ENGINEERING STANDARD

FOR

INSTRUMENT ELECTRICAL POWER SUPPLY

AND

DISTRIBUTION SYSTEMS

CONTENTS :

PAGE No.

1. SCOPE 2
2. REFERENCES 2
3. UNITS 2
4. GENERAL 2
5. CLASSIFICATION 3
6. QUALITY OF SUPPLY 3
7. STAND-BY POWER SUPPLY 4
8. DISTRIBUTION SYSTEM 4
9. WIRING METHODS 6
10. SYSTEM AND EQUIPMENT GROUNDING 6

APPENDICES:

APPENDIX A POWER SOURCES 7
APPENDIX B STABILIZING AND DISTRIBUTION SECTIONS 9
APPENDIX C METERING FOR d.c. SECTIONS 12
APPENDIX D SYMBOLS 13

1. SCOPE

This Standard covers the minimum and general requirements of electrical power supply and distribution system, for all instruments and related equipment within the scope of this Standard.

For materials specifications and installation procedures of different components of electrical power supply such as: transformers, circuit breakers, fuses, rectifiers, battery chargers, etc., reference to be made to related electrical standards.

It is intended to be used in oil, gas, and petrochemical industries.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these Standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant :

BSI (BRITISH STANDARD INSTITUTION)

BS 88	"Cartridge Fuses for Voltages up to and Including 1000 V a.c. and 1500 V d.c."
BS 646 (1986)	"Cartridge Fuse-Links (Rated up to 5A) for a.c. & d.c. Services"
BS 1362 (1986)	"General Purpose Fuse Links for Domestic and Similar Purposes (Primarily for Use in Plugs)"
BS 3871 (1984) Part 1	"Miniature Air-Break Circuit Breakers for a.c. Circuits"

API (AMERICAN PETROLEUM INSTITUTE)

RP 550 (1981) Part 1,	"Manual on Installation of Refinery Instruments and Control Systems, Process Instrumentation and Control, Section 11-Electrical Power Supply"

IPS (IRANIAN PETROLEUM STANDARDS)

E-GN-100	"Units"
E-IN- 190	"Engineering Standard for Transmission Systems"

3. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

4. GENERAL

4.1 Instrument power supplies, distribution, installation and use of electricity shall generally conform with electrical section of IPS, but the requirements of this Standard shall take precedence.

4.2 Supply and distribution systems for electrically operated instruments and apparatus shall be designed specifically to achieve reliable operation (see Appendices A through C as a typical examples).

4.3 The principle of design reliability applies equally to main distribution systems or to systems incorporating batteries or other power supplies.

4.4 The design of power supply systems shall permit all components to be maintained in safety while retaining supplies to the instruments.

4.5 The instrument power supply shall be extendible for future increase in capacity.

4.6 The d.c. power supply units may be operated free from earth (floated), provided that an earth fault detection system is utilized.

5. CLASSIFICATION

5.1 For the purpose of designing a reliable distribution, instruments shall be classified according to the effect on the plant of their electrical malfunction or failure:

Class A: Apparatus is that by their malfunction or failure can cause complete shut-down of the whole or part of a plant. i.e., emergency trip systems.

Class B: Apparatus is that by their malfunction or failure can cause temporary loss of control of the whole or part of plant, e.g. most automatic control and associated manual operator loops.

Class C: Apparatus is that by their malfunction or failure cannot directly prevent the operation of the plant. This class comprises of indicators, integrators, recorders and most analysers.

5.2 The supply to Class A apparatus shall be separate from that of other classes.

5.3 The supply to Classes B and C may be combined if economically justified .

6. QUALITY OF SUPPLY

6.1 The quality of supply to the three classes of apparatus shall be as detailed in 6.2, 6.3, and 6.4.

In the case of telemetry and data processing equipment it may be economically and technically justifiable to install separate power supply apparatus from that feeding the general process instrumentation.

6.2 Class A apparatus shall be supplied with a continuous uninterrupted power supply. This supply shall, unless specified otherwise by the user, comprise a rectifier-battery system. The battery shall provide a supply 24 volts d.c. for 8 hours within the specified limits at the worst ambient conditions and at maximum demand.

Other d.c. supply voltages and time limits may be considered by user approval.

6.3 Class B apparatus shall be provided with a power supply which meets system requirements in respect of reliability, characteristics and freedom from interference, both radiated and entering from the external power source.

An alternative source of electrical power shall be provided to supply critical instruments and associated equipment in the event of failure of the normal power supply. (see Appendices A through C).

The supply shall continue in operation after an external power failure for as long as any part of the plant requires retention of the process control system. This time shall nominally be one hour or as otherwise agreed by the user.

There shall be no unacceptable break or transient deterioration of the process control due to failure of either the external power source or of any module which is protected by redundancy. This does not necessarily preclude the use of manually started stand-by systems if agreed by the user.

6.4 Class C apparatus shall be provided with a power supply from normal mains sources, without any stand-by, but the supply may be taken from sources supplying Class B apparatus where this arrangement is economically justified.

Instrument power supplies shall be from a single source, and in general, shall be isolated from power and lighting supplies to reduce the effect of load changes, switching transient and human switching errors. Instruments installed in remote isolated locations may be connected to lighting or local power supplies by agreement with the user.

6.5 The power supply apparatus shall remain within its specified limits under the following environmental conditions:

a) Ambient temperature range -15°C to 52°C or as specified by the user.
b) Relative humidity up to 95%.

6.6 a.c. Supplies

Power supplies to instruments requiring a.c. shall be as follows:

a) Nominal frequency 50 Hz . The nominal voltage to be a value selected in accordance with application requirements, but the preferred voltage is not less than 110 volts or more than 120 volts. It shall be stable within ±5% of nominal voltage, ±0.5% of nominal frequency.

b) Ripple or transients in the supply shall be stated as a peak to peak voltage and shall not exceed 3% of the supply voltage. The total harmonic distortion shall not exceed 5%.

7. STAND-BY POWER SUPPLY

7.1 It shall be possible to change over automatically (with alternative manual operation) from normal to stand-by and vice versa while on load. (see Appendices A through C.)

Some equipment may require continuous power supply, in this case static transfer switch may be utilized.

7.2 Normally, on plants equipped with pneumatic instruments, delays inherent with commissioning the stand-by generator from rest may be tolerated. On plants equipped with electronic instruments, especially in cases where control equipment is finally hydraulically or electrically operated, "Limited Break", "No break" or other forms of stand-by supply system which will provide power within a safe time limit shall be used.

7.3 Design shall provide for periodic testing of emergency power systems without upsetting plant operation.

7.4 Annunciators shall be provided to indicate the state of the major units of the normal and stand-by power supply system. A battery should be provided with charge-fail and low battery voltage annunciators . Any float charging system should be so designed that it will fully re-charge the battery under all conditions of load. The use of batteries requiring high boost voltages shall be avoided.

7.5 A method of test shall be provided to enable stand-by batteries to be checked for storage capacity while the normal power supply is operating. See the relevant electrical standards of IPS.

7.6 The capacity of batteries shall be calculated at the lowest operating temperature and shall exclude the capacity of the battery remaining at the end voltage being determined by the connected apparatus.

8. DISTRIBUTION SYSTEM

8.1 Miniature circuit breakers or fuses as specified by the user shall be utilized.

8.2 a.c. distribution systems shall be fused so as to maintain high integrity of supply by proper discrimination of fault level. The sub-circuits to Classes B and C instruments shall be segregated and fused separately.

8.3 The primary fuse clears faults in the primary feed, the transformer and in the secondary distribution board.

The secondary sub-circuits from this distribution board are segregated into Classes B and C sub-circuits. They are fused individually. Each class of sub-circuit covers separate sub-circuits feeding separately operable sections of the control system, corresponding to working sections of the plant.

A secondary circuit supplying one item only, and fed from a transformer shall not be fused.

8.4 The supply shall have a sufficient regulation to feed into a fault without-dropping the voltage to an unacceptable level, while the faulty circuit is cleared by its protecting fuse.

8.5 When a.c. supplies are employed it must be established that output of the supply is compatible with any built-in voltage regulating systems in instruments intended to be connected to an unregulated power source. If necessary the latter should be used and other steps taken to provide continuity of operation.

8.6 Main supply transformers shall be of the double wound type with at least one earthed screen between the primary and secondary windings. The primary winding of the transformer shall be protected by an appropriately rated H.B.C. fuse. The secondary shall have one pole earthed at the transformer only.

Transformers shall be compatible with instrument manufacturer's requirements. If supplies do not have the necessary degree of voltage stability, constant voltage transformers may be used to meet this requirement.

8.7 A secondary sub-circuit feeding more than one instrument loop should be arranged as a ring main. All instruments of a single control loop shall be fed by one fused spur from the ring main. Each control loop shall have its own fuse.

8.8 The fuse of any individual spur shall be rated at three times the normal load current, and not less than 2 amps.

8.9 A sub-circuit or ring fuse shall be rated at twice the total connected load. It shall also have three times the rating of the largest spur fuse connected to the ring.

8.10 The rated power of any secondary sub-circuit fuse shall not exceed one-third of the primary power rating in VA.

8.11 Where instruments, being part of a loop, are fitted with internal power supply fuses, these should normally be removed, subject to manufacturer's agreement, and the circuit made good. Instruments connected individually to the ring main shall be fused as spurs.

8.12 Fuse links of different ratings shall be positively identified.

8.13 Primary and secondary sub-circuit fuses shall comply with BS 88, or any other equivalent standard.

Those for spurs or individually connected instruments shall comply with BS 646 and BS 1362, or any other equivalent standard.

8.14 Miniature circuit breakers shall comply with BS 3871-Part 1, or any other equivalent standard .

8.15 Each Class A emergency shut-down device shall be supplied with an individually switch-fuse unit.

8.16 The power supply to individual instruments installed external to control houses shall be connected through a switch-fuse unit mounted adjacent to the instrument and suitable for the particular area classification relevant to their location.

8.17 The distribution system protection shall be designed to discriminate between fault levels in individual protected zones. In general, fuses or miniature circuit breakers should be used to protect the distribution system against overload, rather than protect the instrument from damage.

8.18 Isolation of individual instruments shall be possible either by a switch or by opening of a miniature circuit breaker. In any single current circuit there shall not be more than one fuse in series.

8.19 Generally, a maximum of six recorders or indicator, may be connected to one switch-fuse unit. Multipoint electronic recorders, analysers and controllers shall be connected through individual switch fuses unless supplied with approved integral isolating devices, when up to three controllers may be connected to one switch-fuse unit. Switch fuse-units shall be suitable for the particular area classification relevant to their location.

For digital instrumentation systems, separate branch circuit shall be provided for each sub-system.

8.20 Branch circuit breakers may be single-pole in the ungrounded lead.

8.21 A branch circuit directory identifying each circuit and all instruments associated with each circuit shall be provided at each branch circuit panel board or equipment cabinet containing more than one circuit breaker or fuse.

8.22 Power distribution centers shall incorporate 15% spare branch circuit disconnect switches.

8.23 Plugs and receptacles may be used as the disconnecting means if the equipment is located in an area classified as " non-classified".

8.24 A branch circuit disconnect switch shall be single-pole in the fused ungrounded lead (Grounded lead shall not be fused). The switch shall be connected before the fuses.

8.25 Branch circuit protection for process stream analysers shall also include the following:

a) The power for all devices associated with a given analyser system shall be supplied from the same source, and each system shall have a single disconnect switch for the entire system. In addition, disconnect switches shall be installed to permit isolation of each device in an analyser system.

b) Each field mounted analyser device shall have a local disconnect switch.

8.26 Disconnect switch enclosures for field use should be explosion proof in class I area, unless otherwise specified.

9. WIRING METHODS

9.1 The actual circuit requirements for the individual instrument shall be determined by the type of instrument being served and is a part of the system design. IPS-E-IN-190 "Transmission Systems": discusses wiring requirements as well as grounding and shielding requirements in detail.

9.2 Wiring methods as per electrical standards of IPS for power wiring shall be used. Attention must be paid to special requirements, which are a result of the circuit function. For instance, special attention shall be paid to routing , safety, control and shutdown circuits. It is desirable to segregate these circuits from normal circuit routes to prevent a fire, explosion, or other accident from disabling critical circuits. It may be necessary to route underground or fireproof the exposed components of these circuits to preserve circuit integrity during a fire.

10. SYSTEM AND EQUIPMENT GROUNDING

10.1 Instrument Signal Grounding

Power supply, equipment, and instrument signal grounds shall not be interconnected. Generally, instrument signal cable shields are grounded on an isolated bus that is connected to a separate ground. The exception can be thermocouple shields, which in many instances are grounded in the field at the thermocouple head.

10.2 Instrument Power supply Grounding

Instrumentation power shall be supplied from a transformer that is dedicated to instruments only. The transformer serves as an electrical isolating device as well as transforming the voltage to the proper utilization level. If the transformer has a Y-connected secondary, then the neutral should be solidly grounded. On a 220/380 volt three-phase transformer, the 220 volt phase to neutral is used to serve most instrument requirements. The 380 volt phase to phase can be used for larger loads, such as computers or common d.c. power supplies.

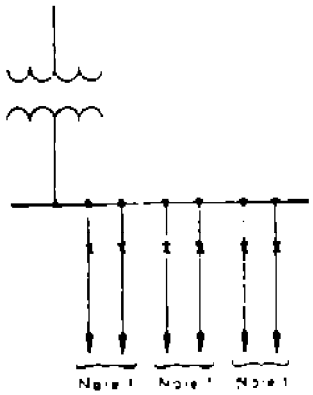
The solid ground neutral holds fixed the phase to neutral voltage and provides a return path for a phase to ground fault that allows ground fault sensing devices to quickly isolate the faulted circuit.

10.3 Equipment Grounding

When there is unintentional contact between an energized circuit or conductor and a metal structure or housing that encloses it, the structure or housing tends to become energized at the voltage level of the energized circuit or conductor. To prevent shock hazard when this occurs, non-current carrying components such as frames and racks must be solidly grounded to earth by a low impedance path, such as a ground conductor connecting to a ground well. This will also minimize conducting paths, or ground loops, that may be inductively or capacitively coupled to the instrument signal circuits. Again, the equipment ground must not be interconnected to the instrument signal ground bus. It is acceptable to connect the equipment ground to the power supply ground well. It is recommended that a grounding conductor connect the equipment directly to the ground well to ensure a low impedance ground path.

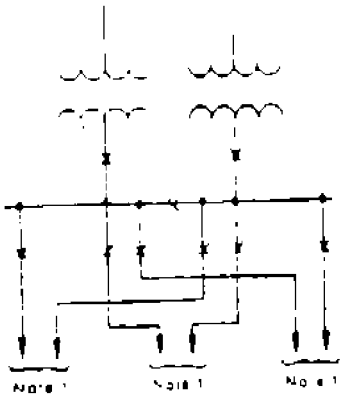
APPENDICES

APPENDIX A
POWER SOURCES



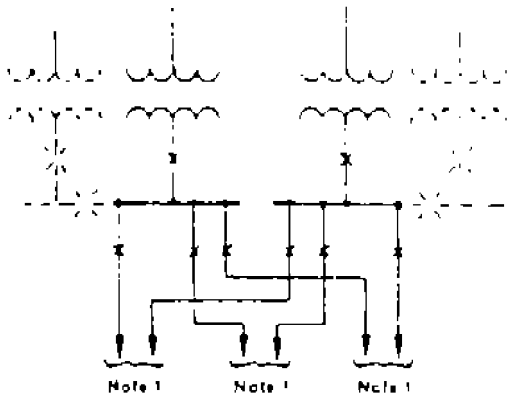
(a)

When standby generator is not required and instrument power supply is for instrumentation of units fed by a single radial substation



(b)

When standby generator is not required and instrument power supply is for instrumentation of units fed by single spot network or secondary selective substation.

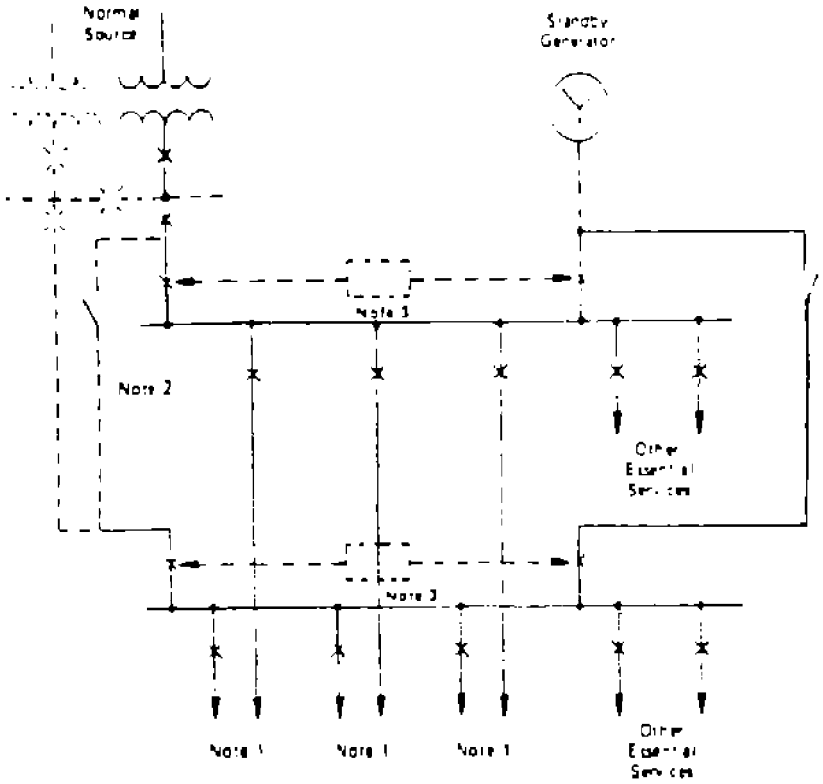


(c)

When standby generator is not required and instrument power supply is for instrumentation of units fed by two or more substations.

(to be continued)

APPENDIX A (continued)



(d)

When standby generator is required normal source to instrument power supply shall be taken from separate busses when supply is for facilities fed by spot network or secondary selective substations.

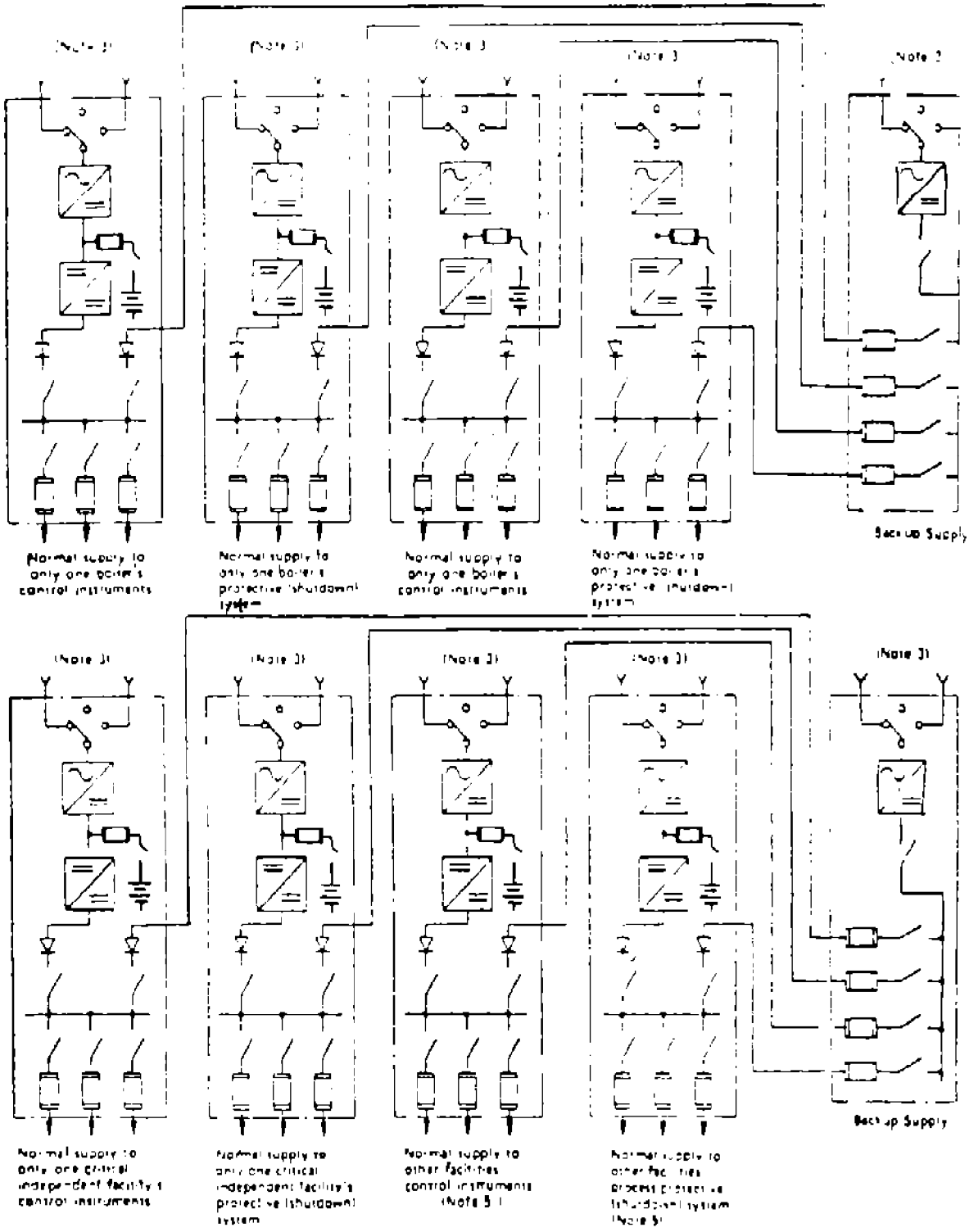
Notes:

1) To stabilization sections of Appendix B.

2) Tie cable and switch between busses used only when normal source is single feeder from radial sub-station.

3) Essential services switchgear with automatic transfer.

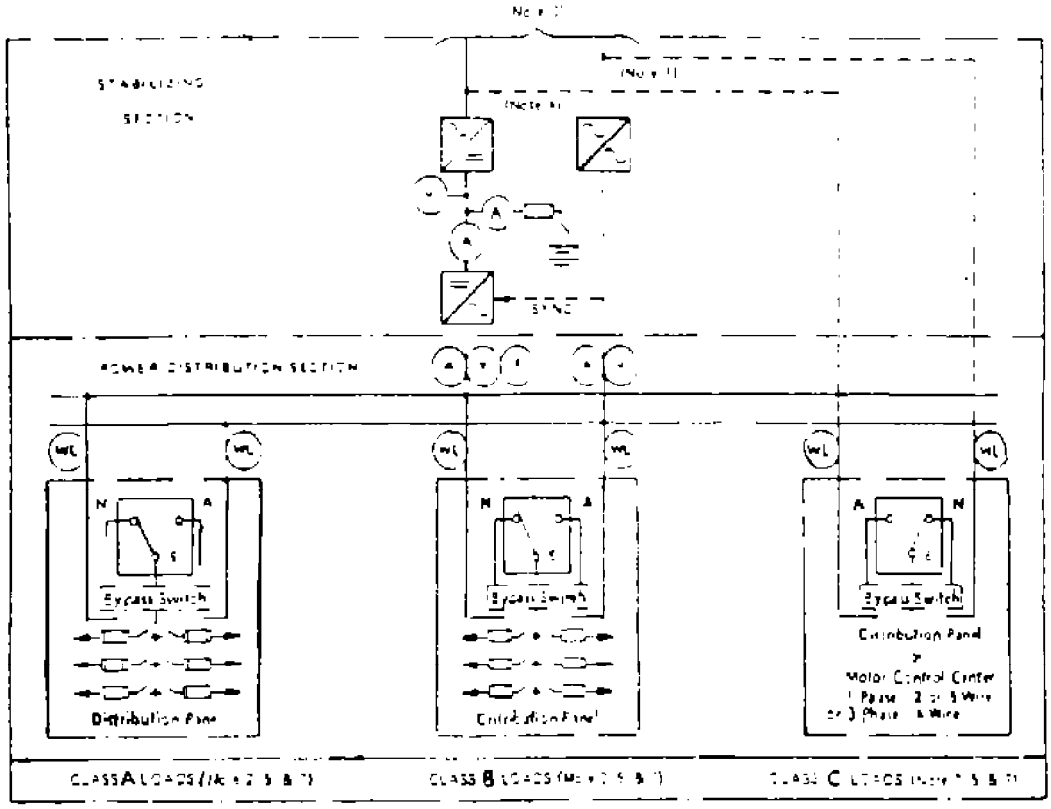
APPENDIX B
STABILIZING AND DISTRIBUTION SECTIONS



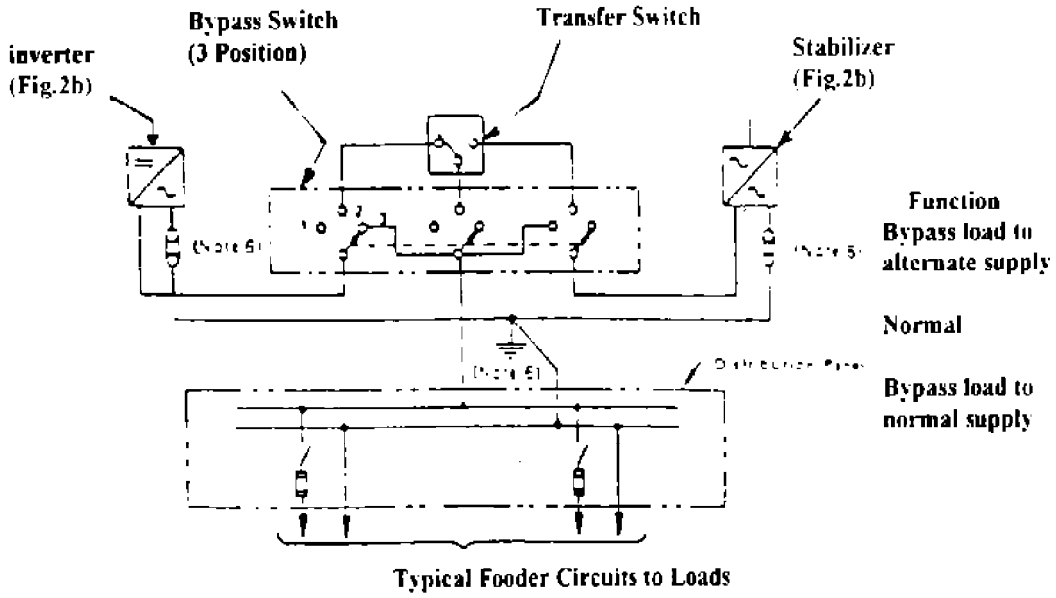
(a) For d.c. Load

(to be continued)

APPENDIX B (continued)



(b) For a.c. Loads



(c) Bypass Switch and Neutral Grounding Details

(to be continued)

APPENDIX B (continued)

Notes:

1) Alternative connection for Class C loads if they are compatible with main supply voltage and frequency deviations.

2) Delete if not required.

3) From main supply in Appendix A provide step-down transformers if required.

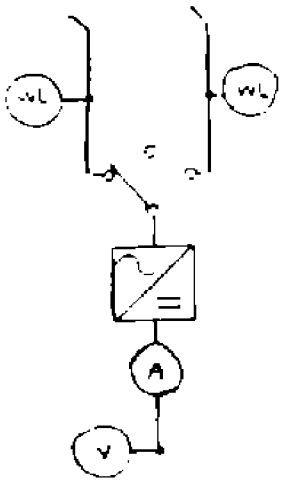
4) Alternative connection for Class C loads if auxiliary generator is included in power source section and loads are compatible with main supply voltage and frequency deviations.

5) Provide separate feeder circuits from distribution panels for each facility.

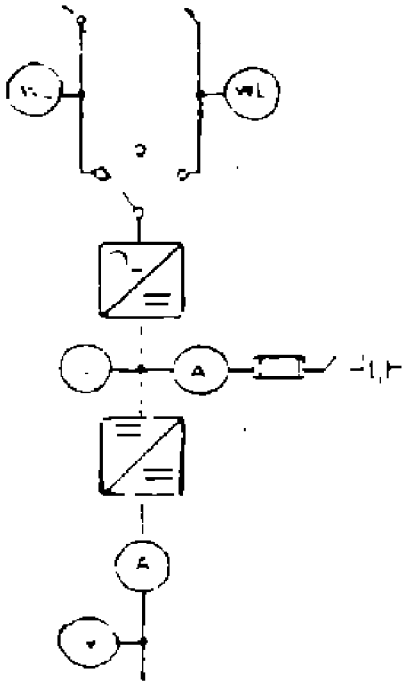
6) Solidly ground the neutral of the a.c. system at only one point on the load side of the inverter and a.c. voltage stabilizer. Provide accessible links or connection points at the output of the inverter and stabilizer to permit removing the neutral ground during testing.

7) Provide single pole switching devices for 2 wire single-phase grounded neutral systems.

APPENDIX C
METERING FOR d.c. SECTIONS



(a) Metering for d.c. Backup Supplies



(b) Metering for d.c. Stabilizing Sections

APPENDIX D
SYMBOLS

(used herein, not mandatory for vendor)