquely numbered and cross referenced to a functional look up table.

4 PERFORMANCE REQUIREMENTS

4.1 Environmental Requirements

This section details the environmental requirements for protection relays which shall be installed in heated relay rooms at NGC substations. It states, where applicable, the type tests of the International Electrotechnical Commission Standard with the class of severity for each requirement. When a Standard is quoted, all the relevant sections apply.

4.1.1 Atmospheric Environment

The basic requirements are shown in NGTS 1, Table 10.

(i) Temperature

The relay is required to operate satisfactorily over the ambient range specified in NGTS 1, Table 10, Class C and be tested to IEC 68-2-1 with severity class -10°C, 96 hours and IEC 68-2-2 with severity class 55°C, 96 hours.

In addition the relay shall be able to withstand an ambient temperature range in accordance with NGTS 1, Table 10, Class S during the period of storage and transportation and be tested to IEC 68-2-1 with severity class -25°C, 96 hours and IEC 68-2-2 with severity class 70°C, 96 hours.

(ii) Relative Humidity

The relay is required to operate satisfactorily as specified in NGTS 1, Table 10, Note 6 and be tested to IEC 68-2-3 with severity class 56 days.

(iii) Enclosure

The relay shall meet the requirements of the test in IEC 529 with classification IP50 (dust protected). If the relay's individual enclosure is to a class less than IP50, then the Contractor shall provide a cubicle to accommodate the relay to classification IP50.

4.1.2 Mechanical Environment

(i) Vibration

The relay shall meet the requirements of the test in IEC 255-21-1 with severity Class 1.

(ii) Shock & Bump

The relay shall meet the requirements of the shock and bump tests in IEC 255-21-2 with severity Class 1.

4.1.3 Electrical Environment

(i) D.C. Supply Voltage

The relay or its associated power supply unit for use in a 110 V (nominal) D.C. supply system, is required to operate satisfactorily with a D.C. supply voltage range 87.5 V to 137.5 V and to withstand a maximum voltage of 143 V.

The relay or its associated power supply unit for use in a 48 V (nominal) D.C. supply system, is required to operate satisfactorily with a D.C. supply voltage of range 43 V to 60 V.

The static measuring relays and protection equipment shall meet the requirements of IEC 255-11 and their performance shall not be affected under the following conditions:

(a) Interruption to the D.C. auxiliary supply of duration up to 10 ms.

(b) A.C. component (ripple) in the D.C. auxiliary supply up to 5% of rated value.

4.1.4 Insulation

(i) Dielectric

The relay shall meet the requirements of the dielectric tests in IEC 255-5. The test voltage shall be selected according to the rated insulation voltage of the relay from Series C of Table 1 of IEC 255-5. The rated insulation voltage of the relays connected to current transformers of high impedance circulating current differential protection, shall not be less than 1 kV. All other relays shall have a rated insulation voltage of not less than 250 V.

The relay open contacts shall withstand a voltage of 1 kV.

(ii) Impulse Voltage

The relay shall meet the requirements of the impulse voltages tests in IEC 255-5 with a test voltage of 5 kV.

4.1.5 Electromagnetic Compatibility

The following requirements are applied to static measuring relays and protection equipment. These requirements may be applied to some electro-mechanical relays which are of high speed or high sensitivity.

For relevant international standards refer to Clause 2 under 'References'.

(i) 50 Hz Interference

The relay shall meet the requirements of the power frequency interference test specified in NGTS 2.13 Electronic Equipment.

(ii) 1 MHz Burst Disturbance

The relay shall meet the requirements of the test in IEC 255-22-1 with severity Class III.

(iii) Electrostatic Discharge

The relay shall meet the requirements of the test in IEC 255-22-2 with severity Class III.

(iv) Radiated Electromagnetic Field Disturbance

The relay shall meet the requirements of the test in IEC 255-22-3 with severity Class III. The test shall be carried out by using Test Method A and sweeping through the entire frequency range 20 MHz to 1000 MHz.

(v) Fast Transient

The relay shall meet the requirements of the test in IEC 255-22-4 with severity level IV.

4.2 Dependability, Security and Non-Power System Performance Requirements

The Contractor is required to show that his system is dependable and secure and has a low incidence of non-power system fault tripping.

4.2.1 Dependability

Dependability is a measure of the ability of protection to initiate successful tripping of circuit-breakers which are associated with the faulty item of plant.

4.2.2 Security

Security is a measure of the ability of the protection to remain stable, ie not to initiate tripping on the non-faulted parts of the primary system when a fault occurs elsewhere on that system so that unnecessary plant disconnections do not take place.

4.2.3 Non-Power System Fault Performance

Non-power system fault tripping is defined as an incident which results in the unwanted tripping of a circuit-breaker as a result of a fault, other than a power system fault, such as the unwanted operation of protection in the absence of a power system fault or the tripping of a circuit-breaker due to some other secondary equipment or to human error.

The protection system shall remain stable for all load conditions, charging and discharging arrangements, harmonic currents, oscillatory currents, resonant effects, or travelling wave effects caused by the transmission system or caused by primary transducers.

In addition, the protection shall not perform unwanted operations in the presence of electrical noise caused by switching operations in the substation or on the transmission system, faults, lightning, electro-magnetic coupling, radio frequency interference, electro static discharge etc. It shall remain stable on energising and de-energising the power supply.

The physical arrangement of the protection system, its connection and the arrangement of any operator interface or testing facilities shall be such that it can always be operated on in a safe manner. In addition, the risk of an operator error causing damage to the equipment or an unwanted trip shall be absolutely minimal.

4.3 Trip Relay Requirements

Where trip relays are provided, they shall operate in a time not exceeding 10 ms.

4.4 Thermal Requirements for CT Fed Relays Based on a Relay Rated at 1 A

These requirements apply to relays associated with a feeder circuit where load current is carried by the relay.

(i) A minimum continuous thermal withstand secondary current of 2.4 A.

(ii) Thermal withstand currents for short duration overloads, after reaching a steady temperature with an initial load of 2.0 A, shall be not less than the values given in Table 1.

Duration (Min)	20	10	5	3	2
Current (Amps)	3.0	3.5	4.0	5.0	6.0

Table 1

5 TEST REQUIREMENTS

5.1 Overall Requirement

Test results and/or in service operating evidence will be required to confirm compliance with general and performance requirements as laid down in Sections 3 and 4 respectively.

5.2 Pre-Commissioning and Energisation Tests

Details of pre-commissioning and energisation tests are required to be submitted to NGC for approval prior to the tests, and provide NGC with the opportunity to witness the commissioning tests. The Contractor shall provide test and commissioning records to the satisfaction of NGC.

6 EQUIPMENT LIFE AND LIFETIME SUPPORT

6.1 Equipment Life

The Contractor shall state service life of the equipment in relation to that of the main HV plant/apparatus so that NGC can assess the cost of any replacement during the life of the substation.

6.2 Lifetime Support

The Contractor shall state how long he will provide lifetime support for the protection and associated systems and make recommendations on spare part provision.

In addition to the documentation required under NGTS 1 Appendix E, the Contractor shall provide Overview Circuit Diagram(s) for each protection system and the associated circuit-breaker tripping system(s). These diagrams shall provide sufficient information to enable fault finding and maintenance to be carried out.

When a Manufacturer or Contractor has been notified of incorrect operation of his equipment or failure to operate when required, he shall investigate the incident and inform NGC of any subsequent modifications required.

The Contractor shall offer a service such that any faulty item of protection equipment is rectified or replaced within a stated period of the defect being reported. The Contractor shall state this repair/replacement period.

The Contractor shall, when requested, offer NGC a maintenance contract for the protection equipment supplied. Information such as test procedures, test frequencies and cost shall be supplied.

The Contractor shall offer training for NGC personnel in the operation and maintenance of the protection equipment.

7 TECHNICAL DATA OF EQUIPMENT SUPPLIED FOR APPROVAL

All protection relays and systems offered under the Contract require approval by NGC (see NGTS 1). To achieve this, technical data shall be supplied in accordance with this Specification and the respective NGTS Level 3 documents.

The Contractor shall confirm that the protection systems comply with this Specification and the relevant NGTS Level 3 documents.

In addition, he shall state areas of non-compliance for each equipment offered using form Appendix A which is to be returned to NGC with the tender document for the contract.

APPENDIX A

STATEMENT OF COMPLIANCE		
NGTS 2.6	PROTECTION	
Contract Description:		
Contract Number:		
Indicate below the extent of compliance of the protection equipment/systems offered under the above contract:		
Fully compliant with General Requirements	Section 3	Y/N
Fully compliant with Performance Requirements	Section 4	Y/N
Fully compliant with Test Requirements	Section 5	Y/N
State below the areas of non-compliance, or outstanding tests required, for each equipment/system offered, together with any alternative recognised standards or specifications that may be accredited to the equipment :		

STATEMENT OF COMPLIANCE (Continued)	
NGTS 2.6	PROTECTION

APPENDIX B

The functional diagrams show interconnectivity of protection systems for typical substation circuit configurations. The relevant NGTS Level 3 specifications are quoted and should be referred to for detail information about its respective protection system. Signal functions may refer to specific operations defined in the appropriate Level 3 specification or generic terms.

The following diagrams are for guidance only:

B1 FEEDER BAY FOR 400 kV DOUBLE BUSBAR SUBSTATION

For details of intertrip initiation and inhibition of DAR sequences refer to NGTS 2.15 and NGTS 3.15.1.

Distance relay Zone 2 and Zone 3 operation is required to lockout the DAR sequence, refer to NGTS 2.15 and NGTS 3.15.1 for more detail.

The requirement for line disconnector sequential operation from protection trip initiations is dependent on the type of switchgear employed and is shown for information only.

Current transformer location is shown for gas insulated type switchgear.

B2 AUTO TRANSFORMER BAY FOR 400 kV DOUBLE BUSBAR SUBSTATION

The requirement for line disconnector sequential operation from protection trip initiation is dependent on the type of switchgear employed and is shown for information only.

The application of fault recorders is defined in NGTS 3.6.12.

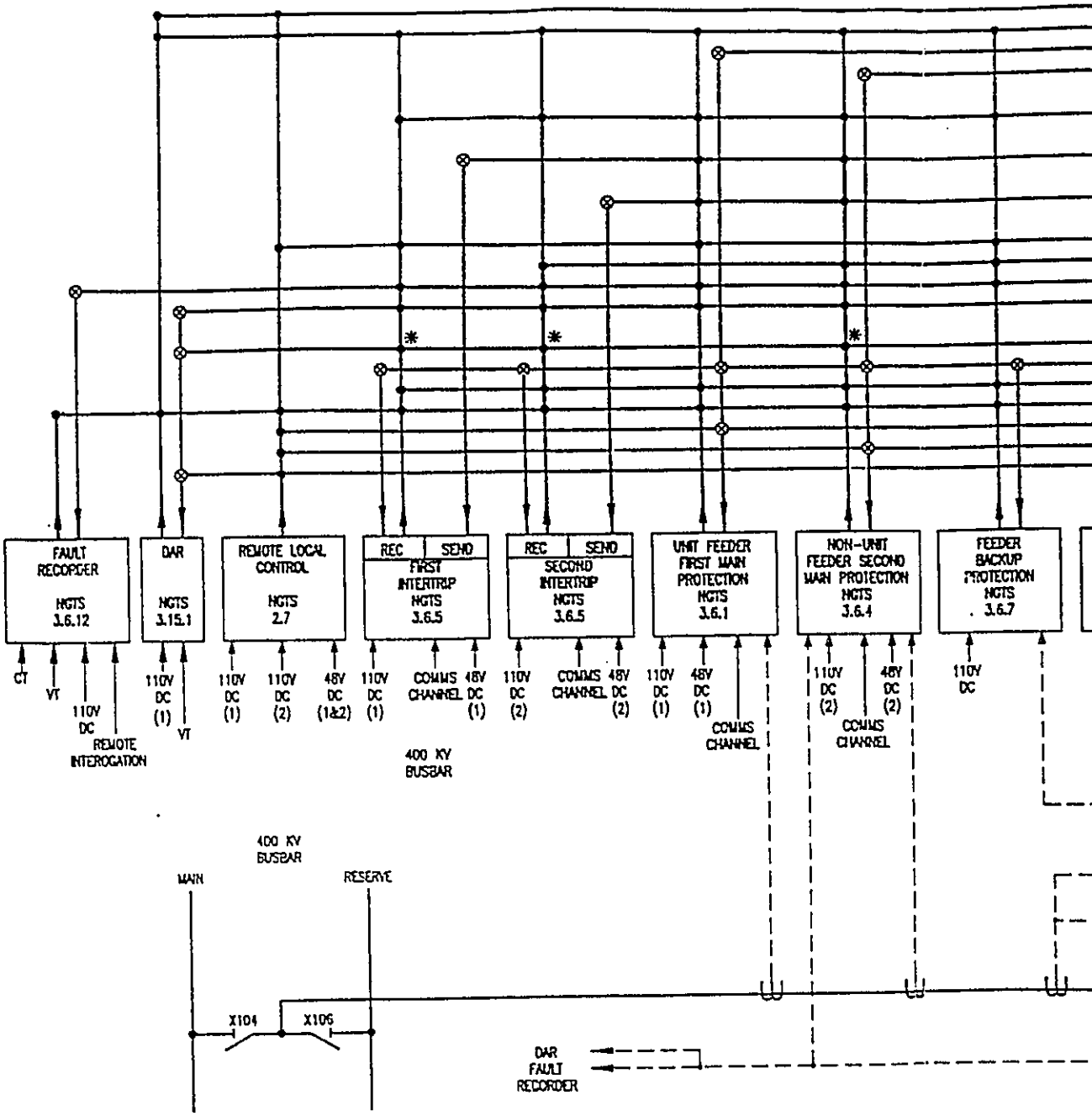
B3 BUSBAR COUPLER OR SECTION BAY FOR 400 kV DOUBLE BUSBAR SUBSTATION

The requirement for line disconnector sequential operation from protection trip initiations is dependent on the type of switchgear employed and is shown for information only.

B4 400 kV MESH CORNER INCLUDING FEEDER AND AUTO TRANSFORMER

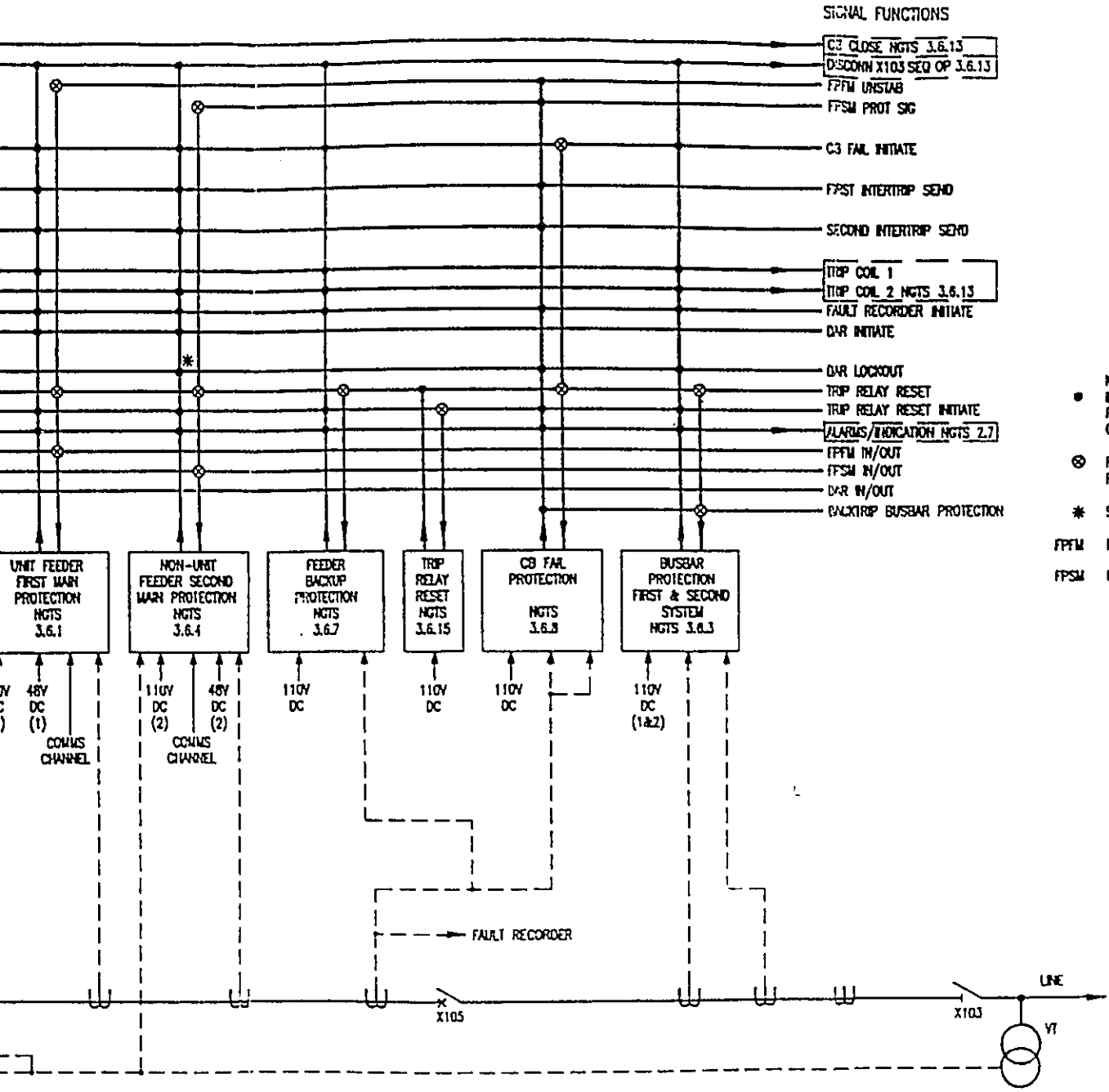
Distance relay Zone 2 and Zone 3 operation is required to lockout the DAR sequence. For details refer to NGTS 2.15 and NGTS 3.15.1.

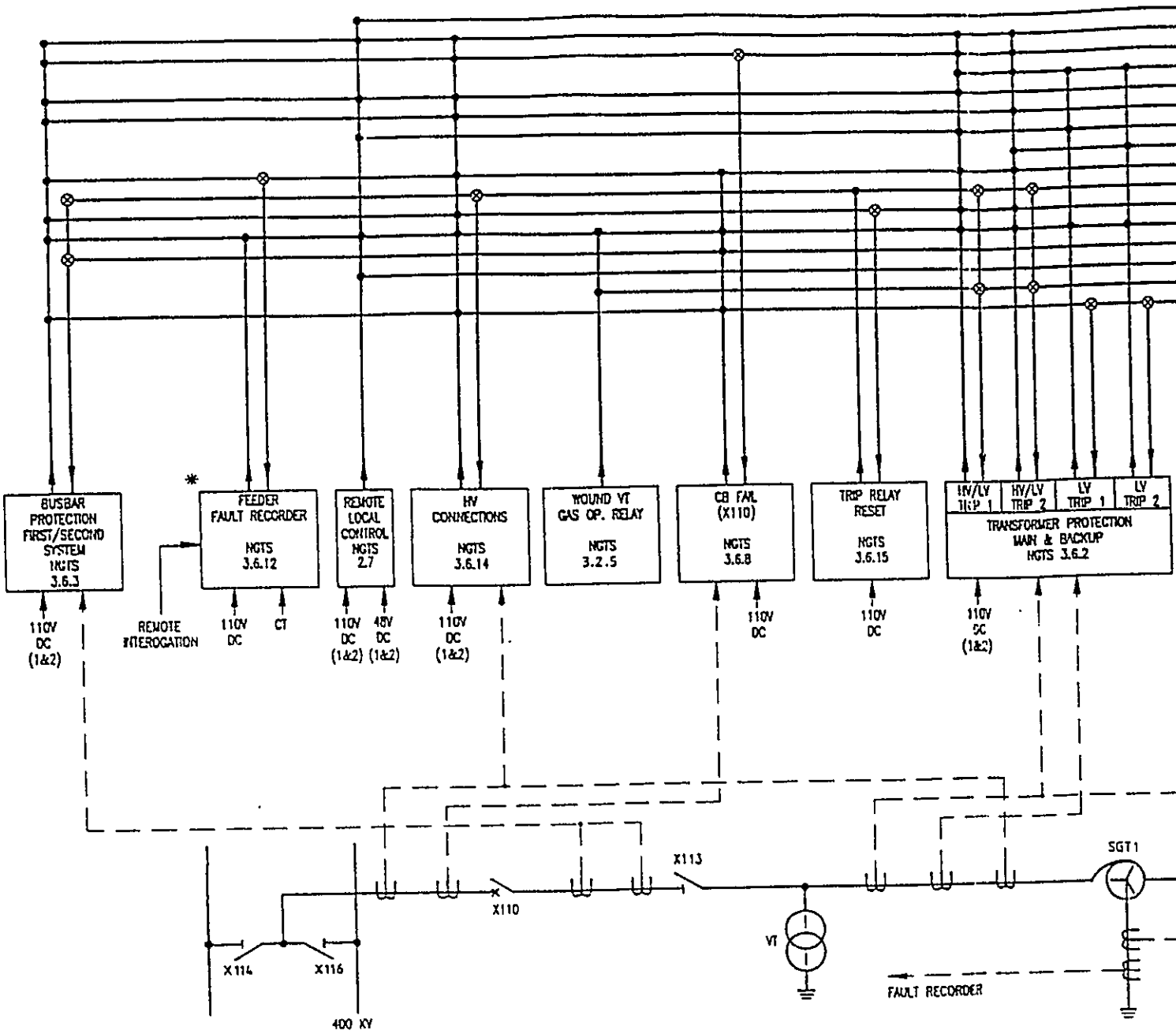
For details of Mesh Corner protection and intertrip DAR sequences at Mesh substations refer to NGTS 2.15 and NGTS 3.15.1.



Appendix B1 - Feeder Bay for 400 Kv Double Busbar Substation

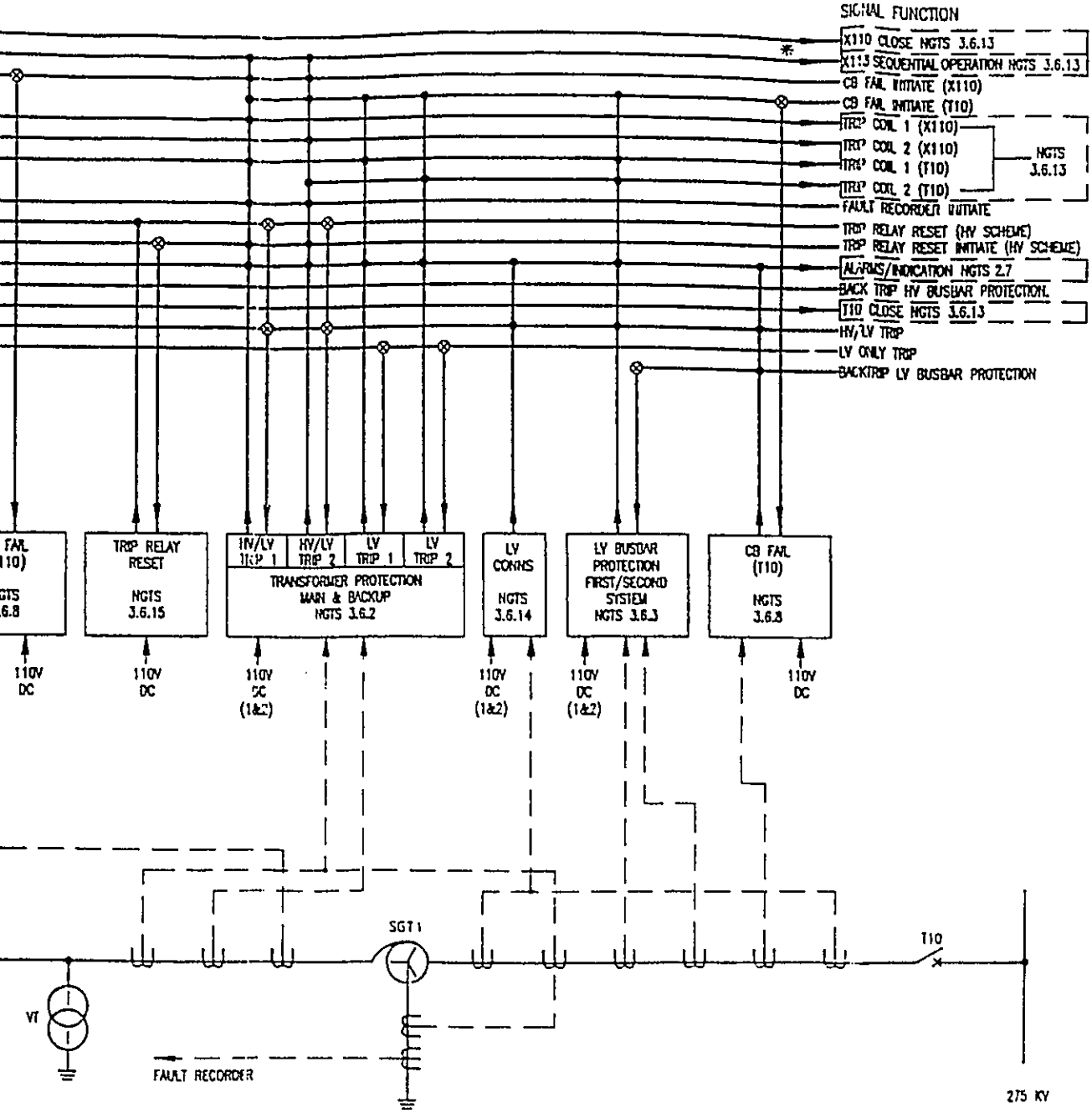
NGC Drg. No. 42/70211


SIGNAL FUNCTIONS
C3 CLOSE NGTS 3.6.13
DISCONN X103 SEQ OP 3.6.13
FPFM UNSTAB
FPSM PROT SIG
C3 FAIL INITIATE
FPST INTERTRIP SEND
SECOND INTERTRIP SEND
TRIP COIL 1
TRIP COIL 2 NGTS 3.6.13
FAULT RECORDER INITIATE
DAR INITIATE
DAR LOCKOUT
TRIP RELAY RESET
TRIP RELAY RESET INITIATE
ALARMS/INDICATION NGTS 2.7
FPFM IN/OUT
FPSM IN/OUT
DAR IN/OUT
BACKTRIP BUSBAR PROTECTION
KEY
INITIATING SIGNAL FROM ONE PROTECTION SYSTEM TO OTHER PROTECTION SYSTEMS
RECEIVE SIGNAL FROM PROTECTION SYSTEMS
SEE TEXT
FPFM FEEDER PROTECTION FIRST MAIN
FPSM FEEDER PROTECTION SECOND MA
UNIT FEEDER FIRST MAIN PROTECTION NGTS 3.6.1
NON-UNIT FEEDER SECOND MAIN PROTECTION NGTS 3.6.4
FEEDER BACKUP PROTECTION NGTS 3.6.7
TRIP RELAY RESET NGTS 3.6.15
C3 FAIL PROTECTION NGTS 3.6.8
BUSBAR PROTECTION FIRST & SECOND SYSTEM NGTS 3.6.3
48V DC (1)
COMMS CHANNEL
110V DC (2)
48V DC (2)
COMMS CHANNEL
110V DC
110V DC
110V DC
110V DC (1&2)
FAULT RECORDER
X105
X103
LINE
VT



Appendix B2 - Auto Transformer Bay for 400 kV Double Busbar Substation

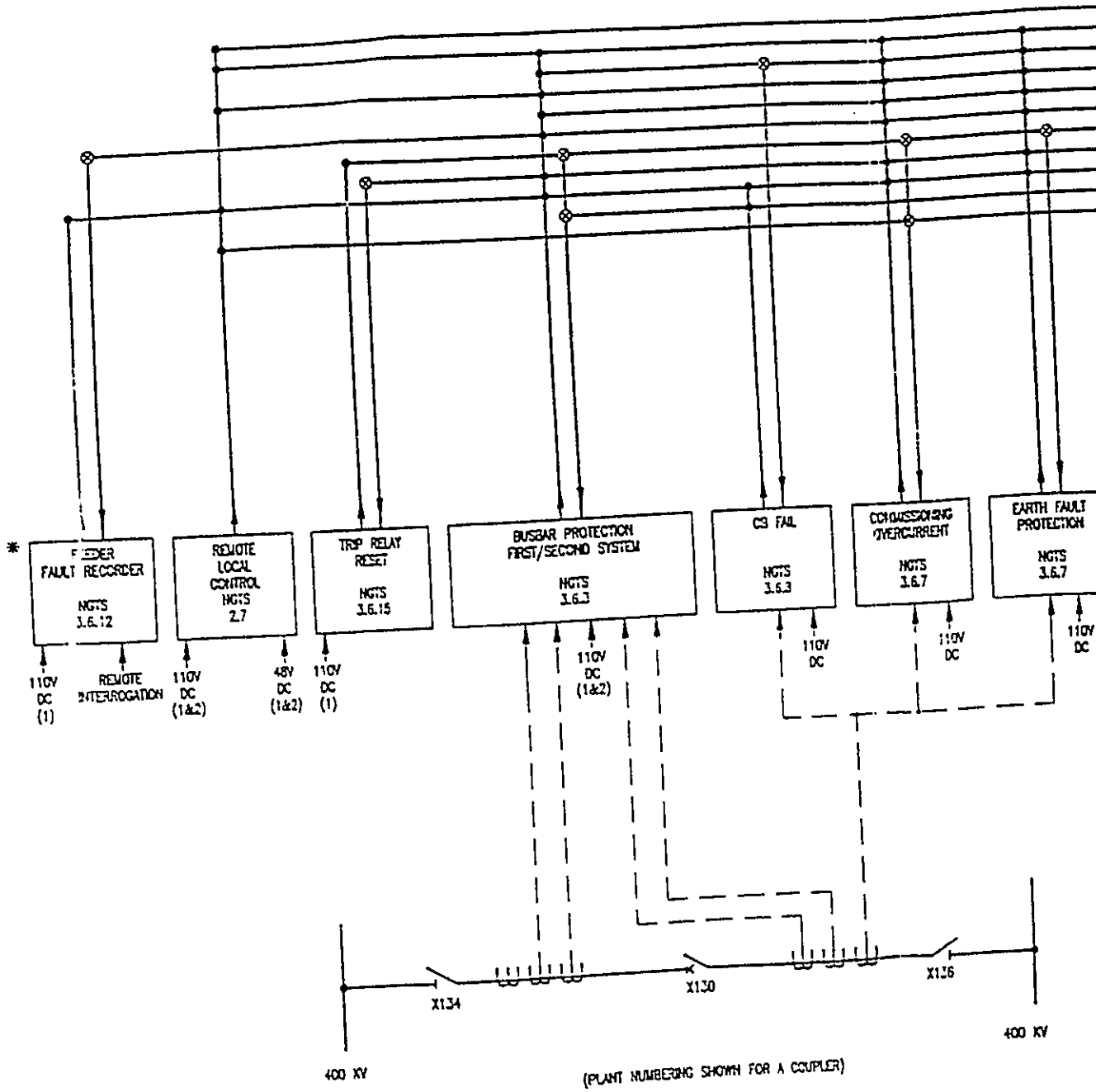
NGC Drg. No. 42/70212



KEY

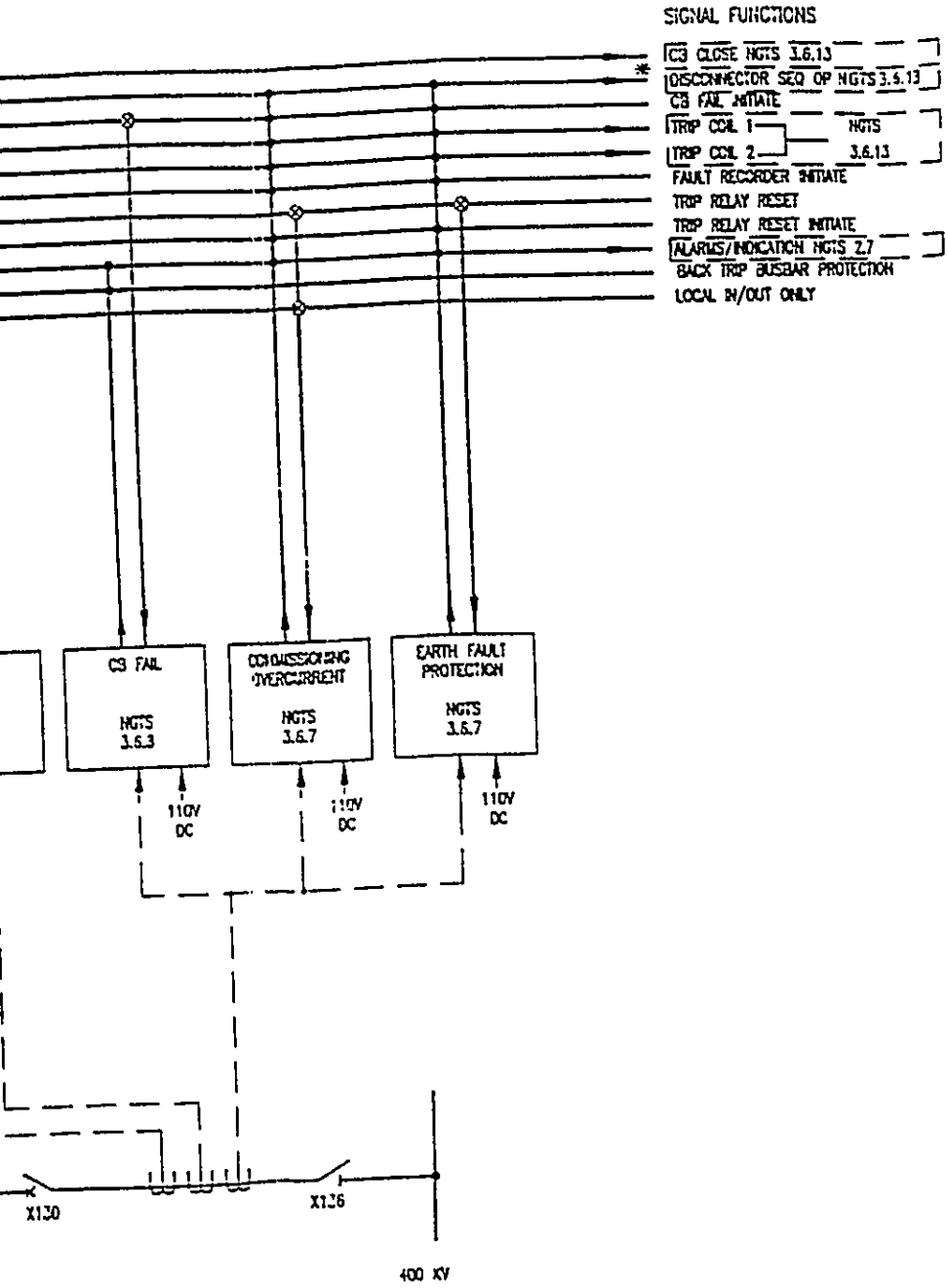
- ● INITIATING SIGNAL FROM ONE PROTECTION SYSTEM TO OTHER PROTECTION SYSTEMS
- ⊗ RECEIVE SIGNAL FROM PROTECTION SYSTEMS
- ✱ SEE TEXT

Substation



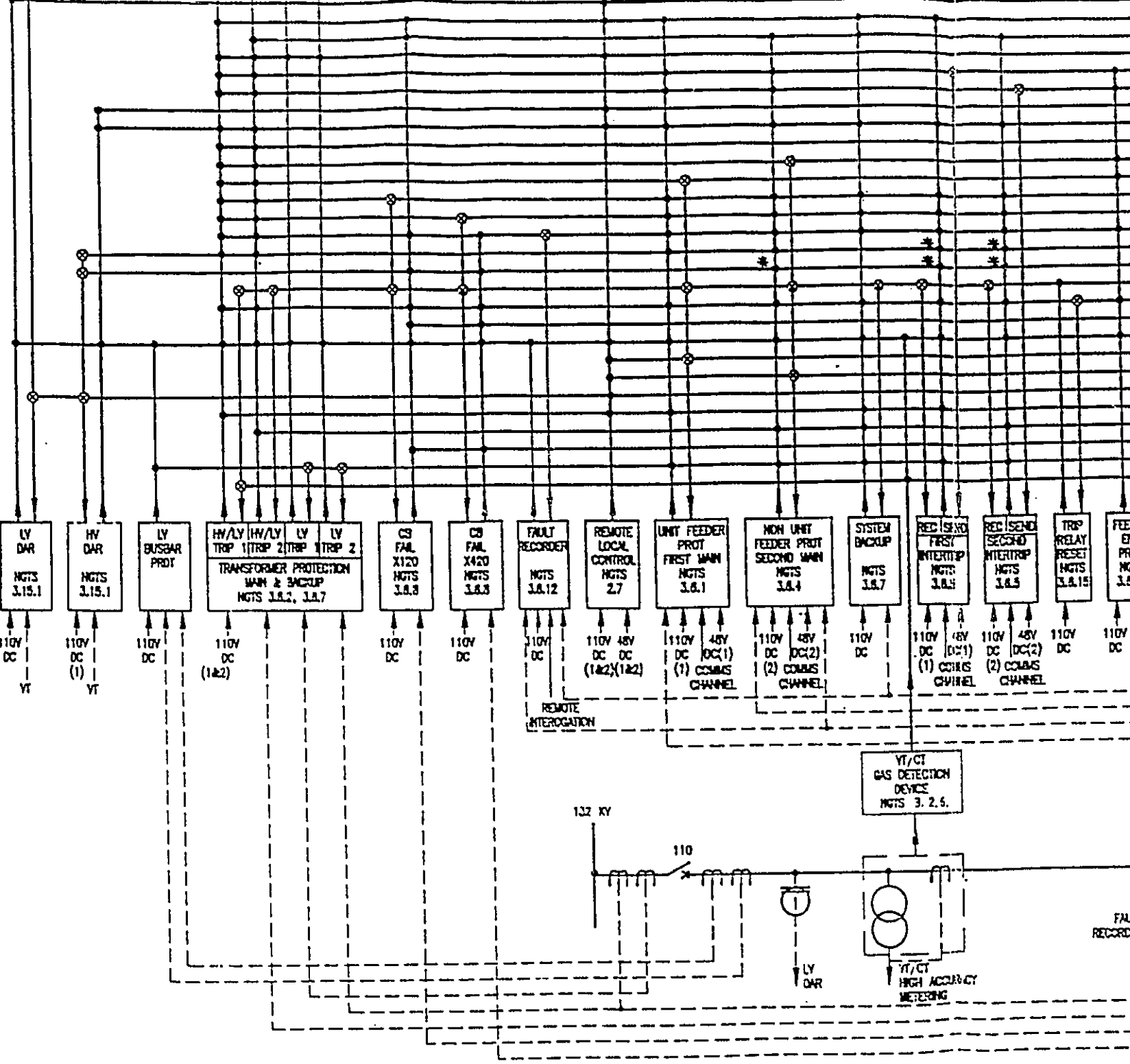
Appendix B3 - Busbar Coupler or Section Bay for 400 kV Double Busbar Station

NGC Drg. No. 42/70213



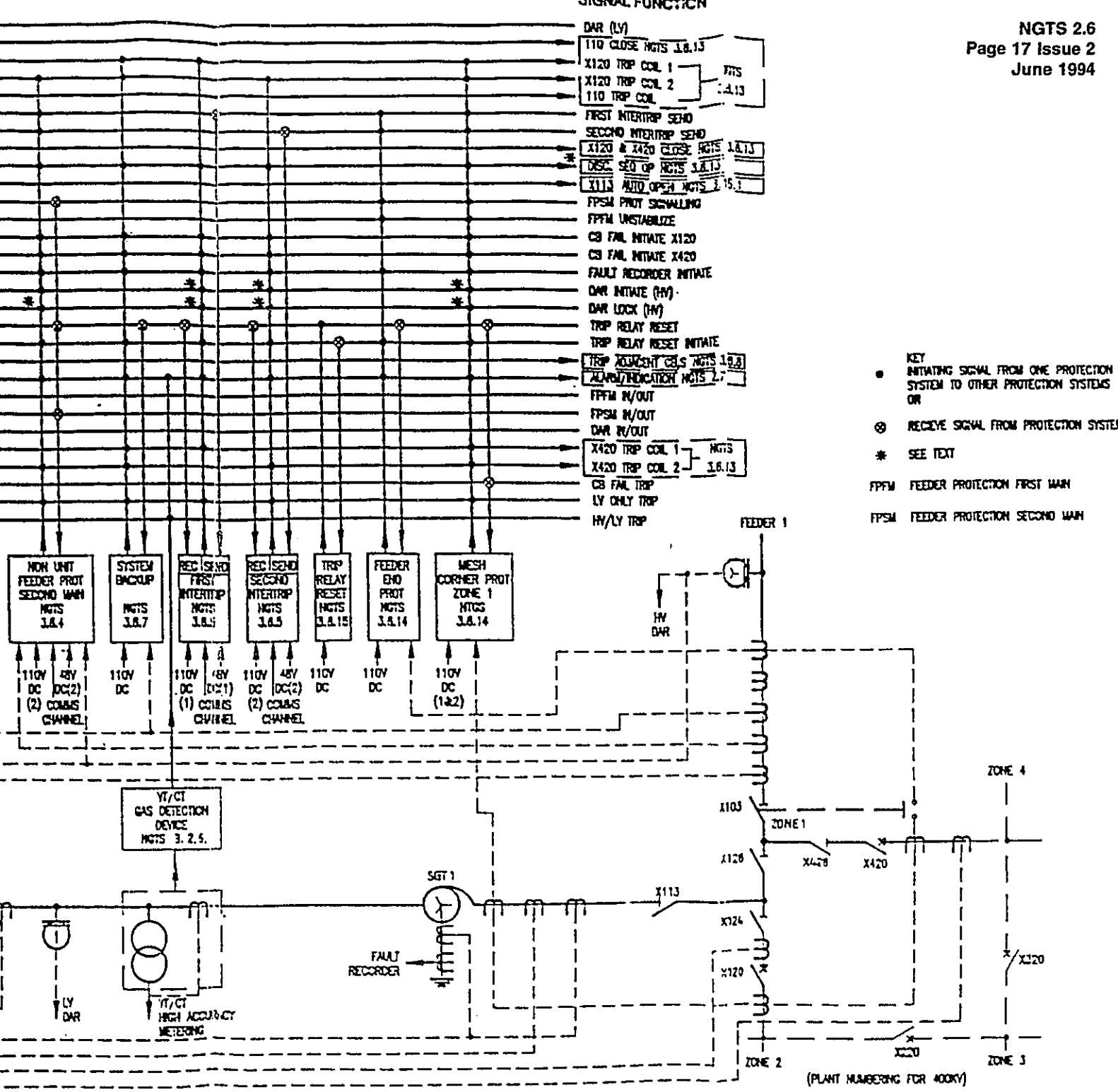
KEY
- ● INITIATING SIGNAL FROM ONE PROTECTION SYSTEM TO OTHER PROTECTION SYSTEMS
- ⊗ RECEIVE SIGNAL FROM PROTECTION SYSTEMS
- ✱ SEE TEXT

Station



Appendix B4 - 400 kV Mesh Corner Including Feeder and Auto Transformer

NGC Drg. No. 42/70214


SIGNAL FUNCTION
DAR (LV)
110 CLOSE NGTS 3.6.13
X120 TRIP COIL 1
X120 TRIP COIL 2
110 TRIP COIL
NGTS 3.6.13
FIRST INTERTRIP SEND
SECOND INTERTRIP SEND
X120 & X420 CLOSE NGTS 3.6.13
DISC SEQ OP NGTS 3.6.13
X113 AUTO OPEN NGTS 3.15.1
FPSM PROT SIGNALLING
FPFM UNSTABILIZE
CB FAIL INITIATE X120
CB FAIL INITIATE X420
FAULT RECORDER INITIATE
DAR INITIATE (HV)
DAR LOCK (HV)
TRIP RELAY RESET
TRIP RELAY RESET INITIATE
TRIP ADJACENT CBS NGTS 3.6.8
ALARM/INDICATION NGTS 2.7
FPFM IN/OUT
FPSM IN/OUT
DAR IN/OUT
X420 TRIP COIL 1
X420 TRIP COIL 2
NGTS 3.6.13
CB FAIL TRIP
LV ONLY TRIP
HV/LV TRIP
KEY
INITIATING SIGNAL FROM ONE PROTECTION SYSTEM TO OTHER PROTECTION SYSTEMS OR
RECEIVE SIGNAL FROM PROTECTION SYSTEM
SEE TEXT
FPFM FEEDER PROTECTION FIRST MAIN
FPSM FEEDER PROTECTION SECOND MAIN
NON UNIT FEEDER PROT SECOND MAIN NGTS 3.6.4
SYSTEM BACKUP NGTS 3.6.7
REC SEND FIRST INTERTRIP NGTS 3.6.5
REC SEND SECOND INTERTRIP NGTS 3.6.5
TRIP RELAY RESET NGTS 3.6.15
FEEDER END PROT NGTS 3.6.14
MESH CORNER PROT ZONE 1 NGTS 3.6.14
110V DC
48V DC(2) COMMS CHANNEL
110V DC (1) 48V DC(1) COMMS CHANNEL
110V DC (2) 48V DC(2) COMMS CHANNEL
110V DC
110V DC
110V DC (1&2)
FEEDER 1
HV DAR
ZONE 4
X103
ZONE 1
X126
X428
X420
SGT 1
X113
X124
X120
FAULT RECORDER
VT/CT GAS DETECTION DEVICE NGTS 3.2.5.
LV DAR
VT/CT HIGH ACCURACY METERING
X120
X120
ZONE 2
ZONE 3
(PLANT NUMBERING FOR 400KV)

sformer

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