DATA SHEET 1

CABLE TERMINATION SHEET

CABLE ID: __-_____-_____-_____-__ TYPE:_____ SIZE: _____ CONDS: _____

Cable OD: _____ inches Minimum Cable Training Radius: _____ inches

Conductor OD: _____ inches Minimum Conductor Training Radius: _____ inches

Measuring Device ID:_____ Cal Due Date _____

Megger Reading:_____Megohms Megger ID:_____ Cal Due Date _____

HI POT Reading:_____Microamps HI POT TEST SET ID:_____ Cal Due Date _____

	"FROM" Termination	"TO" Termination
Equipment ID:	__-_____-_____-_____-__	__-_____-_____-_____-__
Location:	_____	_____
Environment:	_____ per 47E235-____, R___	_____ per 47E235-____, R___
Connection Dwg:	_____, R _____	_____, R _____
Data Sheets:	_____	_____
Crimp Tool ID:	_____	_____
Torque Value:	_____ ft/lbs	_____ ft/lbs
Wrench ID:	_____ Cal Due Date _____	_____ Cal Due Date _____
Performed By:	_____/_____ Craftsman Date	_____/_____ Craftsman Date

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QC INSPECTIONS

		"FROM" Termination	"TO" Termination
6.1	Terminal Lugs	_____/_____	_____/_____
6.2.1	Continuity Test	_____/_____	_____/_____
6.2.2	Megger Reading	_____/_____	_____/_____
6.2.3	Hi Pot Reading	_____/_____	_____/_____
6.3	Heat Shrink	_____/_____	_____/_____
6.4	Bolted Connection	_____/_____	_____/_____
6.5	Bend Radius	_____/_____	_____/_____
6.6	Terminations	_____/_____	_____/_____
6.7	Previous Terminations	_____/_____	_____/_____

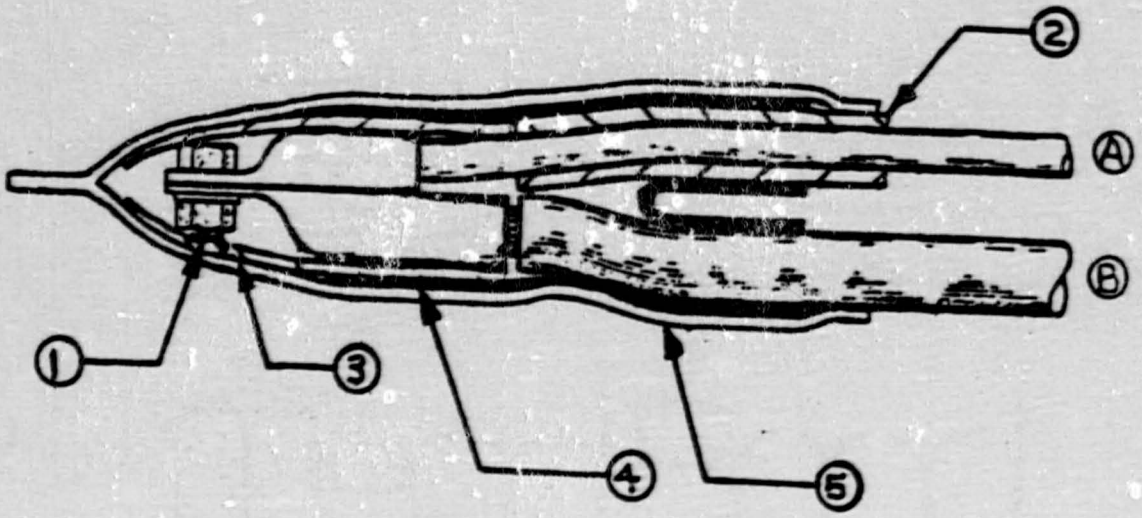
Remarks: _____

_____

_____

DATA SHEET 2

MOTOR TERMINATION SHEET



(A) Conductor OD: _____ inches (B) Conducter OD: _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___
MEASURING DEVICE ID: _____ CAL DUE DATE: _____
MEASURED BY: _____/_____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____/_____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt or screw, lockwasher, and nut) the maximum limits of the kit selected.
2		Conductor shim _____ to be used on conductor/cable _____
3		Bolt pad _____
4		Breakout _____
5		Bonded end cap _____

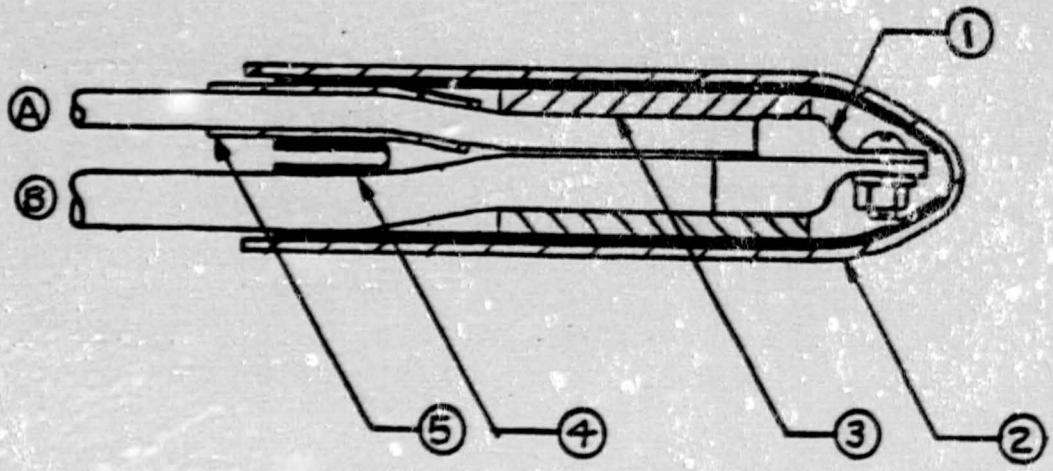
or

Raychem Kit number_____

NOTE: Raychem MMCK Kits are supplied to insulate three phases. Use the manufacture's instructions to install the kit except use only an electric heat gun as a heat source.

DATA SHEET 3

TYPE "V"-STUB TERMINATION SHEET



(A) Conductor OD: _____ inches (B) Conductor OD: _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___
MEASURING DEVICE ID: _____ CAL DUE DATE: _____
MEASURED BY: _____/_____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____/_____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt or screw, lockwasher, and nut.
2		End Cap _____
3		Body Shim _____
4		Breakout _____
5		Conductor shim_____ _____ to be used on conductor/cable _____.

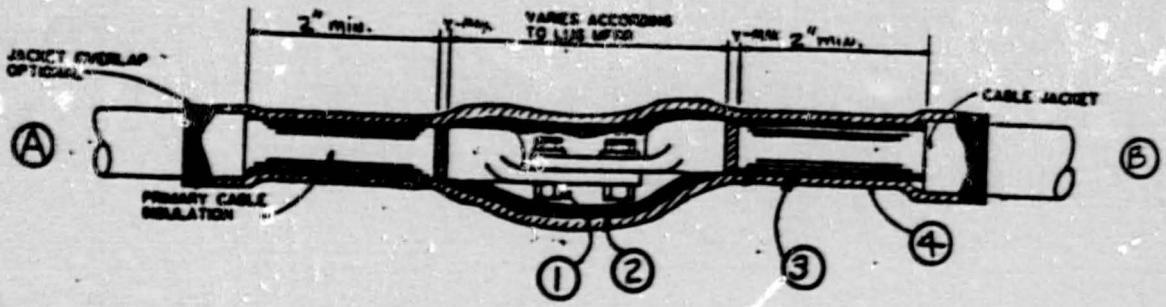
or

Raychem Kit number _____

NOTE: Use the manufacturer's instructions to install the kit except use only an electric heat gun as a heat source.

DATA SHEET 4

TWO SINGLE CONDUCTOR CABLE IN-LINE TERMINATION



(A) Cable OD _____ inches Conductor OD _____ inches
(B) Cable OD _____ inches Conductor OD _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

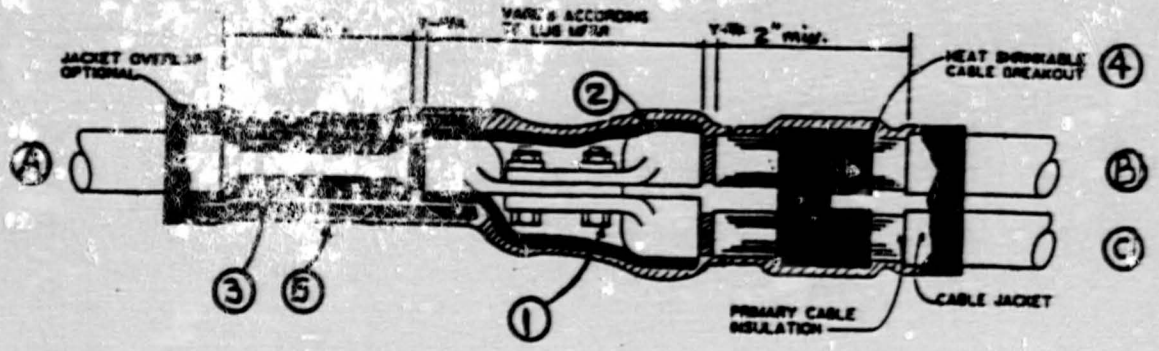
INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____
4		Jacket sleeve _____
		or
		Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 5

THREE SINGLE CONDUCTOR CABLE IN-LINE TERMINATION



(A)	Cable OD _____	inches	Conductor OD _____	inches
(B)	Cable OD _____	inches	Conductor OD _____	inches
(C)	Cable OD _____	inches	Conductor OD _____	inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____
4		Cable breakout _____
5		Jacket sleeve _____

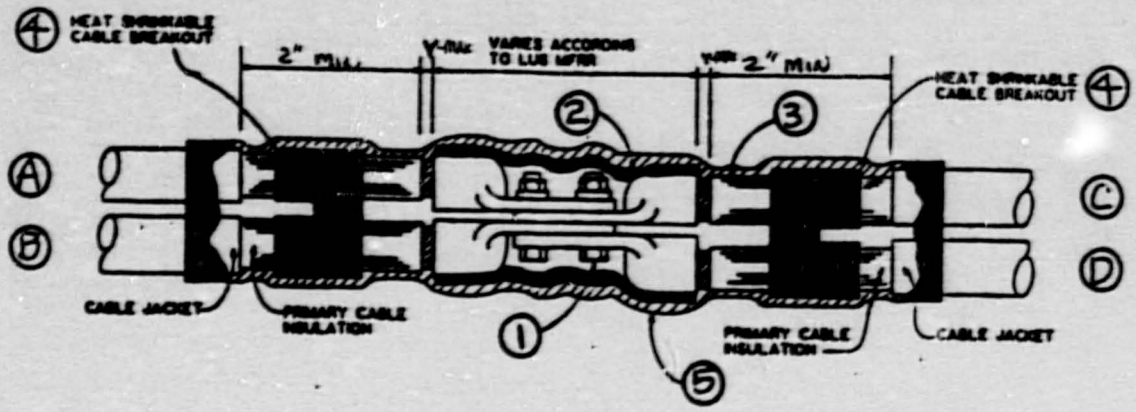
or

Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 6

FOUR SINGLE CONDUCTOR CABLE IN-LINE TERMINATION



A	Cable OD	_____	inches	Conductor OD _____	inches
B	Cable OD	_____	inches	Conductor OD _____	inches
C	Cable OD	_____	inches	Conductor OD _____	inches
D	Cable OD	_____	inches	Conductor OD _____	inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____
4		Cable breakout _____
5		Jacket sleeve _____

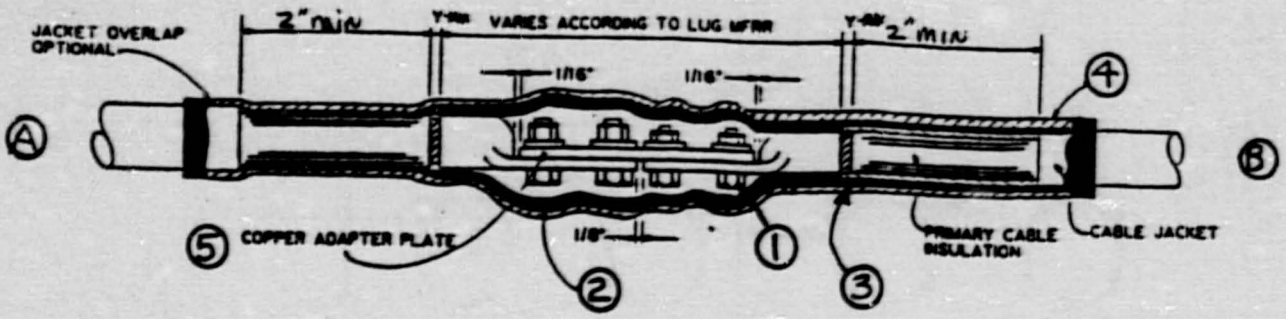
or

Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 7

TWO SINGLE CONDUCTOR CABLE IN-LINE TERMINATION WITH ADAPTER PLATE



(A) Cable OD _____ inches Conductor OD _____ inches
(B) Cable OD _____ inches Conductor OD _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____ and _____ to be used on conductor _____
4		Jacket sleeve _____
5		Craftsman to fabricate copper adapter plate to dimensions specified on attachment 10.

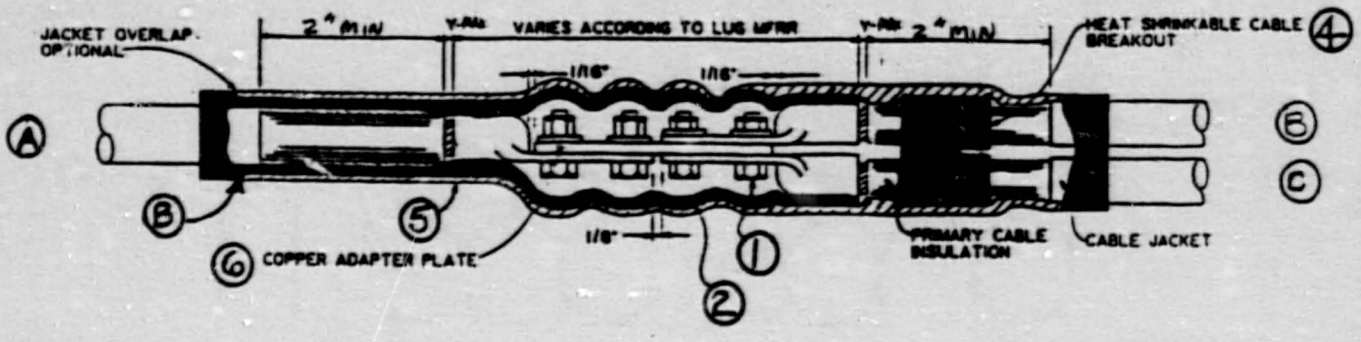
or

Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 8

THREE SINGLE CONDUCTOR CABLE IN-LINE TERMINATION WITH ADAPTER PLATE



(A)	Cable OD _____	inches	Conductor OD _____	inches
(B)	Cable OD _____	inches	Conductor OD _____	inches
(C)	Cable OD _____	inches	Conductor OD _____	inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____ and _____ to be used on conductor _____
4		Cable breakout _____
5		Jacket sleeve _____
6		Craftsman to fabricate copper adapter plate to dimensions specified on attachment 10.

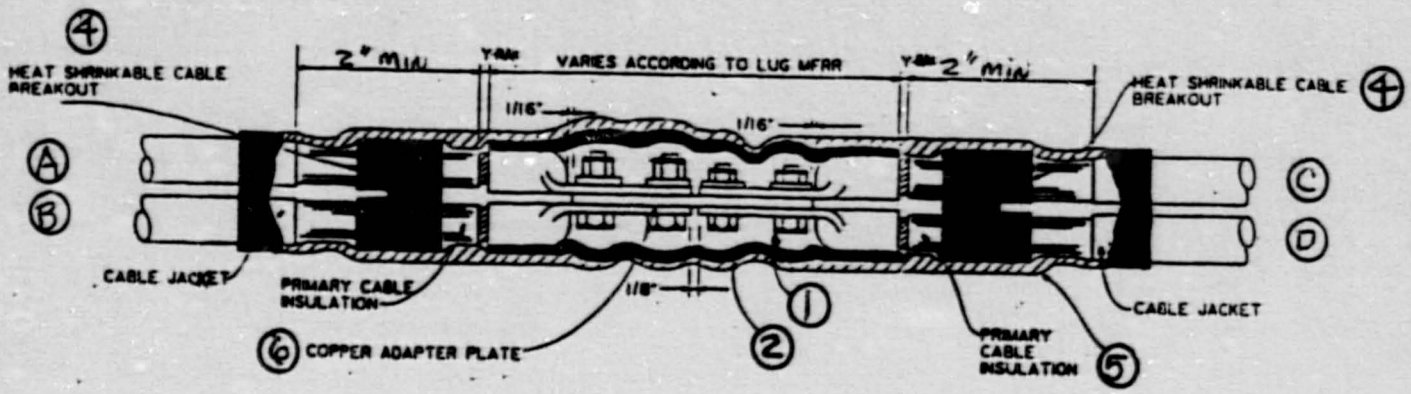
or

Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 9

FOUR SINGLE CONDUCTOR CABLE IN-LINE TERMINATION WITH ADAPTER PLATE



(A)	Cable OD _____	inches	Conductor OD _____	inches
(B)	Cable OD _____	inches	Conductor OD _____	inches
(C)	Cable OD _____	inches	Conductor OD _____	inches
(D)	Cable OD _____	inches	Conductor OD _____	inches

CABLE ID: __-____-____-____-____-__ Equipment ID: __-____-____-____-____-__

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Craftsman to install terminal lugs and bolt assembly (bolt, lockwasher, and nut) within the maximum limits of the kit or sleeve selected.
2		Bolt pad _____
3		Conductor shim _____ and _____ to be used on conductor _____
4		Cable breakout _____
5		Jacket sleeve _____
6		Craftsman to fabricate copper adapter plate to dimensions specified on attachment 10.

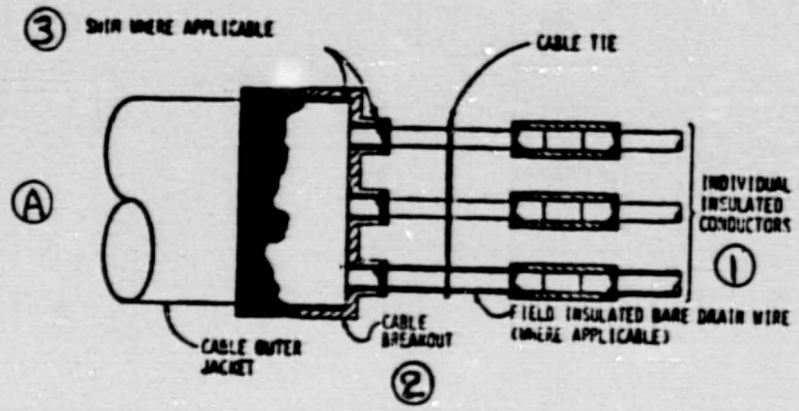
or

Raychem Kit number _____

NOTE: For Y-MAX dimensions, see attachment 10.

DATA SHEET 10

MULTI-CONDUCTOR TO SINGLE CONDUCTOR
CABLE TERMINATION



(A) Cable OD _____ inches

Conductor OD _____ inches
Conductor OD _____ inches
Conductor OD _____ inches
Conductor OD _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

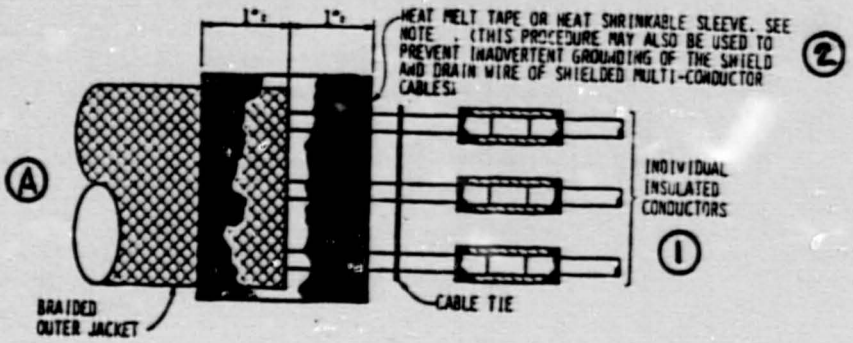
MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1	N/A	Terminate individual conductors using data sheet _____
2		Cable breakout _____
3		Breakout body shim _____
		Breakout leg shim _____

DATA SHEET 11

BRAIDED MULTI-CONDUCTOR TO SINGLE CONDUCTOR CABLE TERMINATION



NOTE : IN ORDER TO PROVIDE A CERTAIN DEGREE OF PROTECTION AND TO PREVENT BRAIDED COVERINGS (ARAMID FIBER, FIBERGLASS, ETC.) FROM BECOMING FRAYED OR UNRAVELED, THE ENDS OF MULTI-CONDUCTOR CABLES WHERE SINGLE CONDUCTORS ARE SPLIT OUT SHALL BE PROTECTED. THIS PROTECTION SHALL COME IN ONE OF TWO WAYS:

A. WRAP HALF-LAPPED LAYERS OF RAYCHEM S-1024 OR S-1119 HEAT-MELT TAPE AROUND THE END OF THE MULTI-CONDUCTOR CABLE WHERE THE SINGLE CONDUCTORS ARE SPLIT OUT, OR
B. USE A 2-INCH PIECE OF RAYCHEM WCSF HEAT SHRINKABLE SLEEVING SELECTED ON THE BASIS OF THE MULTI-CONDUCTOR CABLE OD. CENTER THE SLEEVE APPROXIMATELY ON THE POINT WHERE THE SINGLE CONDUCTORS ARE SPLIT OUT AND SHRINK INTO POSITION.

Ⓐ Cable OD _____ inches

Conductor OD _____ inches
Conductor OD _____ inches
Conductor OD _____ inches
Conductor OD _____ inches

CABLE ID: ___-_____-___-_____-___ Equipment ID: ___-_____-_____-_____-___

MEASURING DEVICE ID: _____ CAL DUE DATE: _____

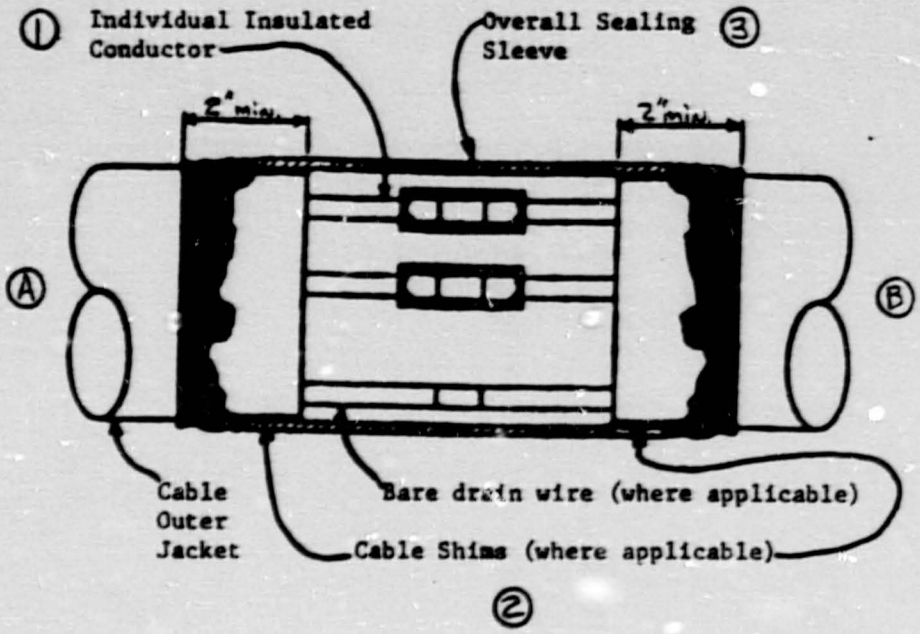
MEASURED BY: _____/_____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____/_____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1	N/A	Terminate individual conductors using data sheet _____
2		Jacket sleeve _____

DATA SHEET 12

MULTI-CONDUCTOR TO MULTI-CONDUCTOR IN-LINE CABLE TERMINATION



Ⓐ Cable OD _____ inches

Ⓑ Cable OD _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___

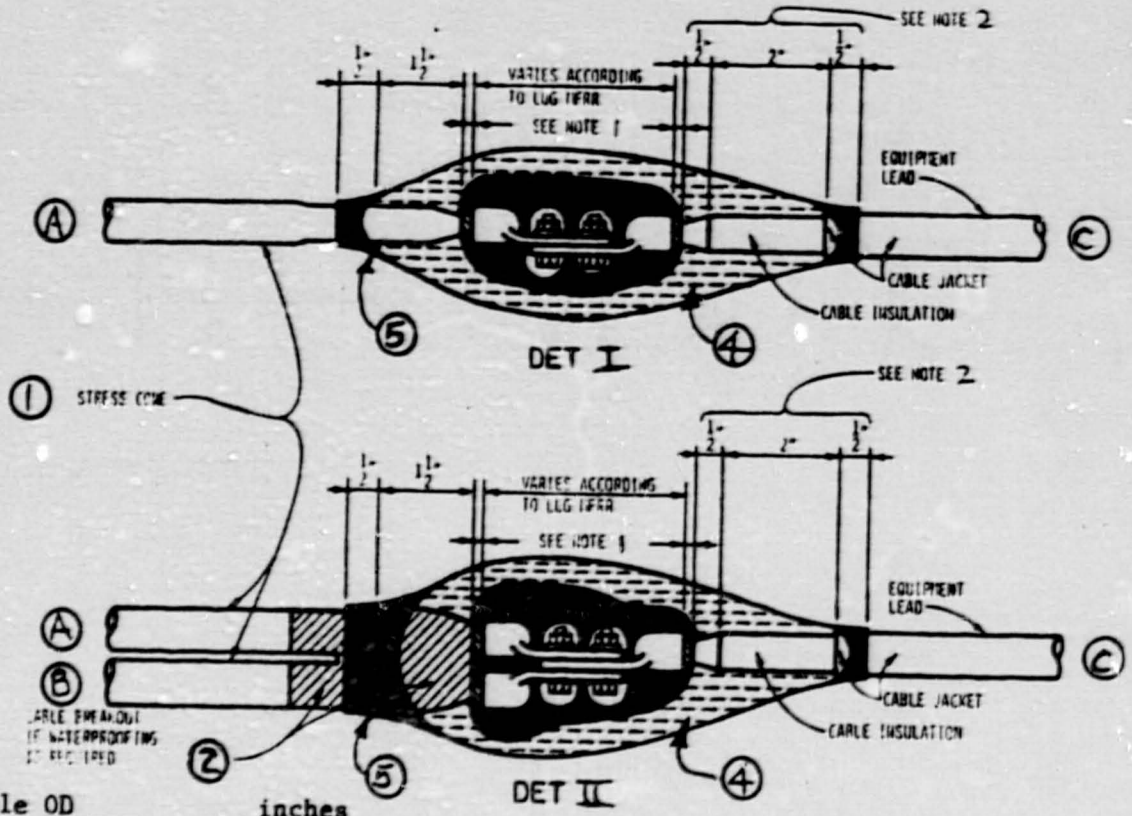
MEASURING DEVICE ID: _____ CAL DUE DATE: _____

MEASURED BY: _____ / _____
Craftsman Date

INSULATION MATERIAL SPECIFIED BY: _____ / _____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1	N/A	Terminate individual conductors using data sheet _____
2		Cable shims _____
3		Jacket sleeve _____

DATA SHEET 13
MEDIUM VOLTAGE TERMINATION SHEET



A Cable OD _____ inches
Cable with stress cone OD: _____ inches
B Cable OD _____ inches
Cable with stress cone OD: _____ inches
C Equipment Lead OD: _____ inches

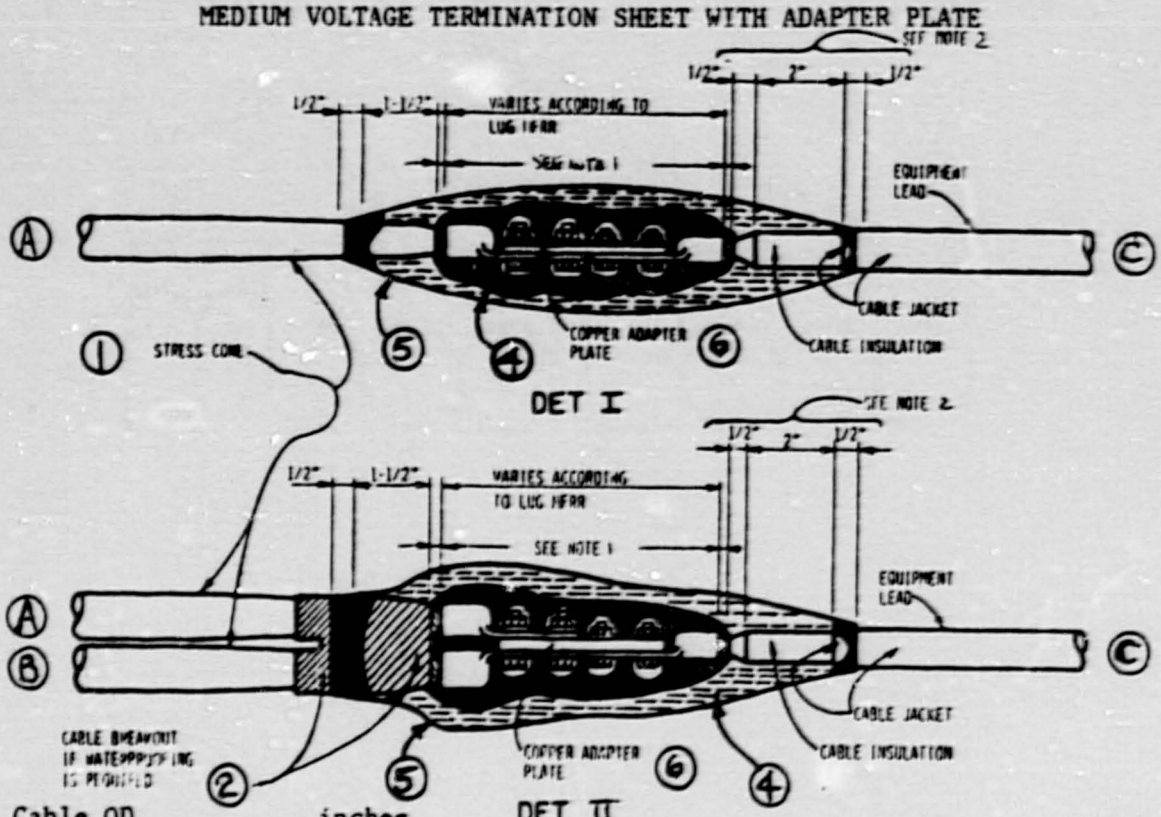
CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___
MEASURING DEVICE ID: _____ CAL DUE DATE: _____
MEASURED BY: _____/_____
Craftsman Date
INSULATION MATERIAL SPECIFIED BY: _____/_____
Cognizant Engineer Date

ITEM	QTY	MATERIALS
1		Termination kit(s) - _____
2		Cable breakout - _____
3		Craftsman to install terminal lugs and bolt assembly (bolt lockwasher, and nut) within the maximum limits of the Raychem Kit specified
4		Insulate termination per attachment 7 or NMCK8-_____
5		Sleeve - _____

NOTE 1: For Y-MAX dimensions, see attachment 10.

NOTE 2: Dimensions for cable preparation and terminal lug installation do not apply where equipment leads already have vendor installed terminal lugs. If the vendor installed terminal lug is a 1-hole lug, a 1-hole lug may also be used on the incoming field cable.

DATA SHEET 14
MEDIUM VOLTAGE TERMINATION SHEET WITH ADAPTER PLATE



A Cable OD _____ inches
Cable with stress cone OD: _____ inches
B Cable OD _____ inches
Cable with stress cone OD: _____ inches
C Equipment Lead OP: _____ inches

CABLE ID: ___-_____-_____-_____-___ Equipment ID: ___-_____-_____-_____-___
MEASURING DEVICE ID: _____ CAL DUE DATE: _____
MEASURED BY: _____/_____
Craftsman Date
INSULATION MATERIAL SPECIFIED BY: _____/_____
Cognizant Engineer Date

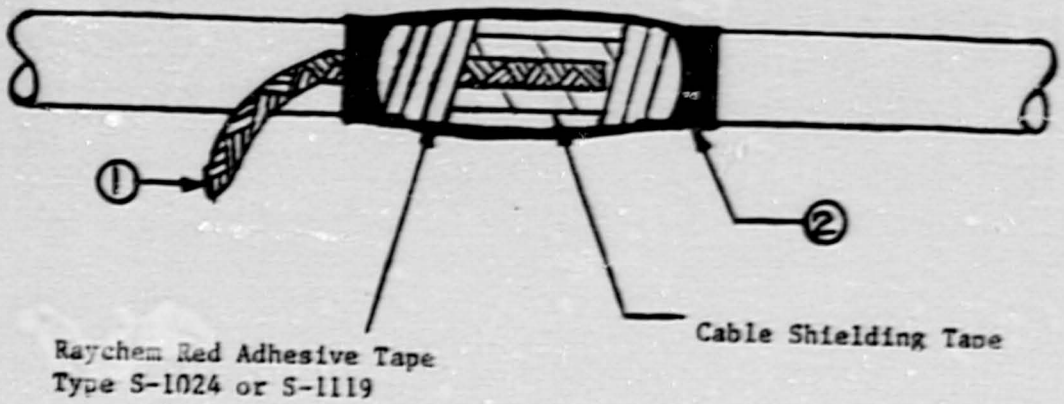
ITEM	QTY	MATERIALS
1		Termination kit(s) - _____
2		Cable breakout - _____
3		Craftsman to install terminal lugs and bolt assembly (bolt lockwasher, and nut) within the maximum limits of the Raychem Kit specified.
4		Insulate termination per attachment 7 or NMCK8-_____
5		Sleeve - _____
6		Craftsman to fabricate copper adapter plate to dimensions specified on attachment 10.

NOTE 1: For Y-MAX dimensions, see attachment 10.

NOTE 2: Dimensions for cable preparation and terminal lug installation do not apply where equipment leads already have vendor-installed terminal lugs. If the vendor installed terminal lug is a 1-hole lug, a 1-hole lug may also be used on the incoming field cable.

DATA SHEET 15

INTERMEDIATE GROUNDS FOR MEDIUM VOLTAGE SHIELDED POWER CABLES



CABLE ID: ___-_____-_____-_____-___

LOCATION OF INTERMEDIATE GROUND: _____

CABLE OD: _____ MEASURING DEVICE ID: _____

CAL DUE DATE: _____

MEASURED BY: _____/_____
Craftsman Date

ITEM	QTY	MATERIALS
1	3	Raychem Ground Clamp Accessory Kit _____
2	3	Raychem Heat Shrinkable Cable Repair Sleeve NJRS - _____

DATA SHEET 16

TEMPORARY WIRE LIFT LOG

Location (Terminal Block, Device, etc.): ______ Wire No. (ID, Color, etc.): ______ ______	No. of wires before lift ______	1st Pty ______ 2nd Pty ______ Date ______
	No. of wires after termination ______	1st Pty ______ 2nd Pty ______ Date ______
Location (Terminal Block, Device, etc.): ______ Wire No. (ID, Color, etc.): ______ ______	No. of wires before lift ______	1st Pty ______ 2nd Pty ______ Date ______
	No. of wires after termination ______	1st Pty ______ 2nd Pty ______ Date ______
Location (Terminal Block, Device, etc.): ______ Wire No. (ID, Color, etc.): ______ ______	No. of wires before lift ______	1st Pty ______ 2nd Pty ______ Date ______
	No. of wires after termination ______	1st Pty ______ 2nd Pty ______ Date ______
Location (Terminal Block, Device, etc.): ______ Wire No. (ID, Color, etc.): ______ ______	No. of wires before lift ______	1st Pty ______ 2nd Pty ______ Date ______
	No. of wires after termination ______	1st Pty ______ 2nd Pty ______ Date ______
Location (Terminal Block, Device, etc.): ______ Wire No. (ID, Color, etc.): ______ ______	No. of wires before lift ______	1st Pty ______ 2nd Pty ______ Date ______
	No. of wires after termination ______	1st Pty ______ 2nd Pty ______ Date ______

NOTE: Craftsman shall record the number of wires on the terminal before the wire lift is made and after the lift is reterminated.

APPENDIX A

Temporary Wire Lifts

1.0 For certain applications that require cables to be temporarily disconnected (e.g., partial cable repulls, maintenance activities, etc.) the wire lift log, data sheet 16, may be used to document these activities.

1.1 The craftsman shall record the information required on data sheet 16 that identifies the wire being lifted. Wires shall be identified by color or ID in accordance with the applicable connection drawings and attachment 2 prior to being lifted.

1.2 The second-party verification shall be someone other than the craftsman performing the wirelift and he must actually witness the wire lift and return to normal.

WATTS BAR NUCLEAR PLANT

MODIFICATIONS AND ADDITIONS INSTRUCTION

MAI-13

INSTALLATION OF CONDUIT AND JUNCTION BOXES

CURRENT REVISION LEVEL 3

Responsible Section: Modifications

Prepared By: Vernon P. Law

Revised By: J. E. Hoffert

Submitted By: [signature]
Supervisor

PORC Review Date: 9/5/86

Approved By: [signature] for Plant Manager

Date Approved: 9/5/86

Last page of this instruction: 67

1C	Doc Control Unit, LP 4S 160D-C
	NRC
1C	NMRG, c/o DCU-LP 4S 160D-C
1C	Plant Master File
	Plant Manager
	Supt (O&T)
	Supt (Maint)
	Plant Adm.Svs Supv
	ASE Duty Station
	Building Services Supv
	Chem Lab
	Chemistry Sect Supv
	Chief, Nuclear Safety Staff
	Chief, Nuclear Training Branch
	Chief, Quality Audits Branch
	Compliance Unit
	Component Engg & Svs Group
	DPSO-WBN
1u	Dwg & Vendor Manual Supv
1u	Elect Maint Supv
	Staff Reference Copy
	Tech Support Supv
	Radiological Control Lab
	Radiological Control Supv
	Industrial Safety Supv
	Instr Maint Supv
	Instr Shop
	Materials Unit Supv
1u	Mech Maint Supv
	Mech Test Unit Supv
1u	Modifications Training Unit
	Operating Instruction Coordinator
	Operations Supv
	Operator Training Classroom
	Operations Training Sect Supv
	P&S Supv
2C	Site Quality Manager
	Training Support Supervisor
	Power Stores Unit Supv
	Preop Test Supv
	Public Safety
	Reactor Engg Unit Supv
	Shift Engr's Office
	Support Svs Supv
	Tech Support Center
	Unit 1 Control Rm
	Unit 2 Control Rm
1C	John Raulston, W10A63 C-K
	Site Director
	Watts Bar Tech Svs
	Design Svs Manager
1C	DCU 24-Hr Sta
1u	Modif - Carol Stidam
1C	DCU - 8 Hr Sta
1C	DCU-B(CC)

0452A

HISTORY OF REVISION/REVIEW

REV. NO.	DATE	REVISED PAGES	REASON FOR CURRENT REVISION(INCLUDE ALL INSTRUCTION CHANGE NUMBERS)
1	02/23/85	All	General revision.
2	08/15/85	All	Minor corrections and additions. Removed MAI-16 and added electrical Support requirements.
3	9/5/86	All	General revision to incorporate changes made to Const Spec G-40, rev 9, SRN-G-40-11, and AI-9.4.2. Also added instructions in section 5 to clear DR-86-124R and NCR W403P and added embedded plate inspection section 6.14.

1.0 PURPOSE

The purpose of this instruction is to define the general installation requirements, inspections, and acceptance criteria of electrical conduit systems and conduit boxes.

2.0 SCOPE

This instruction applies to all electrical conduit systems and conduit * boxes at Watts Bar Nuclear Plant (WBN). On non-CSSC systems the QC inspections may be performed by the cognizant engineer or foreman except for support spacing requirements in Category I structures (see section 6.5).

3.0 REFERENCE

3.1 Source Documents

3.1.1 General Construction Specification G-40, "Installing Electrical Conduit Boxes"

3.2 Other Documents

3.2.1 General Construction Specification G-14, "Selecting, Specifying, Applying, and Inspecting Paint and Coatings"

3.2.2 General Construction Specification G-34, "Repair of Concrete"

3.2.3 General Construction Specification G-47, "Installing Electrical Grounding Systems"

3.2.4 National Electric Code, 1984 Edition

* 3.2.5 Division of Nuclear Engineering (DNE) Electrical Stand Drawing SD-E13.6.3 series, "Conduit Boxes, Frames, and Covers"

* 3.2.6 DNE drawing 47A050 series, "Mechanical Hanger Drawing General Notes"

* 3.2.7 DNE drawing 47A056 series, "Mechanical Category I and IL Conduit Supports"

* 3.2.8 DNE drawing 47A057 series, "Mechanical Seismic Support Lighting Fixtures"

* 3.2.9 Servicair Process Specification SPS-121, "Flex Metal Conduit-Length Stabilization-Measuring and Cutting Procedure" (contract 836820)

* 3.2.10 Servicair Process Specification SPS-122, "Assembly of SB1000/S91000 Conduit Couplings and Kwik-Seels to Serriflex Metal Conduit" (contract 836820)

* 3.2.11 Servicair Process Specification SPS-123, "Field Processing of Flexible Stainless Conduit Silver Braze Method" (contract 836820)

* 3.2.12 WBN Construction Specification N3G-881, "Identification of Structures, Systems, and Components Covered By Watts Bar Nuclear Plant Quality Assurance Program"

* 3.2.13 AI-9.4.2, "Control of Weld Documentation"

* 3.2.14 Modification Section Letter MGL-E5, "Conduit Installation"

* 3.2.15 ONP Program Procedure 1502.07, "Nondestructive Examination Procedures Approved For Use on CSSC Items At All Nuclear Plants"

4.0 GENERAL CRITERIA

4.1 General Conduit Installation Requirements

* 4.1.1 Installation of conduit, fittings, and accessories shall conform to the respective sections of the latest edition of the National Electric Code (NEC) and the DNE-approved drawings and standards. Metallic conduit systems, whether embedded or exposed, shall be installed in accordance with those portions of the NEC which ensure that the systems will be adequately grounded and electrically continuous to function as the equipment grounding conductor. In the event of a conflict between design drawings, standards, or this specification and NEC, the design drawings shall govern.

Table 4.1.1 - Minimum Size Grounding Conductors

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Copper Wire AWG
15	14
20	12
30	10
40	10
60	10
100	8
200	6
300	4
400	3
500	2
600	1
800	0
1000	2/0
1200	3/0
1600	4/0
2000	250 mcm
2500	350 mcm
3000	400 mcm
4000	500 mcm
5000	700 mcm
6000	800 mcm

4.1.2 Conduit exposed to the weather, embedded in concrete, or in wet locations should be sloped for drainage, if possible.

4.1.3 To protect the cables during installation, a bushing, chase nipple, or conduit body (such as a condulet) shall be used at the end of a conduit run where it terminates at a piece of equipment or cable tray. Where equipment design prohibits their use due to space limitations, these conduit accessories may be omitted provided the end of the conduit is deburred and one of the following options exercised:

(a) The end of the conduit shall be beveled or rounded to approximately a 1/16-inch radius, or

(b) The end of the conduit shall be fitted with a collar.

4.1.4 Running threads on field threaded conduits shall not be used on metal conduits for connection at couplings. At terminations, such as at equipment and boxes, running threads may be used on short nipples which are used to extend the conduit system. Running threads may also be used at conduit accessories, such as conduit fittings and bodies, provided the other end of the nipple is being installed in another conduit accessory or in a coupling opposite a conduit section having a tapered thread. Also, the nipple must be long enough to be fully inserted in both accessories or the accessory and the coupling.

4.1.5 Welded or brazed grounds on conduit runs shall be done on the top of couplings only, and extreme care shall be taken to avoid injury to the inner surface of the conduit by excessive heating. The welded or brazed joint shall be coated with asphaltum (e.g., Kippers Bitumastic Jet-Set Primer) or equivalent.

4.1.6 Unless otherwise noted, standard radius field bends (see attachment 1) or manufacturer's bends (bending radius as specified in NEC) shall be used where needed in metal conduit systems. Special long-radius bends (bending radius greater than on attachment 1 or NEC requirements) shall be used where specifically called for on design drawings or where otherwise needed to complete the installation of the conduit system. Short radius elbows (bending radius less than on attachment 1 or NEC requirements) shall not be used unless specified on design drawings.

4.1.7 Field bends for metal conduit shall be made so that the internal diameter of the conduit is not materially changed and the protective coating on the inside and outside of the conduit is not significantly damaged. When making field bends, a certain amount of necking, flattening, nicks, kinks, splits, dents, and/or damage to the protective coating can be expected to occur. Field bends which result in a kink or split in the conduit shall be abandoned. Likewise, if a nick should occur which actually penetrates the wall of the conduit, the bend shall not be used. Nicks and abrasions resulting in significant damage to the protective coating should be repaired by spraying or painting galvanize on the damaged areas. When the following conditions are satisfied, less severe necking, flattening, dents, and nicks which could not result in damage to the cable insulation during pulling are acceptable:

(a) The bending equipment being used is approved for the application.

(b) The manufacturer's instructions and recommendations pertaining to the use of the bending equipment are being followed.

(c) The bending equipment is functioning properly.

Heat shall not be applied in making any metal conduit bend.

4.1.8 Reducers (or enlargers) may be used in the following applications:

(a) To mate up the incoming conduit (rigid or flexible) to a device supplied with hubs or knockouts which do not match the size of the incoming conduit,

(b) To mate up rigid conduit to flexible conduit where mismatched conduit sizes are specified on design drawings, or

* (c) To change the flexible conduit size at the rigid/flexible interface down to the size hub or knockout of the termination device, provided the maximum allowable conduit fill is not exceeded.

* 4.1.9 A conduit run shall not contain more than the equivalent of four 90-degree bends (360-degree total) between pull points.

* 4.1.10 Pull boxes should be installed in runs greater than 50 feet having two 90-degree bends and in runs greater than 150 feet with one 90-degree bend. See attachment 13 for minimum sizes required to be installed. Pull boxes are not required to be identified with a unique ID unless specified on the design drawings. Conduits entering and exiting a pull box do not change IDs.

* 4.1.11 Standard conduit bends are preferred at the top of all vertical conduit runs in lieu of conduit bodies. Pull boxes should be installed in vertical runs, when required, with provisions for supporting the cables such that the minimum cable training radius is not violated. Cables in vertical conduit runs shall be supported at the top of the run (or as close to the top as practical) as well as at each additional interval of spacing as specified below. If the total vertical rise is less than 25 percent of the spacing specified below, no cable support is necessary.

SPACING FOR CABLE SUPPORTS
IN VERTICAL RACEWAYS

CABLE SIZE	SUPPORT SPAN
1/0 AWG and below	Not greater than 100 ft.
2/0 AWG to 4/0 AWG	Not greater than 80 ft.
250 MCM to 350 MCM	Not greater than 60 ft.
400 MCM to 500 MCM	Not greater than 50 ft.
750 MCM	Not greater than 40 ft.

* 4.1.12 Field-installed pull points, such as conduit bodies, shall be adequately sized to accommodate the required splices or terminations (e.g., interfaces with devices with pigtails) and to accommodate the minimum training radius of the cable.

Table 4.1.12
Minimum Training Radii
For Cables Installed
In Conduit Bodies (LL, LR, LB, T, or X)

Standard Conduit Body Size Nominal (inches)	Cable Bend Inner Radius at 40% Fill (inches)
1/2	1.125
3/4	1.375
1	1.438
1-1/2	2.250
2	3.000
2 1/2	3.500
3	4.000
4	5.500

* 4.1.13 Where the minimum bending radius requirements of a cable prohibit the use of conduit bodies in low voltage applications, a junction box, an oversized conduit body (standard conduit bodies sized larger than the conduit system), or Mogul series conduit bodies shall be used. Drawing revisions are not required to document the change in size of the conduit bodies.

* 4.1.14 Copper-silicon alloys, brass, or plastic conduit plugs shall be used where spare conduits are terminated in wet places.

* 4.1.15 After a conduit run is completed, it shall be inspected and cleaned out. Compressed air shall be used in blowing out any accumulation of trapped liquids.

4.2 Exposed Conduit

4.2.1 Supports for straight runs of exposed rigid metal conduit shall not exceed the maximum distances listed in the NEC for systems made up with threaded couplings. This requirement also applies where conduit bodies, such as condulets, are attached directly to electrical equipment or electrical enclosures and isolated from the rigid conduit by flexible conduit.

In seismic Category I structures, exposed conduits shall be supported to the maximum distances specified and use the typical conduit supports in the latest revision of 47A056 series design drawings.

4.2.2 In moist locations and in locations where appearance is of importance, precautions shall be taken, such as by use of strap-type wrenches or equivalent means, to avoid injuring the galvanized coating or surface of stainless steel conduit.

4.2.3 When in the vicinity of piping which must be insulated, the conduit shall be adequately spaced away from the pipe to avoid interferences when the pipe is insulated.

* 4.2.4 Two conduit bodies having three conduit openings each (e.g., two "Tee" condulets) may be used where one conduit body having four openings (e.g., an "X" condulet) is specified on design drawings. The conduit interconnecting the two conduit bodies shall be sized by the cognizant engineer using section letter MGL-E5. This configuration is treated as a single conduit body, and the conduit interconnection is not required to be uniquely identified if it is 12 inches or less in length. Contact DNE when the interconnecting conduit is greater than 12 inches in length.

4.3 Embedded Conduit

4.3.1 A minimum 2-inch clearance shall be maintained between conduits embedded in poured concrete walls or floor slabs, except that detailed design dimensions shall be adhered to adjacent to conduit terminations, etc., where area is restricted. Conduits and conduit sleeves, when located in a bank or group form in a wall pour, may be adjusted as required to line up the bottom outside edge of the smaller sized conduit with the bottom outside edge of the largest conduit in the group in order to continue the group run on a common exposed support. Likewise, grouped conduits in a floor or ceiling slab may be shifted enough to take advantage of a common exposed wall or column support. Embedded conduit runs shall terminate within ±1/2 the nominal diameter of the conduit being installed or 1 inch, whichever is greater, unless the above exceptions apply. Conduits embedded in switchyards and transformer yards shall maintain a 1-inch minimum clearance between conduits.

4.3.2 In switchyards and transformer yards all single conduit or groups of conduits shall be encased in concrete with the outer coverage a minimum of 2-1/2 inches.

* 4.3.3 Where embedded in concrete, extreme care shall be taken to anchor conduit so that it will not be floated when the concrete is placed. Embedded conduit shall be rigidly supported to withstand concrete vibrators or batches of mass concrete placements.

4.3.4 In supporting embedded steel, aluminum, or plastic conduit, extreme care shall be taken to avoid damage to the surface of the conduit if welding or brazing is used near the conduit. In no case shall the conduit be welded or brazed to the support. Plastic conduit in duct runs shall not be supported by reinforcing steel forming closed magnetic loops; preformed plastic spacers shall be used. Reinforcement bars shall be insulated to reduce inductive heating per attachment 2.

4.3.5 Slip joints shall be installed in accordance with attachment 3, where embedded conduits cross expansion or contraction joints, as defined and located on design drawings. Wherever slip joints are used, suitable bonding in accordance with attachment 3 shall be provided around the joint to ensure a continuous ground circuit. Where use of expansion and deflection-type fittings (see attachment 4) are defined in design drawings, the manufacturer's instruction shall be followed in making ground connections.

* 4.3.6 In certain embedded conduit applications, it may be impractical or very costly to use threaded couplings. When these situations are encountered, threadless couplings (such as manufactured by Thomas and Betts or equivalent) may be used if the following conditions are satisfied:

(a) The manufacturer's instructions regarding installation of threadless couplings shall be followed.

(b) Threadless couplings shall be concrete tight.

(c) Threadless couplings shall be made watertight and rustproof in accordance with section 4.4.1.

(d) The conduit systems shall be adequately braced or supported on each side of the threadless coupling to maintain the integrity of the fitting during concrete pours.

(e) The threadless couplings shall be electrically continuous or shall be made electrically continuous by means of a bonding strap or ground cable attached to the conduit system on each side of the fitting.

4.3.7 Except as noted below or unless otherwise specified on design drawings, all embedded conduits turning out of poured concrete shall terminate with a standard coupling flush with the surface of the concrete. Where the thickness of the concrete is not adquate to accommodate the minimum bending radius of the conduit (see attachment 1), one of the following options may be exercised:

(a) A short radius elbow may be used where approval has been obtained from the design project. (Short radius elbows must also be shown on design drawings.)

(b) Where terminating into surface of floor-mounted boxes or equipment, a standard radius field bend or manufacturer's bend may be used and extended beyond the concrete surface as needed to complete the 90-degree bend. If necessary to avoid interferences or to accommodate the minimum bending radius of the cables, the end of the 90-degree bend projecting beyond the concrete surface may be cut, provided the cut end is deburred and handled in accordance with option a or b of section 4.1.3.

(c) Where the conduit bend must be terminated in a coupling to allow the conduit system to be extended beyond the wall or floor surface, the coupling may extend beyond the surface as needed to complete the 90-degree bend.

(d) Where the difference in being able to comply with this section and attachment 1 is small, the straight portion of the bend may be cut as required, provided the minimum bending radius (dimension A on attachment 1) is not altered and the bend is rethreaded to the original specifications.

4.3.8 In duct runs the metallic conduit shall be grounded at each manhole or handhole by brazing the ground wire to the top of the conduit coupling or by using grounding bushings.

4.3.9 Holes for conduits may be drilled in hardened concrete; however, no reinforcing steel will be cut or damaged during the drilling operation. The reinforcing steel may be located by removing the cover concrete. Holes may be relocated up to 8 inches in any direction from the dimensions specified on design drawings and may be canted from one face to the other to avoid the reinforcing steel. After installation of the conduit, the damaged concrete shall be repaired in accordance with MAI-17 or MAI-19 as applicable.

* 4.4 Metal Conduit

4.4.1 Steel conduit and intermediate metal conduit joints and connections shall be made water-tight and rustproof by means of the application of a thread compound which will not insulate the joint. Each field-cut thread shall be cleaned to remove the cutting oil before the compound is applied. An electrically conductive and anti-seize compound for metal surfaces (Thomas and Betts Company "Kopr-Shield"; Jet-Lube, Incorporated "SS-30"; Burndy "Penetrox E"; or equivalent), shall be applied to the male conduit threads. For conduit installed in humidity controlled environments, such as in the Control Building, this compound may be omitted.

* 4.4.2 Split couplings shall not be used inside containment for embedded or exposed installations, but may be used outside containment where spacing or other obstructions hinder the use of three-piece couplings (Erickson type) or standard couplings. Split couplings are suitable for use in rigid or intermediate metal conduit systems, in both embedded or exposed applications. DNE approval for their use is contingent upon the following:

(a) The manufacturer's instructions concerning installation of the split couplings (such as tightening of bolts) shall be carefully observed.

(b) Where grounding of the conduit system is required and to be accomplished by brazing a ground wire to the top of the split coupling, the neoprene gasket shall be temporarily removed prior to the brazing process.

(c) The joint shall be made watertight and rustproof in accordance with section 4.4.1.

* 4.4.3 Threads on conduit or conduit stubups which have been damaged to the extent of preventing the installation of couplings shall be rethreaded using conventional threading equipment. Where this repair method is impractical, threadmaker conduit fittings (Crouse-Hinds), or equivalent, may be used for extending the conduit system.

4.4.4 Aluminum conduit, conduit fittings, or components shall <u>not</u> be used inside reactor building primary containment. The containment spray would react with the aluminum to produce excessive hydrogen. Aluminum conduit may be installed outdoors or in wet locations to the following guidelines:

(a) Preferably aluminum conduit shall be installed with aluminum fittings and supports. Galvanized fittings and supports may be used in special cases. Care must be taken to prevent the contact of aluminum conduit with corrosive materials in places where moisture can accumulate.

(b) Strap-type wrenches or equivalent shall be used to avoid scratching and gouging the aluminum conduit.

(c) Aluminum conduit joints at couplings or fittings tend to seize unless treated. Use a commercial compound, such as Alcoa Thread Lubricant. Satisfactory mixtures such as zinc dust and vaseline (50-50 by weight), or a heavy cup grease containing 25 percent graphite may be used. Aluminum threads shall not be coated with red lead or other lead compounds.

(d) Standard benders may be used for aluminum conduit except that electrical metallic tubing, (EMT) benders shall be used for conduit 1-inch in diameter and below. Use an EMT bender 1/4 inch larger than the conduit size, i.e., 1-1/4 inch for 1-inch rigid, 1-inch for 3/4-inch rigid.

(e) Aluminum conduit shall be grounded by inserting a galvanized steel coupling in the run, brazing the ground wire to the top of the coupling, and carefully coating the joint with asphaltum. The design drawings will show grounding when used for a single phase of a 3-phase circuit.

4.4.5 Electrical metallic tubing (EMT), a threadless, thin-wall steel conduit, requiring special threadless fittings for couplings and terminations may be used in exposed and embedded applications in nonseismic Category I Office and Service Buildings. Installation shall be in accordance with the applicable procedures in this * instruction and Article 348 of the National Electrical Code, latest edition.

4.5 Plastic Conduit

4.5.1 Where plastic conduits are encased in concrete (such as in duct banks between buildings), the conduits shall be anchored with performed plastic spacers to concrete placement. The conduits and spacers shall be located as shown on design drawings.

4.5.2 Plastic conduit may be cut with a hacksaw. After cutting, ends shall be trimmed and rough edges smoothed. Area to be solvent welded (outside of conduit and inside of coupling or fitting) shall be free from dust, dirt, grease, and moisture. Use methyl ethyl ketone (MEK) for cleaning. Polyvinyl chloride (PVC) solvent shall be brushed liberally on the end of the conduit and inside the fitting or coupling when making a joint. After fitting has been pushed on, it should be twisted one-fourth turn to spread the solvent evenly. Continue to hold joint for 15 seconds so that conduit does not push out of fitting.

4.5.3 Bends for nonmetallic conduit are usually purchased as required for the conduit system. Since PVC conduit can be bent in the field, the need for special factory bends is minimized. For installations requiring large radius bends, the conduits may be bent without applying heat to the minimum radii listed on Table 2 on attachment 5. Shorter radius bends can be made in the field by applying heat. Extreme caution should be observed when any source of heat is near plastic conduit. Field bending can be accomplished by the use of a "hot air-cold air" blower; a hand-type hair dryer is recommended by the manufacturer. The ends of the conduit must be plugged and the heat evenly applied if conduit deformation is to be avoided. Table 4 on attachment 5 lists the minimum dimensional requirements for standard radius elbows and field-made bends with heat application.

4.6 Flexible Conduit

4.6.1 Unless otherwise noted on design drawings, flexible conduit shall be used to interface the rigid conduit system with electric equipment and devices that rotate, vibrate, are subject to thermal movement, or where seismic considerations must be taken into account. It shall also be used for connecting flush and recessed lighting fixtures to rigid conduit systems when so indicated on design drawings. Flexible conduit may be used within a rigid exposed conduit run to:

(a) Avoid interferences,

(b) Cross an expansion-contraction joint where the rigid conduit is attached to the structure on each side of the joint, or

(c) When alternating from a rigid hanger to a flexible or rod hanger.

4.6.2 The electrical continuity of the conduit system shall be preserved. Where the flexible conduit being used is not approved for use as or not capable of functioning as the equipment or device grounding conductor, electrical continuity may be achieved by use of a bonding strap or ground cable. This bonding conductor shall be attached to the rigid conduit system at each end of the section of flexible conduit. For support purposes, cable ties will be adequate to secure the grounding conductor to the flexible conduit.

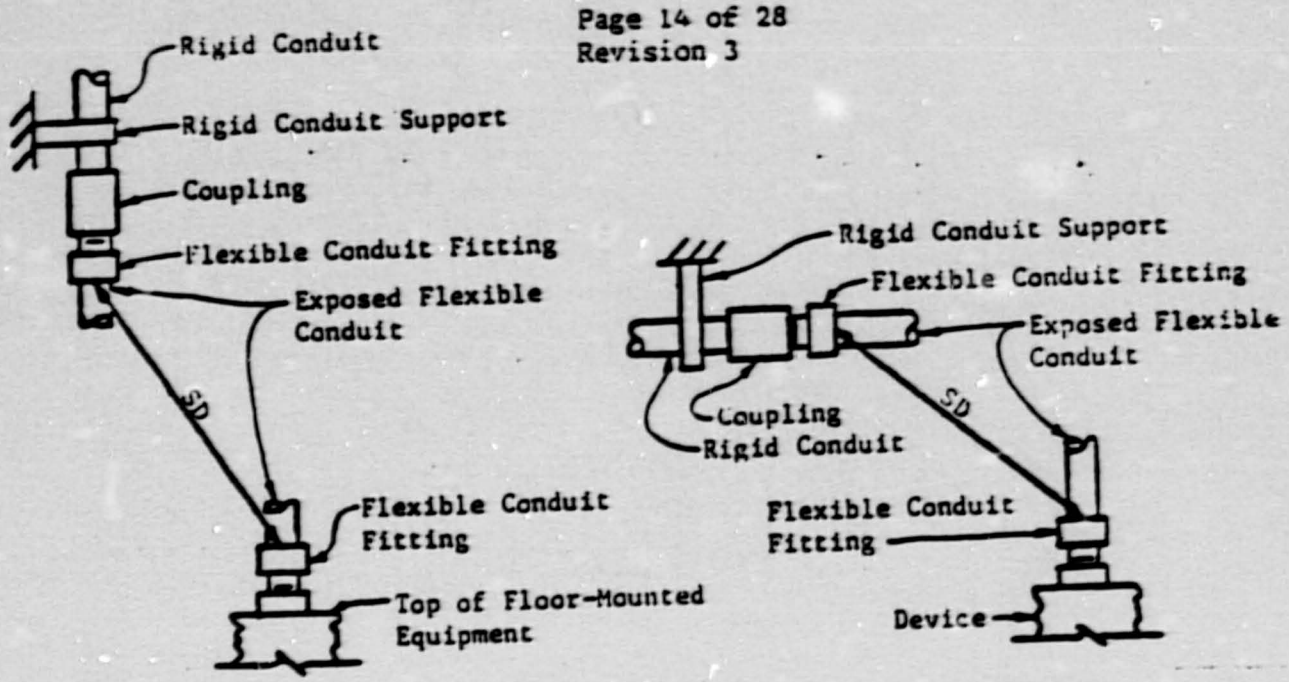
* 4.6.2.1 Flexible metal conduit shall be permitted for grounding if the length does not exceed 6 feet; the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less; and the conduit is terminated in fittings approved for grounding.

* 4.6.2.2 Liquidtight flexible metal conduit shall be permitted for grounding in sizes 1 1/4-inch and smaller if the total length is six feet or less; the conduit is terminated in fittings approved for grounding, and the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less; for 3/8-inch and 1/2-inch sizes and 60 amperes or less 3/4-inch through 1 1/4-inch sizes.

* 4.6.3 Flexible conduit shall be installed between conduit fittings in exposed lengths not exceeding 72 inches, except as noted on design drawings. (For exceptions not noted on design drawings, the cognizant engineer shall contact DNE for resolution.) Rigid conduit shall be located as near the equipment and device as practical as determined by the cognizant engineer or foreman. The flexible conduit shall then be prepared, assembled, and installed in accordance with manufacturer's instructions, including any torquing requirements where applicable. The minimum recommended bend radii given on attachment 6 shall not be violated. Flexible conduit shall be installed without twist and should be oriented away from heat radiating sources, such as hot pipe and its insulation. After installation, the flexible conduit shall not be tight or stretched between flexible conduit fittings.

* 4.6.4 Floor-Mounted Equipment and Devices, Seismic Movement Considerations in Seismic Category I Structures-- During a seismic event, flexible conduit will allow for relative displacement of equipment or devices and a rigid conduit system. To ensure that movement of the rigid conduit system and movement of floor-mounted equipment (such as motors, electrical boards, and panels) are independent during a seismic event, the following installation procedures shall be observed unless otherwise noted on design drawings:

(a) When conduits connect to the top of seismic Category I or Category I(L) floor-mounted equipment, an 18-inch minimum exposed length of flexible conduit shall be installed between the flexible conduit fittings at the rigid conduit coupling and the equipment. The actual minimum conduit length required for a particular installation shall be as specified on design drawings or as calculated by using the equation in Figure 4.6.4-1. This minimum length of flexible conduit will ensure that floor-mounted equipment is capable of sufficient movement in any direction. The minimum bend radii for flexible conduit given on attachment 6 shall not be violated. Where physical limitations prevent the installation of flexible conduits in accordance with the above minimum requirements, the cognizant engineer shall be notified for a resolution with DNE.



Typical Arrangement of Floor-Mounted Equipment or Pipe-Mounted Devices

Figure 4.6.4-1

The equation for calculating the minimum length of exposed flexible conduit required between flexible conduit fittings at rigid conduit couplings and flexible conduit fittings at the floor-mounted equipment or pipe-mounted device is as follows:

FL = SD + K

Where,

FL = Minimum exposed flexible conduit length between flexible conduit fittings. (See Note 1.)

SD = Field measured straight line distance between flexible conduit fittings. (When an obstacle prevents a straight line measurement of SD, the proposed flexible conduit route shall be determined and that distance shall be used for SD.)

K = 1 inch for floor-mounted equipment or 4 inches for pipe-mounted devices (1-inch flexible conduit length is required for maximum seismic movement in any direction at all nuclear plants; 4-inch flexible conduit length is required for maximum combined seismic/thermal movement in any direction at all nuclear plants.)

NOTE 1: For flexible conduit cut length, the field shall add to the minimum calculated length (FL), the flexible conduit length required for conduit fittings and any additional length required for bend radii. The minimum bend radii for flexible conduit given in Table 3.2.6-1 shall not be violated. Any exceptions to minimum calculated lengths (FL) and/or minimum bend radii shall be approved by DNE for Class 1E floor-mounted equipment or pipe-mounted devices.

NOTE 2: Exposed flexible conduit lengths shall not exceed 72 inches or be less than 18 inches, except as noted on design drawings, for Class 1E floor-mounted equipment or pipe-mounted devices. For exceptions not noted on design drawings, contact the DNE engineering project for resolution.

(b) When conduits connect to the bottom of floor-mounted equipment, such as control panels, the minimum length of flexible conduit should be 18 inches but may be less where physical limitations prevent or make it impractical.

(c) When conduits connect to the sides of floor-mounted equipment, such as motors, the flexible conduit shall, as a minimum, be long enough to accommodate its minimum bend radius. (See attachments 6.)

(d) In cases where flexible conduit is used for alignment purposes only and both ends of the flexible conduit are rigidly attached to the same seismic structure, the relative desplacement between ends is zero and therefore exempt from thermal/seismic considerations.

(e) Conduit connections to cable trays should be avoided; however, if conduits are connected to seismic Category 1 cable trays, an 18-inch minimum length of flexible conduit shall be installed as in 4.6.4(a).

4.6.5 Pipe-Mounted Devices, Thermal/Seismic Movement Considerations-- Where electrical connections must be made to devices (such as motor-operated valves, solenoid-operated valves, and temperature switches) which are attached to a mechanical flow system designed for thermal movements, flexible conduit shall be used to compensate for any expansion/contraction and seismic movement. Typically, flexible conduit connected to pipe-mounted electrical devices which are subject to thermal movements are in the 1/2-inch through 1-1/2-inch range. Excessive lengths in smaller flexible conduit sizes shall be avoided to decrease stress and prevent pullout at flexible conduit fittings.

4.6.5.1 Seismic Category I Structures--Flexible conduit to pipe-mounted devices in seismic Category I structures shall be installed to compensate for combined thermal/seismic movements. The minimum length of flexible conduit shall be as specified on design drawings or as calculated using the equation in Figure 4.6.4-1. This minimum length of flexible conduit will ensure that pipe-mounted devices are capable of sufficient movement in any direction. The minimum bend radii for flexible conduit given on attachment 6 shall not be violated.

4.6.5.2 Nonseismic Category I Structures--Flexible conduit to pipe-mounted devices in nonseismic Category I structures shall be installed to compensate for thermal movements only. However, installing conduit per the equation given for seismic Category I structures will provide adequate compensation for nonseismic Category I thermal movements.

4.6.6 In areas outside the primary containment, liquid-tight flexible metal conduit with a synthetic jacket and connectors shall be used for flexible conduit applications, unless otherwise noted on design drawings. Where liquid-tight flexible metal conduit has been damaged during handling or installation, it may be repaired, except as noted below, in the following manner:

(a) Ensure there is no significant damage to the metallic core of the conduit (no sharp edges inside the conduit). If the metallic core has been penetrated, the flexible conduit should be replaced.

(b) Clean the area where the damage has occurred using a clean rag and denatured alcohol or equivalent.

(c) Wrap half-lapped layers of 3M Company Scotch-22 electrical tape or equivalent for a minimum 2-inch distance on each side of the damaged synthetic jacket.

NOTE: Where liquid-tight flexible metal conduit exists inside the primary containment as part of vendor-supplied equipment, it shall not be repaired but replaced with stainless steel flexible conduit.

4.6.7 Stainless steel flexible conduit (Servicair Company SS60, SS63, or SS63C series) shall be used inside primary containment. The flexible conduit shall be cut and processed in accordance with the manufacturer's instruction (see appendix A). Brazing requirements shall be performed using DPM N73M2, Process Specification 1.M.4.1. No inspection of this braze is required.

4.6.8 The flexible conduit and appropriate connector fittings shall be installed in accordance with the manufacturer's instructions; however, no pressure test of the stainless steel flexible conduit is required, unless required as a part of an equipment seal.

TABLE 4.6.8
COMPRESSION NUT TORQUE VALUES FOR POSITIVE RETENTION

CONDUIT/COUPLING SIZE (DASH NO.)	TORQUE REQ'MT LB/FT	TOLERANCE LB/FT
1/2" (04)	4	+2 -0
3/4", 1" (06, 08)	6	+2 -0
1-1/2", 2" (12, 16)	12	+4 -0
3" (24)	25	+5 -0
4" (32)	35	+8 -0
5" (40)	45	+10 -0

4.6.9 Pressure-tight stainless steel flexible conduit (Servicair Company SS63C extra flexible stainless steel), as defined on the design drawings and as approved for use by DNE, shall be used for installations where an equipment seal is required. Install the stainless steel flexible conduit and appropriate connector fittings according to manufacturer's instructions, including pressure test where required.

4.7 Conduit Identification

4.7.1 Conduit identification tagging shall accompany the conduit installation. The tag shall be as designated on the conduit design drawings and/or conduit schedule and in accordance with attachment 7, sheets 1, 2, and 3. Conduits shall be tagged with T&B Corp Ty-Rap self-locking, or self-sticking Mylar conduit markers (e.g., AMP Special Industries or LEM Products, Inc) or self-adhesive polyester conduit markers (e.g., W. H. Brady Company) or Raychem, NTMS-CME modified pololefin installed with Tefzel Ty-Raps or stainless steel, bronze, or brass wire. The tags are to be located at conspicuous intervals (e.g., at entrance and exit points of large rooms; at each pull or junction box; and at each end of the conduit).

4.7.2 In yard areas where conduits are exposed to the natural environment, the conduit tag may be of 1/2-inch minimum width stainless steel or aluminum ribbon material with the designation made using a Dymo tapewriter (or equivalent).

4.7.3 Exposed conduit containing Class IE wiring shall have its di ision of separation identified (by marking, tagging, or taping) with the respective background color code at intervals not to exceed 15 feet. The use of Krylon spray paint, Thomas and Betts Company Ty-Rap, self-sticking Mylar conduit markers, self-adhesive Polyester conduit markers, 3M Scotch 35 tape or equivalent, are suitable means for intermediate color code identification of conduits. Tape shall not be used inside the primary containment.

* 4.8 Conduit Separation

* 4.8.1 Except in the proximity of terminal equipment, a minimum of 1-inch (surface to surface) separation shall be maintained between exposed and embedded wireways for redundant safety-related cables (conduit to conduit and conduit to cable tray). When conduits cross cable trays for redundant cables and are as close as 1 inch (surface-to-surface) to the trays, the tray shall have solid tray covers or bottoms on the tray side adjacent to the conduit. The tray covers or bottoms shall extend a minimum of 3 feet or to the nearest wall, floor, or ceiling on each side of the centerline of the conduit. Likewise, when conduits run parallel with cable trays, the tray enclosure shall extend a minimum of 3 feet beyond each end of the influenced portion of the conduit or until the cable tray terminates at equipment or penetrates a wall or floor.

* 4.8.2 If the above separation requirements are not attainable, a barrier consisting of a 1/2-inch minimum thickness of maranite-36 (or its equivalent) may be used between the raceways provided the trays are enclosed as specified above. The barriers shall be of sufficient length and width to achieve the minimum 1-inch (surface to surface) separation specified above.

4.9 Conduit Boxes

4.9.1 General Installation Requirements

4.9.1.1 Where large boxes are embedded, they shall be properly braced on the inside so that concrete placement will not deflect them. Threaded holes in box frames shall be protected from injury.

4.9.1.2 Outlet boxes in architectural tile or masonry unit walls shall be installed strictly in accordance with design drawings and for best appearance.

* 4.9.1.3 When boxes do not have threaded hubs or bosses, conduits shall be securely fastened to boxes and cabinets, each with a locknut and a bushing inside the box and a locknut outside. (See attachment 9 for locknut spacing requirements.) The conduits shall be of such length that when the bushings are screwed tight against the ends of the conduits, no appreciable space will be left between the bushings and the locknuts. To avoid hotspots or sparking during fault conditions, locknuts shall be firmly tightened against the box. Care shall be taken to prevent deforming the box. As an alternative, a coupling may be used on the end of the conduit system and a chase nipple inside the enclosure (box or cabinet) to connect the enclosure and conduit together. To ensure that the enclosure and conduit are electrically continuous, the T&B grounding wedge having the UL label shall be used. Unless otherwise specified by the manufacturer, the wedge may be installed inside or outside (preferred) the enclosure. When conduit boxes are grounded using a stud grounding lug or other type bolted connection, all nonconductive coatings (such as paint) shall be removed from the threads and other contact surfaces to ensure good electrical continuity. Contact surfaces should be coated with Kopr-Shield to prevent corrosion.

* 4.9.1.4 Where water-tight conduit connections to junction boxes without threaded hubs or bosses are required (see attachment 8), Appleton type HUB conduit hubs, or equivalent, may be used in place of welded hubs.

4.9.1.5 Exposed non-current-carrying metal parts of fixed equipment and boxes shall be grounded. Equipment not secured to and in metallic contact with grounded structural steel shall be connected to the grounding system when indicated on the detailed design drawings by brazing the grounding cable to the equipment and then carefully coating the joint with asphaltum or equivalent.

4.9.1.6 Field-fabricated conduit boxes shall be made in accordance with electrical standard drawing SD-E 13.6.3-series, latest revision.

4.9.1.7 Any unused openings in conduit boxes shall be closed to return the boxes to their original integrity and NEMA rating. Metal plates or plugs similar to Hoffman Hol-Tight oil tight hole seals or as defined on attachment 10 may be used for this purpose. Use RTV silicone rubber (Dow Corning 738) around bolt and screw heads penetrating NEMA 4 and NEMA 12 conduit boxes.

* 4.9.2 Painting

* 4.9.2.1 Field-fabricated surface-mounted boxes shall be painted inside and outside immediately after fabrication. Field-fabricated flush-mounted boxes shall be painted on the inside and the exposed parts only. Primer paints shall be lead free. Zinc chromate primer (see Const Spec G-14, Part I-310) is recommended for black sheet steel. Finish coats for exposed parts shall harmonize with the general painting scheme about the plant as defined on design drawings. Field fabricated surface-mounted boxes used in areas requiring a special protective coating (see drawing 46W466-series) shall be coated in accordance with MI-270.10.

4.9.3 Seismic Mounting

4.9.3.1 Surface-mounted conduit boxes located in seismic Category I structures shall be seismically mounted. Where the mounting surface is poured concrete, boxes shall be attached to embedded steel plates or mounted to the concrete with bolt anchors as shown on equipment seismic suppport design drawings. Seismic mounting of flush or surface boxes to masonry walls shall be in accordance with specific design details.

4.9.4 Identification

4.9.4.1 Junction boxes and/or pull boxes which are assigned junction box numbers and nameplate numbers on design drawings shall be identified by attaching the respective nameplate to its box with self-tapping sheet metal screws. It shall be permissible to use 3M Scotch pressure-sensitive foam tapes for attaching nameplates.

* 4.9.4.2 Junction boxes and/or pull boxes which have assigned box, but no assigned nameplate numbers on design drawings, shall be marked with the applicable color scheme of the division of separation (see attachment 7). The size lettering shall be determined in the field depending on the box size. The use of self-sticking mylar markers (e.g., AMP Special Industries or LEM Products, Incorporated), self-adhesive polyester markers (e.g., W. H. Brady Company), or equivalent, is a suitable means for box identification markings.

4.10 Supports

4.10.1 In seismic Category I structures, exposed conduits, junction boxes and lighting fixtures shall be supported using the typical supports in the latest revision of 47A056-series, "Mechanical Category I and IL Conduit Supports," 47A057-series, "Mechanical Seismic Supports for Lighting Fixtures," and the general notes from the 47A050-series. Attachment of typical supports to engineer supports

(B-P, EDS, or TVA) will require both an FCR and a variance unless specified on DNE-approved drawings. Attachment of typical supports to structural steel/cable tray support will require an DNE approved variance.

4.10.2 In Non-Category I structures, galvanized steel members may be drilled or punched for conduit supporting bolts provided the holes are immediately coated with zinc-dust zinc-oxide paint (Federal Specification TT-P-641d) and galvanized or rust-resisting bolts are used. Threaded stud bolts, Nelson stud anchors, or equivalent, may be used instead of drilling or punching steel members.

4.10.3 Malleable iron 1-hole pipe straps, clamps, U-bolts, hangers, or close bracket-type pipe supports may be used. Pipe back-spacers should be used for the 1-hole malleable iron pipe supports where it is desired to hold a conduit run away from the surface to eliminate offsetting the conduit at the fittings.

4.10.4 Changes to typical supports shall be requested as a variance (attachment 11). It shall be initiated by the cognizant engineer to provide a one-time only deviation from a typical support drawing. The variance shall be used to alter an existing typical support drawing and shall be applicable to one specific support at a specific location. The variance should be detailed completely to allow DNE to properly evaluate the change. Details should include weld symbols, material and corresponding size, the hanger number (if existing), variance number(s) (if existing), number of conduits and size, insulated or uninsulated, etc. For information that remains the same on the typical, the following words should be written in "All items not shown are per typical."

4.10.4.1 Each typical support drawing shall have its own support variance log sheet. The support variance log for electrical supports shall be maintained by the Electrical Modifications Group.

4.10.4.2 When the variance sheet (attachment 11) has been properly completed, a variance number, supplied by the coordinator in the Electrical Modifications Group, shall be assigned and entered in the support variance log.

4.10.4.3 The variance number shall be assigned according to the typical support drawing involved. For example, if the variance involves typical support drawing 47A056-3, the first variance shall be number 56-3-N1, the second shall be 56-3-N2, etc. A variance ID tag shall be attached to the hanger in addition to the support ID (e.g., "Var-56-3-N1"). See section 4.10.8 for the methods of attachment.

NOTE: The "N" prefix indicates that the variance was initiated by the Nuclear Power Division.

4.10.4.4 The cognizant engineer shall submit the original variance and any other documentation needed to describe the changes to the DNE hanger group for resolution. If accepted, the variance is returned to the originating section. If the variance is rejected, DNE will provide an approved design.

4.10.4.5 The variance shall be incorporated into the workplan or MR and a copy of the variance will be maintained by the coordinator.

4.10.4.6 The fabrication of varianced hangers may be completed and the hanger installed in its particular location using a copy of the variance, but final visual inspection shall not be obtained until the approved variance or DNE-approved design is returned and included in the workplan/MR.

4.10.5 Weld maps are not required. Each weld will need to be evaluated by the cognizant engineer before assigning a particular detail weld procedure. When determining the weld procedure, considerations as to the procedure that the welders are qualified to perform should be researched before assigning the procedure. Welders may need to be trained or examined on a particular weld if not previously qualified or if their qualifications has lapsed. The welder shall be qualified to the particular weld procedure before issuance of welding rods. From past experience, detail weld procedures SM-P-1, SM-L-1, or SM-U-1 are acceptable for carbon steel to carbon steel welds. Where the weld symbol for a specific weld is not applicable to the actual configuration, the appropriate type of weld of the same size may be substituted. The cognizant engineer shall add the correct weld symbol to the typical drawing and initial and date the change. A flare bevel weld may replace a fillet weld when required along the curved edge of the tube steel.

NOTE: Where Construction Spec G-29 is specified on the drawings, ONP Program Procedure 1403 should be used, since it implements the NQAM, Part II, Section 6.1, and meets the requirements of G-29 in all areas except nondestructive examinations (NDE). NDE procedures are covered in ONP Program Procedure 1502.07. All welds will require a visual examination in accordance with N-VT-2 (see appendix B). The inspections shall be documented on data sheet 5.

4.10.6 The maximum gap between completed support baseplates and the concrete surface shall be 1/8-inch for supports with 1/2-inch and smaller anchors and 3/16-inch for larger anchors. Wider gaps shall be shimmed or grouted in accordance with MAI-17. If shims are used, they shall be steel and shall be tack welded to the plate or otherwise permanently secured, such as flat steel washers around the anchor bolt.

4.10.7 The following guidelines apply to the location of supports attached to embedded plates.

4.10.7.1 The minimum clear distance between an attachment and the long edge of a rectangular plate or the edge of a square plate shall be 2 inches unless an DNE-approved drawing indicates otherwise. The minimum clear distance between an attachment and the short edge of a rectangular plate shall be 6 inches. For a specific plate, the minimum clear distance may be reduced to the distance from the plate edge to the centerline of the row of studs parallel to the edge (see figure 4.10.7).

4.10.7.2 The spacing between attachments to embedded plates shall be determined by two measurements. Each measurement shall be taken parallel to a plate edge as shown in figure 4.10.7. The minimum clear distance in at least one direction parallel to a plate edge shall be 24 inches. For a specific plate, the minimum clear distance may be reduced to two times the spacing of the stud rows which are perpendicular to the direction of measurement (see figure 4.10.7). These are the minimum spacings allowed unless an DNE-approved drawing indicates otherwise.

4.10.7.3 The minimum spacing between expansion anchors and attachments to embedded shall be in accordance with MAI-1. Attachment location tolerances shall not be used to reduce the minimum edge distances or spacing.

4.10.7.4 If conformance to the requirements of section 4.10.7.1, 4.10.7.2, or 4.10.7.3 is impractical, an embedded plate field change request (EP-FCR) shall be submitted to DNE in accordance with AI-8.5 or AI-8.8.

4.10.8 Each support shall be uniquely identified by one of the following methods:

(1) the number being stenciled on the hanger, or
(2) on a steel tag (stamped or stenciled) fastened to the support using stainless steel aircraft cable or stainless steel wire, or
(3) on a steel tag tack welded to the support. Tack welds need only be workmanlike and do not require visual inspection nor documentation.

The unique ID will be assigned by the coordinator in the Electrical Modifications Group using the Electrical Support Log Book on attachment. This unique ID number shall be developed in accordance with the following system:

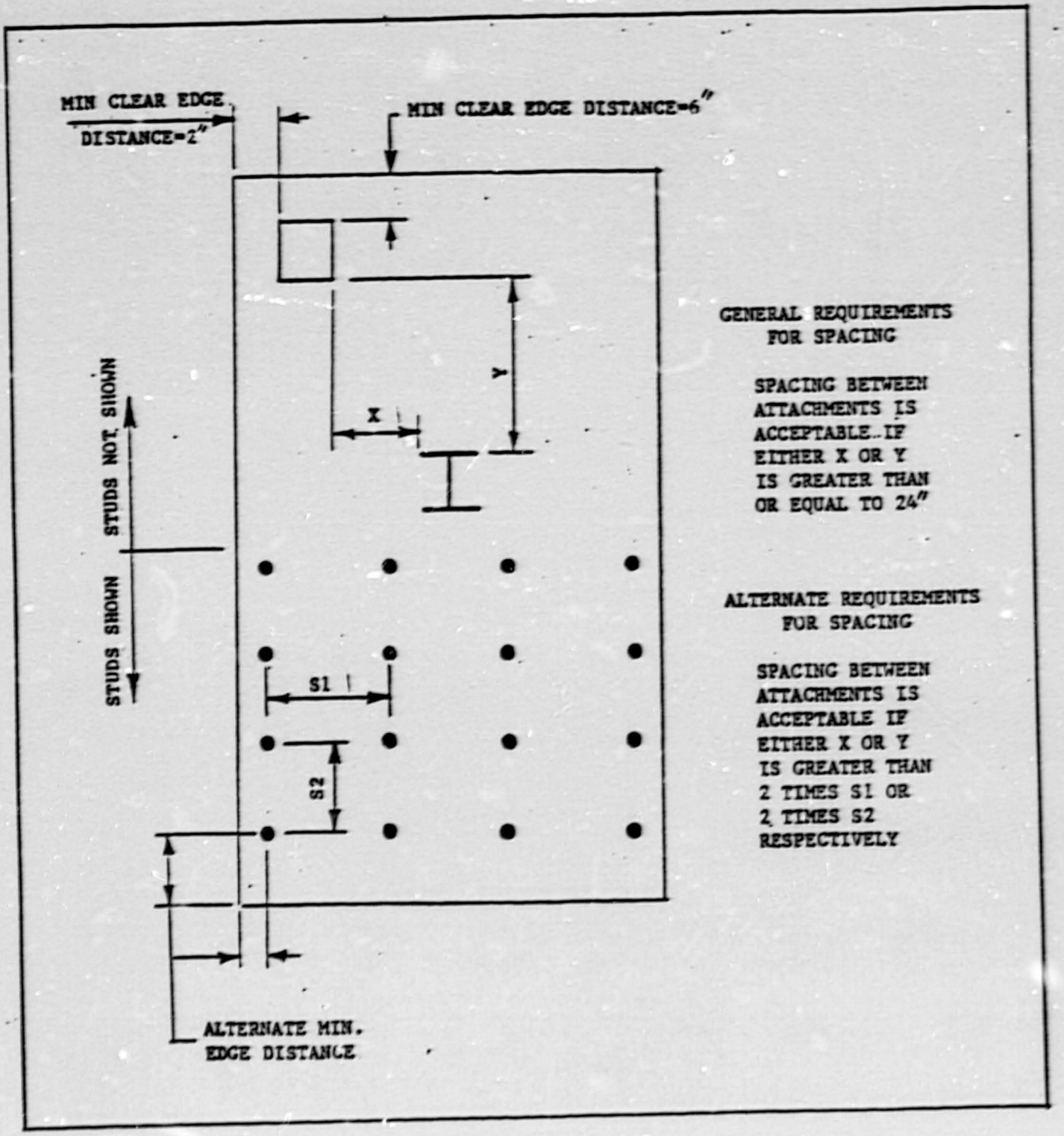
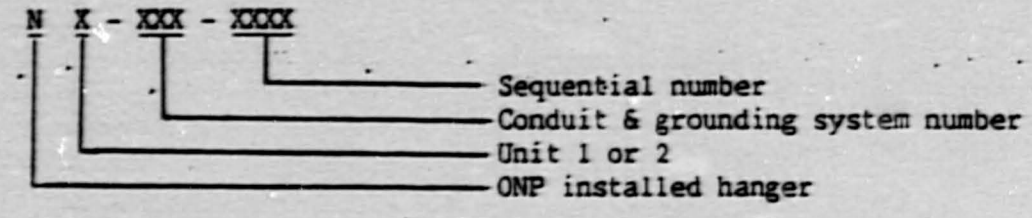

MIN CLEAR EDGE DISTANCE=2"
MIN CLEAR EDGE DISTANCE=6"
STUDS NOT SHOWN
STUDS SHOWN
X
Y
S1
S2
ALTERNATE MIN. EDGE DISTANCE
GENERAL REQUIREMENTS FOR SPACING
SPACING BETWEEN ATTACHMENTS IS ACCEPTABLE IF EITHER X OR Y IS GREATER THAN OR EQUAL TO 24"
ALTERNATE REQUIREMENTS FOR SPACING
SPACING BETWEEN ATTACHMENTS IS ACCEPTABLE IF EITHER X OR Y IS GREATER THAN 2 TIMES S1 OR 2 TIMES S2 RESPECTIVELY

Figure 4.10.7



4.10.8.1 The following types of supports will not be required to be identified; however, they may be assigned a unique identifier as necessary (e.g., a variance to a typical hanger will require that the hanger is uniquely identified.)

(1) One-hole pipe straps for individual conduits less than four inches in diameter as shown on 47A056-2.

(2) Supports for four or less nondivisional conduits one inch and smaller in diameter in Category I and I-L structures when I-L type supports are used.

5.0 INSTALLATION INSTRUCTIONS

5.1 The cognizant engineer will initiate data sheet 1 or data sheet 2, completing the information required for the top half of the data sheets.

* 5.2 Using the design drawings listed on the data sheets, the craftsman shall install the conduits/boxes in accordance with the general criteria outlined in section 4.0 of this instruction. Exposed conduits should be run in straight lines parallel to column lines, walls, or beams. Where conduits are grouped, the bends and fittings shall be installed to present an orderly appearance. Unnecessary bending or crossing shall be avoided. All threaded connections shall be at least wrench tight. A QC inspector shall verify all torqued connections. Detailed step-by-step instructions for the installation will not be required due to the fact that this type of work is within the technical competence of the journeyman electrician performing this work.

* 5.3 When embedded conduit sleeves are installed through fire barrier walls or floors (as defined on 47W240 series drawings), a chipping/drilling permit in accordance with AI-9.8 and a breaching permit in accordance with PHYSI-2 are required before installing the sleeve. Sleeves being installed through security barriers (as defined on 46W501 series drawings) require in addition a breaching permit in accordance with WB10.6. After the sleeve is installed the PHYSI-2 breaching permit must remain enforce or the sleeve must be sealed in accordance with MAI-14.

* 5.4 The craftsman shall install all electrical supports in accordance with section 4.10. He will contact the cognizant engineer to obtain support ID's and to initiate the appropriate data sheets. New supports shall be documented using data sheet 4. Existing supports shall be evaluated by the engineer before having additional conduits installed and document this evaluation on data sheet 6. When supports are removed and not reinstalled, data sheet 7 shall be initiated.

* 5.5 When supports are needed that require welding, the craftsman shall contact the cognizant engineer to initiate data sheet 5 for the welding inspections. He will attach a copy of the latest as-designed revision of the typical support drawing (47A056 or 47A057 series) to the data sheet. For inspection purposes only, he shall number each weld on the typical drawing/variance. These inspection numbers will not be required to be stenciled on the support. QC inspectors shall inspect the welds using appendix B.

5.6 The craftsman shall fill in the installed length on data sheet 1 and notify QC inspector for required inspection of conduit system installations. Partial conduit installations may be inspected by specifying in the comments section of the data sheet the boundaries to which the inspection was performed.

* 5.7 For special modifications or maintenance practices, it may be necessary to remove the flexible conduit connection at a device or other equipment. In cases where there is no material changed, the disconnection and reconnection may be documented using the 2-party signoff on data sheet 3. Removal of stainless steel flexible conduits is required to be torqued and breaching of moisture seals requires resealing. Therefore, the second party for CSSC stainless steel flexible conduit and applicable flex conduit for moisture seals shall be a QC inspector.

6.0 INSPECTION AND ACCEPTANCE CRITERIA

6.1 Size, Type, and Location--The QC inspector shall verify that the size, type, and location of conduits/boxes conform to the design drawings and general criteria of this instruction.

6.2 Cleanliness (Conduit Boxes Only)--The QC inspector shall inspect the inside of conduit boxes for debris, dirt, and moisture. Verify that the interior surface of the box is painted or galvanized and free of rust.

* 6.3 Separation (Conduits Only)--The QC inspector shall verify that the requirements of conduit separation in accordance with section 4.8 have been met.

* 6.4 Identification--The QC inspector shall verify that the conduits are identified in accordance with section 4.7. He shall verify that the junction boxes are identified in accordance with section 4.9.4. He shall verify that supports are identified in accordance with section 4.10.4.3 and 4.10.8.

* 6.5 Support--The QC inspector shall verify that the conduit support spacing requirements for CSSC and non-CSSC conduits as specified on the latest design support drawings in Category I structures have been met. All uniquely identified conduit supports shall be documented on data sheet 4 and meet the bolting requirements on MAI-9.

6.5.1 For one-hole strap supports, the inspector shall verify the correct type and size straps are installed and the spacing requirements of MAI-1 for anchor bolts are acceptable.

6.6 Grounding--The QC inspector shall verify that the conduits are connected to ground by one of the following methods:

a. Securing to building steel or embedded plate.
b. Securing to a grounded conduit support,
c. Securing to a grounded junction box, or
d. Use of U-bolt grounding clamps, grounding straps or grounding bushing secured to a ground conductor.

Conduit boxes shall be grounded at least once by one of the following:

a. Securing to a building steel or embedded plates.
b. Securing to a grounded conduit. (If a conduit is used to ground a conduit box, the box shall not be used as a ground for any of the other conduits terminating in it.)
c. Using a Kearney stud connector or compression lug and bolting an external ground to the box.

NOTE: Cable tray grounds may be used as a grounding connection when no other means are available.

* 6.7 Flexible Conduit Installation--The QC inspector shall verify that the flexible conduits are installed in accordance with section 4.6 and design drawings. For stainless steel flexible conduits, the inspector shall verify the torque specified on table 4.6.8.

* 6.8 Welder Qualifications--QC inspector shall verify that the welder is qualified to the detailed weld procedure specified on the data sheet. This signoff shall be completed before the start of any welding. Additional welders must have qualification verified before performing any welding.

* 6.9 Support Welds--The QC inspector shall inspect each support to determine that the size, length, and location of all welds conform to the requirements of the typical support drawings. He shall verify that no specified welds are omitted and that no unspecified welds are added. The inspection of all welds shall be made using N-VT-2 (see appendix B) and documented on data sheet 5.

6.10 * Anchor Bolts--The support anchor bolts shall be inspected to the requirements of MAI-9.

* 6.11 Bolted Connections--All bolted connections except anchor bolts shall be inspected to the requirements of MAI-9.

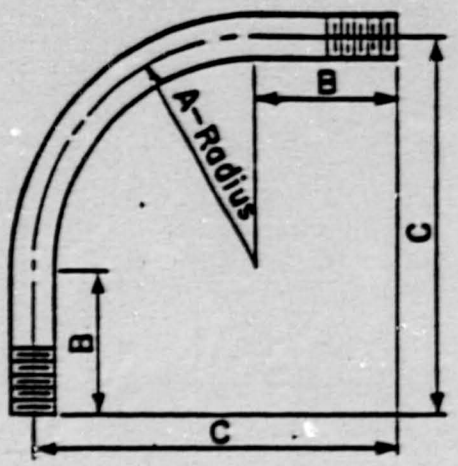
6.12 Configuration--The QC inspector shall verify that the support is built to the configuration of the typical support drawing specified on the data sheet and variance as applicable.

6.13 Gap Inspection--Supports shall be inspected for excessive gaps between the support baseplate and the concrete surface. If any gap is wide enough to permit the metal inspection strip to be pushed under the plate until it touches the anchor (adjacent to the edge or corner of the plate) from two directions approximately 90 degrees apart, the gap is unacceptable. The actual thickness of the metal strip used for checking gaps shall be between 90 and 100 percent of the maximum allowable gap. The maximum gap shall be 1/8 inch for attachments with 1/2 inch and smaller anchors and 3/16 inch for larger anchors. The width of the strip shall be 1/2 inch.

* 6.14 Embedded Plate--The QC inspector shall verify that an attachment to an embedded plate meets the requirements of section 4.10.7.

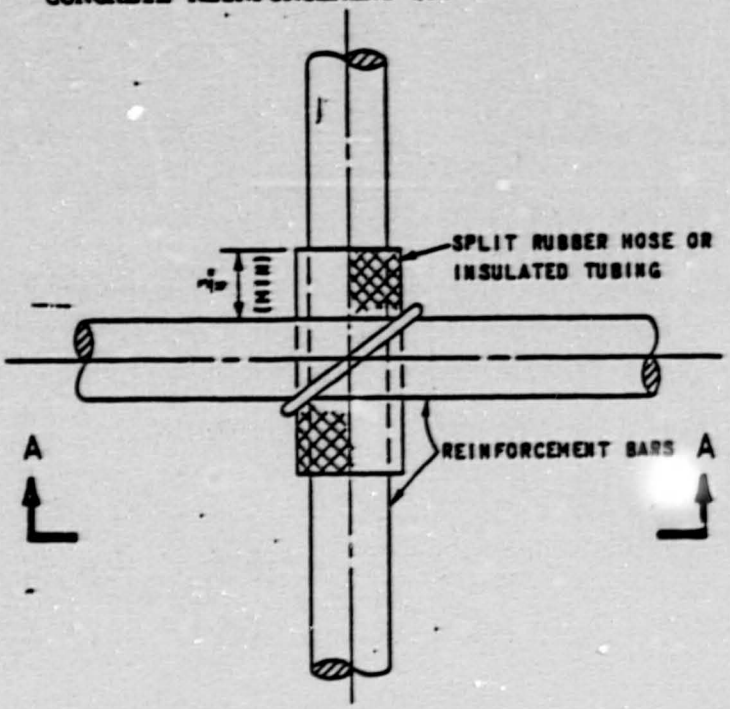
6.15 Moisture Sealing--The QC inspector shall verify that the moisture seals as defined by reference notes on the applicable design conduit and grounding drawings is intact.

RIGID AND INTERMEDIATE METAL CONDUIT
MINIMUM CONDUIT BENDS

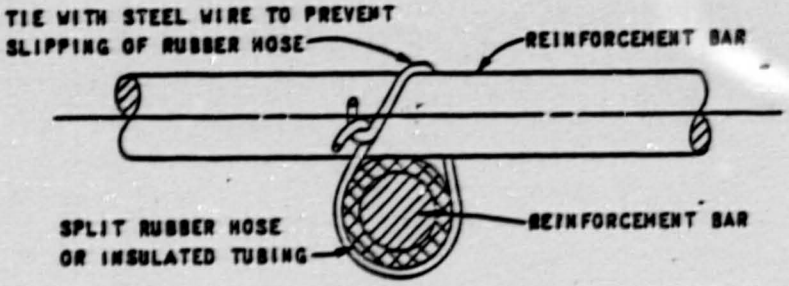


Conduit Trade Size (Inches)	Dimension (minimum) - Inches		
	A	B	C
1/2	4.0	1.50	5.50
3/4	4.50	1.50	6.0
1	5.75	1.88	7.63
1-1/4	7.25	2.0	9.25
1-1/2	8.25	2.0	10.25
2	9.50	2.0	11.50
2-1/2	10.50	3.0	13.50
3	13.0	3.13	16.13
3-1/2	15.0	3.25	18.25
4	16.0	3.38	19.38
5	24.0	3.63	27.63
6	30.0	3.75	33.75

CONCRETE REINFORCEMENT BAR INSULATION



PLAN



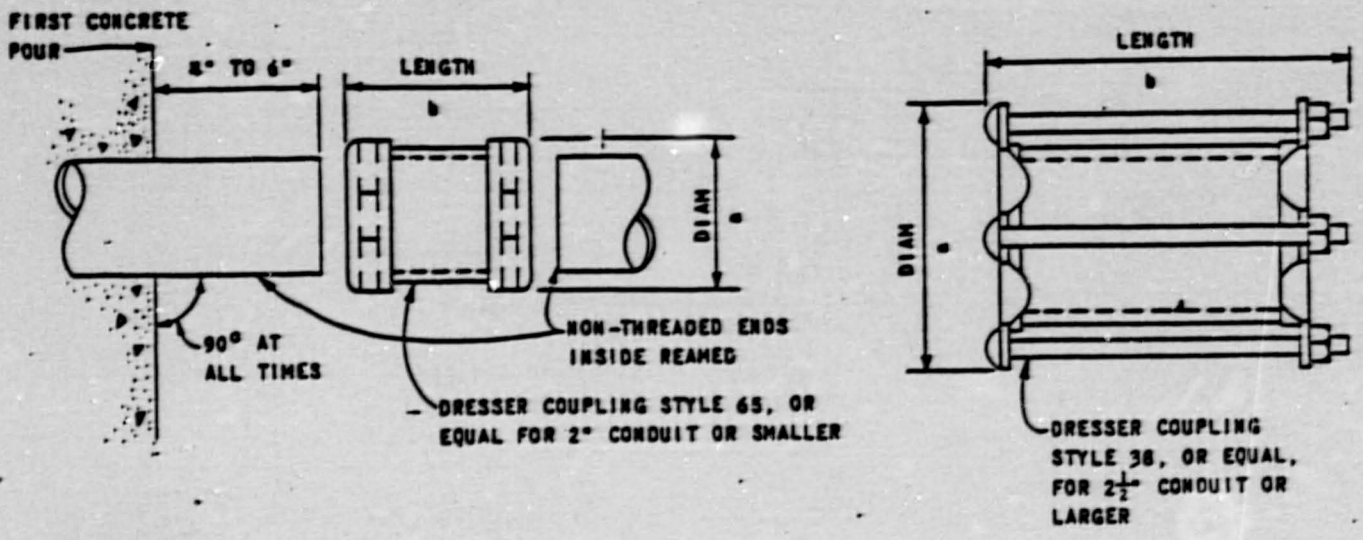
SECTION A-A

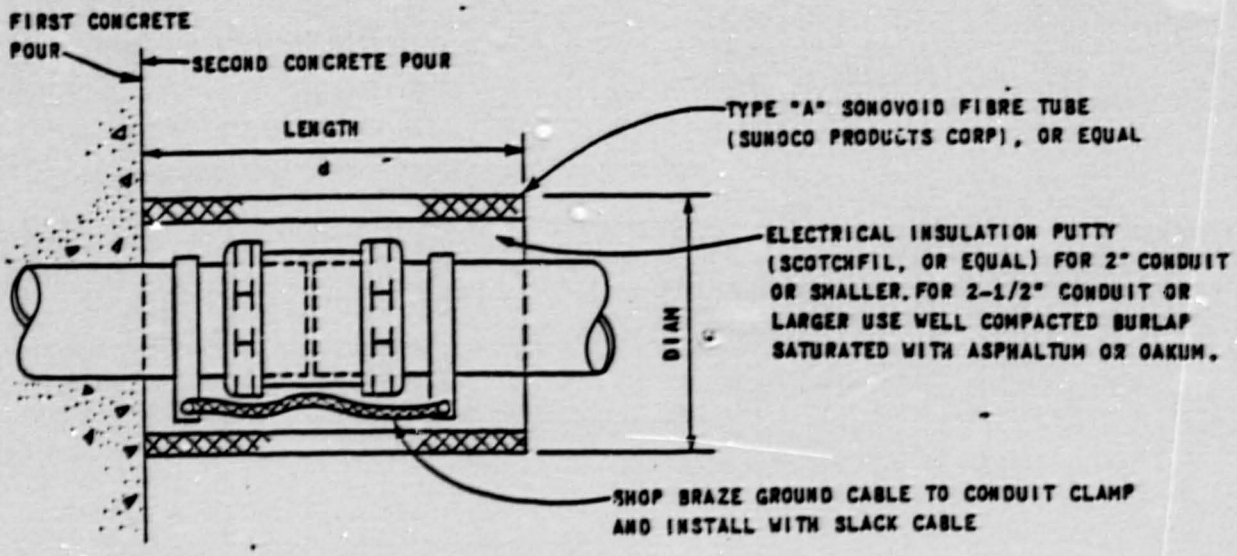
NOTES:

1. To be used near high current ac buses where indicated on electrical design drawings and in duct banks which contain plastic conduit.

2. Reinforcing bar insulation around power cables in conduit banks shall be required when a reinforcing bar passes through a zone formed by a cylinder about the centerline of the cable. The radius of the cylinder shall be determined by the equation $r_1 = r_2 + \frac{I}{500 \text{ Amps/Inch}}$ where r_1 = radius of the cylinder in inches, r_2 = radius of the conduit in inches, I = current carried by the cable in amperes.

EXPANSION/CONTRACTION JOINT FOR CONDUIT





DRESSER COUPLING					SONOVOID	
SIZE	STYLE	a	b	CODE NO.	c	d
1"	65	$2\frac{3}{16}$"	$2\frac{15}{16}$"	0004	6"	7"
$1\frac{1}{2}$"	65	$2\frac{5}{16}$"	$3\frac{9}{16}$"	0006		
2"	65	$3\frac{9}{32}$"	$3\frac{7}{8}$"	0007		
$2\frac{1}{2}$"	38	7"	10"	0022	11"	13"
3"	38	$7\frac{3}{8}$"	10"	0026		
4"	38	$8\frac{3}{4}$"	10"	0036		
5"	38	$9\frac{3}{8}$"	$10\frac{1}{8}$"	0051	$12\frac{1}{2}$"	13"
6"	38	$10\frac{1}{2}$"	$10\frac{1}{8}$"	0057		

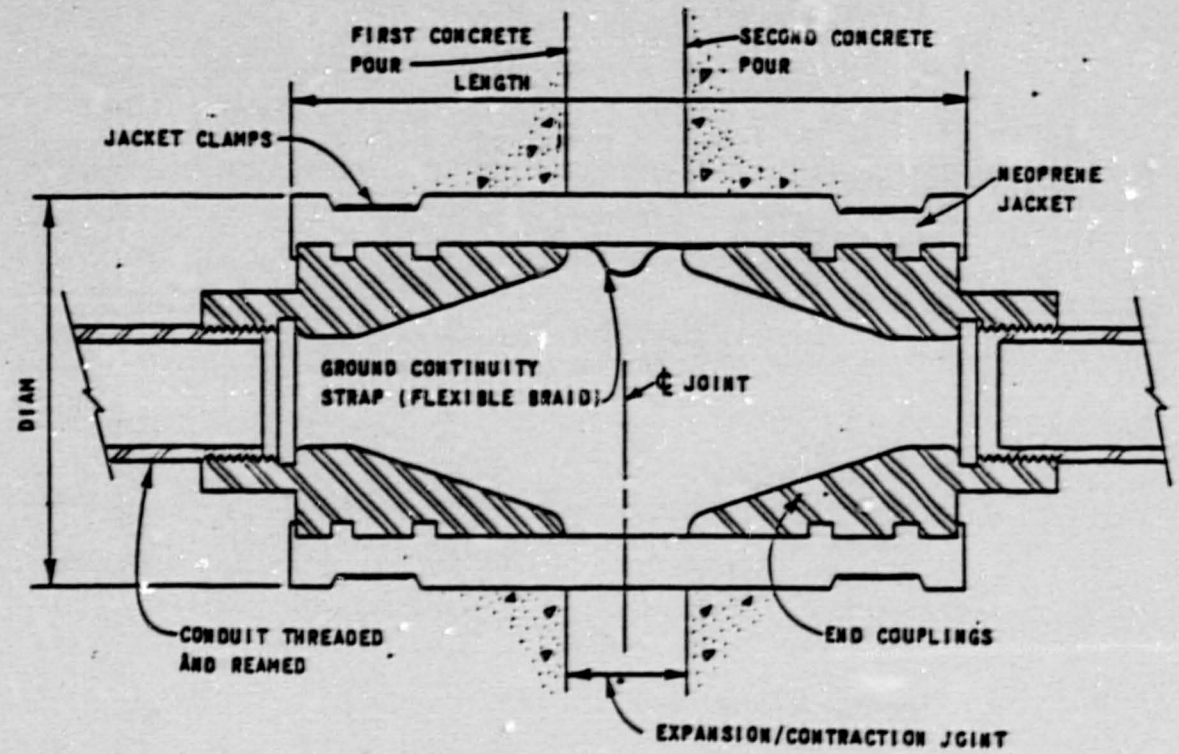
NOTES:

1. WORK INSULATING PUTTY, OAKUM OR BURLAP SATURATED WITH ASPHALTUM AROUND ALL PARTS OF COUPLING BOLTS AND GROUND STRAPS AND JUMPER TO FORM A COVERING AT LEAST $\frac{1}{8}$" THICK OVER ALL PROJECTIONS.

   PLACE "SONOVOID TUBE" OVER COMPLETED JOINT AND FILL ALL VOIDS WITH OAKUM AND TAMP.

2. THIS METHOD MAY BE USED FOR CROSSING EXPANSION/CONTRACTION JOINTS PROVIDED THE SHEAR DOES NOT EXCEED $\frac{1}{8}$ INCH.

EXPANSION AND DEFLECTION CONDUIT FITTING



CONDUIT SIZE	CROUSE-HINDS		C-Z CO.	
	DIAM	LNGTH	DIAM	LNGTH
1"	$3\frac{15}{16}$"	7"	$2\frac{3}{4}$"	7"
$1\frac{1}{2}$"	$4\frac{1}{2}$"	$7\frac{1}{4}$"	$3\frac{3}{8}$"	$7\frac{1}{4}$"
2"	$4\frac{15}{16}$"	$7\frac{1}{4}$"	$3\frac{7}{8}$"	$8\frac{1}{8}$"
$2\frac{1}{2}$"	$5\frac{5}{16}$"	$7\frac{1}{2}$"	$4\frac{5}{16}$"	$8\frac{1}{2}$"
3"	$5\frac{15}{16}$"	$7\frac{5}{8}$"	$4\frac{5}{16}$"	$8\frac{1}{2}$"
4"	$6\frac{15}{16}$"	$7\frac{7}{8}$"	$6\frac{3}{16}$"	$9\frac{1}{4}$"
5"	8"	$7\frac{3}{4}$"	$7\frac{1}{4}$"	$9\frac{3}{8}$"
6"	9"	$8\frac{3}{8}$"	$8\frac{1}{4}$"	$9\frac{3}{8}$"

NOTES:

1. THESE FITTINGS WILL PROVIDE FOR A MOVEMENT OF $\frac{1}{4}$" FROM THE NORMAL IN ALL DIRECTIONS.
2. CARE MUST BE TAKEN TO PROVIDE PROTECTION FOR THE FITTING UNTIL AFTER THE SECOND POUR TO AVOID DAMAGING THE FITTING.
3. MANUFACTURER'S NAMES ARE SHOWN FOR REFERENCE ONLY; SIMILAR MATERIALS THAT ARE ENGINEER APPROVED EQUAL MAY BE USED.

PVC CONDUIT

PVC CONDUIT DATA					
CONDUIT SIZE-INCHES	OUTSIDE DIAMETER INCHES	WALL THICKNESS INCHES		APPROXIMATE WEIGHT-LBS PER 100 FEET[1]	
		TYPE 40	TYPE EB	TYPE 40	TYPE EB
3/4	1.050	.113	.060	22	12
1	1.315	.133	.060	33	16
1-1/4	1.660	.140	.060	44	20
1-1/2	1.900	.148	.060	53	25
2	2.375	.154	.060	69	33
2-1/2	2.875	.203	.070	109	48
3	3.500	.216	.075	143	61
3-1/2	4.000	.226	.080	172	83
4	4.500	.237	.095	204	99
5	5.563	.258	.100	276	142
6	6.625	.280	.125	358	199

TABLE 1

1. STANDARD CONDUIT LENGTHS AVAILABLE ARE 10 FEET AND 20 FEET WITH ONE BELLED END PER LENGTH.

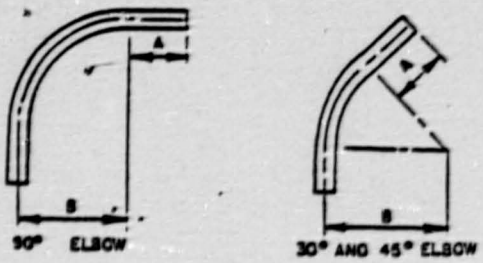


FIGURE 1.

STANDARD MANUFACTURER'S PVC CONDUIT ELBOWS, SEE TABLE 4.

FIELD COLD BENT PVC CONDUIT	
PVC TYPE EB CONDUIT SIZE, INCHES[1]	MINIMUM RECOMMENDED COLD BENT RADIUS-FEET[2]
2	15
3	17
4	20
5	29
6	40

TABLE 2

1. PVC TYPE 40 CONDUIT HAS A MUCH LARGER BENDING RADIUS, USUALLY REQUIRING HEAT APPLICATION.
2. FIGURES ARE APPLICABLE FOR TEMPERATURES HIGHER THAN 50° F.

CEMENT FOR SOLVENT WELD JOINTS	
PVC CONDUIT SIZE-INCHES	ESTIMATED NUMBER OF JOINTS PER QUART
2	90
3	70
4	50
5	25
6	10

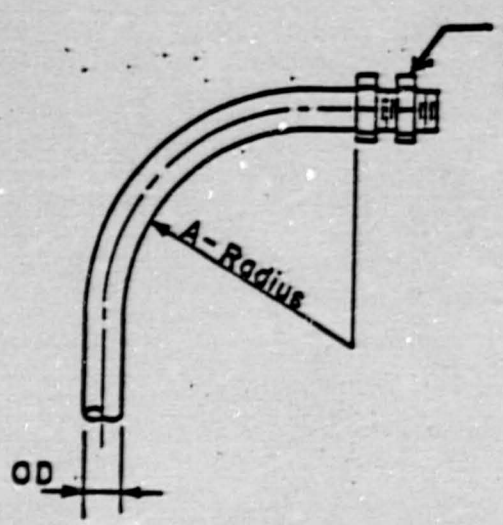
TABLE 3

STANDARD RADIUS ELBOW DIMENSIONS[1]		
PVC CONDUIT SIZE-INCHES	MINIMUM DIMENSIONS-INCHES[2]	
	A	B
3/4	1-1/2	4-1/2
1	1-7/8	5-3/4
1-1/2	2	8-1/4
2	2	9-1/2
3	3-1/8	13
4	3-3/8	16
5	3-5/8	24
6	3-3/4	30

TABLE 4

1. THESE MINIMUM DIMENSIONS ALSO APPLY TO FIELD-MADE BENDS WITH HEAT APPLICATION
2. SEE FIGURE 1.

*

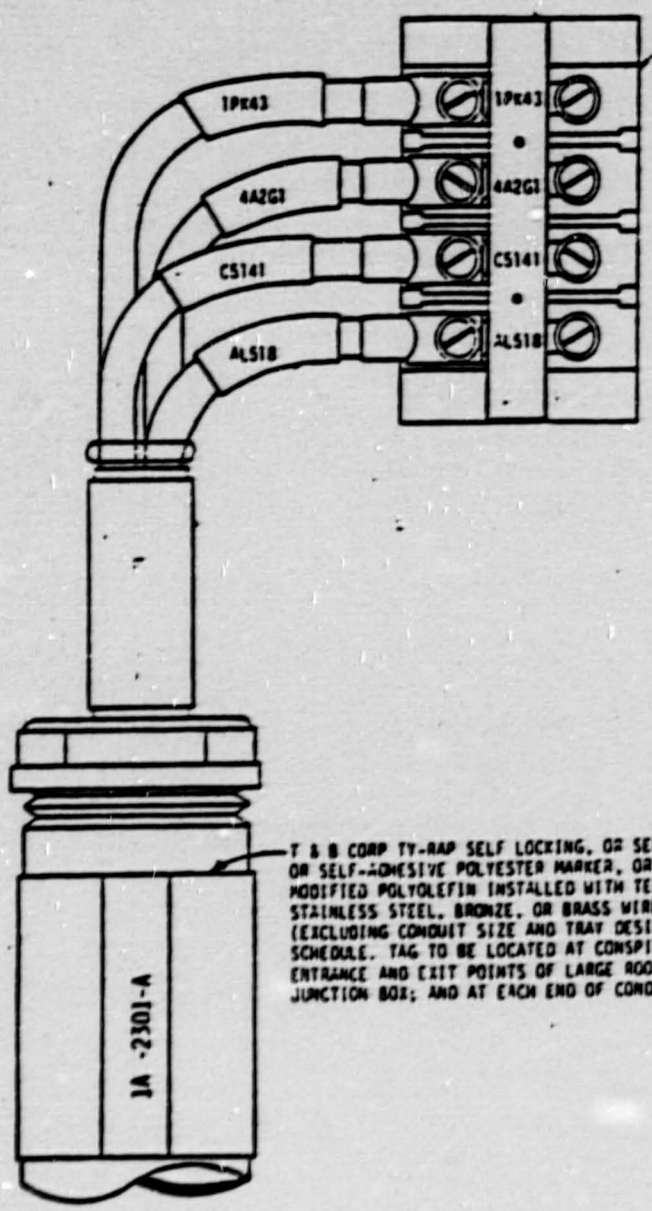


Minimum Bend Radii for Flexible Metal Conduit Dimensions-Inches							
	Anaconda Type U.A.		ServicAir SS63		American Boa B1-O		
Conduit Trade Size (Inches)	A[1](Min.)	OD (Nom.)	A[1](Min.)	OD (Nom.)	A[1](Min.)	A[2](Min.)	OD (Nom.)
1/2	3.5	.84	2.5	.69	2.7	1.17	.67
3/4	5	1.05	3.8	.94	4.5	1.23	1.04
1	6	1.32	5	1.25	5.9	1.38	1.24
1-1/2	5.5	1.90	7.5	1.75	8.6	2.55	1.91
2	7	2.38	10	2.28	9.8	3.81	2.38
2-1/2	9.5	2.88	12	2.78	11	4.54	2.93
3	11.5	3.50	15	3.28	12.8	5.27	3.47
4	14	4.50	20	4.50	19.7	8.74	4.53
5	20	5.57	25	5.56	26.2	12.20	5.61
6	30	6.63	30	6.63	31.7	14.71	6.59

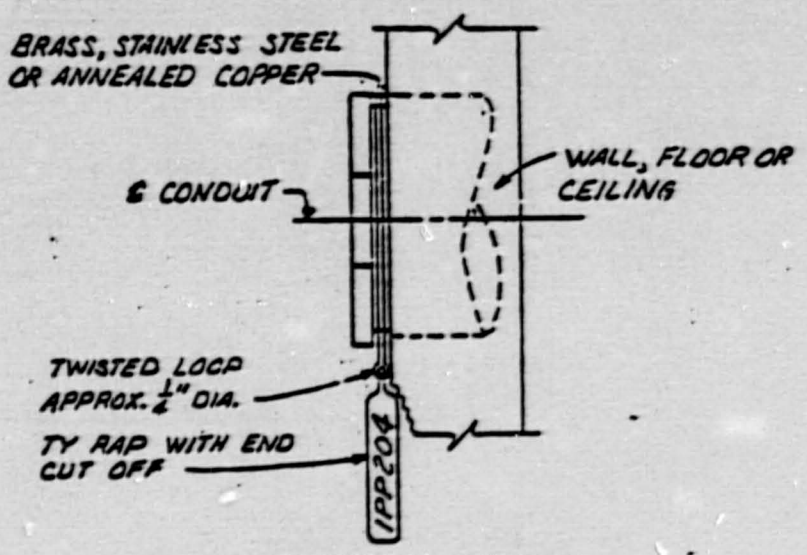
1. Installations where seismic and/or thermal movement considerations are applicable.

2. Installations where seismic and/or thermal movement considerations are not applicable.

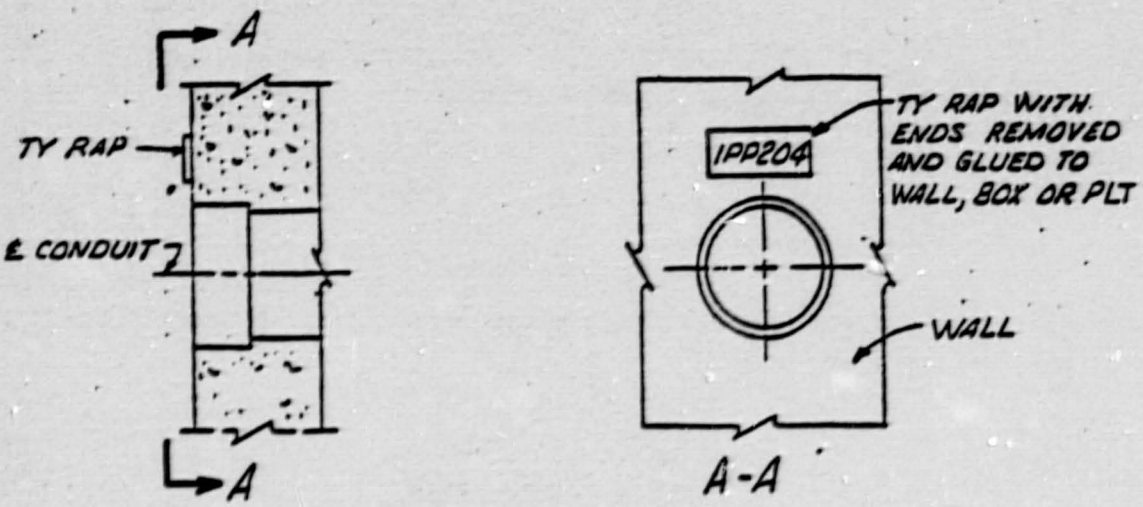
CONDUIT IDENTIFICATION



CONDUIT IDENTIFICATION TAG LOCATION



PERFERRED METHOD
WHERE BUSHING, LOCK NUT OR CHASE NIPPLE IS USED

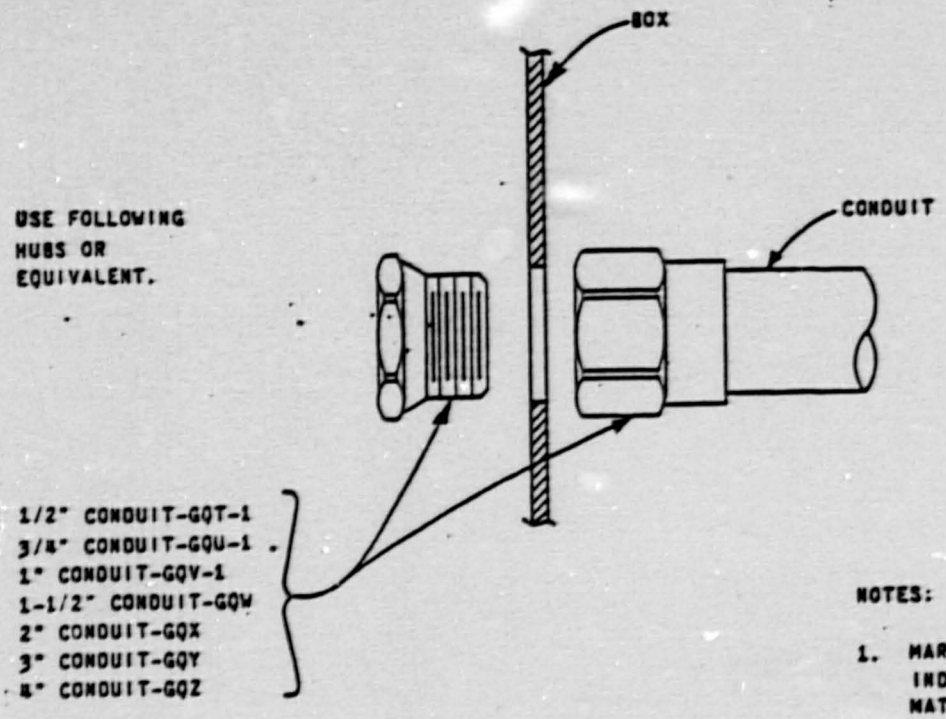


ALTERNATE METHOD

DIVISION OF CONDUIT SEPARATION

SYSTEM	DIVISION OF SEPARATION	BACKGROUND COLOR	LETTERING #	CONDUIT SUFFIX
Engineered safety features (ESF), essential supporting auxiliary systems (ESAS) and Class 1E diesel generator power systems.	Train A Train B	Orange Brown	White White	A B
For safety-related equipment which requires or supplies redundand power sources	Special	Gold	Black	S
(Post accident monitoring)				
PAM 1	1	Purple	White	J
PAM 2	2	Green	Black	K
Reactor protection system (RPS), and Class 1E vital ac and dc distribution systems	Channel I Channel II Channel III Channel IV	Red Black Blue Yellow	White White White Black	D E F G
Normal offsite power supply		White	Black	P
Alt offsite power supply		White	Black	R
Nondivisional		White	Black	

#It is permissible to use back lettering on conductor and cable labels for all but black backgrounds; white lettering shall be used on black background labels.



NOTES:

1. MARK NUMBERS (GQT, GQU, ETC.) INDICATE USE OF EQUIPMENT/ MATERIALS WHICH ARE DEFINED BY THE CLASSICAL ELECTRICAL MASTER BILL OF MATERIAL.

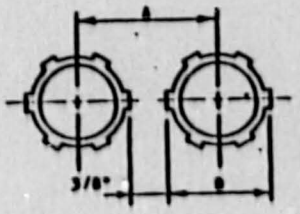
MINIMUM DIMENSIONS BETWEEN ADJACENT CONDUITS TO PROVIDE MINIMUM OF 3/8" CLEARANCE BETWEEN LOCKNUTS

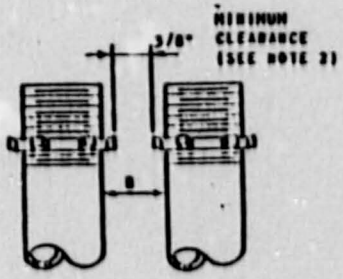
Size of Conduit Inches		Minimum Clearance for Embedded Conduit (Note 2)										
		3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
3/4	A	1.75	1.94	2.22	2.28	2.66	2.94	3.50	3.88	4.07	4.41	5.03
	B	.70	.76	.87	.81	.95	.98	1.23	1.36	1.30	1.16	1.19
1	A	1.94	2.13	2.41	2.47	2.85	3.13	3.70	4.07	4.26	4.60	5.22
	B	.76	.81	.93	.85	1.01	1.04	1.30	1.42	1.36	1.16	1.25
1-1/4	A	2.22	2.41	2.69	2.76	3.12	3.40	3.98	4.35	4.54	4.88	5.50
	B	.87	.53	1.03	.98	1.11	1.15	1.40	1.52	1.46	1.27	1.35
1-1/2	A	2.28	2.47	2.76	2.81	3.19	3.47	4.04	4.41	4.61	4.94	5.56
	B	.81	.85	.98	.91	1.06	1.09	1.34	1.46	1.41	1.21	1.30
2	A	2.66	2.85	3.12	3.19	3.57	3.85	4.42	4.79	4.99	5.31	5.94
	B	.95	1.01	1.11	1.06	1.20	1.23	1.49	1.61	1.56	1.34	1.44
2-1/2	A	2.94	3.13	3.40	3.47	3.85	4.13	4.70	5.07	5.27	5.59	6.22
	B	.98	1.04	1.15	1.09	1.23	1.26	1.52	1.64	1.59	1.37	1.47
3	A	3.50	3.70	3.98	4.04	4.42	4.70	5.23	5.63	5.81	6.16	6.78
	B	1.23	1.30	1.40	1.34	1.49	1.52	1.77	1.89	1.84	1.63	1.71
3-1/2	A	3.88	4.07	4.35	4.41	4.79	5.07	5.63	6.01	6.21	6.53	7.16
	B	1.36	1.42	1.52	1.46	1.61	1.64	1.89	2.01	1.96	1.75	1.84
4	A	4.07	4.26	4.54	5.61	4.99	5.27	5.81	6.21	6.40	6.72	7.34
	B	1.30	1.36	1.46	1.41	1.56	1.59	1.84	1.96	1.90	1.69	1.77
5	A	4.41	4.60	4.88	4.94	5.31	5.59	6.16	6.53	6.72	7.06	7.69
	B	1.10	1.16	1.27	1.21	1.34	1.37	1.63	1.75	1.69	1.50	1.59
6	A	5.03	5.22	5.50	5.56	5.94	6.22	6.78	7.16	7.34	7.69	8.31
	B	1.19	1.25	1.35	1.30	1.44	1.47	1.71	1.84	1.77	1.59	1.68

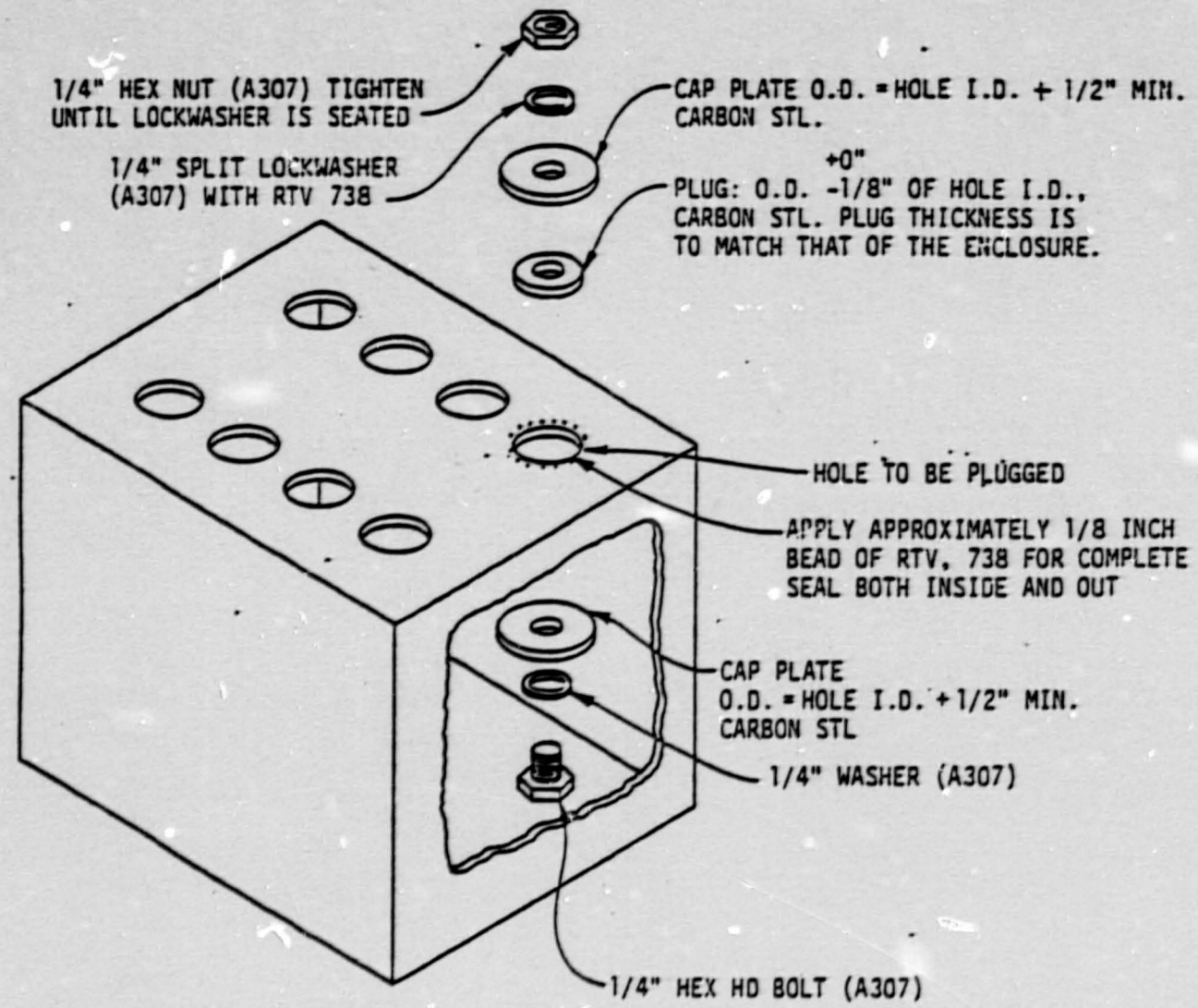
Notes:

1. Overall dimensions of locknuts vary with manufacturers. The diameters listed are considered as being maximum dimensions.
2. The minimum clearance shown (dimension "B") shall be increased where possible so that dimension "B" will be of 2" or greater to permit the flow of concrete between conduits.
3. Minimum clearance between locknuts = 1/8" for exposed conduits. The A and B dimensions may be reduced by 1/4 inch.

Nominal Conduit Size Inches	Locknut Diameter D (Note 1) Inches
3/4	1-3/8
1	1-3/4
1-1/4	2-5/16
1-1/2	2-7/16
2	3-3/16
2-1/2	3-3/4
3	4-7/8
3-1/2	5-5/8
4	6
5	6-11/16
6	7-15/16







ALTERNATIVE METHOD OF REPAIR FOR UNUSED HOLES IN BOXES

NTS

NOTES:

UNUSED HOLES IN BOXES MAY ALSO BE REPAIRED AS FOLLOWS:

(1) USING THE SAME OR EQUIVALENT MATERIAL AS THE BOX, CUT A "PLUG" APPROXIMATELY 1/8" LESS IN DIAMETER THAN THE SIZE OF THE HOLE.
(2) POSITION THE PLUG IN THE HOLE AND WELD ALL AROUND USING A WELD THE SAME SIZE AS THE THICKNESS OF THE BOX MATERIALS.
(3) RESTORE THE BOX FINISH DAMAGED DUE TO WELDING.

ELECTRICAL SUPPORT VARIANCE SHEET

Variance No.: _____ Workplan/MR: _____

Support No.: _____ Typical Drawing/Rev: _____ / _____

Support Location: _____

Sketch Attached: _____ Yes _____ No

Description of Variance:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ / _____ _____ / _____
Cognizant Engineer Date Section Supervisor Date

* Final DNE Resolution: _____ Accept _____ Reject

Remarks:

_____

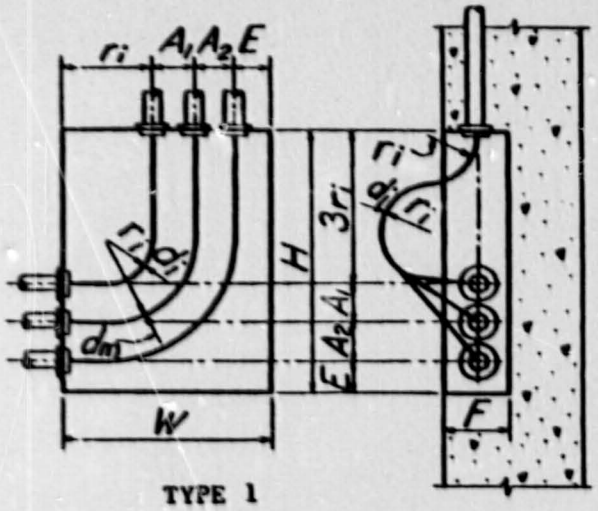
_____

* _____ / _____
DNE Engineer Date

*

ELECTRICAL SUPPORT IDENTIFIER LOG

SUPPORT ID	TYPICAL DWG/REV	LOCATION	WP/MR	VARIANCE NO.	FCR	REMARKS
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						
N - -						



TYPE 1

Height, $H = 3r_i + A_1 + A_2 + E$

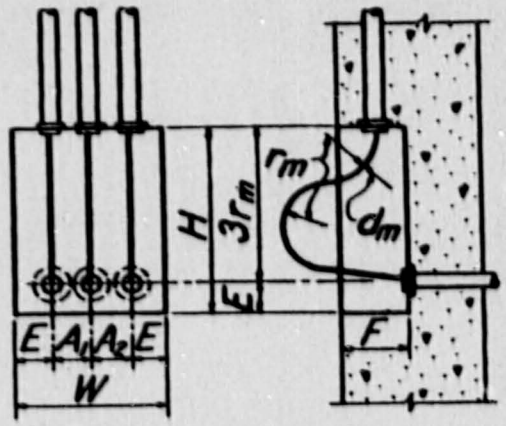
Width, $W = r_i + A_1 + A_2 + E$

Depth, $F = D + (2 \times \text{clearance})$

If r_m is greater than $(r_i + A_1)$ then

Height, $H = 3r_m + A_2 + E$

Width, $W = r_m + A_2 + E$

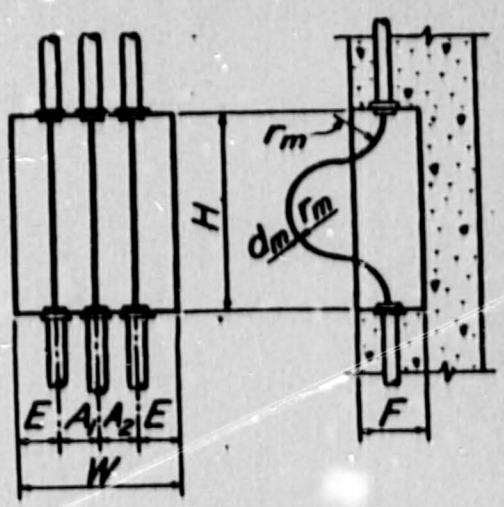


TYPE 2

$H = 3r_m + E$

$W = A_1 + A_2 + 2E$

$F = 1.5r_m$



TYPE 3

$H = 4r_m$

$W = A_1 + A_2 + 2E$

$F = D + (2 \times \text{clearance})$

Notations:

A_1 = 1/2 (locknut diameter$_1$ + locknut diameter$_2$) + clearances. (See Note 1)
A_2 = 1/2 (locknut diameter$_2$ + locknut diameter$_3$) + clearances. (See Note 1)
D = Locknut diameter. (See Note 1)
d_i = Diameter inside cable.
d_m = Diameter maximum cable.
E = 1/2 locknut diameter + clearance.
F = Locknut diameter + (2 × clearance).
r_i = Minimum pulling radius inside cable.
r_m = Minimum pulling radius maximum size cable.

Note:

1. Locknut diameter above refers to maximum overall dimension. For values of A_1, A_2, and D, see Attachment 10.