Installing, Operating and Maintaining Engineered Drive Systems

DRIVE Systems

Instruction Manual D2-3115-2

RELIANCE ELECTRIC

The information in this manual is subject to change without notice.

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

DANGER

THE USER IS RESPONSIBLE FOR CONFORMING WITH ALL APPLICABLE LOCAL, NATIONAL, AND INTERNATIONAL CODES. WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVER-CURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

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1.0 GENERAL INFORMATION

The products described in this instruction manual are manufactured and/or distributed by Reliance Electric Industrial Company.

An Engineered Drive System consists of many individual drive components that operate together to perform the required functions for a specific drive application. These components may be standard drive components that have been selected and modified for integration into the system, or they may be custom components specifically designed for the application.

Whether or not the standard drive components have been modified, their operation as part of a system may involve factors not covered by the standard documentation. Custom hardware or software will of course not be covered by standard documentation. Therefore, it is very important that the engineers and technicians involved in the installation, adjustment and maintenance of a drive system be familiar with Reliance® Engineered Drive Systems standard practices and documentation.

The purpose of this manual is to provide you with the information you need to know to understand these standard practices and documentation. You should thoroughly familiarize yourself with its contents in preparation for the receipt of your equipment.

1.1 Receipt of Equipment

Reliance Electric's terms and conditions of sale are, in most cases, FOB point of origin. A copy of "Standard Terms and Conditions of Sale" is included with the order acknowledgement. Even if other terms were negotiated for your Engineered Drive System, it is in your best interests to identify and thoroughly inspect the equipment before accepting shipment from the transportation company.

Do not sign the delivery receipt before inspecting the material. If the material cannot be immediately uncrated for inspection, examine the crating for external damage. If any damage is found, a written notice of the damage must be made on the carrier's delivery receipt before you sign it. Do not move the material from the point of inspection, and save all packing material. Phone the carrier's nearest office and request an inspection. Then phone the nearest Reliance Electric Sales Office.

If hidden damage is found during later unpacking, phone the carrier, request an inspection, and advise Reliance. Send a copy of the carrier's inspection report to Reliance.

The consignee is responsible for making claim against the carrier for any shortage or damage occuring in transit, unless other terms and conditions have been negotiated for your order. Claims for loss or damage in shipment must not be deducted from the Reliance Electric invoice, nor should payment of the Reliance Electric invoice be withheld while awaiting adjustment of such claims since the carrier guarantees safe delivery. If considerable damage has been incurred and the situation is urgent, or if other than standard terms have been negotiated for your order, contact the nearest Reliance Electric Sales Office for assistance.

1.2 Handling and Storage

The correct lifting procedure must be used for each type of drive control equipment. These procedures are described on the equipment dimension sheets and in Chapter 3 of this manual.

Motors should be lifted using hooks or slings in the lifting lugs on the frame. Motor ventilation hoods or blowers should be removed before lifting. Do not lift motors by the shaft extensions.

All equipment should be placed under protective cover immediately upon receipt. The shipping coverings are NOT suitable for outdoor or unprotected storage.

Control equipment should be stored in an ambient temperature range of 0° to 60° C (32° to 140° F) and a relative humidity range of 5 to 95%. A non-condensing atmosphere must be maintained.

Rotating equipment requires storage with a maximum ambient temperature range of 10° to 50° C (50° to 120° F) and a maximum humidity of 60%. Motors in storage should be rotated every three months to prevent loss of grease protection on bearings and races. Loss of grease protection enables rust to form.

Storage must be away from corrosive atmospheres, shock, and vibration. For long term storage requirements, see section 3.4 of this manual.

1.3 Return of Equipment

During commissioning and start-up of your Engineered Drive System, but before final acceptance, any equipment returns will be handled by your Reliance Electric Service Engineer on site. At any other time, contact your local Reliance Electric Sales Office to obtain the necessary numbered Equipment Return Authorization (ERA) form. This form includes a shipping destination address which may be different from the Reliance Electric plant that originally shipped the equipment.

To return equipment for whatever reason when it is originally received, contact your local Reliance Electric Sales Office within ten days of receipt. Do not return any equipment without a numbered ERA form from Reliance Electric. Reliance Electric reserves the right to inspect any equipment on site before authorizing its return.

1.4 Equipment Identification

Each major piece of equipment provided by Reliance Electric as part of an Engineered Drive System is identified by a unique serial number. The complete serial number (for example, 10TT-847000-V1) is printed on a nameplate on the item and is also listed in the Instruction Book for the system. Reference this number in all correspondence about the item.

Stock items or other vendor items that are part of a suborder may not include the serial number on their nameplate. If the suborder and item number cannot be determined from the descriptions in the Instruction Book, then all of the information listed on the item nameplate, as well as the sales order number, should be provided in any correspondence about the item.

1.4.1 Serial Number Components

The serial number is made up of the sales order number, the suborder prefix, and the multiple quantity suffix. Each of these components is described in the following sections.

1.4.1.1 Sales Order Number (S/O)

The sales order number is the Reliance Electric number assigned to a particular project or order. It is normally a six-digit number, but may include letters.

1.4.1.2 Suborder Prefix

The suborder prefix identifies individual items of equipment within the order. This is an alpha-numeric prefix (for example 10TT, 1KA) that identifies the producing plant and the type of equipment.

1.4.1.3 Multiple Quantity Suffix

Duplicate items produced on the same suborder are individually identified by the suffix V1, V2, etc.

1.4.2 Date Code

The month and year that an item was manufactured are indicated by a two-letter code as shown in Table 1.1. This date code can be found on the item nameplate and should be included in any correspondence with Reliance Electric about the item.

Table 1.1 - Reliance Electric Date Codes

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1985	NL	PL	QL	RL	SL	TL	UL	VL	WL	XL	YL	ZL
1986	NM	PM	QM	RM	SM	TM	UM	VM	WM	XM	YM	ZM
1987	NN	PN	QN	RN	SN	TN	UN	VN	WN	XN	YN	ZN
1988	NP	PP	QP	RP	SP	TP	UP	VP	WP	XP	YP	ZP
1989	NQ	PQ	QQ	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ
1990	NR	PR	QR	RR	SR	TR	UR	VR	WR	XR	YR	ZR
1991	NS	PS	QS	RS	SS	TS	US	VS	WS	XS	YS	ZS
1992	NT	PT	QT	RT	ST	TT	UT	VT	WT	XT	YT	ZT
1993	NU	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	ZU
1994	NW	PW	QW	RW	SW	TW	UW	VW	WW	XW	YW	ZW
1995	NX	PX	QX	RX	SX	TX	UX	VX	WX	XX	YX	ZX
1996	NY	PY	QY	RY	SY	TY	UY	VY	WY	XY	YY	ZY
1997	NZ	PZ	QZ	RZ	SZ	TZ	UZ	VZ	WZ	XZ	YZ	ZZ
1998	AA	BA	CA	DA	EA	FA	GA	HA	JA	KA	LA	MA
1999	AB	BB	CB	DB	EB	FB	GB	HB	JB	KB	LB	MB
2000	AC	BC	CC	DC	EC	FC	GC	HC	JC	KC	LC	MC

1.4.3 Equipment Nameplates

In addition to the serial number and date code, the equipment nameplate includes other information that varies depending upon the type of equipment, such as input voltages and currents or power ratings. Figures 1.1 through 1.3 show typical nameplates for a motor, a drive cabinet, and an operator station, respectively.

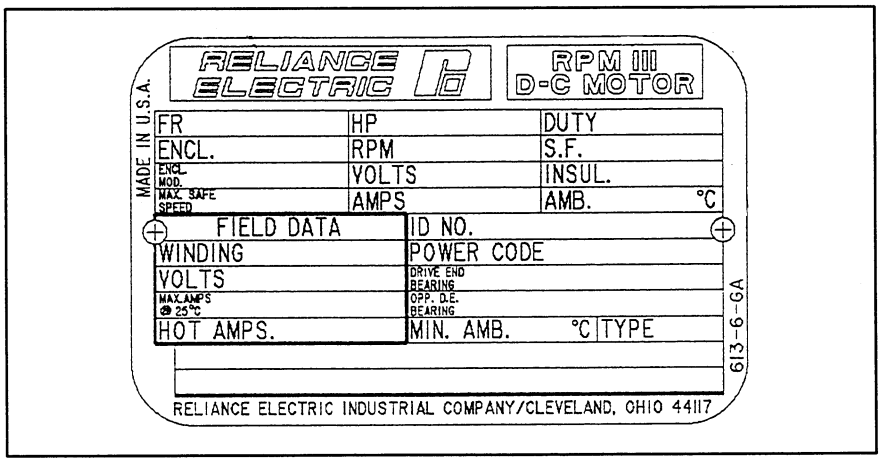


Figure 1.1 - Typical Motor Nameplate

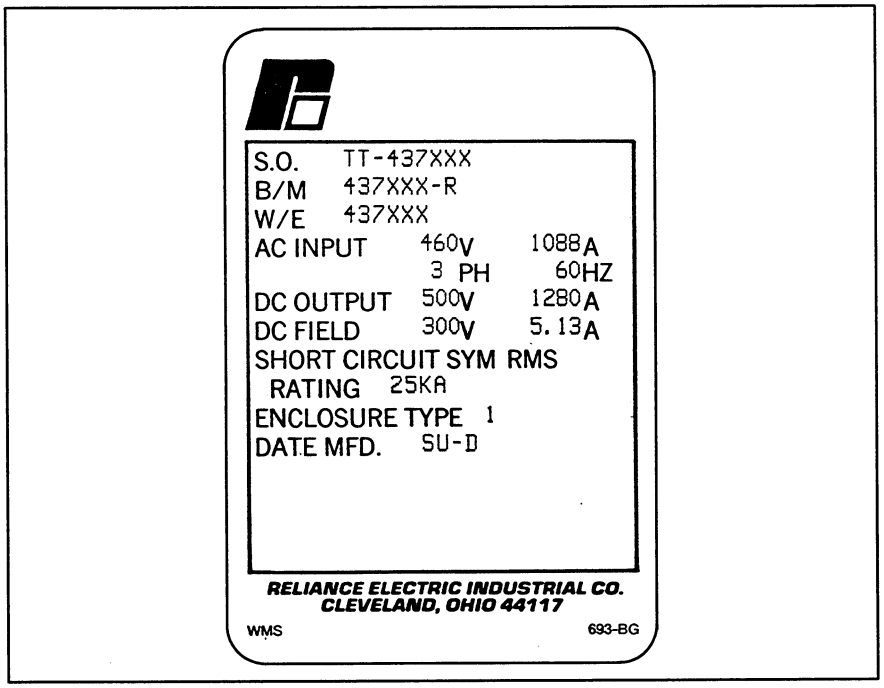


Figure 1.2 - Typical Drive Cabinet Nameplate

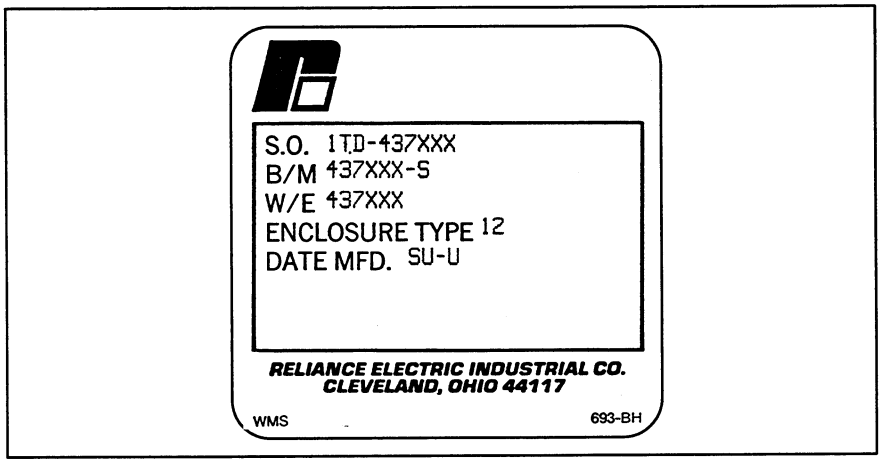


Figure 1.3 - Typical Operator Station Nameplate

2.0 SYSTEM DOCUMENTATION

Reliance Electric provides a standard set of documentation for all Engineered Drive Systems. This includes engineering drawings and dimensions sheets, performance data, instruction manuals, and an Instruction Book. These are issued at various times throughout the progress of a project. This documentation is described in the following sections.

2.1 Engineering Drawings

Each Reliance Electric drawing is usually identified by a two-letter prefix followed by a six- digit number. For sales order documentation, the six-digit number is the sales order number. In some cases, a series of standard drawing numbers is used, or the number is sometimes followed by a suffix.

Table 2.1 identifies the different types of drawings by their two-letter prefix. Not all types are provided for every system. Only those applicable to the specific requirements are provided.

Copies of these drawings are provided in various forms throughout the design stage of an order. The quantities, form, and timing depend upon the specific agreement between Reliance and the customer.

Before the equipment is shipped, these documents are updated with any changes made during manufacturing or testing, and updated prints are included with the hardware shipment. The W/E, W/M, and W/P elementary drawings and all software listings are also updated after start-up and are reissued as revised pages of the Instruction Book (refer to section 2.3). Drawings can be distributed to the customer as hard copies or optionally as electronic files.

Following are more detailed descriptions of the drawings that are provided by Reliance Electric as customer documentation for an Engineered Drive System. These can be provided as full size prints or reproducible copies. Prints reduced to 8-1/2" x 11" or 11" x 17" are included in the Instruction Books provided for the system.

Table 2.1 - Standard Engineering Drawings

DWG. PREFIX	DRAWING TYPE
B/M	BILL OF MATERIAL
D/S	DIMENSION SHEET
W/D	WIRING DIAGRAM
W/E	ELEMENTARY DIAGRAM
W/F	FLOW DIAGRAM
W/I	INTERCONNECTION DIAGRAM
W/L	PANEL LAYOUT
W/M	MOTOR CONTROL CENTER
W/N	STANDARD NOTE SHEET
W/O	OPERATOR'S STATION
W/P	PROGRAM DOCUMENTATION
W/S	CONSTRUCTION DRAWING
W/X	INDEX SHEET

2.1.1 Title Block

Each drawing includes a standard Reliance Electric title block listing the drawing type and number, the sheet number, a functional description of the sheet contents, release dates, last revision dates, and the date printed. Figure 2.1 shows a typical drawing title block.

Each drawing sheet is given a unique number in consecutive order. In some cases, additional sheets are inserted between two existing sheets by adding a decimal point suffix (e.g., 21, 22, 22.01, 22.02, 23).

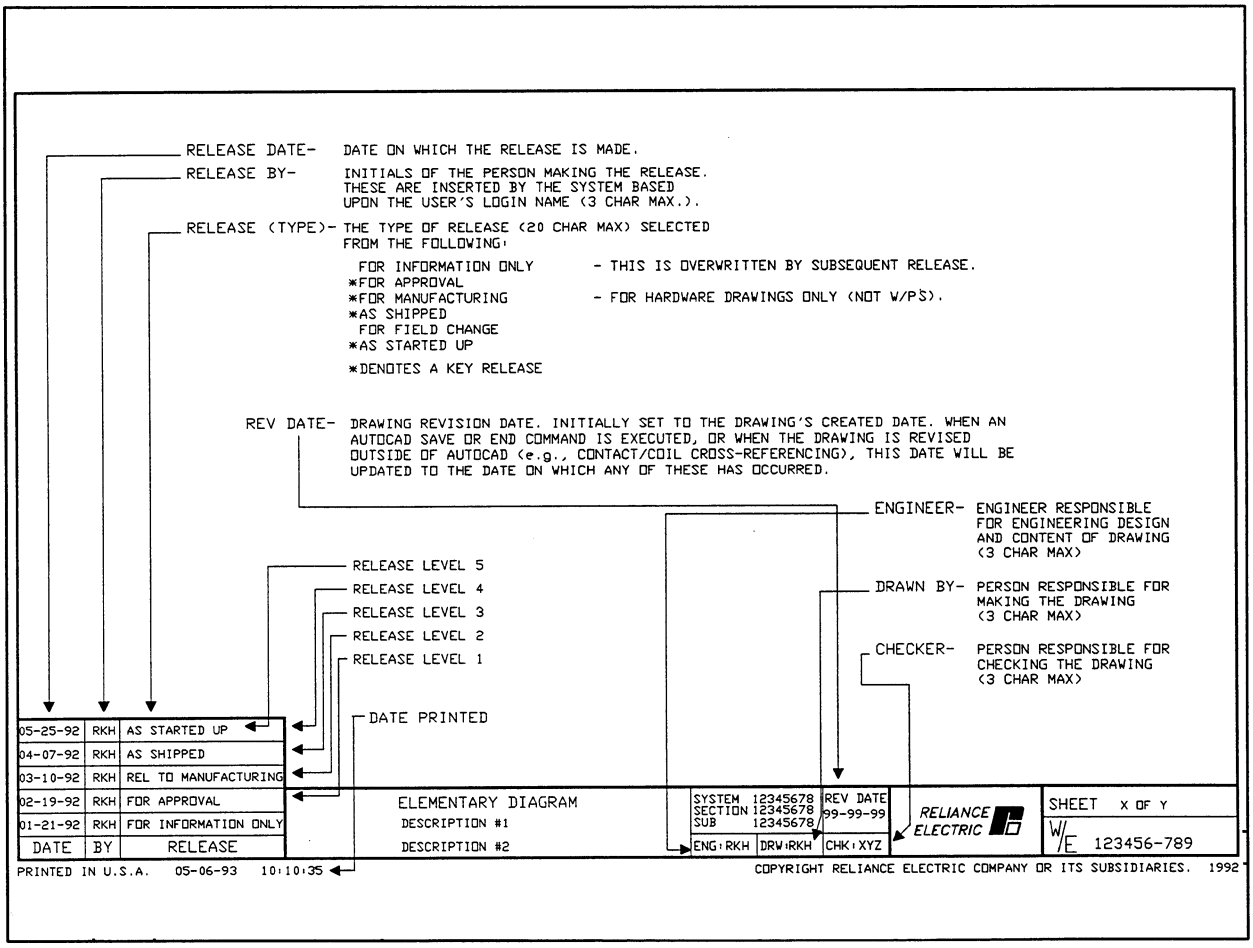


Figure 2.1 - Typical Drawing Title Block

2.1.2 Bill of Material (B/M)

A bill of material is a list of parts and instructions to manufacture and assemble them. In most cases, these lists are not provided to a customer since part number information is listed on the panel layout drawings.

2.1.3 Dimension Sheet (D/S)

Dimension sheets provide outline dimensions, mounting information, approximate weight, and other mechanical information about a part or assembly. These are standard drawings with a number that may be other than the sales order number

2.1.4 Wiring Diagram (W/D)

Wiring diagrams are reference drawings, including schematic diagrams, for standard assemblies included in a drive system. The drawing number is normally not the sales order number.

2.1.5 Wiring Elementary Diagram (W/E)

Wiring elementary diagrams are electrical schematic diagrams. These diagrams show electrical connections of electronic and electrical devices in the Engineered Drive System. These are functional representations only and do not indicate the actual physical size, shape, or location of the device. Notes are placed on the drawings for additional instructions, standard notes, field wiring, etc.

W/Es are usually grouped in a consecutive series of sheets on a per drive or machine control section basis. The title block for each sheet lists the suborder number for the shippable item containing most of the circuitry shown on the sheet. Components may be shown in a W/E that are not physically located in that suborder. These components are indicated by location notes defined on the note sheets (W/N).

W/Es with special cabling notes (slash cabling) are supplied as standard in place of the interconnection diagrams (W/I). Slash cabling notes indicate wiring external to the suborder and power separation levels of field wiring. Refer to Chapter 4 for more information on wiring levels and classes.

Examples of elementary diagrams can be found in Appendix A.

2.1.6 Flow Diagram (W/F)

Flow diagrams may include:

- Process flow diagram showing the relationship between the drive sections, motors, and mechanical regulation schemes in block format.
- Communications single line diagram showing the network and remote I/O arrangements and any other communication lines.
- A-C power single line diagram.

A typical flow diagram is shown in Appendix B.

2.1.7 Interconnection Diagram (W/I)

Interconnection diagrams are provided optionally in place of the standard slash cabling in the elementary diagrams (W/E). They list all interconnecting field wiring between individual assemblies or components provided by Reliance Electric or others (if these are identifiable units). For each wire, the list includes the wire number, the power level, and the end point assemblies or components.

These drawings are not a replacement for the normal construction engineering conduit and cable schedules. No attempt is made to show wire groupings for individual conduits and trays nor to include intermediate equipment like "pullboxes" that may be required for a particular installation. Also, no attempt is made to optimize wire runs for wires that are "daisy-chained" between multiple devices, since Reliance Electric usually does not have knowledge of actual equipment locations.

The sheets are arranged in order, as follows:

- Instruction Sheet
- Index Table
- Wire Table

The instruction sheet lists instructions for interpreting the index and wire tables as well as standard and special notes related to proper wiring procedures. It also references customer name, purchase order number, user's name, and W/E number.

The index table lists all interconnected equipment by name or description. It references all drawings that show the internal wiring for all Reliance Electric provided equipment. All equipment listed is assigned an equipment number for interconnection purposes.

The wire table lists connections from/to equipment shown in the index table for which equipment numbers have been assigned. It indicates wire type (e.g., A-C power, D-C power, A-C control, D-C control, and signal) and lists all wire numbers and any note references necessary for proper wiring.

2.1.8 Panel Layout (W/L)

Panel layout drawings show the physical arrangement of the electrical devices on each control panel, including customer connection terminals with wire numbers. Each sheet normally shows a single panel, although multiple subpanels are sometimes shown on the same sheet.

The first sheet of the W/L drawing shows the panel arrangement in an assembly from a top down view. This view shows the position of base-mounted components. Top-mounted components, if provided, are also shown in a separate view. The parts list of all cabinet mechanical components for the assembly is shown at the bottom of the sheet.

All components or subassemblies on the panel are shown to 3/8 scale on the original drawings. A linear scale is provided on the drawing that allows for estimating dimensions should the original drawing be enlarged or reduced. Each component or subassembly is identified by a unique label that is also shown on the W/E, and by a part number within or adjacent to the device outline. A nameplate with the component label is provided on the actual panel mounted adjacent to the device. Each sheet also serves as a bill of material (B/M) listing all the parts required to make up a complete assembly.

This drawing also shows the nameplate data for each complete assembly. Appendix C contains typical panel layout drawings.

2.1.9 Motor Control Center (W/M)

Motor control center drawings show the physical location of the units or compartments within each Motor control center and the W/E drawing for each unit. If there is more than one motor control center, the drawings for each may consist of consecutive sheets of the same drawing number, or a suffix (such as -1, -2, etc.) may be added to the basic number for each separate assembly.

For each assembly, the sheets are arranged in the following order:

- Arrangement of compartments
- Index of units
- Elementary drawings

The compartment layout indicates unit locations and motor control center size in inches. The conduit entry area is also indicated.

The index sheets list each unit by name and location, and indentify each by starter or device type, size, and function (i.e. #1 FVNR Starter or 100 Amp C/B Feeder). They also refer to the sheet number for the elementary drawings.

The elementary drawings show the internal and external circuitry for each unit in schematic form. This includes cross-referencing to any W/E drawings in the same or related orders.

A typical motor control center drawing is shown in Appendix D.

2.1.10 Note Sheet (W/N)

Note sheets describe wiring instructions and define the standard notes and nomenclature used in the drawings. The notes indicate the location of the components or subassemblies that may be separately mounted. Refer to these note sheets and to Chapter 4 of this manual for electrical wiring and installation instructions.

Typical note sheets are shown in Appendix E.

2.1.11 Operator's Station (W/O)

Operator's station drawings show the arrangement of the operator devices and the location of field terminals with wire numbers for each operator station that is provided with an Engineered Drive System. Each operator station is shown on a separate sheet, or multiple consecutive sheets, containing the following:

- Cover drawing
- Dimensions
- Subpanel drawing (if provided)
- Bills of material

The operator's station cover drawing displays the enclosure cover layout to scale as viewed by the operator. All operator devices are shown pictorially with all legend plates in place. Each operator device is also identified with a unique label similar to the device labels on the W/L drawings. These are used for cross-referencing with the W/E or W/M drawings and with the W/O electrical bill of material. Colors are indicated for push buttons and pilot lights.

The dimensional drawings show the operator station outline dimensions and applicable installation information such as mounting bolt hole locations and conduit or wiring entry areas.

The subpanel drawings show any electrical devices mounted on subpanels, if any, inside the enclosure. They also show all field terminal locations with the wire numbers from the W/E drawings and the nameplate data for the assembly.

A mechanical bill of material includes all sheet metal fabricated parts required to make up the assembly. An electrical bill of material lists the Reliance Electric part numbers for each operator device or subpanel electrical device cross-referenced to the device label.

Examples of operator's station drawings are shown in Appendix F.

2.1.12 Program Documentation (W/P)

These drawings for software-based systems provide documentation that is supplemental to the software listings. These drawings are block diagrams of the application tasks. An example of program documentation is shown in Appendix G.

2.1.13 Construction Drawing (W/S)

Construction drawings provide the information required for the installation of Class A or Class B open Mill Control or for control rooms (Mill Control Houses). They show the overall dimensions of each assembly, the mounting details, and conduit entry locations. They specify the lifting methods and give an estimated weight of the assembly. Class A, B, and C Mill Control W/S drawings may show the location of each control panel within the assembly and the location and type of terminal boards provided.

These drawings may be issued in two versions, preliminary and final. Preliminary construction information is often provided before engineering is complete to allow the drawing to be used for installation planning and general site preparation. This is the best data available as of the preliminary issue date, but must not be used for final construction engineering.

Final construction drawings are always provided when the design is complete and drawings are released to manufacturing. Only these drawings should be used for actual installation. See Appendix H for a typical construction drawing.

Similar information for cabinet-type construction and other equipment is shown on the outline dimension drawing (D/S).

2.1.14 Index Sheet (W/X)

Index sheets list the description, last revision date, document prefix, drawing number, sheet number and sub order for all drawings in the sales order. The index sheets provide a means to identify which drawings comprise a complete and up-to-date set of prints.

2.2 Drawing Standards

Reliance Electric uses the ANSI/NEMA Standard Device Designations and Symbols on the elementary drawings provided with Engineered Drive Systems. These are listed in the ANSI/NEMA Standards Publication for Industrial Controls and Systems, Part ICS 1-101. Most of these symbols are also shown in figure 2.2. Additional symbols are shown on the sample note sheets in Appendix E. Note sheets are provided with every Engineered Drive System.

2.3 Instruction Books

Instruction Books provide a complete record of the equipment supplied and contain the following sections:

- Equipment List - description and serial number for each item with reference numbers for D/S, W/D, B/M or other drawings as applicable, including performance data on motors.
- Operation - optional written description of the machine parameters, electrical system arrangement, electrical operation, control details, and performance criteria.
- Manuals - instruction manuals or engineering manuals that provide standard installation and maintenance procedures for motors, tachometers, regulators, and purchased items, if available.
- Dimension Sheets - for all customer-installed equipment.
- Electrical Diagrams - including the W/D, W/I (if supplied), W/L, W/M, W/O, W/P, and W/S as described above on 8-1/2" x 11" or 11" x 17" sheets.
- Engineering Data - performance curves or other required data not included in the diagrams.
- Renewal Parts - list of spare parts with part numbers, list prices, and recommended quantities.
- For software-based systems, one binder is included with the copies of the Instruction Books containing one set of executive operating system disks, one set of application program disks, firmware (F/W) sales order number nnnnnn, and one documented listing of all custom application software with cross-referencing. These listings are either source code or ladder diagrams depending on which is applicable. Two duplicate copies of this binder, less the operating system disks, are sent to the local Reliance Electric District Office. One copy of the application disks is to be returned to Drive Systems Engineering with start-up changes.

Multiple sets of the Instruction Book for an Engineered Drive System are sent by Reliance Electric within two weeks after the final equipment shipment. The quantities sent and the recipients of each are determined by agreement between Reliance Electric and the customer.

After start-up, the W/E, W/M, and W/P drawings and software listings are returned **updated with any changes made during start-up**. Prints of all revised sheets and revised listings are reissued to update the Instruction Books.

2.4 Component Identification

All parts or sub-assemblies used in an Engineered Drive System are given a Reliance Electric part number or assembly number so that they can be identified for replacement purposes. When ordering spare parts, the entire number must be used including any prefix or suffix.

Table 2.2 - Component Identification Key

Type of Part	Typical Part Number
Commercial	846862-3CPA
Customer Property	14CPT-847179
Reliance Electric Standard	77801-4WD, or 402422-3K
Standard Model Number	45C202A

2.4.1 Commercial Part Numbers

For a commercial part purchased for a specific sales order, the Reliance Electric part number will be the sales order number with no prefix, followed by the suffix "nCPx". The "n" in the suffix identifies the Reliance purchase requisition number; the "x" in the suffix is a different letter for each item on the purchase requisition.

2.4.2 Customer Property Part Numbers

In some cases, customer parts or assemblies are mounted on Reliance Electric equipment at a Reliance Electric plant. Typical examples are motor or reducer couplings or special customer-supplied meters on an operator station. For each item, the customer is given a Customer Property Tag identifying the part and the assembly on which it is mounted. This tag also includes shipping information. If these parts are shown on Reliance Electric drawings, they are identified by the six-digit part number prefixed or suffixed by nCPT. The basic six-digit number is the sales order number; the "n" in the prefix is a unique number for each customer-supplied part. Occasionally, the six-digit number may consist of an alpha character followed by five digits, e.g., Xnnnnn.

2.4.3 Reliance Electric Standard Part Numbers

Most other Reliance Electric parts or assemblies are identified by standard part numbers. The part number consists of a basic number of up to six digits, followed by a modification number of up to three digits and a symbol of one or two letters. The basic number and model number are separated by a hyphen and define the part drawing. The one- or two-letter symbols are used to distinguish between multiple parts on the same drawing.

Standard part numbers sometimes include a prefix that may or may not be optional. When ordering a spare part, the full number shown on the Reliance Electric drawings must be specified.

2.4.4 Standard Model Numbers

Standard model number products used in an Engineered Drive System are identified by their model numbers.

In some cases, a standard part will be modified for a specific application without being given a new part number. In these cases, the basic part number is shown on all drawings accompanied by the note, "Modified by W/E nnnnnn, Sheet nn". This refers to the sheet of the elementary diagrams where the modification is described. The part also has a label attached to it with the same information. When ordering replacement parts, you must include this modification note.

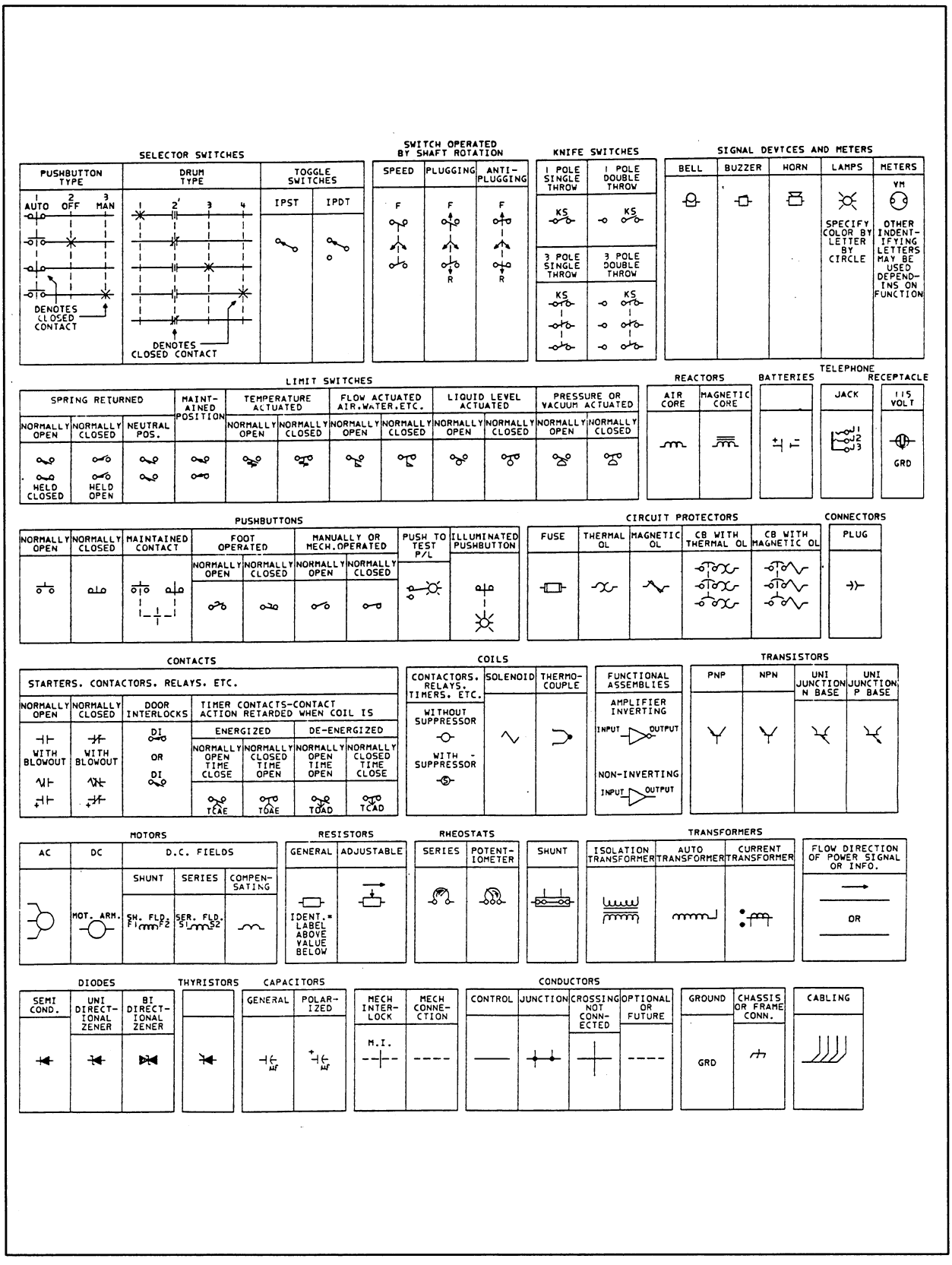


Figure 2.2 - Standard Symbols

3.0 MECHANICAL CONSIDERATIONS IN DRIVE SYSTEM INSTALLATION

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

The physical environment and other mechanical factors can affect the operation and reliability of electrical equipment. Reliance Electric Drive System equipment is designed to operate reliably in a factory environment within a standard range of service conditions as specified by NEMA. When other conditions exist, Reliance Electric can provide equipment in optional NEMA enclosures with special features to help withstand them. Reliance Electric equipment also includes features to accommodate other mechanical requirements of the installation.

In order to get the maximum value from your Engineered Drive System, and to maintain its warranty, you must be aware of the drive equipment's specified mechanical features and its range of application. If these are not consistent with the respective service conditions for your installation, you may need to provide additional protection for the drive equipment, or change the specifications before the drive equipment is designed and built. Your Reliance Electric Sales Engineer can advise you of the cost of any non-standard features.

Reliance Electric is not responsible for the specification, design, or operation of the driven equipment. The specification, location, and functions of the operator stations, emergency disconnects, guarding or other safety devices or procedures, as may be desirable or as may be required by safety codes, are not provided by Reliance Electric and are not the responsibility of Reliance Electric.

This chapter will help you determine the mechanical and environmental requirements for your Engineered Drive System and will suggest actions you can take to comply with them. It is based on the industry standards listed below, which have been used by Reliance Electric in the design of the equipment. You can obtain copies of these standards from the respective issuing agency.

- CSA C22.2 No. 14-M91, "Industrial Control Equipment"
- IEEE 518, "IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources"
- NEMA Publication Number ICS 1, "General Standards for Industrial Control and Systems", Part ICS 1-108, "Service and Installation Conditions"
- NEMA Publication Number ICS 3.1, Part 4, "Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems"
- NEMA Publication Number ICS 6, "Enclosures for Industrial Control Systems"
- NEMA Publication Number MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors"
- NEMA Publication Number 250, "Enclosures for Electrical Equipment (1000 volts maximum)"
- NFPA 70, "National Electrical Code"
- NFPA 79, "Electrical Standard for Industrial Machinery"
- UL file E 149052, "Industrial Control Panels"
- UL 50, "Cabinets and Boxes"
- UL 508, "Standards for Industrial Control Equipment"

Addresses for ordering these publications are shown in Chapter 4 of this manual.

3.1 Site Planning

The most important mechanical considerations in the design of your installation are to provide adequate space and adequate support for the equipment and to make provisions for the entry and exit of wiring. These are described in the following sections.

3.1.1 Space Requirements

The minimum clearances listed in Table 3.1 should be followed when choosing a location for your drive equipment in order to provide unrestricted ventilation and proper clearance for access to service the equipment.

Table 3.1 - Typical Equipment Clearance Requirements

TYPE OF EQUIPMENT	CLEARANCE REQUIRED			
	FRONT	BACK	ENDS	TOP
Wall Mounted Operator Cab.	*	None	10 inches 254 mm	6 inches 152.4 mm
Floor Mounted Consoles, B/B	*	36 inches 914.4 mm	18 inches 457.2 mm	18 inches 457.2 mm
Deadback Floor Mtd. Cabinet	36 inches 914.4 mm	None	18 inches 457.2 mm	12 inches 304.8 mm
Liveback Floor Mtd. Cabinet	36 inches 914.4 mm	36 inches 914.4 mm	18 inches 457.2 mm	12 inches 304.8 mm
Class B & C Mill Control	42 inches 1066.8 mm	None	48 inches 1219.2 mm	None
Class A Mill Control	None	None	48 inches 1219.2 mm	None
Mill Control Rooms	12 inches 304.8 mm	12 inches 304.8 mm	48 inches 1219.2 mm	** 12 inches 304.8 mm

* As required for operating personnel and/or door swing.

**75 inches if there is an air conditioner or other equipment mounted on the roof requiring maintenance access.

In addition to these minimum requirements, the requirements of the National Electrical Code Article 110-16 for working space must also be met based on the applicable conditions. Local regulations and codes may require greater clearances and should be observed by the installer.

Note that you should advise Reliance Electric if you plan to mount drive cabinets end to end without the above spacing between them. Additional cooling may be required. The same is true if a cabinet is installed with one or both ends against a wall.

Motors and gears also require clearances for cooling and maintenance access. Forced-ventilated and fan-cooled machines require space for unrestricted movement of air at the inlet and exhaust openings. Non-ventilated machines require space for convective cooling at the exposed surfaces. Free access must be provided to conduit boxes and brush inspection covers. Where space is critical, you should discuss these requirements with Reliance Electric on an individual basis.

3.1.2 Anchoring and Mounting

All drive equipment must be supported by a rigid structure or foundation to which it is firmly attached. The mating surfaces must be smooth and even to avoid deformation or stresses in the equipment. For rotating equipment, the supporting structure and attaching means must be capable of withstanding any applied torque as well as the weight of the equipment. The structure must also be rigid enough to prevent excessive resonant vibrations in the normal operation range.

Control enclosures and operator stations must be firmly attached to the supporting structure to prevent any motion that could cause stresses in the connecting wiring. Some enclosures may also be top heavy.

The dimension sheets provided for these enclosures include detailed information on mounting methods. For motors and other mechanical devices, the mounting requirements are described in the respective instruction manuals.

3.1.3 Wiring Access

The dimension sheets provided for all enclosures include the locations where holes can be drilled for conduit. Removable plates can be provided by Reliance Electric. NEMA 1 enclosures usually have open floors for wiring access.

See figure 3.1 for a typical cabinet dimension sheet.

3.2 Operating Conditions

Drive regulators, power modules, and other control hardware are normally provided in NEMA 1 cabinets with either convection cooling or forced ventilation, depending on the internal heat losses. Isolation transformers are normally NEMA 1 with convection cooling. Motor control centers and switchgear are normally NEMA 1 non-ventilated. The least expensive enclosures for A-C and D-C motors are protected and drip proof guarded respectively.

All of these enclosures are designed for a standard set of service conditions defined by the National Electrical Manufacturers Association. Ambient air must be cool, clean and dry, and free of flammable or combustible vapors and corrosive chemical fumes. These conditions are further defined below along with suggested corrective actions when they are exceeded.

Some electrical equipment, such as computers and their peripherals, require more restrictive service conditions. When Reliance Electric provides such equipment, Reliance Electric also provides you with the manufacturer's user or installation manuals. Refer to these for service conditions and other installation requirements.

3.2.1 Altitude

All electrical drive equipment is designed for a maximum altitude of 1000 meters (3300 feet) without derating. At higher elevations, the thinner air may not provide adequate cooling. If the equipment will be operated at such elevations, advise your Reliance Electric Sales Engineer.

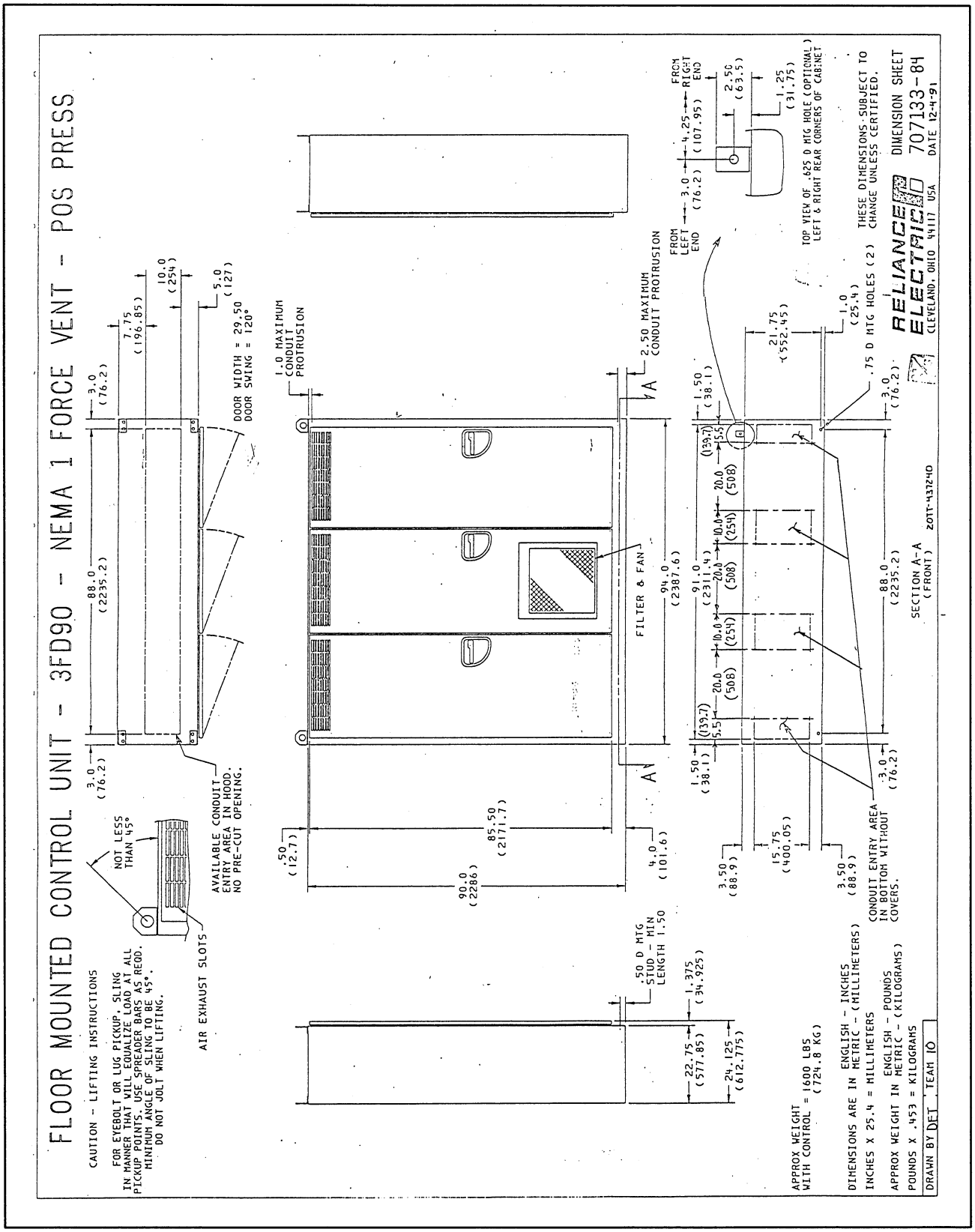


Figure 3.1 - Typical Cabinet Dimension Sheet

3.2.2 Corrosive Atmosphere

Industries such as paper, metal strip processing and coating, wire drawing and textile manufacturing have by-products of their processes that may affect drive equipment. Chlorides, sulfides, and some other chemical fumes have a corrosive effect on copper, the main component in electronic products. Sea air can also affect copper, aluminum, and steel structural elements. Solvent fumes may affect insulation or protective coatings.

Electrical control equipment can be provided by Reliance Electric, at additional cost, in NEMA 4X enclosures to withstand these effects except where this does not provide adequate cooling. In these cases, clean air must be ducted into the enclosures, or the control equipment must be installed in an air-conditioned environment.

Motors in corrosive environments should be totally enclosed with XT (Extra Tough) features.

3.2.3 Dust

Insulating dust can cause excessive resistance at contact surfaces resulting in improper operation of the equipment. Metallic or other conductive dust or particles can cause short circuits resulting in a partial or complete failure of the equipment. Any dust, fibers, or other airborne particles can interfere with the operation of electromechanical devices (such as contactors) or prevent proper cooling.

NEMA 12 cabinets, or NEMA 1A cabinets with positive pressure ventilation and filters can protect electrical control equipment from the effects of airborne particles as long as all doors and covers are closed. Additional protection should be provided during maintenance. Alternately, standard NEMA 1 equipment or open panels can be installed in air conditioned control rooms.

Motors can be supplied with forced cooling with filters or should be totally enclosed if installed in dusty environments. They can be provided with special seals if the dust is abrasive.

Whenever equipment is provided with forced ventilation and filters, the filters must be cleaned or replaced periodically to prevent equipment overheating.

3.2.4 Hazardous Locations

Drive control equipment should not be installed in hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings unless the equipment is approved in compliance with the National Electrical Code. Generally, the enclosure requirements do not allow for the dissipation of the internally generated heat. This equipment should be installed remotely.

Totally enclosed motors that are purged with clean air, or motors in approved explosion-proof enclosures, can be installed in hazardous locations in compliance with the requirements of the National Electrical Code. The same applies to tachometers and other machine-mounted sensors. Note that for purged equipment, the control must include provisions to prevent the application of power until purging is complete.

Operator devices can also be installed in hazardous locations in approved explosion-proof enclosures.

3.2.5 Humidity

Drive electrical control equipment is designed to operate with a humidity of 5 to 95%, non-condensing. Excess humidity or condensation can cause short circuits or corrosion. These may result in intermittent faults or permanent damage to components, such as open circuits, low resistance paths to ground, or sticking electro-mechanical components.

The same humidity limits apply to A-C and D-C motors. In addition, D-C motors require an absolute humidity of at least 2 grains per cubic foot to prevent excessive brush wear.

3.2.6 Shock and Vibration

Physical shock and vibration can cause the failure of electrical connections or of part mounting hardware. They can also cause spurious operation of the contacts on relays or contactors and intermittent loss of continuity on potentiometer or rheostat wipers. In severe cases, shock or vibration can cause mechanical failure or disintegration of electrical components.

For motors and gears, mechanical shocks can cause permanent damage to bearings without any visible external damage. Shock or vibration can loosen coils, damage seals, or crack castings.

Reliance Electric can provide mechanical consulting services for applications where physical shock or vibration may be a problem. Contact your Reliance Electric Sales Engineer for details.

3.2.7 Temperature

All drive equipment is designed for operation with a maximum ambient temperatures of 40°C without derating or other special features. Exceeding these temperatures during operation may cause insulation failures or destruction of solid state devices. If it is known that these temperatures may be exceeded, some devices can be derated to a lower full load current. In other cases, supplementary cooling or air conditioning will be required.

Drive equipment is designed for operation with a minimum ambient temperature of 0°C. At lower temperatures, there may be damage from frost or freezing of absorbed moisture in some components. D-C motors may experience excessive brush or commutator wear if cooled by air at less than 0°C. Also the base speed and regulation may not stay within NEMA limits. If temperatures below 0°C are anticipated, supplementary heating is required. Motors may also need special lubricants.

All electrical equipment generates heat during operation. If you are providing supplementary cooling, Reliance Electric can advise you of the expected thermal losses of each piece of equipment. For separately ventilated motors, Reliance Electric can also advise you of the cooling air CFM and pressure drop requirements.

Regardless of the cooling method, the equipment is designed assuming some of this heat is dissipated at the equipment surfaces. Adequate space must be provided around the equipment for the free flow of air across these surfaces. This is especially important for non-ventilated equipment. See Table 3-1 for typical space requirements for drive enclosures.

If there is a source of radiant heat energy within sight of the equipment (such as hot metal slabs), there may be problems even if the ambient air is at less than 40°C. These cases must be discussed on an individual basis with Reliance Electric.

3.3 Installation and Start-Up

During the installation and start-up of a drive system, unusual conditions may exist that are not normally encountered while in service. For example, the equipment must be physically moved and protective covers frequently must be open for service access. Some of these conditions may also exist during normal maintenance. The following describes installation and start-up requirements to accommodate these conditions.

3.3.1 Site Preparation

Site preparation before installation is important regardless of the size of the drive system. However, larger systems require greater care for a good site plan. Many times a large number of vendors and trades are working on a construction site at the same time. This amount of activity creates a great deal of dust, dirt, and physical movement. The arrival of the drive system should be coordinated such that the site chosen for the equipment is protected from exposure to the construction activity.

If a separate control room is being used, the following should be accomplished before the control electronics are put into place.

1. All construction in the room is complete.
2. The concrete floor is swept clean and sealed with a commercial sealer in order to minimize dust contamination.
3. All air conditioning/air filtration systems are in place and operational.

If the above steps are not possible within the timeframe allowed for the project, or if a separate control room is not provided, additional steps must be taken to protect the equipment from the following:

1. Cement dust and other construction debris.
2. Chemical atmospheres (especially sulfides and chlorides).
3. Condensing humidity.
4. Temperature extremes: above 40°C (104°F); below 0°C (32°F).
5. Physical damage due to construction activity.

3.3.2 Unpacking

Protective wrappings, bags, cartons or crating containing equipment and parts should not be removed until equipment reaches its final installation site, except as required for acceptance inspection. After inspection, the shipping protection should be re-installed and sealed. Exercise care in removal of protective materials.

Shipping skids, when supplied, should not be removed until equipment reaches the final installation site and is ready to be lifted into position for anchoring. Skids should be detached with care, since some equipment is top heavy.

3.3.3 Lifting and Handling

All large floor-mounted pieces of drive equipment are shipped on separate skids. In some cases, smaller pieces are shipped on a common skid. The skids provide for easy movement of the equipment by forklift trucks. As stated above, the equipment should remain on the shipping skids until it is ready to be installed in its final location. Then use the following procedures to lift the equipment off the skids and into place.

- **Wall-Mounted Equipment**
  Depending on the size and weight, these items should be lifted into position by hand or by hoist using a padded sling properly located to distribute the weight.

- **Operator Floor-Mounted Benchboards/Consoles**
  Unbolt the equipment from the shipping skid and slide it into position taking care not to tip it over. Benchboards are usually top heavy.

- **Floor-Mounted Cabinets and Mill Control**
  Lift equipment using ALL of the eyebolts or lifting lugs supplied.
  Assure that the load is equalized on all lift points by using the proper slings. Prevent damage to the equipment by using spreader bars and padding as required.

- **Motors and Gears**
  Lift the equipment using the eyebolts supplied. Note that for assemblies, the eyebolt for each piece is designed only for lifting that piece and its normal auxiliary equipment. Motor/reducer/ baseplate assemblies must be lifted by the baseplate with the motor and reducer uncoupled.

- **Drive Transformers**
  Lift with a forklift under the unit.

Additional information on lifting is included in the dimension sheets and instruction manuals for the respective equipment.

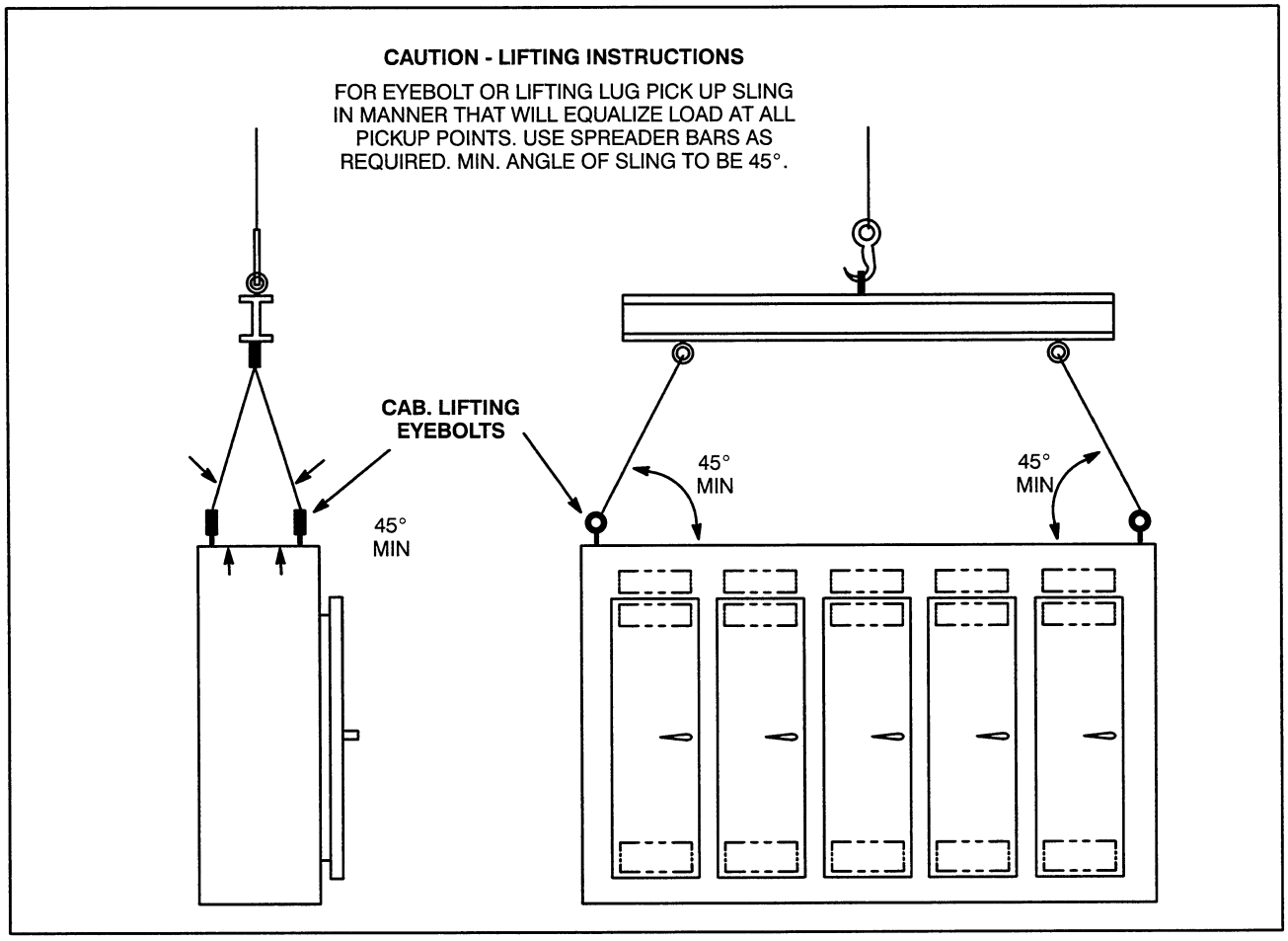


Figure 3.2 - Lifting Control Cabinets

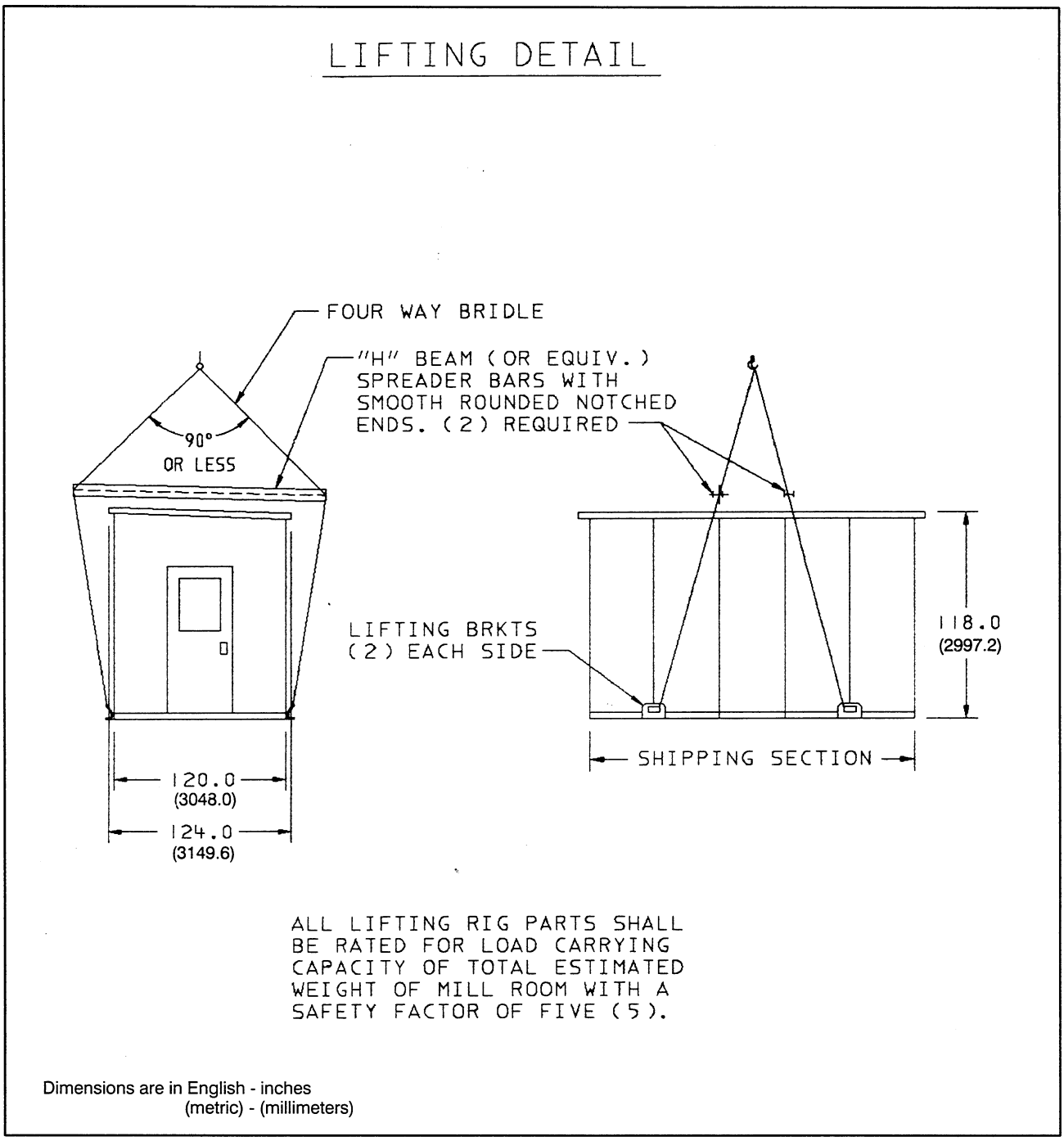


Figure 3.3 - Lifting Mill Houses

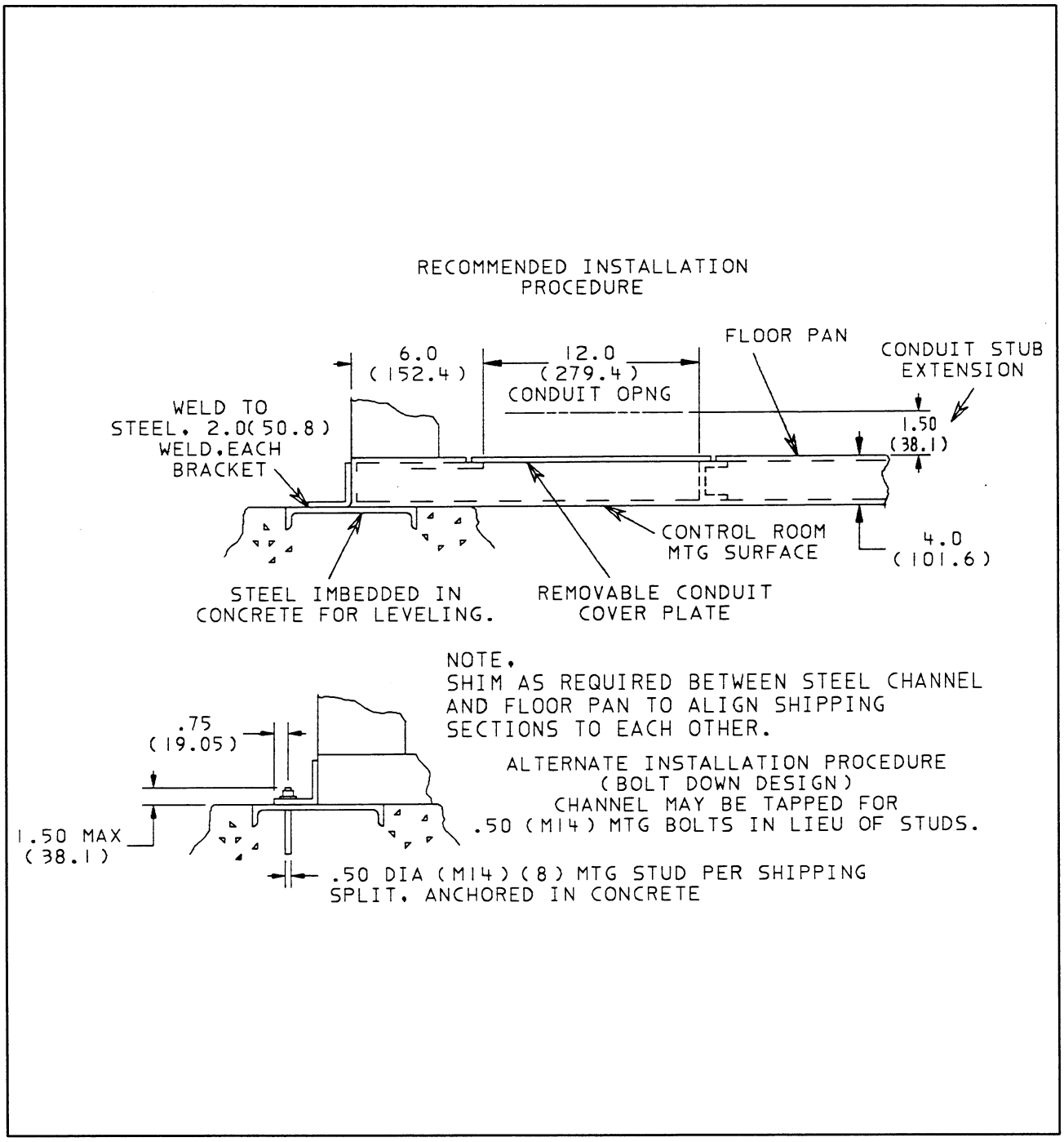


Figure 3.4 - Anchoring Mill Houses

3.3.4 Control Alignment and Anchoring

Before the final anchoring of control enclosures, check that the equipment is level and fully supported at all anchor points using steel shims as necessary. If this is not done, the enclosure skin or control panels may be distorted causing wiring stresses, broken components, or improper environmental sealing. Refer to the dimension sheets (D/S or W/S) of the supplied equipment to determine mounting requirements and mounting hole locations.

3.3.5 Conduit Installation

When installing wiring conduit or raceways which require holes or openings to be cut in the equipment sheet metal enclosure, care must be taken to prevent damage to internal components or the enclosure itself. **Internal electronics must be protected from debris (metal chips) caused by drilling or sawing.**

When the installation is complete, the interior of the equipment cabinet should be vacuumed out and wiped clean.

3.3.6 Rotating Equipment Installation

The alignment and anchoring of motors and gears is critical for proper operation and long life. Misalignment and/or inadequate anchoring can cause variations in speed or torque and even bearing or shaft failure. Refer to the instruction manuals for each piece of equipment for detailed information regarding its installation, operation, and maintenance. These manuals are included in the Instruction Books for your Engineered Drive System and are also available through your local Reliance Electric Sales Office.

Reliance Electric motors are designed and built in accordance with the National Electric Manufacturers Association (NEMA) publication MG 2 entitled "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators". Reliance Electric recommends that this publication be referred to whenever you select or install any motor. Copies may be obtained from NEMA Publication Distribution Center, P.O. Box 338, Annapolis Junction, MD 20701-0338. In addition, all motors must be installed in accordance with the National Electric Code and applicable local codes.

When separate foot-mounted tachometers, pulse generators, or resolvers are coupled to motors for speed feedback, the alignment between the device and the motor is especially critical. Any misalignment may cause speed feedback variations that are amplified by the closed loop control. Also, a torsionally stiff flexible coupling, such as Reliance Electric Part Number 406041-A, must be provided between the motor and the speed-sensing device to prevent bearing failure. See figure 3-5 for general alignment instructions.

See the instruction manual for the respective speed-sensing device for the correct alignment procedures, or refer to instruction manual C-3095. Re-alignment is not required at installation if the speed-sensing device is provided flange-mounted with the motor.

DANGER

PROVIDE SUITABLE GUARDS FOR COUPLINGS BETWEEN THE TACHOMETER AND MOTOR SHAFTS AND OTHER ROTATING SHAFTS. THIS IS PARTICULARY IMPORTANT WHERE THE PARTS HAVE SURFACE IRREGULARITIES SUCH AS BOLTS, NUTS, SET SCREWS, KEYS, ETC. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

ROTATING PARTS, SUCH AS COUPLINGS, PULLEYS, EXTERNAL FANS, AND UNUSED SHAFT EXTENSIONS, SHOULD BE PERMANENTLY GUARDED AGAINST ACCIDENTAL CONTACT WITH HANDS OR CLOTHING. THIS IS PARTICULARLY IMPORTANT WHERE THE PARTS HAVE SURFACE IRREGULARITIES SUCH AS KEYS, KEYWAYS OR SET SCREWS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

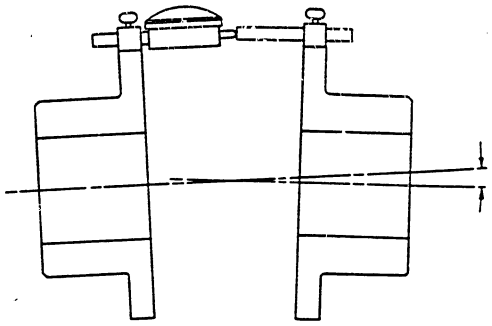
Proper guards and other suitable safety devices, as may be desirable or as may be specified in safety codes, showed be provided by the user. These items are not provided by Reliance Electric and are not the responsibility of Reliance Electric.

Correct installation and alignment will assure long life and smooth, trouble free service.

Two methods are commonly accepted:

1. Dial indicator method (required for variable speed & high power machines)
2. Caliper and straight edge (alternate method.)

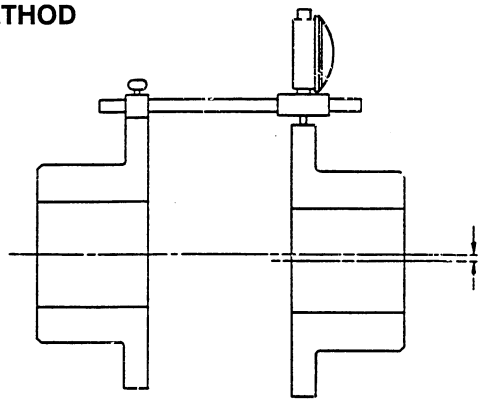
DIAL INDICATOR METHOD



CHECK FOR ANGULAR MISALIGNMENT

Dial indicator measures maximum longitudinal variation in hub spacing through 360° rotation.

1. Attach dial indicator to a hub, as with a hose clamp; rotate coupling 360° to locate point of minimum reading on dial; then rotate body or face of indicator so that zero reading lines up with pointer.
2. Rotate coupling 360°. Watch indicator for misalignment reading.
3. Driver and driven units will be lined up when dial indicator reading comes within maximum allowable variation. The total angular misalignment should not exceed 0.002 inches (0.05 mm) for flexible couplings and 0.001 inches for solid couplings.

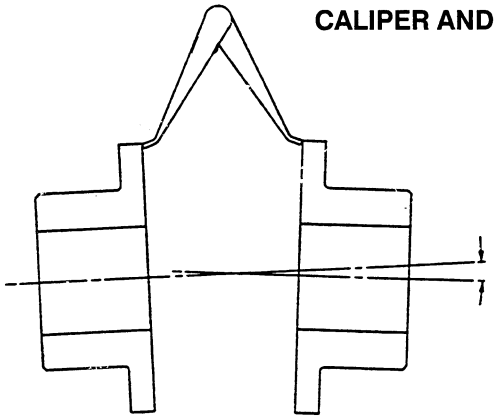


CHECK FOR PARALLEL MISALIGNMENT

Dial indicator measures displacement of one shaft center line from the other.

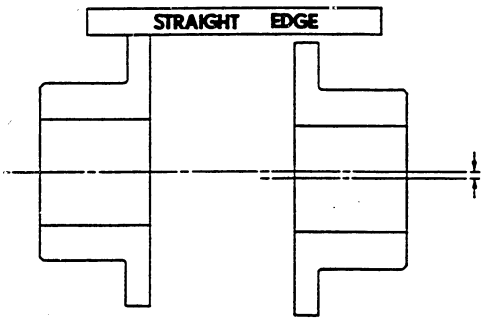
4. Reset pointer to zero and repeat above operations 1 and 2 when either driven unit or driver is moved during aligning trials.
5. Check for parallel misalignment as shown. Move or shim units so that parallel misalignment is brought within the maximum allowable variations for the coupling style.
6. Coupling should be rotated several revolutions to make sure no "end-wise creep" in connected shafts is measured.
7. Tighten all locknuts or capscrews.
8. Re-check and tighten all locknuts or capcrews after several hours of operation.

CALIPER AND STRAIGHT EDGE METHOD



CHECK FOR ANGULAR MISALIGNMENT

1. Use calipers to check the gap between hubs. Gap should be the same at all points around the hub.
2. Place straight edge on the rims at the top and sides. When the coupling is in alignment the straight edge should rest evenly and both disc pack assemblies should be in a perfect plane at right angles to the straight edge.
3. Tighten all locknuts or capscrews.
4. After several hours of operation recheck gap between hubs, and recheck tightness of all locknuts or capscrews.



CHECK FOR PARALLEL MISALIGNMENT

Figure 3.5 - General Alignment Instructions

3.4 Long Term Storage

The following sections provide guidelines for storing drive control or rotating equipment for an indefinite period of time.

3.4.1 Drive Control Equipment

The environmental factors that must be controlled for indefinite storage of Reliance Electric control equipment are temperature, dust, shock and vibration, corrosive atmosphere, and humidity. With normal packaging, do not store equipment outside.

- **Temperature**
  The temperature limits for storage of control cabinets are 0° to +60°C (+32° to +140°F). Space heaters should be provided if the temperature is below the lower limit, and an adequate air supply or air conditioning should be provided above the upper limit.

- **Dust**
  If the storage facilities are not dust free, then the equipment should be wrapped and sealed in a polyvinyl or polyethylene film. The method wrapping should be air-tight to eliminate the possibility of the interchange of air between the enclosure and the ambient due to slight pressure differentials.

- **Shock and Vibration**
  The storage area should be free of vibration. High or continuous vibration levels can loosen screws, damage meter movements, etc.

  Also, in the case of operator control consoles, special care should be taken to protect the projecting devices (meters, push buttons, selector switches, rheostat handles, etc.) from damage due to impact from careless handling and storage practices. Nothing should be stacked on these consoles without adequate protection for these devices.

- **Corrosive Atmosphere**
  Electrical equipment should not be stored in a corrosive atmosphere unless it can be enclosed in sealed and purged containers.

- **Humidity**
  Prevention of condensation on the equipment is important whether the equipment is stored open or wrapped and sealed. Steps must be taken to prevent condensation due to changes in temperature or to moisture from the environment during the storage period. Adequate storage methods are:

  1. Use sealed leakproof containers containing an adequate amount of an approved desiccant.
  2. Use sealed leakproof containers with a dry gas purge.
  3. Store in a temperature and humidity controlled area.

3.4.2 Rotating Equipment

Motor and gear storage requires additional care and consideration. Contact Reliance Electric Industrial Sales for information on the proper storage of the particular motors and gears in your system, or see Reliance Electric Motor Division Service Bulletins A-8013 or A-8018 available through your nearest Reliance Electric Sales Office.

4.0 ELECTRICAL CONSIDERATIONS IN DRIVE SYSTEM INSTALLATION

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

DANGER

THE USER IS RESPONSIBLE FOR CONFORMING WITH ALL APPLICABLE LOCAL, NATIONAL, AND INTERNATIONAL CODES. WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVER-CURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

4.1 User and Electrical Contractor Responsibilities

Reliance Electric is not responsible for construction engineering, utility supply, equipment installation or site code compliance unless Installation Services are specifically included in the contract. Reliance Electric is responsible only for the electrical drive equipment being designed and built in accordance with applicable codes and standards.

It is your responsibility, and the responsibility of your installing electrical contractor, to ensure that your Reliance Electric equipment is installed properly according to this manual and any other notes or instructions in the engineering drawing package and instruction manuals supplied for your system.

Reliance Electric cannot guarantee the performance of your system if these recommendations are not followed. The requirements for noise prevention for signal wiring are especially important to system performance.

Reliance Electric is not responsible for the specification, design, or operation of the driven equipment. The specification, location, and functions of the operator stations, emergency disconnects, guarding or other safety devices or procedures, as may be desirable or as may be required by safety codes, are not provided by Reliance Electric and are not the responsibility of Reliance Electric.

The electrical contractor must also follow all applicable codes for power and control wiring in the installation of your Reliance Electric equipment, unless you receive prior approval for exceptions from your local inspector.

4.2 Reference Documents

The primary code covering the installation of the motors, controllers, operator devices and other related equipment is NFPA 70 "National Electrical Code" published by the National Fire Protection Association. It covers wire and device sizing, overload and short circuit protection, grounding, and disconnecting means for power and control circuits. Copies of the "National Electrical Code" may be obtained from the National Fire Protection Association, One Battery March Parkway, P.O. Box 9101, Quincy, Massachusetts 02269-9990.

Other local, national, or international codes may also apply. Consult your local inspecting agency for information about any other codes that may apply to industrial electrical equipment for your installation.

Other publications that will be useful during the installation and on-going operation of this equipment are:

- NFPA 70B, "Electrical Equipment Maintenance"
- NFPA 70E, "Electrical Safety Requirements for Employee Workplaces"
- NFPA 79, "Electrical Standards for Industrial Machinery"
- NEMA Standard ICS 1.1, "Safety Guidelines for the Application, Installation and Maintenance of Solid State Control"
- NEMA Standard ICS 3.1, "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems"

NEMA Standards can be obtained from the National Electrical Manufacturers Association, NEMA Publication Distribution Center, P.O. Box 338, Annapolis Junction, MD 20701-0338.

- ANSI/IEEE STD 518, "Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources"
- ANSI/IEEE STD 428, "IEEE Standard Definitions and Requirements for Thyristor A-C Power Controllers"

IEEE Standards can be obtained from IEEE Service Center, Publication Sales Department, 445 Hoes Lane, Piscataway, NJ 08855-1331.

4.3 Code Requirements

The National Electrical Code and most local codes define the installation practices required to prevent fires and insure that the installation is safe for personnel and equipment. Reliance Electric equipment is designed and built to conform to the National Electrical Code. Options are available at extra cost to comply with local codes when these exceed the requirements of the NEC, such as UL, CSA, IEC, and any applicable state and local codes.

The following sections describe some of the items you need to consider for your installation in order to conform with the NEC.

4.3.1 Branch Circuit Protection

The drive overload and short circuit protection may or may not provide branch circuit protection. Per the NEC, the protection level depends on the length of the A-C input feeder, the ampere rating of the wire or bus used, and the rating of the upstream protective device. These must be coordinated as part of the installation design. Reference NEC (NFPA 70) article 110-9, 110-10.

The available fault current of the source must not exceed the value given on the system elementary (W/E) drawings.

4.3.2 Disconnecting Means

If specified, a drive disconnect is provided by Reliance Electric as part of the drive enclosure. If not provided by Reliance Electric, a drive disconnect must be provided by others within 50 feet of the driven machine and it must be visible from the drive enclosure. It must also be capable of handling at least 115% of full load current at the rated line voltage.

If the drive disconnect is not padlockable in the off position, the NEC requires a separate disconnect within 50 feet of the driven machine and it must be visible from the motor and the driven machine.

The specification, function, and location of additional disconnecting means, as may be desirable or as may be required by applicable safety codes, are the responsibility of the user, machine designer, OEM, or other third party.

4.3.3 Grounding

Exposed noncurrent-carrying metal parts of electric motor controller enclosures must be grounded in accordance with the requirements of the National Electrical Code. For Reliance Electric equipment, an adequately-sized grounding conductor is required from the enclosure direct to the building ground. This grounding conductor must be supplied by the user, machine designer, OEM, or other third party. This also applies to switchgear and transformer enclosures and motor frames in most applications. See the NEC (NFPA 79) for exceptions.

Operator stations and desks must be grounded if any internal circuitry operates at 150V or more above ground potential, in accordance with NEC requirements. It is recommended that they be grounded even when the voltages are less than 150V.

All conduit, wireways, and junction boxes must provide continuous ground paths to the grounded enclosures.

Isolation transformers used to power adjustable speed drives should have their secondary circuits grounded. Reliance Electric recommends a high resistance ground to minimize arcing fault damage to equipment during a ground fault. For y-connected transformer secondaries, the grounding resistor should be connected to the transformer neutral. For delta-connected transformer secondaries, a pseudo neutral may be created with devices such as grounding transformers.

CAUTION

INPUT AND OUTPUT CIRCUITS CANNOT BOTH BE GROUNDED FOR THE SAME ADJUSTABLE SPEED DRIVE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT.

Reliance Electric requires all low level signal and regulator circuits to be ungrounded. Reliance Electric must be advised if any connecting circuits or equipment contain ground paths; isolating amplifiers may be required. Isolating modems may be required for communications circuits.

4.3.4 Phasing

Reliance standard phasing is A - B - C at customer connection terminals, left to right or top to bottom. All current drive system designs are phase insensitive. Phase rotation on A-C motors may be adjusted to give desired motor shaft rotation.

4.3.5 Wire Size

Except as noted above, Reliance Electric does not recommend wire sizes or types for power wiring between equipment (defined by the NEC as "Premises Wiring"). The selection of such wiring depends on site factors that are not normally known by Reliance Electric.

However, Reliance Electric W/E drawings provide the full load ampere ratings and voltage ratings for all power circuits, as shown in Appendix A. This information can be used to select wire types and sizes according to the NEC as part of the installation conduit design.

4.4 Wiring Levels and Classes

Drive systems include a wide variety of electrical and electronic circuits. These range from power circuits that radiate considerable electromagnetic energy, to sensitive electronic circuits susceptible to induced voltages or currents. Solid state digital logic circuits may be sensitive to transients produced by switching large currents or by close coupling of field wiring conductors unless properly protected.

System wiring is divided into four basic levels depending upon each circuit's susceptibility to noise or its noise-generating capability. The installation wiring for these levels must be physically separated to prevent poor system performance as a result of induced noise. Within each level there also may be classes that require additional grouping and separation of installation wiring. These levels and classes are defined in ANSI/IEEE Standard 518, Section 6.4.3.1 as follows:

Level 1 - High Susceptibility.

Level 2 - Medium Susceptibility.

Level 3 - Low Susceptibility.

Level 4 - Power.

Different levels must be run in separate conduit or wire trays. Classes within a level must be run in separate conduit, but may be run in the same wire trays as long as they are grouped and separated. The IEEE levels and classes are identified on the Reliance Electric W/E drawings for installation wiring with slash cabling notes.

Following are more detailed definitions of the circuit levels based on the IEEE Standard 518-1982, and descriptions of the practices required for each level. Material reprinted with modification from ANSI/IEEE Std 518-1982, IEEE Guide for the Installation of Electrical Equipment to Minimize Noise Inputs to Controllers from External Sources, copyright 1982 by The Institute of Electrical and Electronics Engineers, Inc., by permission of the IEEE Standards Department.

4.4.1 Level Identification

Examples of typical circuits commonly found in Reliance Electric drive systems for each level:

- LEVEL 1 - LOW LEVEL SIGNAL CIRCUITS
  Analog signals less than 50 V and digital signals less than 15 V.
  * Signal common for Level 1.
  * D-C power supply buses less than 50 V feeding analog hardware or solid state digital hardware.
  * 15 volt and less non-inductive D-C control.
  * Operational amplifier inputs and outputs.
  * Power amplifier inputs or outputs less than 50 V.
  * 4-20 ma and 0-10 V analog inputs and outputs.
  * Resolvers and digital tachs or pulse generators. (See W/E drawings for additional notes.)
  * Analog tachometers below 50 V.
  * Force transducers and thermocouples.
  * Serial or parallel digital communications lines.
  * Communication circuits using coax.
  * Phone circuits.
  * Fiber-optic interconnecting cables.
- LEVEL 2 - MEDIUM LEVEL SIGNAL CIRCUITS
  Analog signals greater than 50V, switching signals less than 50V.
  * Signal common for Level 2.
  * Indicating lights, push buttons and relays at 50 V or less.
  * Machine-mounted limit switches, proximity switches, pressure switches, thermostats, solenoids, etc., below 50 V.
  * Analog tachometers above 50 V.
  * Low voltage or current signals to isolating transducers or meters.
  * Selsyn and synchro signals.

- LEVEL 3 - CONTROL CIRCUITS
  Switching signals greater than 50 V, analog signals greater than 50 V, regulating signals of 50 V with currents less than 20A, and A-C feeders 20 A or less.
  * Fused control supply buses 50 to 250 V D-C.
  * A-C feeders 20 A or less. (A-C feeders above 250 V or feeders to A-C motors may be included in level 4 regardless of ampere rating for Reliance systems.)
  * Indicating lights, push buttons and relays above 50 V.
  * Machine-mounted limit switches, proximity switches, pressure switches, thermostats, etc., above 50 V.
  * Contactor, starter and solenoid coils above 50 V.
  * Motor or generator fields 20 A or less. (For Reliance drives, these may be included in level 4.)
  * Convenience outlets and cabinet or panel lighting.
  * Power voltage or current signals to isolating transducers or meters. (Class 3S for power circuits above 1000 V and/or 800 A.)
  * Ground detector circuits. (Class 3S for power circuits above 1000 V and/or 800 A.)
- LEVEL 4 - POWER CIRCUITS
  A-C and D-C buses up to 1000 volts with currents up to 800 amperes. (Class 4S for power greater than 1000 volts and/or 800 amperes.)
  * A-C feeders above 20 A or 250 V.
  * D-C motor and generator armature circuits.
  * Machine fields above 20 A.
  * A-C motors.
  * Primaries and secondaries of transformers above 5KVA.
  * Static exciters (regulated and unregulated) A-C input and D-C output.
  * 250 V and above D-C power bus.

4.4.2 Noise Level Application Precautions

The following wiring practices must be followed to minimize electromagnetic noise. These recommendations are given in ANSI/IEEE Standard 518 with some additional restrictions based on Reliance Electric's experience with drive systems.

4.4.2.1 Tray-to-Tray Spacing

Table 4.1 indicates the minimum distance in inches between the top of one wire tray and the bottom of the tray above, or between the sides of adjacent trays. This also applies to the distance between trays and power equipment of less than 100 KVA (see note 5 in section 4.4.2.4).

Table 4.1 - Tray-To-Tray Spacing In Inches (Millimeters)

LEVEL	1	2	3	3S	4	4S
1	0	NOTE 2	6 (152.4)	6 (152.4)	26 (660.4)	26 (660.4)
2	NOTE 2	0	6 (152.4)	6 (152.4)	18 (457.2)	26 (660.4)
3	6 (152.4)	6 (152.4)	0	0	NOTE 1	12 (304.8)
3S	6 (152.4)	6 (152.4)	0	0	8 (203.2)	18 (457.2)
4	26 (660.4)	18 (457.2)	NOTE 1	8 (203.2)	0	0
4S	26 (660.4)	26 (660.4)	12 (304.8)	18 (457.2)	0	0

4.4.2.2 Conduit-to-Tray Spacing

Table 4.2 indicates minimum distance in inches between wire trays and conduits. This also applies to the distance between trays or conduits and power equipment of less than 100 KVA. Use the notes with Table 3.1.

Table 4.2 - Conduit-To-Tray Spacing In Inches (Millimeters)

LEVEL	1	2	3	3S	4	4S
1	0	1 (25.4)	4 (101.6)	4 (101.6)	18 (457.2)	18 (457.2)
2	1 (25.4)	0	4 (101.6)	4 (101.6)	12 (304.8)	18 (457.2)
3	4 (101.6)	4 (101.6)	0	0	0	8 (203.2)
3S	4 (101.6)	4 (101.6)	0	0	6 (152.4)	12 (304.8)
4	18 (457.2)	12 (304.8)	0	6 (152.4)	0	0
4S	18 (457.2)	18 (457.2)	8 (203.2)	12 (304.8)	0	0

4.4.2.3 Conduit-to-Conduit Spacing

Table 4.3 indicates the minimum distance in inches between the outside surfaces of conduits being run in banks. This also applies to the distance between conduits and power equipment of less than 100 KVA.

Table 4.3 - Conduit-To-Conduit Spacing In Inches (Millimeters)

LEVEL	1	2	3	3S	4	4S
1	0	1 (25.4)	3 (76.2)	3 (76.2)	12 (304.8)	12 (304.8)
2	1 (25.4)	0 0	3 (76.2)	3 (76.2)	9 (228.6)	12 (304.8)
3	3 (76.2)	3 (76.2)	0	0	0	6 (152.4)
3S	3 (76.2)	3 (76.2)	0	0	6 (154.2)	9 (228.6)
4	12 (304.8)	9 (228.6)	0 0	6 (152.4)	0	0
4S	12 (304.8)	12 (304.8)	6 (152.4)	9 (228.6)	0	0

4.4.2.4 Tray and Conduit Cabling Notes

1. Level 3 may be run in a common tray with level 4, but should be separated by a barrier. (This barrier does not necessarily have to be grounded). Spacing should be for level 4, however.
2. When separate trays are impractical, levels 1 and 2 may be combined in a common tray, provided levels are separated by a grounded steel barrier. This practice is not as effective as separate trays and some re-routing at start-up may be required. Where levels 1 and 2 are run side by side in trays, one-inch minimum spacing is recommended.
3. When unlike signal levels must cross either in trays or conduits, they should cross at 90 degree angles at a maximum spacing. Where it is not possible to maintain spacing, a grounded steel barrier should be placed between unlike levels at the crossing point.
4. Trays containing level 1 and level 2 wiring must have solid bottoms and covers. Ventilation slots or louvers may be used on other trays. Cover contact to side rails must be positive and continuous to avoid high reluctance air gaps which impair shielding.

   Trays and conduit for all levels should be metal, solidly grounded with good ground continuity. Reliance Electric requires trays and conduit for levels 1 and 2 to be made of steel for magnetic shielding.
5. Trays and conduits containing levels 1, 2 and 3S should not be routed parallel to high power equipment enclosures of 100KVA and larger at a spacing of less than five feet for trays and two and one half feet for conduit.
6. Where practical for level 4 and 4S wiring, the complete power circuit between equipment should be routed in the same path, i.e., in the same tray or conduit. This practice will minimize the possibility of power and control encircling each other.
7. When entering terminal equipment and the spacings previously listed are difficult to maintain, parallel runs should be kept to a minimum and should not exceed 5 feet in the overall run.
8. All spacing given in Table 4.2 assume that the levels 1 and 2 trays will be covered.
9. Where "0" is indicated as a tray or conduit spacing, the levels may be run together, but spacing to other levels must be based on the worst case.
10. Level 3 and 3S may be combined in the same tray or conduit, but cannot be combined in the same cable.
11. Locate level 1 and 2 trays and conduits closest to the control panels.

4.4.2.5 Pullboxes and Junction Boxes

Different levels must be kept separate within pullboxes and junction boxes, with grounded steel barriers where possible. Reliance Electric requires that level 1 and 2 NOT be routed through the same pullboxes and junction boxes as levels 3 and 4.

Care should be taken to cross unlike levels at right angles and maintain required separation.

4.4.2.6 Conduits Around and Through Machinery

Conduits running through and attached to machinery housings should follow the same level spacing recommendations.

Trunions entering operator's cabinets should be kept as short as possible thereby minimizing parallel runs of unlike levels. Cables of unlike levels should be kept separate for as long a distance as possible.

Where different levels are run together for short distances (up to 5 feet maximum), each level should be segregated by cord ties, barriers, or some logical method so that intermixing is avoided.

4.4.2.7 Transitional Areas

When entering or leaving conduits or trays, care should be taken to assure that cables of unlike levels do not become intermixed and that different levels cross at right angles.

Grounded steel barriers must be used for level separation when parallel runs over 5 feet overall become necessary.

4.5 Reliance Electric Recommendations and Standard Practices

The following wiring recommendations and standard practices apply to all Electrical Drive System equipment provided by Reliance Electric unless superseded by other information provided by Reliance Electric for a specific application.

4.5.1 Standard Wiring Notes

Reliance Electric uses a set of standard notes (W/N) to help you select the proper wiring and route field-installed cabling and conduit runs. These notes include component locations and any special wiring practices that are required. The notes also identify different wire classes that must be segregated within an IEEE level.

The standard note sheets are always included with W/E drawings, along with any special notes for a specific application. Examples are given in Appendix E of this manual and in figures 4.1 and 4.2.

4.5.2 Wiring to Drive Enclosures

Premises wiring (as defined by the NEC) entering Reliance Electric enclosures and panels must follow the same IEEE separation rules defined above. This wiring should enter the enclosure at the designated conduit entry points closest to the provided terminations. These entry points are shown on the enclosure dimension sheets as shown in figure 3.1. The termination locations are shown on the panel layout (W/L) drawings, as shown in Appendix C.

Reliance Electric control panels are normally designed for A-C power entry at the top, A-C or D-C power output at the bottom, and control or signal entry and exit at either the top or bottom. If other arrangements or non-standard conduit entry points are required, Reliance Electric must be advised in advance so that additional provisions can be made within the enclosures for routing the premises wiring.

CAUTION

PREMISES WIRING MUST NOT BE RUN WITHIN THE CONTROL PANEL WIRE CHANNELS THAT ARE USED FOR INTERNAL WIRING. PREMISES WIRING MUST NOT BE ROUTED THROUGH CONTROL PANELS EXCEPT IN AREAS DESIGNATED FOR CUSTOMER WIRING. FAILURE TO OBSERVE THESE RULES MAY VOID YOUR WARRANTY FOR AFFECTED CIRCUITS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT.

As a general rule, all control and signal terminal boards are provided with lashing bars or tie pads for securing incoming cables. No more than two wires are to be connected to any control terminal.

Wiring for foreign circuitry not connected to terminals in an enclosure should not be routed through the enclosure.

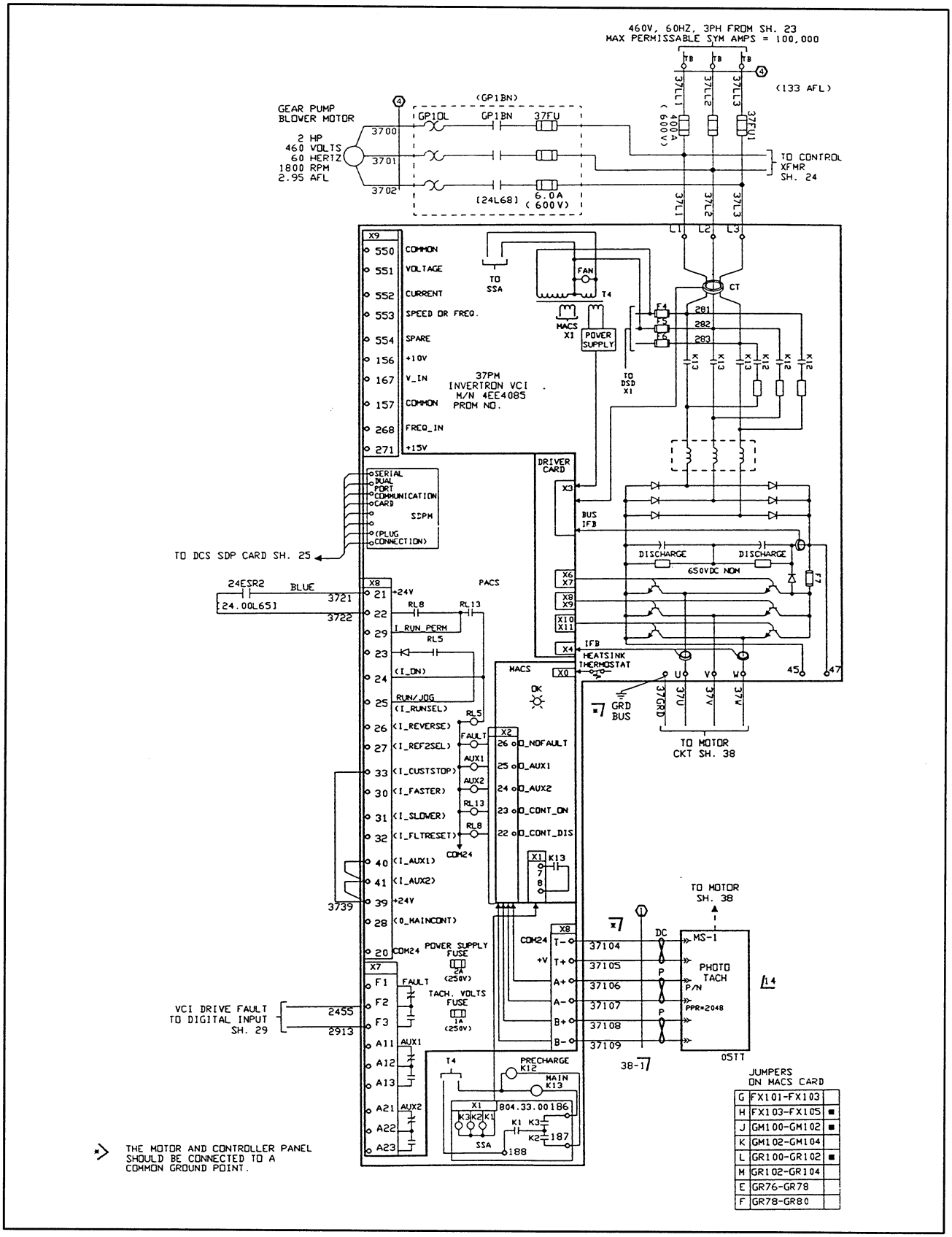
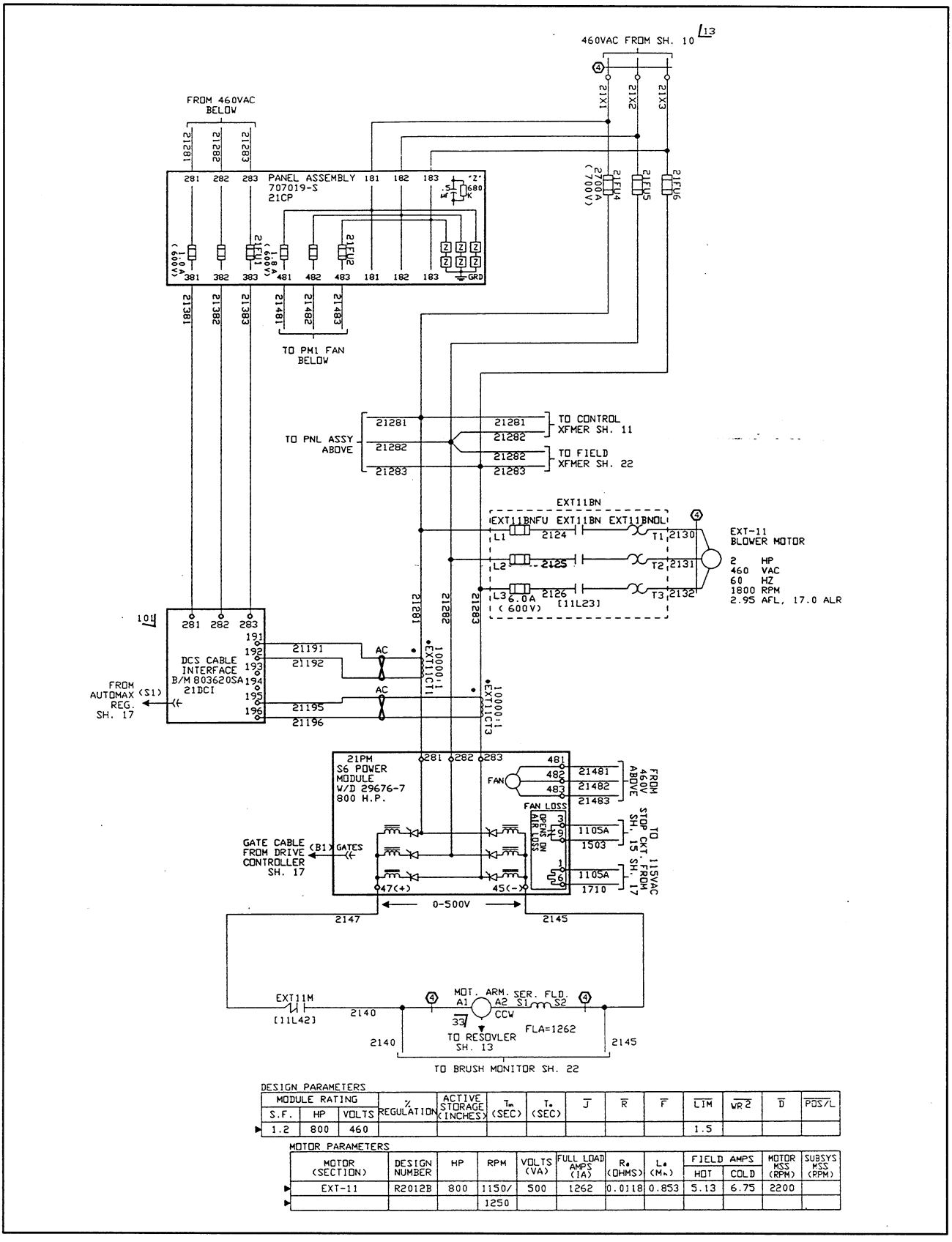


Figure 4.1 - Typical Wiring Notes on Elementary Diagram (A-C)



DESIGN PARAMETERS

MODULE RATING			% REGULATION	ACTIVE STORAGE (INCHES)	T_m (SEC)	T_e (SEC)	$\overline{J}$	$\overline{R}$	$\overline{F}$	$\overline{LIM}$	$\overline{WR^2}$	$\overline{D}$	$\overline{POS/L}$
S.F.	HP	VOLTS											
1.2	800	460								1.5			

MOTOR PARAMETERS

MOTOR (SECTION)	DESIGN NUMBER	HP	RPM	VOLTS (VA)	FULL LOAD AMPS (IA)	R_a (OHMS)	L_a (MH)	FIELD AMPS HOT	FIELD AMPS COLD	MOTOR MSS (RPM)	SUBSYS MSS (PPM)
EXT-11	R2012B	800	1150/ 1250	500	1262	0.0118	0.853	5.13	6.75	2200	

Figure 4.2 - Typical Wiring Notes on Elementary Diagram (D-C)

4.5.3 Coil Suppression

If wiring connected to circuitry provided by others enters a Reliance Electric enclosure, or is run in the same conduit or wire trays, all relays and contactors in the other equipment must be suppressed according to figure 4.3. Actual part numbers may vary depending on contactor or relay sizes.

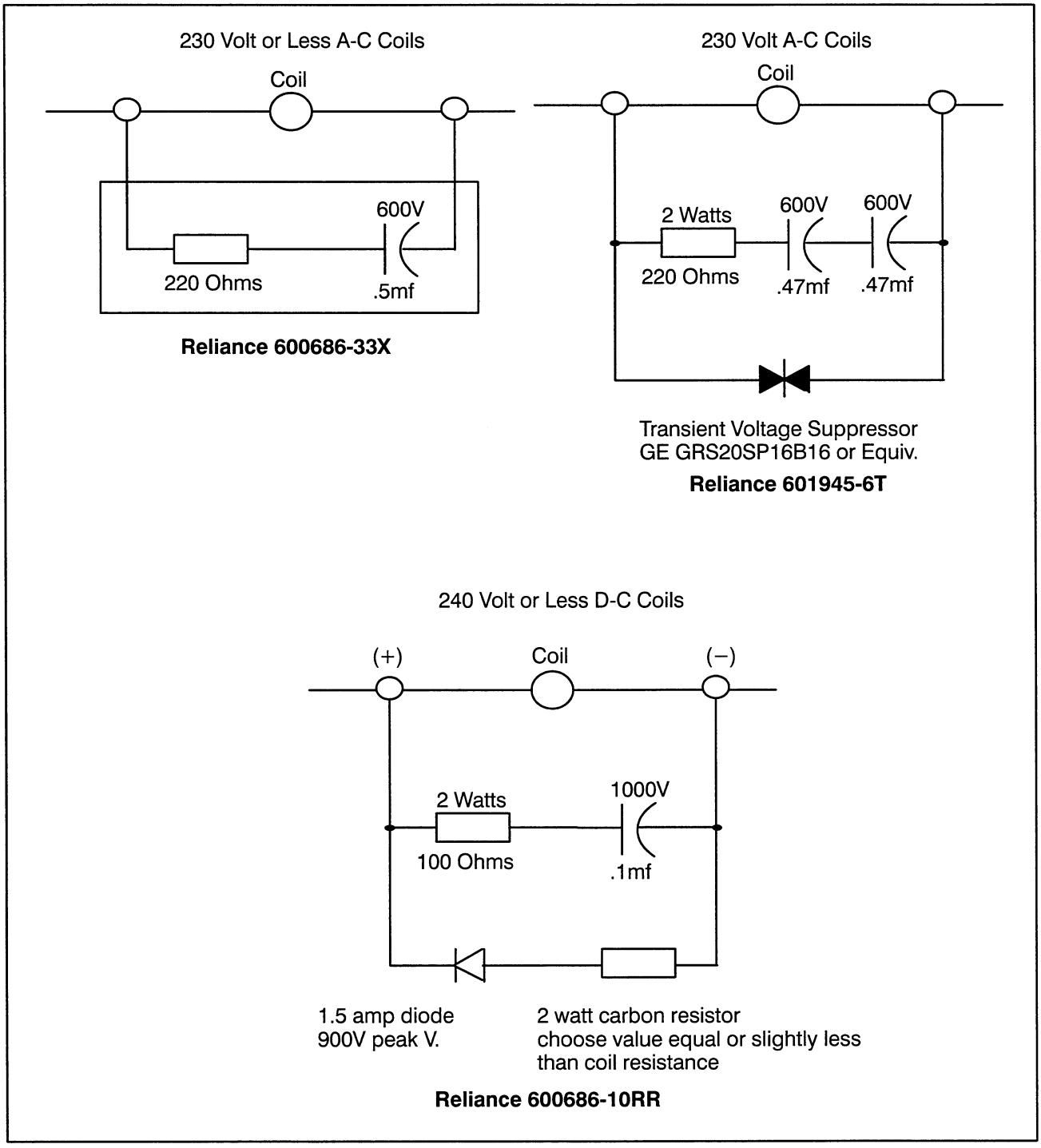


Figure 4.3 - Typical Coil Supression Configurations

4.5.4 Signal Wire Specifications

Different classes of signal wire (levels 1 and 2) are identified on the Reliance Electric W/E drawings by standard notes as shown in figure 4.4. These notes define the wire types and separation requirements as described above.

Where twisted pair wire is specified, it must be unshielded and have at least two complete turns per inch (.5 inch lay). Twisted triplet must also be unshielded and have eight complete turns per foot (1.5 inch lay). The following wire meets these specifications.

Wire sizes must be selected based on the length of the wire run, the current in the circuit, and the allowable voltage drop.

Reliance Electric can advise you of the requirements for other specific circuits if long wire runs are expected.

Table 4.4 - Signal Wire Selection

Reliance Part No.	Vendor	Vendor Part No.	Description	Wire Guage	Ohms / Foot	Temp Rating	Insul. Rating
417900-92DAD	N/A	N/A	1 Pair Twisted	18	.020	200°C	600V
417900-76EAD	N/A	N/A	1 Pair Twisted	16	.014	105°C	600V
N/A	Belden	9497	1 Pair Twisted	16	.014	105°C	300V
417900-79X	N/A	N/A	1 Triple Twisted	16	.014	105°C	600V
N/A	Belden	9498	1 Triple Twisted	16	.014	105°C	300V
417900-207CG	Paige Elec.	N/A	3 Pair Twisted Jacketed	18	.020	105°C	300V

Note: 417900-92 DAD recommended for long runs.

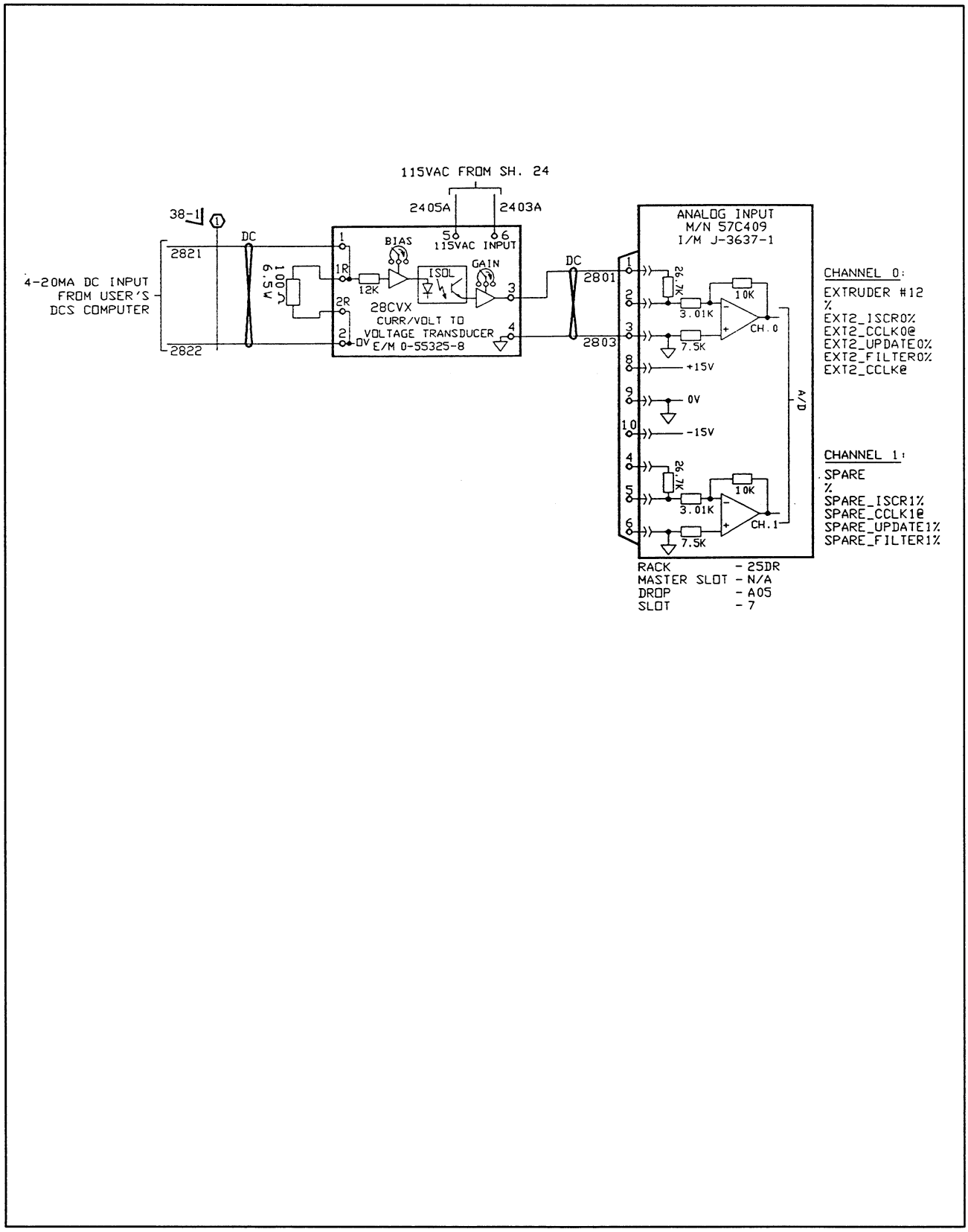


Figure 4.4 - Typical Signal Circuit Elementary Drawing (W/E)

4.6 Coaxial Cable

The following applies to coaxial cable used for high speed serial communications lines such as networks, remote I/O communications lines, or high speed communications on computer systems.

4.6.1 Cable Type Selection

The type of coaxial cable required for a specific circuit depends on the signal frequency, the length of the wire run, and the type of equipment connected to the cable.

Two types of 75 ohm coaxial cable are specified for Reliance Electric equipment; RG-59/U as standard and RG-11/U for higher performance (or longer wire runs). When using RG-59/U cable, the correct connectors are standard BNC/59 connectors. When using RG-11/U cable, the correct connectors are reducing BNC connectors which accommodate the large RG-11/U cable. A 75 ohm terminator is required at the last drop at each end of a network. (A network can have only two ends since only two cables can connect at a node. Reliance Electric networks cannot be connected in a continuous loop.)

Table 4.5 - Coax Cable and Connector Selection

Reliance Part No.	Vendor	Vendor Part No.	Description	Temp. Rating	Nom. O.D.
417900-148A	Belden	9259	RG-59/U	80°C	0.242"
417900-149A	Belden	8238	RG-11/U	80°C	0.405"
N/A	Belden	89259	RG-59/U	200°C	0.218"
N/A	Belden	89292	RG-11/U	200°C	0.363"
405504-74A	Amphenol	31-212-1005	RG-59 Connector	N/A	N/A
*612293-2R	Amp	1-227079-3	RG-59 Connector	N/A	N/A
612293-B	Amphenol	6775	RG-11 Connector	N/A	N/A
*612293-1R	Amp	P87-334-019	RG-11 Connector	N/A	N/A
707204-20A	Amphenol	46650-75	Terminator	N/A	N/A

* These parts need special tooling and are not recommended for field installation. See Reliance part drawing of connector for correct tooling.

4.6.2 Installation

Coaxial cable should be treated like level 1 wiring. It should be separated from all power and control wiring. It can be run with twisted pair and other low level signal wiring.

Make runs as direct as possible. Do not run coax next to or near RF transmitters (greater than 5 watts power).

For more information on cable selection and installation, refer to the R-Net Cable Installation instruction manual (J2-3009), the AutoMax Network Communications Module instruction manual (J2-3001), and the AutoMax Remote I/O Communications Module instruction manual (J-3606).

4.7 Fiber-Optic Cable

WARNING

TURN OFF, LOCK OUT, AND TAG POWER TO BOTH THE RACK CONTAINING THE UDC MODULE AND TO ITS CORRESPONDING PMI HARDWARE BEFORE VIEWING THE FIBER-OPTIC CABLE OR TRANSMITTER UNDER MAGNIFICATION. VIEWING A POWERED FIBER-OPTIC TRANSMITTER OR CONNECTED CABLE UNDER MAGNIFICATION MAY RESULT IN DAMAGE TO THE EYE. FOR ADDITIONAL INFORMATION REFER TO ANSI PUBLICATION Z136.1-1981. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

This section applies to fiber-optic cabling as used on AutoMax Distributed Power system applications. The fiber-optic cables provide a serial link between the Universal Drive Controller (UDC) module and the Power Module Interface (PMI) Processor module.

4.7.1 Cable Selection

The UDC and PMI Processor modules require a 62.5 micron duplex fiber-optic cable; however, 50 micron fiber-optic cable is an acceptable substitute. Specifications for both 62.5 and 50 micron cables are shown in Table 4.6.

Table 4.6 - Fiber-Optic Cable Specifications

	62.5 Micron Cable	50 Micron Cable
Reliance part number	613611-A	N/A
Number of fibers	2	2
Recommended manufacturer Belden or equivalent	225362 Breakout cable	227302 Breakout cable
NEC type	OFNR	OFNR
UL style	UL 1581 UL 1666	UL 1581 UL 1666
CSA flame test	FT 4	FT 4
Recommended connector or equivalent	3M Type ST 80-6106-2549-5	3M Type ST 80-6106-2549-5
Maximum installation distance	2500 feet (750 meters)	660 feet (200 meters)
Outer diameter	.236" (6 mm)	.236" (6 mm)
Weight	17 lbs per 1000'	17 lbs per 1000'
Maximum pulling tension	150 lbs	150 lbs
Maximum recommended long-term load	25 lbs	25 lbs
Operating temperature	−36° to 176°F −20° to 80°C	−36° to 176°F −20° to 80°C
Crush resistance	250 lbs/sq.in	250 lbs/sq. in
Minimum installation bend radius	15 times diameter	15 times diameter
Minimum long term bend radius	10 times diameter	10 times diameter

4.7.2 Installation

Refer to the Distributed Power Systems Fiber-Optic Cabling instruction manual (S-3009) for information about cable selection and installation. Unless you have in-house expertise with fiber-optic cable assemblies and installation, Reliance Electric recommends that you contact an experienced contractor for making up and installing fiber-optic cables.

The fiber-optic cable must be properly handled prior to and during installation. Improper handling may result in damage to the cable.

Use the following guidelines to protect the cable:

- Cap the ends of the cable immediately after final polishing and/or testing.
- Coil completed cable in a 10" diameter coil.
- Route the fiber-optic cable to protect it from abrasion, vibration, moving parts, and personnel traffic. Be sure the cable does not touch abrasive surfaces such as concrete which could wear through and damage the cable's outer jacket.
- Locate the 62.5 micron fiber-optic cable away from temperatures greater than 176° F (80° C).
- Protect the fiber-optic cable from: oil, grease, acids, caustics, and other hazardous chemicals.
- Do not exceed the minimum bend radius (3") of the fiber-optic cable.
- Do not exceed the cable's maximum recommended pulling tension.
- Use a cable lubricant to reduce friction when pulling the cable.
- Use only ceramic ferrule ST type connectors.

4.8 Resolver Wiring

Resolver wiring is considered low level signal wiring and therefore must be run in separate conduit or tray with proper spacing. (see section 4.4.2). Reliance recommends the use of unshielded twisted pair wires with a minimum of 2 twists per inch ($^1/_2$ inch lay). See the following table for installation recommendations.

Table 4.7 - Resolver Cable Recommendations

Recommended Reliance Part	No. of Twisted Pairs	Twists Per Inch	AWG	Recommended Maximum Distance for Each Resolver Type		
				X1	X2	X3
41790-207CG	3	2–3	18	600 ft.	600 ft.	300 ft.
*41790-76EAD	1	2–3	16	300 ft.	300 ft.	150 ft.
*41790-92DAD	1	2–3	18	1000 ft.	1000 ft.	600 ft.

Distance beyond those recommended may require additional tuning. Use Reliance Custom Panel 0-58801.

*May only be run in conduit per NEC.

5.0 AVAILABLE SERVICES

The following services are available from Reliance Electric:

- Start-up assistance
- After start-up assistance
- Renewal parts
- Equipment repair
- Industrial training

These services are described in detail in the sections that follow.

5.1 Start-Up Assistance

Proper start-up of your Reliance Drive System is necessary to ensure optimum performance. You can contract for start-up assistance by contacting your local Reliance Sales Office.

Reliance Electric provides technical guidance and/or technical supervision of on-site activities during start-up to complement your own participation and involvement. Use the start-up period to become familiar with the equipment so that you can continue to maintain it when Reliance Electric's continuous participation ends.

RELIANCE ELECTRIC START-UP SERVICES BEGIN WHEN THE INSTALLATION IS COMPLETE AND ALL WIRING IS TERMINATED. Exceptions are possible if installation supervision is arranged or other agreements are reached at the pre-start-up meeting.

The start-up process is intended to make the equipment ready for regular production with material. Start-up is complete when the specifications contained in the Reliance Electric Engineering Analysis are met, when the machine (process) is put into productive service, or when the start-up work is stopped at your direction.

5.1.1 The Scope of Reliance Electric's Activity

The scope of the Reliance Electric's Service Engineer's involvement will be to assist you in performing the following functions:

1. Inspect the drive and tighten all loose parts, fittings, nuts, bolts and wires. Check for unintentional grounds, the presence of all necessary wires on outgoing terminals, proper transformer connections, etc., to avoid unsafe conditions when power is applied.
2. Make an operational inspection of all control logic, relays, contactors, operator devices, limit switches and safety devices to verify operation consistent with the wiring diagrams.
3. Make basic static (motors not running) and dynamic (motors running) checks and adjustments on individual motors, power supplies, regulators, transducers, and feedback devices. Verify polarity and phase connections of power and feedback devices.
4. Tune the drive to the extent possible by running the complete system without material. Simulate a system running condition to adjust motor tracking, maximum speeds, vernier adjustments, and machine section speed relationships.
5. Run the machine with material to the extent necessary to adjust regulators, feedback devices, and limit switches, as required to obtain the specified performance. Verify that all safety devices specified by the customer and Reliance Electric operate in the manner specified. The specification, location, and functions of operator stations, emergency disconnects, guarding or other safety devices or procedures related to the driven equipment, as may be desirable or as may be required by safety codes, are not provided by Reliance Electric and are not the responsibility of Reliance Electric.

5.1.2 Methods of Purchase

Start-up services may be purchased in three ways. This determination may be made at any time prior to the commencement of the start-up. Additional time is available at the hourly or daily rate at any time.

- **Hourly or Daily Rate**

  You may purchase start-up at the time the service is performed at the current hourly or daily rate. The Reliance Service Engineers will provide daily written reports of activities and time spent.

  Warranty work will also be reported but is not chargeable if performed during normal working hours. A premium hourly adder will be charged for overtime activity requested by you to speed up the start-up.

  Invoicing will be done on a weekly basis. Note that if the hourly rate is selected, overnight and travel expenses will be added. These additional expenses are included in the daily rate for domestic U.S.A. service.

- **Pre-paid Number of Days**

  You may purchase a specific number of days of start-up at the same time that you purchase your drive system. The days are priced at the daily rate in effect at the time of the order placement.

  The Reliance Electric Service Engineers will work the specified number of man-days with no extra charges for travel or living expenses and will provide daily written reports of activities and time spent.

  Warranty work will also be reported but is not charged against the pre-paid man-days if performed during normal working hours. A premium hourly adder will be charged for overtime activity requested by you to speed up the start-up.

  If the start-up cannot be finished in the allocated time, a purchase order will be requested to complete the project. Payment for the additional time will be at the hourly or daily rate in effect at the time the work is performed, as explained above.

  If the start-up is finished in less than the specified number of man-days, the extra time may be used for training the operators or maintenance personnel, reviewing the spare parts inventory, discussing maintenance arrangements, or other activities at your discretion.

- **Firm Price**

  A firm price start-up may be negotiated at the time of the original equipment purchase or separately prior to start-up. It is defined as a specified number of dollars received by Reliance Electric from you to perform the functions described under the "Scope of Reliance Electric's Activity" above.

  A firm price start-up requires that you furnish the required manpower (supervisors, operators, electricians), equipment and services (hydraulics, pneumatics, cooling, lubrication), spare parts, and product and materials of the specified grades and sizes in adequate quantities to set-up, adjust and measure the performance of the Drive System.

  The completion of the start-up service occurs when the specifications are met or when Reliance Electric no longer has the authority to have the machine started or stopped, change speeds or produce sufficient material to verify performance.

  Delays due to circumstances beyond Reliance Electric's control, such as, but not limited to, unavailability of the machine or product, will be invoiced at the service rate in effect at the time.

  The Reliance Electric Service Engineers will provide daily written reports of activities and time spent. Firm price start-up provides for pre-scheduled 8 hour normal day shifts, Monday through Friday. Overtime, shift, weekend or holiday work will be invoiced at the appropriate premium rate adder in effect at the time.

Firm price start-up includes the costs of all travel between the job site and headquarters for the staff specified in the order. If additional manpower is requested later, the extra services will be quoted and billed at the rates in effect at the time the work is performed. Changes will be quoted as a firm price or as time and material before proceeding.

5.1.3 Start-Up Planning

Reliance's responsibility for your start-up is limited to technical guidance and supervision as explained above. Efficient management of a start-up requires planning on your part with the collaboration of Reliance's Systems Engineering and Service Departments. The following should be considered in your start-up plan:

5.1.3.1 Pre-Start-Up Meeting

Reliance Electric recommends a pre-start-up meeting for all Electrical Drive Systems orders. This meeting should be attended by members of your staff who have the decision making authority for the start-up. It will also be attended by representatives of Reliance Electric Sales, Service, and Systems Engineering departments.

The meeting should be scheduled approximately one month prior to the first involvement by Reliance Electric in the start-up. The following should be accomplished prior to or during the meeting:

1. Identify your Project Manager.
2. Identify the Reliance Electric Site Manager or lead Service Engineer.
3. Finalize the calendar schedule for the start-up.
4. Establish the daily work schedule.
5. Define manpower requirements.
6. Arrange for office/phone/lockbox for Reliance Electric as required.
7. Confirm availability of your electricians and/or technicians for checkout.
8. Define installation contractor policy for work done by Reliance Electric.
9. Review plant safety practices to ensure that Reliance Electric's work practices during start-up conform to those practices.
10. Name your authorized representative to sign daily reports.
11. Define who can approve overtime.
12. Confirm the proper billing address and purchase order, if applicable.
13. Confirm the desired billing frequency, if applicable.
14. Review overtime invoicing policy.
15. Establish policy for "holdover" in lieu of weekend travel.
16. Review Reliance Electric warranty policy.
17. Define handling of start-up spare parts.
18. Confirm availability of operating crews when needed.
19. Confirm availability of process material when needed.
20. Define final acceptance test and/or start-up completion.
21. Define documentation requirements after start-up completion.
22. Review training requirements for your staff.

5.1.3.2 Start-Up Site Manager

Larger projects, or those with short time schedules, often require more than one Reliance Electric Service Engineer on site. In these cases, one Service Engineer is appointed as the "lead" man who is the primary contact between you, your construction people, and Reliance Electric.

When sufficient Reliance Electric manpower is required such that five or more people are regularly on site, Reliance Electric will appoint a "Site Manager" whose job will exclusively be to direct the activities of the other Service Engineers. He will be the Reliance Electric contact with all parties involved.

5.2 After Start-Up Assistance

Once the start-up is completed and you have accepted the operation of your drive system, the Reliance Electric Service Engineer will no longer be at your plant. If situations arise in which you desire further assistance from Reliance Electric, several options are available. These are described in the following sections.

5.2.1 As-Needed Service

Reliance Electric maintains a staff of qualified Service Engineers at most sales offices. By calling your local office you can arrange for their help on an "as needed" basis. This can be for scheduled maintenance or for breakdown troubleshooting and repairs.

The cost will be at the hourly rate in effect plus travel and expenses, plus the cost of any parts required, if the drive is out of warranty.

5.2.2 Reliance Service Agreements

Reliance Electric offers a wide range of services which can be tailored into a Service Agreement to help improve your productivity, complement your maintenance of the Reliance electrical equipment and reduce your cost. Services can range from scheduled visits for preventive maintenance only to complete maintenance programs.

Our approach to assisting you is to make our services fit your requirements. To do this, one of our local service agreement supervisors will work with you to customize our services to fit your needs.

The advantages of a Reliance Service Agreement include the reduction of your maintenance manpower requirements, budgeted maintenance costs, and reliable completion of preventive maintenance that will not be pre-empted by other higher priority work.

Examples of services which can be included in your Reliance Service Agreement are:

- Development of a preventive maintenance program
- Scheduled preventive maintenance visits
- Resident Service Engineer
- Breakdown services
- Parts assistance and coverage
- Mechanical services to rotating equipment
- Vibration analysis
- Engineering services
- On the job training
- After hours telephone assistance (Service 724)

5.2.3 Field Modifications

Reliance Service Engineers are available to inspect, analyze and recommend improvements for the electrical equipment applied in your production process. They combine hands on experience with the latest state of the art equipment to produce hardware and software additions and modifications such as:

- Adding electrical equipment to one or more drive sections of an existing production line, at the direction of your machinery supplier.
- Increasing horsepower and speed capabilities as defined by your machinery supplier.
- Improving regulation or control of speed, tension, etc.
- Replacing worn-out and high maintenance mechanical relays or old programmable controllers with modern AutoMax® or AutoMate® Industrial Controls.
- Performing upgrades on existing DCS AutoMax lines to bring them up to the most recent revision level.
- Adding or modifying DCS, AutoMax or AutoMate software and hardware.
- Adding a function, another mode, or increasing the range of operation.

5.2.4 Rotating Repairs

This service may include one or more of the following, including parts:

- Replacement of motor brushes.
- Replacement of motor bearings.
- Armature and field dip and bake.
- Armature and field rewind.

Such repairs are not covered if the equipment is abused or otherwise used in an improper manner. Removal, reinstalling, and transportation charges are not included.

5.2.5 Telephone Consultation (724)

If your maintenance personnel can generally troubleshoot and repair your equipment without assistance, you should consider Reliance's 724 Service. A set of the wiring diagrams for your drive system will be kept in a file available to qualified Reliance Electric Service Engineers whom you can contact by telephone for troubleshooting consultation. This phone is manned 24 hours a day, 7 days a week, 365 days a year.

If you have made changes in the wiring diagram since the start-up was completed, these changes can be added to the drawings at a nominal per sheet charge. This will ensure that equivalent information is being used by both parties.

5.2.6 Vibration Analysis

After an initial study establishes a base line of the vibration characteristics for each rotating element, periodic measurements are taken to detect trends that may result in machine downtime. Findings and recommendations are provided in written reports.

5.2.7 In-Plant Power Survey

As new equipment is installed in your plant, the demands on your power system change. Its ability to meet these demands, and the continuing demands of existing equipment, also changes. Reliance Electric can analyze your electrical power system to determine its ability to meet these demands and to recommend changes if your power system is inadequate. The following items will be studied:

- The distribution and load sharing of the primary supply.
- Power line analysis and recordings.

- Identification of spare capacity.
- Sizing and location of power factor correcting capacitors.
- Loading of transformers, lines, and load centers in relation to their capacities.
- Determination of line voltage fluctuations (regulation) over a 24 hour period.
- Analysis of the ground grid system.

All findings are documented in a written report which includes current operating conditions, maintenance and operating recommendations and alternatives, and identification of present and potential future problem areas.

5.3 Renewal Parts

Reliance Electric can supply replacement parts or spare parts for all of your Reliance Drive System equipment. These can be included with your Drive System order or can be ordered later as needed. Most parts can be provided from stock. Special service and expediting is available for breakdowns.

5.3.1 Initial Contact Points

Reliance Electric has several Renewal Parts stocking facilities throughout the country. The following should be your initial contact points for the services indicated:

- **For Gears, Gearmotors, Brake Motors and Reeves Drives:**

Greenville, South Carolina:

Reliance Electric Service Center
Roper Court
P.O. Box 499 29602
Greenville, South Carolina 29607

8:00AM to 5:00PM Weekdays

Order Entry,	Eastern Division	(803) 297-3080
	Midwestern Division	(803) 288-3340
	Southern Division	(803) 288-9330
	Western Division	(803) 288-3202
Quotations, Proposals, Parts Lists, I/M		(803) 297-4160

After-Hours and Weekends

Emergency Parts and Rebuild Service	(803) 297-4800

- **For All Other Reliance Electric Supplied Equipment:**

Cleveland, Ohio:

Reliance Electric Renewal Parts Center
4950 East 49th Street
Cleveland, Ohio 44125

8:00AM to 5:00PM Weekdays

Order Entry for Control Parts	(216) 266-7246
Order Entry for Motor Parts	(216) 266-7253
D/S, W/D, I/M, Parts Lists	(216) 266-6034
Quotations	(216) 266-7222

After-Hours and Weekends

Emergency Parts and Rebuild Service	(216) 861-6434

5.3.2 Other Stocking Locations

Reliance Electric contracts with many independent distributors to offer local availability of often used repair or replacement parts. Contact your local Reliance Electric Sales Office for a list of these distributors, or refer to your local telephone directory for the one nearest you.

5.3.3 Additional Services

In addition to drive replacement parts, Reliance Electric offers a wide variety of parts related services through the Renewal Parts facilities, such as the following:

- **Spare Parts Proposal**

  A Spare Parts Proposal is a summarized listing of recommended spare parts prepared expressly for your specific Drive System. This proposal recommends quantities of each part that you should have for maintenance coverage for various time intervals.

- **Renewal Parts List**

  A Renewal Parts List is a custom-made catalog of replacement parts for the equipment in your specific drive system. Its contents include wiring diagrams, bills of material, parts lists, etc., giving a complete breakdown of sub-assemblies and description of component parts.

- **Reliance Electric Drawings**

  Many types of drawings, including main wiring diagrams, bills of material, and sub-assembly drawings that display part numbers are available.

- **Winding Data**

  Motor winding data is available on Mush (Random) Wound coils only. All other winding data is considered proprietary. Requests for such data are answered by a quotation for replacement coils.

- **Installation, Maintenance and Lubrication Manuals**

  Preprinted standard instruction manuals provide necessary information for installation and normal maintenance of drive equipment.

5.4 Equipment Repair

The Reliance Electric network of Regional Service Centers provides a full range of repair services for all Reliance Electric products as well as similar products from other manufacturers and allied equipment requiring the same skills.

Capabilities at these Service Centers range to 5000 horsepower. They are available 24 hours a day, seven days a week.

5.5 Industrial Training

Your electrical drive and control equipment consists of valuable sophisticated hardware and software. It requires knowledgeable individuals to operate and maintain it. Proper training for these individuals is essential to achieve maximum productivity.

Reliance Electric offers various introductory, intermediate, and advanced courses for your engineers and technicians to teach them the basic principles of your drive equipment and how to troubleshoot and maintain it. These can be provided in several formats as listed below. For additional information or to enroll in these courses, call your local Reliance Electric Sales Office or the following numbers:

Toll Free: 1 (800) 735-4262 (REL-IANC)
In Ohio: 1 (216) 266-6000

5.5.1 Training Center Courses

Regularly scheduled courses are conducted at Reliance Electric's Industrial Training Headquarters in Cleveland, Ohio, and at the Regional Drives Center in Los Angeles, California.

5.5.2 Regional Courses

Periodically courses are offered in various cities throughout the United States.

5.5.3 In-Plant Courses

For large installations and multi-shift operations it is often not feasible to schedule travel to the Training Centers or regional schools. In order to handle this special situation, Reliance Electric offers the same courses in your own plant. These courses are customized to teach the specific equipment in your facility and are geared to match the technical level of your staff. Demonstration equipment can be included to allow hands-on troubleshooting by your personnel.

5.5.4 Audio Visual Training

Reliance Electric offers videotaped and interactive videotaped training on its products. These professional quality programs are carefully designed to provide years of efficient in-house training for your personnel to learn and periodically review the subjects and procedures at any time. Printed reference material is included for all diagnostic and troubleshooting tapes. For information on these audio visual programs, contact your local Reliance Electric Sales Office.

Appendices

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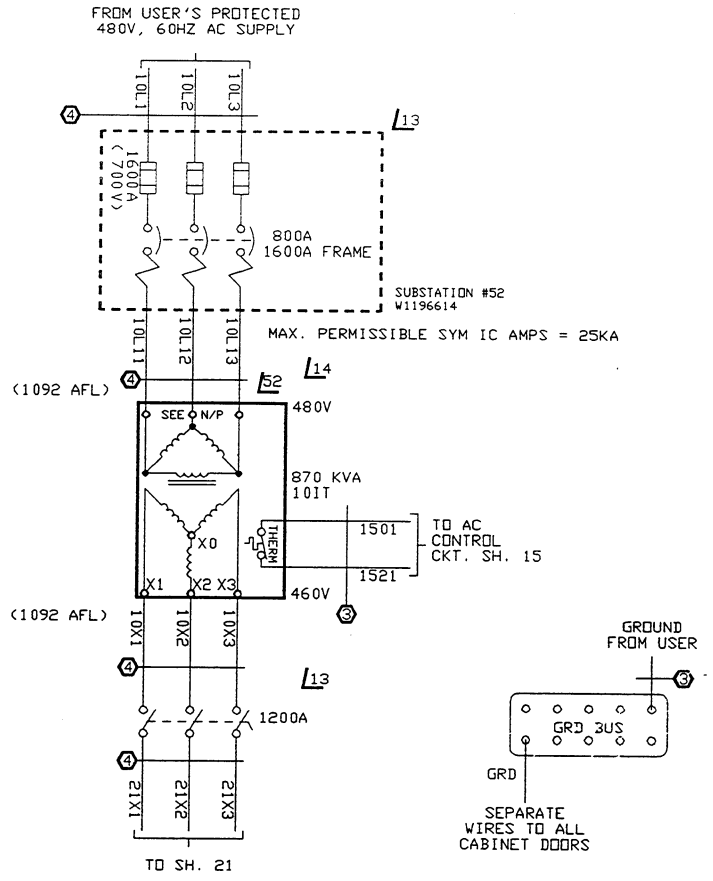
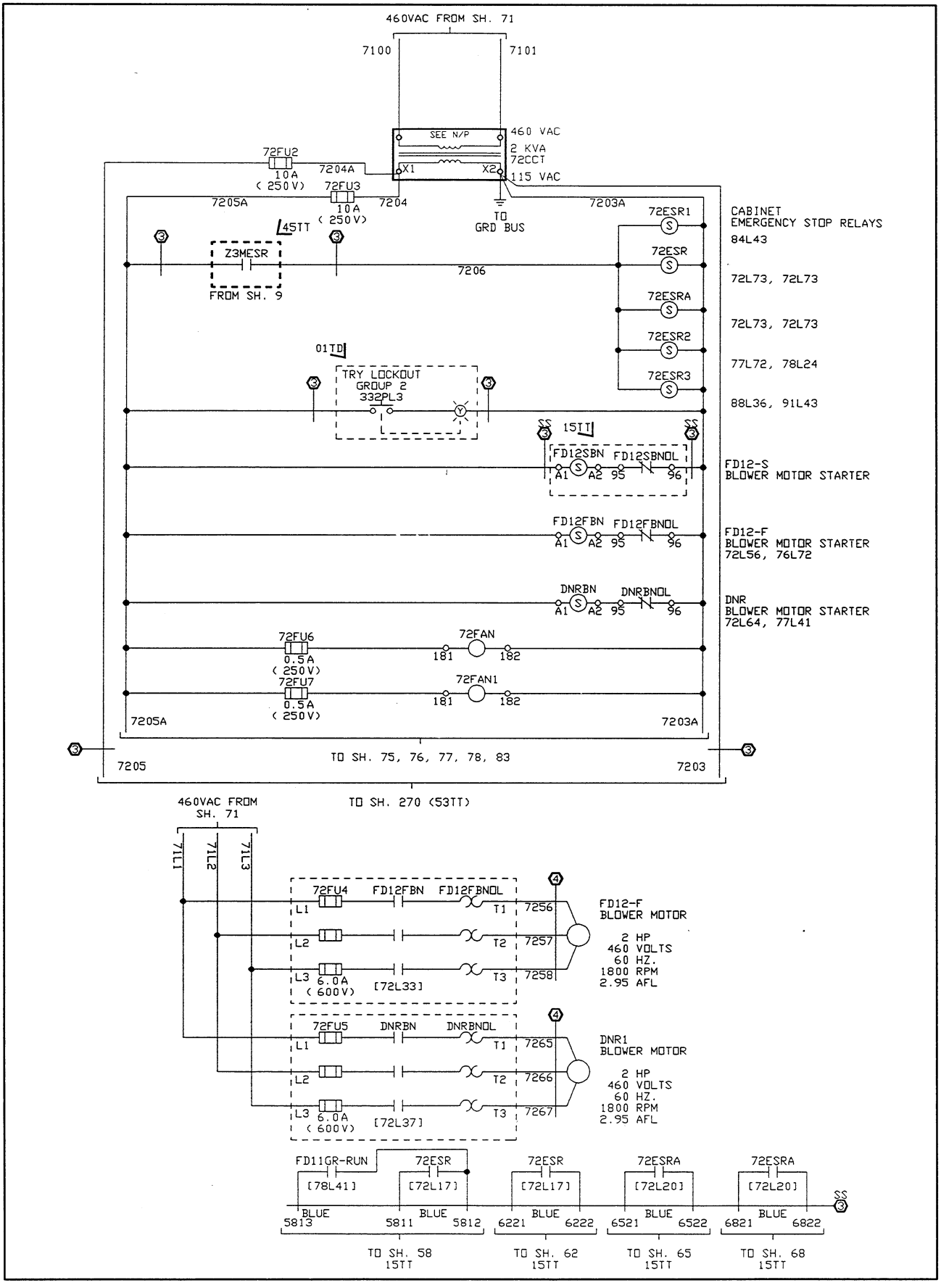
Appendix A

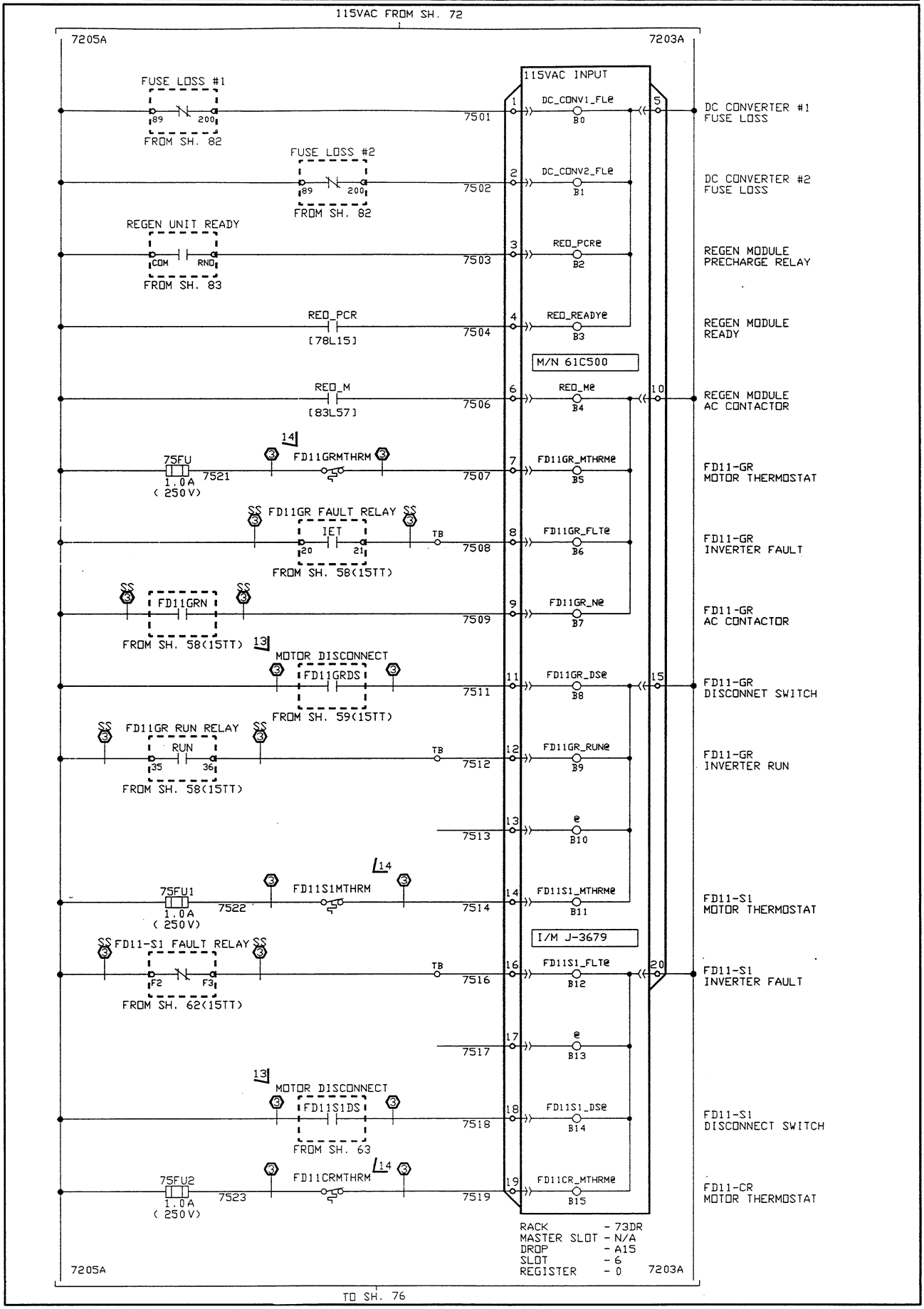
Sample Elementary (W/E) Diagrams



Appendix A – (Continued)

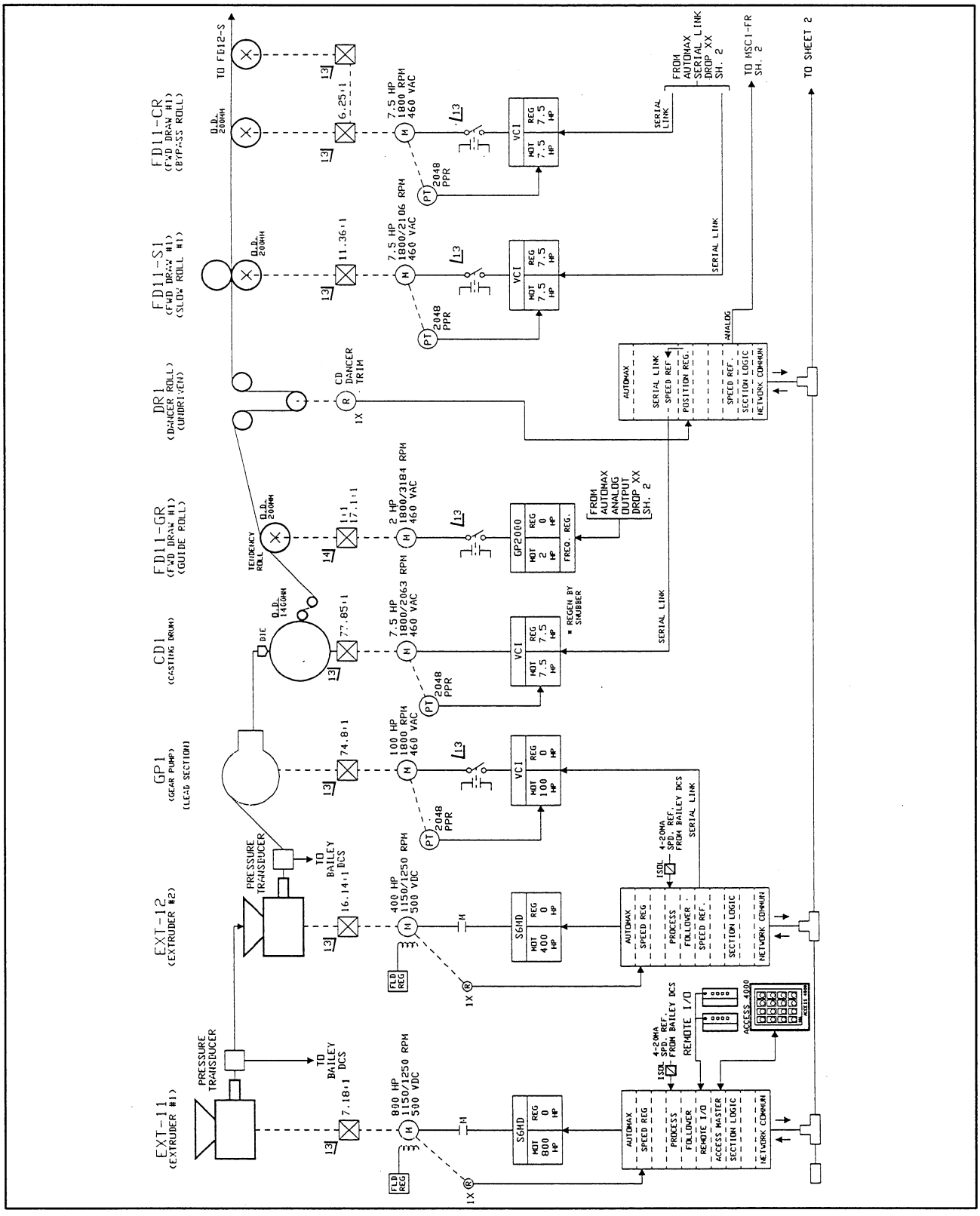


Appendix A – (Continued)



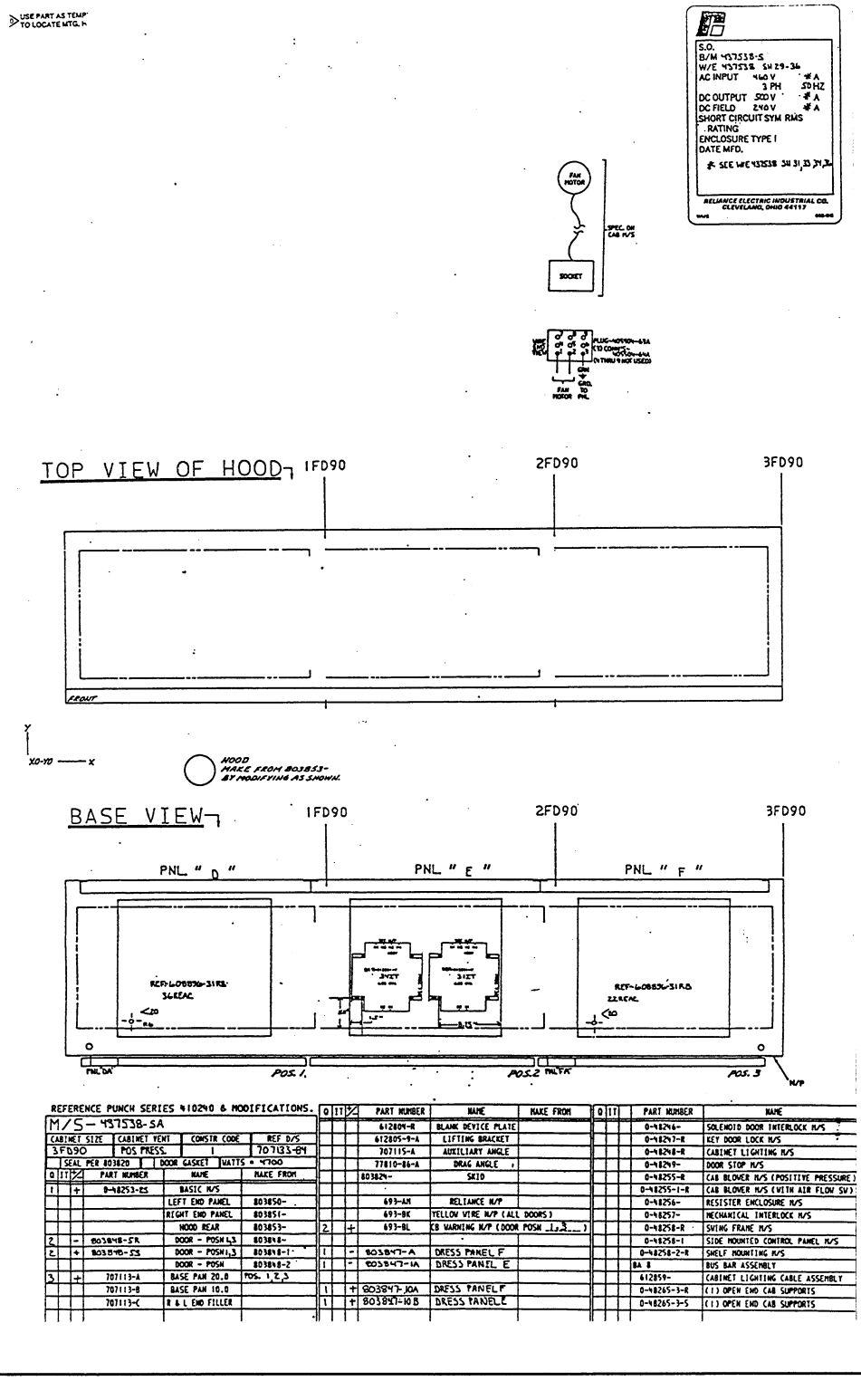
Appendix B

Sample Flow (W/F) Diagram



Appendix C

Sample Panel Layout (W/L) Drawings



REFERENCE PUNCH SERIES 810240 & MODIFICATIONS.

M/S - 937538-SA

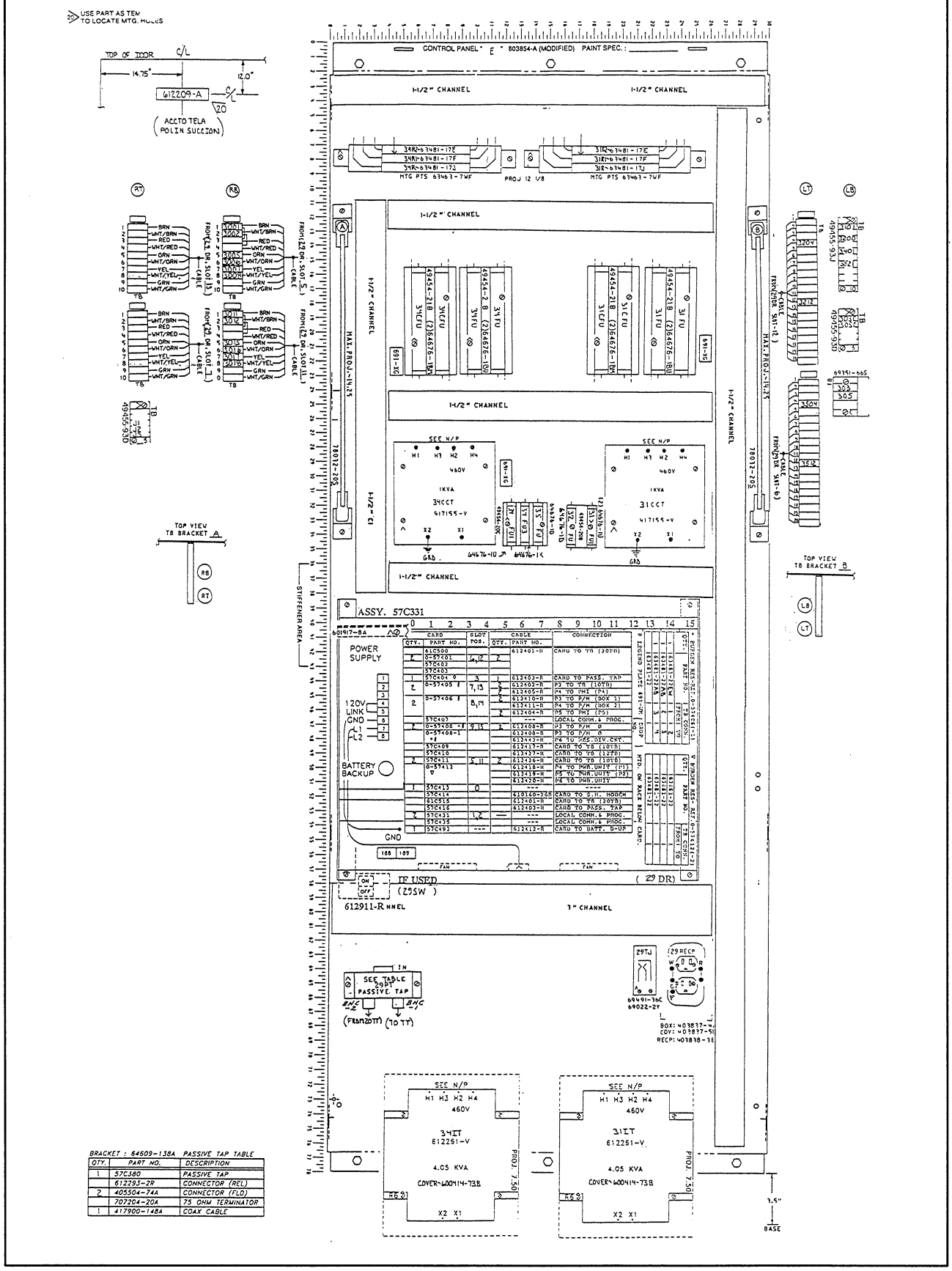
CABINET SIZE	CABINET VENT	CONSTR CODE	REF D/S
3FD90	POS. PRESS.	1	707133-84
SEAL PER 803820	DOOR GASKET	WATTS = 47900	

Q	IT	+/-	PART NUMBER	NAME	MAKE FROM
1		+	0-48253-ES	BASIC M/S	
				LEFT END PANEL	803850-
				RIGHT END PANEL	803851-
				HOOD REAR	803853-
2		-	803848-SR	DOOR - POSH 1,3	803848-
2		+	803845-SS	DOOR - POSH 1,3	803848-1
				DOOR - POSH	803848-2
3		+	707113-A	BASE PAN 20.8	POS. 1,2,3
			707113-B	BASE PAN 10.8	
			707113-C	R & L END FILLER	

Q	IT	+/-	PART NUMBER	NAME	MAKE FROM
			612804-R	BLANK DEVICE PLATE	
			612805-9-A	LIFTING BRACKET	
			707115-A	AUXILIARY ANGLE	
			77810-86-A	DRAG ANGLE	
			803824-	SKID	
			693-AR	RELIANCE N/P	
			693-BK	YELLOW WIRE N/P (ALL DOORS)	
2		+	693-BL	CB WARNING N/P (DOOR POSN 1,2,3)	
1		-	803847-A	DRESS PANEL F	
1		-	803847-1A	DRESS PANEL E	
1		+	803847-10A	DRESS PANEL F	
1		+	803847-10B	DRESS PANEL E	

Q	IT	PART NUMBER	NAME
		0-48246-	SOLENOID DOOR INTERLOCK M/S
		0-48247-R	KEY DOOR LOCK M/S
		0-48248-R	CABINET LIGHTING M/S
		0-48249-	DOOR STOP M/S
		0-48255-R	CAB BLOWER M/S (POSITIVE PRESSURE)
		0-48255-1-R	CAB BLOWER M/S (WITH AIR FLOW SW)
		0-48256-	RESISTER ENCLOSURE M/S
		0-48257-	MECHANICAL INTERLOCK M/S
		0-48258-R	SWING FRAME M/S
		0-48258-1	SIDE MOUNTED CONTROL PANEL M/S
		0-48258-2-R	SHELF MOUNTING M/S
		BA 8	BUS BAR ASSEMBLY
		612859-	CABINET LIGHTING CABLE ASSEMBLY
		0-48265-3-R	(1) OPEN END CAB SUPPORTS
		0-48265-3-S	(1) OPEN END CAB SUPPORTS

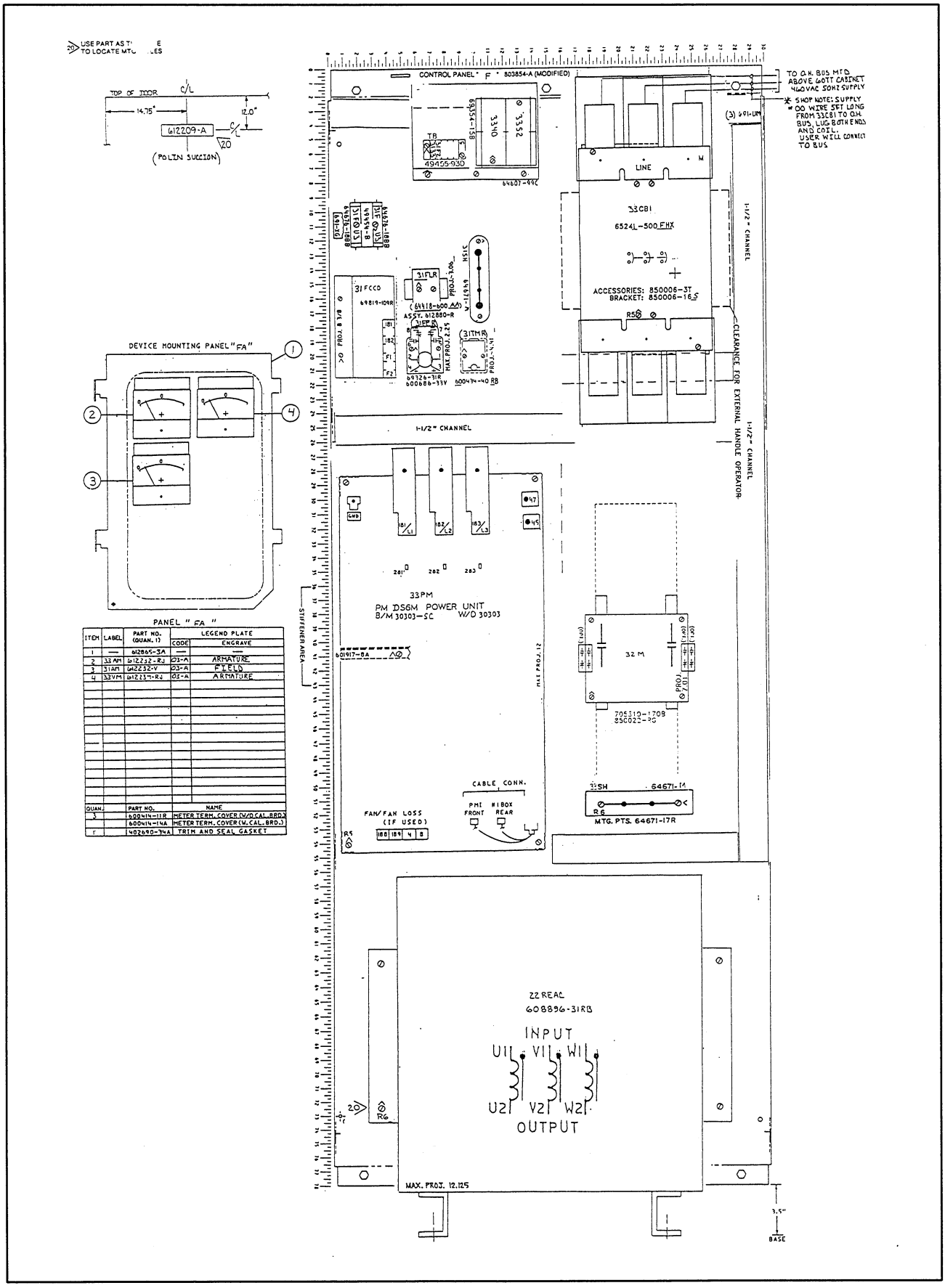
Appendix C – (Continued)



BRACKET : 64609-138A PASSIVE TAP TABLE

QTY.	PART NO.	DESCRIPTION
1	57C380	PASSIVE TAP
	612293-2R	CONNECTOR (REL)
2	405504-74A	CONNECTOR (FLD)
	707204-20A	75 OHM TERMINATOR
1	417900-148A	COAX CABLE

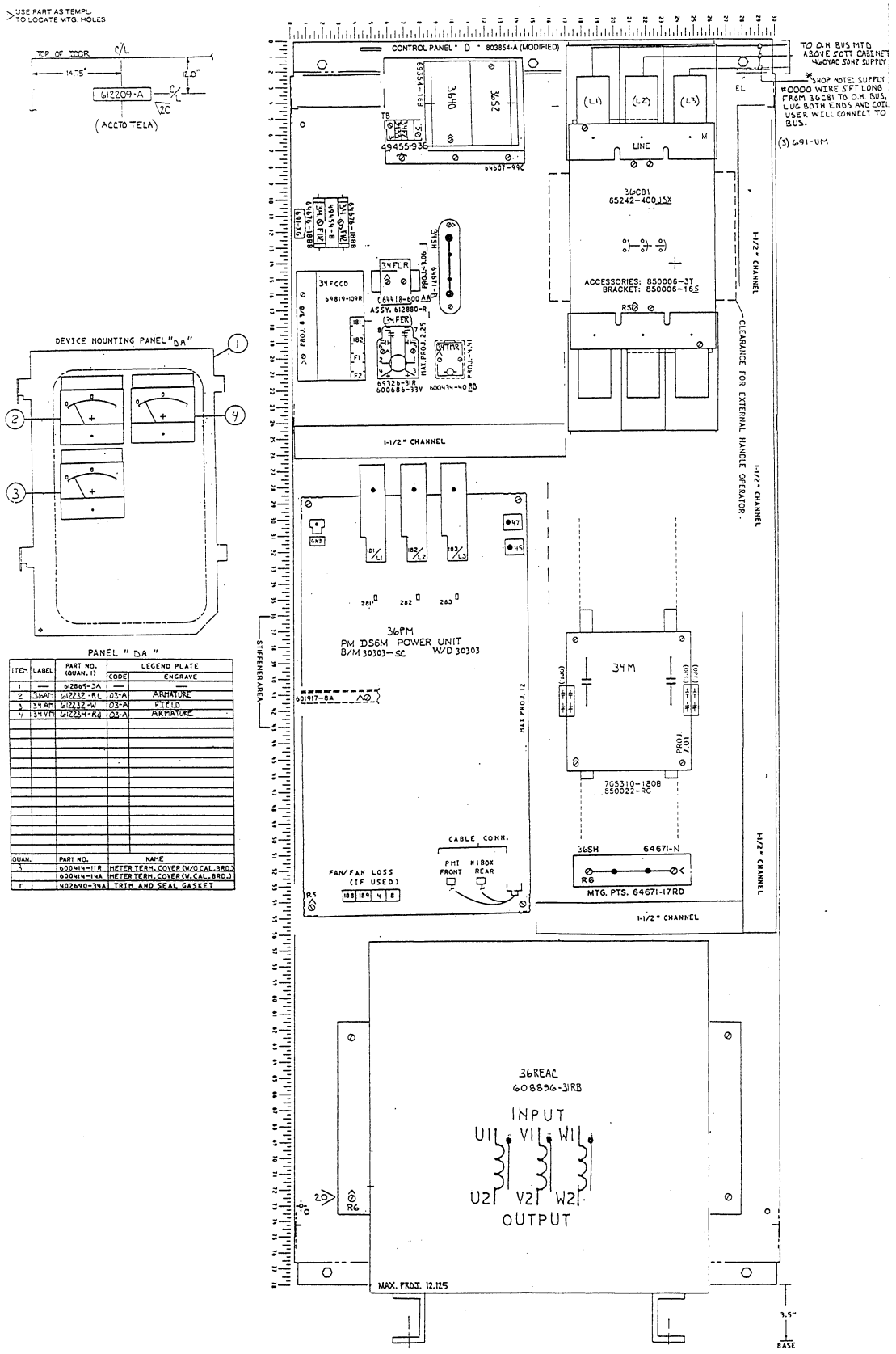
Appendix C – (Continued)



ITEM	LABEL	PART NO. (QUAN. 1)	LEGEND PLATE CODE	LEGEND PLATE ENGRAVE
1	—	612865-3A	—	—
2	32AM	612232-RJ	03-A	ARMATURE
3	31AM	612232-Y	03-A	FIELD
4	32VM	612237-RJ	02-A	ARMATURE

QUAN.	PART NO.	NAME
3	600414-11R	METER TERM. COVER (W/O CAL. BRD.)
1	600414-11A	METER TERM. COVER (W. CAL. BRD.)
1	402690-3A	TRIM AND SEAL GASKET

Appendix C – (Continued)



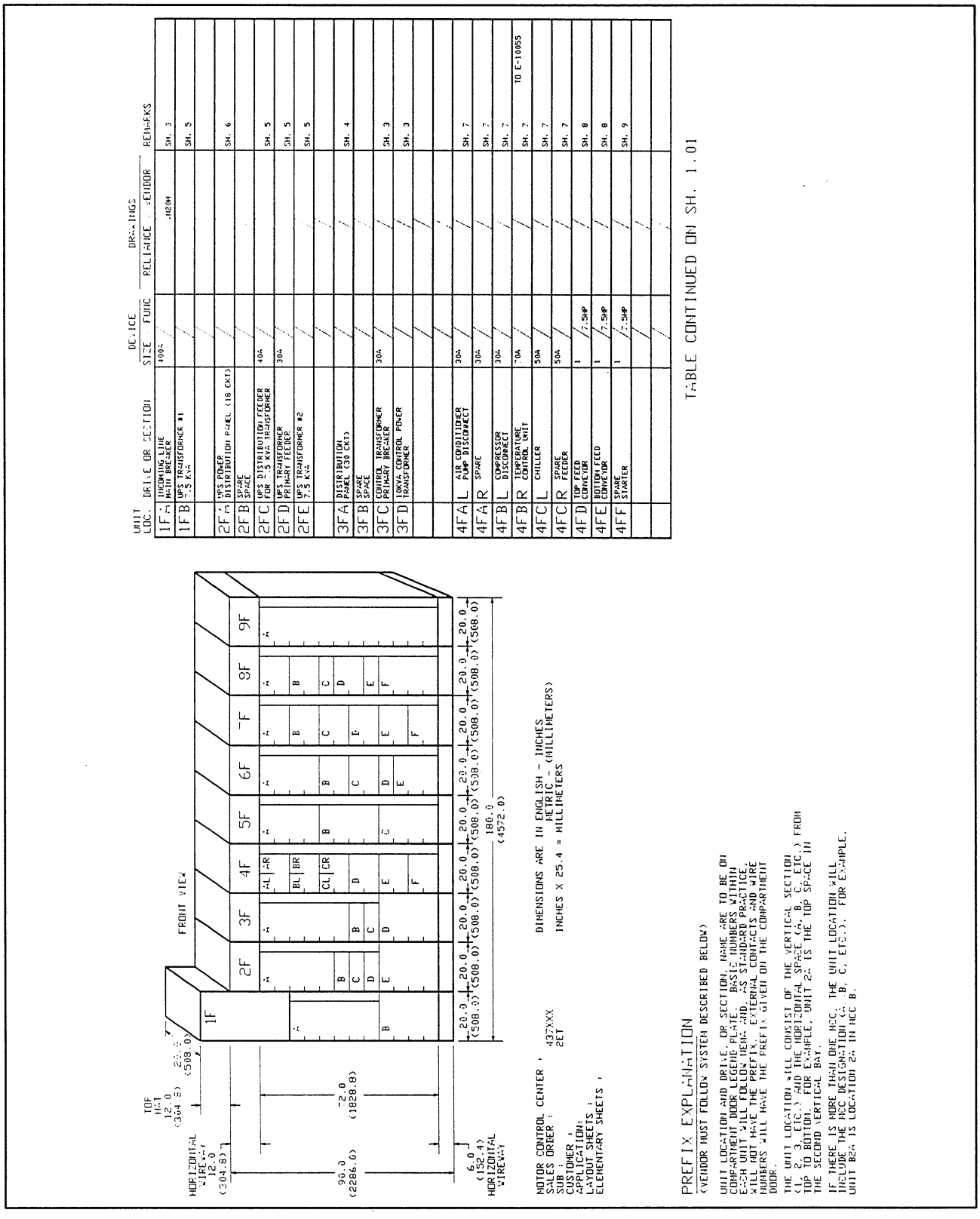
PANEL " DA "

ITEM	LABEL	PART NO. (QUAN. 1)	LEGEND PLATE CODE	LEGEND PLATE ENGRAVE
1	—	612869-3A	—	—
2	36AM	612232-RL	03-A	ARMATURE
3	34AM	612232-W	03-A	FIELD
4	34VM	612234-RW	03-A	ARMATURE

QUAN.	PART NO.	NAME
3	600414-11R	METER TERM. COVER (W/O CAL. BRD.)
1	600414-14A	METER TERM. COVER (W. CAL. BRD.)
1	402690-34A	TRIM AND SEAL GASKET

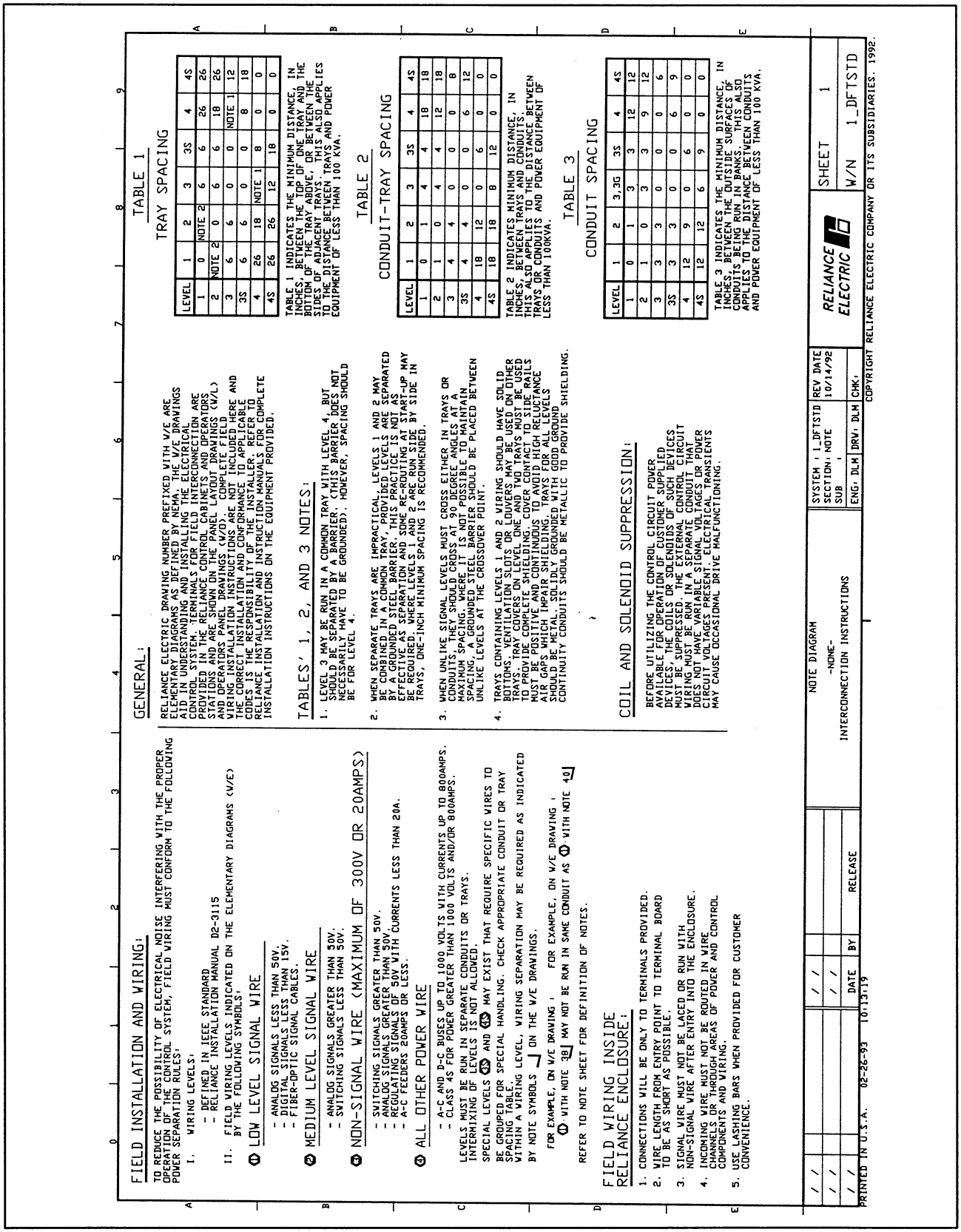
Appendix D

Sample Motor Control Center (W/M) Drawing



Appendix E

Sample Note Sheets (W/N)



FIELD INSTALLATION AND WIRING:

TO REDUCE THE POSSIBILITY OF ELECTRICAL NOISE INTERFERING WITH THE PROPER OPERATION OF THE CONTROL SYSTEM, FIELD WIRING MUST CONFORM TO THE FOLLOWING POWER SEPARATION RULES:

I. WIRING LEVELS:
   - DEFINED IN IEEE STANDARD
   - RELIANCE INSTALLATION MANUAL D2-3115

II. FIELD WIRING LEVELS INDICATED ON THE ELEMENTARY DIAGRAMS (W/E) BY THE FOLLOWING SYMBOLS:

① LOW LEVEL SIGNAL WIRE
   - ANALOG SIGNALS LESS THAN 50V.
   - DIGITAL SIGNALS LESS THAN 15V.
   - FIBER-OPTIC SIGNAL CABLES.

② MEDIUM LEVEL SIGNAL WIRE
   - ANALOG SIGNALS GREATER THAN 50V.
   - SWITCHING SIGNALS LESS THAN 50V.

③ NON-SIGNAL WIRE (MAXIMUM OF 300V OR 20AMPS)
   - SWITCHING SIGNALS GREATER THAN 50V.
   - ANALOG SIGNALS GREATER THAN 50V.
   - REGULATING SIGNALS OF 50V WITH CURRENTS LESS THAN 20A.
   - A-C FEEDERS 20AMPS OR LESS.

④ ALL OTHER POWER WIRE
   - A-C AND D-C BUSES UP TO 1000 VOLTS WITH CURRENTS UP TO 800AMPS.
   - CLASS 4S FOR POWER GREATER THAN 1000 VOLTS AND/OR 800AMPS.

LEVELS MUST BE RUN IN SEPARATE CONDUITS OR TRAYS. INTERMIXING OF LEVELS IS NOT ALLOWED.

SPECIAL LEVELS ⑤ AND ⑥ MAY EXIST THAT REQUIRE SPECIFIC WIRES TO BE GROUPED FOR SPECIAL HANDLING. CHECK APPROPRIATE CONDUIT OR TRAY SPACING TABLE.

WITHIN A WIRING LEVEL, WIRING SEPARATION MAY BE REQUIRED AS INDICATED BY NOTE SYMBOLS ⌐ ON THE W/E DRAWINGS.

FOR EXAMPLE, ON W/E DRAWING ; FOR EXAMPLE, ON W/E DRAWING ;
① WITH NOTE 38 MAY NOT BE RUN IN SAME CONDUIT AS ④ WITH NOTE 40

REFER TO NOTE SHEET FOR DEFINITION OF NOTES.

FIELD WIRING INSIDE RELIANCE ENCLOSURE:

1. CONNECTIONS WILL BE ONLY TO TERMINALS PROVIDED.
2. WIRE LENGTH FROM ENTRY POINT TO TERMINAL BOARD TO BE AS SHORT AS POSSIBLE.
3. SIGNAL WIRE MUST NOT BE LACED OR RUN WITH NON-SIGNAL WIRE AFTER ENTRY INTO THE ENCLOSURE.
4. INCOMING WIRE MUST NOT BE ROUTED IN WIRE CHANNELS OR THROUGH AREAS OF POWER AND CONTROL COMPONENTS AND WIRING.
5. USE LASHING BARS WHEN PROVIDED FOR CUSTOMER CONVENIENCE.

GENERAL:

RELIANCE ELECTRIC DRAWING NUMBER PREFIXED WITH W/E ARE ELEMENTARY DIAGRAMS AS DEFINED BY NEMA. THE W/E DRAWINGS AID IN UNDERSTANDING AND INSTALLING THE ELECTRICAL CONTROL SYSTEM. TERMINALS FOR FIELD INTERCONNECTION ARE PROVIDED IN THE RELIANCE CONTROL CABINETS AND OPERATORS STATIONS AND ARE SHOWN ON THE PANEL LAYOUT DRAWINGS (W/L) AND OPERATORS PANEL DRAWINGS (W/D). COMPLETE FIELD WIRING INSTALLATION INSTRUCTIONS ARE NOT INCLUDED HERE AND ARE CONTAINED IN THE RELIANCE INSTALLATION MANUALS FOR COMPLETE THE CORRECT INSTALLATION AND CONFORMANCE TO APPLICABLE CODES. IT IS THE RESPONSIBILITY OF THE INSTALLER: REFER TO RELIANCE INSTALLATION INSTRUCTION MANUALS FOR COMPLETE INSTALLATION INSTRUCTIONS ON THE EQUIPMENT PROVIDED.

TABLES' 1, 2, AND 3 NOTES:

1. LEVEL 3 MAY BE RUN IN A COMMON TRAY WITH LEVEL 4, BUT SHOULD BE SEPARATED BY A BARRIER. (THIS BARRIER DOES NOT NECESSARILY HAVE TO BE GROUNDED). HOWEVER, SPACING SHOULD BE FOR LEVEL 4.

2. WHEN SEPARATE TRAYS ARE IMPRACTICAL, LEVELS 1 AND 2 MAY BE COMBINED IN A COMMON TRAY, IF PRACTICAL LEVELS ARE SEPARATED BY A GROUNDED STEEL BARRIER. THIS PRACTICE IS NOT AS EFFECTIVE AS SEPARATION AND SOME RE-ROUTING AT START-UP MAY BE REQUIRED, WHERE LEVELS 1 AND 2 ARE RUN SIDE BY SIDE IN TRAYS, ONE-INCH MINIMUM SPACING IS RECOMMENDED.

3. WHEN UNLIKE SIGNAL LEVELS MUST CROSS EITHER IN TRAYS OR CONDUITS, THEY SHOULD CROSS AT 90 DEGREE ANGLES AT A MAXIMUM SPACING. WHERE IT IS NOT POSSIBLE TO MAINTAIN SPACING, A GROUNDED STEEL BARRIER SHOULD BE PLACED BETWEEN UNLIKE LEVELS AT THE CROSSOVER POINT.

4. TRAYS CONTAINING LEVELS 1 AND 2 WIRING SHOULD HAVE SOLID BOTTOMS. VENTILATED TROUGH TYPE MAY BE USED ON OTHER TRAYS. TRAY COVERS ON LEVEL ONE AND TWO TRAYS MUST BE USED TO PROVIDE COMPLETE SHIELDING. COVER CONTACT TO SIDE RAILS MUST BE POSITIVE AND CONTINUOUS TO AVOID HIGH RELUCTANCE AIR GAPS WHICH IMPAIR SHIELDING. TRAYS FOR ALL LEVELS SHOULD BE METAL, SOLIDLY GROUNDED WITH GOOD GROUND CONTINUITY CONDUITS SHOULD BE METALLIC TO PROVIDE SHIELDING.

COIL AND SOLENOID SUPPRESSION:

BEFORE UTILIZING THE CONTROL CIRCUIT POWER AVAILABLE FOR OPERATION OF CUSTOMER SUPPLIED DEVICES, THE COILS OR SOLENOIDS OF SUCH DEVICES MUST BE SUPPRESSED. THE EXTERNAL CONTROL CIRCUIT WIRING MUST BE RUN IN A SEPARATE CONDUIT THAT DOES NOT HAVE VARIABLE SIGNAL VOLTAGES OR POWER CIRCUIT VOLTAGES PRESENT. ELECTRICAL TRANSIENTS MAY CAUSE OCCASIONAL DRIVE MALFUNCTIONING.

TABLE 1
TRAY SPACING

LEVEL	1	2	3	3S	4	4S
1	0	NOTE 2	6	6	26	26
2	NOTE 2	0	6	6	18	26
3	6	6	0	0	NOTE 1	12
3S	6	6	0	0	8	18
4	26	18	NOTE 1	8	0	0
4S	26	26	12	18	0	0

TABLE 1 INDICATES THE MINIMUM DISTANCE, IN INCHES, BETWEEN THE TOP OF ONE TRAY AND THE BOTTOM OF THE TRAY ABOVE, OR BETWEEN THE SIDES OF ADJACENT TRAYS. THIS ALSO APPLIES TO THE DISTANCE BETWEEN TRAYS AND POWER EQUIPMENT OF LESS THAN 100 KVA.

TABLE 2
CONDUIT-TRAY SPACING

LEVEL	1	2	3	3S	4	4S
1	0	1	4	4	10	18
2	1	0	4	4	12	18
3	4	4	0	0	0	8
3S	4	4	0	0	6	12
4	10	12	0	6	0	0
4S	18	18	8	12	0	0

TABLE 2 INDICATES MINIMUM DISTANCE, IN INCHES, BETWEEN TRAYS AND CONDUITS. THIS ALSO APPLIES TO THE DISTANCE BETWEEN TRAYS OR CONDUITS AND POWER EQUIPMENT OF LESS THAN 100KVA.

TABLE 3
CONDUIT SPACING

LEVEL	1	2	3,3G	3S	4	4S
1	0	1	3	3	12	12
2	1	0	3	3	9	12
3	3	3	0	0	0	6
3S	3	3	0	0	6	9
4	12	9	0	6	0	0
4S	12	12	6	9	0	0

TABLE 3 INDICATES THE MINIMUM DISTANCE, IN INCHES, BETWEEN THE OUTSIDE SURFACES OF CONDUITS BEING RUN IN BANKS. APPLIES TO THE DISTANCE BETWEEN CONDUITS AND POWER EQUITMENT OF LESS THAN 100 KVA.

NOTE DIAGRAM
-NONE-
INTERCONNECTION INSTRUCTIONS

SYSTEM : 1_DFTSTD | REV DATE 10/14/92
SECTION: NOTE
SUB :
ENG: DLM | DRW: DLM | CHK:

RELIANCE ELECTRIC

SHEET 1
W/N 1_DFTSTD

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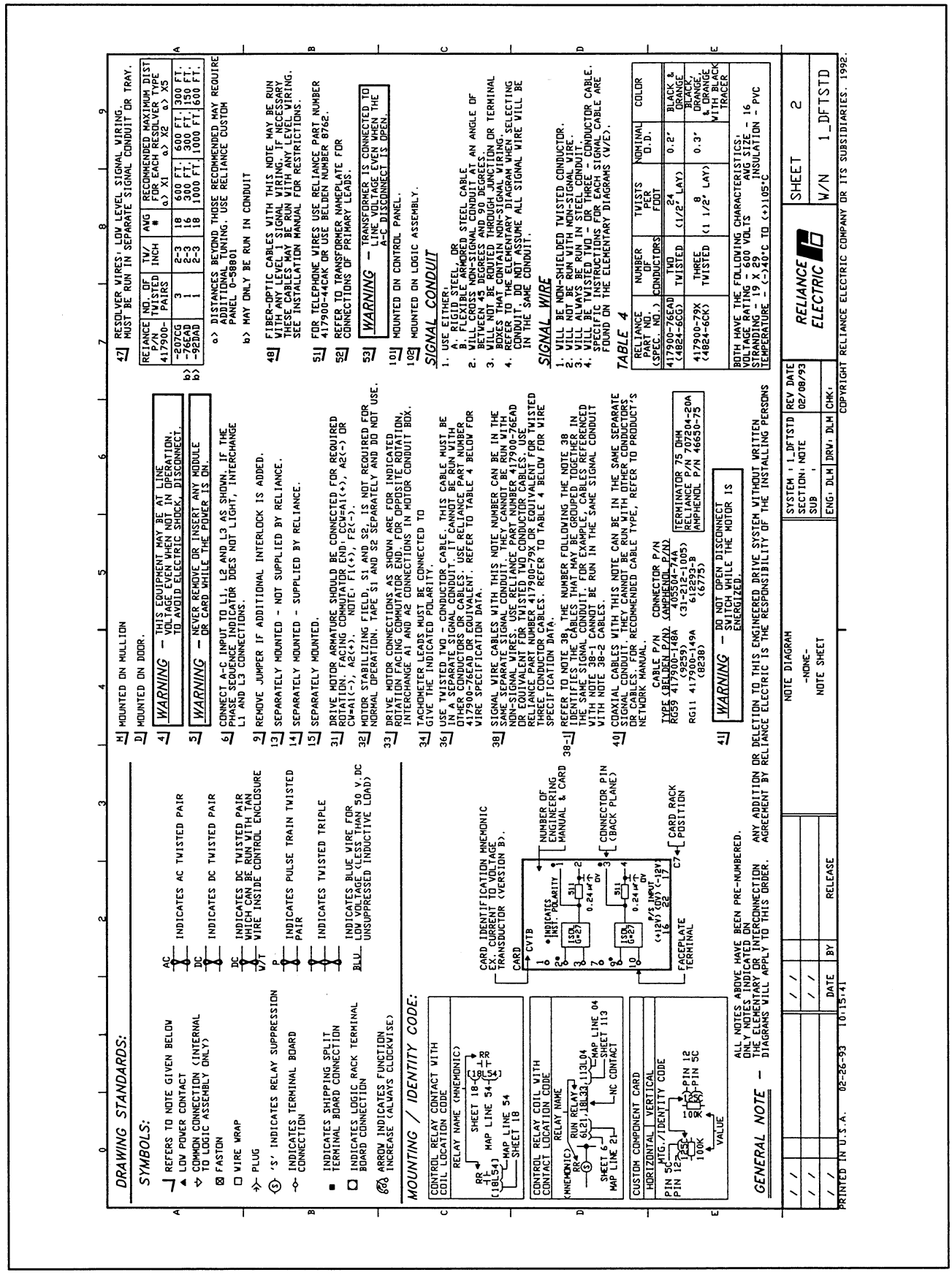
Appendix E (Continued)



Appendix F

Sample Operator's Station (W/O) Drawings

B/M 437281-YN

SIZE- 3036-OPS ASSY- 803813

CONSTR CODE NO - 12 WATTS = -

Q	IT	%	PART NUMBER	NAME	MAKE FROM
1			W/O 437281-YM	COVER	707105-16-R
1			803810-6-R	BODY	
1			B/M437281-97-A	L/P PACK.	
1			B/M437281-97-B	LABEL PACK	
1			693-AL	CABINET N/P	
2			69481-25-B	HINGE	
2			69481-25-C	HINGE PIN	
4			421321-A	MTG FOOT	
2			400877-19-R	FASTENER	
2			612801-4-A	TRIM PLATE	
-			707103-V	COVER SUPP ASSY	
-			803818-2-S	PEDESTAL ASSY	
-				TRUNION ASSY	
				DRIP CAP	
1			402690-A	GASKET	128" LG.
1			410550-127-R	PACKAGING SPEC	
-			421322-D	LASHING ROD	
1			612827-A	HASP PADLOCK	
1			612827-B	HASP PADLOCK	

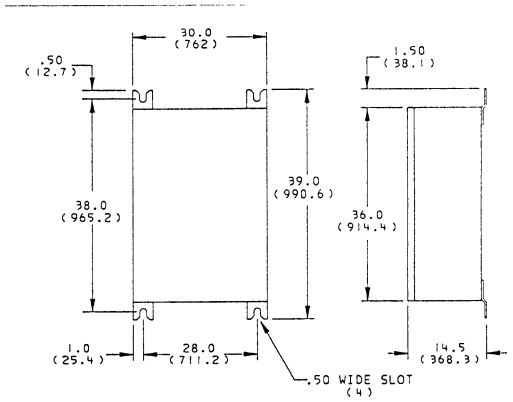
	ENGLISH	METRIC
DIM	INCHES	(MM)
WT	194 LB	88 KG

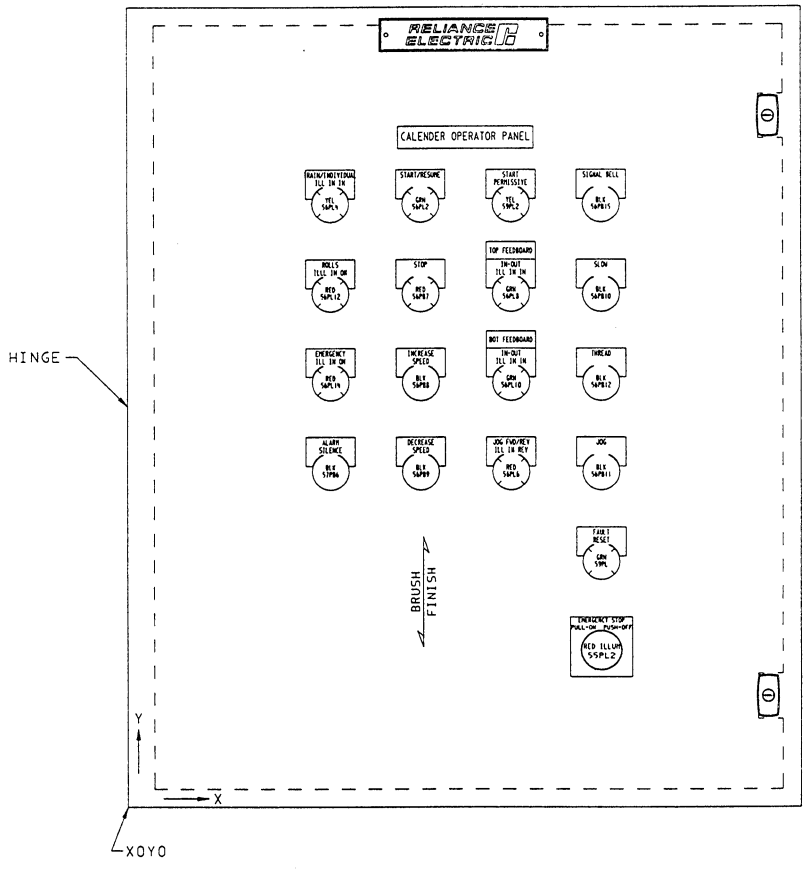
THESE DIMENSIONS SUBJECT TO CHANGE UNLESS CERTIFIED.

VENDOR TO IDENTIFY EACH PART WITH RELIANCE PART NUMBER.

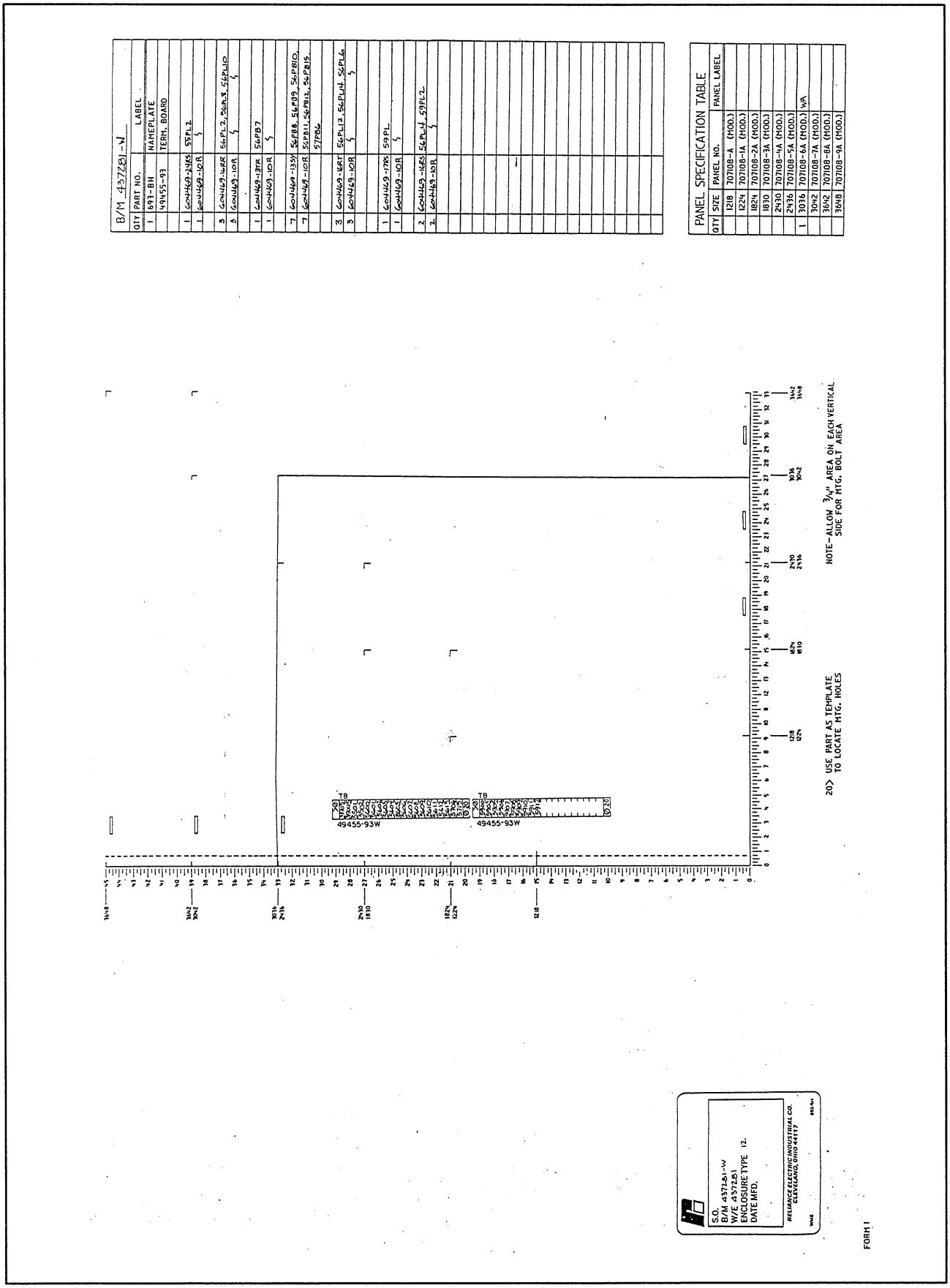
DO NOT PAINT O/P COVER (STAINLESS STEEL)

GR	YM	O/P COVER
REF PUNCH SERIES 410240 & MODIFICATIONS		



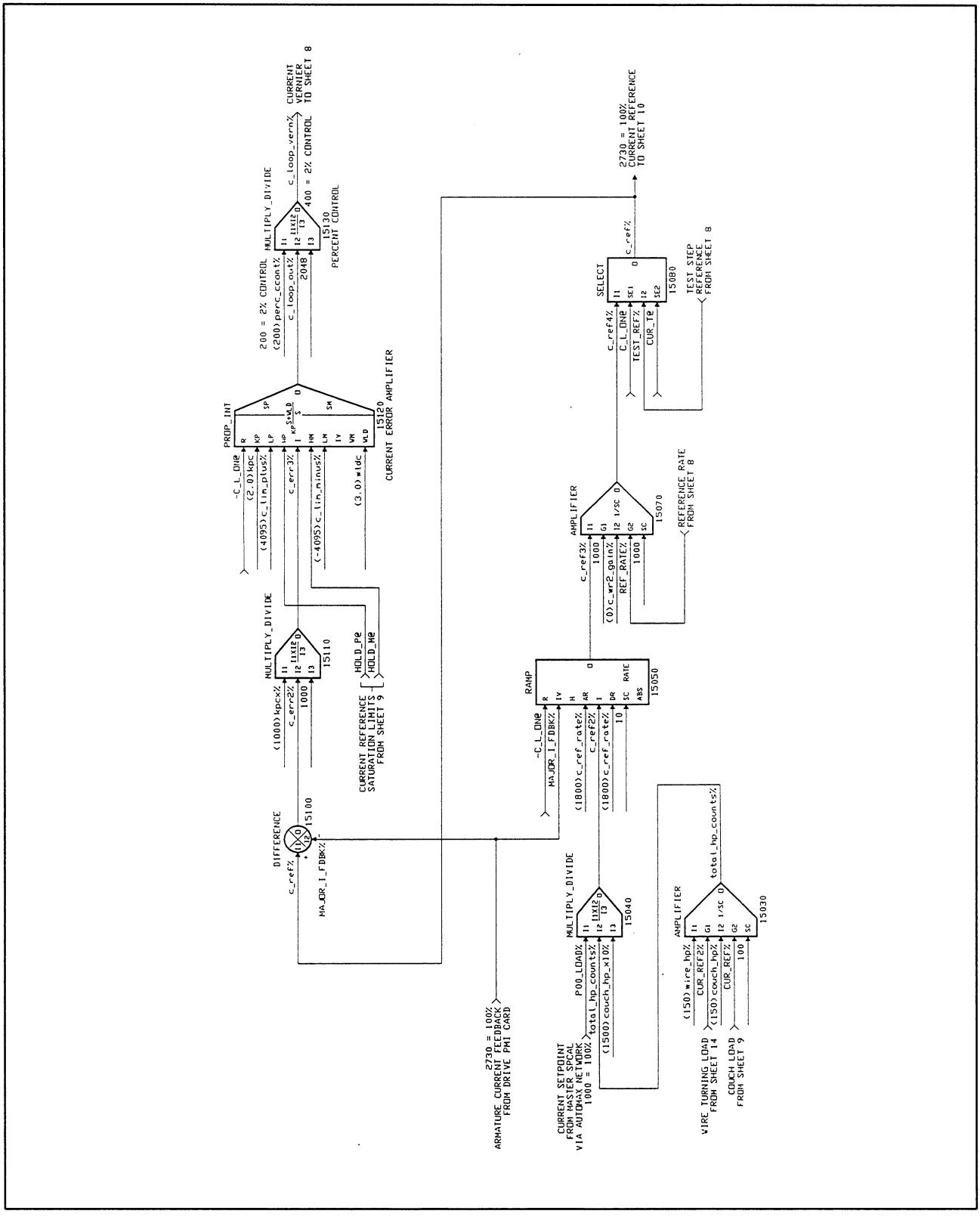


Appendix F (Continued)



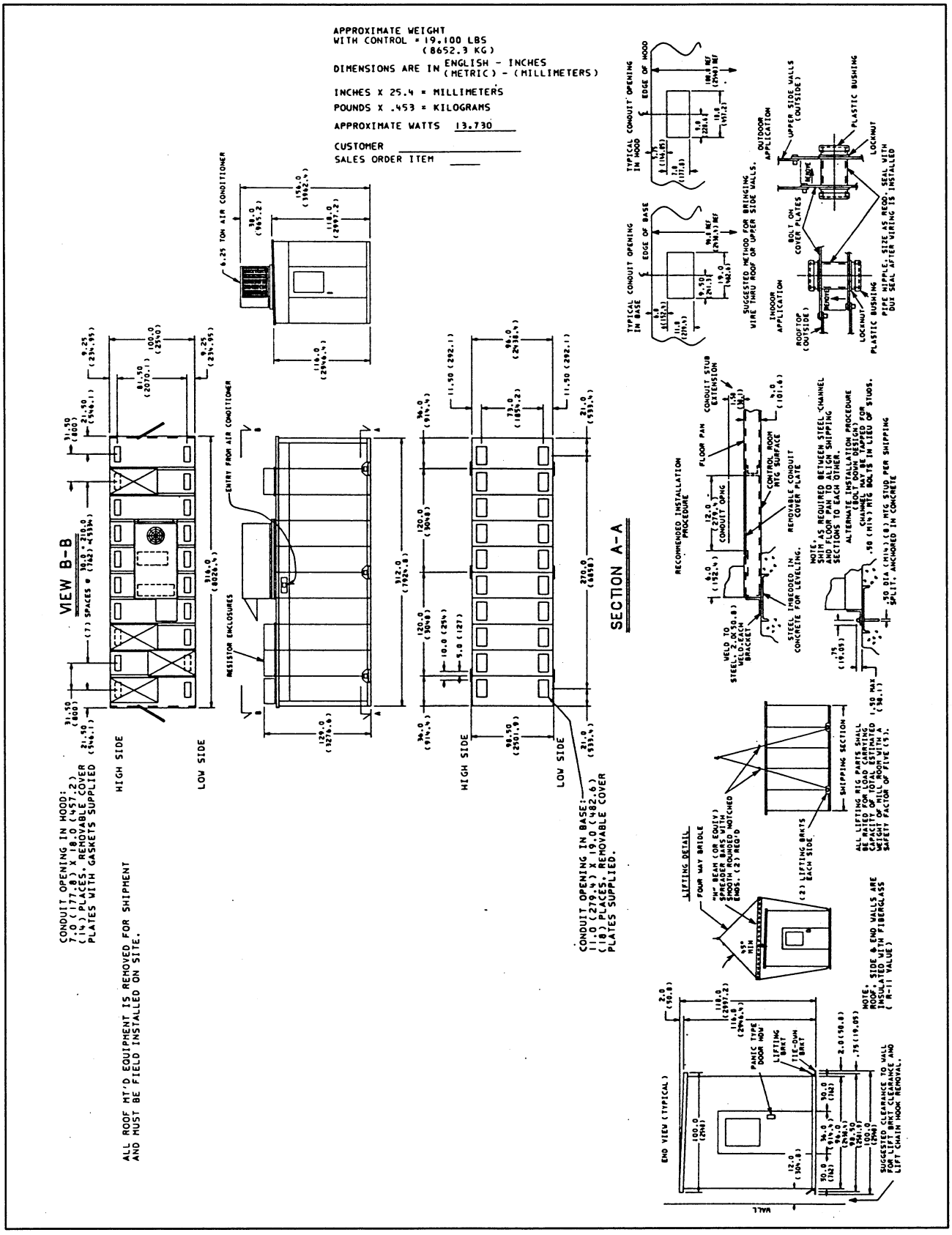
Appendix G

Sample Program (W/P) Documentation



Appendix H

Sample Construction (W/S) Drawing for Mill Control



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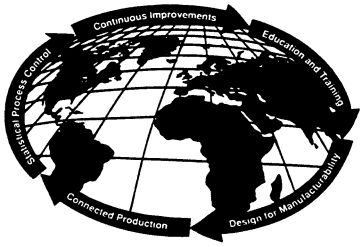
Cleveland, OH 44117



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Follow-Up Action:

Writer: _____ Date: _____

Thank you for your comments . . .

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