APPENDIX C

SYSTEM REQUIREMENTS DOCUMENT (SRD) FOR CABLING

SNS 109010000-SR0001-R00

Spallation Neutron Source

Systems Requirements Document (SRD) for Cabling

October 2000

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SPALLATION NEUTRON SOURCE
SYSTEMS REQUIREMENTS DOCUMENT
FOR CABLING

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SPALLATION NEUTRON SOURCE
SYSTEMS REQUIREMENTS DOCUMENT
FOR CABLING

October 2000

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CONTENTS

1. PURPOSE & SCOPE

This document defines project-wide requirements for power and signal cables (including fiber) to conventional facilities and technical systems equipment as shown in Figure 1 of Appendix A. This includes:

1) All cabling in shielding penetrations (including power, lighting, PA, fire alarm, etc.)
2) All Personnel Protection System, Target Protection System, and other safety related cabling
3) Cabling from conventional facilities power panels and motor control centers to equipment and power supplies and from power supplies to technical components
4) Global controls Ethernet, timing system, fast protect system, and other communication links
5) All cabling connected to Integrated Controls System Input/Output Controllers (IOC)
6) Cabling for analog signals hardwired to the control room
7) All cabling entering control rooms
8) All signal and power cabling from sensors to PLCs, control cabinets, and power supplies

This document does not provide requirements for cabling inside equipment cabinets or racks.

2. CABLE NUMBERING AND DATABASE

Penetrations, cable, and cabinets within the scope of this document shall be numbered as defined in Appendix A and shall have the data shown in Appendix B entered into the project cabling database.

3. CABLE TRAY SECTIONS

Cabling shall be installed in raceway that is sectioned as follows:

Designation	Section Definition	Cables carried
PPS	Personnel Protection System (PPS)	PPS cabling
TPS	Target Protection System (TPS)	TPS cabling
FA	Fire Alarm	Fire Alarm
LLS	Low Level Signal	Power with voltage < 50V, 4-20 ma, 0-10 VDC, 0/24VDC, fieldbus, Linac HPRF control cabling, etc.
COMM	Communication & Network cabling	Fiber optic cabling, communications (networks, data acquistion, ICS, DeviceNet, ControlNet, EPICS ethernet, CAT5, phone line) cabling, Public Address, Timing system, Equipment protection system (EPS)
VLLS	Very Low Level Signal	Beam instrumentation/diagnostics, RF Control, Silicon diode temperatures, etc.
REF	RF Reference cable	Temperature controlled, Low Level RF Reference coax cable (in Linac tunel only)
HPRF	High Power RF	High power RF cabling (Expected only in Ring area)
PWR	Standard Power (AC and DC)	Power with voltage of 50 to 600V Magnet power (except for DC)
MAGPWR	DC Magnet power	DC power to magnets
HVVAC	High voltage (>3kV) vacuum system power	High voltage vacuum system power

4. FUNCTIONAL REQUIREMENTS

4.1 All Cabling

All cabling shall

a) provide the functional requirements for the system is serves,
b) meet applicable requirements of the National Electric Code (NEC),
c) be of copper or fiber optic construction (no aluminum cable should be used unless specifically needed to perform its function)
d) have at least 10% spare conductors in multi-conductor cables that are difficult to replace. Heliax, power and other cabling shall have spare cabling appropriate to the service they provide.
e) be installed in cable tray sections separate conduits as stated in Section 3. Within penetrations and ductbanks, cabling in different tray sections shall be installed in separate conduits. To insure meeting the NEC code requirement that 300v and 600v rated cabling cannot be installed in the same tray section, all cabling in tray types HPRF, PWR, MAGPWR shall be 600v rated cables.
f) be the cable types listed on the project office maintained listing of standard cables wherever possible
g) have labels placed near both ends of the cable where they will be in plain view after installation. Labels should indicate the cable number, its source location, and its destination location
h) have conductor colors stated in IEEE, NEMA, or other national standards to the extent possible

4.2 Cabling in Radiation Areas

Cabling located in tunnels and penetrations shall be copper to greatest extent possible. Where fiber optic cable is needed in tunnels to provide needed functions, the cable shall radiation resistant cabling and routing shall minimize the distance traveled in the tunnel.

Cabling installed in areas where radiation will significantly decrease cable life shall be minimized and use a appropriate combination of radiation resistant cabling and design methods (such as junction boxes and connectors) that facilitate rapid replacement. Radiation in the Front End, Drift Tube Linac, and Coupled Cavity Linac are not expected to cause cabling problems. Radiation in the Superconducting Linac, transfer lines, and Ring tunnels are expected to be 4 to 20 rad/hr. Radiation in the areas around columnators, the injection area, and extraction area are expected to be 400 to 1000 rad/hr.

Multi-conductor cabling in penetrations and other areas where installing additional cabling would be difficult shall have 30% spare conductors. Heliax, power and other cabling shall have spare cabling appropriate to the service they provide.

Except for PPS, TPS, Heliax and diagnostics cabling, all low voltage controls cabling serving technical systems shall be terminated at junction boxes provided on both ends of penetrations. Conventional facilities cabling does not require junction boxes.

4.3 Fire Protection Requirements

The facility is classified as a Special Purpose Industrial Occupancy (low hazard) in all areas where cabling is installed. Thus, fire protection requirements consist only of meeting the applicable sections of NFPA 101 Life Safety Code and NFPA 70, National Electrical Code.

4.4 Installation Requirements

Installation documentation shall be in accordance with the standard drawings shown in Appendix C. Installation activities shall be in accordance with the requirements listed in Appendix C.

Appendix A: Cabinet/Rack, Cable and Penetration Numbering

1. PURPOSE AND SCOPE

This appendix provides requirements for naming and numbering cabinets, cabling and penetrations. The designations listed are to be used on drawings, schematics, project databases, computer software, equipment name tags, test procedures, and other sources of information.

2. REQUIREMENTS

2.1 Cabinet/Racks and Junction box naming

Cabinets shall be named in accordance with SNS 102000000-SR0001 Systems Requirements Document for Equipment, Device and Signal Naming. They shall also indicate

a) a unique identification
b) the system and/or subsystem being served and
c) the general location in the plant

Naming format shall be as shown in Figure 1

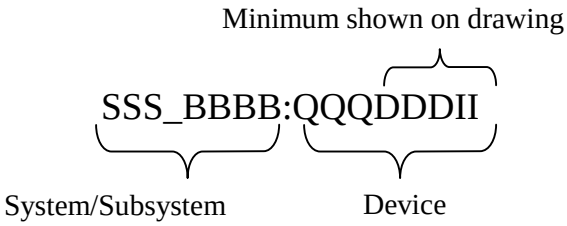


Figure 1: Format

SSS, BBBB, (System and subsystem,) are those listed in Table 2 and 3 of SNS 102000000-SR0001 *Systems Requirements Document for Equipment, Device and Signal Naming*. The subsystem designation (BBBB) may be eliminated if the subsystem is obvious from the system or device name.

The system, subsystem, and/or qualifier designation may be eliminated on drawings where the drawing clearly indicates the system, subsystem, and or location for the equipment. However, where a drawing for one system shows cabinets in other systems, the full name must be shown.

Cabinet nameplates should also indicate their unique identification number, function, and location. The system, subsystem, and qualifiers should be used to provide the shortest name that provides this information. Note: For consoles and other portable equipment, the name tag should be installed on permanently mounted equipment at the location.

QQQ (Device qualifier) – Qualifiers should indicate the installed location of the cabinet by using an appropriate location from Table 1.

DDD (Device) is:

Cab for cabinets or racks
Csl for consoles
Encl for enclosures (such as a Hoffman box).
Jbx for junction boxes

II (Instance numbers) are assigned by level 3 task leaders to give a unique cabinet/rack or junction box number. Use more than 2 digits where needed.

Example: An Integrated Controls Systems (WBS 1.9) cabinet located in the Central Control Room equipment room and providing service to Target systems equipment would be named

Tgt_ICS:CERCab01.

Example: A junction box in the CCL1 portion of the Linac tunnel and serving RF cabling would be named CCL_RF:CCL1Jbx01. A junction box in the CCL1 portion of the klystron building would be numbered CCL_RF:CCL1Jbx02. Note that these two boxes must have different instance numbers because the klyston building and the Linac tunnel areas have the same location designation.

Table 1 – Plant Location Designations
Note: Building numbers are listed in document
SNS 108000000-ST001 "SNS Building Numbers and Description

Designation	Location Description
	Linac Areas
RFQ	Klystron building area where cabinets serving RFQ equipment are located
DTL1-2, DTL 2-3, etc.	DTL portions of the Linac Tunnel and Klystron Building
CCL1, CCL2, etc	CCL portions of the Linac Tunnel and Klystron Building
MB1-4, MB5-8, MB9-11	Medium Beta portions of the Linac Tunnel and Klystron bldg.
HB1-3, HB4-6, etc.	High Beta portions of the Linac Tunnel and Klystron building
	Buildings
CE	Central Exhaust enclosure
CL	Central laboratory office building
CH	Central Helium Liquifier (CHL) building
CU	Central Utilities Building (CUB)
ED	Extraction dump building
FE	Front End Building
HE	HEBT tunnel
HS	HEBT service building
ID	Injection dump building
KL	Klystron building
TD	Linac dump building
LN	Linac tunnel
RG	Ring tunnel

RN	Ring service building
RT	RTBT tunnel
RS	RTBT service building
SC	Superconducting RF test and assembly building (SCRF)
ST	Site
TA	Target building
TS	Target services building

Target Building Areas

LWS1,2,3.	Target building light water system vaults
D2O	Target building heavy water system vault
TAHC1,2,3,4	Target building hot cell areas
TATH	Target building top of hot cell area
TAIH	Target building instrument hall
TAIS	Target building instrument support area
TAOP	Target building operating gallery
TASV	Target building Service gallery
TASE	Target building Shielding Equipment Room

Ring Service Building Areas

A,B,C, or D	Ring superperiod areas in the ring tunnel
DP	High field dipoles
EK	Extraction kickers
IK	Injection kickers
LF	Low field correctors
QD	High field quadrupoles
SX	High field sextupoles

Main Control Rooms

CFCC	Conventional facilities control center
CCR	Central control room in CLO building
CER	Central control room equipment room
NFCC	Nuclear Facilities Control Center in the CLO building

Local Control and Communication Rooms

xxCTR1,2,3,etc	Control rooms in the “xx” building
xxCR1,2,3,etc.	Communciation rooms in the “xx” building

Other Areas

Room number, colunm lines, etc.	Areas not listed on this table

2.2 Cable Numbering

Cable numbering does **not** follow the requirements of SNS 102000000-SR0001 *Systems Requirements Document for Equipment, Device and Signal Naming*.

Cable numbering is intended to provide a unique number that will allow retrieving all cable attributes from the project cabling data base and indicate the general area of the plant where the cable is installed.

Cable labelling is to show the the cable number and the souce and destination end points of the cable to facilitate installation and maintenance.

Thus, the cable number should be a unique, 7 digit, instance number assigned as shown in Figure 2. Note that cable numbers for technical system equipment (3xxxxxx – 7xxxxxx) should begin with the appropriate level 2 WBS number for that system (for example, Front End system cables will be 3xxxxxx).

Cable labelling should include the cable number and indicate the source and destination of the cabinet, rack, or junction box or equipment where the cable is terminated. Source and destination names should be the equipment name assigned in accordance with SNS 102000000-SR0001 *Systems Requirements Document for Equipment, Device and Signal Naming*. Where source and destination connection methods differ, the source and destination ends should be identified by showing the appropriate cabinet or device name in bold, a prominent color, or some other convenient means.

Cable labels should be placed near both ends of the cable where they will be in plain view after installation.

2.3 Penetration Numbering

Penetration numbering does **not** follow the requirements of SNS 102000000-SR0001 *Systems Requirements Document for Equipment, Device and Signal Naming*. Penetration numbering is intended to:

a) provide a unique number that to identify the penetration and
b) indicate the location of penetration

Penetration numbers should have the form FF_LLLL_III, where

a) FF is only used in the linac area. Designators are
   WC for Waveguide Chase
   LC for low level voltage signal chase (RF control, diagnostics, etc.)
   SC for spare chase
   FC for conventional facilities
   MC for MAO reference chase

b) LLLL is the Linac, Ring tunnel superperiod, or Hot cell areas location identification from Table 1.
c) III is an instance number giving the penetration number a unique identification

2.4 Conduit numbering

Conduits in penetrations shall be indentified by their penetration number and a unique instance number. Other conduits shall be numbered by a typical scheme used for conventional facilities.

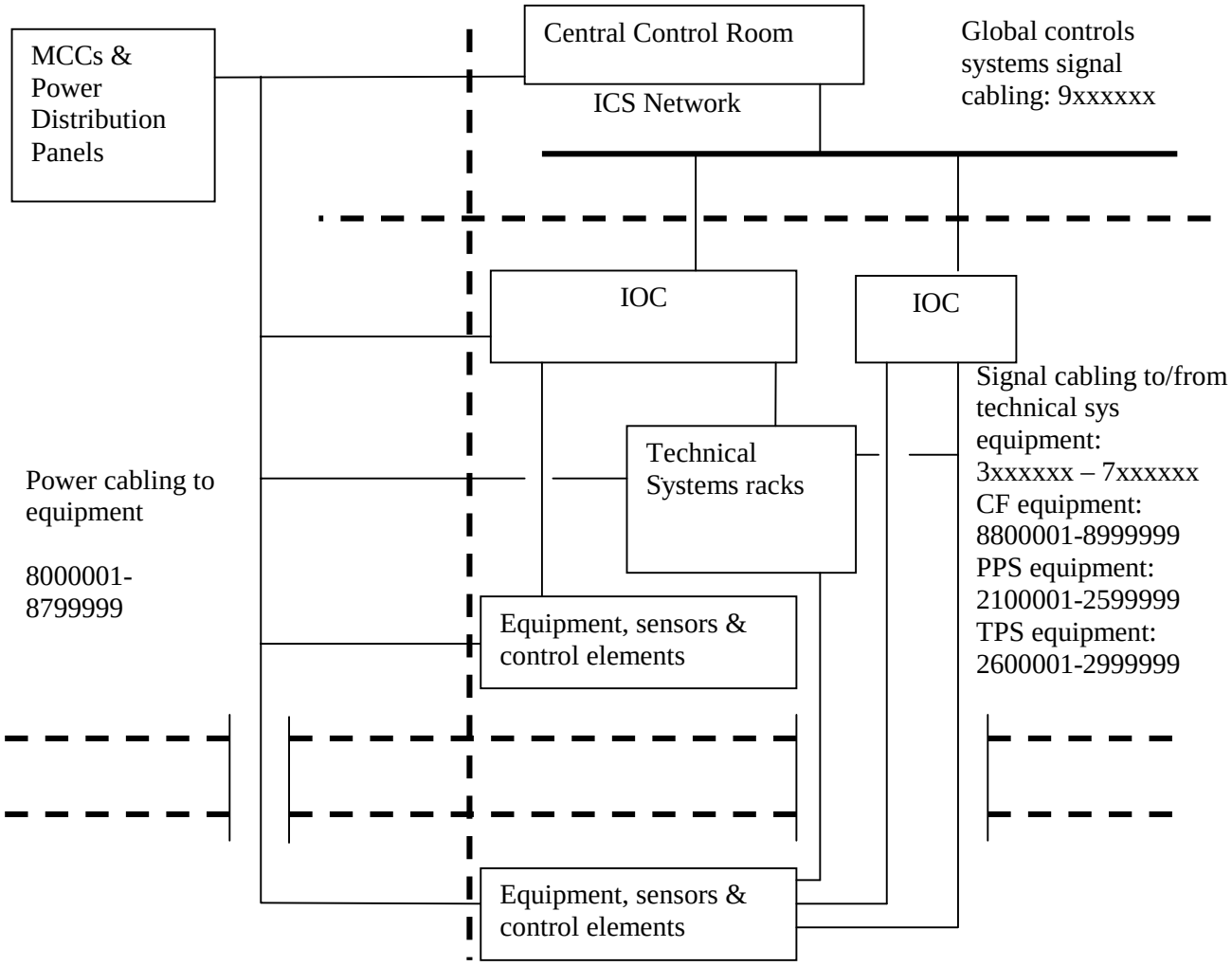


Figure 2 Cable Numbering

Appendix B Cabling Database Attributes

No.	Attribute	Description
1	Database number	Assigned by database system
2	SNS Cable Number	Unique number for database and on cable tag
3	Laboratory	ANL, BNL, LANL, LBNL, JLAB, ORNL, AE,CM
4	Subproject	FE, Linac, Ring, Target, Instruments, CF, CHL, ICS
5	WBS No. & Name	Applicable Level 2 or 3 WBS element
6	Group responsible for cable	Person or organization responsible for managing the cable
7	System	Systems listed in Device & Naming SRD
8	Subsystem	Subsystems listed in Device & Naming SRD
9	Source	Cabinet, junction box, or device name
10	Destination	Cabinet, junction box, or device name
11	Source location	Building where cable source is located
12	Destination location	Building where cable destination is located
13	Tray section or conduit system	See Section 3.0 of this document
14	Penetration number	Penetration designations listed in Appendix A
15	Cable Type	Fiber, Bare copper, RG213, etc.
16	Connector	Where applicable, connector used (automatically selected if connector listed for cable type is used
17	Cable Characteristics	Data used to order each type of cable
18	Length	Feet
19	Expected Current	Amps or mA
20	Installation drawing number	Drawing number
21	Wiring drawing number	Drawing number
22	Fabrication by	Lab shop, rack factory, equipment supplier, field route, etc.
23	Installation by	SNS operations, DB, Laboratory, equipment supplier, etc.
24	Termination by	SNS operations, DB, Laboratory, equipment supplier, etc.

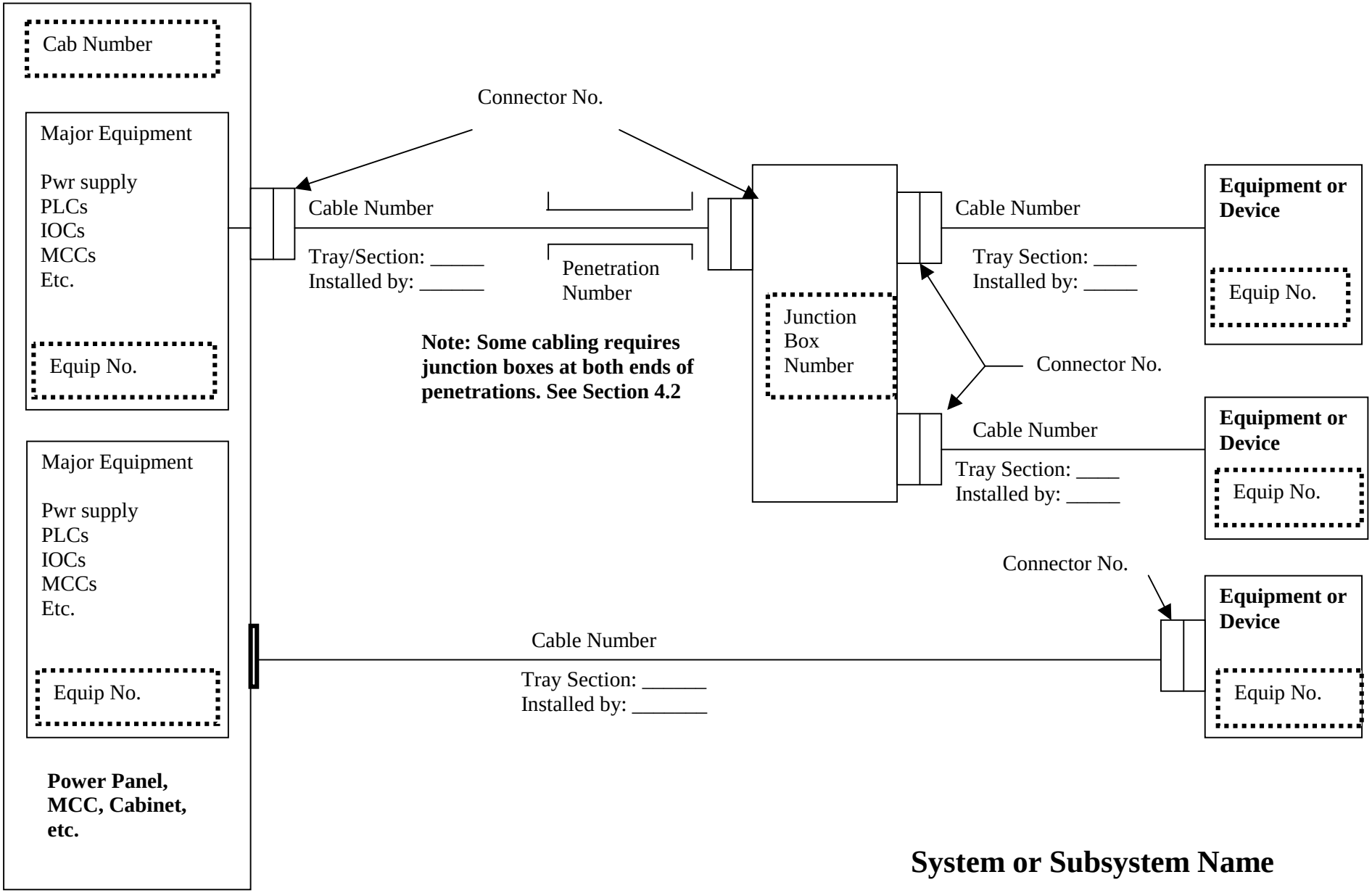
Appendix C Installation Requirements

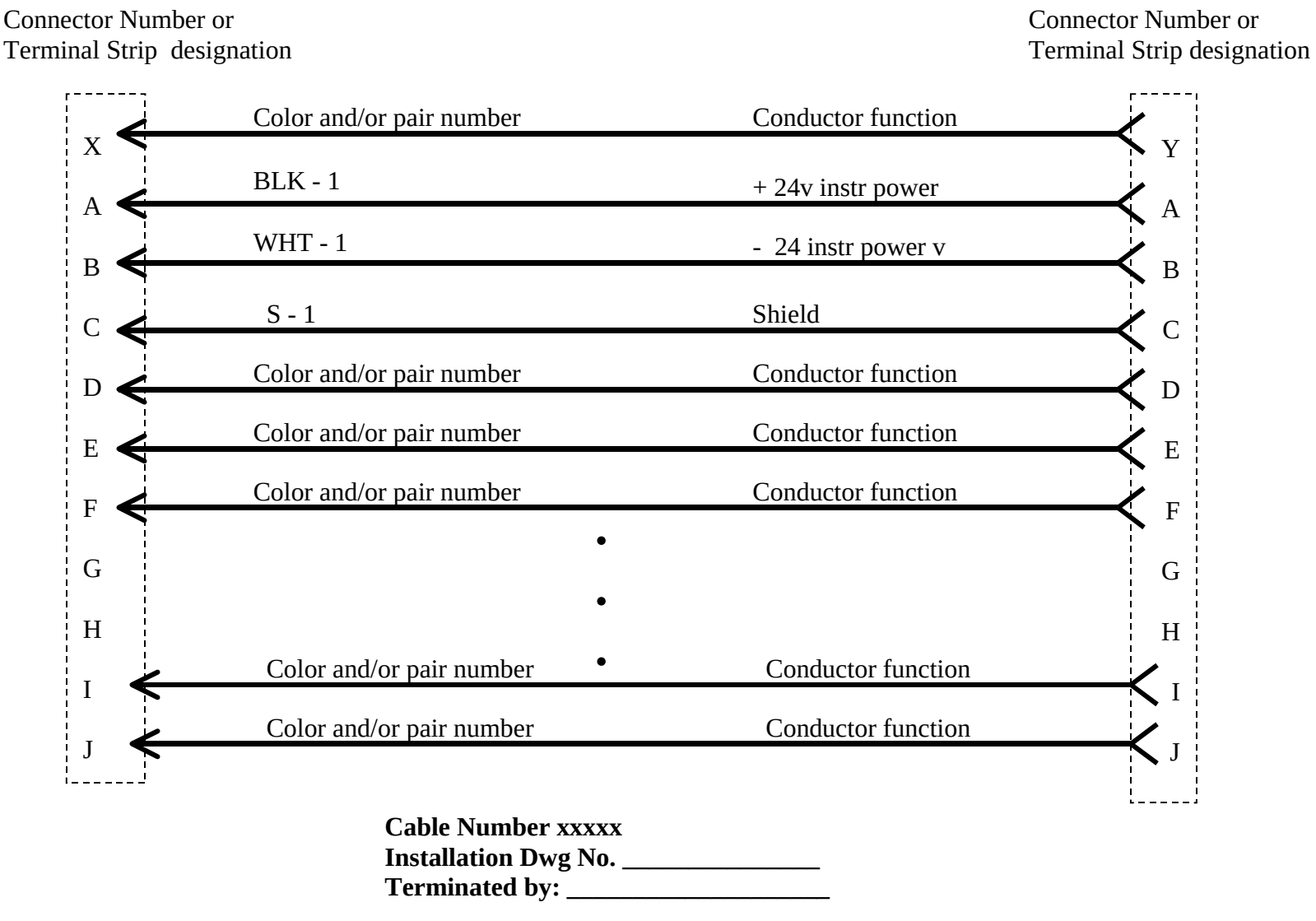
Field installation and cabling terminations shall be documented on a standard set of drawings as shown in Figures 1 and 2. It is expected that equipment in systems will be grouped and all shown on the same installation drawing. For example, all the cabinets, junction boxes, etc between magnet power supply and the magnets it supplies should be on the same drawing. Further, it is acceptable to show the wiring diagram information and other information (such as device location along the beam line) on the installation drawing.

Installation techniques shall in the following:

1) Labels shall be placed near both ends of the cable where they will be in plain view after installation. Labels should indicate the cable number, its source location, and its destination location.
2) No wire and cable shall be pulled until the conduit system is complete from pull point to pull point.
3) Care shall be exercised while installing wire in conduits so as not to damage the conductor insulation. Wire pulling compounds shall be used if wire is pulled by mechanical means.
4) The bending radius of any insulated wire or cable shall not be less than the minimum recommended by the manufacturer. Maximum pull tension of any wire or cable shall not exceed manufacturer's recommended values.
5) Conductors shall be laid in cable trays straight and flat, without twists, without unnecessary crossings, and so as to avoid bearing against edges of tray or tray supports. Additional cable ties required to support cables in an orderly manner shall be used when appropriate. Further, cabling carrying large currents shall be secured in a manner to prevent movement due to magnetic forces.
6) Conduit shall be cut square with a conduit cutter and threaded with a conduit threader. The ends shall be reamed of burrs, and all metal shavings and cutting lubricants shall be removed before the conduit is connected to the conduit system. Bends, offsets, and bevels shall be avoided where practical; but where they are necessary, they shall be made with a bending device. In no case shall the radius of any conduit bend be less than that specified in the NEC or less than the allowable bending radius of the installed conductors. Where a number of conduits are run together, the radii of any required bends shall be such that the installation will be neat in appearance.
7) Conduit shall be adequately supported. Conduit supports shall be erected square and true to line and grade. Also, one support shall be provided within 3 feet of each conduit bend and one adjacent to conduit terminal fittings or boxes, in accordance with applicable Sections of the NEC.
8) Conduit shall be secured to cable tray, framing, etc., by the use of malleable iron galvanized U bolts, beam clamps, conduit straps, or "Unistrut" fittings. Conduit shall be securely fastened to all outlet boxes or cabinets with double locknuts and insulating bushings unless boxes or cabinets with conduit hubs are provided.
9) Wireways and trays shall be installed and connected together to provide a continuous circuit for fault currents. Each shall be connected to ground system. Fittings on conduit systems having threaded connections shall be made up tight with full thread engagement and with a minimum of wrench work in order to avoid wrench cuts. Joints shall provide structural rigidity and low electrical resistance across the joints. Metallic conduit run into metal boxes without threaded hubs shall have a locknut outside and a locknut and bushing inside. All open conduit ends shall have bushings. Before making up conduit runs, the interiors of all conduit, conduit bends, and fittings shall be inspected and cleaned of all dirt, cuttings, and other foreign material. All fittings shall be of the same construction as the wireway or tray. Where additional holes are cut in enclosures, raceway, or cable tray for equipment mounting, cable support, etc., all metal shavings, filing, and cutting lubricants shall be removed.
10) After installation; continuity, loop, megger, and other testing should be performed and documented in accordance with procedures that are appropriate to the cabling function provided.

Figure 1 Typical Cable Installation Drawing





Cable Number xxxxx
Installation Dwg No. _____
Terminated by: _____

Figure 2 Cable Wiring Diagram