Q. **System Protection**

Provide Hydro's relay protection design criteria before 2014 and after January 2014.

A. Hydro's relay protection design criteria are based on many years of operating experience. The original designs have evolved over the years to adapt to changing system conditions. The introduction of microprocessor-based relays has increased setting flexibility and provided monitoring capability during disturbances. Disturbance records are retrieved remotely at the master station in Hydro Place after the outage occurs and analyzed by protection and operations personnel and, if necessary, changes are made to protection designs and settings. Depending on the severity of the disturbance and the effect on the system, the records can be analyzed shortly after the occurrence. If the effects are minimal, the records can be reviewed during normal hours.

Existing Protection and Control Standards cover mostly functional requirements for equipment and specific standards of acceptance. A copy of the Standards is attached as PUB-NLH-327 Attachment 1. The standard relay protection design criteria are documented in drawings and settings for specific equipment such as transmission lines, transformers and generators. Examples of standard protection drawings for a transmission line and a transformer are attached as PUB-NLH-237 Attachment 2.

Older protection design criteria would have primary protection and backup protection. With the use of modern microprocessor relays, redundant primary relays with similar functions can be used. Hydro uses relays from different manufacturers as Primary Protection 1 and Primary Protection 2 on transmission

lines, generating units and power transformers. This is a common industry practice to avoid relay design flaws being present on both primary protection systems.

The recommendations from Hydro's internal report, the Board's interim report and Hydro's various compliance reports have been itemized on Hydro's Integrated Action Plan with scheduled completion dates. There are 19 recommendations for Protection and Control to complete. The main points from these recommendations are:

- A number of the recommendations are related to breaker failure in terminal stations, which has resulted in a review of the existing breaker failure design in stations and a review of stations that do not have breaker failure protection. These reviews will be completed by November 30, 2014.
- A Protection and Control Standard for breaker failure will be prepared by November 30, 2014, which will clearly lay out the criteria for future designs, and the modifications needed for existing installations.
- A review of key priority alarms to be provided to the operators in the Energy Control Centre will be completed by November 28, 2014.
- A plan to implement modern digital relays that can record disturbance information will be completed by October 24, 2014.
- Relay setting changes to improve performance will be completed by December 15, 2014

Hydro’s protection design criteria will continue to evolve as system conditions warrant and as relay technology develops.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

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STANDARD NO.	TITLE
P01-002-R1	Protection and Control Standards Committee - Terms of Reference
P01-003-R1	Development Procedure for a Protection and Control Standards
P01-010-R0	Organization of the P&C Standards Manual
P01-020-R1	Distribution of the P&C Standards Manual
P01-030-R0	Standard Site Abbreviations
P01-080-R0	Graphic Symbols for 2- and 3- Line A.C. and D.C. Schematics
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P13-030-R0	Potential/Current Transformer Junction Boxes
P15-001-R0	Terminal Station - Control
P15-010-R0	Synchronizing
P15-025-R0	Switchboard Meters
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P15-080-R0	Terminal Station Annunciators
P16-010-R0	125 V DC Station Service Distribution
P17-050-R0	Mimic Buses
P17-075-R0	Switchboard Wiring
P17-090-R0	Control Cables - 600 Volts
P21-005-R0	Panel Device Identification
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P21-050-R0	Fuses and Fuseholders
P21-090-R0	Indicating Lights
P23-020-R0	Supervisory Control and Data Acquisition (SCADA) Interface
P23-030-R0	Isolation for Supervisory Control, Protection Signals, and Teleprotection
P23-090-R0	Supervisory Junction Box

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PROTECTION AND CONTROL ENGINEERING STANDARD

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Number:	P01-INDEX-R3
Page :	1 of 1
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STANDARD NO.	TITLE
P01-002-R1	Protection and Control Standards Committee - Terms of Reference
P01-003-R1	Development Procedure for a Protection and Control Standard
P01-010-RO	Organization of the P&C Standards Manual
P01-020-R1	Distribution of the P&C Standards Manual
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P01-080-RO	Graphic Symbols for 2- and 3- Line A.C. and D.C. Schematics

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PROTECTION & CONTROL ENGINEERING STANDARD

No. :	P01-002-R1
Page :	1 of 2
Issued :	1992-03-30
App'd.	T. D. Collett
	D. W. Reeves

PROTECTION AND CONTROL STANDARDS COMMITTEE TERMS OF REFERENCE

1.0 SCOPE

This Standard comprises the complete terms of reference for the Protection and Control Standards Committee including objectives, membership, meeting format and specific responsibilities.

2.0 OBJECTIVE

The Committee is responsible for the development and updating of Protection and Control Standards which will ensure a high degree of system performance and maintainability while staying within the guidelines of sound engineering practice.

3.0 MEMBERS

The Protection and Control Standards Committee shall consist of the following personnel:

Manager System Performance and Protection	(Operations)
Senior Protection and Control Design Engineer	(Engineering)
Protection and Commissioning Specialist	(Operations)
Senior Supervisory Control Engineer	(Telecontrol)
Senior Electrical Engineer	(CFLCo)
A Protection and Control Supervisor	(T.R.O.)

The Chairman and Secretary are to be elected by members of the Committee annually.

The permanent members of the Committee shall be as stated above, however, interim members may be appointed by the Committee as deemed necessary.

4.0 MEETINGS

The Committee will hold a minimum of four (4) meetings in a year, and more if necessary. Four (4) permanent members will constitute a quorum.

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PROTECTION & CONTROL ENGINEERING STANDARD

5.0 RESPONSIBILITIES

The Protection and Control Standards Committee is accountable to the Engineering Standards Review Committee per the Corporation's Policy and Procedure No. ENG 1.

The responsibilities of the Protection and Control Standards Committee are as follows:

(a) To develop Protection and Control Standards for incorporation into the appropriate Hydro Standards Manual. These Standards are to address and establish written standards in all areas of protection and control with emphasis on philosophy and hardware.

(b) To ensure that present Hydro's Protection and Control standards which are deemed acceptable are included in the appropriate standards manual and to establish new standards in areas where none exist.

(c) As developed, to recommend to the Engineering Standards Review Committee that the various standards be adopted by Hydro.

(d) Once established, to update and revise the standards as required.

(e) To monitor and investigate areas of concern in protection and control and to establish new standards to cover those areas.

(f) To ensure that all Hydro personnel who should have input to the appropriate standards are given the opportunity to do so.

5.0 Responsibilities

The Protection and Control Standards Committee is accountable to and governed by the Engineering Standards Review Committee per the Corporation's Policy and Procedure No. 51.1.

The responsibilities of the Protection and Control Standards Committee are as follows:

(a) To develop a Protection and Control Standard for incorporation into Hydro's Standard Manual. The Standard is to address and establish written standards in all areas of protection and control with emphasis on philosophy and hardware.

(b) To ensure that present Hydro standards which are deemed acceptable are included in the standard Manual and to establish new standards in areas where none exist.

(c) As developed, to recommend to the Engineering Standards Review Committee that the various standards be adopted by Hydro.

(d) Once established, to update and revise the standards as required.

(e) To monitor and investigate areas of concern in protection and control and to establish new standards to cover those areas.

(f) To ensure that all Hydro personnel who should have input to the appropriate standards are given the opportunity to do so.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No. : P01-003-R0

Issued : 1986-01-08

DEVELOPMENT PROCEDURE FOR A
PROTECTION AND CONTROL STANDARD

TRANSMITTAL PREPARATION DATE : 1985-04-09

SUBMITTED	CHMN. P & C STD'S COMM.	85-04-10 DATE
RECOMMENDED	CHMN. ENG. STD'S REVIEW COMM.	85-07-16 DATE
APPROVED	V.P. ENG. & CONSTR.	85-08-20 DATE
APPROVED	V. P. OPERATIONS	85-11-04 DATE

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PROTECTION & CONTROL ENGINEERING STANDARD

DEVELOPMENT PROCEDURE FOR A PROTECTION AND CONTROL STANDARD

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Page :	1 of 1
Issued :	1993-02-08
App'd.	T. D. Collett
	D. W. Reeves

Under its Terms of Reference, the Protection and Control Standards Committee (PCSC) will hold regular meetings to develop and maintain Hydro's P&C criteria.

Upon agreement by the PCSC to adopt a new or revised Standard, the text will be typed on the Protection and Control Engineering Standard forms. Sufficient copies of this, with all applicable drawings, will be forwarded to the Chairman of the Engineering Standards Review Committee (ESRC) under cover of the Engineering Standard Transmittal form. This transmittal form will have been signed and dated by the Chairman of the PCSC to indicate that this Committee is recommending the adoption of that particular Standard.

The ESRC will review the Standard and if acceptable, the Chairman will sign and date the transmittal and circulate it with a copy of the Standard to the Vice-President of Engineering and Construction and the Vice-President of Operations for their signatures which indicate final approval.

The completed transmittal form will be returned to the Chairman of the PCSC verifying complete acceptance. The original pages will then have the names of the Vice-Presidents concerned typed in to finalize the Standard. The now completed Standard will be copied and distributed to all appropriate parties.

Should the ESRC reject the draft Standard, it shall notify the Chairman of the PCSC, in writing, the reasons for rejection. It may be necessary, and indeed desirable, for both the PCSC and the ESRC to meet from time to time and discuss the resolution of any outstanding items.

Any changes to a Standard, including pertinent drawings, will result in the complete Standard being re-issued with an updated revision number. To avoid possible confusion, cross-references between Standards will not include the revision number.

Revisions will be highlighted using a vertical line.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL
No. : P01-010-R0
Issued : 1986-01-08

ORGANIZATION OF THE P & C STANDARDS MANUAL

TRANSMITTAL PREPARATION DATE : 1985-04-09

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PROTECTION & CONTROL ENGINEERING STANDARD

ORGANIZATION OF THE P & C STANDARDS MANUAL

No : P01-010-R0	
Page : 1 of 2	
Issued : 1986-01-08	
App'd.	L. J. Cole
	T. D. Collett

1.0 General Format

This manual forms the protection and control standards for Newfoundland and Labrador Hydro. Certain standards are developed as design guidelines while others detail specific criteria. A standard may be intended to cover only terminal stations and not generating plants; this distinction is made in the applicable standard.

Section 01 applies to general subjects which are common to all the remaining standards. Such subjects include policy statements, distribution lists, and standard definitions, abbreviations and symbols.

Section 02 is reserved for future use.

Sections 03 through 10 are for standards related to the protection and control of specific equipment such as transmission lines, generators and transformers.

Sections 11 through 14 deal with the protection and control aspects of high voltage equipment including breakers, motor operated disconnects, current and potential transformers.

Sections 15 through 22 address low voltage equipment such as annunciators, relay panels and control cables as well as various protection and control schemes, as for example, service restorers and underfrequency load shedding.

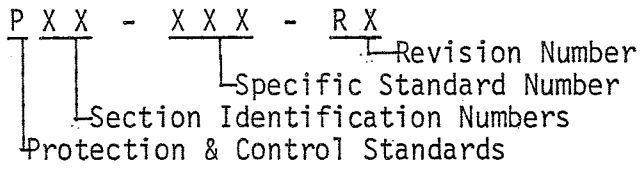
Section 23 contains those standards related to Telecontrol facilities and the station equipment interface with those facilities.

Additional sections may be added as the need arises.

2.0 Standard Numbering

Each section described in 1.0 above will have an index which will list all the standards contained therein by number and title. All subjects listed without an assigned number are intended for future issuance.

Standards will be numbered using the following system:



For Example,

P 2 1 - 0 1 0 - R 0
- R 0 — Revision Zero
- 0 1 0 — Test Switch Standard
- P 2 1 — Devices & Hardware Section
- P — Protection & Control Standards

3.0 Drawings

Standards which reference specific drawings will contain those drawings as in integral part. Each drawing will be assigned a number which is consistent with the applicable standard. In those cases where a drawing is referred to by more than one standard, the number will be changed accordingly to form part of the additional standards.

The following is an example of drawing numbering:

P 2 1 - 0 1 0 - D 1 - R 2
- R 2 — Revision 2
- D 1 — Drawing No. 1
- 0 1 0 — Test Switch Standard
- P 2 1 — Devices & Hardware Section
- P — Protection & Control Standards

All drawings will be prepared using standard symbols and abbreviations as adopted by the various Engineering Standards Committees.

Drawings will be made on a drafting sheet specifically intended for Protection and Control Standards. This sheet may also be adopted by other Standards Committees, if desired.

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PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No. : P01-020-R0

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DISTRIBUTION OF THE P & C STANDARDS MANUAL

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APPROVED	V.P. ENG. & CONSTR.	85-08-20 DATE
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PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

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PROTECTION AND CONTROL STANDARDS COMMITTEE
TERMS OF REFERENCE

TRANSMITTAL PREPARATION DATE : 1985-04-09

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APPROVED	V. P. ENG. & CONSTR.	85-08-20 DATE
APPROVED	V. P. OPERATIONS	85-11-04 DATE

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PROTECTION & CONTROL ENGINEERING STANDARD

DISTRIBUTION OF THE P & C STANDARDS MANUAL

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Issued :	1993-02-08
App'd.	T. D. Collett
	D. W. Reeves

1.0 PURPOSE

This Standard is a listing of those people who will be issued a Protection and Control Standards Manual. Newly approved Standards and revisions to existing Standards will be forwarded to those listed herein.

2.0 DISTRIBUTION

Manuals will be provided for the following:

1. Director, Engineering Design
2. Members, Protection and Control Standards Committee
3. Plant and Regional Managers
4. Power System and Telecontrol Superintendents
5. Protection and Control and Telecontrol Supervisors
6. Corporate Library

In addition to the above, two (2) copies will be available for temporary circulation to any outside consultants working directly in this field on Hydro Capital Projects.

Copies of the Manual will also be made available to other interested parties upon receipt of a written request on the parties' Corporate letterhead and with the approval of the Director, Engineering Design. For this purpose, a suitable number of spare manuals will be maintained in a current state at all times as well as an accurate file of recipients and addresses.

It shall be the responsibility of the Chairman of the Protection and Control Standards Committee to distribute approved Standards in accordance with this listing and maintain all spare copies in an up-to-date condition.

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PROTECTION AND CONTROL ENGINEERING STANDARD

Number:	P01-030-R0
Page :	1 of 5
Issued:	1994-03-24
App'd : E&CS:	D. W. Reeves
Oper:	T. D. Collett

STANDARD SITE ABBREVIATIONS

1.0 Scope

This standard lists the three letter abbreviations for significant sites associated with operations. It does not include all CFLCo sites or all diesel plants. Non-corporate owned sites are included when they are commonly referred to, as a result of important interfaces to corporate owned sites.

2.0 Sites to be Listed

This standard shall include abbreviations for, but not be limited to the following sites:

1. Corporate owned generating sites.
2. Corporate owned terminal stations.
3. Sites included on the "System Single Line Diagram".
4. Corporate owned microwave sites.
5. Corporate owned repeater sites.
6. Non-corporate owned repeater sites used for the operational voice system.
7. Sites with commissioned Telecontrol equipment.
8. Revenue metering sites.

3.0 Applications

These abbreviations shall be used wherever possible for engineering documentation requiring such an abbreviation. The use of the site abbreviations shall include, but not be limited to the following applications:

1. Communications circuit designations.
2. Computerized trouble tickets and trouble reports.
3. RTU documentation.
4. ECC computer displays and computer reports.
5. Memos and miscellaneous correspondence.
6. Engineering reports.

4.0 List of Standard Site Abbreviations

AMR	Atikonak Microwave Repeater
ANN	Annieopsquotch Repeater
ASV	Abitibi Stephenville (Abitibi Price Co.)
BBK	Bottom Brook Terminal Station
BBR	Bonne Bay (Three Tom) Repeater
BCV	Bear Cove Terminal Station
BCX	Barachoix Terminal Station
BDE	Bay D'Espoir Terminal Station
BDH	Bay D'Espoir Hill Microwave/Repeater
BDP	Bay D'Espoir Plant
BFD	Brookfield Substation (Nfld. Power)
BFO	Bishop Falls Office
BFS	Bishop Falls Substation (Nfld. Power)
BGH	Blue Grass Hill Microwave/Repeater
BHL	Berry Hill Terminal Station
BLA	Bay L'Argent Substation (Nfld. Power)
BLK	Blaketown Substation (Nfld. Power)
BLR	Bay L'Argent Repeater
BOY	Boyd's Cove Substation (Nfld. Power)
BRB	Bay Roberts Substation (Nfld. Power)
BRC	Brent's Cove Substation
BRT	Bartlett Substation
BTC	Brent's Cove Repeater
BTD	Burnt Dam Control Structure
BTH	Burnt Hill Repeater
BUC	Buchans Terminal Station
BUR	Burgeo Substation
BVM	Baie Verte Mines Substation (Nfld. Power)
BWT	Bottom Waters Terminal Station
CAI	Cat Arm Intake
CAM	Coney Arm Terminal Station
CAR	Carmanville Repeater
CAT	Cat Arm Plant
CBC	Come By Chance Terminal Station
CBF	Corner Brook Frequency Converter
CBK	Corner Brook Repeater
CDY	Codroy Pond Repeater
CFS	Churchill Falls Terminal Station
CHD	Cow Head Terminal Station
CIS	Change Island Substation
CLV	Clarenville Substation (Nfld. Power)
CNA	Churchill Falls Control and Adminstration Building
COB	Cobb's Pond Substation (Nfld. Power)
CRV	Conne River Terminal Station
CVL	Clarenville Repeater

4.0 List of Standard Site Abbreviations (cont'd.)

DHR	Daniel's Harbour Terminal Station
DLK	Deer Lake Terminal Station
DLO	Deer Lake Office
DLP	Deer Lake Power Plant (Deer Lake Power Co.)
DLR	Deer Lake Passive Repeater
DLS	Doyles Terminal Station
DML	Demille Lake Repeater
EBE	Ebbegunbaeg Control Structure
ECC	Energy Control Center
EHW	English Harbour West Terminal Station
EMR	Emeril Microwave Repeater
FGO	Fogo Substation
FHD	Farewell Head Terminal Station
FLC	Flower's Cove Station
GAM	Gambo Substation (Nfld. Power)
GAN	Gander Substation (Nfld. Power)
GBK	Grandy Brook Terminal Station
GBO	Gambo Repeater
GBY	Grand Bay Substation (Nfld. Power)
GDH	Godaleich Hill Microwave/Repeater
GDS	Gander VHF Switch (Nfld. Telephone)
GFC	Grand Falls Frequency Converter
GFM	Grand Falls Mill (Abitibi Price Co.)
GFS	Grand Falls 25 kV Substation (Nfld. Power)
GIR	Gull Island Repeater
GLB	Glenburnie Terminal Station
GLN	Glenwood Substation (Nfld. Power)
GLK	Grace Lake Repeater
GPH	Gull Pond Hill Microwave
HBK	Hope Brook Terminal Station
HBY	Hawke's Bay Terminal Station
HDN	Hampden Terminal Station
HKH	Hawke's Hill Repeater
HLC	Hinds Lake Control Structure
HLI	Hinds Lake Intake
HLK	Hinds Lake Plant
HLP	Hinds Lake Passive Repeater
HLS	Hinds Lake Spillway
HLY	Howley Terminal Station
HOL	Holyrood Substation (Nfld. Power)
HPR	Hamilton Passive Repeater
HRD	Holyrood Terminal Station
HRL	Harrie Lake Substation
HRP	Holyrood Plant
HTG	Hermitage Repeater
HUD	Hudson Substation

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PROTECTION AND CONTROL
ENGINEERING STANDARD

4.0 List of Standard Site Abbreviations (cont'd.)

HVB	Happy Valley Boiler (DND)
HVD	Happy Valley North Diesel Plant
HVG	Happy Valley Gas Turbine
HVO	Happy Valley Office
HVY	Happy Valley Terminal Station
HWD	Hardwoods Terminal Station
IRV	Indian River Terminal Station
JAM	Jackson's Arm Terminal Station
JAR	Jackson's Arm Repeater
KMT	Kenmount Hill Repeater
LHR	Long Harbour Terminal Station
LLK	Linton Lake Substation (Nfld. Power)
LMR	Lake Melville Repeater (Pine Tree / Dome Mountain)
LOG	Logan Repeater
MBK	Main Brook Terminal Station
MDR	Massey Drive Terminal Station
MFR	Muskrat Falls Repeater
MKS	Monkstown Substation (Nfld. Power)
MMH	Mary March Hill Microwave
MMT	Marble Mountain Substation (Nfld. Power)
MRF	Muskrat Falls Control Structure
MTM	Mount Margaret Repeater
MTN	Millertown Repeater
MYS	Marystown Substation (Nfld. Power)
NLH	Newfoundland and Labrador Hydro (All Sites)
NLP	Newfoundland Power Co. (All Sites)
NSD	North Salmon Dam Control Structure
NTC	Newfoundland Telephone Co. (All Sites)
OPD	Oxen Pond Terminal Station
PAS	Pasadena Substation (Nfld. Power)
PBN	Peter's Barren Terminal Station
PDC	Pond Cove Station
PHR	Petty Harbour Long Pond Passive Repeater
PLD	Portland Creek Repeater
PPD	Parson's Pond Terminal Station
PPT	Plum Point Terminal Station
PRV	Paradise River Plant
PSD	Port Saunders Office
PSR	Port Saunders Repeater
QZT	Quartzite Substation
RAR	Roberts Arm Substation
RCF	Red Cliff Repeater
RDP	Roddickton Diesel Plant
RHR	Rocky Harbour Terminal Station
RLK	Ritchie Lake Repeater
RMH	Roddickton Mini Hydro Plant

4.0 List of Standard Site Abbreviations (cont'd.)

RRE	Rocky Ridge Repeater
RRK	Red Rocks Repeater
RWC	Roddickton Wood Chip Plant
SAM	Snook's Arm Plant
SAO	St. Anthony Office
SAT	St. Anthony Repeater
SBH	Sandy Brook Hill Microwave
SCR	Seal Cove Road Substation (Nfld. Power)
SCV	Sally's Cove Substation
SDP	St. Anthony Diesel Plant
SFD	Sheffield Repeater
SOK	South Brook Terminal Station
SPF	Springfield Substation (Nfld. Power)
SPL	Springdale Terminal Station
SPT	Salt Pond Substation (Nfld. Power)
SRH	Serrated Hills Repeater
SSD	Sunnyside Terminal Station
STA	St. Anthony Airport Terminal Station
STB	Stony Brook Terminal Station
STJ	St. John's Office/Communications Center
SVG	Stephenville Gas Turbine
SVL	Stephenville Terminal Station
SVO	Stephenville Office
SVR	Stephenville Repeater
SWB	South West Brook Repeater
TSS	Town Switching Substation (Labrador City)
USI	Upper Salmon Intake
USL	Upper Salmon Plant
VAN	Vanier Substation
VBT	Venam's Bight Plant
VIC	Victoria Control Structure
VIS	Victoria Spillway
WAB	Wabush Office
WAV	Western Avalon Terminal Station
WBN	Whitbourne Office
WBS	Wabush Towmsite Substation (46/12.5/4.16 kV)
WDL	Wiltondale Terminal Station
WLR	Wilson Lake Repeater
WSS	West Salmon Spillway
WTS	Wabush Terminal Station (230/46 kV)

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No. : P01-080-R0

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GRAPHIC SYMBOLS FOR 2- AND 3- LINE A.C. AND D.C. SCHEMATICS

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APPROVED	V. P. OPERATIONS	85/12/18 DATE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

Graphic Symbols for 2- and 3- Line A.C. and D.C. Schematics

No :	P01-080-R0
Page :	1 of 23
Issued :	1986-01-08
App'd.	L. J. Cole
	T. D. Collett

1.0 Scope

This Standard provides a listing of graphic symbols to be uniformly used in the preparation of 2- and 3- line a.c. and d.c. schematics. In most cases however, they may be easily adopted to single line diagrams. No attempt has been made to cover the application of every control device, terminal, etc., but rather those most commonly used repetitively on terminal and generating station drawings. Standard device designations and ratings will be added where necessary.

2.0 References

Symbols developed in this Standard are generally in accordance with ANSI Standard Y32.2 (also known as CSA Z99 and IEEE 315). This, in turn, tends to follow International Electrotechnical Commission publication 117.

Some symbols other than those of ANSI have been used where either the ANSI symbol was considered unsuitable or just non-existent.

Any symbol not included in this listing shall be selected from the ANSI standards, if applicable. Otherwise, a new symbol shall be used and its function shall be clearly defined on the drawing.

3.0 Size of Symbol

Neither the size of the symbol nor its line width or orientation affects the meaning of the symbol. This Standard attempts to show the relative sizing and line weight to be given the symbols as they are illustrated. However, it is not meant to be a restriction on the use of good drafting practices with respect to drawing layout, spacing, lettering, etc.

4.0 Symbols For Contacts

In gereral terms, a device contact is shown on a drawing in the state that exists when the device is in the non-operated or de-energized position.

The following sub-headings are intended to further clarify this general principle.

4.1 Relay Contacts

Contacts shall be shown with the coil de-energized. In the case of latching relays, contacts shall be shown following a 'normal state' operation and a note shall be added to the drawing stating which coil was last energized. If the manufacturer identifies the coils, for example, 1 and 2 or set and reset, this distinction will be shown on the drawings.

4.2 Power Apparatus Auxiliary Contacts

Auxiliary Contacts on circuit breakers, motorized and manual disconnects and other equipment shall be shown with the equipment in the open position.

'a' auxiliary contacts shall be shown open
'b' auxiliary contacts shall be shown closed

4.3 Control and Selector Switch Contacts

Control and selector switches shall be shown in their normal service condition. For example the station '43S Local/Supervisory' switch shall show the contact status when the switch is in 'Supervisory'. Spring-return-to-normal switches shall show their contacts when in the normal position.

4.4 Non-Electrical Device Contacts

Contacts on non-electrical devices such as pressure and level switches, shall be shown in the normal service position. For example, the gas detector relay contact will be shown open.

5.0 Index

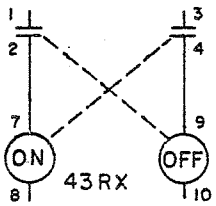
The symbols in this list are indexed in alphabetical order under one of nine categories which were chosen from, and in the most part are consistent with ANSI Standard Y32.2

The categories are listed below to facilitate tracing of the appropriate symbol.

QUALIFYING SYMBOLS

Symbol No.	Symbol	Typical Application	Description
1			Adjustability
			Adjustable resistor
			Connection symbols
			2-phase, 3-wire, ungrounded
			2-phase, 3-wire, grounded
			3-phase, 2-wire, delta ungrounded
			3-phase, 3-wire, delta grounded
			3-phase, 4-wire, delta ungrounded

Symbol No.	Symbol	Typical Application	Description
2			3-phase, 4-wire, delta grounded
			3-phase, open delta, ungrounded
			3-phase, open delta, grounded at common point
			3-phase, open delta grounded at middle point of the winding
			3-phase, broken delta
			3-phase, wye, ungrounded
			3-phase, wye, grounded neutral

Symbol No.	Symbol	Typical Application	Description
2			3-phase, 4-wire, wye ungrounded
			3-phase, zigzag, ungrounded
			3-phase, zigzag, grounded
3			This symbol is used to indicate items which are physically related and should only be used where the items are in close proximity on the diagram.
			Latching relay. Dotted lines show the relationship between coils and contacts.

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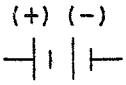
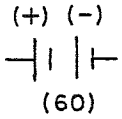
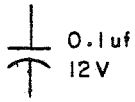
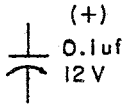
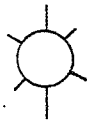
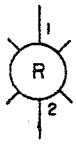
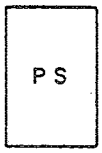
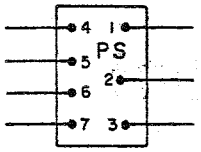
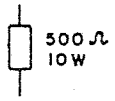
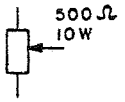
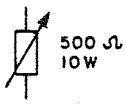
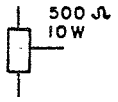
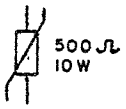
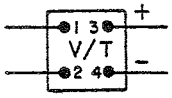
FUNDAMENTAL ITEMS

Symbol No.	Symbol	Typical Application	Description
1			Audible alarm - horn, bell, buzzer, etc.
2			Multi-cell battery bank - the long line is positive and may be designated "+" if so desired
			- number of cell shall be indicated, e.g. 60
3			Capacitor -show capacitance -show voltage rating
			Polarized electrolytic capacitor
4			Convenience Outlet, 120VAC polarized
5			Diode

Symbol No.	Symbol	Typical Application	Description
6			Diode, zener
7			Heater - show watt rating
8			Indicating light
			Indicating light which may contain a built-in resistor. Add lens color designation as follows. R - red G - green A - amber W - white BL - blue Y - yellow N - clear cap with neon lamp
9			Phase shifting transformer
			Phase shifting transformer 2 - element type

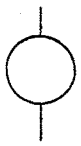
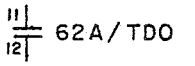
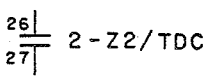
Symbol No.	Symbol	Typical Application	Description
10			Resistor - (fixed) - show resistance - show watt rating
			Resistor with variable tap (3-terminal device)
			Adjustable resistor (2-terminal device)
			Resistor - fixed tap
			Resistor - nonlinear (intrinsic)
11			Transducer
			Voltage tranducer; show relative polarities on the output. For watt and var tranducers, show the output on the voltage circuit.

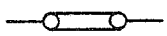
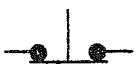
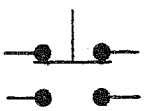
TRANSMISSION PATH

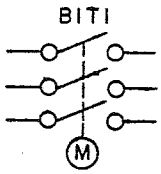
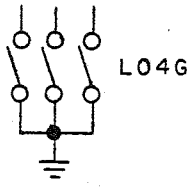
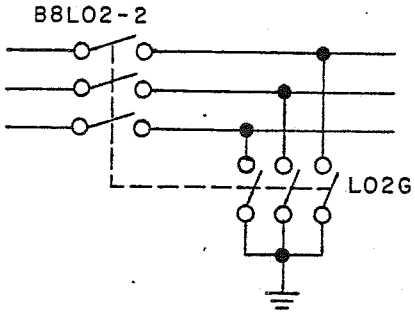
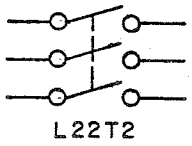
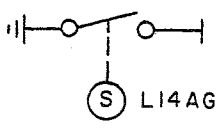
Symbol No.	Symbol	Typical Application	Description
1			Bus bar, with connections shown - used to highlight certain circuits
2			General symbol for one conductor/wire
			Junction of conductors/ wires
			Crossover junction-connected path
			Crossover only - without connection
3			Ground connection. A conducting path or connection to the station ground grid

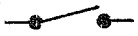
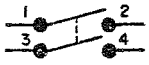
Symbol No.	Symbol	Typical Application	Description
4			Interrupted path. Each path is shown on each side of a diagrammatic interruption.

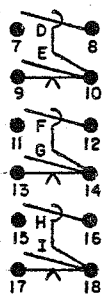
CONTACTS, SWITCHES, CONTACTORS AND RELAYS

Symbol No.	Symbol	Typical Application	Description
1			Coil; relay, meter or counter
			Undervoltage relay; add device designations and coil terminal numbers.
2			Normally open contact. Actuating media to close may be an electrical coil, selector switch, device auxiliary switch, etc.
			Device 62A Open contact with time-delay opening (TDO)
			Device 2-Z2 Open contact with time-delay closing (TDC)
3			Normally closed contact. Actuating media to open may be an electrical coil, selector switch, device auxiliary switch, etc.

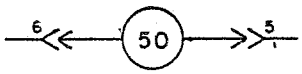
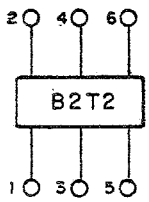
Symbol No.	Symbol	Typical Application	Description
3		26 / 27 2-Z2/TDO	Device 2-Z2 Closed contact with time-delay opening (TDO)
		16 / 17 62A/TDC	Device 62A Closed contact with time delay closing (TDC)
4			Mechanical isolating link; typically refers to a removable section of busbar
5			Push button, momentary or maintained.
			Normally open, push to close, spring return to open.
			Normally closed, push to open, spring return to close.
			Two circuit push button switch.

Symbol No.	Symbol	Typical Application	Description
6			Switch; high voltage disconnect or ground
			3-phase, group operated motorized disconnect. Add system equipment number.
			3-phase, group operated ground switch. Add system equipment number.
			3-phase, group operated disconnect with 3-phase group operated ground switch interlocked. Add system equipment numbers.
			3-phase, group operated manual disconnect. Add system equipment number.
			Single phase, high speed, solenoid operated ground switch. Add system number.

Symbol No.	Symbol	Typical Application	Description
7			Switch; knife or blocking. Typically used for the isolation of low voltage circuits.
			Double pole, single throw, ganged knife switch.
8			Limit switch, normally open, directly actuated, spring returned.
9			Limit switch, normally open, held closed.
10			Limit switch, normally closed.
11			Limit switch, normally closed, held open.
12			Pressure switch, closes on rising pressure. Add pressure setting and arrow to indicate whether setting is on rising or dropping pressure.

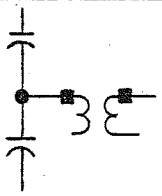
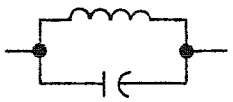
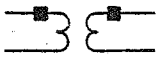
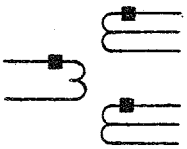
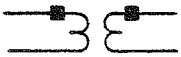
Symbol No.	Symbol	Typical Application	Description
13			Pressure switch, open on rising pressure. Add pressure setting and arrow to indicate whether setting is on rising or dropping pressure.
14	CONTACT / INDICATOR POSITION: A, B, C 1-2: X 3-4: X 5-6: X 7-8: X X-INDICATES CONTACT CLOSED		Switch, master or control. A table of contact operation must be shown on the switch development drawing.
		43TT CONTACT / INDICATOR POSITION: ON, OFF 1-2: X 3-4: X 5-6: X X-INDICATES CONTACT CLOSED	Carrier transfer trip switch, 43TT. Number of contacts and arrangement vary with the application.
15	 18TS1		Test switch. Current switch grouping only is shown. Potential switches although a part of the same unit are usually separated on the diagram. Add test switch designation.

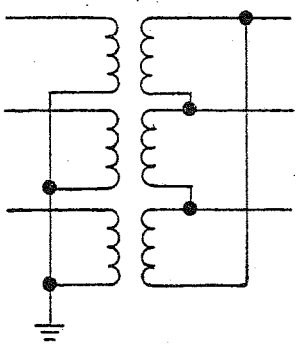
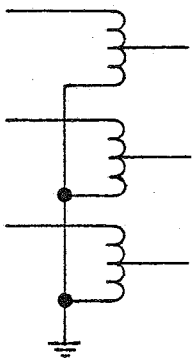
TERMINALS AND CONNECTORS

Symbol No.	Symbol	Typical Application	Description
1			Male plug, jack, connector or disconnecting device.
2			Female plug, jack, connector, or disconnecting device.
			Separable connectors, engaged. Add appropriate number, if required.
3			Power apparatus high voltage terminal. Typically used to denote transformer bushings, breaker terminals, etc.
			Power circuit breaker bushings. Bushings must be numbered if the breaker is assymetrical. Add system equipment designation.
4			Terminal on switchboard terminal block.

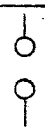
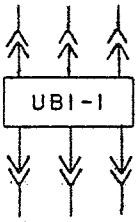
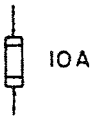
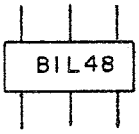
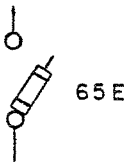
Symbol No.	Symbol	Typical Application	Description
4		7XA2	Terminal XA2 on Panel No. 7
5			Terminal on power apparatus main terminal block, e.g. breaker, MOD and power transformer.
6			Terminal on power apparatus secondary terminal block.
7			Terminal located in the supervisory junction box.
8			Terminal located in a marshalling cabinet or junction box.
			NOTE: Other symbols may be developed for addtional special applications. The uses of such symbols and their description must be detailed on the drawings.
			Denotes terminal strip mounted on ASEA combiflex relay case.

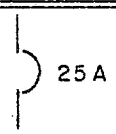
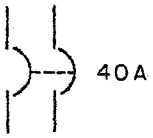
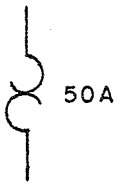
TRANSFORMERS, INDUCTORS AND WINDINGS

Symbol No.	Symbol	Typical Application	Description
1			Capacitive voltage transformer equipped with carrier coupling facility; show polarity markings.
2			Carrier wave trap.
3			Current transformer; show polarity markings.
4			Electromagnetic instrument transformer, show polarity markings.
			- potential transformers
			- with 2 secondaries and tap
			- two winding current transformers
5			Power transformer winding

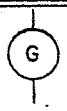
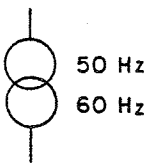
Symbol No.	Symbol	Typical Application	Description
5			3-phase or bank of 3 single phase transformers, without tertiary, connected grounded-wye/delta.
			3-phase auto-transformer, grounded wye/wye.

CIRCUIT PROTECTORS

Symbol No.	Symbol	Typical Application	Description
1			Lightning arrestor.
2			Draw-out type circuit breaker. Add plant equipment number.
3			Fuse; show ampere rating.
4			Fuse replaced by a solid link (dummy fuse).
5			Interrupting device, e.g. circuit breaker or recloser. Add system equipment number.
6			Power fuse; show ampere rating and element characteristic.

Symbol No.	Symbol	Typical Application	Description
7			Thermal breaker; show ampere rating.
			- double pole breaker
8			Thermal element; show ampere rating

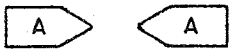
ROTATING MACHINES

Symbol No.	Symbol	Typical Applications	Description
1			Generator
2			Motor
			A.C. motor
			D.C. motor
3			Rotary frequency converter; show frequencies on both sides.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

MISCELLANEOUS

Symbol No.	Symbol	Typical Application	Description
1			This symbol is used to indicate a connection on an A.C. or D.C. schematic where it is inconvenient to draw the connection in. A letter is used as a reference to match up corresponding connection points. The point gives the direction to go to find the corresponding connection point. (Points should line up.)

HYDRO

PROTECTION AND CONTROL
ENGINEERING STANDARD

Number:	P13-INDEX-R1
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Issued:	1994-03-24
App'd :	E&CS: -
	Oper: -

INSTRUMENT TRANSFORMERS - INDEX

STANDARD NO.	TITLE
P13-010-R0	Capacitor Voltage Transformers
P13-030-R0	Potential/Current Transformer Junction Boxes

HYDRO PROTECTION AND CONTROL ENGINEERING STANDARD	Number: P13-010-R0	
	Page : 1	
	Issued: 1994-02-02	
CAPACITOR VOLTAGE TRANSFORMERS	App'd :	E&CS: D. W. Reeves
		Oper: T. D. Collett

1.0 SCOPE

This Standard establishes the technical requirements for Capacitor Voltage Transformers (CVTs) on the power system. It does not include the requirements for the installation, insulation rating or physical arrangement of the CVTs.

2.0 APPLICATION

CVTs are used to provide a low voltage supply source for protective relaying and metering. CVTs are also used for Power Line Carrier (PLC) coupling applications.

It is normal practice to use CVTs on 138 kV and above.

3.0 TECHNICAL REQUIREMENTS

3.1 Ratios and Voltages

Two secondaries shall be required, with dual ratios on each secondary, rated at 115 V and 69 V line-to-neutral. Standard ratios shall be as below:

Nominal primary voltage	Standard ratios	Actual secondary voltage
230 kV	1200:1/2000:1	110.7/66.4 V
138 kV	700:1/1200:1	113.8/66.4 V
69 kV	350:1/ 600:1	113.8/66.4 V

3.2 Accuracy and Burden Rating

The accuracy and burden rating shall be governed by CSA C13, Sections 5.2 and 5.3.

Typically, for relaying and statistical metering, a 0.6 accuracy class CVT shall be used with 200 VA burden for transmission lines (0.6 W,X,Y,Z), and with 400 VA burden for load buses (0.6 W,X,Y,Z,ZZ). The actual choice of VA rating will depend on the specific application.

For revenue metering a 0.3 accuracy class CVT shall be used and shall be approved by the appropriate Federal agency.

3.3 Thermal Burden Rating

The thermal burden rating of CVTs used in terminal stations shall be a minimum of 1000 VA.

3.4 Capacitance

In general, the total capacitance (C1+C2) of the CVT installed for use with Power Line Carrier equipment varies from 3000 pF to 11000 pF.

The exact value shall meet the minimum requirement as specified in the Telecontrol Engineering Standard number TC05-001.

3.5 Transient Performance

Linear transient error (transient response) shall be less than 10% of the crest of residual voltage in 1 cycle and ferroresonance suppression less than 10% of crest in 200 ms at 120% of rated voltage.

3.6 Fuse Protection

The CVT shall withstand secondary short circuit current continuously, therefore no fuses are required in the connection box on the CVT. However, 30 A fuses shall be provided in the P.T. junction box for downstream protection.

3.7 Miscellaneous Requirements

The CVT base box shall contain adequate power line protective circuitry such as a choke coil, spark gap, ferroresonance supression and harmonic suppression as well as a suitable ground switch. When equipped for use with carrier the CVT base box shall also contain the required accessories which include a drain coil, spark gap and a suitable carrier grounding switch. The base box and the low voltage connection box shall be made of die cast high strength corrosion resistant aluminum alloy.

The connection box shall contain tin plated brass stud terminals. A cutout, with nominal dimension of 100 mm x 130 mm, shall be provided at the bottom of the box for wiring access. The cutout shall be complete with a gland plate. The connection box shall also contain a suitable 120 V ac heater for anti-condensation.

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PROTECTION AND CONTROL ENGINEERING STANDARD

Number:	P13-030-R0
Page :	1 of 2
Issued:	1994-03-24
App'd :	E&CS: D. W. Reeves
	Oper: T. D. Collett

POTENTIAL/CURRENT TRANSFORMER JUNCTION BOXES

1.0 SCOPE

This Standard covers the general concepts, construction, wiring and layout of junction boxes used for potential and current transformers, rated 12.5 kV and above.

2.0 GENERAL CONCEPTS

2.1 Potential Transformer (PT)

Drawing P13-030-D1 shows a typical connection and layout of a junction box for a three phase PT.

Drawing P13-030-D2 shows a typical connection and layout of a junction box for a single phase PT.

2.2 Current Transformer (CT)

Non-bushing type CTs shall have a separate junction box. For applications where high voltage outages are not easily obtained additional ratios shall be wired to the junction box to facilitate future changes. The additional ratios required shall depend on the specific application. For those applications a design similar to Drawing P13-030-D3 shall be used. In locations such as ring buses where outages are more easily obtained, a design similar to Drawing P13-030-D4 shall be used.

3.0 CONSTRUCTION

The junction box shall be constructed of a fibreglass reinforced material built to CEMA/NEMA 4X classification. It shall be supplied complete with an inner metal mounting plate. All metal parts within the box shall be grounded through a ground lug. The hinges and latches shall be constructed of a fibreglass reinforced polyester or stainless steel. The junction box access door shall be hinged such that it will swing open in a horizontal plane.

4.0 DIMENSIONS

The size of the junction box shall be determined by the specific application. To allow ease of wiring and terminating cables, the minimum margin between equipment and between the equipment and the sides of the box shall be 5 cm. The depth of the box shall be approximately 15 cm for CTs and 20 cm for PTs.

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PROTECTION AND CONTROL
ENGINEERING STANDARD

Number:	P13-030-R0
Page :	2 of 2
Issued:	1994-03-24

4.0 DIMENSIONS (cont'd)

Typical sizes shall be as follows:

	Depth x Width x Height	
a)	20 cm x 45 cm x 60 cm	3 phase PT Box
b)	20 cm x 30 cm x 45 cm	1 phase PT Box
c)	15 cm x 30 cm x 45 cm	CT Box (24 Terminals Maximum)
d)	15 cm x 45 cm x 60 cm	CT Box (48 Terminals Maximum)

5.0 CABLE ACCESS

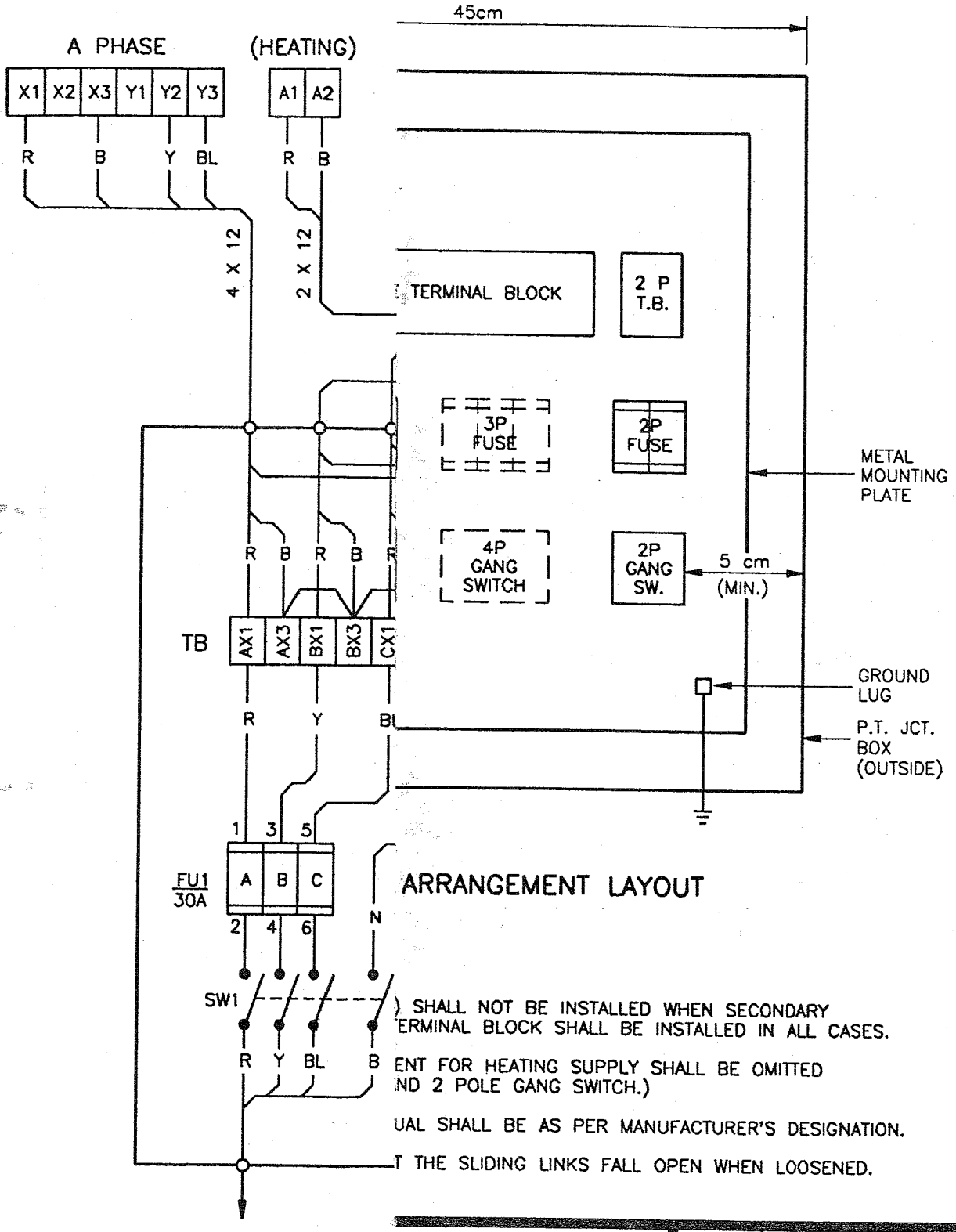
Cable access to the junction box shall be made by PVC or Flexible (Liquid Tight) conduit. Any PVC conduit from the ground (direct burial) to the junction box shall be fitted with a PVC expansion joint. All conduit connections shall be made to the bottom of the junction box. To allow ease of conduit and cable installation, the minium margin between the equipment and the bottom of the box shall be 10 cm.

6.0 CONNECTION DIAGRAMS

Typical connection diagrams as noted below form an integral part of this standard.

P13-030-D1	3 ϕ Potential Transformer Junction Box (Connection and Layout)
P13-030-D2	Single ϕ Potential Transformer Junction Box (Connection and Layout)
P13-030-D3	Current Transformer Multi-Ratio (Connection and Layout)
P13-030-D4	Current Transformer Single Ratio (Connection and Layout)

JUNCTION BOX



ARRANGEMENT LAYOUT

) SHALL NOT BE INSTALLED WHEN SECONDARY
ERMINAL BLOCK SHALL BE INSTALLED IN ALL CASES.

ENT FOR HEATING SUPPLY SHALL BE OMITTED
ND 2 POLE GANG SWITCH.)

UAL SHALL BE AS PER MANUFACTURER'S DESIGNATION.

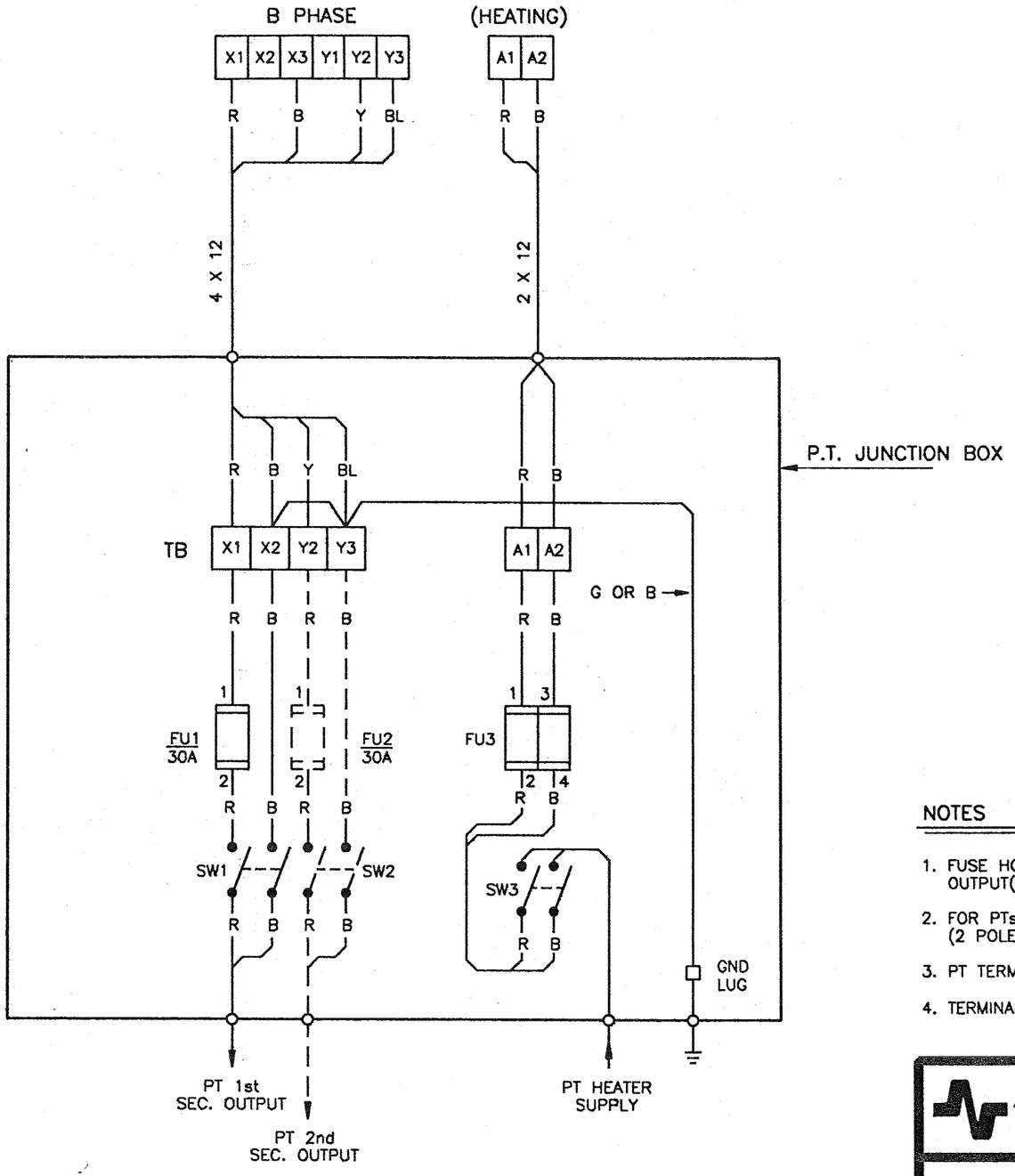
T THE SLIDING LINKS FALL OPEN WHEN LOOSENED.

CONTROL
ANDARDS

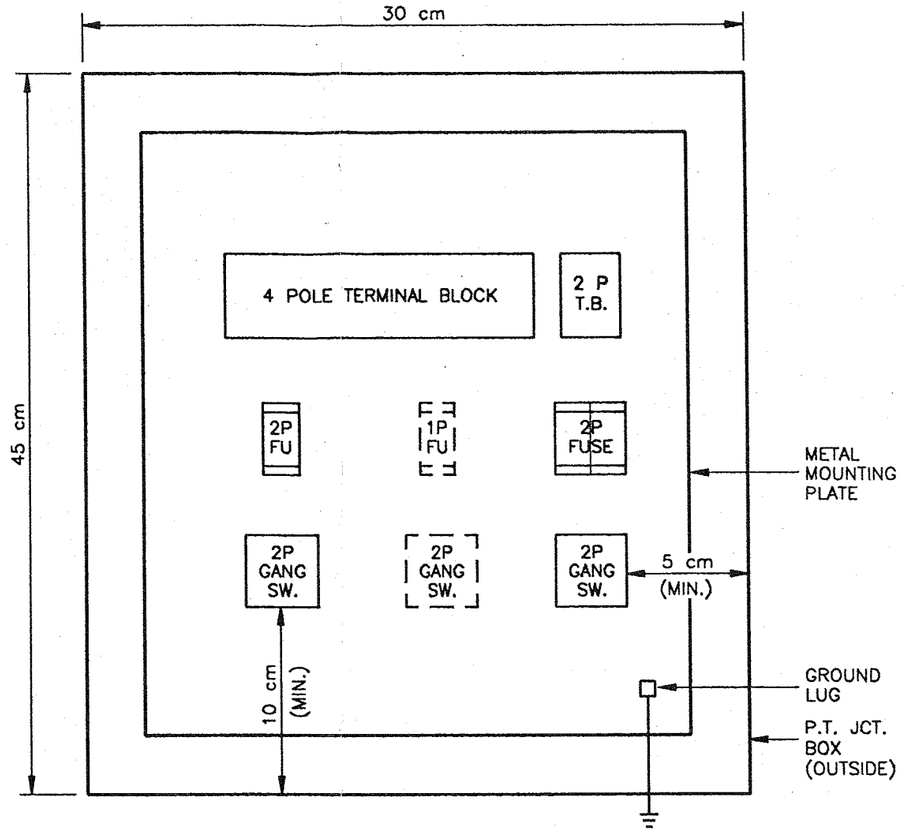
JNCTION BOX
)UT)

APP'D	D. W. REEVES		
	T. D. COLLETT		
ISSUED	1994-03-24		
DRAWN	W.B.	SCALE	N.T.S.
CHECKED	D. CULL		
DWG.NO.	P13-030-D1-R0		

SINGLE ø PT CONNECTION



PT JUNCTION BOX



EQUIPMENT ARRANGEMENT LAYOUT

NOTES

1. FUSE HOLDER(S) AND ASSOCIATED GANG SWITCH(ES) SHALL NOT BE INSTALLED WHEN SECONDARY OUTPUT(S) IS NOT USED, HOWEVER THE 4 POLE TERMINAL BLOCK SHALL BE INSTALLED IN ALL CASES.
2. FOR PTs WITHOUT HEATER, ALL ASSOCIATED EQUIPMENT FOR HEATING SUPPLY SHALL BE OMITTED (2 POLE TERMNAL BLOCK, DOUBLE FUSE HOLDER AND 2 POLE GANG SWITCH.)
3. PT TERMINAL DESIGNATIONS ARE TYPICAL ONLY. ACTUAL SHALL BE AS PER MANUFACTURER'S DESIGNATION.
4. TERMINAL BLOCKS SHALL BE POSITIONED SUCH THAT THE SLIDING LINKS FALL OPEN WHEN LOOSENED.

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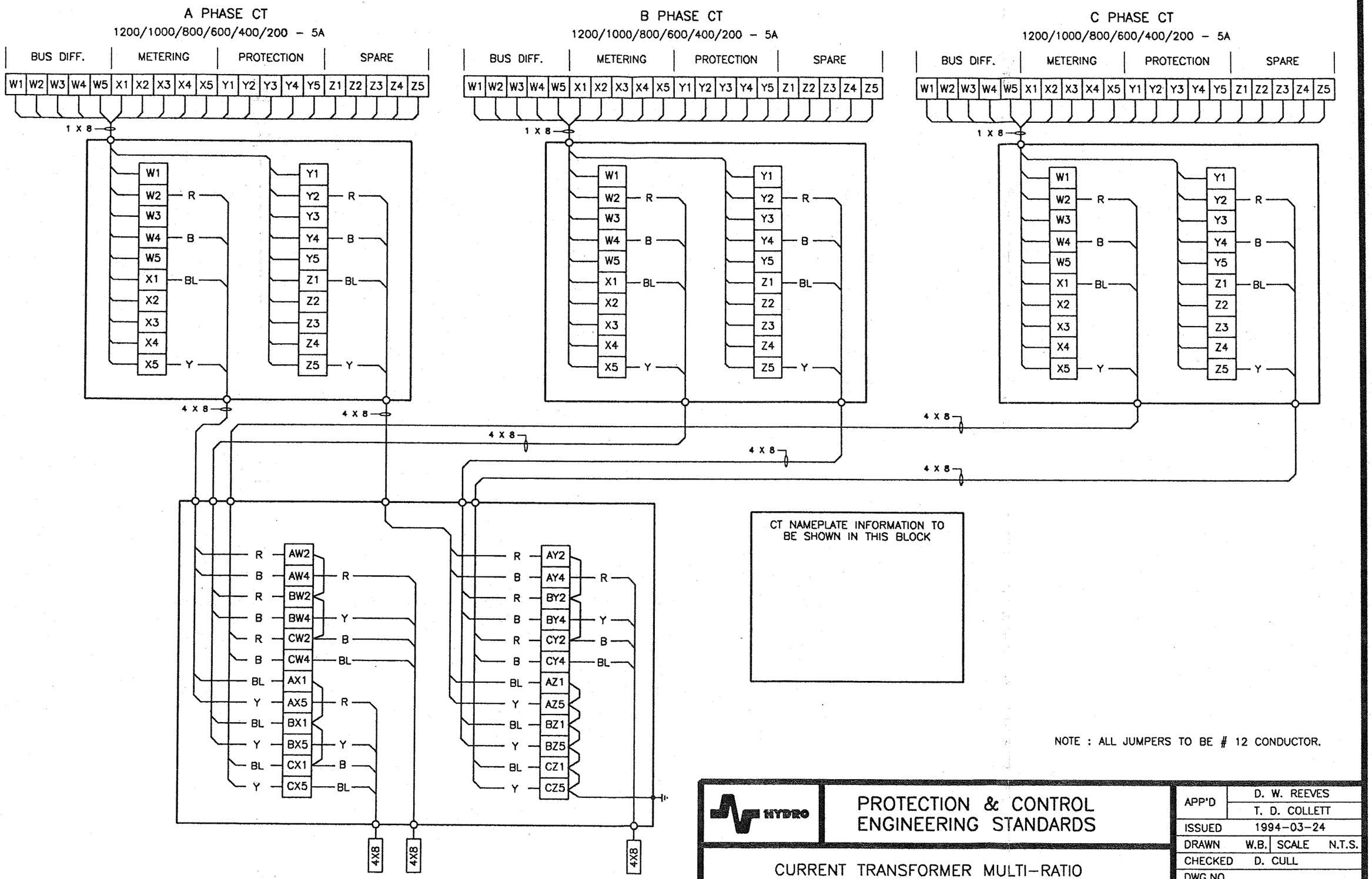
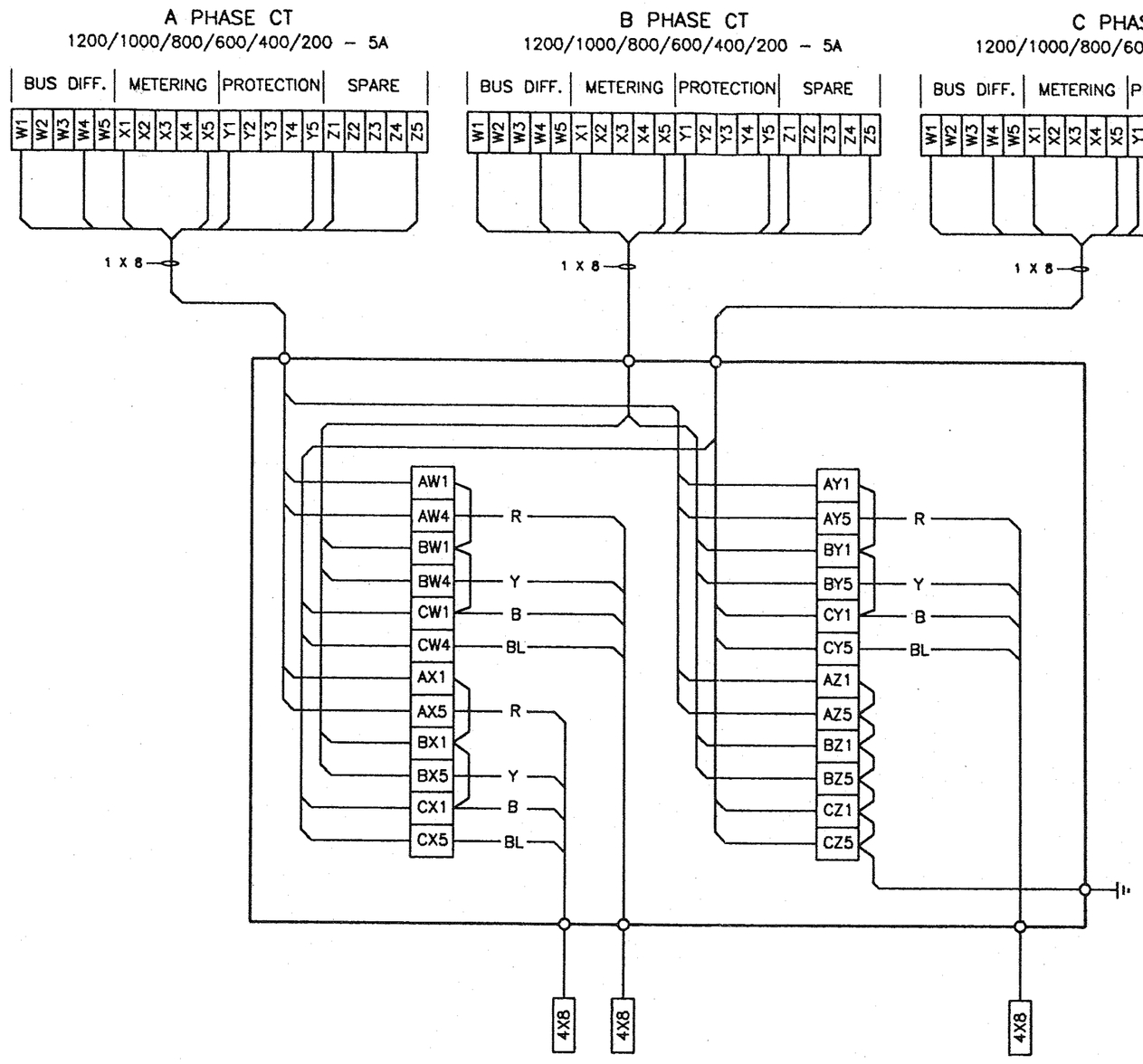
PROTECTION & CONTROL ENGINEERING STANDARDS

SINGLE ø POTENTIAL TRANSFORMER JUNCTION BOX (CONNECTION AND LAYOUT)

APP'D	D. W. REEVES		
	T. D. COLLETT		
ISSUED	1994-03-24		
DRAWN	W.B.	SCALE	N.T.S.
CHECKED	D. CULL		
DWG.NO.	P13-030-D2-R0		


A PHASE CT
1200/1000/800/600/400/200 – 5A
B PHASE CT
1200/1000/800/600/400/200 – 5A
C PHASE CT
1200/1000/800/600/400/200 – 5A
BUS DIFF.
METERING
PROTECTION
SPARE
W1 W2 W3 W4 W5 X1 X2 X3 X4 X5 Y1 Y2 Y3 Y4 Y5 Z1 Z2 Z3 Z4 Z5
1 X 8
4 X 8
R
B
BL
Y
AW2 AW4 BW2 BW4 CW2 CW4 AX1 AX5 BX1 BX5 CX1 CX5
AY2 AY4 BY2 BY4 CY2 CY4 AZ1 AZ5 BZ1 BZ5 CZ1 CZ5
4X8
CT NAMEPLATE INFORMATION TO BE SHOWN IN THIS BLOCK
NOTE : ALL JUMPERS TO BE # 12 CONDUCTOR.
HYDRO
PROTECTION & CONTROL ENGINEERING STANDARDS
CURRENT TRANSFORMER MULTI–RATIO (CONNECTION AND LAYOUT)
APP'D D. W. REEVES
T. D. COLLETT
ISSUED 1994–03–24
DRAWN W.B. SCALE N.T.S.
CHECKED D. CULL
DWG.NO. P13–030–D3–R0



CT NAMEPLATE INFORMATION TO BE SHOWN IN THIS BLOCK

NOTE : ALL JUMPERS TO BE # 12 CONDUCTOR.

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

CURRENT TRANSFORMER SINGLE RATIO
(CONNECTION AND LAYOUT)

APP'D	D. W. REEVES
	T. D. COLLETT
ISSUED	1994-03-24
DRAWN	W.B.
SCALE	N.T.S.
CHECKED	D. CULL
DWG.NO.	P13-030-D4-R0

HYDRO

PROTECTION AND CONTROL ENGINEERING STANDARD

Number:	P15-INDEX-R3
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Issued:	1994-03-24
App'd : E&CS:	-
Oper:	-

STATION CONTROL, METERING AND ANNUNCIATION - INDEX

STANDARD NO.	TITLE
P15-001-R0	Terminal Station Control
P15-010-R0	Synchronizing
P15-025-R0	Switchboard Meters
P15-030-R0	Transducers
P15-080-R0	Terminal Station Annunciators

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No.: P15-001-R0

Issued: 1986-01-08

TERMINAL STATION CONTROL

TRANSMITTAL PREPARATION DATE : 1985-09-09

SUBMITTED	CHMN. P & C STD'S COMM.	85-09-13 DATE
RECOMMENDED	CHMN. ENG. STD'S REVIEW COMM.	85-10-30 DATE
APPROVED	V. P. ENG. & CONSTR.	85-11-07 DATE
APPROVED	V. P. OPERATIONS	85-11-19 DATE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TERMINAL STATION CONTROL

No :	P15-001-R0
Page :	1 of 9
Issued :	1986-01-08
App'd.	L. J. Cole
	T. D. Collett

1.0 Scope

This Standard formulates the local/remote/supervisory control criteria for terminal stations. The operational aspects of various equipment including circuit breakers, motor operated disconnects and on-load tap changers as well as their complementary control schemes, such as synchronizing and reclosing are covered. The subject of equipment isolation for personnel safety is not addressed in this standard.

The unique conditions encountered in generating stations and their associated terminals are covered in P15-002.

2.0 General Arrangement

Terminal stations basically come under two distinct groupings for control purposes, those without and those with supervisory control facilities. The criteria for the control of each device and logic scheme for both groups are developed in turn.

3.0 Stations Without Supervisory Control

For those stations under this grouping, control may be possible from two separate locations:

1. Directly at the device itself, e.g. outdoor LTC compartment or outdoor breaker cabinet. Under this condition, the device is said to be in "LOCAL" control.

2. Remotely from the device, e.g. control room, or outdoor common-control enclosure. Under this condition the device is said to be in "REMOTE" control. For the purpose of this standard the phrases 'control room' and 'outdoor common control enclosure' may be interchanged as applicable.

3.1 High Voltage Circuit Breakers

Circuit breakers will have a "LOCAL-REMOTE" switch and a "TRIP-CLOSE" switch incorporated as part of the intergral control circuitry of their outdoor control cabinet.

3.1.1 Protection Operations

Tripping of the breaker by the operation of a protective device will be independent of all selector switches. Subsequent reclosing, if any, is only permitted with the selector switch in 'REMOTE'.

3.1.2 Interlocks

Regardless of selector switch position, all closing control will be interlocked with various station protective relays such as transformer and bus lockouts as well as the breakers inherent self-protection devices such as low gas pressure, density and the like. In applications where a service restorer scheme is utilized the transformer interlock with the breaker closing control may be by-passed by a transformer high side disconnect auxiliary contact.

3.1.3 Standard Features

Standard features of the breaker control circuitry will include anti-pump logic, operations counters (on a per phase basis for those breakers designed for single-pole tripping) and disagreement tripping/alarm functions where applicable.

3.1.4 Local Control

With the selector switch in "LOCAL", controlled closing and tripping of the breaker is only possible with the "TRIP-CLOSE" selector switch located in the breaker's outdoor cabinet. Closing of the breaker under these conditions is not monitored by the synchronizing equipment but is supervised by the interlock circuit.

3.1.5 Remote Control

With the selector switch in "REMOTE" controlled closing and tripping of the breaker is only possible with the "TRIP-CLOSE" selector switch located on the control room panel. Closing of the breaker under these conditions is monitored by the manual or automatic synchronizing logic and is supervised by the interlock circuit.

3.2 Motor Operated Disconnects (MOD's)

All disconnect switches, 230 kV and above, will be motorized in attempts to improve the safety conditions of terminal operators and facilitate operation of the switches.

Disconnects located between the high voltage bushings of power transformers and the high voltage bus may be motorized to facilitate protection functions and transformer energization. With the exception of 230 kV and above, MOD's will not be required if there is a dedicated high side breaker.

3.2.1. Interlocks

The controlled opening or closing of MOD's will be monitored by certain interlocks regardless of the position of the "LOCAL-REMOTE" switch. For example, line disconnects will be interlocked with their associated breaker and high side transformer MOD's will be interlocked with applicable low side breakers and associated protective devices.

The "OPEN", "CLOSE" circuits will be interlocked with each other and sealed in to ensure that only one command may be executed at any time and that once issued, must be completed regardless of subsequent commands, interlock status changes or protective device operations.

3.2.2 Motor-Manual Control

All MOD's will be equipped with a "MOTOR-MANUAL" transfer switch. When placed in the "MANUAL" position, the motor and control circuits are de-energized and the motor is decoupled from the drive mechanism. Under these conditions, operation of the disconnect is only possible by manual means. For any electrical operation the transfer switch must be in "MOTOR".

3.2.3 Local-Remote Control

In addition, the MOD's will have a "LOCAL-REMOTE" selector switch and "OPEN", "CLOSE" pushbuttons in the outdoor control cabinet. When in the "LOCAL" position, controlled opening and closing of the MOD is only possible from the outdoor cabinet. When in the "REMOTE" position, controlled opening and closing are only possible with the "OPEN-CLOSE" selector switch on the control room panel.

In the case of disconnects operated by a protective device, opening of the MOD is not contingent upon the position of the "LOCAL-REMOTE", selector switch nor the status of any breaker interlocks.

3.3 Transformer on-Load Tap Changers (LTC's)

Transformers equipped with on-load tap changers will have "LOCAL-REMOTE" "AUTO-MANUAL" and "RAISE-LOWER" selector switches located in their outdoor control cabinets. If the LTC drive unit itself is such that it has built-in operational controls, then operation at the drive is only possible with the selector switch in "LOCAL".

3.3.1 Standard Features

Standard features of the LTC will include emergency hand-crank drive, extreme tap cut-off, raise-lower interlock, individual timers for initial and subsequent step delays when being controlled by the regulating relay, and equipment for parallel operation using the circulating current method.

The control circuitry will ensure that once a raise or lower command is issued, it will be completed. Should control voltage be lost during a tap change, the operation will automatically be completed upon voltage restoration.

3.3.2 Local Control

With the "LOCAL-REMOTE" switch in "LOCAL", control of the LTC is only possible from the transformers outdoor control cabinet and the drive unit, if applicable. Under this status, control may be selected as either "AUTO-MANUAL" and if "AUTO", the LTC will be governed by the voltage regulating relay setpoint. Should "MANUAL" be chosen, the automatic circuit is negated and operation is accomplished via the "RAISE-LOWER" selector switch.

3.3.3 Remote Control

With the "LOCAL-REMOTE" switch in "REMOTE" control of the LTC is transferred to the control room panel which contains both an "AUTO-MANUAL" and "RAISE LOWER" selector switch. With the "MANUAL" position chosen, control of the LTC is via the control room panel "RAISE-LOWER" switch only. When placed in the "AUTO" position, the tap changer is normally under the control of the voltage regulating relay. However, in many instances, the LTC is used for voltage matching when low-side breakers are being synchronized. Under such conditions, the command to synchronize an applicable breaker will actuate an auxiliary relay to isolate the regulating relay circuit and enable the synchronizing voltage matching equipment. When the synchronizing logic resets either upon successful breaker closing or an incomplete sequence, the LTC will revert to control of the regulating relay.

3.4 Reclosers

For the purposes of this Standard, the term "recloser" will be synonymous with the relay logic package that is applied to individual high voltage circuit breakers.

Whether the recloser is enabled, or not, will be determined by an "ON-OFF" selector switch on the control room panel. For those breakers in a ring bus, breaker-and-a-half or similar scheme, the control switches will supervise the reclosing of each line. That is, both breakers associated with a particular line will be either enabled, or disabled, by the same switch.

3.4.1 Single-Pole Reclosers

With the selector switch in the "ON" position, the reclosing circuits are set up to attempt a single-pole reclose if the initiating and subsequent input signals are correct.

With the selector switch in the "OFF" position, the recloser logic will initiate three-pole tripping without reclosing.

3.4.2 Three-Pole Recloser

With the selector switch in the "ON" position, the reclosing logic is enabled and will attempt three-pole reclosing when initiated.

With the selector switch in the "OFF" position, the reclosing logic is completely disabled.

Three pole reclosing will be supervised by either the automatic synchronizing or the dead line/bus verification logic.

3.5 Synchronizing

Circuit breakers may be synchronized in either the manual or automatic mode. Standard equipment provided in a station synchronizing scheme may include synchronizing, sync-check and voltage matching relays together with 'incoming' and 'running' voltmeters, synchroscope and auxiliary logic relays.

3.5.1 Automatic Synchronizing

If automatic synchronizing facilities are provided in a terminal, they will be controlled by a synchronizing selector switch. This switch will have three positions, designated "AUTO-OFF-TEST".

When in the "AUTO" position, operation of the appropriate breaker control switch in the control room to the "CLOSE" position will initiate the automatic synchronizing logic. When the synchronizing parameters of voltage, phase angle and frequency fall within predetermined limits, the logic sends the close signal to the selected breaker.

When in the "OFF" position, all the automatic synchronizing logic is electrically isolated.

When in the "TEST" position, the sequential operation of the logic is identical to when in "AUTO" except the actual close pulse is not transmitted to the breaker.

3.5.2 Manual Synchronizing

Each breaker for which manual synchronizing is intended will have a manual synchronizing "ON-OFF" selector switch, spring return to the "OFF" position, mounted adjacent to the breaker control switch on the control room panel.

With this switch in the"ON" position, the "incoming" and "running" voltmeters as well as the synchroscope are energized. Also, the manual synchronizing circuits of the breaker close logic is enabled.

A closing signal to the breaker can only be initiated by holding the manual synchronizing switch in the "ON" position and turning the breaker control switch to the "CLOSE" position.

3.5.3 Interlocks

The automatic and manual circuits are interlocked by the specific arrangement of the "AUTO-OFF-TEST" switch and the "ON-OFF" selector switches.

The "AUTO-OFF-TEST" switch has an operating handle which is only removable in the "OFF" position. This handle is keyed to fit the various manual synchronizing "ON-OFF" switches in the station.

Standard practice will be to have only one such switch handle available in any terminal station. To manually synchronize any breaker, the automatic circuit is isolated by removing the operating handle from the "AUTO-OFF-TEST" switch and inserting it in the appropriate manual synchronizing "ON-OFF" switch.

4.0 Stations with Supervisory Control

For those stations under this grouping, control is normally from the control center via one or more communications links.

These terminals will be equipped with an overall station control selector switch, designated 43S, mounted on a relay panel in the control room. This switch will have positions "LOCAL-SUPERVISORY" and will determine the 'point of control' for many of the stations devices and logic functions.

4.1 High Voltage Circuit Breakers

With the station's 43S switch in "LOCAL", the breaker may only be operated as in described in Sections 3.1.1 through 3.1.5.

When the 43S switch is turned to "SUPERVISORY" tripping and automatic synchronizing from the control room is disabled: manual synchronizing is still possible. Controlled tripping and closing is now possible from the control center. In this mode, all closing from the control center is through the automatic synchronizing logic.

Regardless of the 43S switch position, operation of the breaker from its outdoor cabinet is permitted provided the selector switch in the cabinet is in "LOCAL".

The operation of protective devices is as described in Section 3.1.1 and standard features as per 3.1.3.

4.1.1 Interlocks

The interlocking logic will be as described as per Section 3.1.2 with the following exception. For those applications where the transformer protection opens the transformer high-side disconnect, and a service restorer is not employed, auxiliary contacts from the MOD can be used to short circuit the lockout contact in the close circuit of the high side breaker(s). This will only be incorporated into the design provided it can decrease the restoration time of a system component.

An example is where a transformer is connected between two line breakers.

4.2 Motor Operated Disconnects (MOD's)

Operation of line MOD's from the control center is not provided. As such, Sections 3.2.1 through 3.2.3 will apply where appropriate.

Transformer high-side disconnects may be operated via the supervisory system. If the selector switch in the MOD outdoor cabinet is in "LOCAL", control is only possible at this cabinet. When the "REMOTE" position is selected, control may be from either the terminal station control room panel or the control center depending upon the 43S switch. Should the 43S switch be in "LOCAL", control is confined to the terminal station control room. When the 43S is in "SUPERVISORY", control is transferred to the control center.

All other aspects of Sections 3.2.1 through 3.2.3 will remain in effect.

4.3 Transformer On-Load Tap Changers (LTC's)

The supervisory control of on-load tap changers will include the selection of "AUTO-MANUAL" modes and direct "RAISE-LOWER" functions of the LTC.

Supervisory control is only possible with the transformer outdoor cabinet selection switch in "REMOTE". If this switch is in "LOCAL", control must be as per Section 3.3.3.

When in "REMOTE", the 'point of control' is determined by the 43S switch. Should the 43S be in "LOCAL", operation is only possible as per Section 3.3.3.

Should the 43S be in "SUPERVISORY", control of the tap changer is transferred to the control center. Under these conditions, the LTC may be placed in "AUTO" or "MANUAL" by remote control of a latching relay in the terminal station. When "AUTO" is selected, the LTC is under the supervision of the voltage regulating relay. When "MANUAL" is selected, the voltage regulating relay is disabled and the transformer may be stepped to any desired tap by the "RAISE-LOWER" functions from the control center.

If the station is returned to "LOCAL" control, the latching relay is controlled by the "AUTO-MANUAL" switch on the control room panel. On changing the position of the 43S switch, the state of the latching relay will not be affected.

4.4 Reclosers

All terminals with supervisory control will be designed so that reclosers may be disabled and enabled from the control center.

Control of the recloser "ON-OFF" function from the control center will be possible only with the 43S switch in "SUPERVISORY". However, control from the terminal station control room panel is independant of the 43S switch. The recloser logic "ON-OFF" functions will be remotely controlled with a latching relay. The logic will be arranged such that if either the recloser local selector switch is "OFF" or the supervisory "OFF" function is selected, reclosing is disabled.

All the aspects of Sections 3.4 through 3.4.2 will apply.

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SYNCHRONIZING	App'd :	E&CS: D. W. Reeves
		Oper: T. D. Collett

1.0 SCOPE

This standard covers the application, control logic, general arrangement and technical requirements for synchronizing in generating and terminal stations. Diesel plants are not covered by this standard.

2.0 APPLICATION

All generating stations shall employ both automatic and manual synchronizing. The automatic synchronizing shall be equipped with both automatic speed and voltage matching capabilities. The manual synchronizing shall be supervised by a sync check relay.

When required, all terminal stations shall be equipped with manual synchronizing, an automatic synchronizing relay with voltage matching capabilities and/or a sync check relay. The manual synchronizing will not be supervised by a sync check relay.

3.0 GENERAL ARRANGEMENT

The AC logic of the synchronizing is similar for both generating and terminal stations. The DC logic and equipment requirements are developed individually for generating and terminal stations.

4.0 AC LOGIC

The AC logic of the synchronizing shall include an incoming and a running bus. These buses shall operate at 115 volts AC and will supply voltage to the synchronizing equipment. The incoming bus will be energized by the equipment being synchronized, i.e. generator, line, etc. and the running bus will be energized by the system voltage.

The AC voltage signals from the potential transformers feeding the incoming and running buses will first go through isolation transformers in order to isolate the PT grounds. The isolation transformers shall be protected by a 6 A fuse on the source side and shall have an accuracy rating of 0.3 WXY. Each potential transformer secondary will have one ground applied in the PT junction box, and the isolation transformers will be grounded by one ground applied to the synchronizing "common" bus.

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4.0 AC LOGIC (cont'd)

The phasor diagram shall be shown on the drawing to indicate the phasing relationship between the different supplies.

The potential transformers which will supply the incoming and running buses will be determined by the manual synchronizing switch or the automatic synchronizing logic for the particular breaker to be synchronized. The automatic synchronizing logic shall be such as to prevent more than one potential transformer from supplying the incoming or running bus simultaneously. All switching will be done on the incoming and running buses with the common bus remaining non-switched.

4.1 Manual Synchronizing

With any manual synchronizing switch (43MS) in the "ON" position the incoming and running buses shall energize the following equipment:

1. Synchroscope.
2. Incoming voltmeter.
3. Running voltmeter.
4. Sync check relay (generating station only).

4.2 Automatic Synchronizing

With the automatic synchronizing circuits enabled the incoming and running buses shall energize the following equipment:

1. All equipment associated with manual synchronizing.
2. Synchronizing relay (where applicable).
3. Sync check relay.
4. Voltage matching/acceptance relay.
5. Dead line, dead bus verification relays.

5.0 TERMINAL STATION DC LOGIC

5.1 Manual Synchronizing

Manual synchronizing in the terminal stations requires the operation of two switches, the 43MS switch for the selected breaker and the breaker control switch (52CS).

5.1 Manual Synchronizing (cont'd)

With the 43MS switch in the "ON" position the close circuit of the breaker is enabled. Operation of the 52CS switch to the "CLOSE" position will complete the circuit to the breaker close coil, thereby closing the breaker.

Manual synchronizing is not supervised by the Local/Supervisory switch (43S), therefore, manual synchronizing is possible whether the station is in "Local" or "Supervisory" control.

5.2 Automatic synchronizing

Automatic synchronizing can only be initiated with the 43AS switch in the "AUTO" or "TEST" position. The operation of the synchronizing circuits is similar with the 43AS switch in the "AUTO" or "TEST" position except that with the switch in the "TEST" position a close pulse will not be sent to the breaker.

With the 43S switch in the appropriate position, automatic synchronizing is initiated by operating the 52CS switch to the "CLOSE" position or by a remote "CLOSE" signal from the ECC.

Except for breakers on the low side of transformers with load tap changers, a close pulse is sent to the selected breaker providing the 43AS switch is in the "AUTO" position and one of the following conditions are met:

1. Operation of the synchronizing relay.

2. Operation of the sync check relay.

3. Operation of the dead line/dead bus verification relay.

For breakers on the low side of transformers with load tap changers the above conditions are supervised by a voltage acceptance relay providing the LTC control is in "AUTO". The voltage acceptance feature shall be bypassed if the LTC control is in "MANUAL" or if one side of the breaker is de-energized.

The circuits shall be monitored such that a blue light will indicate "AUTO SYNC ON" and an amber light will indicate "CLOSE PULSE SENT".

5.2 Automatic Synchronizing (cont'd)

The logic shall be arranged such that a second breaker cannot be selected for synchronizing until the synchronizing circuits have reset. The circuits will reset under one of the following conditions:

1. When the selected breaker closes.
2. When the synchronizing times out due to an incomplete sequence.
3. If the 43AS switch is turned to the "OFF" position.
4. If the ECC initiates a trip pulse to the selected breaker.

When synchronizing across a transformer with a load tap changer, which is in "AUTO" control, the voltage matching relay shall pulse the transformer tap changer control to match the voltages across the transformer breaker to facilitate synchronizing. When synchronizing across a transformer which has its load tap changer control in "MANUAL" or which is being placed in parallel with a transformer already connected to the bus the voltage matching feature will be blocked.

6.0 GENERATING STATION DC LOGIC

6.1 Manual Synchronizing

Manual synchronizing in generating stations shall be supervised by a sync check relay, and shall require the operation of the 43MS and the 52CS switches.

Operation of the 43MS switch to the "ON" position shall enable the closing circuit of the selected breaker. Operation of the 52CS switch to the "CLOSE" position shall send a close pulse to the selected breaker providing the sync check relay contact is closed.

6.2 Automatic Synchronizing

Automatic synchronizing shall only be initiated with the 43AS switch in the "TEST" or "AUTO" position.

Operations of the synchronizing circuits is similar with the 43AS switch in the "TEST" or "AUTO" position. The only difference is that with the 43AS switch in the "TEST" position a close pulse will not be sent to the breaker.

6.2 Automatic Synchronizing (cont'd)

With the 43S switch in the appropriate position, automatic synchronizing is initiated by operating the 52CS switch to the "CLOSE" position or by a remote "CLOSE" signal from the ECC. The automatic synchronizing can also be initiated by a speed switch in the start-up circuit of the generator being synchronized.

Once automatic synchronizing is initiated the speed and voltage matching devices are enabled. These devices shall pulse the governor and exciter in order to match the generator to the system.

When the voltage, slip, and phase angle are within predetermined limits the synchronizer will send a close pulse to the breaker at the proper advance angle to ensure the breaker closes at synchronism. When synchronizing onto a dead bus, the dead bus verification relay shall send a "Dead Bus Verify" indication to the ECC. The ECC operator must then issue a "Dead Bus Verification" command in order to allow the breaker to close onto the dead bus.

The logic shall be arranged such that a second breaker cannot be selected for synchronizing until the synchronizing circuits have reset. The circuits shall reset under one of the following conditions:

1. When the selected breaker closes.
2. When the synchronizing times out due to an incomplete sequence.
3. If the 43AS switch is turned to the "OFF" position.
4. If the ECC initiates a trip pulse to the selected breaker.

7.0 TECHNICAL REQUIREMENTS

7.1 Manual Synchronizing Switch

Each breaker for which manual synchronizing is intended shall have a manual synchronizing selector switch (43MS) located preferably to the left of the breaker control switch on the control room panel. The 43MS switch shall have two positions, designated "OFF-ON", and shall be spring return from the "ON" position for terminal stations and shall be a maintained switch for generating stations. The handle for this switch shall be removable in the "OFF" position only.

7.2 Automatic Synchronizing Switch

Each station with automatic synchronizing capabilities shall be equipped with an automatic synchronizing selector switch (43AS). This switch shall have three positions, designated "TEST-OFF-AUTO". The handle for this switch shall be removable in the "OFF" position only.

7.3 Switch Interlock

The automatic and manual synchronizing circuits are interlocked by the specific arrangement of the 43AS and the 43MS switches. The 43AS switch has an operating handle which is removable in the "OFF" position and which is keyed to fit the 43MS switches in the "OFF" position.

Standard practice shall be to have only one such handle for each automatic synchronizing scheme. To manually synchronize any breaker, the automatic synchronizing is isolated by turning the 43AS switch to the "OFF" position, removing the operating handle, and inserting it into the appropriate 43MS switch.

7.4 Generating Station Synchronizing Relays

7.4.1 Automatic Synchronizer

The automatic synchronizer installed in generating stations shall be equipped with speed matching, voltage matching and voltage acceptance capabilities.

The synchronizer shall send a close pulse at the proper advance angle to allow for breaker closure at synchronism when the slip and voltage differences are within the limits set on the relay. The relay shall not send a close pulse for the loss of one voltage.

Inputs to the relay shall be single phase, 115 volts, 60 Hz. Power supply for the relay shall be typically 125 volts DC. The output contacts for speed raise/lower, voltage raise/lower and close pulse shall be rated 5 amps continuous with an interrupting rating of 1 amp resistive at 125 volts DC.

7.4.1 Automatic Synchronizer (cont'd)

The synchronizer shall have provisions for setting the following parameters: advance angle, breaker closing time, upper and lower voltage limits and permissive voltage difference. The speed matching capability settings shall include raise pulse duration, lower pulse duration and kicker raise pulse time. The voltage matching capability settings shall include acceptable voltage difference, pulse duration and time between pulses.

7.4.2 Sync Check Relay

The sync check relay employed in generating stations shall be used to verify the condition of synchronism between two system voltages. The contacts will close instantaneously when the voltages are within set phase angle and slip limits. The sync check relay shall be equipped with dead line/dead bus capabilities.

Inputs to the relay shall be single phase, 115 volts, 60 Hz. Power supply for the relay shall be 125 volts DC. The relay shall have two form "C" output contacts, rated 5 amps continuous.

The relay shall have provisions for setting the following parameters; angular separation, slip frequency, and dead line/dead bus selection "IN" or "OUT".

The sync check relay will be used to supervise the manual and automatic synchronizing operations.

7.5 Terminal Station Synchronizing Relays

7.5.1 Synchronizing Relay

The synchronizing relay installed in terminal stations shall be capable of sending a close pulse when separate systems become synchronized.

Inputs to the relay shall be single phase, 115 volts, 60 Hz. The relay output contact shall be rated 5 amps continuous.

Settings for the relay shall include angular separation and slip frequency.

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7.5.2 Sync Check Relay

The sync check relay shall be used in terminal stations to verify that the two sources being measured are interconnected elsewhere.

Inputs to the sync check relay shall be single phase, 115 volts, 60 Hz. The output contacts shall have a rating of 5 amps continuous.

The sync check relay shall be equipped with dead line/dead bus capabilities.

The relay shall have provisions for setting the maximum allowable angular separation and the time delay for contact closure.

7.5.3 Voltage Matching Relay

The voltage matching relay employed in terminal stations is intended to pulse the load tap changer control to ensure the voltage difference across the breaker being synchronized is within acceptable limits.

Inputs to the voltage matching relay shall be 115 volts, 60 Hz. The output contacts shall be rated 5 amps continuous.

The relay shall have provisions for setting the voltage difference between the two input voltages. If the voltage difference is outside these set limits, the relay shall pulse the load tap changer. When the voltage difference is within the set limits, the output contacts of the relay shall close.

8.0 DRAWINGS

Drawings P15-010-D1, P15-010-D2, P15010-D3 and P15-010-D4 form an integral part of this standard and shall be used as a reference.

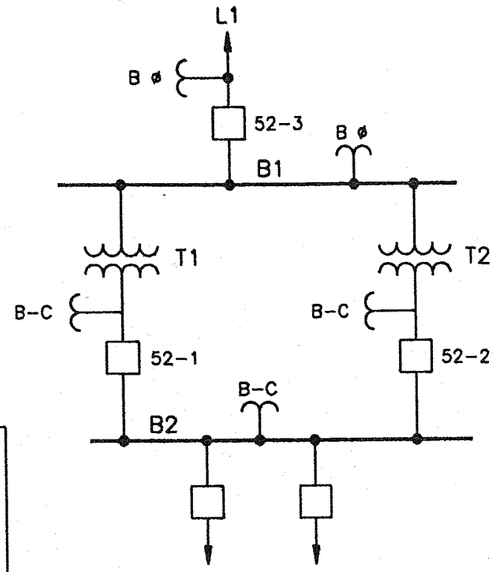
9.0 STANDARDS OF ACCEPTANCE

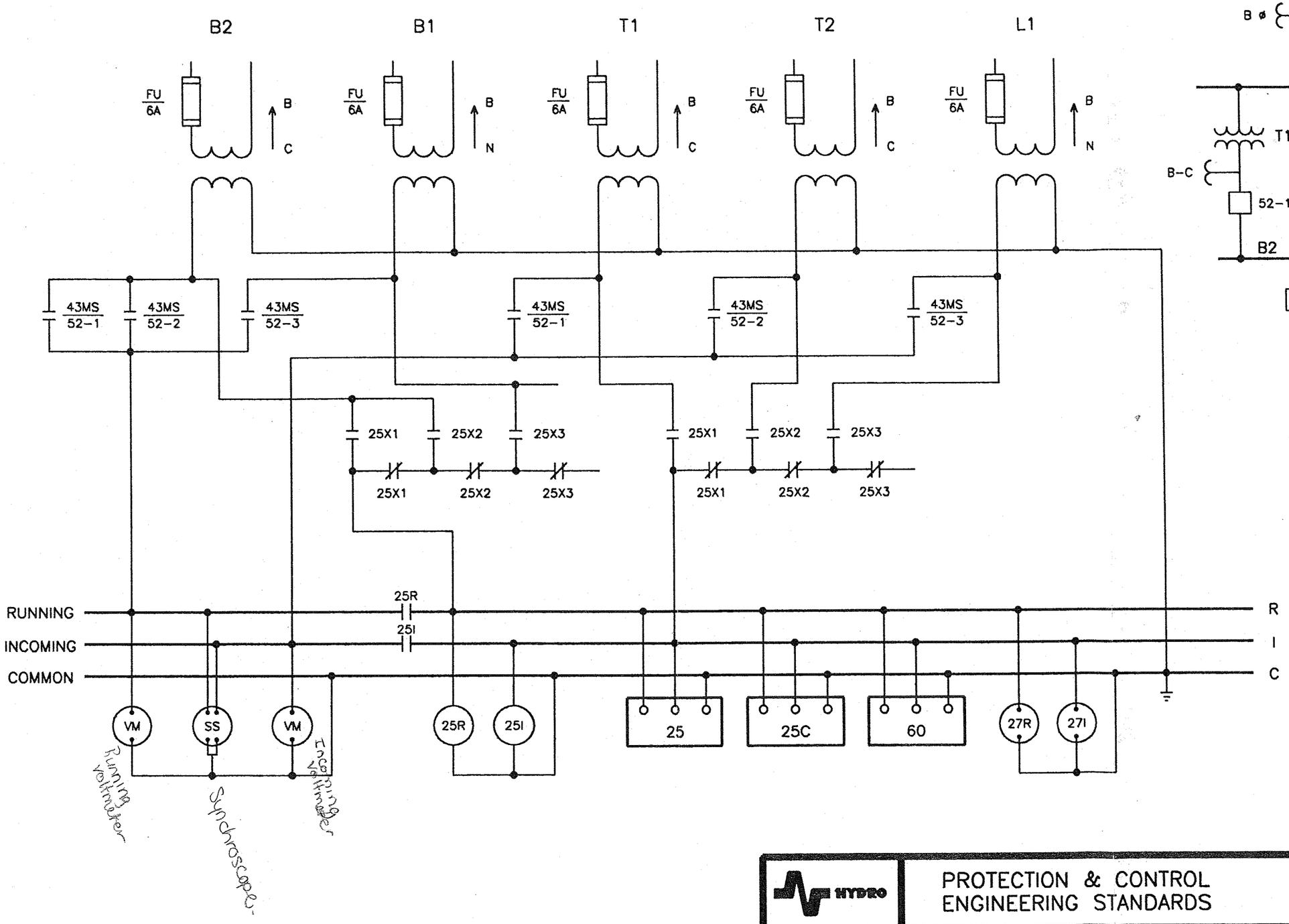
Automatic synchronizer	-	Westinghouse type XASV
Synchronizing relay	-	C.G.E. type GXS
Sync check relay	-	Westinghouse type SVE-2H
	-	C.G.E. type IJS
	-	GEC type MAVS
Voltage matching relay	-	B.B. type CUH2V.

4.5 Synchronizing

Supervisory "TRIP" and "CLOSE" functions are contingent upon the position of the station's 43S switch. With this switch in "LOCAL", synchronizing will be as per Section 3.5.1.

With the 43S in "SUPERVISORY", the synchronizing logic is initiated by the appropriate breaker "CLOSE" command from the control center. Prior to closing, if a remote "TRIP" command is initiated, the synchronizing logic is reset and the breaker is not closed.



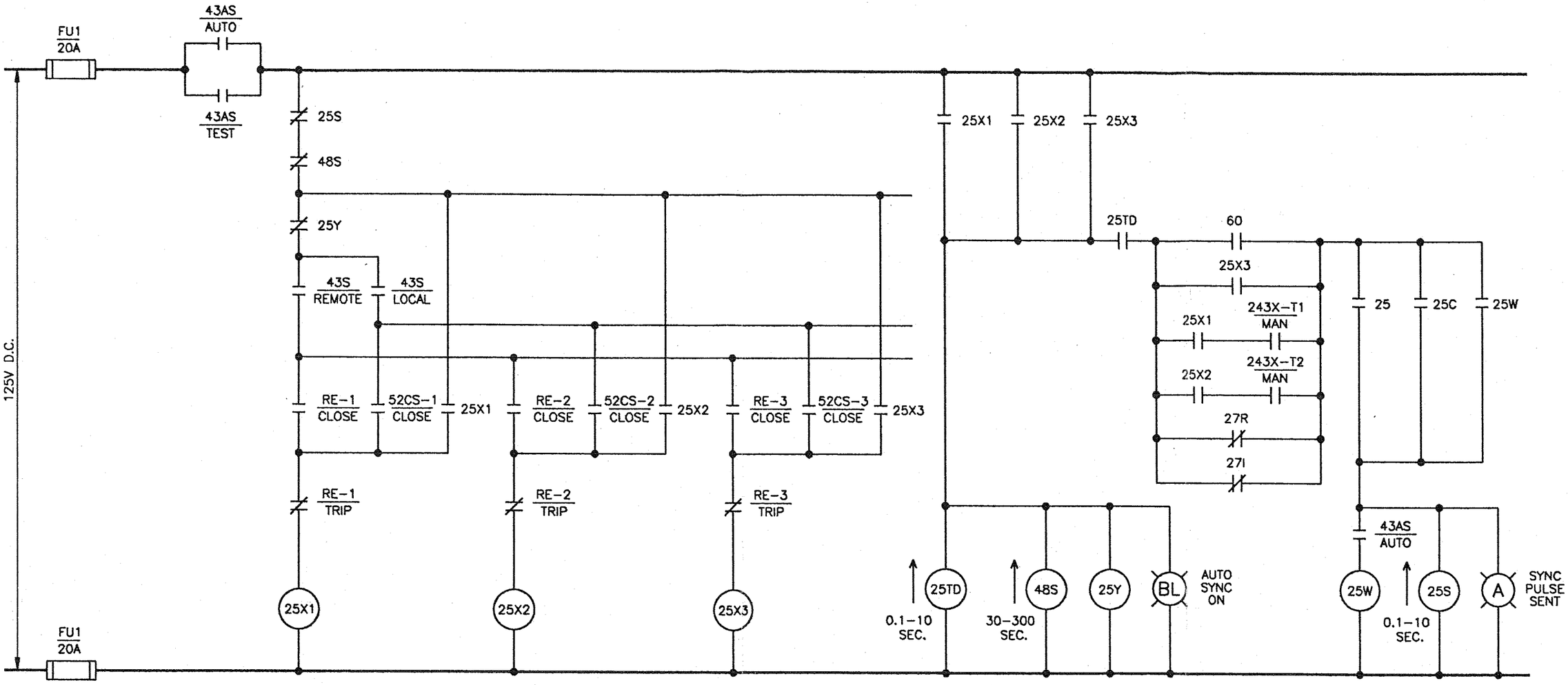


HYDRO

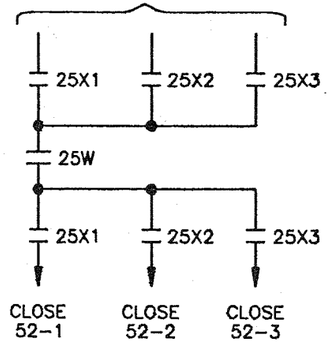
PROTECTION & CONTROL ENGINEERING STANDARDS

TERMINAL STATION
TYPICAL SYNCHRONIZING A.C. SCHEMATIC

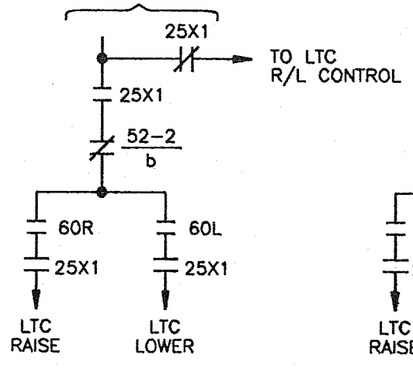
APP'D	D. W. REEVES		
	T. D. COLLETT		
ISSUED	1994-03-24		
DRAWN	W.B.	SCALE	N.T.S.
CHECKED	D. CULL		
DWG.NO.	P15-010-D1-R0		



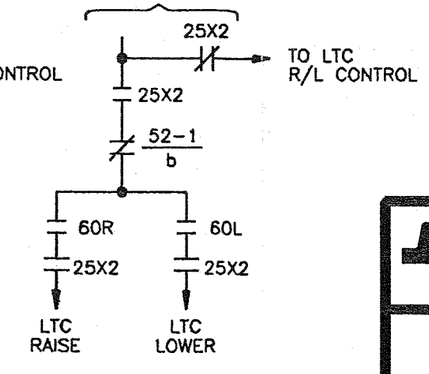
BREAKER CLOSING CIRCUIT



T1 LTC CONTROL



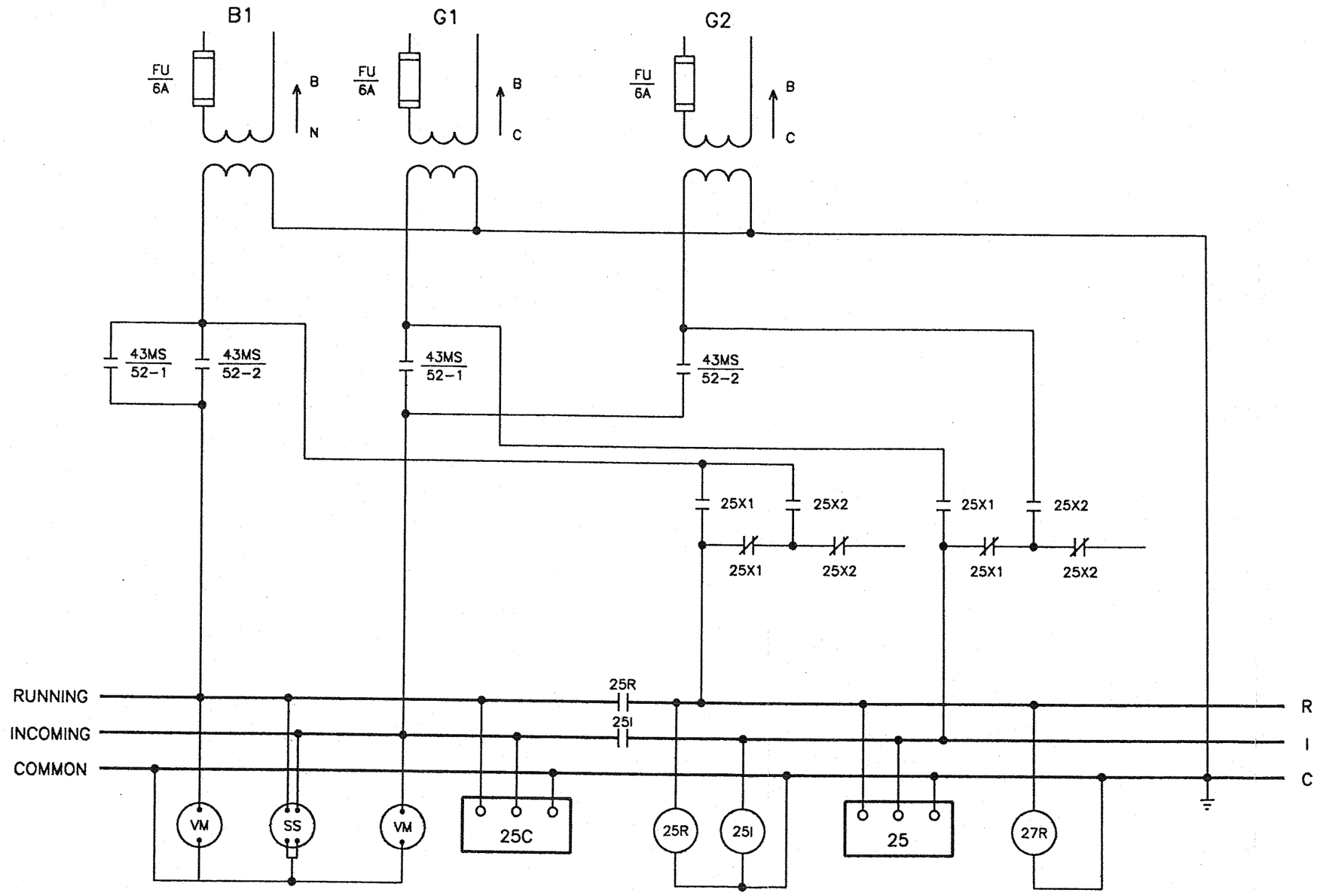
T2 LTC CONTROL

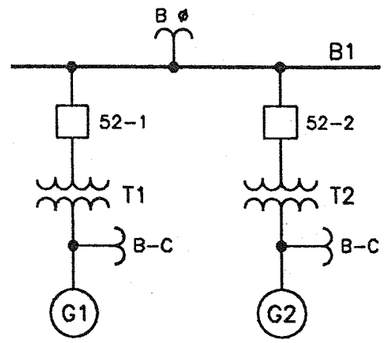


NOTES

1. 52-1 & 52-2 ARE LOW SIDE BREAKERS ON A TRANSFORMER WITH LOAD TAP CHANGER.

HYDRO	PROTECTION & CONTROL ENGINEERING STANDARDS	APP'D: D. W. REEVES; T. D. COLLETT
		ISSUED: 1994-03-24
	TERMINAL STATION TYPICAL SYNCHRONIZING D.C. SCHEMATIC	DRAWN: W.B. SCALE: N.T.S.
		CHECKED: D. CULL
		DWG.NO. P15-010-D2-R0





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PROTECTION & CONTROL
ENGINEERING STANDARDS

GENERATING STATION
TYPICAL SYNCHRONIZING A.C. SCHEMATIC

APP'D	D. W. REEVES		
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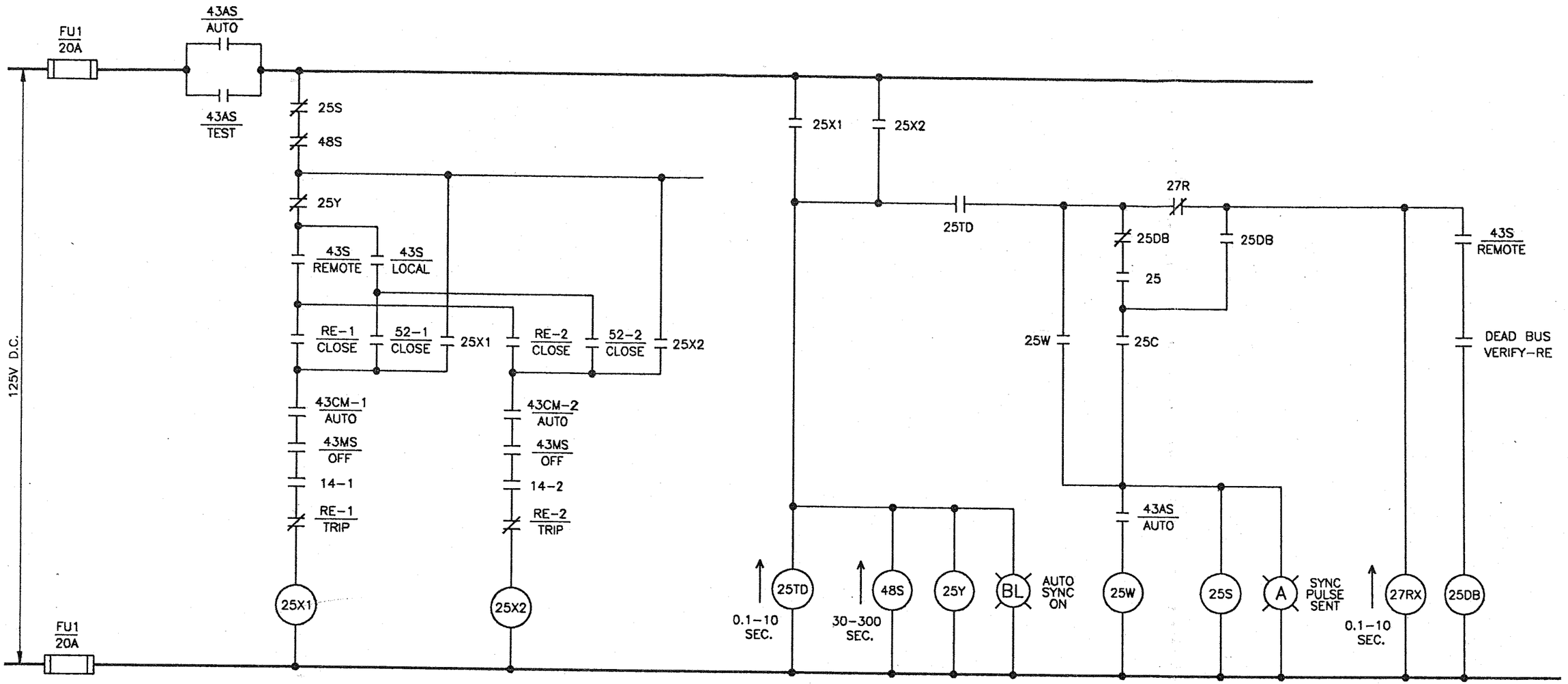
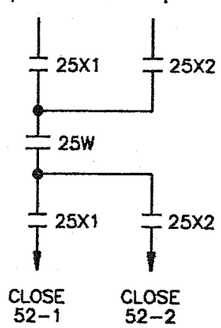
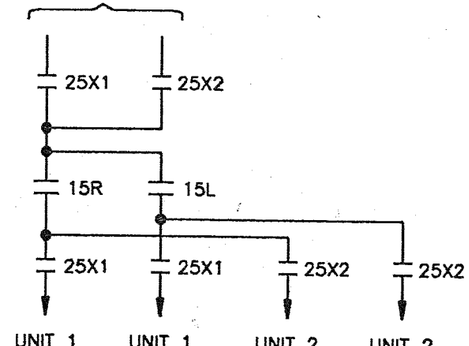
DWG.NO.	P15-010-D3-R0		



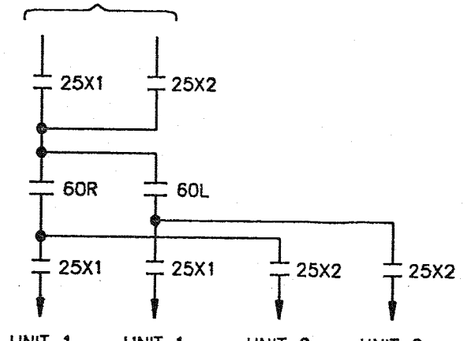
BREAKER CLOSE CIRCUIT



UNIT SPEED/LOAD CONTROL CIRCUIT



UNIT VOLTAGE CONTROL CIRCUIT



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PROTECTION & CONTROL ENGINEERING STANDARDS

GENERATING STATION
TYPICAL SYNCHRONIZING D.C. SCHEMATIC

APP'D	D. W. REEVES T. D. COLLETT		
ISSUED	1994-03-24		
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CHECKED	D. CULL		
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App'd.	T. D. Collett
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SWITCHBOARD METERS

1.0 SCOPE

This standard establishes the technical requirements and station application of indicating type switchboard meters. The criteria only covers those meters applied to apparatus rated at 69 kV or above. For the purpose of this standard 66 kV is considered to be the same as 69 kV.

2.0 PURPOSE

Switchboard meters are provided to indicate an electrical quantity associated with a specific piece of station equipment such as a transformer, transmission line or bus. The meters are used to assist in local control or to record statistical data.

3.0 APPLICATION

In general, switchboard meters will be used in those stations with control buildings. Rules of application for various apparatus are outlined in the following subsections.

3.1 Transmission Lines

Individual megawatt (MW) and megavar (MVAR) switchboard meters will be applied at both terminals of the line. Should the line constitute an element in a ring bus or breaker-and-a-half scheme, a single voltmeter will also be included. The voltmeter will be switched between all three potential transformers by a 3-position selector switch labelled A-B, B-C, C-A. If the line is connected to a load bus, a voltmeter is unnecessary as the requirement is met by the bus voltmeter.

3.2 Power Transformers

Power transformers will have individual MW and MVAR meters applied for statistical purposes. A thermal demand ammeter which also provides an indication of the instantaneous current will be connected on B-phase only.

Wherever possible, switchboard meters will be connected on the high voltage side of the transformer.

Transformers equipped with on-load tap changers will be provided with a remote position indicator (RPI).

3.3 Busses

A single voltmeter will be applied for each load bus and be switched between all three potential transformers by a 3-position selector switch labelled A-B, B-C, C-A.

Busses configured in a ring or breaker-and-a-half arrangement will not be equipped with voltmeters as the requirement is met with those on the individual lines.

3.4 Capacitor Banks

Ammeters will be applied on each phase of the bank.

3.5 Synchronizing

Each station equipped for the manual synchronization of circuit breaker will be provided with the following switchboard meters:

i) Running Voltmeter - indicates the voltage of the running bus associated with the selected breaker.

ii) Incoming Voltmeter - indicates the voltage of the incoming bus associated with the selected breaker.

iii) Synchroscope - indicates the difference in frequency and phase angle between the incoming and running busses.

These three meters are common to all breakers with the voltages supplied to their terminals being switched dependent upon the breaker being synchronized.

3.6 Special Applications

At certain system locations or under exceptional conditions, it may be deemed necessary to provide switchboard meters over and above those previously mentioned. Examples of such meters could include frequency meters and/or power factor meters.

These special applications will be governed by the principles and intent of this standard.

4.0 TECHNICAL REQUIREMENTS

4.1 Voltage, Megawatt, Megavar and Synchroscope Meters

The voltage, current, MW, MVAR meters and synchroscope described in Sections 3.1 through 3.5 shall meet or exceed the latest requirements of ANSI Specification C39.1. These instruments will be of the transformer rated, analog indicating type, with AC inputs supplied directly from current and/or potential transformers. Meters shall be $\pm$ 1% of full scale basic accuracy class. The instruments front cover shall be nominally 108 mm square; scales shall be 250^0, 175 mm long, having black numeral on a white background. Stations with large control rooms may require larger synchronizing meters to facilitate reading. In such instances, these shall have front covers nominally 220 mm square with 250^0 scales, 350 mm long.

All meters shall have an ambient temperature range of 20^0C to 65^0C and a minimum insulation rating of 2500 volts r.m.s.

4.1.1 Voltmeters

Generally, voltmeters will have a full scale rating of 150 VAC and a continuous overload capability of 180 VAC.

Voltmeters will be scaled as per the following table:

Primary Voltage	P.T. Ratio	Scale
230 kV	2000:1	0 - 300 kV
138 kV	1200:1	0 - 180 kV
69 kV	600:1	0 - 90 kV

Synchronizing voltmeters will be scaled 0 - 150 volts.

4.1.2 Megawatt and Megavar Meters

Generally, MW and MVAR meters will be 2-element type connected in the 3-phase, 3-wire configuration, rated 120 VAC, 5 amperes. MVAR meters will be connected through a suitable phase-shifting transformer, unless it forms an integral part of the meter.

Overload ratings for the potential coils will be 1.2 times continuous over the rated value; current coils will be 2.0 times continuous and 10 times for 1 second over the rated value.

Scaling of these instruments will be determined by the particular application and instrument transformer ratios. The following chart will be used to select the appropriate scaling.

PRIMARY VOLTAGE	P.T. RATIO	MW METER C.T. RATIO	MW METER (ZERO LEFT) RADIAL FEED	MVAR METER (ZERO CENTER) 2-TERMINAL FEED	ZERO CENTRE ALL FEEDS
230 kV	2000:1	100/5	0 - 50	50 -0- 50	25 -0- 25
230 kV	2000:1	200/5	0 - 75	75 -0- 75	50 -0- 50
230 kV	2000:1	300/5	0 - 125	125 -0- 125	60 -0- 60
230 kV	2000:1	400/5	0 - 150	150 -0- 150	75 -0- 75
230 kV	2000:1	500/5	0 - 200	200 -0- 200	100 -0- 100
230 kV	2000:1	600/5	0 - 250	250 -0- 250	125 -0- 125
230 kV	2000:1	800/5	0 - 300	300 -0- 300	150 -0- 150
230 kV	2000:1	1000/5	0 - 400	400 -0- 400	200 -0- 200
230 kV	2000:1	1200/5	0 - 500	500 -0- 500	250 -0- 250
138 kV	1200:1	100/5	0 - 25	25 -0- 25	15 -0- 15
138 kV	1200:1	200/5	0 - 50	50 -0- 50	25 -0- 25
138 kV	1200:1	300/5	0 - 75	75 -0- 75	40 -0- 40
138 kV	1200:1	400/5	0 - 100	100 -0- 100	50 -0- 50
138 kV	1200:1	500/5	0 - 125	125 -0- 125	60 -0- 60
138 kV	1200:1	600/5	0 - 150	150 -0- 150	75 -0- 75
138 kV	1200:1	800/5	0 - 200	200 -0- 200	100 -0- 100
138 kV	1200:1	1000/5	0 - 250	250 -0- 250	125 -0- 125
138 kV	1200:1	1200/5	0 - 300	300 -0- 300	150 -0- 150
69 kV	600/1	100/5	0 - 15	15 -0- 15	5 -0- 5
69 kV	600/1	200/5	0 - 25	25 -0- 25	15 -0- 15
69 kV	600/1	300/5	0 - 40	40 -0- 40	20 -0- 20
69 kV	600/1	400/5	0 - 50	50 -0- 50	25 -0- 25
69 kV	600/1	500/5	0 - 60	60 -0- 60	30 -0- 30
69 kV	600/1	600/5	0 - 75	75 -0- 75	40 -0- 40
69 kV	600/1	800/5	0 - 100	100 -0- 100	50 -0- 50
69 kV	600/1	1000/5	0 - 125	125 -0- 125	60 -0- 60
69 kV	600/1	1200/5	0 - 150	150 -0- 150	75 -0- 75

4.1.2 Megawatt and Megavar Meters (cont'd.)

Zero Center scales will contain the words "IN" and "OUT" to indicate the flow of real and reactive power. The scale will have a (-) symbol below the word "IN" and a (+) symbol below "OUT". Standard convention for a station will have power flow "OUT" of a bus disignated as Positive (+). The only exception will be synchronous machine metering which will have the flow "OUT" of the unit disignated as positive (+).

Zero left scales will have the appropriate word "IN" or "OUT" and (+) or (-) symbols.

4.1.3 Synchroscopes

Synchroscopes will be nominally rated for 120 VAC, 60 Hz. Scales will read "Slow-Fast".

4.2 Thermal Demand Ammeters

Thermal demand ammeters will have an accuracy of 2% and a full scale rating of 5 amperes. The instrument will have an overload capability of 1.3 times continuous and 40 times for 1 second.

The demand scale will be 100 mm long; the instantaneous scale 60 mm long. The maximum demand will be indicated by a black pointer which is pushed up-scale by a red pointer connected to the thermal element. The thermal element will have a lag time of 30 minutes, i.e. final registration will be shown after a constant current has been applied for 30 minutes.

The meter will be equipped with an external reset for the demand pointer. The reset will have provisions for a tamper-proof seal.

Scaling of the thermal elements will be determined by the current transformer ratio. Scaling of the instantaneous elements will be determined by the C.T. secondary rating. For example, an instrument connected to a 600/5 amp C.T. secondary will have a thermal scale ranging 0-600 amps, and an instantaneous scale 0-5A.

4.3 Ammeters

Ammeters will be ± 1% basic accuracy class with a full scale rating of 5 amperes. The meter shall be capable of a continuous overload of 2.0 times nominal and 10 times nominal for 1 second. Scaling of the meter will be determined by the current transformer ratio.

4.4 R.P.I.'s

The remote position indicators shall be of the selsyn type. They shall indicate the correct position of the transformer LTC and be suitable for semi-flush mounting on the front of the switchboard.

5.0 Standards of Acceptance

Voltmeter, ammeter, synchroscope, MW and MVAR meters	C.G.E. Type AB 40
Thermal demand ammeter	Westinghouse Type KNA
Remote position indicator	Westinghouse "Synchrotie"

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No:	P15-030-RO
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Issued:	1992-04-30
App'd.	T. D. Collett
	D. W. Reeves

TRANSDUCERS

1.0 SCOPE

This Standard establishes the application and technical requirements of transducers used in terminal stations and for primary statistical metering in generating stations.

2.0 PURPOSE

Transducers are used to convert station electrical quantities into low level dc currents. These low level signals become inputs to the stations supervisory equipment which produce telemetry outputs at the Energy Control Center. These remote outputs are required to accurately monitor and control the provincial grid.

Transducers may also be used to drive other local devices such as recorders and meters.

3.0 APPLICATION

In general, transducers are used in those stations with any form of supervisory system and where telemetry is established as an operating requirement.

Typical rules of application for various apparatus are outlined in the following subsections.

3.1 Transmission Lines

Watt, Var and Voltage transducers will be applied at both terminals of the line.

3.2 Power Transformers

Power transformers will have Watt and Var transducers applied. Wherever possible these transducers will be connected on the high voltage side of the transformer. Units with on-load tapchangers will be provided with a transducer for remote tap position indication.

3.3 Buses

A voltage transducer will be applied to each load bus.

3.4 Generators

Generators shall have Watt, Var, voltage and frequency transducers applied for remote monitoring of primary metering.

3.5 Special Applications

At certain system locations or under exceptional conditions, it may be necessary to provide transducers over and above those previously mentioned. These special applications will be governed by the principles and intent of this standard.

4.0 TECHNICAL REQUIREMENTS

All voltage, frequency, Watt and Var transducers shall have an accuracy of ± 0.25% of full scale, or better, at 20°C. These transducers shall be capable of operating over a temperature range of -20°C to +60°C, a humidity range of 0-95% and a frequency range of 55-65 Hz; the frequency transducer shall be capable of operating over a frequency range of 57 to 63 Hz.

The output peak ac component shall not exceed 1% of full scale and the response time for 0 to 99% shall be less than 400 ms. The transducers shall meet or exceed the surge withstand capabilities of ANSI C37.90a, latest revision. All units with ± 1ma output shall be self-powered and have an output calibration adjustment of ± 10%.

Transducers shall have their output totally isolated from their input. Transducers used in SCADA applications shall be dedicated solely to that function and shall not be looped to other equipment or devices.

4.1 Voltage Transducers

Voltage transducers shall have an input range of 0-150 V ac and an output of 0-1 ma dc into a load of 0-10 Kohms. The minimum overload capability shall be 180 volts continuous. Maximum burden at 120 V ac shall be 2 VA. Voltage transducers will be connected phase-phase where possible.

4.2 Frequency Transducers

Frequency transducers shall have an input range of 57 to 63 Hz and an output of ± 1 ma dc into a load of 0-10 K ohms. The continuous operating voltage range shall be -30% to +25% of the nominal 120 V ac input voltage. The burden shall not exceed 1.5 VA.

4.3 Watt/Var Transducers

Watt and Var transducers shall have nominal inputs of 120 volt, 5 amps and be of the 2-element type. Operating potential and current ranges consistent with the stated accuracy shall be 85-150 volts and 0-10 amps respectively. The transducers shall be capable of withstanding overloads of 175 volts and 15 amps continuously. Potential and current burdens shall not exceed 4 VA and 0.25 VA respectively.

Watt (VAR) transducers shall measure forward and reverse power (reactive power) flow, be calibrated for 500 watts (vars) per element and have an output of ± 1 ma dc into 0-10 Kohms.

Combination Watt/Var transducers may be used provided they meet the technical requirements of this standard and both outputs are isolated from each other.

4.4 Tap Position Transducer

Power transformers with on-load tapchangers shall be equipped with a potential dividing resistor arrangement or similar device. A rotary switch will adjust the number of resistors in the circuit dependent upon the tap position. The voltage supplied to this resistor network will be the nominal dc station service, typically 130 volts dc.

The tap position transducer shall be rated for an input of the nominal dc station service voltage and an output of 4 to 20 ma dc into 0-750 ohms. For example, a transformer used in a station with 130 V dc station service voltage and with 17 tap positions, will have a tap position transducer with an input of 0-130 volts dc and an output of 4-20 ma dc. Transducer power supply shall be rated 120 volt, 60 Hz.

5.0 TYPICAL CONNECTION DIAGRAM

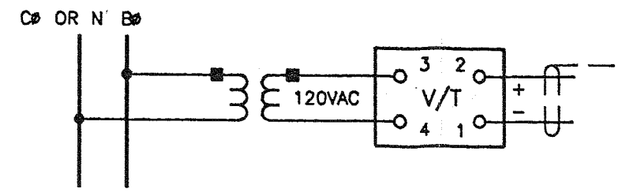
Drawing P15-030-D1 shows typical connections for the voltage, frequency, Watt, Var and tap position transducer and forms an integral part of this standard.

Watt and Var transducers which have potential and current connections on separate drawings, shall show the dc output on the potential schematic. Output terminals shall have polarity markings, + and -, as well as the terminal numbers.

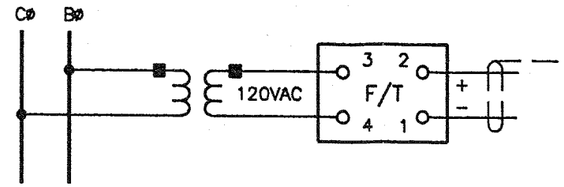
Tap position transducer connections will be shown on the tapchanger control schematic, if possible.

6.0 STANDARDS OF ACCEPTANCE

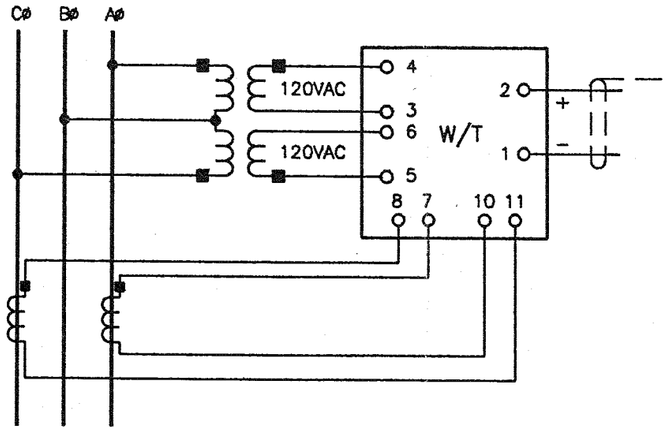
Voltage Transducer:	Transdata 10PS501
Frequency Transducer:	Wodex: H6301
Watt Transducer:	Transdata 20EWS500
Var Transducer:	Transdata 20ERS500
Tap Position Transducer:	Rochester Instruments SC1302



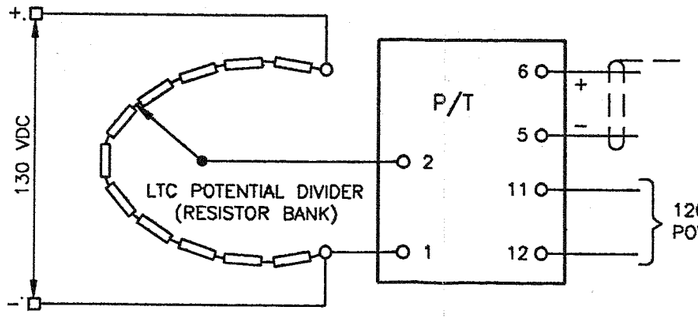
VOLTAGE TRANSDUCER



FREQUENCY TRANSDUCER



WATT (VAR) TRANSDUCER



TRANSFORMER TAP
POSITION TRANSDUCER

120 VAC
POWER SUPPLY

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TRANSDUCER TYPICAL CONNECTION DIAGRAM

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-030-D1-R0

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PROTECTION & CONTROL ENGINEERING STANDARD

No :	P15-080-R0
Page :	1 of 2
Issued :	1992-04-30
App'd.	T. D. Collett
	D. W. Reeves

TERMINAL STATION ANNUNCIATORS

1.0 SCOPE

This standard establishes the general requirements, method of operation, technical specifications and typical alarm groupings for terminal station annunciators.

2.0 GENERAL REQUIREMENTS

Annunciators are required in terminal stations to provide a visual and audible alarm for abnormal station conditions with auxiliary contacts for remote alarm indication on the SCADA systems.

An annunciator will be provided in all terminal stations with control buildings. The size of the annunciator is to be dependent on the size of the station, but adequate space for future expansion must be considered.

3.0 METHOD OF OPERATION

The operation of the annunciator will conform to the sequence table as shown on Dwg. No. P15-080-D4. A typical operation is described as follows:

On closure of a field contact indicating an abnormal condition the visual and audible alarms will be initiated. The visual alarms will flash and continue to flash until the acknowledge button is pushed to silence the audible and cause the visual alarm to go to a steady on. Pushing of the reset button will extinguish the visual alarm if the field contact has returned to a normal state.

On initiation of the test button all windows will light.

4.0 TECHNICAL SPECIFICATIONS

1. To be of a back lighted window design suitable for standard panel mounting.

2. To have the capability of operating on the nominal station dc voltage.

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PROTECTION & CONTROL ENGINEERING STANDARD

4.0 TECHNICAL SPECIFICATIONS (cont'd.)

3. Windows are to be white with black engraving and nominally 4.5cm x 2.8cm. Engraving is to be done utilizing minimum of 4 mm characters.

4. The annunciator is to accept normally open dry field contacts. Output to field contacts is to be a minimum of 24 V dc.

5. The annunciator is to be provided with three operating buttons - acknowledge, test and reset. These are to be of pushbutton design and, if separate from the annunciator they are to be mounted immediately below the windows, acknowledge on the left, test in the center and reset on the right.

6. A timer is to be provided which will silence the audible alarm after five seconds. The range of timer should be adjustable from 1 to 180 seconds.

7. Lamps are to be replaceable from the front of the annunciator and are to be of long life design, 50,000 hours, lamp type 757.

8. Output contacts are to be provided for each alarm point. This contact is to be of the non latching type, i.e. the contact follows the field condition. The contact shall be rated one ampere minimum. This contact is used to provide remote indication.

9. The current drain shall not exceed 100 ma per point.

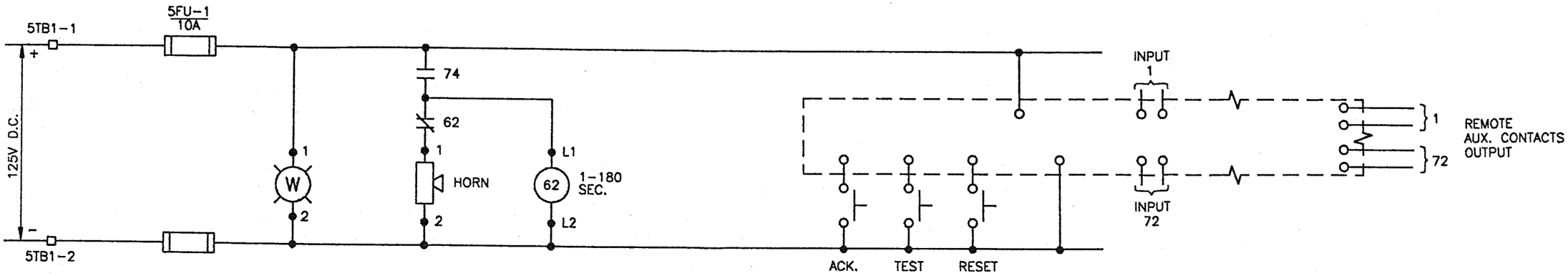
10. Suitable terminations for #16 AWG wire are to be provided on the annunciator for field input contacts and remote output contacts.

5.0 TYPICAL ALARM GROUPING AND ABBREVIATIONS

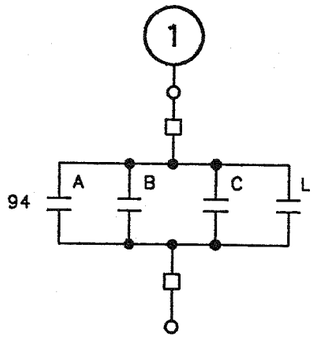
Alarm grouping and wording shall be generally as per the attached table and as indicated on the dc schematic.

The following drawings form an integral part of this standard and are to be used as a reference:

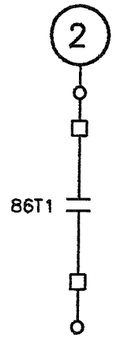
Dwg. No. P15-080-D1
Dwg. No. P15-080-D2
Dwg. No. P15-080-D3
Dwg. No. P15-080-D4



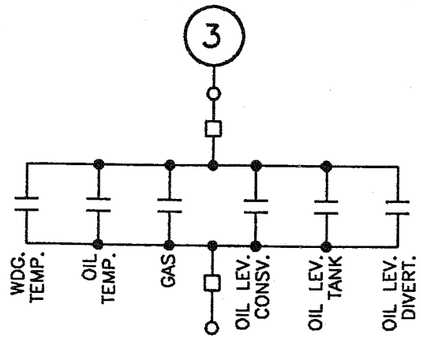
TYPICAL D.C. ANNUNCIATOR CIRCUIT



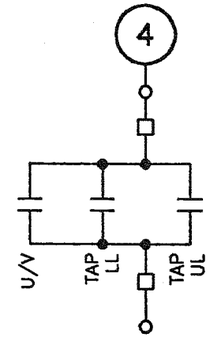
TL LINE
PROTECTION TRIP



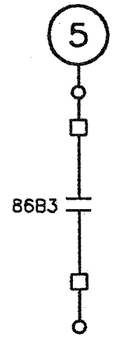
T1 LOCKOUT



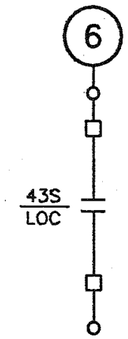
T1 GAS TEMP.
OIL LEVEL



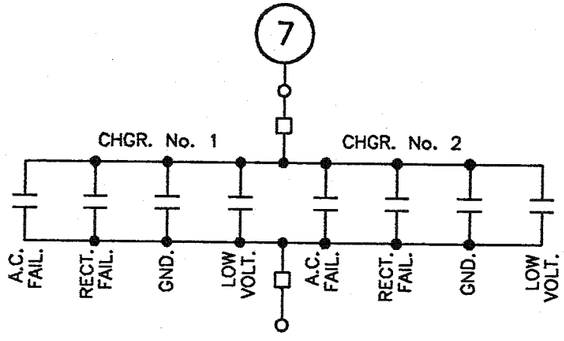
T1 LTC U/V
EXT. TAP



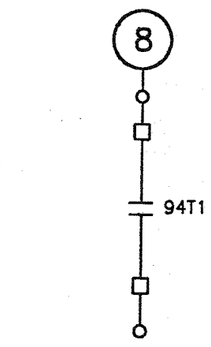
230kV BUS
LOCKOUT



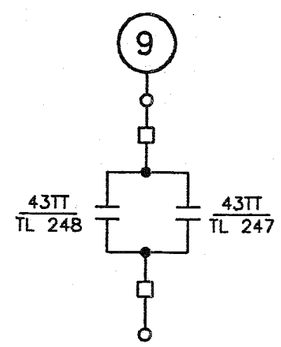
STATION
IN LOCAL



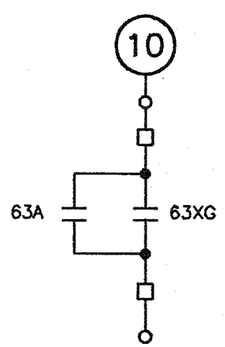
125V D.C.
BATT. CHGR.



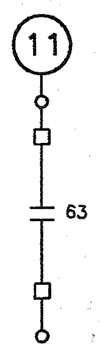
T1 PROTECTION
TRIP



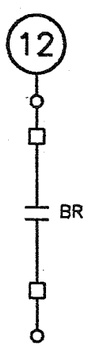
TL LINE
PROTECTION TRIP



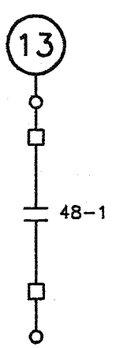
B3L47
SF6 LOW



B1L39 HI/LO
AIR PRESS.



B1L47 BLOCK
TRIP/CL.



B3L47
DISAGR.

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PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL ANNUNCIATOR D. C. SCHEMATIC

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D1-R0

TL 247 PROT. TRIP	TL 248 PROT. TRIP	TL 239 PROT. TRIP	T1 LOCKOUT	T1 GAS TEMP. OIL LEVEL	T1 LTC U/V EXT. TAP	T1 PROT. TRIP		
230kV BUS LOCKOUT	138kV BUS LOCKOUT	STATION SERV/D.C. FAIL.	AUTO SYNC. OFF	STATION IN LOCAL	125V D.C. BATT. CHGR.		TRANS. TRIP OFF	
B3L47 SF6 LOW	B3L47 BLOCK TRIP/CL.	B3L47 DISAGR.	B3L48 SF6 LOW	B3L48 BLOCK TRIP/CL.	B3L48 DISAGR.	B1L39 SF6 LOW	B1L39 HI/LO AIR PRESS.	

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PROTECTION & CONTROL ENGINEERING STANDARDS

TYPICAL STATION ALARMS

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D2-R0

POINT	ANNUNCIATOR POINT DESCRIPTION	SUPERVISORY ALARM DESCRIPTION
1A	T.L. 247 PROT. TRIP	LINE PROT. TRIP
1B	T.L. 248 PROT. TRIP	LINE PROT. TRIP
1C	T.L. 239 PROT. TRIP	LINE PROT. TRIP
2A	T1 LOCKOUT	T1 LOCKOUT
2B	T1 GAS, TEMP, OIL LEVEL	T1 GAS, TEMP, OIL LEVEL
2C	T1 LTC U/V, EXT. TAP	T1 LTC U/V, EXT. TAP
3A	T1 PROT. TRIP	T1 PROT. TRIP
3B		
3C		
4A	230kV BUS LOCKOUT	BUS LOCKOUT TRIP
4B	138kV BUS LOCKOUT	BUS LOCKOUT TRIP
4C	STATION SERVICE/D.C. FAIL.	STATION SERVICE/D.C. FAIL.
5A	AUTO SYNC. OFF	AUTO SYNC. OFF
5B	STATION IN LOCAL	STATION IN LOCAL
5C	125V D.C. BATTERY CHARGER	STATION SERVICE/D.C. FAIL.
6A		
6B	TRANSFER TRIP OFF	TRANSFER TRIP OFF
6C		
7A	B3L47 SF6 LOW	BREAKER ANOMALY
7B	B3L47 BLOCK TRIP/CL.	BREAKER ANOMALY
7C	B3L47 DISAGREEMENT	BREAKER ANOMALY
8A	B3L48 SF6 LOW	BREAKER ANOMALY
8B	B3L48 BLOCK TRIP/CL.	BREAKER ANOMALY
8C	B3L48 DISAGREEMENT	BREAKER ANOMALY
9A	B1L39 SF6 LOW	BREAKER ANOMALY
9B	B1L39 HI/LO AIR PRESSURE	BREAKER ANOMALY
9C		

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PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL REMOTE GROUPING

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D3-R0

SEQUENCE M		
CONDITION	VISUAL	AUDIBLE
NORMAL	OFF	OFF
ALERT	FLASH	ON
ACKNOWLEDGE	ON	OFF
RETURN TO NORMAL	ON	OFF
RETURN TO NORMAL BEFORE ACK.	FLASH	ON
ACKNOWLEDGE	ON	OFF
RESET	OFF	OFF

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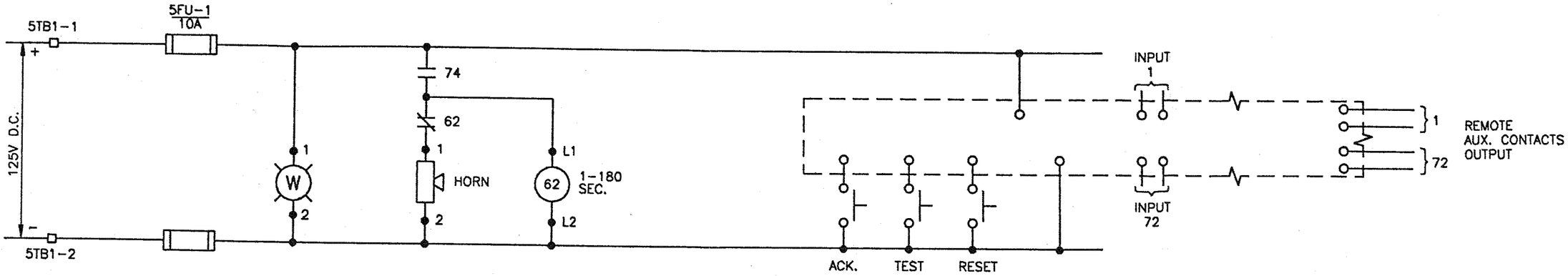
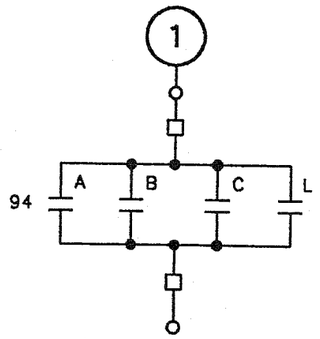
PROTECTION & CONTROL
ENGINEERING STANDARDS

ANNUNCIATOR SEQUENCE TABLE

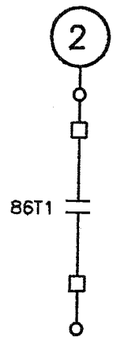
APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D4-R0



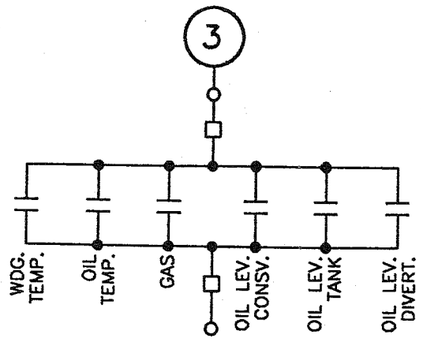
TYPICAL D.C. ANNUNCIATOR CIRCUIT



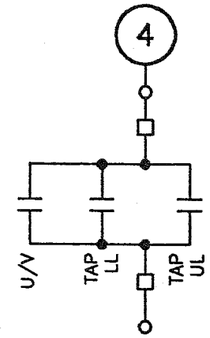
TL LINE
PROTECTION TRIP



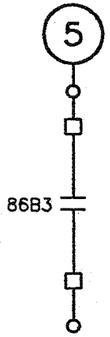
T1 LOCKOUT



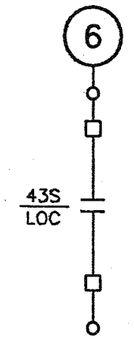
T1 GAS TEMP.
OIL LEVEL



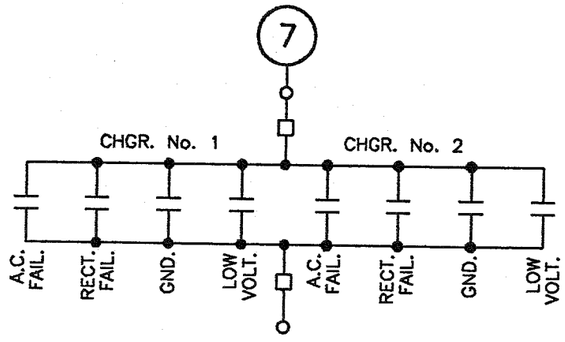
T1 LTC U/V
EXT. TAP



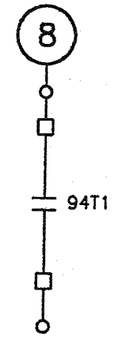
230kV BUS
LOCKOUT



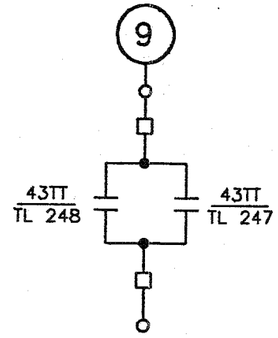
STATION
IN LOCAL



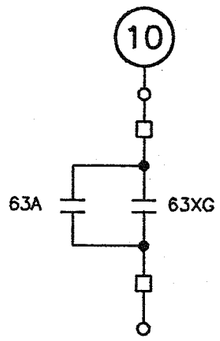
125V D.C.
BATT. CHGR.



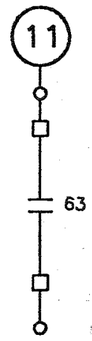
T1 PROTECTION
TRIP



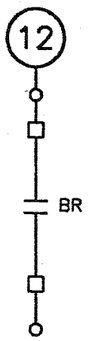
TL LINE
PROTECTION TRIP



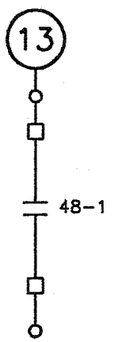
B3L47
SF6 LOW



B1L39 HI/LO
AIR PRESS.



B1L47 BLOCK
TRIP/CL.



B3L47
DISAGR.

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL ANNUNCIATOR D. C. SCHEMATIC

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D1-R0

TL 247 PROT. TRIP	TL 248 PROT. TRIP	TL 239 PROT. TRIP	T1 LOCKOUT	T1 GAS TEMP. OIL LEVEL	T1 LTC U/V EXT. TAP	T1 PROT. TRIP		
230kV BUS LOCKOUT	138kV BUS LOCKOUT	STATION SERV/D.C. FAIL.	AUTO SYNC. OFF	STATION IN LOCAL	125V D.C. BATT. CHGR.		TRANS. TRIP OFF	
B3L47 SF6 LOW	B3L47 BLOCK TRIP/CL.	B3L47 DISAGR.	B3L48 SF6 LOW	B3L48 BLOCK TRIP/CL.	B3L48 DISAGR.	B1L39 SF6 LOW	B1L39 HI/LO AIR PRESS.	

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL STATION ALARMS

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D2-R0

POINT	ANNUNCIATOR POINT DESCRIPTION	SUPERVISORY ALARM DESCRIPTION
1A	T.L. 247 PROT. TRIP	LINE PROT. TRIP
1B	T.L. 248 PROT. TRIP	LINE PROT. TRIP
1C	T.L. 239 PROT. TRIP	LINE PROT. TRIP
2A	T1 LOCKOUT	T1 LOCKOUT
2B	T1 GAS, TEMP, OIL LEVEL	T1 GAS, TEMP, OIL LEVEL
2C	T1 LTC U/V, EXT. TAP	T1 LTC U/V, EXT. TAP
3A	T1 PROT. TRIP	T1 PROT. TRIP
3B		
3C		
4A	230kV BUS LOCKOUT	BUS LOCKOUT TRIP
4B	138kV BUS LOCKOUT	BUS LOCKOUT TRIP
4C	STATION SERVICE/D.C. FAIL.	STATION SERVICE/D.C. FAIL.
5A	AUTO SYNC. OFF	AUTO SYNC. OFF
5B	STATION IN LOCAL	STATION IN LOCAL
5C	125V D.C. BATTERY CHARGER	STATION SERVICE/D.C. FAIL.
6A		
6B	TRANSFER TRIP OFF	TRANSFER TRIP OFF
6C		
7A	B3L47 SF6 LOW	BREAKER ANOMALY
7B	B3L47 BLOCK TRIP/CL.	BREAKER ANOMALY
7C	B3L47 DISAGREEMENT	BREAKER ANOMALY
8A	B3L48 SF6 LOW	BREAKER ANOMALY
8B	B3L48 BLOCK TRIP/CL.	BREAKER ANOMALY
8C	B3L48 DISAGREEMENT	BREAKER ANOMALY
9A	B1L39 SF6 LOW	BREAKER ANOMALY
9B	B1L39 HI/LO AIR PRESSURE	BREAKER ANOMALY
9C		

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL REMOTE GROUPING

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D3-R0

SEQUENCE M		
CONDITION	VISUAL	AUDIBLE
NORMAL	OFF	OFF
ALERT	FLASH	ON
ACKNOWLEDGE	ON	OFF
RETURN TO NORMAL	ON	OFF
RETURN TO NORMAL BEFORE ACK.	FLASH	ON
ACKNOWLEDGE	ON	OFF
RESET	OFF	OFF

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARDS

ANNUNCIATOR SEQUENCE TABLE

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P15-080-D4-R0

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

A.C. AND D.C.
STATION SERVICES - INDEX

No :	P16-INDEX-RO
Page :	1 of 1
Issued :	1986 03 31
App'd.	

STANDARD NO.	TITLE
P16-010-RO	125 VDC Station Service Distribution

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No. : P16-010-R0

Issued : 1986 03 31

125 VDC STATION SERVICE DISTRIBUTION

TRANSMITTAL PREPARATION DATE : 1986 02 12

SUBMITTED	CHMN. P & C STD'S COMM.	86-02-17 DATE
RECOMMENDED	CHMN. ENG. STD'S REVIEW COMM.	86-03-09 DATE
APPROVED	V.P. ENG. & CONSTR.	86-03-20 DATE
APPROVED	V. P. OPERATIONS	86-03-19 DATE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P16-010-R0
Page :	1 of 3
Issued :	1986 03 31
App'd.	L. J. Cole
	T. D. Collett

125 VDC STATION SERVICE DISTRIBUTION

1.0 Scope

This standard covers the general concepts and typical arrangement of the 125 vdc Station Service Distribution in terminal stations. Generating stations will be considered elesewhere.

2.0 General Concepts

The 125 vdc distribution scheme is based upon the concept of providing as much independence of circuit supply as is practically possible within the constraints of a single main dc bus.

It should be recognized that in newly designed terminals, as much segregation as possible will be implemented, that is, breakers will not be left as spares in the panel if they can be utilized to increase the degree of segregation. As the terminal station expands, total independence becomes impractical; however, the distribution arrangement will be developed such that loss of any dc circuit will have minimum influence upon the overall protection and control functions.

A circuit or device which provides a backup function to another circuit or device shall have its dc supplied from a separate branch breaker in the distribution panel.

In cases where a branch circuit supplies various sub-circuits, these sub-circuits will be grouped into generic types, e.g. primary protection with other primary protection, MOD control with other MOD control.

Various station control circuits such as synchronizing and service restorer schemes will have their dc supplied from the same branch breakers.

Sub-circuits will be fused at appropriate ampere ratings to co-ordinate with the branch breakers.

Branch breakers should be sized in accordance with the current carrying capacity of the cables connected to the breaker.

3.0 Typical Arrangement

Consistent with the general concepts described above, a typical 125 vdc distribution arrangement would be developed as follows:

1. Primary Line Protection

   Several primary line protection circuits of the same voltage class, e.g. 138 kV, will be supplied from the same independent branch breaker.

3.0 Typical Arrangement (Cont'd)

2. Backup Line Protection

Several backup line protection circuits of the same voltage class, e.g. 230 kV, will be supplied from the same independent branch breaker.

3. Bus Protection

All station bus differential, overvoltage, undervoltage schemes, etc. will be supplied from the same independent branch breaker.

4. Transformer Primary Protection

All transformer primary protection circuits will be supplied from the same independent branch breaker.

5. Transformer Backup Protection

All transformer backup protection circuits will be supplied from the same independent branch breakers.

6. Capacitor Bank/Reactor Bank Protection

All capacitor and reactor bank protection circuits will be supplied from the same independent branch breaker.

7. Breaker Failure Protection

All breaker failure schemes will be supplied from the same independent branch breaker.

8. Single Trip Coil Circuit Breakers

Control and recloser dc, if any, for each breaker will be supplied from the same independent branch breaker.

9. Dual Trip Coil Circuit Breakers

Control, trip coil #2 and recloser dc, if any, for each breaker will be supplied from the same independent branch breaker.

Trip coil #1 of several dual trip coil circuit breakers will be supplied from a common dc distribution circuit.

10. Motorized Disconnects and Ground Switches

Several motor operated disconnects and ground switches of a specific voltage class, e.g. 230 kV, will be supplied from the independent branch breaker.

3.0 Typical Arrangment (Cont'd)

11. Annunciator

The power supply and field contacts of the station annunciator will be supplied from an independent branch breaker.

12. Synchronizing and Common Controls

Synchronizing and other station common controls such as interposing relays, tap changer controls, service restorer, etc., will be supplied from the same independent branch breaker.

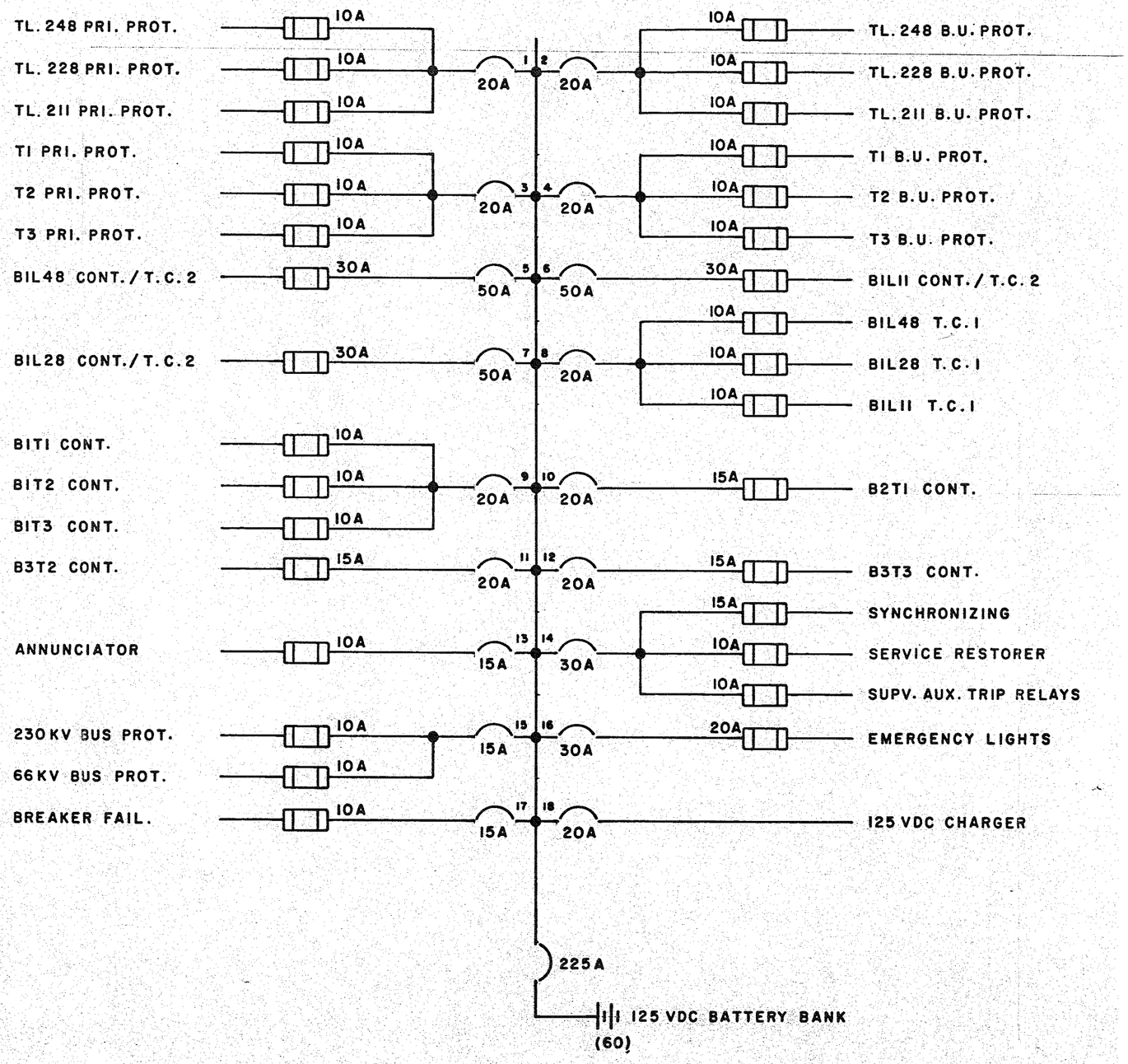
13. Emergency Lighting.

One or more dedicated branch breakers will be provided as required.

The foregoing typical arrangment is graphically depicted on Drawing No. P16-010-D1-R0 which forms an integral part of this Standard. For each terminal there will be at least one 125 vdc distribution single line diagram. This drawing will detail the arrangement of all 125 vdc circuits including branch breaker and sub-circuit fuse ratings.

4.0 Exceptions

In those cases where backup protection cannot be segregated from the primary, then the protection for the equipment will be supplied from an independent branch breaker.


TL. 248 PRI. PROT.
TL. 228 PRI. PROT.
TL. 211 PRI. PROT.
TI PRI. PROT.
T2 PRI. PROT.
T3 PRI. PROT.
BIL48 CONT./T.C.2
BIL28 CONT./T.C.2
BITI CONT.
BIT2 CONT.
BIT3 CONT.
B3T2 CONT.
ANNUNCIATOR
230KV BUS PROT.
66KV BUS PROT.
BREAKER FAIL.
10A
30A
15A
20A
50A
225A
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
TL. 248 B.U. PROT.
TL. 228 B.U. PROT.
TL. 211 B.U. PROT.
TI B.U. PROT.
T2 B.U. PROT.
T3 B.U. PROT.
BIL11 CONT./T.C.2
BIL48 T.C.1
BIL28 T.C.1
BIL11 T.C.1
B2TI CONT.
B3T3 CONT.
SYNCHRONIZING
SERVICE RESTORER
SUPV. AUX. TRIP RELAYS
EMERGENCY LIGHTS
125 VDC CHARGER
125 VDC BATTERY BANK
(60)

HYDRO PROTECTION AND CONTROL ENGINEERING STANDARD

No:	P17-INDEX-R1
Page:	1 of 1
Issued:	1994-02-02
App'd.	E&C:
	Oper:

RELAY PANELS, WIRING AND CABLES - INDEX

STANDARD NO.	TITLE
P17-050-R0	Mimic Buses
P17-075-RO	Switchboard Wiring
P17-090-RO	Control Cables - 600 Volt

HYDRO

PROTECTION AND CONTROL ENGINEERING STANDARD

Number:	P17-050-R0
Page :	1
Issued:	1994-02-02
App'd :	E&CS: D. W. Reeves
	Oper: T. D. Collett

MIMIC BUSES

1.0 SCOPE

This standard establishes the technical requirements for mimic buses on the control panels in our stations.

2.0 GENERAL ARRANGEMENT

The mimic bus in a station shall be laid out as closely as possible to the actual single line diagram of the station.

The control switches for isolating devices such as breakers, circuit switches, reclosers, motor operated disconnects, etc. shall be properly located in the mimic bus. In those stations where a ring bus, breaker and a half scheme, etc. are planned, the mimic bus with the control switches shall be located, where possible, on a separate control panel.

Manually operated isolating devices such as disconnects, ground switches, etc. shall be shown in the open position.

Other primary equipment such as generators, transformers, voltage regulators, etc. shall be displayed by standard symbols, as shown on drawing P17-050-D2, properly located in the mimic bus.

3.0 TECHNICAL REQUIREMENTS

The mimic bus, including equipment symbols, shall be made of solid acrylic material that is a minimum of 2 mm thick. The straight mimic bus shall be 10 mm wide and the dimensions of the equipment symbols shall be as shown on drawing P17-050-D2.

The mimic bus shall be attached to the panels with double faced tape.

The mimic bus including equipment symbols shall be color coded by system voltages as follows:

230 kV	-	Red
138 kV	-	Green
69 kV	-	Blue
46 kV	-	Orange
25 kV	-	Brown
16 kV	-	Yellow

HYDRO

PROTECTION AND CONTROL
ENGINEERING STANDARD

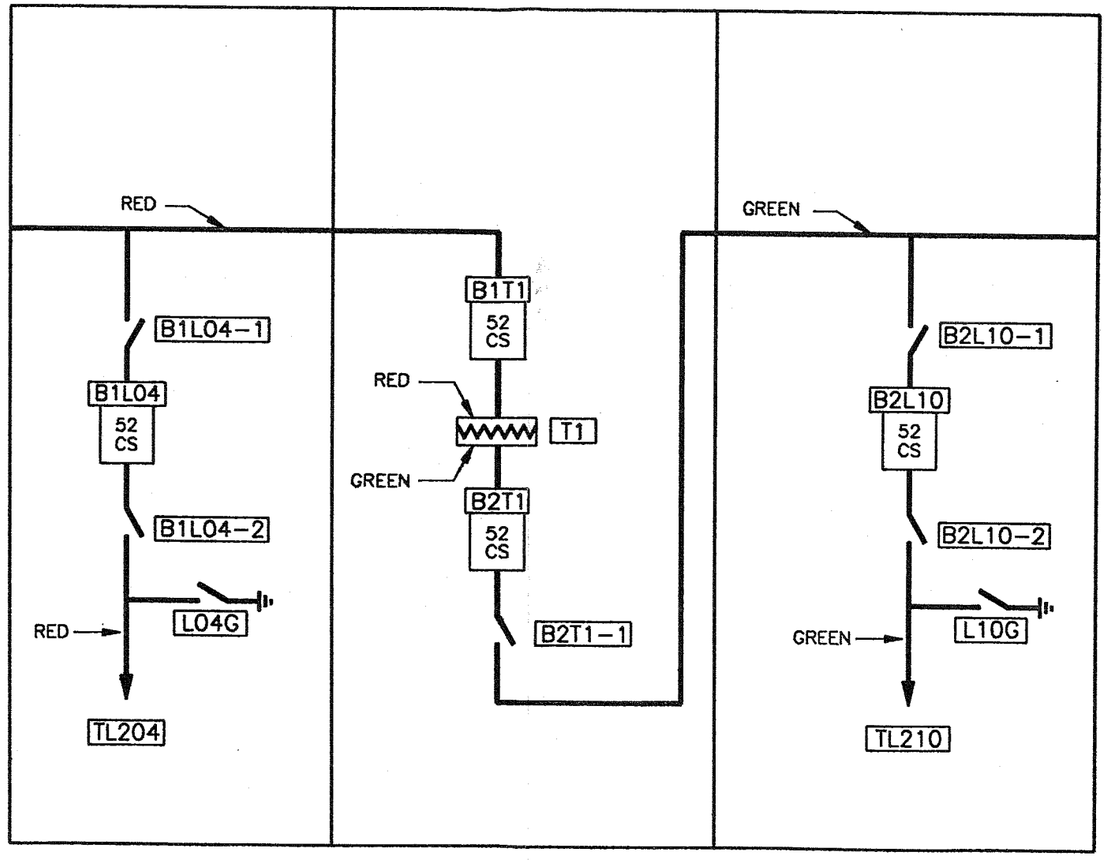
Number:	P17-050-R0
Page :	2
Issued:	1994-02-02

3.0 TECHNICAL REQUIREMENTS (cont'd.)

13.8 kV	-	Yellow
12.5 kV	-	Yellow
6.9 kV	-	Black
4160 V	-	Black
600 V & less	-	White

4.0 DRAWINGS

Drawings P17-050-D1 and P17-050-D2 form an integral part of this standard and are to be used as a reference for layout, dimensions and standard symbols.



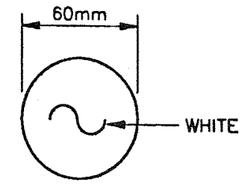
SCALE: N.T.S.

HYDRO

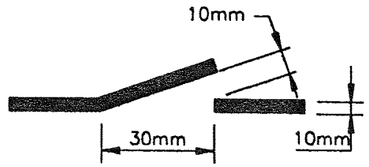
PROTECTION & CONTROL
ENGINEERING STANDARDS

MIMIC BUS
TYPICAL ARRANGEMENT

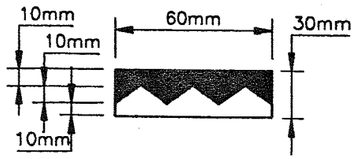
APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1994-02-02
DRAWN	W.B.
CHECKED	D. CULL
DWG.NO.	P17-050-D1-R0



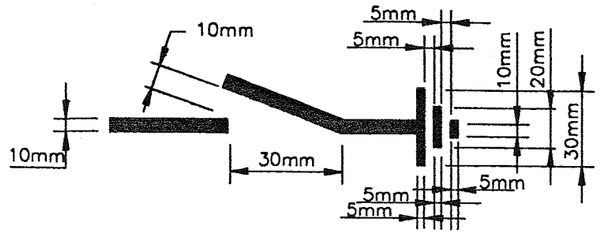
GENERATOR



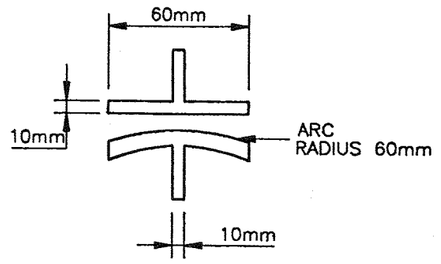
DISCONNECT



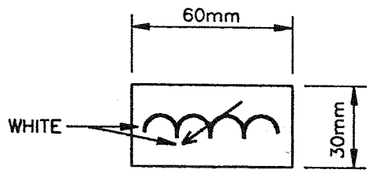
POWER TRANSFORMER



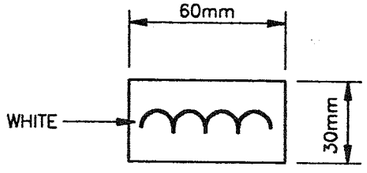
GROUND SWITCH



CAPACITOR BANK



REGULATOR



REACTOR

SCALE: N.T.S.

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

MIMIC BUS
EQUIPMENT SYMBOLS

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1994-02-02
DRAWN	W.B.
CHECKED	D. CULL
DWG.NO.	P17-050-D2-R0

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P17-075-RO
Page :	1 of 1
Issued :	1992-03-30
App'd.	T. D. Collett
	D. W. Reeves

SWITCHBOARD WIRING

1.0 SCOPE

This standard covers the methods and materials used for wiring control, metering and relaying switchboards in terminal and generating stations.

2.0 METHODS

All panel wiring shall be terminal to terminal without splices or tee-connectors. In general, not more than two conductors shall be connected to any one terminal. Wherever possible, i.e. on stud and screw terminals, etc. wires shall be terminated using ring-tongue, insulated, compression type connectors. Spade type lugs will not be used.

Any wiring connected to specialized equipment, i.e. Combiflex cases, shall have the appropriate connectors. All wiring shall be neatly trunked with sufficient slack left at the component terminals to permit re-arrangement of the connections, if required.

Any unused areas of the panel shall be kept free of wiring to permit the installation of possible future equipment.

3.0 MATERIALS

All panel wiring shall be No. 14 AWG type TEW, 41 strand, 105^{0}C, 600 Volts with black insulation, to CSA C22-2 No. 127, UL listed, AWM style 1015 with the following exceptions:

1. All annunciator wiring as above No. 16 AWG, 26 strand.

2. Transducer output circuits shall be wired with shielded cables. The shielded wiring shall comprise single, twisted pair conductors No. 18 AWG, 300V, with a bare copper drain wire, aluminum Mylar shield and overall PVC jacket. The drain wire shall be minimum No. 22 AWG and shall be carried with the shield and jacket as near as physically possible to the transducer.

   The shield and drain wire will not be grounded inside the panel.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P17-090-R0
Page :	1 of 4
Issued :	1992-03-30
App'd.	T. D. Collett
	D. W. Reeves

CONTROL CABLES - 600 VOLT

1.0 SCOPE

This Standard establishes the technical specifications for control cables rated at 600 Volts to be used in terminal and generating stations. These cables may be used for a.c. and d.c. control, and other circuits operating at voltages not exceeding 300 Volts.

2.0 REFERENCE STANDARDS

Unless otherwise stated, cables shall comply with the requirements and latest revisions of the following standards:

- CSA C21.1	600 Volt Control Cables
- CSA C22.2 No. 75	Thermoplastic Insulated Wires and Cables
- CSA Z 299.3	Quality Verification Program Requirements
- IEEE 383	Vertical Flame Test.

3.0 CONSTRUCTION

Cables shall be suitable for outdoor installation either by direct burial or installed in covered cable trench or conduit above and below ground.

Conductors, as well as finished cables, shall have a circular cross-section.

3.1 Conductors

The number and size of conductors per cable will depend upon the particular application, however, the most typical types encountered are the following:

1. 2-conductor No. 12 AWG for d.c. supplies and control/indication circuits.

2. 4-conductor No. 12 AWG for 3-phase potential transformer secondaries and general control circuits.

3. 8-conductor No. 12 AWG for control/indication.

3.1 Conductors (cont'd.)

4. 4-conductor No. 8 AWG for 3-phase current transformer secondaries.

Each stranded conductor shall be of bare annealed copper assembled in concentric layers in accordance with Table 9 of CSA C21.1 with each successive layer reversed in direction.

The current carrying capacity shall be in accordance with CSA C22.1, Canadian Electrical Code, Part 1.

3.2 Insulation

Each conductor shall be individually insulated with an extrusion of PVC having a minimum thickness in accordance with CSA C21.2. Insulation shall be type TW Minus 40^0C suitable for a working temperature range of -40^0C to $+75^0$C.

Conductors shall be identified by solid colors and by solid colors with tracers in a continuous spiral. The color shall be distributed throughout the PVC insulation. Coloring applied to the surface only will not be accepted. The shade of the solid color and tracer shall be such that they will maintain a definite contrast between each other. Each tracer will be a minimum 1.6 mm wide with a maximum lay of 30 cm. The material used for solid tracers will meet the requirements of CSA C21.1 Clause 6.2.1.

3.2.1. Color Coding

Standard design practices will adhere to a color code system for cables used in 3-phase and single phase a.c. circuits, and 2-wire d.c. circuits, as follows:

3-Phase Circuits

"A" Phase current or potential - Red
"B" Phase current or potential - Yellow
"C" Phase current or potential - Blue
Neutral or ground wire - Black

3.2.1 Color Coding (cont'd.)

1-Phase Circuits

Hot Conductor	- Red
Neutral or ground wire	- Black

DC Circuits

Positive (+) conductor	- Red
Negative (-) conductor	- Black

Because of this practice, all 2-conductor cables will have a red and a black conductor; all 4-conductor cables will have red, yellow, blue and black insulated conductors.

For cables with more than four (4) conductors the color coding requirement is less stringent but, where practical and economical to do so, will conform to the following example for a 12-conductor cable.

Conductor No.	Color
1	Black
2	Red
3	Blue
4	Yellow
5	Orange
6	Brown
7	Red with Black Tracer
8	Blue with Black Tracer
9	Yellow with Black Tracer
10	Orange with Black Tracer
11	Brown with Black Tracer
12	Black with Red Tracer

Tracer colors will continue in the same order as the solid colors, i.e. red, blue, yellow, orange, etc.

3.3 Shielding

The cabled conductors shall be wrapped with a minimum 2.5 mil mylar aluminum tape, half-lapped for 100% coverage. This tape shall be applied with the aluminum side inwards.

A tinned copper drain wire, minimum No.22 AWG, shall be assembled along the entire length of the aluminum tape.

3.4 Jacket

The overall jacket shall be extruded PVC suitable for a working temperature range of -40^0C to $+75^0$C. Jacket thickness shall be in accordance with CSA C21.1, Table 10 and shall meet the flame retardancy requirements of CSA C22.2 No. 75 and IEEE 383. Jacket shall be black in color.

Each cable jacket shall be marked every 30 cm, "Control Cable - 600 Volt - Shielded", size and number of conductors, type of insulation and temperature rating.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P21-INDEX-R2
Page :	1 of 1
Issued :	1993-02-08
App'd.	

DEVICES AND HARDWARE - INDEX

STANDARD NO.	TITLE
P21-005-R0	Panel Device Identification
P21-010-R0	Blocking Switches
P21-015-R0	Test Switches
P21-020-R0	Isolating Guidelines for Low Voltage Circuits
P21-040-R0	Terminal Blocks
P21-050-R0	Fuses and Fuseholders
P21-090-R0	Indicating Lights

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

PANEL DEVICE IDENTIFICATION

No :	P21-005-RO
Page :	1 of 13
Issued :	1993-02-08
App'd.	T. D. Collett
	D. W. Reeves

1.0 SCOPE

This standard establishes the requirement for panel device identification in our terminal and generating stations.

2.0 PURPOSE

Panel device identification labels are provided to facilitate correct information recording in the event of a system disturbance and to assist the operating personnel in the correct operation of the equipment.

3.0 APPLICATION

In general identification labels will be applied on all devices mounted on control panels in the terminal and generating station.

4.0 REQUIREMENTS

The identification labels will be made from 2 ply flexible engraving stock, typically 1.5 mm thick. The labels will have a black surface and a white background. Adhesive backing will be supplied on all labels to facilitate fixing to the control panels.

Labels wider than 10 mm shall be supplied with a beveled edge, and those 10 mm and below shall be supplied with an unbeveled edge.

The examples following this standard form an integral part of the standard and are to be referred to for label and letter size and also the lettering layout.

5.0 STANDARDS OF ACCEPTANCE

Hermes Gravoply 2, Cat No. 210-226.

PANEL DEVICE IDENTIFICATION

SELECTOR SWITCHES (TAG = 25 mm x 60 mm, LETTERS = 6 mm)

(1)	Transfer trip on/off -	TL204 TRANSFER TRIP 43TT
(2)	Recloser on/off -	TL204 RECLOSER 43R
(3)	Manual synchronizing on/off -	B1L04 MAN SYNCH 43MS
(4)	Automatic synchronizing test/off/auto -	AUTO SYNCH 43AS
(5)	Supervisory local/remote -	SUPERVISORY 43S
(6)	Transformer tap changer auto/manual -	T1 TAP CHANGER 43LTC
(7)	Automatic voltage regulator auto/manual -	UNIT 1 VOLT REG 43VR
(8)	Automatic voltage matcher on/off -	AUTO VOLT MATCH. 43VM
(9)	Unit master control mode transfer auto/manual -	UNIT 1 MASTER CONTROL MODE 43CM

(10) Unit running mode Gen/Synch Cond. - UNIT 1 RUNNING MODE 43RM

(11) Voltmeter phase select - 230KV B1 VOLTAGE 43V

(12) Potential transformer transfer PT1/PT2 - 230KV PTS 43PT

CONTROL SWITCHES (TAG = 25 mm x 60 mm, LETTERS = 6 mm)

(1) Transformer tap changer raise/lower - T1 TAP CHANGER 84LTC

(2) Headgate raise/lower - UNIT 1/2 HEADGATE 84HG

(3) Unit master control start/stop - UNIT 2 START/STOP 1CS

(4) Unit speed/load control raise/lower - UNIT 2 SPEED/LOAD 15CS

(5) Automatic voltage regulator raise/lower - UNIT 2 AUTO VOLT REG 90CS

(6) Manual voltage regulator raise/lower - UNIT 2 MAN VOLT REG 70CS

(7) Circuit breaker trip/close - B1L04

(8) Motor operated disconnect open/close - B1T1

(9) Field breaker trip/close - UNIT 2 FIELD BREAKER 41CS

(10) Spherical valve close/open - SPHERICAL VALVE 1 20CS

(11) Unit wicket gate limit raise/lower - UNIT 2 WICKET GATE LIMIT 84WGL

PUSHBUTTONS (TAGS = 25 mm x 60 mm, LETTERS = 6 mm)

(1) Unit master control start/stop - UNIT 1 START/STOP 1PB

(2) Spherical valve control close/open - SV1 CLOSE/OPEN 20PB

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

LIGHTS (TAG = 20 mm x 40 mm, LETTERS = 6 mm)

(1) Control d.c. supervision -	B1L04 CONT. D.C.
(2) Protection d.c. supervision -	TL204 PROT. D.C.
(3) Trip coil supervision (1 set of trip coils) -	B1L04 T.C. SUPV.
(4) Trip coil supervision (more than 1 set of trip coils) -	B1L04 TC2 SUPV.
(5) PT supervision (3PT's) -	230KV B1 PTS TL204 PROT.
(6) PT supervision (1 PT) -	L204 Bϕ PT SYNCH & METER
(7) Transformer tap change in progress -	T1 LTC IN PROGRESS
(8) Transformer gas & wdg. temp. trip -	T10 GAS & WDG TEMP TRIP
(9) Recloser ON -	TL204 RECLOSER ON

(10) Automatic synchronizer ON - AUTO SYNCH ON

(11) Synchronizing pulse sent - SYNCH PULSE SENT

(12) Unit brakes ON - UNIT 2 BRAKES ON

(13) Unit running - UNIT 2 RUNNING

(14) Transformer fans ON - T1 FANS STAGE 1 ON

(15) Headgate in motion - UNIT 1/2 HEADGATE IN MOTION

NOTES:

(1) PT Supervision lights for three phase to neutral PT circuits are always arranged from left to right in the following order: AN, BN, CN.

(2) PT Supervision lights for three phase to phase PT circuits are always arranged from left to right in the following order: AB, BC, CA.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

COUNTERS (TAG = 20 mm x 60 mm. LETTERS = 6 mm)

(1) Breaker reclose -

B1L04 RECLOSE

(2) Protection trip -

TL204 Aϕ TRIP
TL204 PRIM Aϕ TRIP
TL204 B/U 3ϕ TRIP

PANEL ID (TAGS = 40 mm x 100 mm, LETTERS = 8 mm)

(1) Transmission line -

TL204 PROTECTION & CONTROL

(2) Transformer -

TRANSFORMER T1 PROTECTION & CONTROL

(3) Auto synchronizing -

AUTOMATIC SYNCHRONIZING

(4) 230 kv breaker failure protection -

230 KV BREAKER FAILURE PROTECTION

(5) Annunciator & station service -

ANNUNCIATOR & STATION SERVICE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

(6) 230 KV & 66 KV bus protection -

230 KV & 66 KV BUS PROTECTION

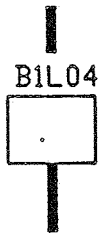
(7) Unit protection -

UNIT 2 PROTECTION

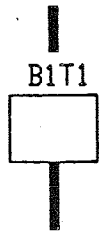
Panel Number (TAG = 25 x 25 mm, LETTERS = 15 mm) - FRONT & BACK

MIMIC BUS (TAGS = 20 mm x 40 mm, LETTERS = 6 mm)

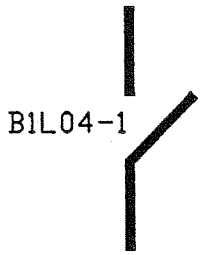
(1) Circuit breaker -



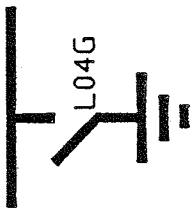
(2) Motor operated disconnect switch -



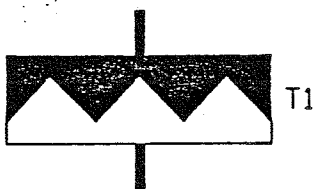
(3) Manual disconnect switch -



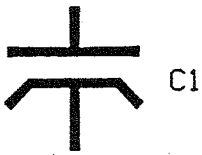
(4) Manual ground switch -



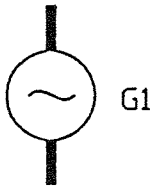
(5) Transformer -



(6) Capacitor bank -



(7) Generator -

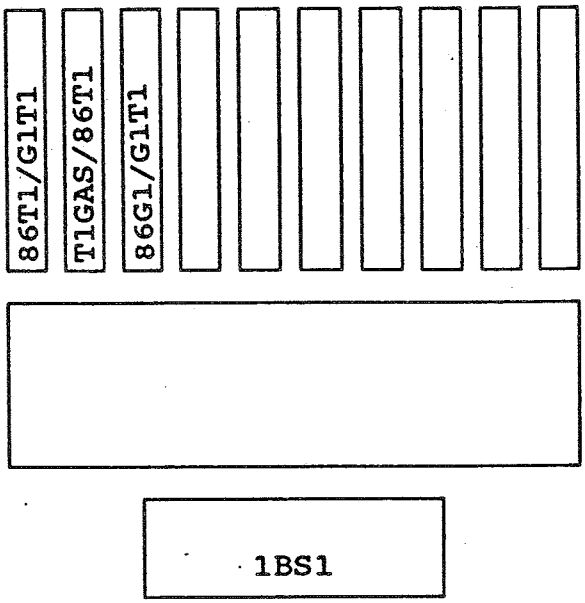


BLOCKING/ TESTING/ ISOLATING SWITCHES

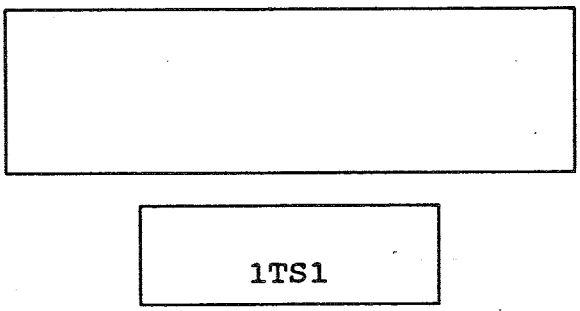
(Switch block ID - TAG = 20 mm x 60 mm, LETTERS = 6 mm)

(Individual switch ID - TAG = 10 mm x 40 mm, LETTERS = 4 mm)

(1) Blocking switch -



(2) Testing switch -



HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

FUSES (1 POLE FUSE BOX - TAG = 20 mm x 40 mm, LETTERS = 4 mm)
(2 POLE FUSE BOX - TAG = 20 mm x 40 mm, LETTERS = 4 mm)
(3 POLE FUSE BOX - TAG = 20 mm x 60 mm, LETTERS = 4 mm)
(4 POLE FUSE BOX - TAG = 20 mm x 80 mm, LETTERS = 4 mm)

(1) Protection d.c. -	3FU2 TL204 PROT D.C.
(2) Primary protection d.c. -	3FU3 TL204 PRIM PROT D.C.
(3) Backup protection d.c. -	4FU1 TL204 B/U PROT D.C.
(4) Control d.c. -	6FU4 B1L04 CONT D.C.
(5) Annunciator d.c.	2FU3 ANNUN D.C.
(6) Synchronizing d.c. -	5FU4 SYNCH D.C.
(7) Synchronizing PT -	6FU5 UNIT 2 SYNCH P.T.
(8) Protection PTS -	4FU4 TL204 PROT PTS
(9) Metering PTS -	8FU7 TL204 METER PTS

(10) Protection and Metering PTS -

7FU6
TL204 PROT & METER PTS

NOTES:

(1) A 2 pole fuse block, used for d.c., always has the positive (+) on the left and the negative (-) on the right.

(2) A 2 pole fuse block, used for one phase to neutral PT circuit, always has the phases on the left and the neutral on the right.

(3) A 2 pole fuse block, used for phase to phase PT circuit, always has the phases arranged from left to right in one of the following orders: AB, BC, or CA.

(4) A 4 pole fuse block, used for three phases to neutral PT circuit, is always arranged from left to right in the following order: ABCN.

(4) A 3 or 4 pole fuse block, used for three phases to phase PT circuit, is always arranged from left to right in the following order: ABC.

RELAYS (TAGS = 10 mm x 60 mm, LETTERS = 6 mm)

NOTE: On top half of panel, place ID tags under relays and on bottom half of panel, place ID tags over relays.

(1) Transmission line (a) One protection scheme per panel
- 94L
- 21NZ1
- 21Z1
- 21Z2
- 50B
- 67N
- 50/51L
- 50/51N
- 27XA
- 30Z2
- 30TT
- 30TTL0

(b) More than one protection scheme per panel
- TL204-21NZ1
- TL204-50/51L
- TL205-67N
- TL205-50B

(C) one relay per phase
- 21NZ1-A
- 50/51L-A
- 50B-A

(2) Transformers
- 86T1
- 87T1-A
- 51NT1
- 50/51T1-A
- 30LTC
- 30GA/WT

(3) Bus
- 86B1
- 87B1-C
- 59B1

(4) Generating unit (a) one protection scheme per panel
- 87G-A
- 50/51G-A
- 86G
- 51V-B
- 46G
- 59G
- 64G
- 40G
- 78G
- 27G
- 81G

(b) more than one protection scheme per panel
- 87G1-A
- 86G1
- 78G2
- 64G2

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No.	P21-010-RO
Page:	1 of 3
Issued:	1992-04-30
App'd.	T. D. Collett
	D. W. Reeves

BLOCKING SWITCHES

1.0 SCOPE

This standard covers the application and technical requirements of blocking switches in protection and control circuits.

2.0 PURPOSE

Blocking switches will be used in the routine maintenance, calibration and function testing of protective devices to prevent undesirable equipment operation.

3.0 APPLICATION

In general, blocking switches will be applied to those protective devices whose output contacts are connected to trip circuits, shutdown circuits or any protection and control circuit where inadvertant contact closure would result in undesirable action.

All primary protective devices performing trip functions through auxiliary relays will have blocking switches applied to their contacts as well as the trip contacts of the auxiliary relays. This will facilitate the isolation of these primary devices without the necessity of blocking all the protection. For primary relays which are used on a per phase basis, one blocking switch will be applied to cover the three trip contacts.

A special application is the supervision of the non-electrical trip devices associated with transformer protection, i.e. gas detection, winding temperature, etc. This circuit comprises a blocking switch, 100 K resistor and a neon light, arranged as shown in Drawing No. P21-010-D3. This particular arrangement is used by operating personnel for transformer switching to confirm that the trip circuits are reset before the protection is restored to service.

4.0 TECHNICAL REQUIREMENTS

Switches will be arranged in a self-contained group of ten (10) individual switches of the knife blade type, hinged at the bottom with barriers separating each switch.

4.0 TECHNICAL REQUIREMENTS (cont'd.)

The switches shall have an insulation rating of 600 Volts and a continuous current rating of 30 amperes. The minimum short time rating of the switches will be 500 amperes for 1 second.

The blocking switch group shall have a removable protective cover which cannot be in place while any individual switch is open.

5.0 LOCATION

For ease of operation and inspection, the blocking switches shall be suitable for semi-flush mounting on the front of the relay panel. The groups will be as near to the middle of the panel as is practical with sufficient area above the group to permit the identification of individual switches on the panel.

Blocking switches will be located on the same panel as the trip device for which it is intended.

6.0 DESIGNATION

Blocking switch groups will be designated on the relay panels as per the following example.

3BS2

where, 3 - Station Panel Number

BS - designates blocking switch as opposed to other devices, e.g. test switch

2 - the sequential number of the blocking switch group on that particular panel.

Individual switches will be identified with a lamacoid nameplate adhered to the relay panel directly above the switch. The nameplate will have white lettering on a black background. The engraving will be such that the device blocked is indicated first followed by the device which the isolated contact operates.

For example, where the first zone distance relay Contact 21Z1, operates into the three phase line trip relay, 94L, the blocking switch which isolates the 21Z1 will be labelled 21Z1/94L.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

6.0 DESIGNATION (cont'd.)

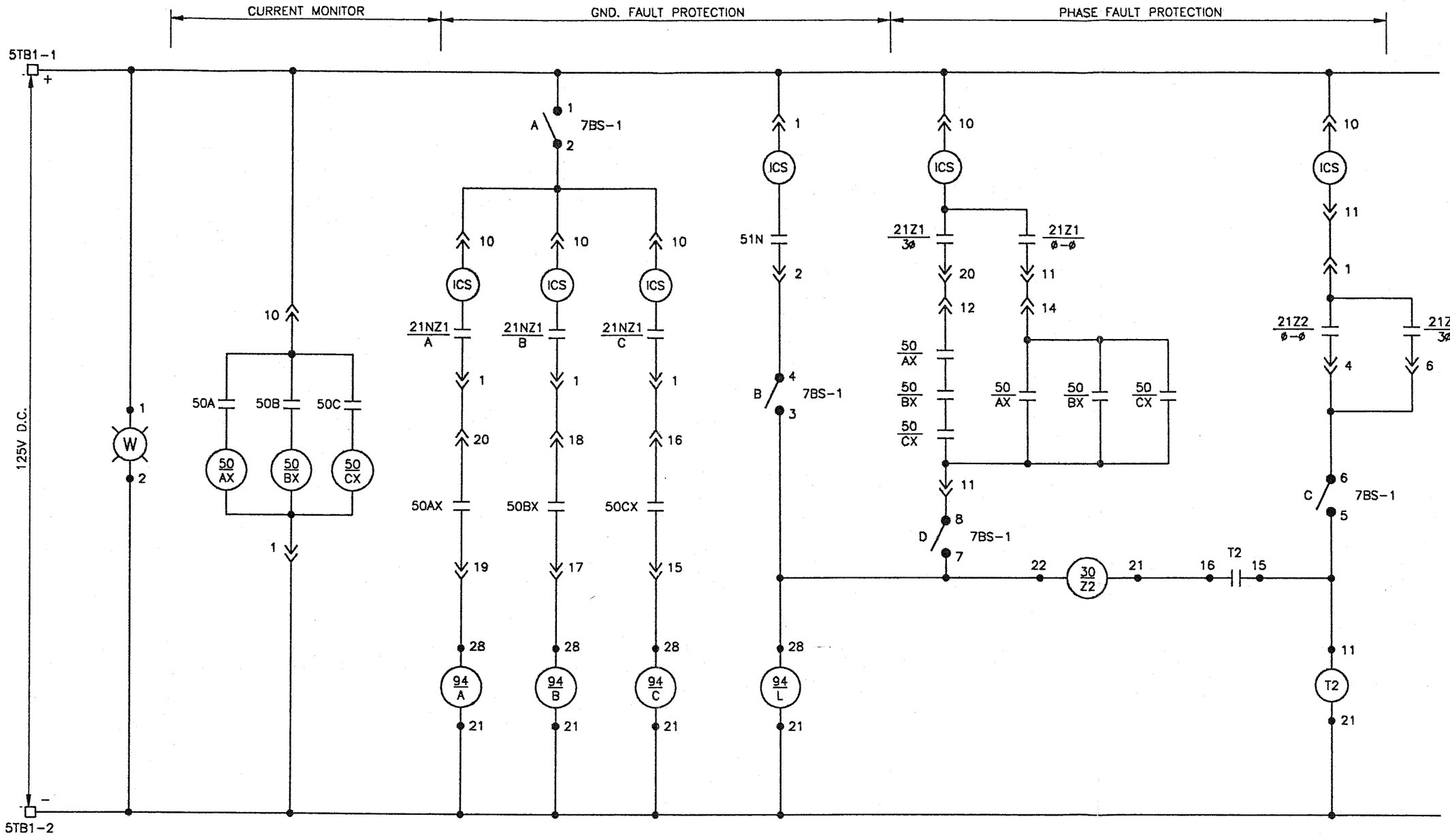
Where a particular transformer lockout (86T1) contact trips a particular breaker, say B1T1, the blocking switch for that contact will be labelled 86T1/B1T1.

7.0 CONNECTION DIAGRAMS

Typical schematic diagrams, Drawing No's P21-010-D1, P21-010-D2, and P21-010-D3 form an integral part of this standard.

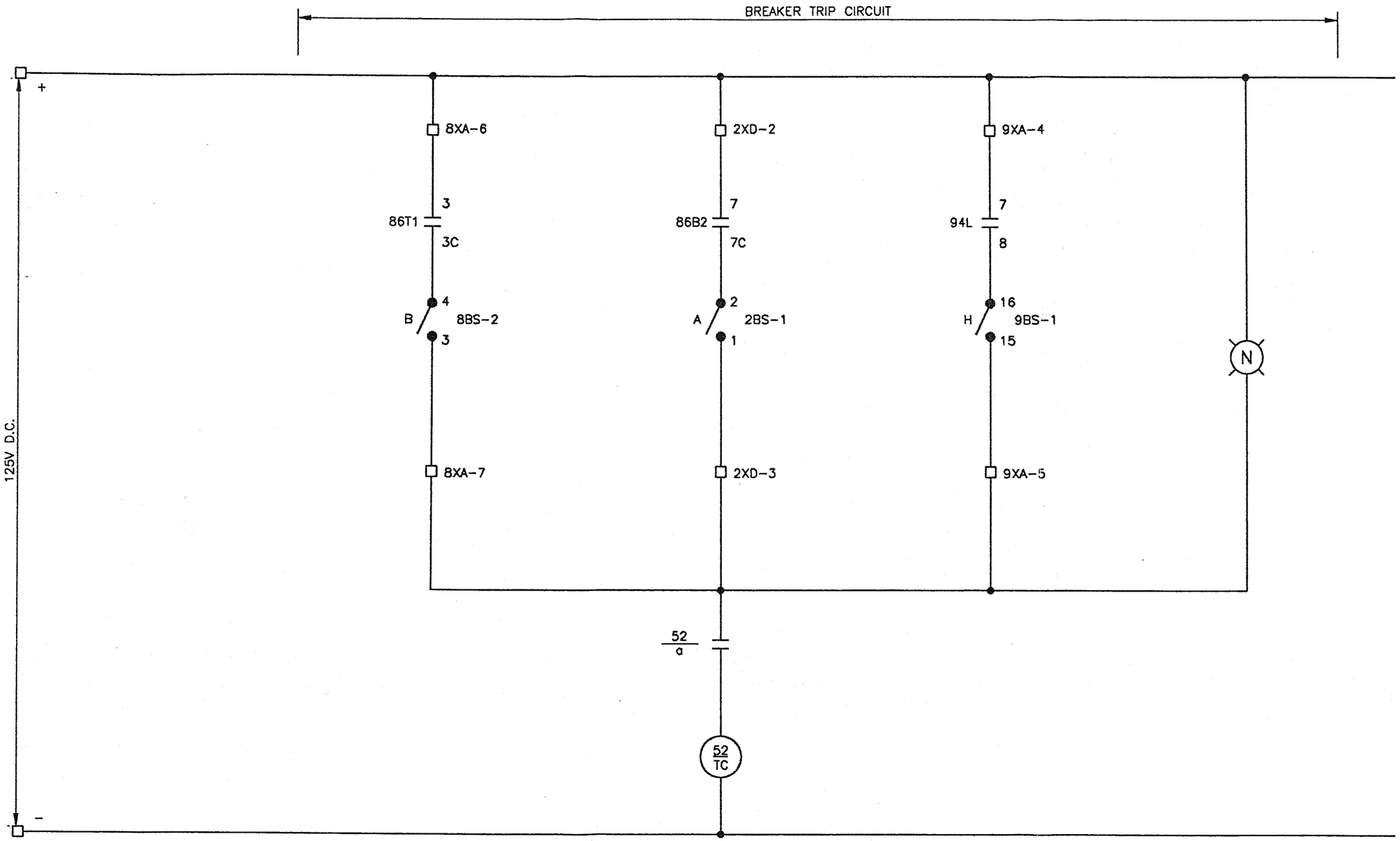
8.0 STANDARD OF ACCEPTANCE

Westinghouse Type FT-1.



HYDRO	PROTECTION & CONTROL ENGINEERING STANDARDS
TYPICAL CONNECTION DIAGRAM PRIMARY PROTECTION BLOCKING SWITCHES	

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-010-D1-R0



NOTES

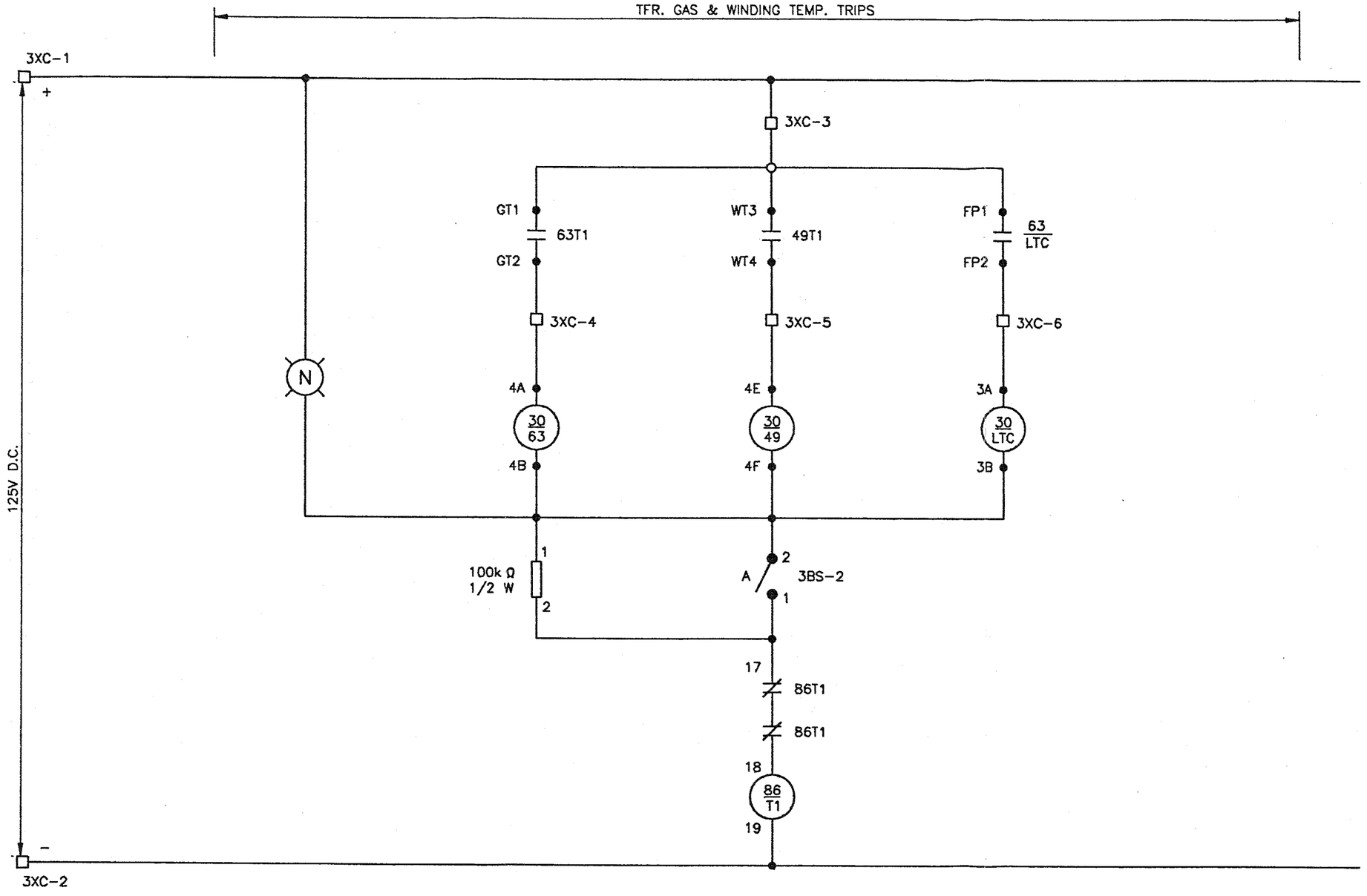
1. WHEREVER POSSIBLE, THE BLOCKING SWITCH WILL BE ON THE NEGATIVE D.C. BUS SIDE OF THE TRIP CONTACT WITH THE HINGED TERMINAL WIRED TO THE TRIP CONTACT.

HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL CONNECTION DIAGRAM
TRIP BLOCKING SWITCHES

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-010-D2-R0



HYDRO

PROTECTION & CONTROL
ENGINEERING STANDARDS

TYPICAL CONNECTION DIAGRAM
TFR. GAS & WDG. TEMP. TRIPS

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-010-D3-R0

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No.	P21-015-R0
Page:	1 of 2
Issued:	1992-04-30
App'd.	T. D. Collett
	D. W. Reeves

TEST SWITCHES

1.0 SCOPE

This standard establishes the requirements for test switches on the secondary circuits of potential and current transformers.

2.0 GENERAL ARRANGEMENTS

In general, test switches will be applied on the secondaries of potential and current transformers for the following purposes:

i) To test revenue metering equipment

ii) To test statistical metering equipment

iii) To determine individual contributions from each C.T. in a differential scheme unless this can be achieved at a relay test point.

iv) To test other relays and instrumentation which do not have inherent test facilities.

Because most protective relays have built-in test points, test switches will not be provided for these circuits. In those cases where statistical metering is on the same core as the protective relays, test switches will not be employed provided the relays have their own test points.

Test switches are not applied as primary isolation or shorting devices except for non-drawout type relays where switches are to be added to isolate the relay for testing purposes.

3.0 TECHNICAL REQUIREMENTS

All test switches will contain four (4) potential poles and six (6) current poles arranged as follows when viewed from the front of the switch PPP CC CC CC P. (CC designates current shorting).

Individual poles shall be of the knife blade type hinged at the bottom with barriers separating each pole.

3.0 TECHNICAL REQUIREMENTS (cont'd.)

The switches shall have an insulation rating of 600 Volts and a continuous current rating of 30 amperes. The minimum short time rating of the switches will be 500 amperes for 1 second.

The test switches shall have a removable protective cover which cannot be in place while any individual blade is open.

4.0 LOCATION

Test switches shall be suitable for semi-flush mounting on the front of the relay panel and shall be located at the bottom of the panel a minimum of 100 mm from the floor. Test switches will be mounted on the same panel as the equipment for which it is intended.

5.0 DESIGNATION

Test switches will be designated on the panels as per the following example.

5TS3

where, 5 - station panel number

TS - designates test switch as opposed to other equipment, e.g. blocking switch

3 - the sequential number of the test switch on that particular panel.

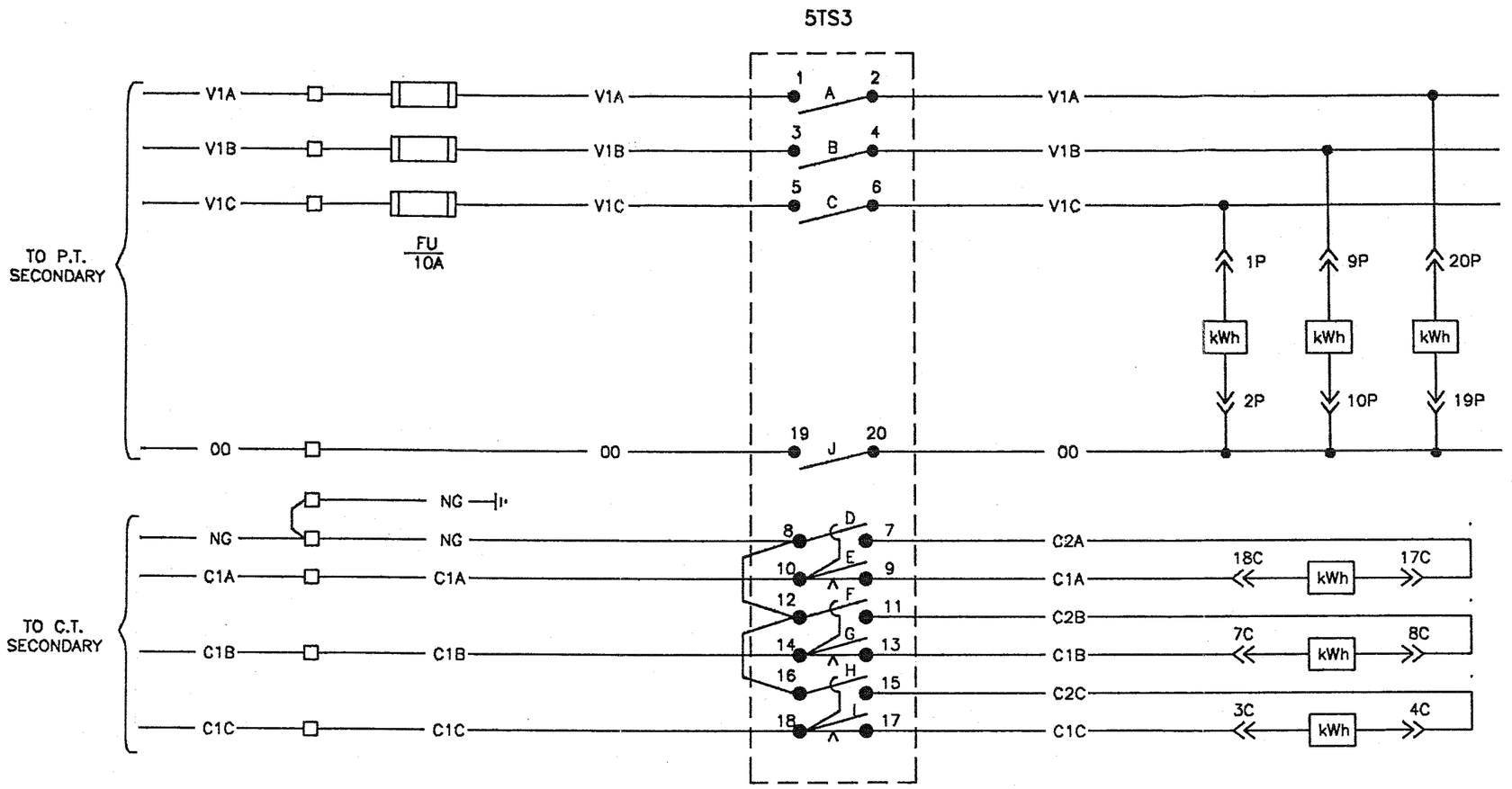
6.0 CONNECTION DIAGRAMS

Typical connection diagrams as noted below form an integral part of this standard.

Revenue Metering - Drawing No. P21-015-D1

Statistical Metering - Drawing No. P21-015-D2

Differential Protection - Drawing No. P21-015-D3



NOTES

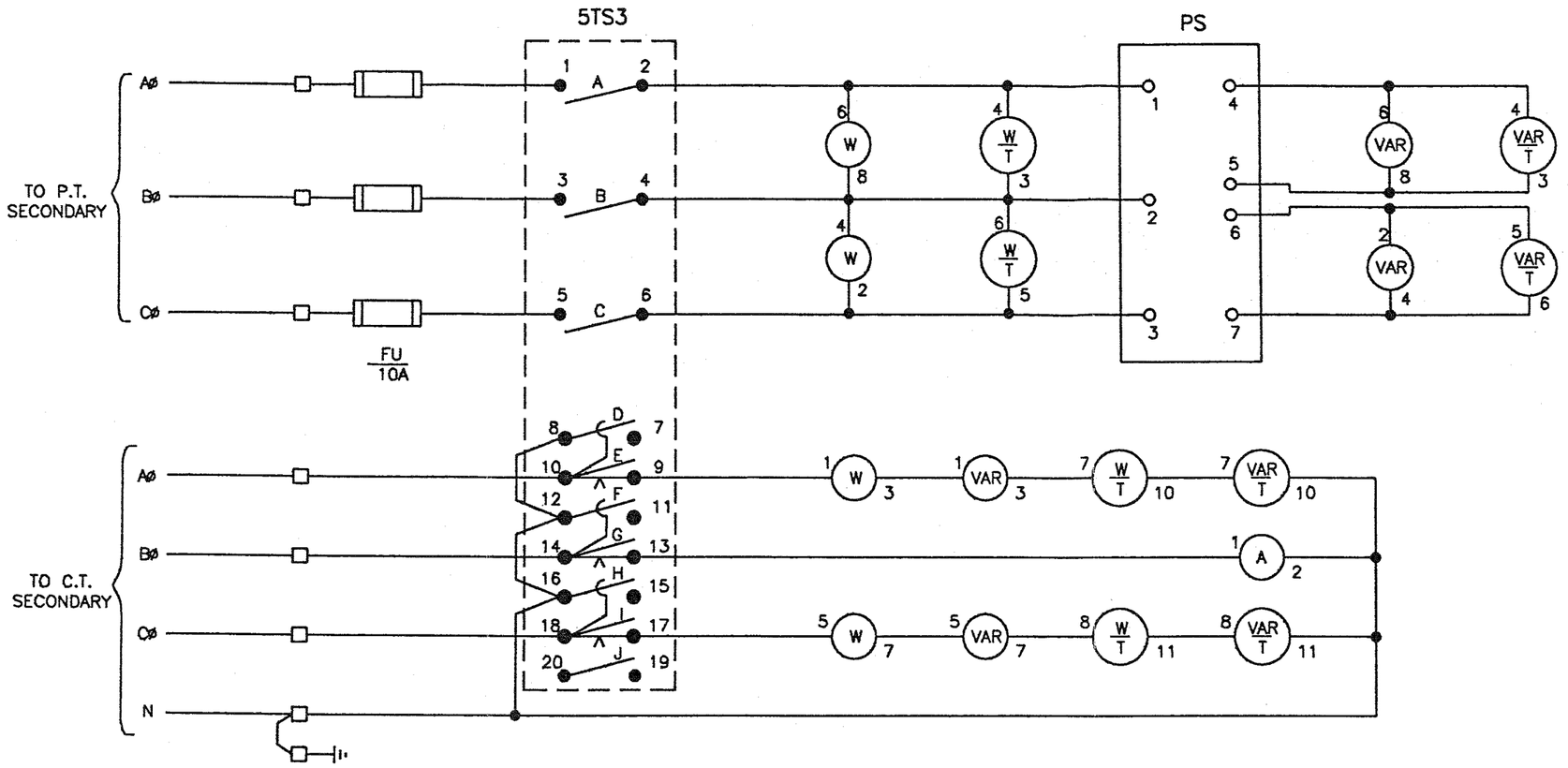
1. WHEN TWO(2) OR MORE C. T. SECONDARIES ARE REQUIRED, TEST SWITCHES WILL BE APPLIED TO EACH SECONDARY WITH THE PARALLEL CONNECTION ON THE METER SIDE OF THE TEST SWITCH.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARDS

TYPICAL CONNECTION DIAGRAM
REVENUE METERING

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-015-D1-R0



NOTES

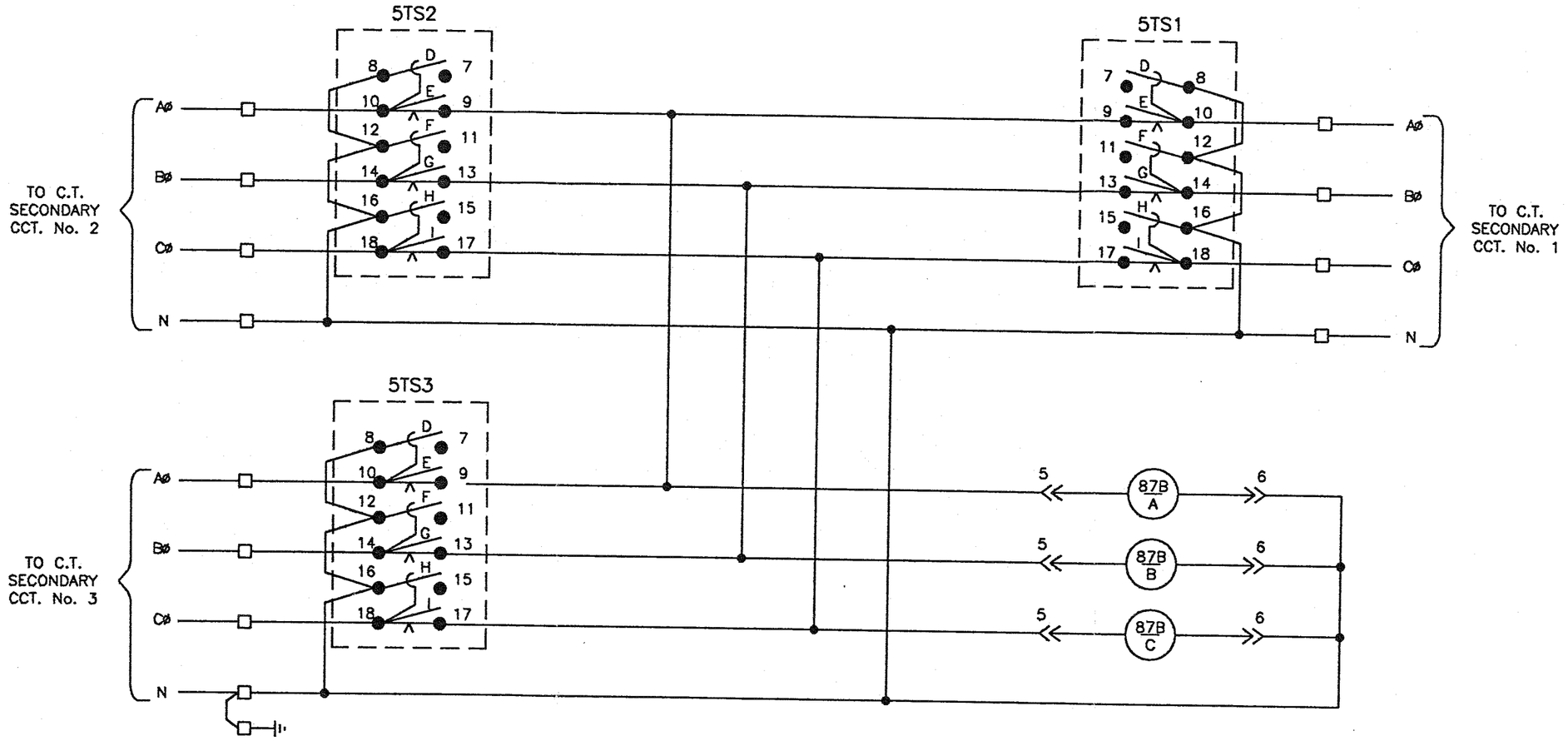
1. WHEN TWO(2) OR MORE C. T. SECONDARIES ARE REQUIRED, ONLY ONE(1) TEST SWITCH WILL BE APPLIED. THE SECONDARIES WILL BE TERMINATED ON SEPARATE PANEL TERMINALS WITH THE PARALLELING CONNECTION MADE ON THE TEST SWITCH SIDE OF THE TERMINAL.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARDS

TYPICAL CONNECTION DIAGRAM STATISTICAL METERING

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-015-D2-R0



NOTES

1. WHERE AN AUXILIARY C.T. IS REQUIRED ON A SECONDARY TO ACHIEVE THE PROPER RATIO, THE TEST SWITCH SHALL BE ON THE RELAY SIDE OF THE AUXILIARY C.T. PROVIDED THERE IS ONLY ONE SECONDARY TO BE CORRECTED. IN CASES WHERE TWO(2) OR MORE SECONDARIES REQUIRE CORRECTION AND ONLY ONE(1) AUXILIARY C.T. IS USED, TEST SWITCHES WILL BE APPLIED TO EACH SECONDARY OF THE MAIN C.T.'S.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARDS

TYPICAL CONNECTION DIAGRAM DIFFERENTIAL SCHEME

APP'D	T. D. COLLETT
	D. W. REEVES
ISSUED	1992-04-30
DRAWN	W. B.
CHECKED	D. CULL
DWG.NO.	P21-015-D3-R0

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P21-020-R0
Page :	1 of 2
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App'd.	T. D. Collett
	D. W. Reeves

ISOLATING GUIDELINES FOR LOW VOLTAGE CIRCUITS

1.0 SCOPE

This standard establishes the requirement for isolating devices in control circuits of less than 250 volts.

2.0 GENERAL

Isolating switches will be generally used for the following purposes:

1. To remove control power from primary equipment; e.g. circuit breakers, motor operated disconnects, etc.

2. To isolate the secondaries of potential transformers, including the neutral, to prevent backfeed while work is in progress.

3. To remove power from heater circuits while work is in progress; e.g., equipment cabinet heaters, oil circuit breaker tank heaters, etc.

Isolating switches will not be used to isolate current transformer secondaries. The secondaries of current transformers will be wired through sliding links on the relay control panel. These links are to provide the required isolation.

D.C. supplies to protection and control circuits on relay panels shall be wired through sliding links and then through fuses. The sliding links will be used to provide isolation for work on protection and control circuits.

3.0 TECHNICAL REQUIREMENTS

Switches shall be of the knife-blade type, hinged at the bottom with barriers separating each switch, unless the switches are supplied with and form an integral part of the equipment.

Switches shall have an insulation rating of 600 volts and a continuous current rating of 30 amperes. The minimum short time rating of the switches will be 500 amperes for one second.

3.0 TECHNICAL REQUIREMENTS (cont'd.)

When circuits breakers are used to isolate equipment, they shall have visible contacts to indicate that the breaker is in the open position.

Switches which are used to isolate equipment for permit purposes shall be ganged such that only one operation is required to effect isolation.

4.0 LOCATION

Switches which are used to isolate control power shall be located in the primary device control cabinet.

5.0 DESIGNATION

Isolating devices will be designated as per the following examples:

1. Switches used to isolate d.c. control power shall be labeled "Control D.C.".

2. Switches used to isolate potential transformer secondaries shall be labeled "230 kV B1 P.T.'S".

3. Sliding links used for isolation of supplies to protection and control panels shall be identified as to what circuit they isolate. This does not apply to current transformer circuits.

In all cases, isolation devices shall be located and designated such that there is no ambiguity as to its function.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P21-040-R0
Page :	1 of 2
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App'd.	T. D. Collett
	D. W. Reeves

TERMINAL BLOCKS

1.0 SCOPE

This Standard establishes the requirement for terminal blocks in terminal and generation stations.

2.0 BASIC REQUIREMENT

Terminal blocks shall be used in all switchboard panels, junction boxes, and primary equipment cabinets where wiring is required for protection, control, and metering circuits between any two locations, except for transducer outputs. Terminal blocks shall not be required for transducer outputs on switchboard panels wired to the supervisory junction box.

3.0 TECHNICAL SPECIFICATIONS

All terminal blocks shall have the following specifications with exceptions for specific applications as shown in 3.1 and 3.2:

1. 600 Volt rating.
2. 30 AMP rating.
3. A sliding disconnect link for visible isolation of the circuit and a method of locking in the open or close position. The locking screw is to be part of the sliding link mechanism and shall be of a corrosion resistant material.
4. A minimum #8 terminating stud on both sides of the block capable of terminating at least two #12 AWG conductors fitted with ring tongue connectors.
5. An adequate barrier between poles.
6. A facility for fast and easy labelling to clearly identify individual poles.
7. Self-extinguishing, flame retardant material.
8. Corrosion resistant current carrying parts.

3.1 Current Transformer Circuits

Terminal blocks used in current transformer circuits shall have the following exception. Specification number four in Section 3.0 shall change to read as follows:

A #10 terminating stud on both sides of the block capable of terminating at least two #8 AWG conductors fitted with ring tongue connectors.

3.2 Annunciator Panels, Synchronizing Panels and Supervisory Junction Boxes

Terminal blocks used on annunciator panels, synchronizing panels, and supervisory junction boxes shall have the following exceptions. Specification numbered one through four in Section 3.0 shall change to read as follows:

1. 300 Volt rating.

2. 25 AMP rating.

3. A disconnect plug as a method of opening or closing the circuit, except for the drain wire terminal block which shall be a through type.

4. A method of terminating at least two #14 AWG conductors on both sides.

4.0 MOUNTING DETAILS

Terminal blocks shall be mounted vertically (horizontal sliding links) wherever possible.

Terminal block mounted vertically on the side wings of switchboard panels shall be positioned such that the open links are on the panel side of the block.

All horizontally mounted terminal blocks (vertical sliding links) shall be positioned such that the links fall open when loosened, except for links in current transformer circuits which fall closed when loosened.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No :	P21-050-R0
Page :	1 of 4
Issued :	1992-03-30
App'd.	T. D. Collett
	D. W. Reeves

FUSES AND FUSEHOLDERS

1.0 SCOPE

This standard establishes the requirements for the fusing of:

1. Secondary circuits of potential transformers
2. D.C. Protection and Control Circuits
3. A.C. Circuits used in control functions

2.0 BASIC REQUIREMENTS

Fuses and fuseholders are required in potential transformer secondary circuits, all D.C. circuits and A.C. control circuits to prevent damage due to overload and short circuit. Dummy fuses or fuseholders are not required in the neutrals of A.C. circuits. Fuse application is required as follows:

2.1 P.T. Secondary Circuit

1. P.T. terminal box - No fusing is required at this point.

2. P.T. junction box - Fuses are to be located between the terminal block and the isolating switch. They shall be typically rated 20 amperes but will be sized in accordance with the thermal rating and P.T. application requirements. Fusing with blown fuse contacts for control and alarm functions shall be provided for secondaries used in synchronizing circuits.

3. Panel - Branch fuses of adequate size are to be utilized at the panel immediately after the cable termination at the panel side of the terminal blocks. Each circuit is to be individually fused with fuses typically of 6 ampere rating for metering circuits and 10 amperes for protection circuits. Fuses are to be of the non-delay type. No fuses are required at the panel in synchronizing circuits. Protection for these circuits is provided by the fuses in the junction box.

2.2 D.C. Protection and Control

1. D.C. Distribution Panel - Fuses are not generally utilized at the D.C. distribution panel.

2. Switchboard Panel - Fuses are to be provided in all protection and control D.C. circuits at the panel associated with the protection and control immediately after the terminal blocks on the panel side. Fuses for all circuits, except where otherwise noted, are to be of the non-time delay type. Typical fuse sizing is to be as follows:

Breaker Control	-	20A
Protection Circuits	-	10A
Synchronizing	-	15A
Annunciators	-	10A
Service Restorer	-	10A

These values may vary as per the specific application.

3. Motor Operated Disconnect Control Boxes - Fuses are to be supplied at the point of supply to the boxes. These fuses are to be typically 5 A time delay.

2.3 A.C. Control Circuits

In all A.C. control circuits such as those employed in tapchangers, fuses are to be utilized as required in the application.

3.0 FUSE DESIGNATION ARRANGEMENT

Fuses will be designated on the panels as per the following example: 5FU3, where,

"5" indicates the panel number on which the fuse is located,
"FU" designates fuse
"3" indicates the individual group of fuses on a panel

Each fuse on a panel is to be labelled as above as well as labelled as to function: e.g., TL212 Line Protection D.C.

In D.C. circuits the positive fuse is to be mounted to the left of the negative fuse when viewing the front of the fuseholder.

3.0 FUSE DESIGNATION ARRANGEMENT (cont'd.)

In A.C. circuits the fuses are to be mounted such that they are mounted "A", "B", "C" left to right when viewing the front of the fuseholder.

The supply to the fuseholder is to be terminated on the top side of the holder.

4.0 SPECIFICATIONS

4.1 Fuses

1. All fuses are to be Type HRCI-R.
2. All fuses are to be of the enclosed cartridge hard fibre tube type.
3. All fuses are to be of the non-renewable type.
4. Fuse voltage rating is to be 250 volts.
5. All fuses are to be of the ferrule type.
6. All fuses are to be the nominal 5 cm length.

4.2 Fuseholders

1. To be capable of accepting the above fuses, that is the 5 cm., ferrule design.
2. All holders are to be the class R type.
3. Holders are to be voltage rated 250 volts and current rated 30 amperes.
4. Holders are to be supplied which provide adequate retention of the fuse.
5. Bases are to be made of molded phenolic and have suitable means for securely mounting and preventing rotation of the holder assembly. Holes for mounting screws shall be countersunk.
6. Terminals are to be of the screw type, accommodating not smaller than a size No. 10 lug of the ring tongue type.

4.2 Fuseholders (cont'd.)

7. Fuseholders are to be of the open design permitting visual observation of the fuse, and easy removal and replacement with scissors type fuse pullers.

5.0 STANDARD OF ACCEPTANCE

USD Fuseholder	R250301S
	R250302S
	R250303S

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

No.	P21-090-RO
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	D. W. Reeves

INDICATING LIGHTS

1.0 SCOPE

This standard establishes the requirement for indicating lights on the generating and terminal station main control, relaying and metering panels.

2.0 GENERAL REQUIREMENTS

Panel indicating lights are to be used for the following purposes:

a) To indicate the operating position of primary apparatus.

b) To indicate the presence of voltage on a circuit.

c) To monitor trip circuits for continuity.

d) To indicate selected functions.

e) To indicate operation in progress.

3.0 TECHNICAL REQUIREMENTS

Indicating lamp assemblies shall be switchboard type, complete with the appropriately coloured lenses and integrally mounted resistors, and shall be suitably rated for the applied voltage.

Coloured caps shall be clear, interchangeable and removable from the front of the panel.

Bulbs shall be the bayonet type, size T-31/4, and shall be replaceable from the front of the panel. Bulbs shall be long-life; 3,000 hours minimum.

Terminals shall be readily accessible and shall have facilities for clamped connections.

4.0 COLOUR CODING

The following colour coding shall apply to indicating lights:

White
- To indicate presence of voltage, pressure or other sources of energy.
- To indicate a specific event has been selected.
- To indicate when a certain step has been reached in a series of events.
- To indicate when pre-start conditions have been met.

Red
- To indicate the position or condition of the device in which it can permit the flow of current, water, steam, etc.

Green
- To indicate the position or condition of the device in which it will prevent the flow of current, water, steam, etc.

Clear
- To monitor continuity of trip circuits.

Blue
- To indicate "Auto" control has been selected.

Yellow
- To indicate "Manual" control has been selected.
- To indicate an abnormal condition exists.
- To indicate when equipment is operating outside its normal range.

Amber
- To indicate an operation in progress.

5.0 LOCATION AND IDENTIFICATION

All indicating lights must be properly located and clearly identified as per the following examples:

1. White light for voltage supervision should be located on the control panel associated with the device, and should be identified as follows:

Device no. and function. (eg. B1L18 Cont. D.C., TL 218 Prot. D.C., B1 P.T. Supervision, etc.)

5.0 LOCATION AND IDENTIFICATION (cont'd.)

2. The position indicating lights for a circuit breaker, circuit switcher, or motor operated disconnect, etc., should be located and identified as follows:

The green (open) light should be located at the top left hand corner of the control switch, the red (close) light should be located at the top right hand corner of the control switch. The identification for the lights and control switch shall consist of the device number (eg. B1L18), and should be located directly above the control switch and between the two lights.

6.0 APPLICATIONS

The following examples are typical applications and should serve as a guide for colour selection. These lights will be "ON" when the condition is met.

White:
- D.C. Voltage Supervision
- P.T. Voltage Supervision
- Generate selected
- Sync. condenser selected
- Gate cracked

Red:
- Breaker closed
- Motor operated disconnect closed
- Ground switch closed
- Control valve open
- Gate raised
- Unit running
- Pump running

Green:
- Breaker open
- Circuit switcher open
- Gate lowered
- Control valve closed
- Brakes on
- Drain valve closed

Clear:
- Breaker trip coil supervision
- Transformer protection supervision

Blue:
- Auto sync. "ON"
- Recloser "ON"
- Pump in "Auto"
- Voltage regular in "Auto"

6.0 APPLICATIONS (cont'd)

Yellow: - Pump in "Manual"
- Voltage regulator in "Manual"
- Voltage regulator on "Lower Limit"

Amber: - Tap change in progress
- Synchronizing in progress
- Transformer fans "On"
- Gate in motion

7.0 STANDARD OF ACCEPTANCE

CGE Type ET-16
CGE Type ET-17

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TELEPROTECTION, SUPERVISORY SYSTEMS AND COMMUNICATIONS - INDEX

No.	P23-INDEX-R1
Page:	1 of 1
Issued:	1986-03-31
App'd.	

STANDARD NO.	TITLE
P23-020-R0	Supervisory Control and Data Acquisition (SCADA) Interface
P23-030-R0	Isolation for Supervisory Control, Protection Signals, and Teleprotection
P23-090-R0	Supervisory Junction Box

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No.: P23-020-R0

Issued: 1986-01-08

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) INTERFACE

TRANSMITTAL PREPARATION DATE: 1985-09-13

SUBMITTED	CHMN. P & C STD'S COMM.	85-09-13 DATE
RECOMMENDED	CHMN. ENG. STD'S REVIEW COMM.	85-10-30 DATE
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HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

SUPERVISORY CONTROL AND
DATA ACQUISITION (SCADA) INTERFACE

No :	P23-020-R0
Page :	1 of 4
Issued :	1986-01-08
App'd.	L. J. Cole
	T. D. Collett

1.0 Scope

This standard will outline the method of interfacing SCADA equipment with station/plant equipment. This standard will cover the following point classifications:-

i) Control
ii) Indication
iii) Alarm
iv) Telemetry

2.0 Interface Location

All SCADA points to be interconnected to station equipment shall be interfaced in the supervisory junction box(es). The supervisory junction box layout is covered under standard P23-090.

3.0 Alarm Points

Each alarm point to be interfaced will provide an open set of dry contacts when the alarm point is in its normal (non-alarm) state. When an alarm occurs, the set of contacts will close. The contacts will be non-latching so that supervisory equipment will follow the state of the alarm in the station equipment.

The grouping of alarms shall be done at the annunciator panel.

4.0 Status Points

For each status point interfaced to SCADA equipment, there shall be defined a 'usual' operating mode. The most common devices are listed in section 6.0. Devices interfaced shall be categorized also according to operation time. All contacts shall be dry NO non-latching type.

4.1 Category 1

Devices which operate (i.e. change from one state to another) in less than 10 seconds shall be interfaced by 1 set of contacts.

4.2 Category 2A

Devices which require greater than 10 seconds to operate and for which supervisory control capability is provided shall provide 2 sets of contacts for status indication thereby providing the in-transit state.

4.3 Category 2B

Devices which require more than 10 seconds to operate, but are not under supervisory control shall be interfaced by 1 set of contacts.

5.0 State Definition

When a device from Category 1 or Category 2B are interfaced, an open set of dry contacts shall provide indication of the 'usual' operating state for the device. When the contacts close, the 'other' operating state will be specified for the device.

When a device from Category 2A is interfaced, two sets of contacts are required and these will be referred to as, and numbered (1) and (2).

These numbers will also be provided on supervisory junction box drawings to illustrate the location of the contacts.

When the 2 sets of contacts are in the described state, the following indication will be provided.

Device State	Contact 1	Contact 2
Usual Mode	Open	Closed
Intransit	Closed	Closed
Error	Open	Open
Other Mode	Closed	Open

The intransit state indicates that the device is neither in its 'usual' or 'other' operating mode.

The error state indicates an illegal state which is used by the SCADA master station computers.

6.0 Device Nomenclature

Device	'Usual'	'Other'
Breaker	Closed	Open/Trip
Disconnect (Manual & Motor)	Closed	Open
Recloser	On	Off
Transformer LTC	Auto	Manual
Remote/Local Switch	Remote	Local
Generator	On/Start	Off/Stop
Unit Mode	Generator	Sync Condensor
Gates	Raised/Open	Closed/Lowered
Spherical Valve	Open	Closed

7.0 Supervisory System Status Points

All equipments connected to a supervisory system sending or receiving alarm/status information shall be designed according to the following:

1) Loss of supervisory system shall not initiate any control function in connected equipments.

2) When the communications system connecting each end of a supervisory system fails, the supervisory system will cause all contacts 'closed' to 'open'.

3) All alarm/status points sent on a scanner system shall have open contacts for the usual operating condition of the connected equipments.

4) If required, supervisory equipment will supply a channel/system failure alarm.

8.0 Telemetry

8.1 Analog Telemetry

Each analog telemetry point to be interfaced to SCADA equipment requires that the transducer output (mA) range and the scaling range be specified. When the communications system connecting each end of a supervisory system fails, the supervisory will cause the telemetry points to go to the zero current position.

8.2 Digital Telemetry Points

Each digital telemetry point to be interfaced should provide a BCD format (8,4,2,1) with isolated buffered parallel bits each capable of 2 TTL unit loads each (TTL/CMOS compatible). Bits will be supplied under 5 volt logic with a digital ground for each meter to be wired to the junction box. Polarity plus a HOLD signal shall also be wired out for each point. Telecontrol equipment is capable of receiving 3½ BCD digits (13 bits) + polarity and overrange. The HOLD Signal must be a low level input (referred to user's digital ground). Polarity out signal from station digital meter will present a high level for negative (minus) polarity.

9.0 Control Points

Each control function to be interfaced with station equipment shall have a dedicated relay. Contacts provided by the SCADA equipment shall be 'open' on a de-energized coil. When the control function is performed the contacts will close for 250 ms. (Note this does not apply to control points interfaced on a scanner system).

Raise/Lower type of control function (with the exception of transformer tap change) is capable of producing a pulse train type output with pulses spaced a minimum of 0.5 second.

Also all Raise/Lower type controls require a comparative change value for the SCADA master station. This means that when the dispatcher issues a Raise/Lower function he knows approximately how much change each pulse will initiate.

10.0 Control Points on a Supervisory System

Control points on a supervisory system shall follow the input and shall not be limited to any particular time interval. Contacts will stay in their matching in/out state unless the equipment fails or there is loss of communication.

11.0 Contact Ratings

Input contacts to the SCADA equipment shall be rated 50V D.C. 200 ma minimum.

Output contacts from the SCADA equipment shall be rated 150V D.C. 10 amp minimum.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

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ISOLATION FOR SUPERVISORY CONTROL, PROTECTION SIGNALS, AND TELEPROTECTION

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APPROVED	V.P. OPERATIONS	85-11-19 DATE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

ISOLATION FOR SUPERVISORY CONTROL, PROTECTION SIGNALS, AND TELEPROTECTION.

No :	P23-030-R0
Page :	1 of 3
Issued :	1986-01-08
App'd.	L. J. Cole
	T. D. Collett

1.0 Scope

This standard establishes the method of isolation of supervisory control and teleprotection equipment from protection and control circuits.

2.0 Purpose

Isolation is provided to prevent inadvertent operation of primary equipment by contact closure during maintenance and testing of supervisory control and teleprotection equipment. It is not intended to provide total isolation to the interface contacts.

3.0 Basic Requirement

All protection and control functions which interface with supervisory control and teleprotection equipment will be provided isolation through a selector switch. Other functions which interface with telecontrol equipment such as telemetering, alarms, and indication do not require isolation by means of a selector switch. The selector switch used for isolation has to be front mounted on a control panel and clearly accessible to operating personnel.

Isolation will be provided on the input and output interface contacts of protection and teleprotection signals; but only on the output interface contacts of the receive end supervisory control signals.

4.0 Terminal Stations

4.1 Supervisory Control

As all supervisory control in terminal stations is through the station supervisory control switch, 43S Local/Supervisory, (refer to Terminal Station Control Standard, P15-001), isolation to supervisory control signals shall be provided by this switch. This switch is to be alarmed when placed in "Local".

4.2 Teleprotection

Isolation for teleprotection signals associated with transmission lines will be provided on each line termination with a 2 position "on-Off" selector switch designated 43C On/Off for each teleprotection system through which all carrier codes for teleprotection will be wired. This switch is to be front mounted on the associated line protection panel.

With the switch in the "ON" position all transfer trip codes for that particular carrier system, both transmit and receive, will be enabled. When in the "OFF" position, both receive the transmit codes are blocked and also a closed contact is provided for alarm purposes.

5.0 Generating Stations

5.1 Supervisory Control

As all supervisory control in generating stations for unit and remote structure control is through supervisory control switches, e.g. 43S RA/LA/LM unit control, or 43US LOCAL/REMOTE UPSTREAM STRUCTURE CONTROLS (referenced in Generating Station Control Standard P15-002) isolation for supervisory control signals shall be provided through these switches.

At each remote structure which is under supervisory control, isolation for supervisory control signals between the Generating Station and the structure will be provided through an isolation switch at the structure, labelled "43S LOCAL/REMOTE".

These switches are to be alarmed when placed in the "LOCAL" position.

5.2 Teleprotection and Transmission Lines

Isolation for teleprotection signals associated with transmission lines terminated in generating stations will be as in section 4.2 above.

5.3 Protection Signals for Remote Structures

Isolation for teleprotection signals associated with remote structures will be provided for at each end with 2 position "ON-OFF" selector switches designated 43P ON/OFF through which all routine protection signals will be wired. These switches are to be mounted on the panels associated with the structure controls.

With the switch on the "ON" position all protection signals associated with that particular remote structure, both transmit and receive, will be enabled.

With the switch in the "OFF" position, both receive and transmit protection signals are blocked. A closed contact is also to be provided for alarm purposes.

6.0 Special Applications

6.1 Single Redundancy Protective Systems

On circuits which are deemed vital for operation, redundancy of protection may be provided, e.g. headgate drop for runaway via an overspeed switch. For these circuits a selector switch designated 43P1/43P2 is to be utilized to insure that at least one protection signal is in service.

This switch is to have four positions designated "43P1 ON-43P1/43P2 On-43P2 ON-43P1/P2 OFF". With the switch in the "43P1 ON" position, only the protection signals on the channel 1 will be enabled. Those on channel 2 will be disabled.

6.1 Single Redundancy Protective Systems (cont'd)

With the switch in the "43P2 ON" position, only the protection signals on channel 2 will be enabled. Those on channel 1 will be disabled.

With the switch in the "43P1/43P2 ON" position protection signals on both channels 1 and 2 will be enabled.

With this switch in the"43P1/P2 OFF" position protection signals on both channels 1 and 2 will be disabled. A closed contact is to be provided in this position for alarm purposes.

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

TRANSMITTAL

No.: P23-090-R0

Issued: 1986 03 31

SUPERVISORY JUNCTION BOX

TRANSMITTAL PREPARATION DATE: 1986 02 12

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APPROVED	V. P. ENG. & CONSTR.	86-03-20 DATE
APPROVED	V. P. OPERATIONS	86-03-19 DATE

HYDRO

PROTECTION & CONTROL ENGINEERING STANDARD

SUPERVISORY JUNCTION BOX

No :	P23-090-R0
Page :	1 of 3
Issued :	1986 03 31
App'd.	L. J. Cole
	T. D. Collett

1.0 Scope

This standard will outline the construction, location, wiring, and layout of the supervisory junction box. This standard will also cover all drawings which illustrate the layout and interconnection points in the supervisory junction box.

2.0 Supervisory Junction Box

The supervisory junction box will be the interconnection location between all supervisory equipment and station equipment. Supervisory protection and teleprotection signals are not to be interfaced in this location.

The following is a summary of points which may be wired into the supervisory junction box.

1) Control
2) Indication
3) Alarms
4) Telemetry

3.0 Construction

The supervisory junction box shall be at least a Nema type 12 control panel enclosure made of steel. Data pocket placed on inside of door shall be supplied. Enclosure may be wall or floor mounted with appropriate mounting pads. Interior and panel shall be finished in white baked enamel. Exterior shall be finished in a gray prime coat over phosphated surface.

3.1 Size

The size of a supervisory junction box shall be determined by the amount of equipment to be interfaced. The initial provision shall be for at least a 50% expansion for each class of point.

3.2 Cable Access

Cable access to the supervisory junction box shall be by cable tray and/or PVC conduit. Cable access routes installed shall be designed for the shortest possible cable lengths. The initial provision shall accommodate at least a 50% increase in points. Cables from supervisory equipment will enter from the top of the box and cables from station equipment will enter from the bottom.

3.3 Interconnection Cables

Cables entering the supervisory junction box to connect points listed in section 2.0 shall conform to the following standards.

Control Points	- Minimum 18 AWG stranded individually shielded pair with a minimum 22 AWG drain per control point.
Indication, Alarm, Analog Telemetry	- Minimum 22 AWG stranded individually shielded pair with a minimum 22 AWG drain per point.
Digital Telemetry	- Minimum requirements; 22 AWG stranded 19 conductor cable with 22 AWG drain per meter point.

Cables from supervisory equipment to be terminated on the right hand side of the terminal blocks and cables from the station equipment to be terminated on the left hand side. The shield shall be carried as near as possible to the terminal block. The shield and drain wire will not be grounded inside the junction box.

4.0 Layout

A supervisory junction box will contain at most four (4) classes of points as per section 2.0. The points will be referenced in the junction box and on all junction box drawings as follows:-

1) Control
2) Indication
3) Alarms
4) Telemetry

Layout shall be as per drawing P23-090-D1

4.1 Terminal blocks shall be as per Terminal Blocks Standard P21-040.

4.2 Labels

Each class of points to be interfaced shall have a distinct terminal block grouping.

i.e. Control - TB1
Indication - TB2
Alarms - TB3
Telemetry - TB4

Each classification shall be distinctly marked in the supervisory

4.0 Layout (Cont'd)

4.2 Labels (Cont'd)

junction box. Each class shall have its terminal numbered consecutively 1, 2, 3.... omitting the drain wire terminal. These shall be identified with a ground symbol.

5.0 Drawings

Each supervisory junction box provided shall have a distinct drawing showing the point classifications, labels and descriptions of each point to be interfaced.

5.1 Control Points

For each control function there shall be assigned two distinctly marked terminals plus a terminal for the drain. Each set of control point terminals will be identified by the device and control description to the right of the terminal.

5.2 Indication Points

For each indication point there shall be assigned two distinctly marked terminals plus a terminal for the drain. Each set of indication point terminals will be identified by the device description to the right of the terminal. For points which require 2 contacts for indication, the contacts shall be marked (1) and (2) as defined in standard P23-020.

5.3 Alarm Points

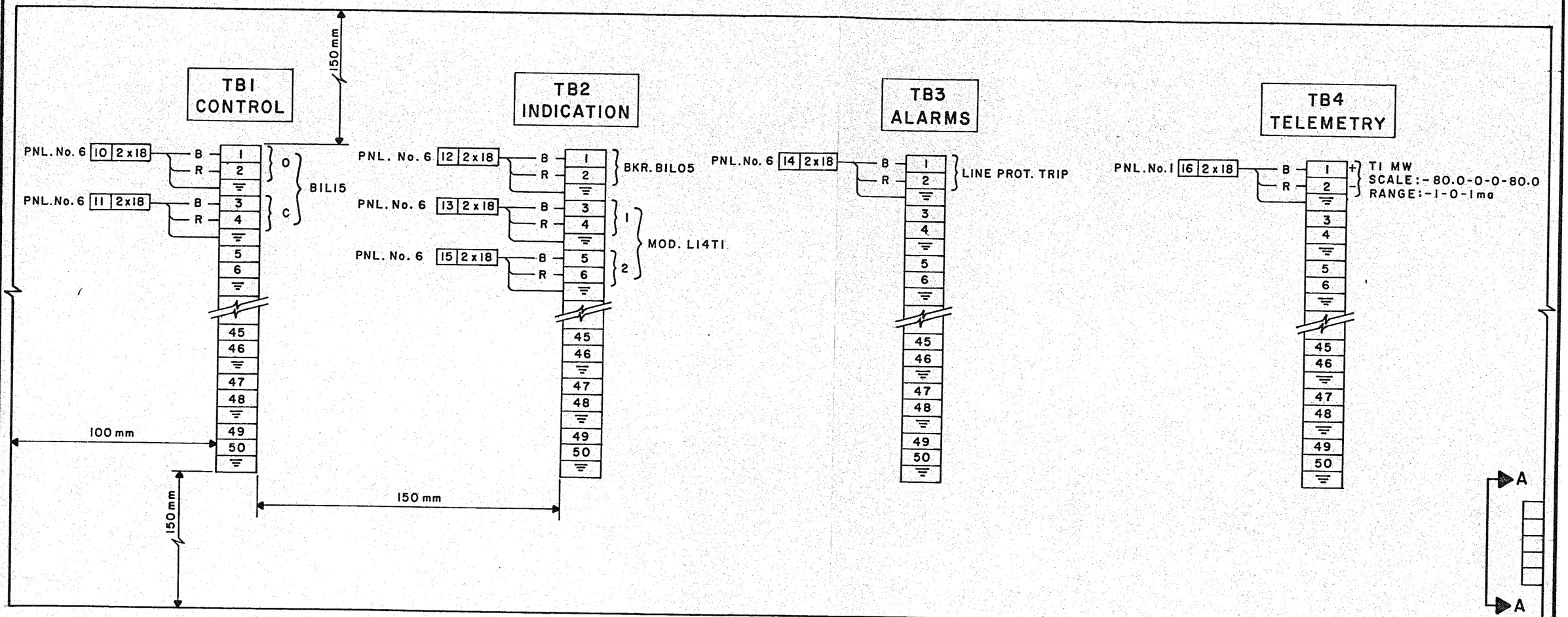
For each alarm point there shall be assigned two distinctly marked terminals plus a terminal for the drain. Each set of alarm point terminals will be identified by the alarm description to the right of the terminal.

5.4 Telemetry Points

For each telemetry point there shall be assigned distinctly numbered terminals plus a terminal for the drain. Each set of terminals will be identified to the right as follows:

i) for analog telemetry - a description of the point and the scale range, transducer output range, plus a (+) and (-) current designation.

ii) for digital telemetry - a description of the point, and the scale range, and bit designation.



NOTES

1. WHERE MORE THAN I ROW OF POINTS ARE REQUIRED PER POINT CLASS, NECESSARY ROW(S) SHALL HAVE THE SAME TBX NUMBER AND THE TERMINAL BLOCKS SHALL BE NUMBERED SEQUENTIALLY.
2. TELECONTROL SHALL WIRE FROM RIGHT OF TERMINAL BLOCKS.
3. EACH POINT CLASS TO HAVE A DISTINCT TBX NUMBER AT EACH ROW AND GROUP TO BE MARKED ACCORDINGLY ie "CONTROL" ETC.
4. TYPICAL EXAMPLES ARE GIVEN FOR EACH POINT CLASS AS WELL AS NECESSARY INFORMATION.

VIEW 'A-A'

TERMINAL BLOCK AND JACK TO BE SUPPLIED AND INSTALLED BY TELECONTROL FOR PLC COMMUNICATION TO THE PROVINCIAL CONTROL CENTER

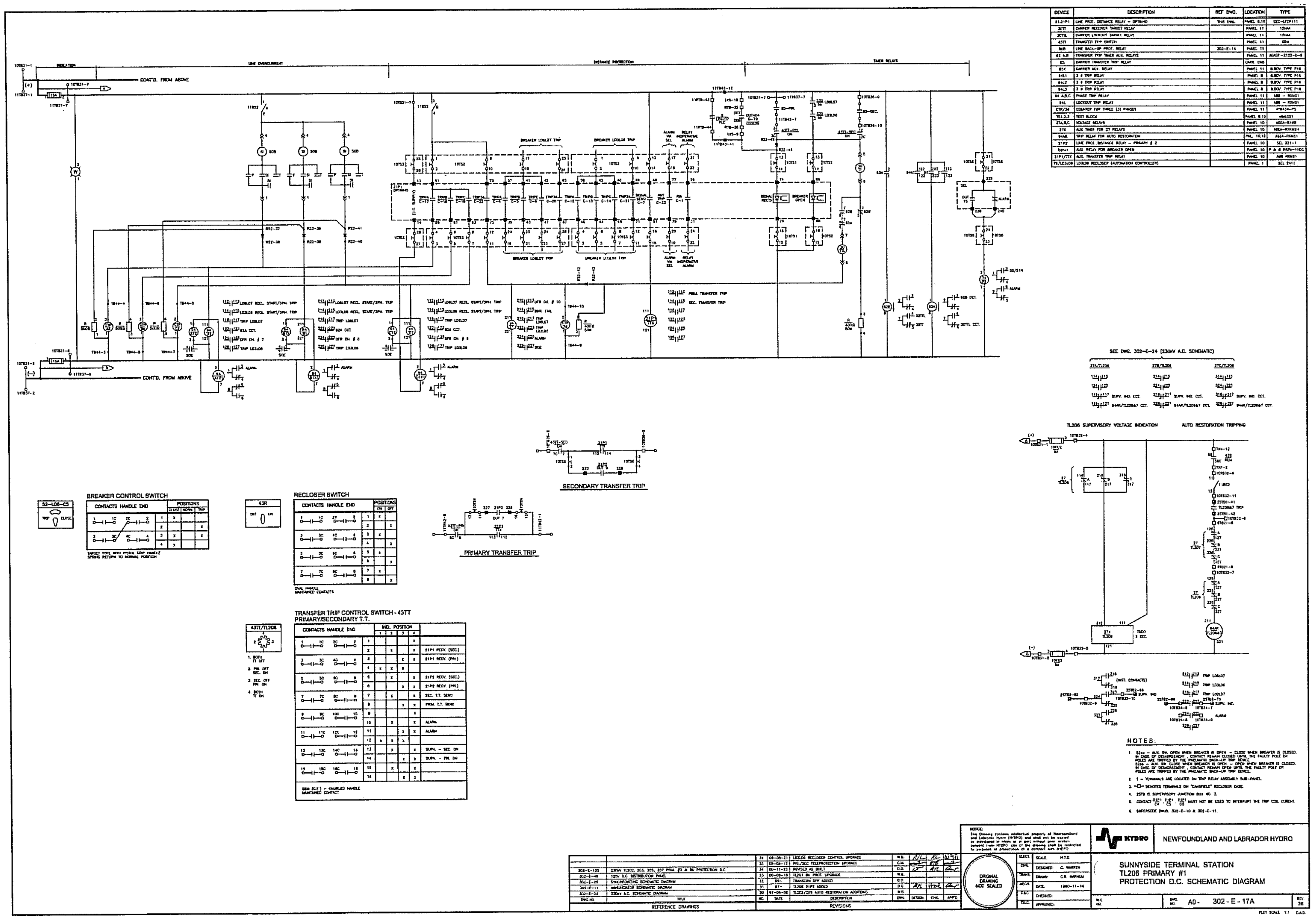
HYDRO

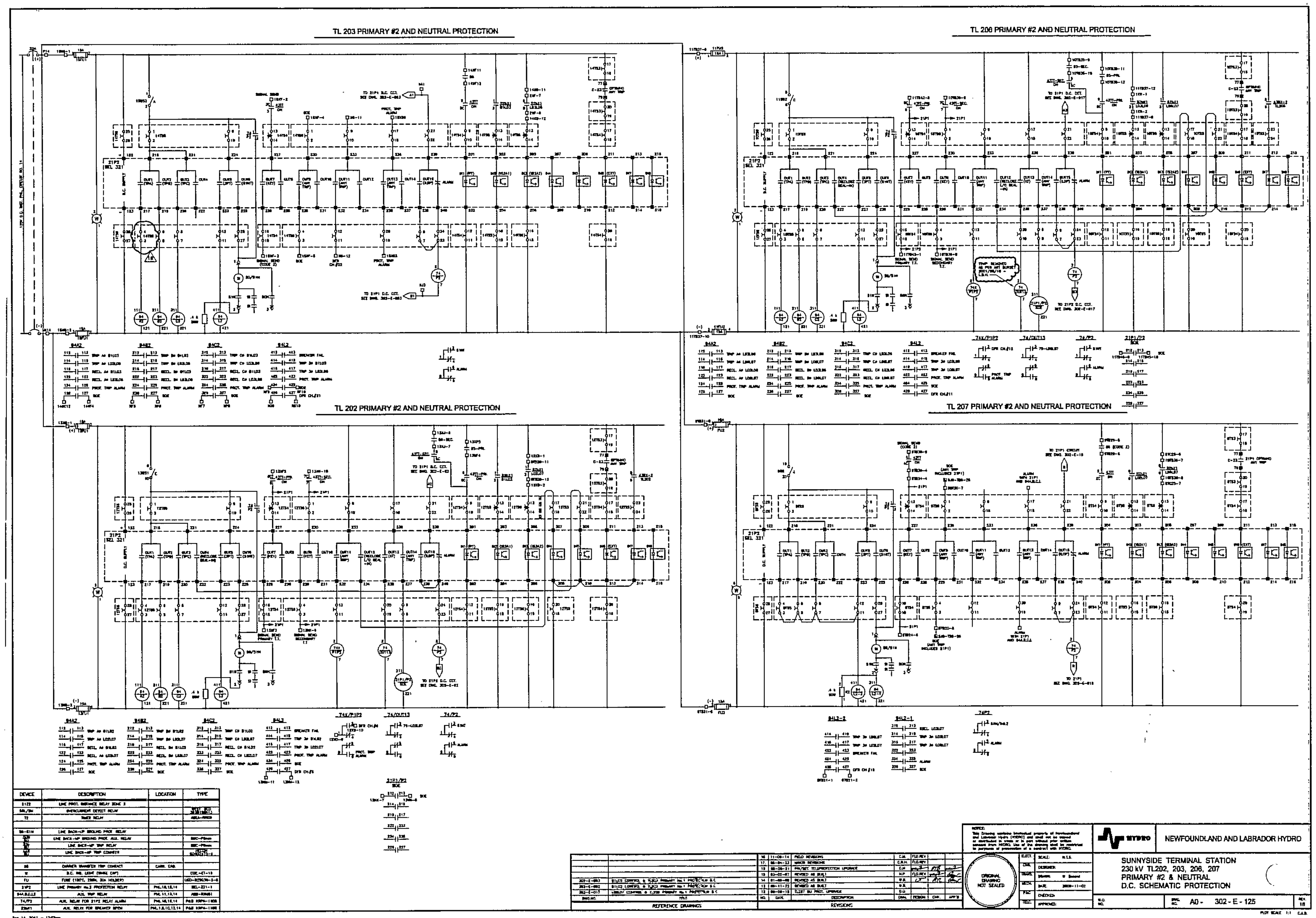
PROTECTION & CONTROL ENGINEERING STANDARDS

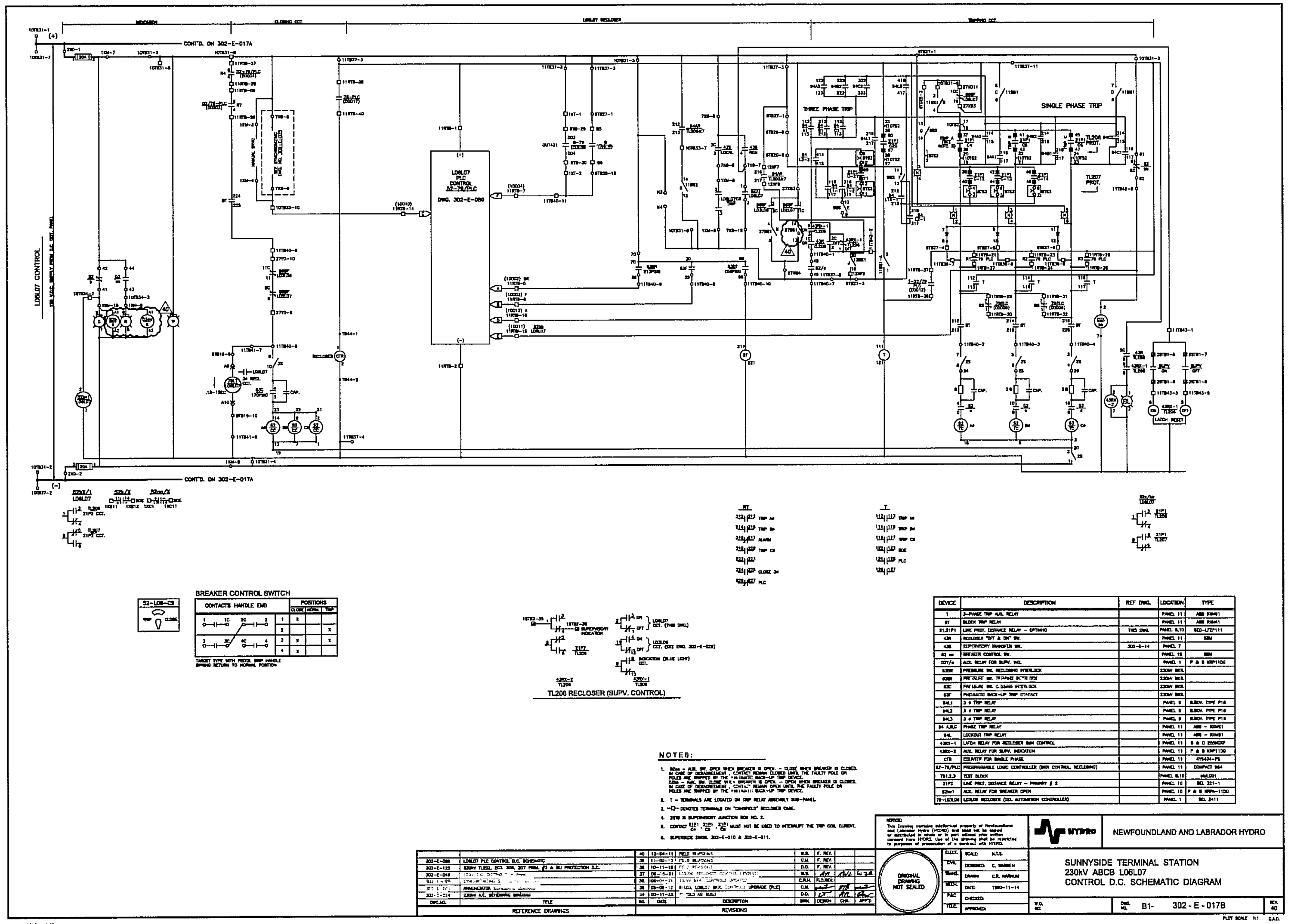
SUPERVISORY JUNCTION BOX LAYOUT

APP'D.	L. J. COLE
	T. D. COLLETT
ISSUED	86-03-31
DRAWN	G. E. M.
CHECKED	
DWG. No.	P23-090-DI-RO

11 85


NEWFOUNDLAND AND LABRADOR HYDRO
SUNNYSIDE TERMINAL STATION
TL206 PRIMARY #1
PROTECTION D.C. SCHEMATIC DIAGRAM
ORIGINAL DRAWING NOT SEALED
SCALE N.T.S.
DESIGNED: C. WARREN
DRAWN: C.R. HARNUM
DATE: 1990-11-14
DWG. NO. A0- 302-E-17A
REV. 36
BREAKER CONTROL SWITCH
RECLOSER SWITCH
TRANSFER TRIP CONTROL SWITCH - 43TT PRIMARY/SECONDARY T.T.
SECONDARY TRANSFER TRIP
PRIMARY TRANSFER TRIP
NOTES:
REFERENCE DRAWINGS
REVISIONS


TL 203 PRIMARY #2 AND NEUTRAL PROTECTION
TL 206 PRIMARY #2 AND NEUTRAL PROTECTION
TL 202 PRIMARY #2 AND NEUTRAL PROTECTION
TL 207 PRIMARY #2 AND NEUTRAL PROTECTION
NEWFOUNDLAND AND LABRADOR HYDRO
SUNNYSIDE TERMINAL STATION
230 kV TL202, 203, 206, 207
PRIMARY #2 & NEUTRAL
D.C. SCHEMATIC PROTECTION
AD - 302 - E - 125
REFERENCE DRAWINGS
REVISIONS


SINGLE PHASE TRIP
THREE PHASE TRIP
L06L07 CONTROL
BREAKER CONTROL SWITCH
TL206 RECLOSER (SUPV. CONTROL)
NOTES:
DEVICE
DESCRIPTION
REF DWG.
LOCATION
TYPE
NEWFOUNDLAND AND LABRADOR HYDRO
SUNNYSIDE TERMINAL STATION
230kV ABCB L06L07
CONTROL D.C. SCHEMATIC DIAGRAM
ORIGINAL DRAWING NOT SEALED
SCALE: N.T.S.
DATE: 1990-11-14
B1- 302-E-017B
REV. 40
REFERENCE DRAWINGS
REVISIONS
PLOT SCALE 1:1
C.A.D.