DELPHI

Application Guideline for Muting Two-Hand Control Devices in a Control Reliable Circuit

DA-2103

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Index

1. Abstract

Muting of a hardwired safety circuit is allowed, using an equivalent safety level hardwired circuit. Muting a Control Reliable hardwired safety circuit must use a Control Reliable hardwired mute circuit. Product literature commonly shows muting in a Control Reliable fashion. Their examples however reflect straight-forward applications such as a dual-sensor Control Reliable safety circuit from a robot machine base which mutes a light curtain when the robot is a safe distance away.

This document looks more pointedly at a Control Reliable two-hand control application where it is safe to mute based on multiple machine positions, even muting while motion is occurring. The hazards have been eliminated for the retract motions such that the operator can let go of the two-hand devices, turning attention to other production tasks. Muting is allowed, and required, to keep the machine in-cycle yet must be designed to the same safety circuit performance level as the initial Control Reliable two-hand control. This document looks at specification, component, and circuit design considerations; summing these all up with the finalized design.

Within particular design criteria a safety circuit can be Control Reliable independent of a PLC being interconnected to the circuit.

2. Goals

It is Delphi's goal to have safe machines while minimizing cost, doing this by consistently applying the appropriate safety circuit to the application. This document has goals for the circuit design and additional goals for the overall document and process.

Goals for the circuit include:

- ✓ Meet appropriate safety specifications
- ✓ Ease to design
- ✓ Ease to adapt to different applications
- ✓ Ease to communicate / teach / and enforce
- ✓ Ease to maintain / troubleshoot

Goals for the document include:

- ✓ Document intent of safety specifications
- ✓ Encourage consistent control design consideration
- ✓ Document failure mode considerations
- ✓ Document other design options which should not be used

Common references, safety circuits, and performance levels

3. Specifications

It is the readers' responsibility to obtain, fully read and understand all the standards / specifications which apply to the application.

Delphi's *Design-In Health and Safety Specification* contains risk assessment and risk reduction sections[1] which detail the process to obtain the safety circuit performance level. For an operator loading to the point-of-operation (frequency is more than once per hour) where injury would be categorized as serious (OSHA recordable) whether avoidance is likely or unlikely; the associated circuit performance required is Control Reliable.

Note that, keeping all other criteria the same, but lowering the injury to a slight severity (non-OSHA recordable) lowers the required circuit performance to Single Channel[2], which allows PLC two-hand control and therefore PLC based muting[3]. This document does not address this lower circuit performance example.

3.1 Control Reliable

Several national and international standards give definition to Control Reliable. Delphi's *Design-In Health and Safety Specification* establishes the rules for Control Reliable safety circuitry[4] within Delphi. Control Reliable circuits are required to be hardware based, include checked redundancy to and including the final switching device(s), and take into account common modes of failure.

Electrical Control Reliable safety circuits require the use of dual-channel safety relays, two inputs with short circuit detection, and outputs relays with positive-guided contacts[5]. Contacts from any of these positive-guided relays are used in series to protect against a single failure, and "opposite state" contacts are used in circuitry which monitors the function of the safety circuits[6]. Positive-guided relays are sometimes added to a Control Reliable circuit to help monitor devices which do not have "positive-guided" indication that they are functioning properly[7].

Safety interlock switches for Control Reliable applications require positive opening contacts (either two contacts on one switch or two switches with one contact each). Multiple switches, such as from a series of guards, can be run into one safety relay, but for a mute application one of the a typical device failure modes prohibits the practice of multiple sensors in series for the muting relay. Look for further details in the *Muting* subsection of this chapter.

Control Reliable safety circuits include checked redundancy in the fluid power

[1] DA-2006 section 3.3, 3.4, 3.5
[2] DA-2006 Table 4
[3] DA-2001 item 6.3.2
[4] DA-2006 item 3.5.5.4
[5] DA-2001 item 4.1.2
[6] DA-2001 section 5.4
[7] DA-2001 item 5.4.5.2

controls[8]. This typically requires one or a combination of the following:

1. dual blocking valves with functional monitoring
2. dual motion valves where failure of one device is detected and does not lead to a hazard
3. use of safety-rated self-checked components
4. quick stopping / or position holding devices

3.2 Two-Hand Control

Two-hand control performance specifications can be found in many documents.

ANSI defines a two-hand control devices as "an actuating control that requires the concurrent use of the operator's hands to initiate or control machine motion during the hazardous portion of the machine cycle.[9]" Two-hand controls are required to be located far enough from the nearest hazard such that the operator cannot reach the hazard before it ceases[10]. Two-hand devices are also to be designed and installed to protect against accidental operation[11]. This often means ring guards or other protective shields. Common practice in industry is to make all forms of operator safeguarding difficult to defeat.

For ergonomics and part handling reasons many machines within Delphi use a one-hand cycle initiation method; a whisker switch in combination with other guarding (e.g. sliding Plexiglas door). The use of dual whisker switches for two-hand control however is discouraged; most pointedly because of the above ANSI requirements. Second, dual whisker switch combinations are too easily defeated by physically hooking a string or wire between both switches thus making it a one-hand control system.

Concurrency on actuation of the two-hand devices has historically been limited to 0.5 seconds, although some standards have state no limit or leave the limit to be specified by the machine supplier. The latest NFPA-79 does state a time limit of 0.5 seconds[12].

Delphi's specification reiterate the above requirements for two-hand control.

3.3 Muting

Muting is the automatic temporary bypass of any safety related function[13]. The concept of muting circuits performing to the same safety level (as the safety function being muted) has been industry expectation for many years. "A simple cam-operated limit switch wired in parallel with the device's output is inadequate as its failure can remain undetected[14]."

Control Reliable muting circuits have to be hardware based, designed, constructed and applied such that any single component failure does not prevent the stopping of the equipment, and generate a stop when a fault occurs. Control systems incorporating software and firmware (PLCs) are allowed to either further limit the muting

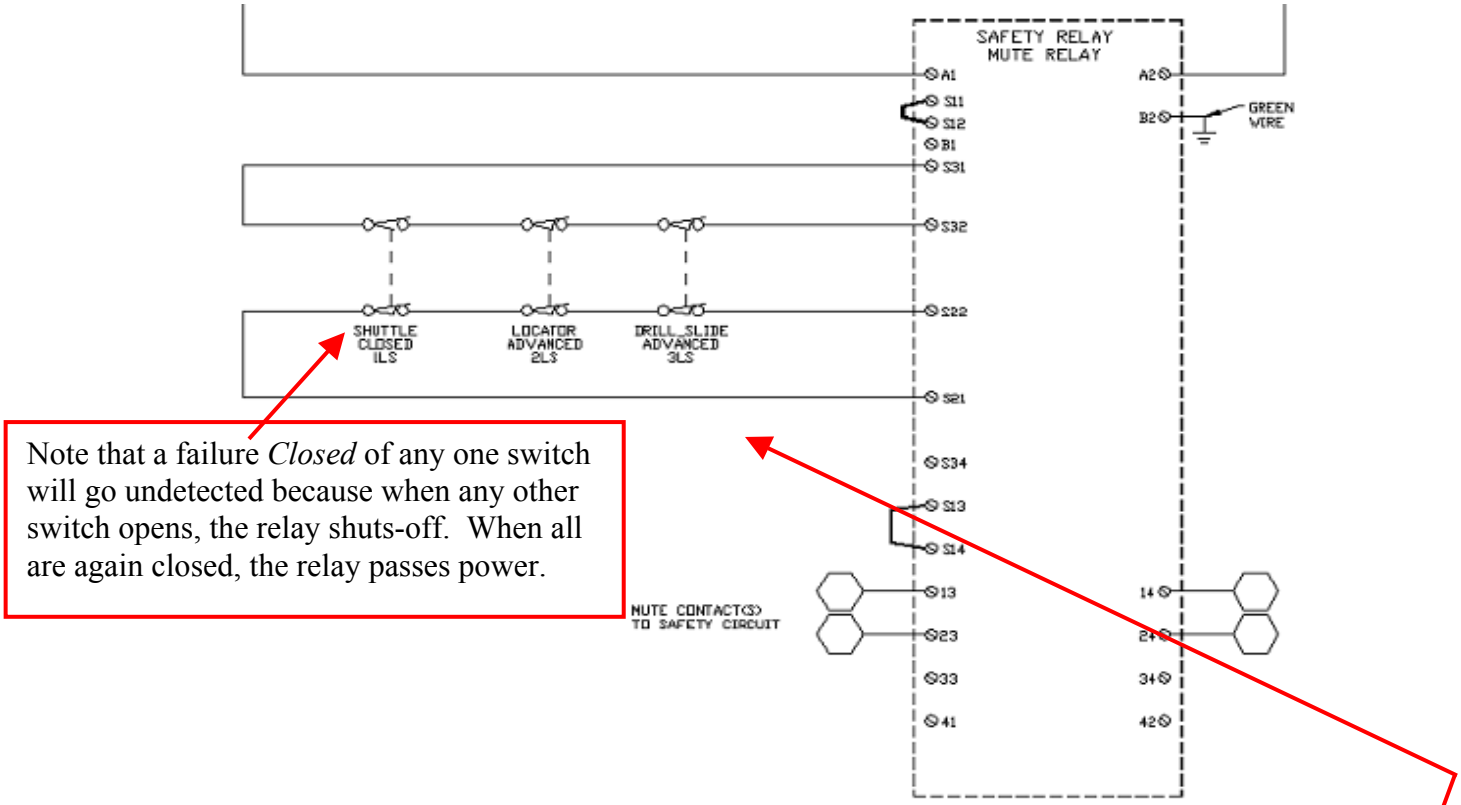
[8] DA-2001, section 8
[9] ANSI B11.19-2003 item 3.73
[10] *ibid* item 6.2
[11] ANSI B11.19-1990 item 4.2.4.2.1
[12] NFPA-79, 2002 item 9.2.5.6(2)
[13] DA-2001 item 3.8
[14] ANSI B11.19-1990 item 4.2.3.3.7

function of the hardwired circuit[15], or provide protection against any single failure (shutdown to a safe state) equivalent to that of a hardwired control system[16] (safety PLC implications).

On machines which could have the safeguarding muted after the completion of multiple motions, one might include a completely hardwired muting circuit as drawn below. **Note that the circuit depicted below is not an approved Control Reliable mute safety circuit.**

A method to design-out the failure modes detailed below would be to include multiple safety relays (in this case: one safety relay for **each** of the three motion limit switches). This can be complex depending on the machine, and does not address applications which need to mute while some cylinders are in motion.

Again, this document addresses these concerns through use of a PLC, while maintaining the safety circuit reliability independent of the PLC.



Note that a failure *Closed* of any one switch will go undetected because when any other switch opens, the relay shuts-off. When all are again closed, the relay passes power.

On a *Mute* application, which is different than multiple guards run into one guard safety relay, the failure of one limit switch is **guaranteed** to be ignored by the functioning of any other limit switch every cycle.

[15] DA-2001 item 5.5.6
[16] NFPA-79, 2002 item 9.4.3

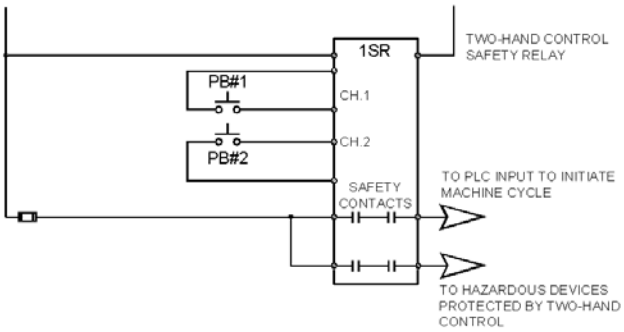
Components and applications

4. Two-Hand Control Components

Electrical, two-hand control, safety components consists of the safety relay and the input devices.

European standards on safety relays give classification to two-hand control safety relays. EN574 describes devices by type (type I, II, IIIA, IIIB, and IIIC) and risk assessment results as the basis for selecting devices[17]. None of these types exactly match Delphi requirements, although type IIIB can meet our requirements, and IIIC devices always meet them.

Delphi requires a hardwired, dual-channel, two-hand control safety relay with 500ms concurrency between single contacts off of two buttons[18] for both Single Channel w/Monitoring and Control Reliable circuits.



All of the basic criteria for safety relay selection, such as output contact current rating, monitor inputs, etc., have to be considered for two-hand control safety relay selection as well. Input simultaneity on two-hand control safety relays is set at 500ms maximum.

Many devices have been used as inputs to two-hand control safety relays, such as capacitive devices, low-force buttons, etc. When considering component selection it should be noted that some safety relays are rated for mechanical switches only, requiring an unspecified delay in the reaction time between the buttons N.O. and N.C. contacts. Others are now coming on the market designed for electronic devices. In addition, electronic pushbuttons for safety circuits have to be immune to RFI or other type of electrical interference.

Industry does market some devices that combine both the pushbuttons and safety relay; which can be used when compliant to the appropriate standards.

5. Point-of-Operation Guarding

Point-of-operation guarding, in this case a two-hand control system, is used to guard a person who performs an interactive task such as loading, unloading or inspecting in an area of a machine where a hazard exits. The two-hand control not only provides a guarding function while the machine is in-cycle, but also provides cycle initiation via a non-safety-rated means.

Compared to light curtains, application of two-hand control devices typically does not require additional fixed hard guarding. However, for process

[17] EN 574
[18] DA-2001 item 6.3.2

containment, hard guards and an additional interlocked moveable guard such as a closing door which operates each cycle may be required.

Interruption of the two-hand control safety circuitry (release during the hazardous portion of the cycle) does not need to disable the PLC machine-in-cycle logic although frequently it will. When the machine-in-cycle logic is not inhibited the cycle overtime timer should also continue timing.

Release of the two-hand control safety circuitry during the hazardous portion of the cycle raises additional logic concerns. In some applications, an immediate stop may be required and the part classified as a reject. In other applications there may be good reason for the machine to continue its cycle when the two-hand devices are again actuated.

6. Two-Hand Safe Distance Calculations

Many safety standards refer to a safe distance formula for the proper placement of safeguards; this includes two-hand controls. Refer to Delphi's *Specification for the Application of Safety Circuits* Annex B, Safe Distance Formulas[19]. The placement of the two-hand pushbuttons shall be consistent with these calculations. In some applications *where* to mount the two-hand devices may relate to *when* to mute.

Machine Example

7. Machine Overview

Application: The machine is a manually loaded lean assembly station, which pushes bushings and washers into opposing sides of the rack & pinion steering gear housing. The term "press" is used throughout the machine prints, but this is not to say that the machine is a hydraulic or mechanical power press. Designing the mute circuit for this machine, because multiple motions would indicate when the machine was in a safe position to mute, and the need to mute while some of these motions were retracting, a PLC-determined hardwired Control Reliable circuit was proposed.

Description: As initially built, the machine sequence was as follows. (Refer to sheet 13 of the ACAD prints in Annex B)

The operator loads bushings into the bottom press mandrels, then a housing into the fixture. The operator then needs to press and maintain the two-hand control for the complete upper and lower press-to-depth and dwell. The top press then retracts.

The operator is allowed to release the two-hand control to load washers, then must reactivate and hold the two-hand control to reapply the top press and dwell. Both presses are then retracted, the cycle is complete, and the operator allowed to release the two-hand control.

[19] DA-2001 Annex B

New machine sequence: The revision to the machine sequence, which drove the need for the mute circuit, was basically a production improvement to allow the operator to release the two-hand control after press-depth.

The operator's hands were freed during the first press dwell and top retract, to prepare to load the washers prior to the second half of the cycle.

The operator is also allowed to release the two-hand control after the washer press; now available to stage the next housing and bushings during the dwell, retract, and unclamp.

The mechanics of the machine have been modified with Plexiglas covers to protected the operator from retract motions.

Since this was an existing machine, the request to revise the machine's safety circuits meant the changes had to be designed to the same circuit performance level as the initial safety circuit. Since the existing two-hand was control reliable, the muting would have to be control reliable.

8. Risk Assessment Example

This machine was built prior to the formal Delphi documented risk assessment being put in place. The following is a sample risk assessment which could have been done in order to document the appropriate circuit performance level; both for the initial machine build, and then an updated risk assessment for the production floor changes.

Application:
Bushing and Washer Assembly Station for a Rack & Pinion Steering Gear Housing

Compan
Delphi Saginaw Steering Systems, Plant 7

Descripton:
Sample Risk Assessment for use in the Delphi Controls COE whitepaper titled Muting Two-Hand Control Devices in a Control Reliable Circuit. Twice during a normal machine cycle, the operator releases the two-hand control to manually load components. The mechanics of the machine has been modified to eliminate hazards in the retract direction(s), yet single-solenoid valves could not be the risk reduction method as some motions need to stay advanced / energized for process dwells during the second part-load stage.

User	Task	Hazard / Failure Mode	S	E	A	Categorg	Solution	Risk Reduction Methods
Operator	Manually loads bushings	Unexpected clamp motion	S1	E2	A1	R2B	Engr Ctrls	Single-channel safety circuit: hardwired removal of power to the basic motion control
Operator	Manually loads bushings	Unexpected press(es) advancing	S1	E2	A1	R2B	Engr Ctrls	
Operator	Manually loads housing	Unexpected clamp motion	S1	E2	A1	R2B	Engr Ctrls	
Operator	Manually loads housing	Unexpected press(es) advancing	S2	E2	A1	R3C	Engr Ctrls	Control-reliable two-hand control with dual blocking valves in hydraulic circuit
Operator	In cycle	Expected clamp motion	S1	E2	A1	R2B	Engr Ctrls	
Operator	In cycle	Expected press(es) advancing	S2	E2	A1	R3C	Engr Ctrls	
~~Operator~~	~~In cycle~~	~~Expected retracting~~	~~S2~~	~~E2~~	~~A1~~	~~R3C~~	~~Engr Ctrls~~	~~Control reliable two-hand control with dual blocking valves in hydraulic circuit~~
Operator	In cycle	Expected retracting	S2	E2	A1	R3C	Engr Ctrls	Fixed mechanical guards over all retract motions (R3C did not apply to clamp but clamp's R2B is covered by suggested
Operator	Manually loads washer	Unexpected top press advancing	S2	E2	A1	R3C	Engr Ctrls	
Operator	Manually loads washer	Unexpected bottom press or clamp retracting	S2	E2	A1	R3C	Engr Ctrls	
Operator	Manually unload part	Unexpected clamp motion	S1	E2	A1	R2B	Engr Ctrls	
Operator	Manually unload part	Unexpected press(es) advancing	S2	E2	A1	R3C	Engr Ctrls	
Skilled Trades	Troubleshooting	exposure to all hazards outlined above						Solutions for operator and job setter address exposure
Skilled Trades	Major Repair	numerous					Lockout	Remove all hazardous energy
Operator	Machine Cleaning	numerous					Lockout	Remove all hazardous energy

Task/hazard combinations highlighted indicate the most stringent category for various motions, and therefore the safety circuit performance level for those motions.

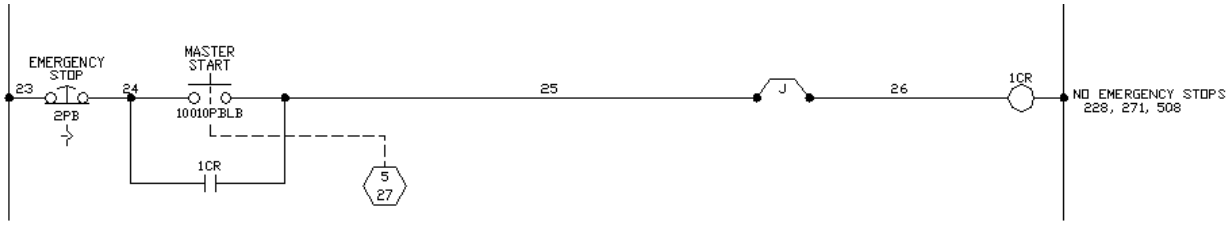
The update to the risk assessment reflecting the changes to the existing machine; the fixed guard risk reduction method replaces holding the two-hand control for the complete cycle.

Hardwired safety circuit design

9. Two-Hand Control Circuit Design

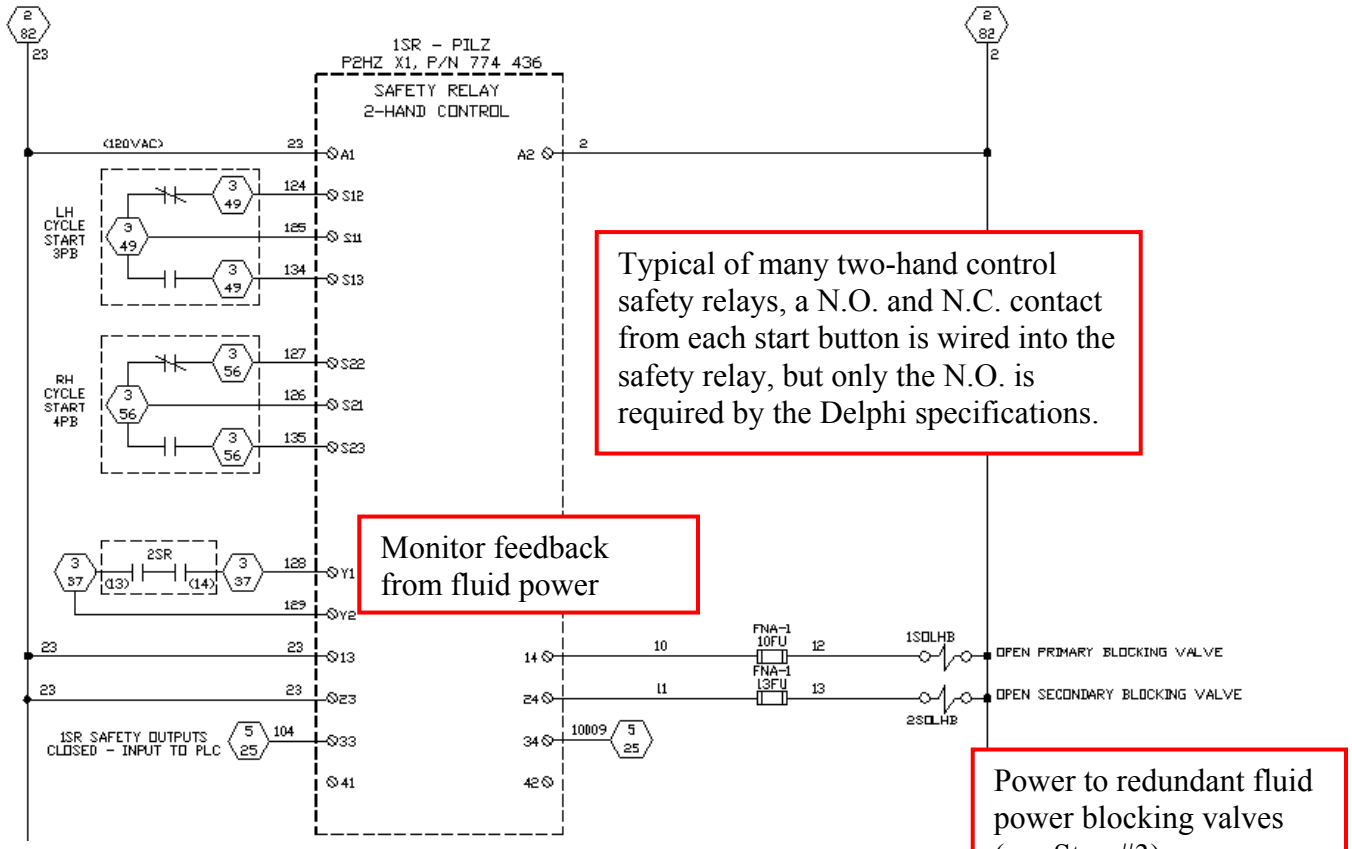
The hardwire control circuit design is for a Control Reliable implementation and has been broken down into individual circuit steps for clarity purposes. The first few steps, covered in this section, were from the initial machine design, not reflecting the changes required to implement the mute function. Also note that the complete machine control print has been included in this document as Annex B.

Step #1: E-stop circuit design



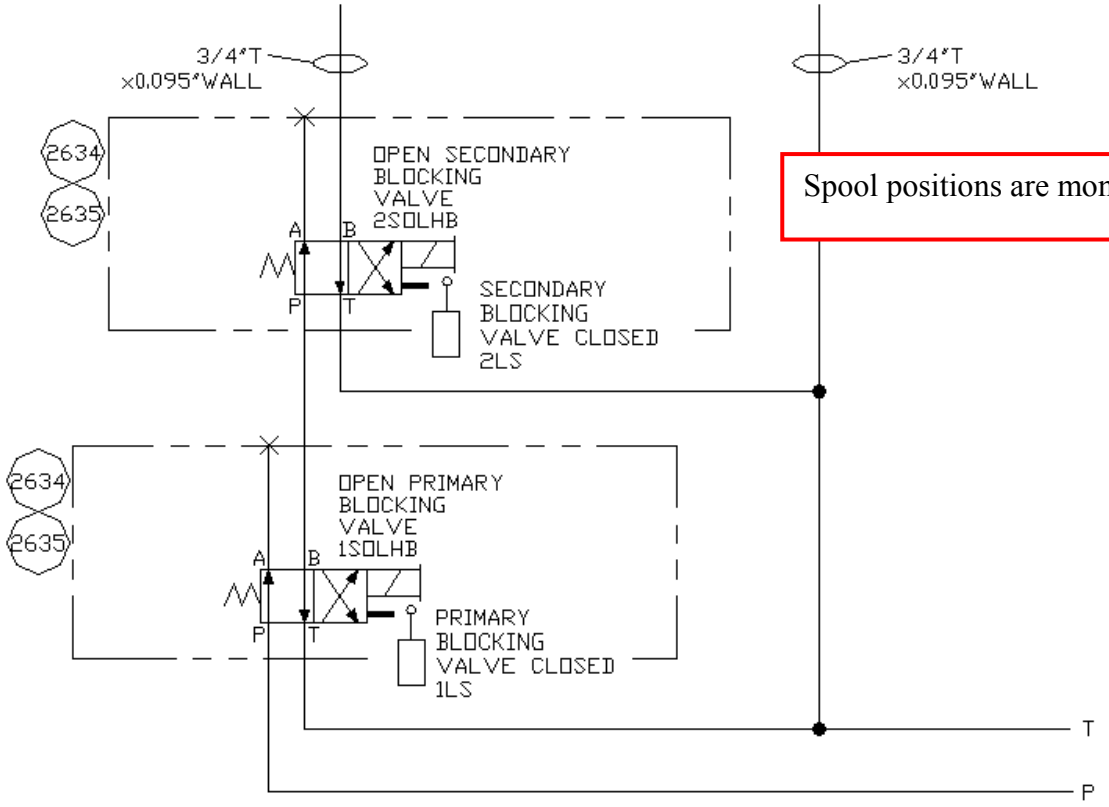
The risk assessment has determined that the two-hand control safety circuit addresses all hazards, therefore the e-stop circuit need only be a single channel circuit performance level.

Step #2: Two-hand control relay design



The two-hand control safety relay removes electrical power from redundant blocking valves.
An additional contact from 1SR is run to a PLC input to enable *Machine In Cycle*.

Step #3: Fluid power redundancy

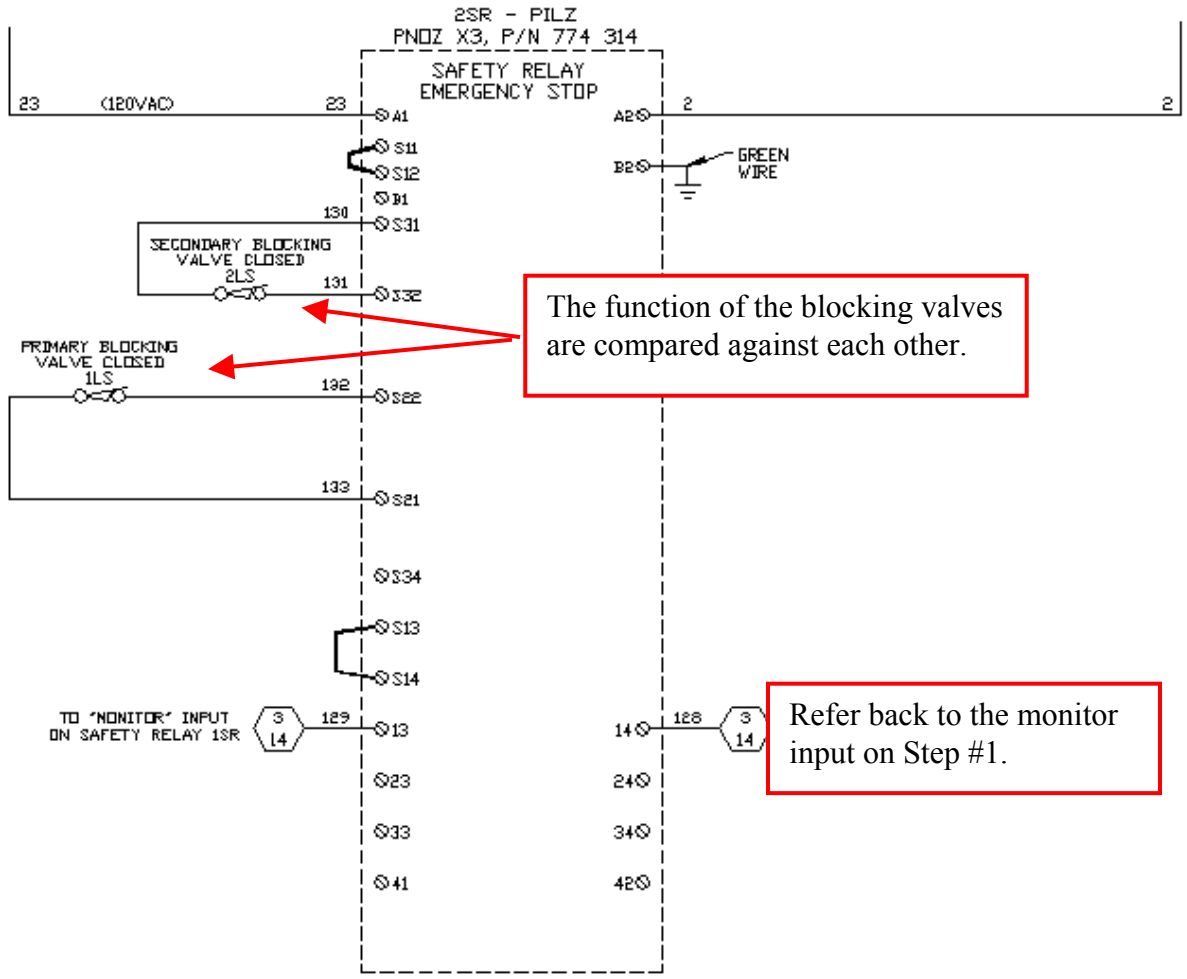


Spool positions are monitored

Hydraulic fluid power to all motion valves was initially removed via redundant blocking valves, whenever the two-hand control was released.

Pneumatic fluid power to the clamp has not been removed by any safety circuit or blocking valve. The risk assessment would have indicated that the motion required a Single Channel safety circuit, which is covered by the basic motion control circuit.

Step #4: Fluid power monitoring



The final switching devices, in this case the redundant hydraulic blocking valves, are monitored. When 1SR kills power to the blocking valves, both inputs to 2SR must close, indicating that both blocking valves have functioned, in order for 2SR's output to pass power to the *Monitor* input of 1SR. This allows 1SR to reset the next time the two-hand inputs are pressed.

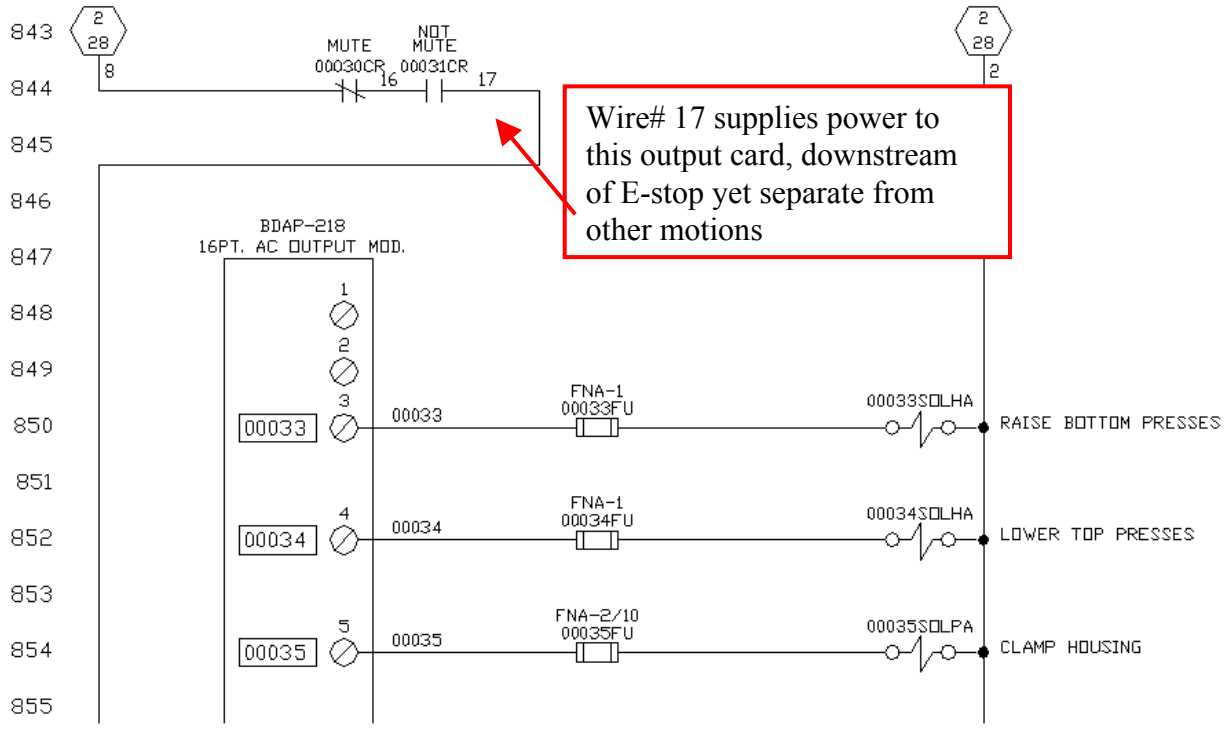
10. Muting Circuit Design

The revisions to the machine's control circuits, accomplishing Control Reliable muting yet driven by PLC logic, are described as follows:

Step #5: Separation of outputs

A critical component to designing the mute system as a hardwired safety circuit independent of the PLC is that the machine has motions which can be separated into those which are allowed to occur while muted, and those which are not. There needs to be multiple motions in each category. It is critical that these motions are on separate output cards, not just receiving power from a separate wire#. More detail is provided in the *Failure Mode Considerations* section of this document.

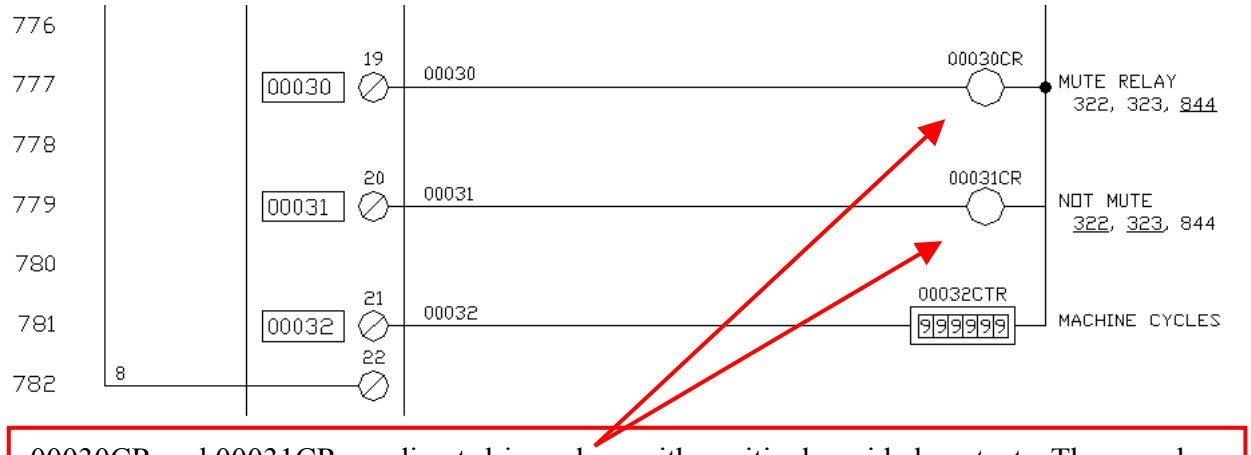
As it worked out for this machine, a new output card was added and three outputs moved to that card.



These outputs were separated from the non-hazardous / retract motions.

Raise Bottom Presses and *Lower Top Presses* are the hazards protected by two-hand control. The initial design did not include the clamp in the two-hand circuit.

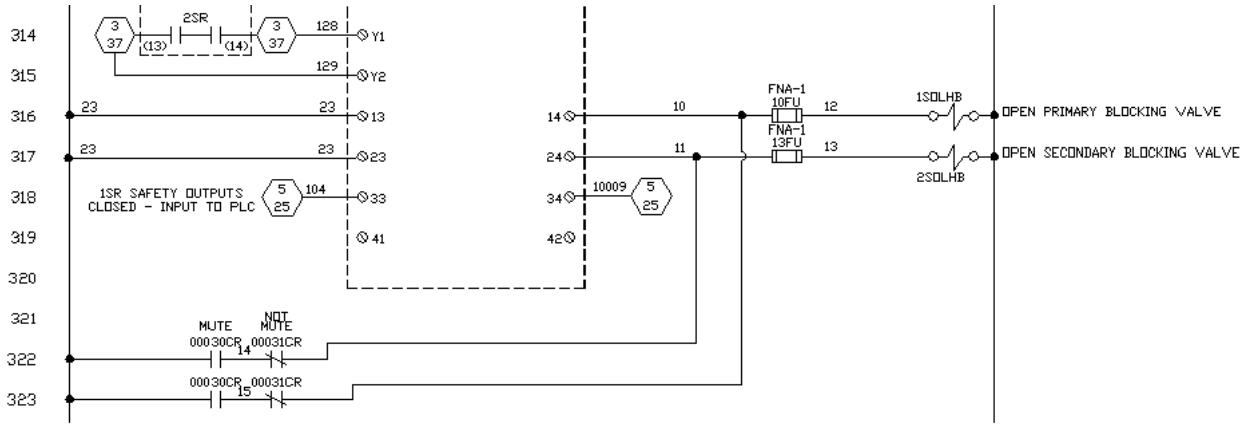
Step #6: PLC driven mute relays



00030CR and 00031CR are direct-drive relays with positively guided contacts. They can be controlled by any PLC output card that does not control hazardous motions. 00030CR is identified as the *Mute Relay* which energizes to provide power to the safety blocking valves when it is safe to release the two-hand control. 00031CR is the NOT state of the 00030CR

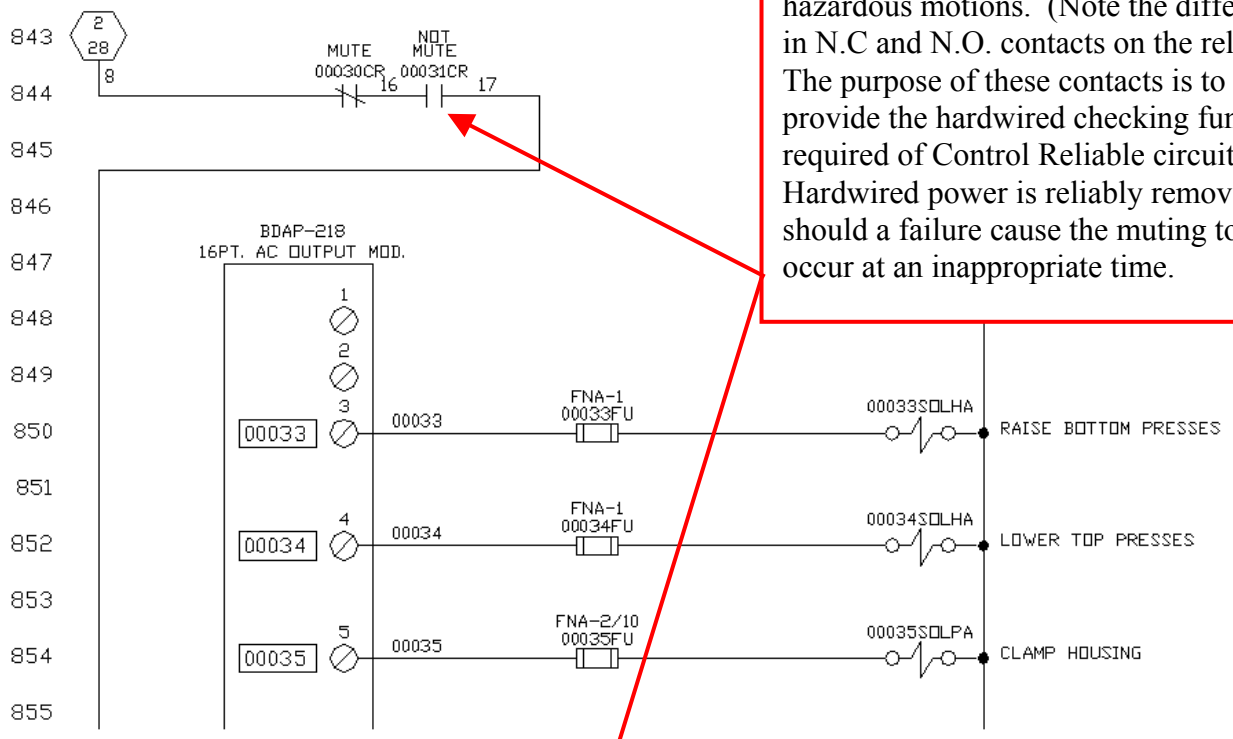
Note that the 00030CR / 00031CR cannot be replaced with two outputs driving a safety relay. There are two issues: One- current safety relays do not offer safety contacts which pass power when the relay is off (the contact required in *Step#8* of this document), and, Two- there are logic synchronization issues as noted in section 12.

Step #7: Muting the safety circuit



00030CR and 00031CR contacts mute the two-hand control safety relay contacts, keeping power to the hydraulic blocking valves. The mute timing is controlled by the PLC at those times in the cycle when it is safe for the operator to release the two-hand control. The *Not Mute* provides the redundancy as required in Control Reliable circuits and single point-of-failure protection as described in the *Failure Mode Considerations* section of this document.

Step #8: Hardwired safety contacts (checking function)



Contacts from 00030CR and 00031CR relays are wired into the wire supplying power to the output card controlling all hazardous motions. (Note the difference in N.C and N.O. contacts on the relays). The purpose of these contacts is to provide the hardwired checking function required of Control Reliable circuits. Hardwired power is reliably removed should a failure cause the muting to occur at an inappropriate time.

A safety relay cannot be used in place of 00030CR / 00031CR (combined) because the opposite-state contacts required here are not available from a safety relay.

Other Considerations

11. Failure Mode Considerations

Control Reliable circuit applications are by definition to be implemented in hardware, and not controlled by a PLC[20]. The mute circuit implemented on this machine requires interface with a PLC for determination of *when* it is safe to mute the circuit, yet keeps the safety portion of the circuit as hardwire component based. Failures of a single component, such as the PLC, have been addressed per the following failure mode considerations.

Failure mode considerations for the Control Reliable two-hand control and blocking valve circuits are not documented herein.

Normal mode of operation: In normal operation of the machine, 00030CR relay will turn on and mute the two-hand safety relay after the press-to-depth. The mute shuts off upon the next cycle request (two-hand control PLC input), but is turned back on after the washer press. This functionality is controlled by the PLC enabling of 00030CR (and disabling 00031CR) positive guided relay(s).

Failure Modes:

1. If 00030CR hardware should fail in an "***Always On***" state (electronic output failure, coil seizure, contact weld, etc.), the hardwired circuit would remove power to the output card controlling hazardous motion through the N.C. 00030CR contact in the incoming power feed wire (refer to *Steps #5 & #8* of section 10 above). This keeps the machine from sequencing. Particularly, one failure has not caused an improper mute, yet hardwire disables the hazardous motions.

2. If 00030CR hardware should fail in an "***Always Off***" state, the hydraulic blocking valves will be de-energized (go to a blocking state) when the operator releases the two-hand control (refer to *Step #7* of section 10 above). Note that for this mode of failure the machine may actually completely cycle if the operator continues to hold the two-hand control.

3. If there is a program error or other PLC error that allows 00030CR to "***Turn On***" at the wrong time in the cycle (e.g., too early), power will be removed from the hazardous motions output card through the N.C. 00030CR contact in the incoming power feed wire (refer to *Step #5 & #8* of section 10 above). This will hardwire disable motion until the failure is corrected. This contact is critical to why this system is considered a hardwire safety circuit (not PLC based).

4. If there is a program error that allows 00030CR to "***Turn Off***" at the wrong time in the cycle, the hydraulic blocking valves will be de-energized (go to a blocking state) when the operator releases the two-hand control (refer to *Step #7* of section 10 above).

5. Field wiring, output card electronic failures (all outputs electronically "***Turn On***"), and other failures which would cause 00030CR and 00031CR to function "as the same relay" are addressed by 00031CR being *Not Mute*, the logical opposite of 00030CR.

6. All failure modes of 00031CR are addressed by 00030CR considerations (opposites mode) mentioned in item 1 through 4 above.

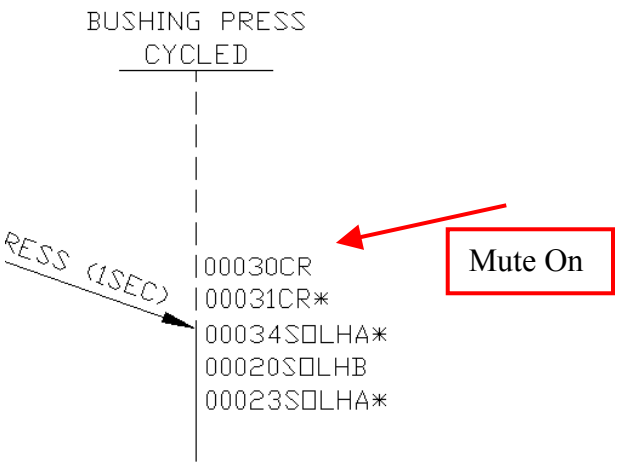
[20] DA-2001 item 5.1.4

12. Logic Design Considerations

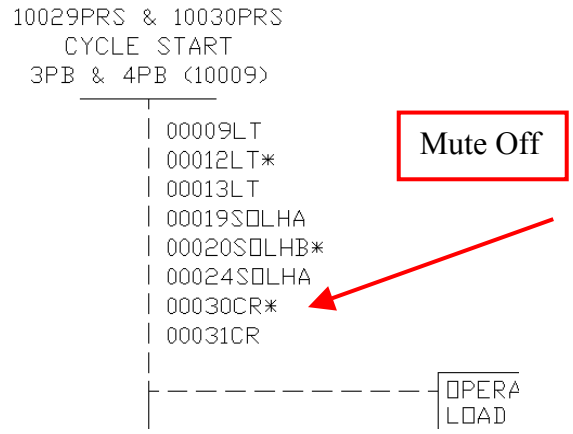
As with all point-of-operation guard applications, the machine sequence logic needs to consider such things as part quality issues if the two-hand is released early and then reapplied. Should the sequence be allowed to continue? These sort of logic issues are independent of the Mute function.

This machine's logic had to be revised to match the new machine sequence; adding the *Mute On* and *Mute Off* points as noted in the line sequence diagram.

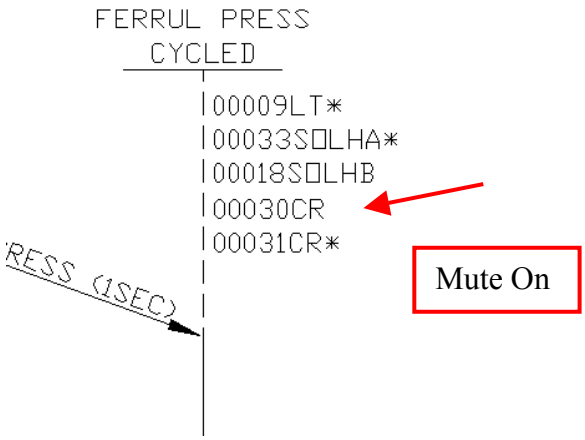
The mute was activated after press to-depth:



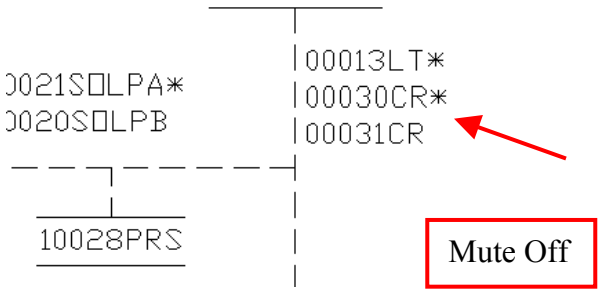
but turned off at the start the second half of the cycle:



The mute was also activated after the washer-press:



and left on until the cycle completed.



12. Logic Design Considerations (continued)

One final logic-related issue should be considered. As pointed out (in *Step #6* from section 10 of this document), there are logic constraints on designs which had used a PLC-driven safety relay for the mute function. Due to reaction times (both *On* and *Off*) for safety relay input channels, PLC de-bounce timers are frequently required when switching between *Mute On* and *Mute Off* modes. To avoid nuisance safety relay lock-ups, logic and timers would be used to keep the machine in either *Mute On* or *Mute Off* mode for a minimum amount of time (typically 0.5 seconds). This de-bounce particular **does not** need to be considered for the positive-guided relay version of mute presented in this document.

The mute logic is very basic; mute while in-cycle and at the appropriate sequences. A printout of the machine logic is not embedded in this document.

Annex A. Bibliography

DA-2006, *Design-In Health and Safety Specification*, Delphi Automotive Systems, Version 1.0, December 20, 2001

DA-2001, *Specification for the Application of Safety Circuits*, Delphi Corporation, Revision 2.1, March 2003

ANSI B11.19-2003, *Performance Criteria for Safeguarding*, American National Standards Institute, Inc.

ANSI B11.19-1990, *Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards – Performance Criteria for the Design, Construction, Care, and Operation*, American National Standards Institute, Inc.

NFPA 79, *Electrical Standard for Industrial Machinery 2002 Edition*, National Fire Protection Agency

EN 574, *Safety of Machinery – Two-Hand Control Devices – Functional Aspects – Principles for Design*, European Committee for Standardization

Annex B : Machine Schematics

SHEET NUMBER	DESCRIPTION
E1	SHEET INDEX, MISC. USAGE CHARTS
E2	POWER DISTRIBUTION & MASTER CONTROL WIRING
E3	SAFETY RELAY/PROX BLOCK WIRING
E4	MODICON RACK LAYOUT
E5	24VDC INPUT WIRING
E6	24VDC INPUT WIRING
E7	24VDC OUTPUT WIRING & 120VAC OUTPUT WIRING
E8	PRESS SLIDE ANALOG INPUT WIRING
E9	CONTROL PANEL LAYOUT
E10	OPERATOR STATION FABRICATION
E11	OPERATOR STATION WIRING
E12	ELECTRICAL MATERIAL LIST
E13	LINE SEQUENCE DIAGRAM
P1	PNEUMATIC DIAGRAM
P2	PNEUMATIC/LUBE DIAGRAM
P3	PNEUMATIC/LUBE MATERIAL LIST
H1	HYDRAULIC DIAGRAM
H2	HYDRAULIC MATERIAL LIST

UTILITY REQUIREMENTS

SUPPLY VOLTAGE: 480V, 3PH, 60HZ
FULL LOAD CURRENT: 13 AMPS
DISCONNECT RATING: 30 AMPS

AIR: 70 PSI, 2 SCFM

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

MISC. DEVICES

TYPE	ABBREV.	LAST USED
DISCONNECT	DISC	1
PUSHBUTTON	PB	4
PUSHBUTTON, ILLUMINATED	PBL	1
RELAY	CR	1
FUSE	FU	14
RECEPTACLE	RECP	1
SELECTOR SWITCH	SS	1
POWER SUPPLY	PWS	1
DISPLAY	DISP	1
CENTRAL PROCESSING UNIT	CPU	1
CABLE	-	1
PILOT LIGHT	LT	1
PROXIMITY SWITCH	PRS	2
TRANSFORMER	T	1
SAFETY RELAY	SR	2
SOLENOID	SOL	2
LIMIT SWITCH	LS	2

WIRE NUMBER USAGE CHART

X	AC WIRE: X	1X	2X	3X	4X	5X	6X	7X	8X	9X	DC WIRE: 10X	11X	12X	13X	14X
0		3	2											3	
1	2	3	2								2			3	
2	2	3	2								2			3	
3		3	2								2			3	
4		3	2								2		3	3	
5	2	3	2								8		3	3	
6	2	8	2								8		3		
7	2	8											3		
8	2												3		
9	2												3		

INDICATES SHEET NO. WIRE USED ON

DA-21xx

COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

STAMP OR ETCH ON ALL DETAILS:
DRAWING NUMBER AND DETAIL NUMBER WITH THE LATEST REVISION SYMBOL APPLICABLE TO THAT DETAIL

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

SHEET INDEX & MISC. USAGE CHARTS
BUSHING PRESS MACHINE

PART NO. | PART NO.

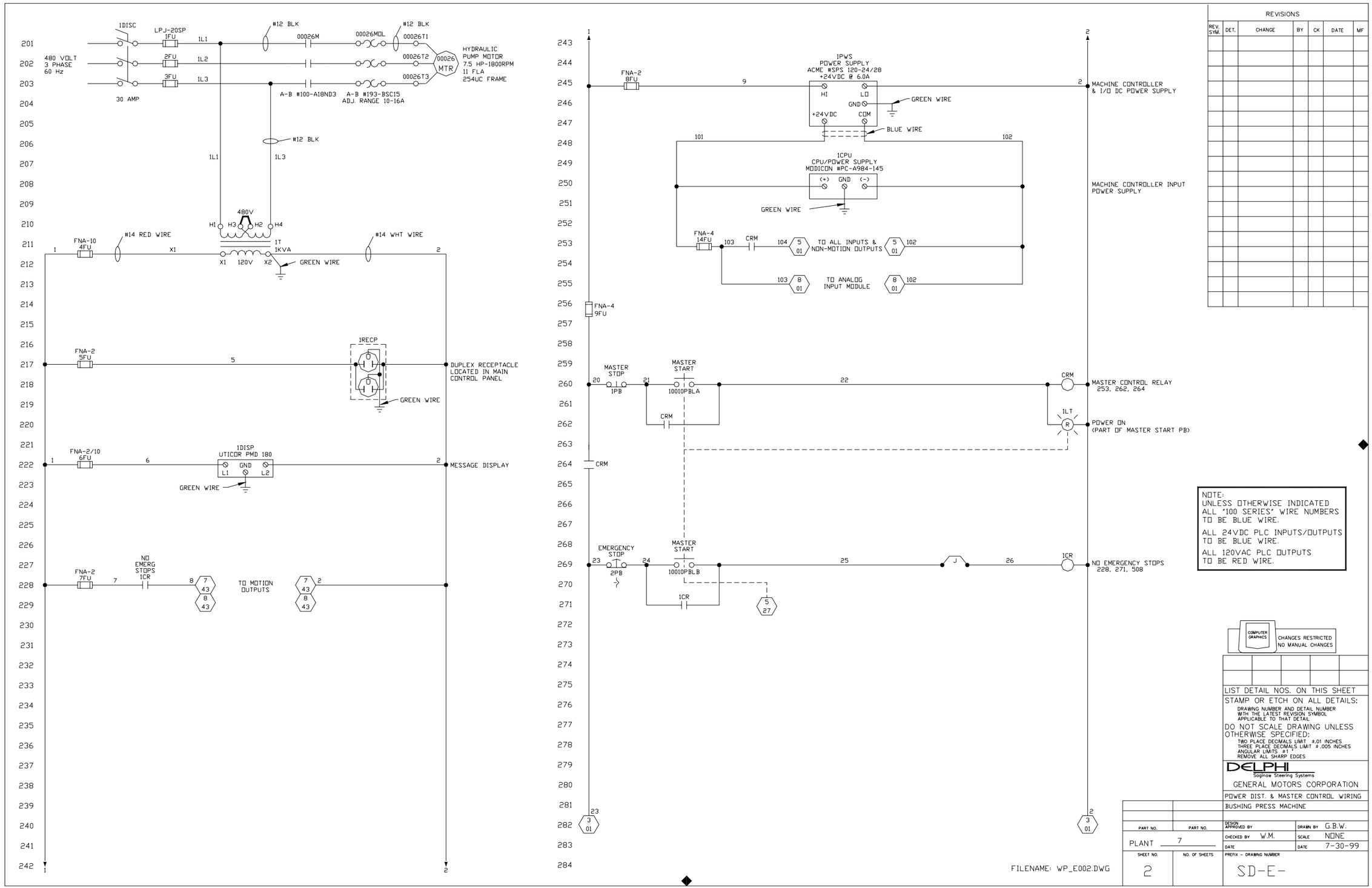
DESIGN APPROVED BY
DRAWN BY G.B.W.
CHECKED BY W.M.
SCALE NONE
DATE
DATE 7-30-99

PLANT 7

SHEET NO. 1 | NO. OF SHEETS 13

PREFIX - DRAWING NUMBER SD-E-

FILENAME: WP_E001.DWG


1DISC
LPJ-20SP
1FU
2FU
3FU
1L1
1L2
1L3
480 VOLT
3 PHASE
60 Hz
30 AMP
#12 BLK
00026M
00026MOL
00026T1
00026T2
00026T3
00026
MTR
HYDRAULIC
PUMP MOTOR
7.5 HP-1800RPM
11 FLA
254UC FRAME
A-B #100-A18ND3
A-B #193-BSC15
ADJ. RANGE 10-16A
480V
H1
H3
H2
H4
1T
1KVA
X1
120V
X2
GREEN WIRE
#14 RED WIRE
#14 WHT WIRE
FNA-10
4FU
1RECP
DUPLEX RECEPTACLE
LOCATED IN MAIN
CONTROL PANEL
FNA-2
5FU
FNA-2/10
6FU
1DISP
UTICOR PMD 180
GND
L1
L2
MESSAGE DISPLAY
FNA-2
7FU
NO
EMERG
STOPS
ICR
TO MOTION
OUTPUTS
1PWS
POWER SUPPLY
ACME #SPS 120-24/28
+24VDC @ 6.0A
HI
LO
GND
+24VDC
COM
FNA-2
8FU
MACHINE CONTROLLER
& I/O DC POWER SUPPLY
BLUE WIRE
1CPU
CPU/POWER SUPPLY
MODICON #PC-A984-145
(+)
GND
(-)
MACHINE CONTROLLER INPUT
POWER SUPPLY
FNA-4
14FU
CRM
TO ALL INPUTS &
NON-MOTION OUTPUTS
TO ANALOG
INPUT MODULE
FNA-4
9FU
MASTER
STOP
1PB
MASTER
START
10010PBLA
MASTER CONTROL RELAY
253, 262, 264
1LT
POWER ON
(PART OF MASTER START PB)
EMERGENCY
STOP
2PB
10010PBLB
NO EMERGENCY STOPS
228, 271, 508
NOTE:
UNLESS OTHERWISE INDICATED
ALL "100 SERIES" WIRE NUMBERS
TO BE BLUE WIRE.
ALL 24VDC PLC INPUTS/OUTPUTS
TO BE BLUE WIRE.
ALL 120VAC PLC OUTPUTS
TO BE RED WIRE.
REVISIONS
REV. SYM.
DET.
CHANGE
BY
CK
DATE
MF
COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES
LIST DETAIL NOS. ON THIS SHEET
STAMP OR ETCH ON ALL DETAILS:
DRAWING NUMBER AND DETAIL NUMBER
WITH THE LATEST REVISION SYMBOL
APPLICABLE TO THAT DETAIL
DO NOT SCALE DRAWING UNLESS
OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES
DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION
POWER DIST. & MASTER CONTROL WIRING
BUSHING PRESS MACHINE
PART NO.
PART NO.
DESIGN APPROVED BY
DRAWN BY G.B.W.
CHECKED BY W.M.
SCALE NONE
DATE
DATE 7-30-99
PLANT 7
SHEET NO. 2
NO. OF SHEETS
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SD-E-
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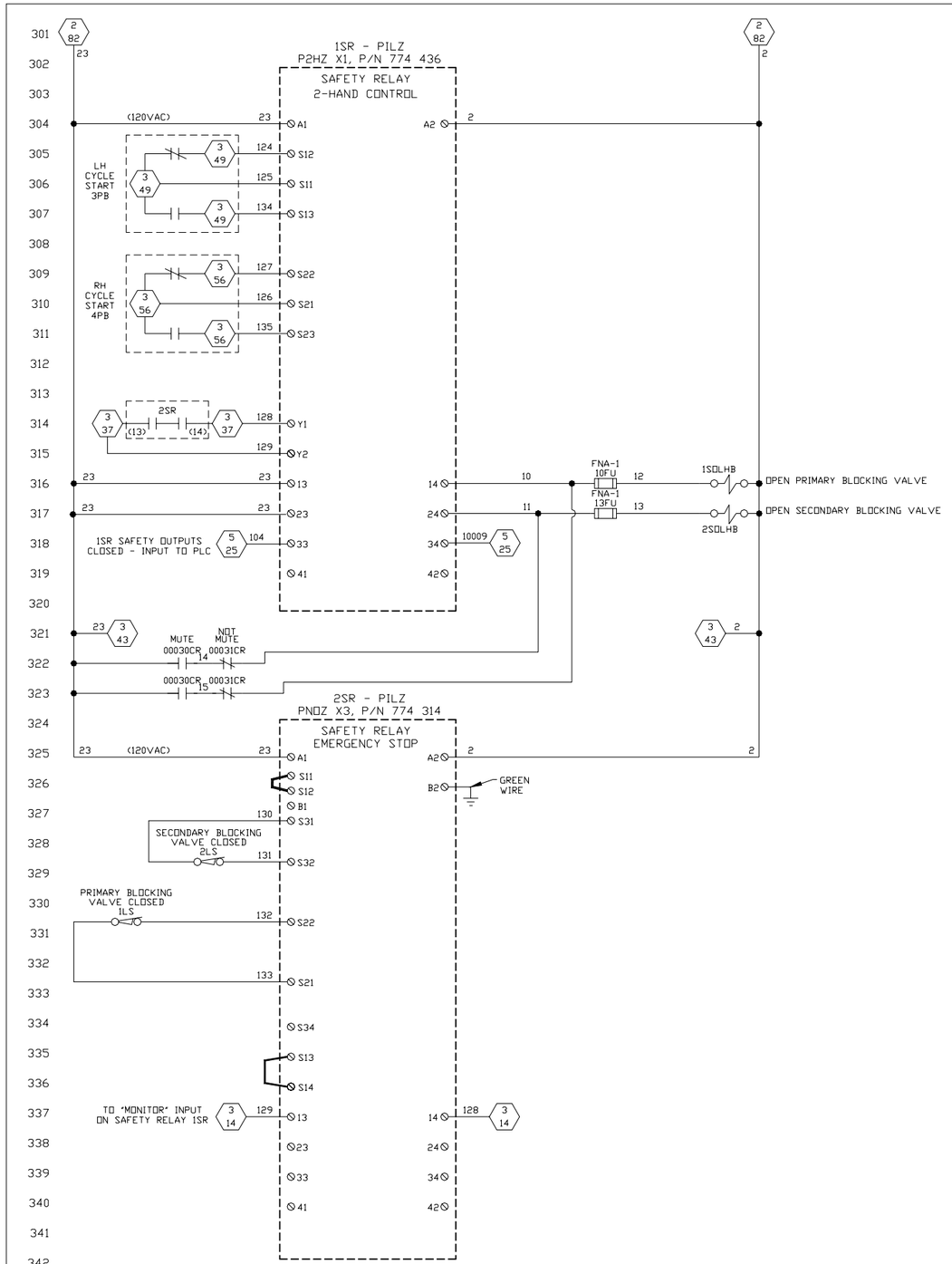

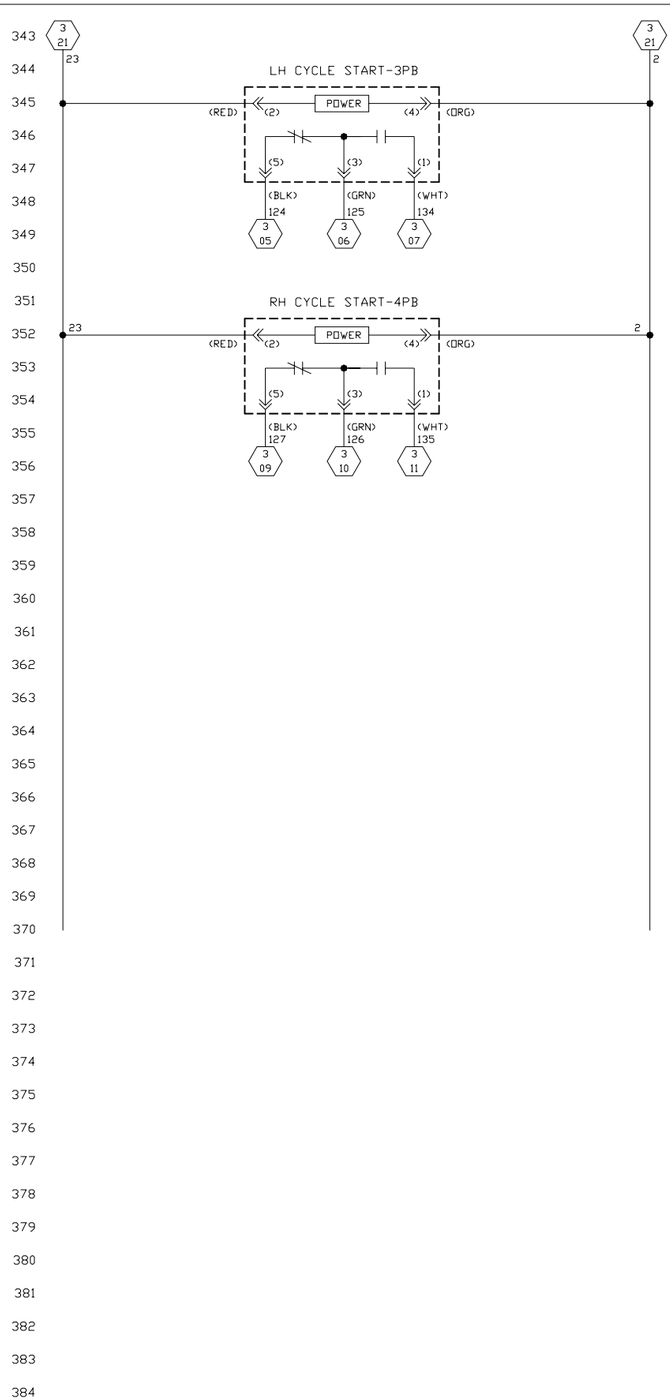

REVISIONS

REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF
B		REVISED PER DA-21xx	CDE	CDE	06-01	

COMPUTER GRAPHICS — CHANGES RESTRICTED NO MANUAL CHANGES

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DRAWING NUMBER AND DETAIL NUMBER WITH THE LATEST REVISION SYMBOL APPLICABLE TO THAT DETAIL

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

SAFETY RELAY WIRING
BUSHING PRESS MACHINE

PART NO.	PART NO.		
		DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 3	NO. OF SHEETS	PREFIX - DRAWING NUMBER SD-E-	

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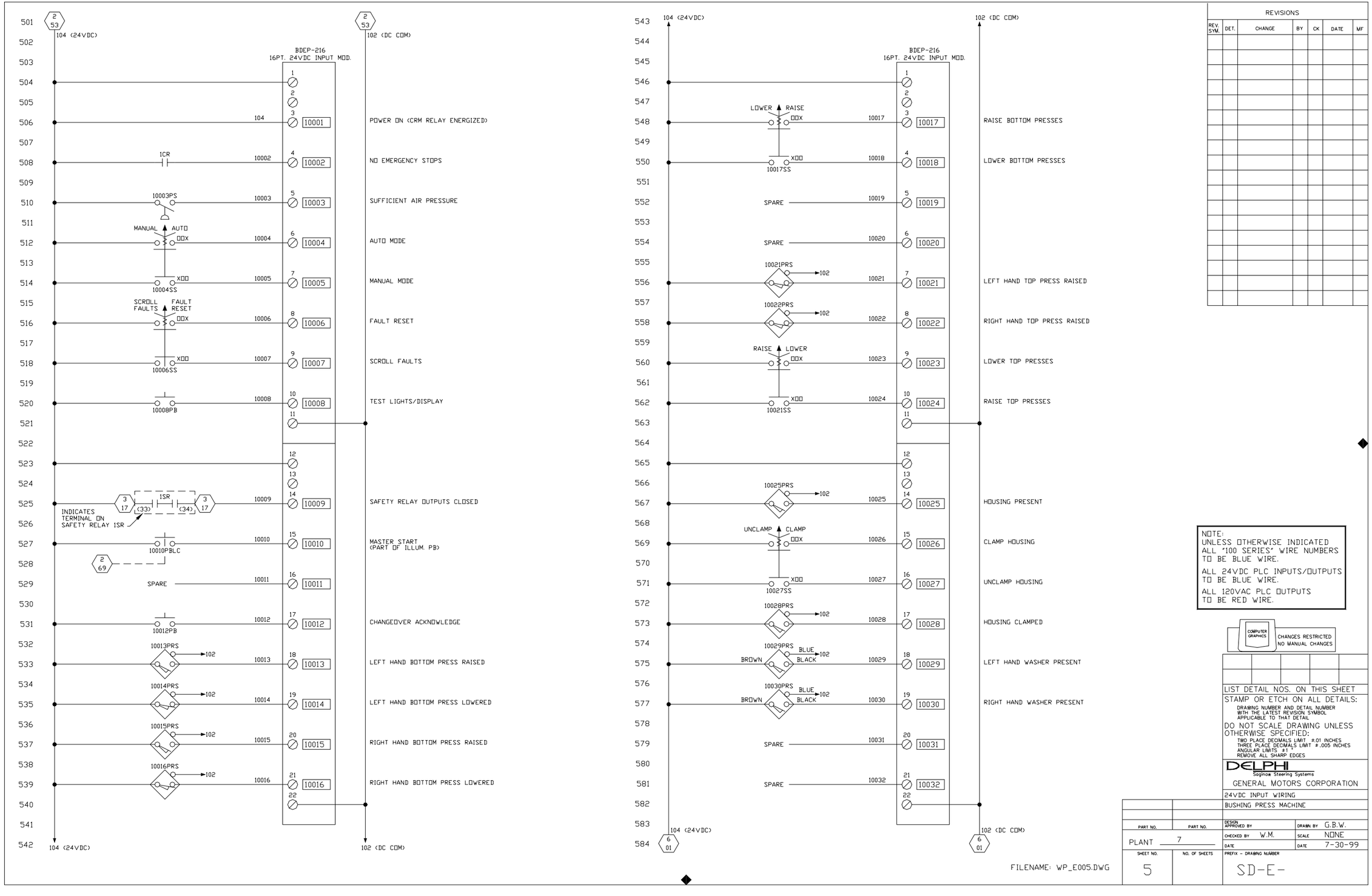

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

NOTE:
UNLESS OTHERWISE INDICATED
ALL "100 SERIES" WIRE NUMBERS
TO BE BLUE WIRE.

ALL 24VDC PLC INPUTS/OUTPUTS
TO BE BLUE WIRE.

ALL 120VAC PLC OUTPUTS
TO BE RED WIRE.

COMPUTER GRAPHICS — CHANGES RESTRICTED NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

STAMP OR ETCH ON ALL DETAILS:
DRAWING NUMBER AND DETAIL NUMBER WITH THE LATEST REVISION SYMBOL APPLICABLE TO THAT DETAIL

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

24VDC INPUT WIRING
BUSHING PRESS MACHINE

PART NO.	PART NO.		
		DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 5	NO. OF SHEETS	PREFIX - DRAWING NUMBER	SD-E-

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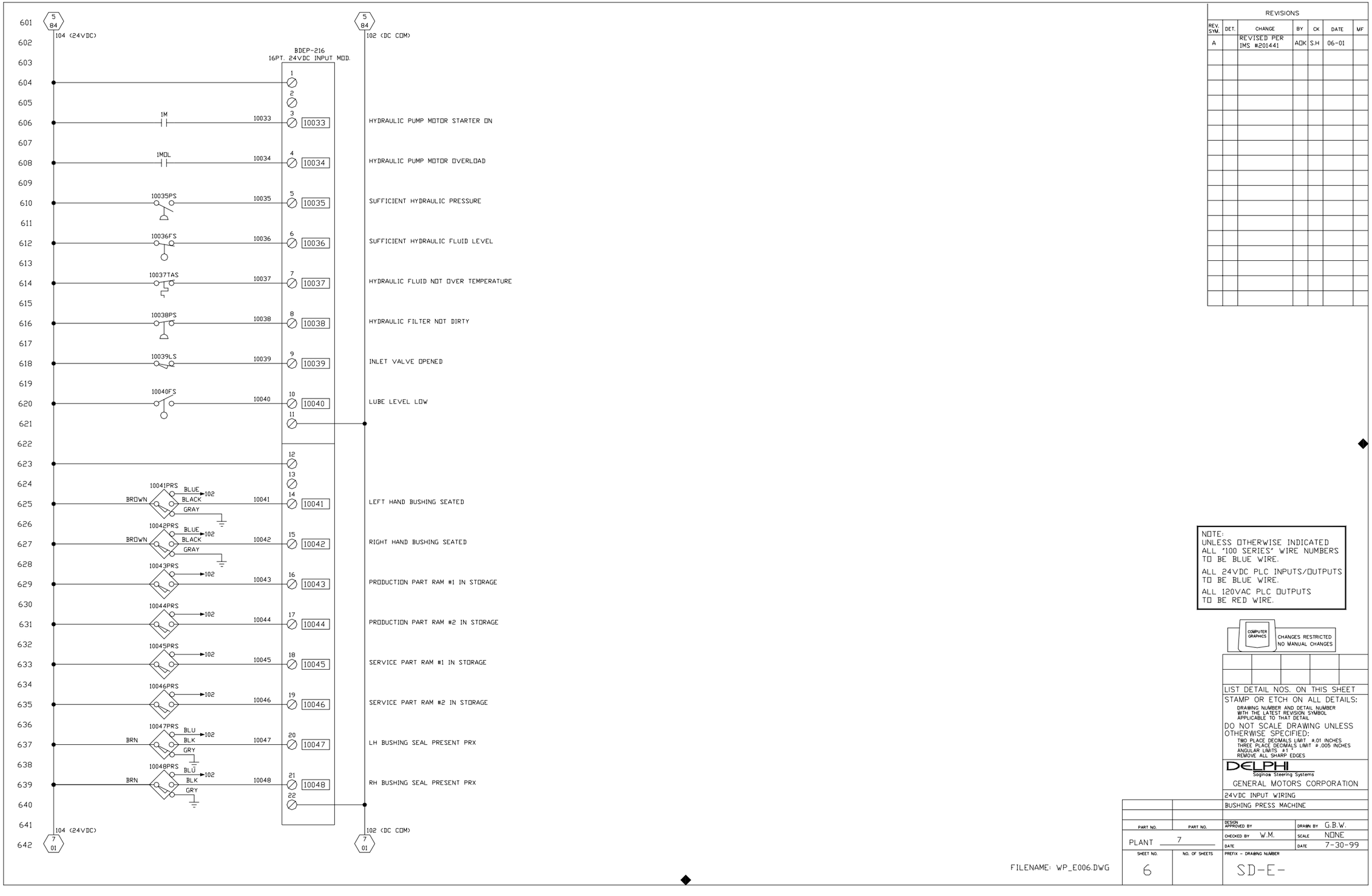

REVISIONS

REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF
A		REVISED PER IMS #201441	AOK	S.H	06-01	

NOTE:
UNLESS OTHERWISE INDICATED
ALL "100 SERIES" WIRE NUMBERS
TO BE BLUE WIRE.

ALL 24VDC PLC INPUTS/OUTPUTS
TO BE BLUE WIRE.

ALL 120VAC PLC OUTPUTS
TO BE RED WIRE.

COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

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DRAWING NUMBER AND DETAIL NUMBER
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OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION

24VDC INPUT WIRING
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY		DRAWN BY	G.B.W.
PLANT 7		CHECKED BY	W.M.	SCALE	NONE
		DATE		DATE	7-30-99
SHEET NO. 6	NO. OF SHEETS	PREFIX - DRAWING NUMBER		SD-E-	

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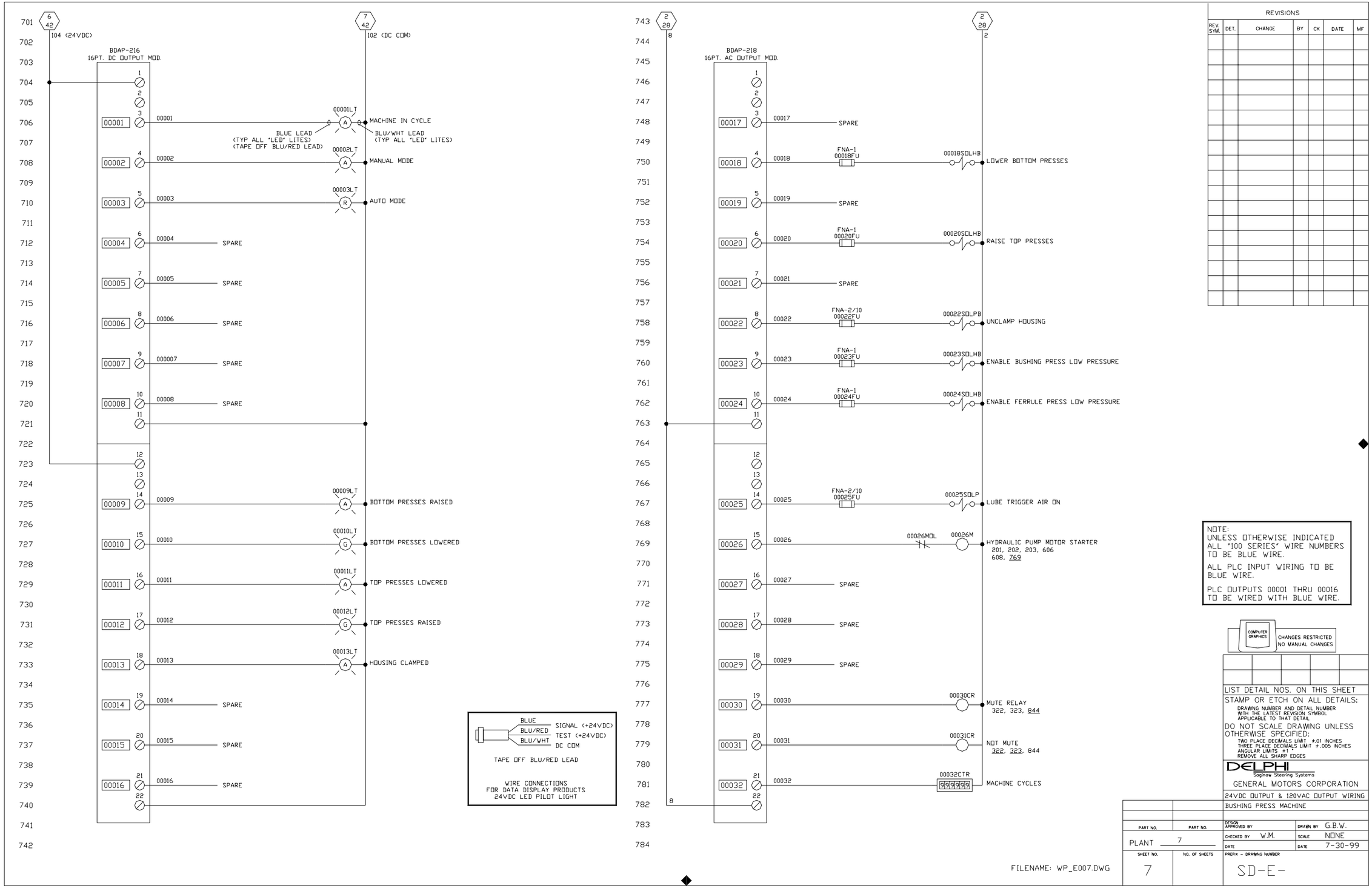
BDAP-216
16PT. DC OUTPUT MOD.
104 (24VDC)
102 (DC COM)
00001LT
MACHINE IN CYCLE
BLUE LEAD
(TYP ALL "LED" LITES)
(TAPE OFF BLU/RED LEAD)
BLU/WHT LEAD
(TYP ALL "LED" LITES)
00002LT
MANUAL MODE
00003LT
AUTO MODE
SPARE
00009LT
BOTTOM PRESSES RAISED
00010LT
BOTTOM PRESSES LOWERED
00011LT
TOP PRESSES LOWERED
00012LT
TOP PRESSES RAISED
00013LT
HOUSING CLAMPED
BLUE
BLU/RED
BLU/WHT
SIGNAL (+24VDC)
TEST (+24VDC)
DC COM
TAPE OFF BLU/RED LEAD
WIRE CONNECTIONS
FOR DATA DISPLAY PRODUCTS
24VDC LED PILOT LIGHT
BDAP-218
16PT. AC OUTPUT MOD.
FNA-1
00018FU
00018SOLHB
LOWER BOTTOM PRESSES
FNA-2/10
00022FU
00022SOLPB
UNCLAMP HOUSING
00023FU
00023SOLHB
ENABLE BUSHING PRESS LOW PRESSURE
00024FU
00024SOLHB
ENABLE FERRULE PRESS LOW PRESSURE
00025FU
00025SOLP
LUBE TRIGGER AIR ON
00026MDL
00026M
HYDRAULIC PUMP MOTOR STARTER
201, 202, 203, 606
608, 769
00030CR
MUTE RELAY
322, 323, 844
00031CR
NOT MUTE
322, 323, 844
00032CTR
MACHINE CYCLES
NOTE:
UNLESS OTHERWISE INDICATED
ALL "100 SERIES" WIRE NUMBERS
TO BE BLUE WIRE.
ALL PLC INPUT WIRING TO BE
BLUE WIRE.
PLC OUTPUTS 00001 THRU 00016
TO BE WIRED WITH BLUE WIRE.
REVISIONS
REV. SYM.
DET.
CHANGE
BY
CK
DATE
MF
COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES
LIST DETAIL NOS. ON THIS SHEET
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THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES
DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION
24VDC OUTPUT & 120VAC OUTPUT WIRING
BUSHING PRESS MACHINE
PART NO.
PART NO.
DESIGN APPROVED BY
DRAWN BY G.B.W.
CHECKED BY W.M.
SCALE NONE
DATE
DATE 7-30-99
PLANT 7
SHEET NO. 7
NO. OF SHEETS
PREFIX - DRAWING NUMBER
SD-E-
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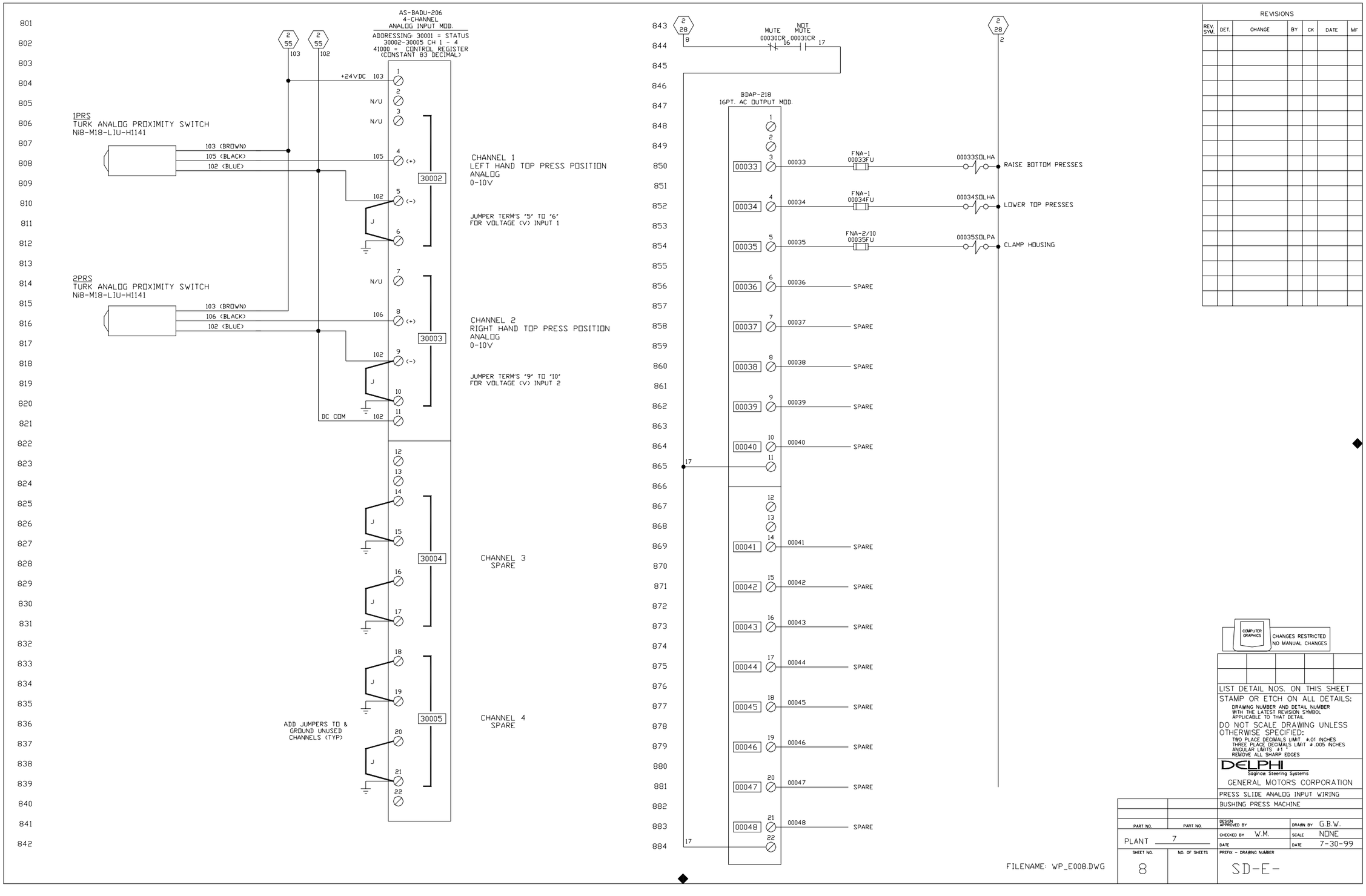
AS-BADU-206
4-CHANNEL
ANALOG INPUT MOD.
ADDRESSING: 30001 = STATUS
30002-30005 CH 1 - 4
41000 = CONTROL REGISTER
(CONSTANT 83 DECIMAL)
2 55 103
2 55 102
+24VDC 103
N/U
N/U
1PRS
TURK ANALOG PROXIMITY SWITCH
Ni8-M18-LIU-H1141
103 (BROWN)
105 (BLACK)
102 (BLUE)
105
102
(+)
(-)
J
30002
CHANNEL 1
LEFT HAND TOP PRESS POSITION
ANALOG
0-10V
JUMPER TERM'S "5" TO "6"
FOR VOLTAGE (V) INPUT 1
N/U
2PRS
TURK ANALOG PROXIMITY SWITCH
Ni8-M18-LIU-H1141
103 (BROWN)
106 (BLACK)
102 (BLUE)
106
102
30003
CHANNEL 2
RIGHT HAND TOP PRESS POSITION
ANALOG
0-10V
JUMPER TERM'S "9" TO "10"
FOR VOLTAGE (V) INPUT 2
DC COM 102
30004
CHANNEL 3
SPARE
30005
CHANNEL 4
SPARE
ADD JUMPERS TO &
GROUND UNUSED
CHANNELS (TYP)
2 28 8
MUTE 00030CR
NOT MUTE 00031CR
16
17
2 28 2
BDAP-218
16PT. AC OUTPUT MOD.
00033
00033
FNA-1 00033FU
00033SOLHA
RAISE BOTTOM PRESSES
00034
00034
FNA-1 00034FU
00034SOLHA
LOWER TOP PRESSES
00035
00035
FNA-2/10 00035FU
00035SOLPA
CLAMP HOUSING
00036
00036
SPARE
00037
00037
SPARE
00038
00038
SPARE
00039
00039
SPARE
00040
00040
SPARE
17
00041
00041
SPARE
00042
00042
SPARE
00043
00043
SPARE
00044
00044
SPARE
00045
00045
SPARE
00046
00046
SPARE
00047
00047
SPARE
00048
00048
SPARE
17
REVISIONS
REV. SYM.
DET.
CHANGE
BY
CK
DATE
MF
COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES
LIST DETAIL NOS. ON THIS SHEET
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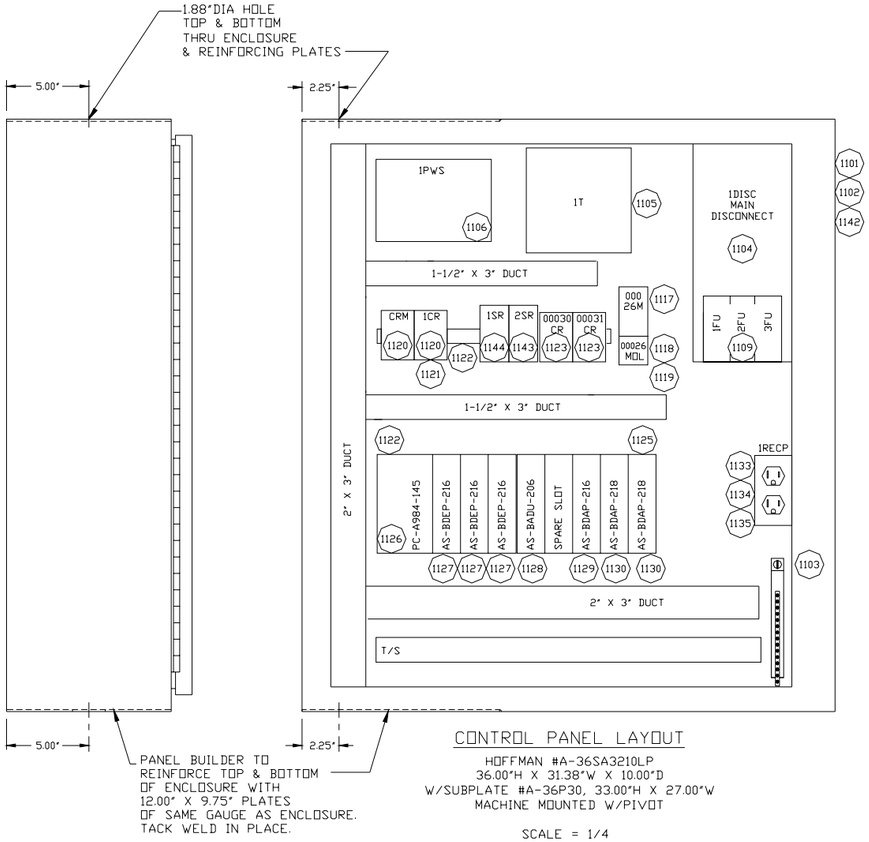
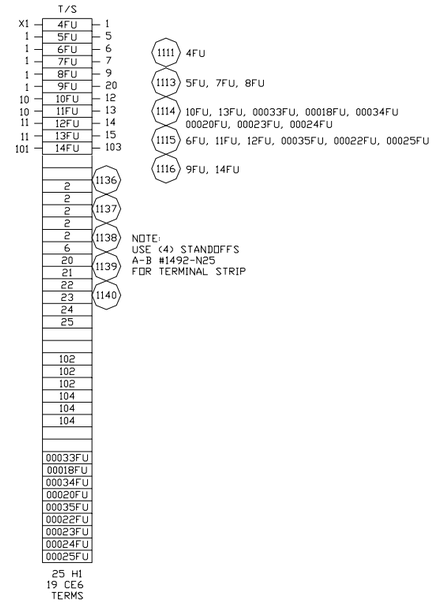
OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES
DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION
PRESS SLIDE ANALOG INPUT WIRING
BUSHING PRESS MACHINE
PART NO.
PART NO.
DESIGN APPROVED BY
DRAWN BY G.B.W.
CHECKED BY W.M.
SCALE NONE
DATE
DATE 7-30-99
PLANT 7
SHEET NO. 8
NO. OF SHEETS
PREFIX - DRAWING NUMBER
SD-E-
FILENAME: WP_E008.DWG



CONTROL PANEL LAYOUT

HOFFMAN #A-36SA3210LP
36.00"H X 31.38"W X 10.00"D
W/SUBPLATE #A-36P30, 33.00"H X 27.00"W
MACHINE MOUNTED W/PIVOT

SCALE = 1/4



NOTE:
TERMINATE THOSE WIRES INDICATED ON TERMINAL STRIP.
ALL OTHER WIRING TO TERMINATE AT DEVICES.

PAINT SPECIFICATION

ENCLOSURE & DOOR EXTERIOR:
BLUE, FEDERAL CODE #15187
WATER BASE ACRYLIC
GLIDDEN

ENCLOSURE INTERIOR & SUBPLATE:
GLOSS WHITE

REVISIONS

REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

STAMP OR ETCH ON ALL DETAILS:
DRAWING NUMBER AND DETAIL NUMBER WITH THE LATEST REVISON SYMBOL APPLICABLE TO THAT DETAIL

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION

CONTROL PANEL LAYOUT
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY		DRAWN BY	G.B.W.
PLANT 7		CHECKED BY	W.M.	SCALE	NONE
		DATE		DATE	7-30-99
SHEET NO. 9	NO. OF SHEETS	PREFIX - DRAWING NUMBER	SD-E-		

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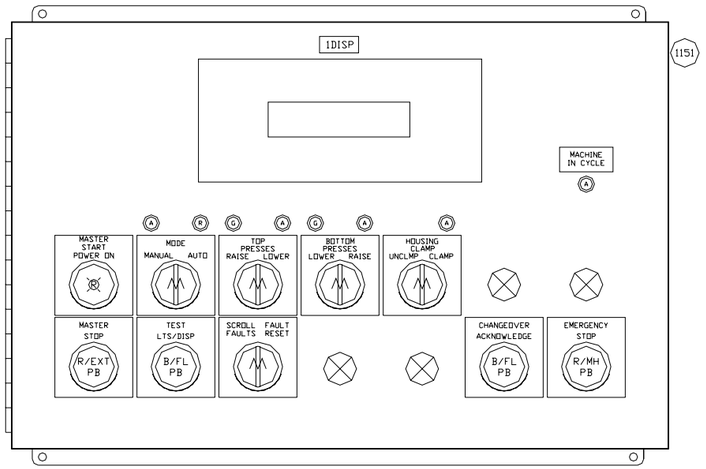
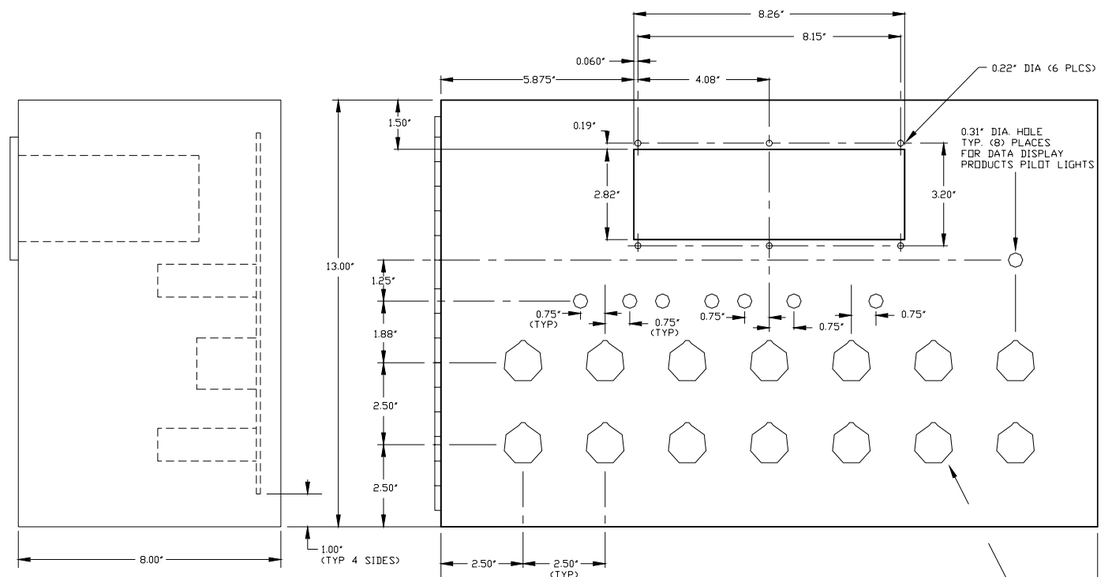


OPERATOR STATION

SIMILAR TO HOFFMAN BULLETIN PBI
EXTRA LARGE PUSHBUTTON "PBY" ENCLOSURE
20"H X 13"W X 8"D

1/2 SCALE



1/2 SCALE

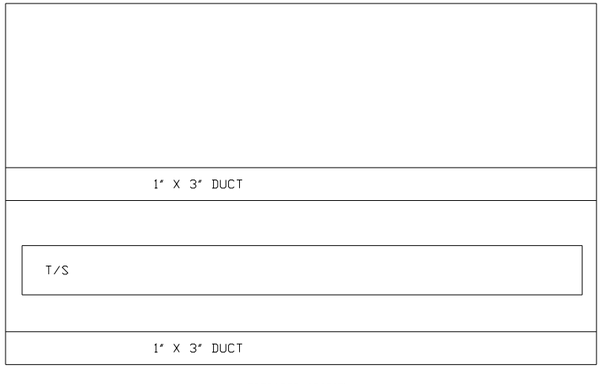
0.875" DIA. HOLE TYP. (14) PLACES FOR A-B #800E IEC PB'S AND S/SW'S.

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

PAINT SPECIFICATION

ENCLOSURE & DOOR EXTERIOR:
BLUE, FEDERAL CODE #15187
WATER BASE ACRYLIC
GLIDDEN

ENCLOSURE INTERIOR & SUBPLATE:
GLOSS WHITE



OPERATOR STATION
SUBPLATE LAYOUT
11"H X 18"W

1/2 SCALE

SEE SHEET 11 FOR TERMINAL STRIP LAYOUT

FILENAME: WP_E010.DWG

COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

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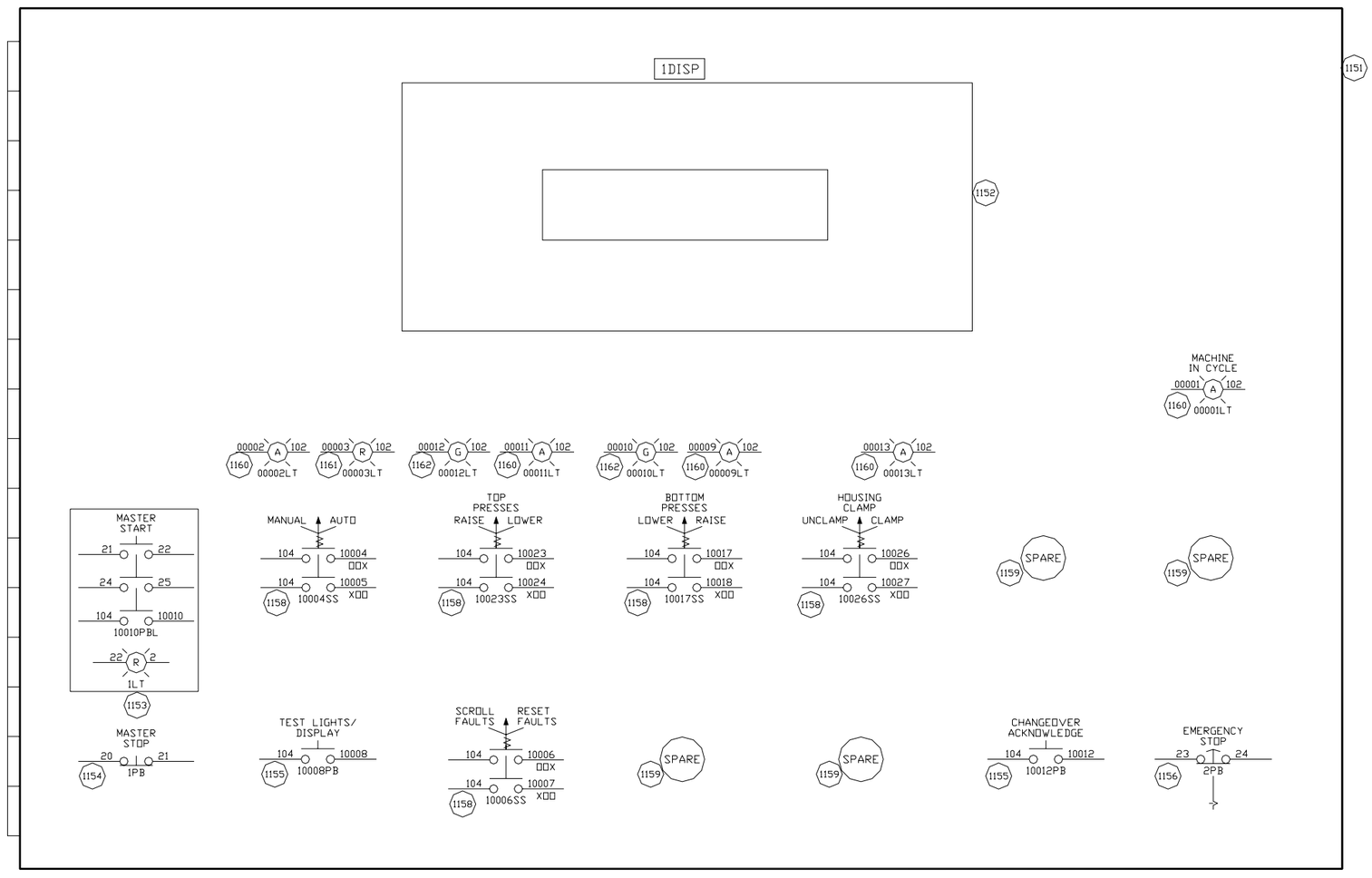
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

OPERATOR STATION FABRICATION
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY	DRAWN BY G.B.W.
		CHECKED BY W.M.	SCALE NONE
PLANT 7		DATE	DATE 7-30-99
SHEET NO. 10	NO. OF SHEETS	PREFIX - DRAWING NUMBER SD-E-	



NO SCALE

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T/S

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

COMPUTER GRAPHICS
CHANGES RESTRICTED
NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

STAMP OR ETCH ON ALL DETAILS:
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TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

OPERATOR STATION WIRING
BUSHING PRESS MACHINE

PART NO. | PART NO.

DESIGN APPROVED BY | DRAWN BY G.B.W.
CHECKED BY W.M. | SCALE NONE
DATE | DATE 7-30-99

PLANT 7

SHEET NO. 11 | NO. OF SHEETS

PREFIX - DRAWING NUMBER
SD-E-

FILENAME: WP_E011.DWG

6840-010-402 CONTROL PANEL MATERIAL

DET.	QTY.	MANUFACTURER	PART No.	DESCRIPTION
1101	1	HOFFMAN	A-36SA3210LP	ENCLOSURE, FOR FLANGE MOUNTED DISCONNECT
				36.00"H X 31.38"W X 10.00"D
1102	1	HOFFMAN	A-36P30	SUBPLATE, 33.00"H X 27.00"W
1103	1	SQUARE D	PK15GTAL	GROUND BAR
1104	1	SQUARE D	9422-ATCF-331	DISCONNECT SWITCH, 30A, 600V, 3 POLE
1105	1	HEVI-DUTY	T1000	TRANSFORMER, 240/480V PRI, 120V SEC
				1PH, 60HZ, 1KVA, "SMT" SERIES
1106	1	ACME	SPS 120-24/28	POWER SUPPLY, +24VDC @ 6.0 AMPS
1107				
1108				
1109	3	BUSSMANN	LPJ-20SP	FUSE, 20A, 600V
1110				
1111	1	BUSSMANN	FNA-10	FUSE, 10A, 125V
1112				
1113	3	BUSSMANN	FNA-2	FUSE, 2A, 125V
1114	8	BUSSMANN	FNA-1	FUSE, 1A, 125V
1115	6	BUSSMANN	FNA-2/10	FUSE, 2/10A, 250V
1116	2	BUSSMANN	FNA-4	FUSE, 4A, 125V
1117	1	ALLEN BRADLEY	100-A18ND3	CONTACTOR, NON-REVERSING, 18 AMP
				120VAC COIL
1118	1	ALLEN BRADLEY	193-BSC15	OVERLOAD RELAY, 10-16AMPS ADJ RANGE
1119	1	ALLEN BRADLEY	193-BC1	ANTI-TAMPER SHIELD FOR OVERLOAD RELAY
1120	2	ALLEN BRADLEY	700-F400-A1	RELAY, 120VAC COIL, 4NO CONTACTS
1121	1	ALLEN BRADLEY	195-FA31	ADDER DECK, 3NO-1NC CONTACTS
1122	1	ALLEN BRADLEY	199-DR1	DIN MOUNTING RAIL, 1 METER LONG
1123	2	ALLEN BRADLEY	700-CF310D	RELAY, 120VAC COIL, 3NO-1NC CONTACTS
1124	1	MODICON	AS-HDTA-200	I/O HOUSING, PRIMARY, 1CPU & 3 MODULES
				1 MODBUS PORT, 1 MODBUS PLUS PORT
1125	1	MODICON	AS-HDTA-201	I/O HOUSING, SECONDARY, 5 MODULES
1126	1	MODICON	PC-A984-145	CONTROLLER, 8K RAM MEMORY
1127	3	MODICON	AS-BDEP-216	INPUT MODULE, 16 POINT, 24VDC
1128	1	MODICON	AS-BADU-206	ANALOG INPUT MODULE, 4 CHANNEL
1129	1	MODICON	AS-BDAP-216	OUTPUT MODULE, 16 POINT, 24VDC
1130	2	MODICON	AS-BDAP-218	OUTPUT MODULE, 16 POINT, 120VAC
1131	1	MODICON	AS-HBOX-201	3-1/2" DISKETTE STORAGE BOX
1132				
1133	1	BRYANT	5252	DUPLEX RECEPTACLE
1134	1	APPLETON	4CS-1/2	HANDY BOX
1135	1	APPLETON	2510	DUPLEX COVER
1136	4	ALLEN BRADLEY	1492-N25	MOUNTING RAIL STANDOFF BRACKETS
1137	19	ALLEN BRADLEY	1492-CE6	FUSE TERMINAL
1138	19	ALLEN BRADLEY	1492-N12	FUSE PULLER
1139	150	ALLEN BRADLEY	1492-H1	TERMINAL
1140	2	ALLEN BRADLEY	1492-N22	TERMINAL MOUNTING RAIL, 3FT, RIGID

6840-010-402 CONTROL PANEL MATERIAL

6840-010-403 OPERATOR STA MATERIAL

DET.	QTY.	MANUFACTURER	PART No.	DESCRIPTION
1141	1	DURANT	7-Y-13-RMF-PM-115A	COUNTER, 7 DIGIT, NON-RESET, 120VAC
1142	1	SQUARE D	9423-M4	DOOR CLOSING MECHANISM, 2 POINT LATCH
1143	1	PILZ	774 314	SAFETY RELAY, TYPE PNOZ X3, EMERGENCY
				STOP UNIT, 110VAC
1144	1	PILZ	774 436	SAFETY RELAY, TYPE P2HZ X1, TWO-HAND
				CONTROL, 110VAC
1145				
1146				
1147				
1148				
1149				
1150				
1151	1	CUSTOM	NA	ENCLOSURE, 13.00"H X 20.00"W X 8.00"D
				BUILD/PURCHASE TO PRINT
1152	1	UTICOR	PMD180-22A1N008E0	MESSAGE DISPLAY, 2 LINE, 20 CHAR/LINE
				115VAC, 8K EEPROM MEMORY, NO OPTIONS
1153	1	ALLEN BRADLEY	800EM-LG4-2TL5X30	PUSHBUTTON, ILLUM. RED, GUARDED HEAD
				2 ACROSS MTG, 3NO CONTACTS
1154	1	ALLEN BRADLEY	800EM-E4-2LX01	PUSHBUTTON, RED, EXTENDED HEAD
				2 ACROSS MTG, 1NC CONTACT
1155	2	ALLEN BRADLEY	800EM-F2-2LX10	PUSHBUTTON, BLACK, FLUSH HEAD
				2 ACROSS MTG, 1NO CONTACT
1156	1	ALLEN BRADLEY	800EM-MMP24-2LX01	PUSHBUTTON, RED, MUSH HEAD, PUSH-PULL
				2 ACROSS MTG, 1NC CONTACT
1157				
1158	5	ALLEN BRADLEY	800EM-SB32-2LX20	SELECTOR SWITCH, 3 POS., SPRING RETN LEFT
				& RIGHT TO CENTER, 2 ACROSS MTG, 2NO CONT
1159	4	HOFFMAN	A-SPBG	HOLE SEAL, FOR 22mm DIAMETER HOLE
1160	5	DATA DISPLAY PRODS	SP950612-A	PILOT LIGHT, AMBER W/6FT LEADS
				24VDC L.E.D.
1161	1	DATA DISPLAY PRODS	SP950612-R	PILOT LIGHT, RED W/6FT LEADS
				24VDC L.E.D.
1162	2	DATA DISPLAY PRODS	SP950612-G	PILOT LIGHT, GREEN W/6FT LEADS
				24VDC L.E.D.
1163				
1164				
1165				

REVISIONS

REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

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ANGULAR LIMITS ±1°
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems

GENERAL MOTORS CORPORATION

ELECTRICAL MATERIAL LIST

BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 12	NO. OF SHEETS	PREFIX - DRAWING NUMBER SD-E-	

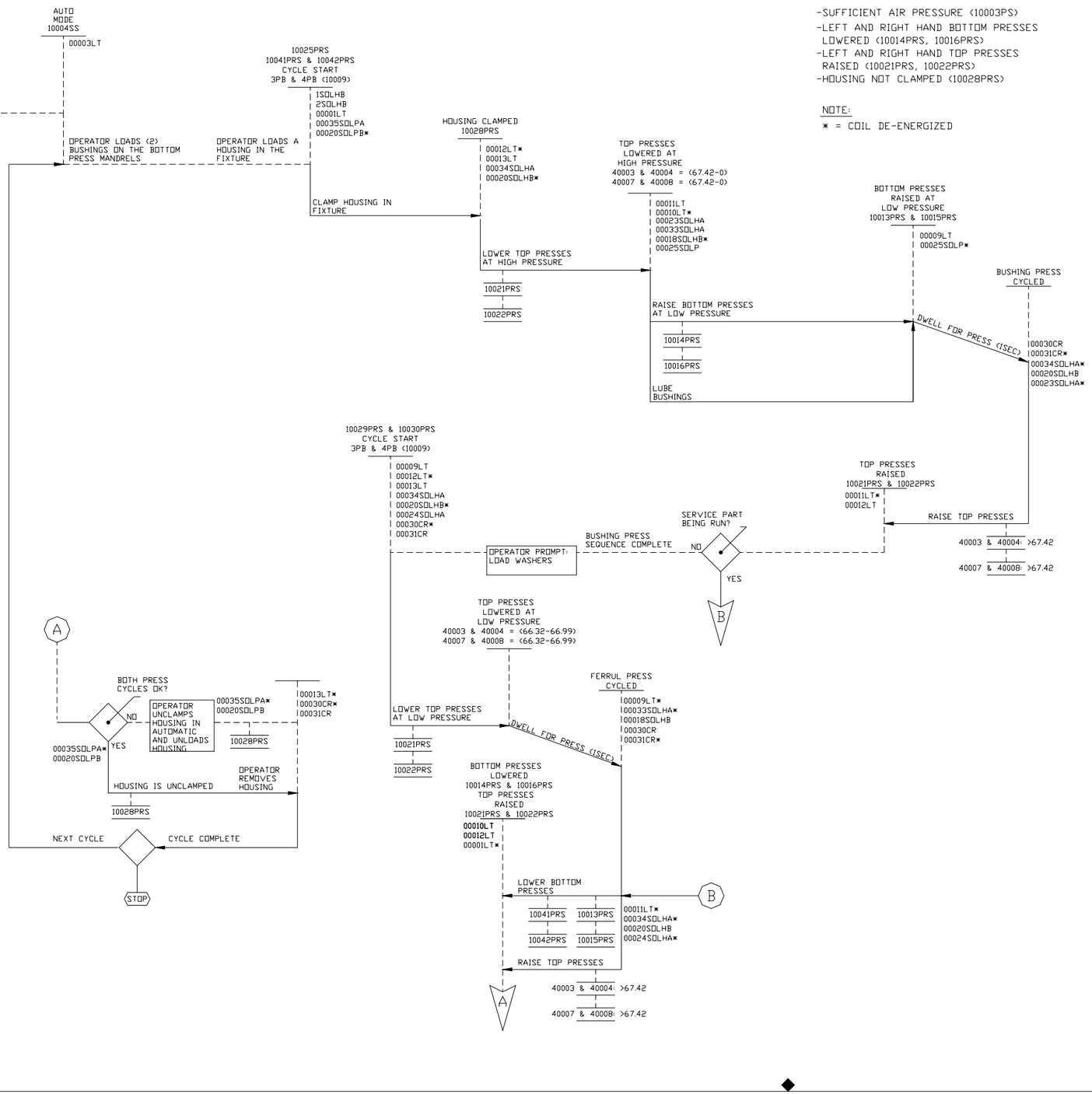
FILENAME: WP_E012.DWG

AUTO CYCLE INITIAL CONDITIONS

-SUFFICIENT AIR PRESSURE (10003PS)
-LEFT AND RIGHT HAND BOTTOM PRESSES LOWERED (10014PRS, 10016PRS)
-LEFT AND RIGHT HAND TOP PRESSES RAISED (10021PRS, 10022PRS)
-HOUSING NOT CLAMPED (10028PRS)

NOTE:
* = COIL DE-ENERGIZED

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF



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ANGULAR LIMITS ±1°
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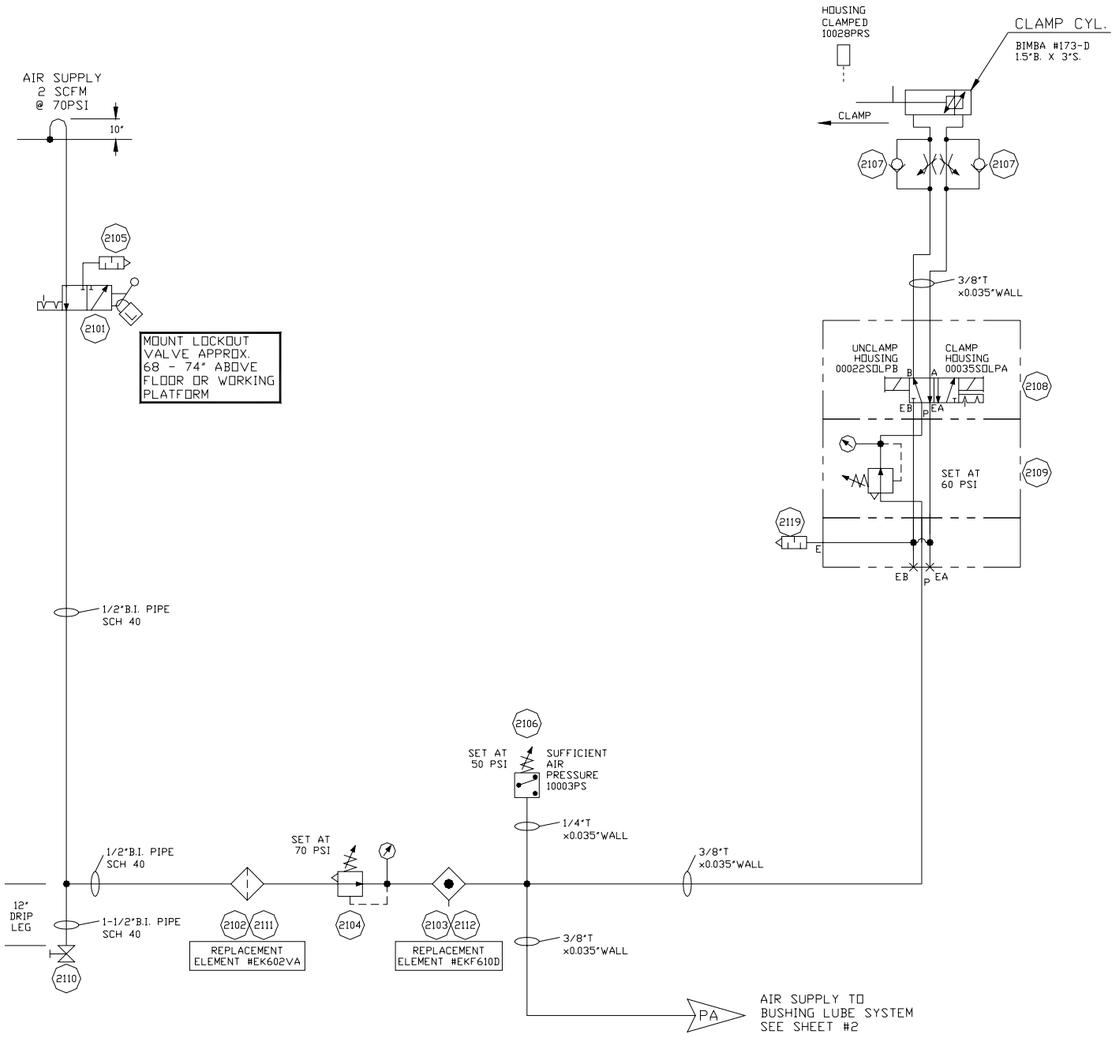
DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

LINE SEQUENCE DIAGRAM
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY		DRAWN BY	G.B.W.
		CHECKED BY	W.M.	SCALE	NONE
PLANT 7		DATE		DATE	8-5-99
SHEET NO. 13	NO. OF SHEETS	PREFIX - DRAWING NUMBER	SD-E-		

FILENAME: WP_E013.DWG



- TUBING TO MEET SAE J-525
- CONNECTORS TO COMPLY WITH SAE J-514

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

COMPUTER GRAPHICS — CHANGES RESTRICTED NO MANUAL CHANGES

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DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

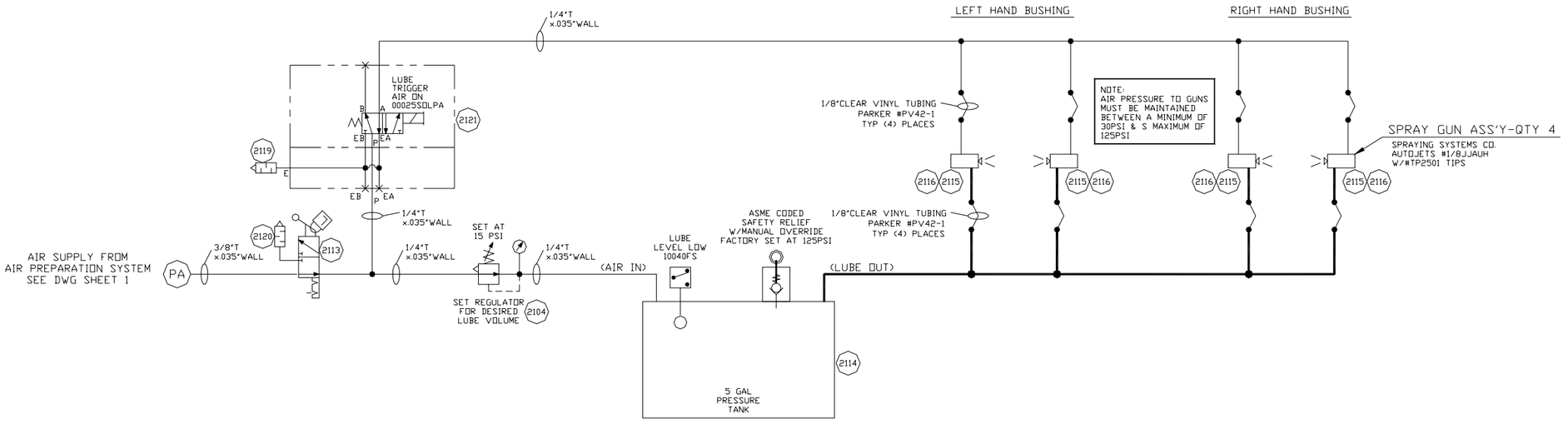
PNEUMATIC DIAGRAM
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 1	NO. OF SHEETS 3	PREFIX - DRAWING NUMBER SD-P-	

FILENAME: WP_P001.DWG

REVISIONS						
REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

BUSHING LUBE SYSTEM



- TUBING TO MEET SAE J-525
- LUBE CONNECTIONS TO COMPLY WITH SAE J-1453 AND SAE J-1926
- AIR CONNECTIONS TO COMPLY WITH SAE J-1453

COMPUTER GRAPHICS
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DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

PNEUMATIC/LUBE DIAGRAM
BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 2	NO. OF SHEETS	PREFIX – DRAWING NUMBER SD-P-	

FILENAME: WP_P002.DWG

6840-010-415
PNEUMATIC/LUBE
COMPONENTS

DET.	QTY.	MANUFACTURER	PART No.	DESCRIPTION
2101	1	NUMATICS	VL30N04Y	LOCKOUT VALVE, 1/2"NPT
2102	1	WATTS	F602-04-BG	FILTER, 1/2"NPT, 5 MICRON ELEMENT,
				MANUAL DRAIN, 8 OZ., W/BOWL GUARD
2103	1	NUMATICS	F610D-04	COALESCING FILTER, 1/2"NPT,
				0.3 MICRON ELEMENT, 16 OZ.
2104	2	WATTS	R119-04-CG	REGULATOR, 1/2"NPT, 2-125PSI, W/GAUGE
2105	1	NUMATICS	M4MN	MUFFLER, 1/2"NPT
2106	1	ALLEN BRADLEY	836T-T253J	PRESSURE SWITCH, 12-150PSI
2107	2	PARKER	F200B	FLOW CONTROL, 1/8"NPT, IN-LINE MOUNTING
2108	1	NUMATICS	081SS400K	VALVE, 2 POS. DETENTED, 120VAC COILS
2109	1	NUMATICS	082RS132J016W	SINGLE PRESS. REG., 10-130PSI, SIDE &
				BTM. PTS., PLUG RECP., STR. GAUGE FTGS.
2110	1	PARKER	DC601-2	DRAIN COCK, 1/8"NPT, 300PSI, BRASS
2111	1	WATTS	SAF602-0572	MTG. BRACKET FOR 1/2"NPT FILTER
2112	1	NUMATICS	PK610	MTG. BRKT. FOR F610 COALESCING FILTER
2113	1	NUMATICS	VL30N03Y	LOCKOUT VALVE, 3/8"NPT
2114	1	SPRAYING SYSTEMS CO	38685-5	PRESSURE TANK FOR LUBE SPRAYING SYSTEM
				5 GALLON, 140PSI MAX PRESSURE
				W/LIQUID LEVEL SWITCH & SAFETY RELIEF
				W/MANUAL OVERRIDE
2115	4	SPRAYING SYSTEMS CO	1/8JJAUH	SPRAY GUN, AUTOJET TYPE, AUTOMATIC
				COMPACT STYLE, AIR OPERATION
2116	4	SPRAYING SYSTEMS CO	TP-250017	TIP FOR SPRAY GUN
2117	1	SPRAYING SYSTEMS CO	38694-2-M4	HOOKUP KIT FOR SPRAY GUNS
2118				
2119	2	NUMATICS	M2MN	MUFFLER, 1/4"NPT
2120	1	NUMATICS	M3MN	MUFFLER, 3/8"NPT
2121	1	NUMATICS	082SA432K	DIRECTIONAL VALVE, 2 POSITION, SPRING
				RETURN, 120VAC COIL
2122				

REVISIONS

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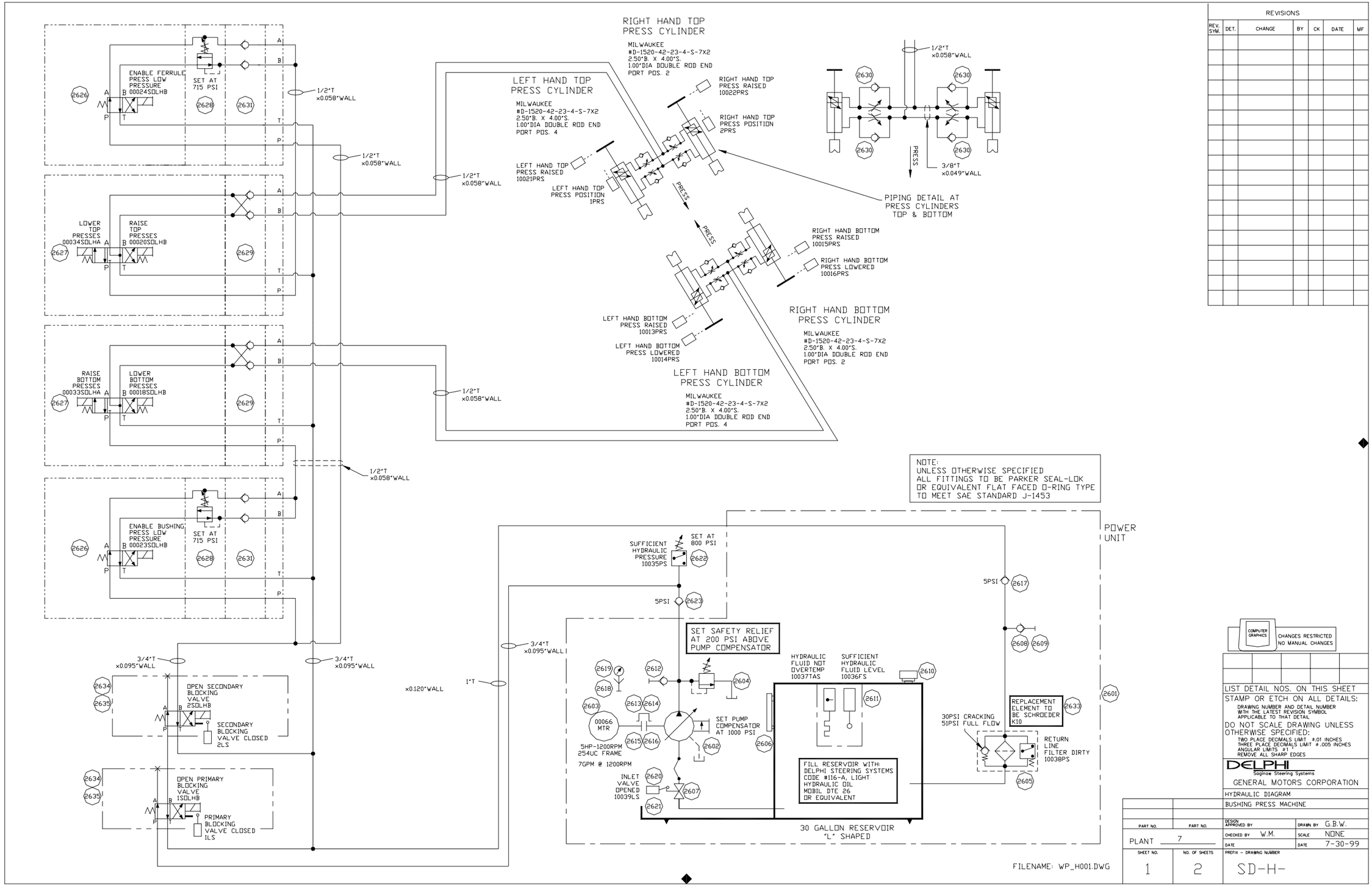
DELPHI
Saginaw Steering Systems
GENERAL MOTORS CORPORATION

PNEUMATIC/LUBE MATERIAL LIST

BUSHING PRESS MACHINE

PART NO.	PART NO.	DESIGN APPROVED BY	DRAWN BY G.B.W.
PLANT 7		CHECKED BY W.M.	SCALE NONE
		DATE	DATE 7-30-99
SHEET NO. 3	NO. OF SHEETS	PREFIX - DRAWING NUMBER SD-P-	

FILENAME: WP_P003.DWG


RIGHT HAND TOP PRESS CYLINDER
MILWAUKEE #D-1520-42-23-4-S-7X2 2.50"B. X 4.00"S. 1.00"DIA DOUBLE ROD END PORT POS. 2
LEFT HAND TOP PRESS CYLINDER
MILWAUKEE #D-1520-42-23-4-S-7X2 2.50"B. X 4.00"S. 1.00"DIA DOUBLE ROD END PORT POS. 4
RIGHT HAND TOP PRESS RAISED 10022PRS
RIGHT HAND TOP PRESS POSITION 2PRS
LEFT HAND TOP PRESS RAISED 10021PRS
LEFT HAND TOP PRESS POSITION 1PRS
PRESS
1/2"T x0.058"WALL
3/8"T x0.049"WALL
PIPING DETAIL AT PRESS CYLINDERS TOP & BOTTOM
RIGHT HAND BOTTOM PRESS RAISED 10015PRS
RIGHT HAND BOTTOM PRESS LOWERED 10016PRS
LEFT HAND BOTTOM PRESS RAISED 10013PRS
LEFT HAND BOTTOM PRESS LOWERED 10014PRS
RIGHT HAND BOTTOM PRESS CYLINDER
MILWAUKEE #D-1520-42-23-4-S-7X2 2.50"B. X 4.00"S. 1.00"DIA DOUBLE ROD END PORT POS. 2
LEFT HAND BOTTOM PRESS CYLINDER
MILWAUKEE #D-1520-42-23-4-S-7X2 2.50"B. X 4.00"S. 1.00"DIA DOUBLE ROD END PORT POS. 4
ENABLE FERRULE PRESS LOW PRESSURE B 00024SOLHB
SET AT 715 PSI
LOWER TOP PRESSES 00034SOLHA
RAISE TOP PRESSES B 00020SOLHB
RAISE BOTTOM PRESSES 00033SOLHA
LOWER BOTTOM PRESSES B 00018SOLHB
ENABLE BUSHING PRESS LOW PRESSURE B 00023SOLHB
3/4"T x0.095"WALL
1"T x0.120"WALL
OPEN SECONDARY BLOCKING VALVE 2SOLHB
SECONDARY BLOCKING VALVE CLOSED 2LS
OPEN PRIMARY BLOCKING VALVE 1SOLHB
PRIMARY BLOCKING VALVE CLOSED 1LS
NOTE: UNLESS OTHERWISE SPECIFIED ALL FITTINGS TO BE PARKER SEAL-LOK OR EQUIVALENT FLAT FACED O-RING TYPE TO MEET SAE STANDARD J-1453
POWER UNIT
SUFFICIENT HYDRAULIC PRESSURE 10035PS
SET AT 800 PSI
5PSI
SET SAFETY RELIEF AT 200 PSI ABOVE PUMP COMPENSATOR
HYDRAULIC FLUID NOT OVERTEMP 10037TAS
SUFFICIENT HYDRAULIC FLUID LEVEL 10036FS
00066 MTR
5HP-1200RPM 254UC FRAME
7GPM @ 1200RPM
SET PUMP COMPENSATOR AT 1000 PSI
INLET VALVE OPENED 10039LS
FILL RESERVOIR WITH: DELPHI STEERING SYSTEMS CODE #116-A, LIGHT HYDRAULIC OIL MOBIL DTE 26 OR EQUIVALENT
30 GALLON RESERVOIR "L" SHAPED
30PSI CRACKING 51PSI FULL FLOW
REPLACEMENT ELEMENT TO BE SCHROEDER K10
RETURN LINE FILTER DIRTY 10038PS
REVISIONS
REV. SYM. | DET. | CHANGE | BY | CK | DATE | MF
COMPUTER GRAPHICS
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DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION
HYDRAULIC DIAGRAM
BUSHING PRESS MACHINE
PART NO. | PART NO.
DESIGN APPROVED BY
DRAWN BY G.B.W.
PLANT 7
CHECKED BY W.M.
SCALE NONE
DATE
DATE 7-30-99
SHEET NO. 1
NO. OF SHEETS 2
PREFIX - DRAWING NUMBER SD-H-
FILENAME: WP_H001.DWG

6840-010-411
MATERIAL
SUPPLIED WITH
POWER UNIT

DET.	QTY.	MANUFACTURER	PART No.	DESCRIPTION
2601	1	Shaltz Fluid Power	427DC	30 GAL. "L" SHAPED RESERVOIR
2602	1	HYDURA/OILGEAR	PVWH10-RSAY-CNNN	PISTON PUMP
2603	1	U. S. MOTORS	6840	5-HP, 1200RPM , 254UC FRAME,
				ELEC. MOTOR
2604	1	CONTINENTAL	P10L-R-08-150GS	RELIEF VALVE, 100-1500 PSI RANGE,
				NO. 8 SAE
2605	1	SCHROEDER	KF3-1K10-S-MS5DC	RETURN FILTER W/ELEC. DIRT ALARM
2606	1	LUBE DEVICES	G642-05-A-1	SIGHT GAUGE
2607	1	DMIC	BVL-0750S-3311	BALL VALVE, 3/4" SAE
2608	1	HANSEN	PDC-8-HK	FILL COUPLING DUST COVER
2609	1	HANSEN	8KP-16	FEMALE END FILL CONNECTOR, 1-5/16"-12FT
2610	1	SCHROEDER	ABF-G1456	BREATHER CAP
2611	1	APCO	TL-008-130	TEMP/LEVEL SW. ASS'Y.
2612	1	SCHROEDER	SP1215UN716P	MINI-CHECK TEST POINT FITTING
2613	1	MAGNALOY	(200) 1-1/8" X 1/4"	COUPLING
2614	1	MAGNALOY	(200) 3/4" X 3/16"	COUPLING
2615	1	MAGNALOY	270N	INSERT, NEOPREME
2616	1	MAGNALOY	M182522A	C-FACE MOUNTING ADAPTOR
2617	1	DMIC	CVH-05-1250S	CHECK VALVE, #20 SAE, 5PSI
2618	1	SCHROEDER	S1215DCUN716	GAUGE COUPLING
2619	1	DMIC	C25SGSB15S	GAUGE, 2-1/2", 1/4" SAE, BOTTOM MT.,
				GLYCERINE FILLED
2620	1	DMIC	DM10166	VALVE MOUNTED LIMIT SWITCH
2621	1	DMIC	BVLSB-0750	LIMIT SWITCH MOUNTING BRACKET
2622	1	ALLEN BRADLEY	836T-302J	PRESSURE SWITCH, 200-3000PSI
2623	1	DMIC	CVH05-0750S	CHECK VALVE, 5PSI
2624				
2625				
2626	2	CONTINENTAL	VS5M-1A-GB5H-L1-60L	DIR. CON. VALVE, SGL ACT., 2 POS. SP.
				OFST., 5 PIN RECPT., W/IND. LTS, 120VAC
2627	2	CONTINENTAL	VS5M-3F-GB5H-L2-60L	DIR. CON. VALVE, DOU. ACT., 3 POS., SP.
				CTRD., 5 PIN RECP., W/IND. LTS., 120VAC
2628	2	CONTINENTAL	P5S-PDB-080-GS	PRESSURE REDUCING VALVE, PILOT OPERATED
				"B" PORT CONTROL, 25-800PSI
2629	2	CONTINENTAL	C5S-PC-GS	PILOT OP. CHECK VALVE, A & B PORTS
2630	8	PARKER	F820S	FLOW CONTROL, SAE-8 THREADS, IN-LINE
				MOUNTING, STEEL
2631	2	SUN	CXCD-XCN/GDY	DIRECT CHECK VALVE ASSSEMBLY
2632	4	DAMAN	DD03-SPS-8S	SUBPLATE, D03 PATTERN, SIDE PORTS
				2.125" CENTERS, SAE THREADS, STEEL
2633	1	SCHROEDER	K10	FILTER REPLACEMENT ELEMENT
2634	2	VICKERS	DG4V3-2A-M-S4-FPA5WL	DIRECTIONAL VALVE, 2 POSITION, SPRING
			-B2-60	OFFSET, 120VAC COIL, 5 PIN RECEPTACLE
				W/INDICATOR LIGHTS & SPOOL INDICATOR
				SWITCH WIRED NORMALLY CLOSED
2635	2	DAMAN	DD03SPS8S	SUBPLATE, D03 PATTERN, SAE THREADS
				STEEL
2636				
2637				
2638				

6840-010-410
HYDRAULIC
COMPONENTS

REVISIONS

REV. SYM.	DET.	CHANGE	BY	CK	DATE	MF

COMPUTER GRAPHICS — CHANGES RESTRICTED NO MANUAL CHANGES

LIST DETAIL NOS. ON THIS SHEET

STAMP OR ETCH ON ALL DETAILS:
DRAWING NUMBER AND DETAIL NUMBER WITH THE LATEST REVISION SYMBOL APPLICABLE TO THAT DETAIL

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED:
TWO PLACE DECIMALS LIMIT ±.01 INCHES
THREE PLACE DECIMALS LIMIT ±.005 INCHES
ANGULAR LIMITS ±1 °
REMOVE ALL SHARP EDGES

DELPHI Saginaw Steering Systems
GENERAL MOTORS CORPORATION

HYDRAULIC MATERIAL LIST
BUSHING PRESS MACHINE

PART NO. | PART NO.

PLANT 7

DESIGN APPROVED BY | DRAWN BY G.B.W.
CHECKED BY W.M. | SCALE NONE
DATE | DATE 7-30-99

SHEET NO. 2 | NO. OF SHEETS

PREFIX - DRAWING NUMBER
SD-H-

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