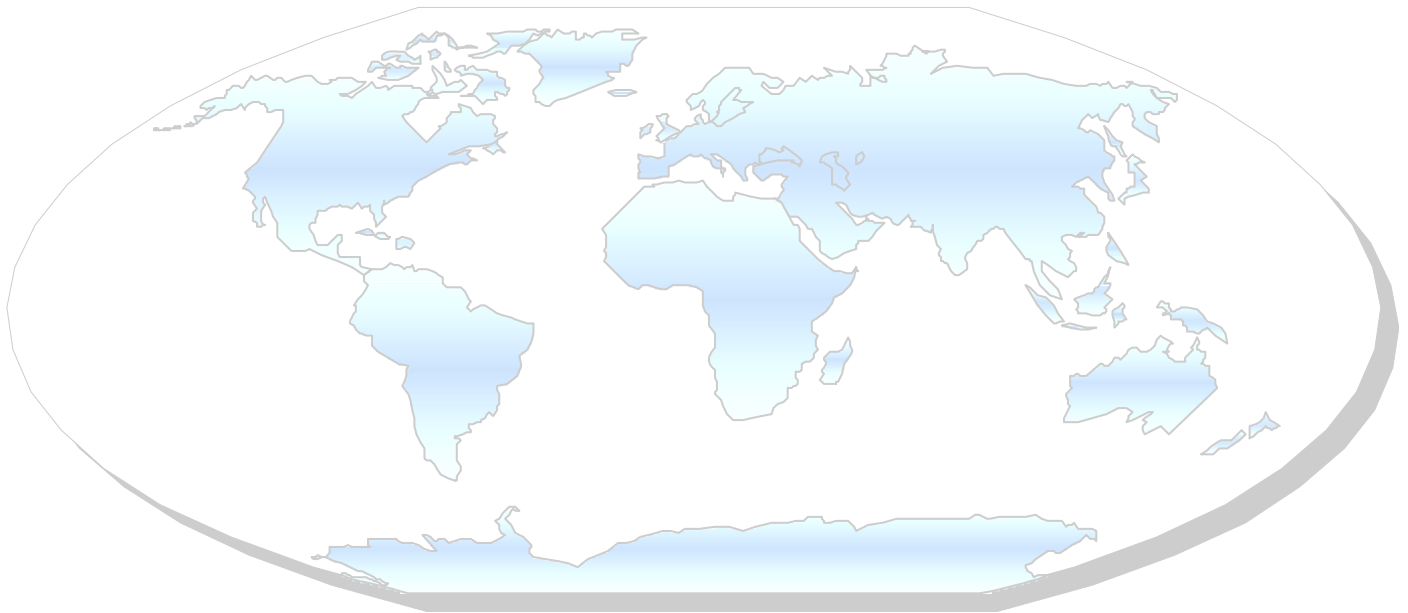


DELPHI

Pneumatic Fluid Power - General Rules Relating to Systems

(ADDENDUM TO ISO 4414, 1998 EDITION)



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Foreword

This Pneumatic Fluid Power-general rules relating to systems specification is issued by Delphi Corporation. The intent is to provide Delphi plants with safe, well designed, reliable, and productive electrical control systems for industrial machinery, which consistently produce high quality products.

This specification is designed as an addendum to “ISO 4414, *Pneumatic Fluid Power-general rules relating to systems*, 1998 edition”. For clarity, the chapter headings and hence the overall format of ISO 4414 have been adopted, even if no additions or changes have been made. All item numbers containing technical content, have been identified as to the type of change made from ISO 4414. The following convention was used:

ADD: Requirement is completely new in Delphi Addendum. Paragraph number does not exist in NFPA 79.

MODIFY: The requirement has been modified significantly from NFPA 79.

APPEND: Additional requirements have been added. All existing requirements in NFPA 79 still apply.

CLARIFY: Informational text has been added to assist in the understanding of the requirement by the user.

This specification was developed by the Delphi Controls Committee with assistance from controls personnel from the Delphi divisions. The mission of the committee was to develop a corporate specification based on a national standard to:

- enhance safety.
- simplify and clarify the specifications in order for machinery and equipment builders to comply at minimum cost.
- encourage the implementation of this technology across Delphi plants.
- improve equipment reliability and maintainability.
- incorporate common divisional and plant specifications into this specification to reduce their size and complexity.
- support lean manufacturing equipment.
- support design-in safety practices.

This specification is not intended to inhibit new technology in any manner; consequently, Delphi would expect and encourage all industrial equipment builders to call to the attention of the purchasing division any situation which, in their opinion, inhibits the application of new technology. This approach allows any new technology proposal to be evaluated on the merits of its application.

Top priority is given to the enhancement of safety in the operation and maintenance of industrial equipment in conjunction with compliance with Federal, State, Provincial, and municipal regulations and safety codes, including national consensus standards and qualified testing laboratories standards.

While Delphi believes that the specifications described in this booklet provide a sound basis for safe pneumatic fluid power control systems for industrial machinery, they are intended only for use within Delphi operations. The specifications were developed based solely on the equipment, operations, processes and facilities of Delphi. These specifications should not be relied on for use at non-Delphi operations and Delphi specifically disclaims any liability should these specifications be used for equipment, operations, processes, and facilities outside their intended purpose.

This specification applies to the purchase of new equipment and major equipment rebuilds. It should not be implied that any existing equipment is required to be retrofitted in order to comply with this specification.

This page reserved for user notes.

Modify the following Clauses and Sub-clauses unless otherwise indicated as an addition:

0 Introduction

In this standard, the words “should” and “shall” are understood as requirements.

3 Definitions

3.14 ADD: . Proper exchange of fluid: To obtain proper exchange of fluid the volume in the actuator should be at least twice that of the respective fluid lines connecting the directional valve to the actuator. In general, line lengths should be less than 36” with 18 inches or less preferred

4 Requirements

4.3 Safety requirements ADD:

The manual safety lock out valve shall have provisions for locking in the “OFF” position only and shall safety vent all circuit pressure as identified by “OSHA” (29 CFR 1910.4). Venting of this pressure shall not create a potential hazard to personnel, uncontrolled motion or damage to equipment.

The manual safety lock out valve should be located at or near the electrical disconnect at the same elevation.

Mufflers shall be rerouted to prevent exhaust at eye/ear level

4.3.1 Design Considerations

4.3.1.1 ADD: Safeguarding

Refer to the following *Delphi documents*:

- DA-2001 Delphi Corporation Specification for the Application of Safety Circuits, Revision 3.0, February 2007
- DA-2006 Delphi Corporation Design-In Health and Safety Specification, Version 2.1, September 2006
- Risk assessment toolkit
- Risk assessment toolkit training

for safeguarding of hazardous motions.

4.3.1.2 ADD: Power press controls

Pneumatic valves controlling the clutch and brake action on power presses shall be applied per current OSHA , ISO, BG, CSA, EN, CCC standards covering power press controls.

4.3.2 Component selection

Over-adjustment of controls shall not result in any leakage of air or hazard to personnel making such adjustments. Adjustment mechanisms must be held captive to prevent a hazard during adjustment.

4.3.3 Minimum component pressure.

All components shall be rated for a minimum of 150 PSI.

4.3.4 Mechanical movements

On vertical and inclined equipment slides, rams and other similar elements, a counterbalance valve, pilot operated check, rod brake, counterbalance weight, shot pins or similar devices shall be provided to prevent downward movement where that that motion would be hazardous. . Pilot operated checks shall have manual bleed operators and shall be limited to light loads, 20 lbs or less.

4.3.5 Noise

Reference Section 14.2.

4.3.7 Airborne hazardous substances

4.3.7.1 ADD: Exhausted air

4.3.7.1.1 ADD: Air contaminants

Exhausted air shall comply with OSHA regulations 29CFR, Part 1910, Subpart Z, Section 1910.1000 Air Contaminants (TLV-TWA).

4.3.7.1.2 ADD: Lubricated systems

Reclassifiers shall be used on the exhaust ports of all lubricated systems in accordance with 4.3.7.1.1.

4.4 System requirements

This standard shall apply to all pneumatic applications on industrial equipment which operates at a maximum pressure of 861 kPa (125 PSIG). Actuators shall be sized and components selected based on a maximum operating pressure of 482 kPa (70 PSIG) unless otherwise specified in writing. All components shall have a minimum service rating of 1034 kPa (150PSIG).

4.5 Site conditions

4.5.1 Specifications

4.5.1.1 Add: Ambient temperature range

The equipment shall be designed to operate in an ambient temperature range of 15° C (59° F) to 40° C (104° F) unless otherwise specified

5 System design

5.1 Circuit diagrams

5.1.1 Add: Computer assisted drawings

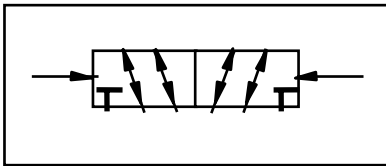
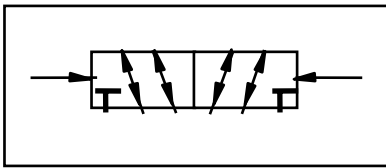
Computer assisted drawings shall be compatible with AutoCAD 2002 or 2005. AutoCAD drawings shall be supplied in .DWG format. All symbols and lettering shall be legible as a B size or metric A3 print. Refer to the purchaser for drawing size requirements. Sample drawings are available from the purchaser.

5.1.2 ADD: Presentation of technical data

For North American operations all units shall be expressed in both metric and standard units [i.e. kPa (PSI)]. (1 kPa = 6.8933 PSI)

5.1.3 ADD: to j)

Ports shall be clearly identified with ISO (Preferred) or ANSI port identification as shown in Figures 1 and 2.



5.2 Identification

All identification tags shall be engraved or stamped, held in place with metallic drive screws, and clearly visible.

5.2.2 Components within a system

The identification tag shall also include a functional description of the component.

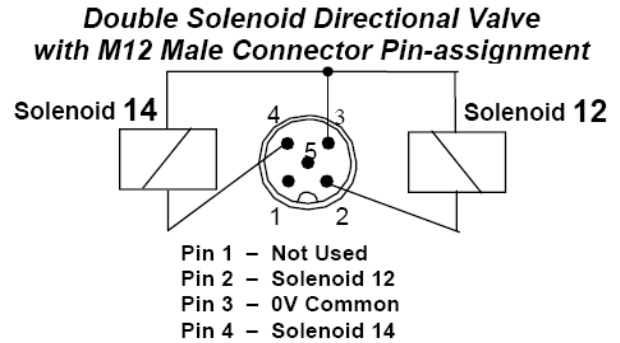
5.2.3 Ports

Plugs and couplers, (quick disconnects), shall be identified by utilizing matching tags, which follow the same identification outlined on the circuit diagram.

5.2.4 Valve control mechanisms

5.2.4.2 Electrical

Pin layout shall conform to ISO 20401 directional control valve specifications. Solenoid #14 shall be used for single solenoid applications.



The 12 coil, which controls the 2 port, shall always control the normal home position of the actuator.

Solenoid-controlled components shall be identified as follows:

Solenoid valve identification example:

SOL 00201 P12,

where:

SOL - Solenoid valve

00201 - Device Number = PLC output number or wire number

P - Pneumatic

12 - Valve port pressurized with solenoid energized

5.2.7 ADD: Pressure adjustable components

Design operating pressures shall be identified by a tag, which is located adjacent to the adjusting mechanism on all pressure adjustable components.

5.2.8 ADD: System efficiency and performance

Optimum efficiency and performance shall be accounted for in the system design. Efficiency is defined as the ratio of useful energy delivered by a dynamic system to the energy supplied to it. System designs shall incorporate the following applications:

5.2.8.1 Valves shall be mounted as close as practical to the actuator to minimize air consumption and improve response time.

5.2.8.2 Discourage the use of air blow-offs. Where necessary, valving shall be utilized in a manner that allows either the automatic shut-off or use of the blow-offs only when required to do work.

5.2.8.3 Air pressure for blow-offs shall be 200 kPa (30 PSI) or less and incorporate a separate regulator.

5.2.8.4 Review any quick stop circuits with the control engineer.

5.2.9 ADD: Engineering calculations

All performance characteristics shall be documented in chart form based on engineering calculations. Microsoft Excel is preferred. The performance characteristics shall

include: weight of each motion element (load plus actuator), peak velocity of each element, acceleration/deceleration time, fluid flow rate required to sustain peak velocity, pressure drop, and anticipated pressure shock for acceleration/deceleration, The chart shall correspond to the sequence of operations.

5.2.10 ADD: Cycle time

Load variations and changes in fluid temperature shall not cause variations in cycle time that are inconsistent with the required service

5.4 Use of standard parts

Refer to the purchaser's preferred components list.

5.5 Seal and sealing devices

5.5.1 ADD: Color identification

The seal material shall be permanently identified by using color pigmentation in the seal material as follows:

- 5.5.1.1 Buna-N (Nitrile & NBR) - Black
- 5.5.1.2 Fluorocarbon (Viton & FPM) - Brown
- 5.5.1.3 Ethylene Propylene (EPR & EPM) - Purple
- 5.5.1.4 Polyurethane (AU & EU) - Yellow

5.5.2 ADD: Specifications

5.5.2.1 Dimensions and material

Seal dimensions and material types shall conform to the applicable ISO ANSI, SAE, and NFPA standards.

5.5.2.2 Sealant material

Self-forming extrudable material (e.g., RTV sealant) shall not be used. Tape-type (Teflon) sealant shall not be used.

5.7 Operation and maintenance manuals

The original component manufacturer's technical service, instruction and programming manuals shall be supplied for all major components, special devices and control systems. These manuals shall provide all information necessary for servicing the equipment.

6 Energy conversion components

6.1 Air motors and semi-rotary actuators

This section also applies to rotary actuators.

6.1.2 Mounting

ISO mounting configurations shall be used where ever possible.

6.1.4 ADD: Positive position stop

Rotary actuators shall not be used as a positive position stop

6.1.5 ADD: Required cushions

As necessary, rotary actuators shall be equipped with

cushions for deceleration control to eliminate shock from circuits and equipment.

6.1.6 ADD: Lubrication

Positive injection type lubrication shall be provided for all rotary actuators and air motors where required by the manufacturer.

6.2 Cylinders

6.2.2 Mounting and alignment

6.2.2.4 ADD: Self-aligning couplings

Self-aligning couplings are not intended to compensate for improper alignment, and shall only be used when tooling is guided.

6.2.3 Cushions and deceleration devices

Cylinders shall be equipped with cushions for deceleration control to eliminate shock caused by circuits and related equipment.

6.2.6 Piston rods

6.2.6.1 ADD: Piston locking

Pistons shall be positively locked to the piston rod. The cylinder rod connector end shall be equipped with a female threaded section that is designed to accept a replaceable stud on rod diameters up to two inches.

6.2.6.2 ADD: Piston seals

Cast iron piston rings shall not be used.

6.2.6.3 ADD: Protection

All piston rods shall be equipped with rod wipers and scrapers. The piston rod material and finish shall be selected to minimize wear, corrosion, and foreseeable damage.

6.2.9 ADD: Mounting dimensions

6.2.9.1 ADD: Global requirements

All general use pneumatic cylinders shall conform to ISO 6432, ISO 6431, ISO 21287 mounting dimensions. Refer to approved components list for further detail.

6.3 Surge tanks and other auxiliary reservoirs

ADD to a): In general, cyclic air pressure change shall not exceed 2% of set point.

ADD f) No pneumatic inlet or outlet connections shall be made through the bottom of the tank. Reserved for drain only.

6.3.1 ADD: Design and construction

Tanks shall conform to the following:

USA - ASME Unfired Pressure Vessel Code (Division

1, Section 8) R2004,

Europe - Directive 97/23/EC Unfired pressure vessel code, EN/13445 for pressures greater than .5 bar, Directive 87/404/EC simple, **as well** as applicable local governmental pressure vessel codes.

6.3.2 ADD: Tank certification

Where required by code, certification papers shall be supplied to the purchasing division.

6.3.3 ADD: Tank information

The following information shall be permanently indicated on each tank:

6.3.3.1 Name of manufacturer

6.3.3.2 Maximum allowable working pressure

6.3.3.3 Manufacturer's serial number

6.3.3.4 Date of manufacture

6.3.3.5 Design working pressure

6.3.3.6 Standard or code designation to which the vessel was manufactured

6.3.3.7 The volumetric capacity (total vessel)

6.3.3.8 Label stating: "CAUTION: PRESSURE VESSEL."

6.3.3.9 Detailed service instructions.

6.3.3.10 Maximum temperature

6.3.4 ADD: Pressure relief

A separate safety relief valve port shall be provided. An unrestricted safety relief valve shall be permanently set and sized to relieve at or below the tank design pressure. The rate of flow shall be considered in the sizing of the relief valve.

Valves

7.1 Selection

Directional valves shall be ISO 15407/2 26mm, ISO 15407/2 18mm, or 5599/2 sizes 2 or 3, can be considered but require prior written approval from purchasing division. All individually sub-base mounted valves shall be provided with a single round molded 4 pin M12x1 plug in connector (Per ISO 9461) wired according to ANSI/B-93.9-1988 (R-1988) Section: 5 (7.4.3) located on the sub base.

Energizing Solenoid 12 (Pin 2) connects port 1 to 2, Energizing Solenoid 14 (Pin 4) connects port 1 to 4

7.2 Mounting

7.2.1 ADD: Disturbance to the piping

Valves shall be removable without disturbance to the piping. Line mounted valves require prior written approval.

7.2.2 ADD: Mounting on movable members

Where directional valves are mounted on moving machine members, they should be mounted with the centerline of the internal elements at a right angle to the direction of the motion to prevent inadvertent spool shift.

7.2.3 ADD: Location

Directional valves shall be located as close to the actuator as practical for minimization of air consumption and proper exchange of fluid

7.2.4 ADD: Manual override

Valves shall be located to provide clearance for actuation of manual overrides.

7.3 Manifolds

7.3.4 Internal passages

The flow capacity of manifold conductors shall be equal to the flow-capacity of corresponding piping and valving.

7.4 Electrically operated valves

7.4.1 Electrical connections

Reference Section 7.1

7.4.3 Solenoids

Integral illuminated solenoid indicator lights are required.

7.4.4 Reference 7.1

7.4.5 Manual override

Flush manual non-locking overrides are required for all valves.

8 Conditioning components

8.1 Filtration

8.1.2 Degree of filtration

8.1.2.1 ADD: General applications

Pneumatic equipment designed to be operated on non-lubricated air shall have a non-clogging separator meeting ISO 8573-1 class 5.5.5.7.4 at a minimum..

8.1.2.2 ADD: Pneumatic logic control systems

A secondary filter meeting the requirements of ISO- 8573- class 1.3.2.at a minimum.

8.1.2.3 ADD: Air gauging filtration

Precision sizing air gage filtration requirements shall meet ISO -8573- class 1.3.2.at a minimum.

8.1.2.4 ADD: Servo or proportional valves

Full flow, non-bypassing filtration shall be used in the supply line preceding a servo or proportional valve.

8.1.4 Provisions for maintenance

The replacement element part number shall be identified on or near the filter housing and on the schematics next to the symbol.

8.2 Pressure regulation

A regulator is required on the supply to each machine and shall be set to a maximum of 70 psi. Additional regulators may be required. Pressure regulation shall be used for efficient and economical system performance. Regulators shall be used on all actuators where the loads may change.

8.3 Lubrication

Non-lubricated, also defined as pre-lubricated for its intended service life, circuit design shall be considered for every application. The use of in-line lubricators is discouraged and requires prior written approval of the purchasing division.

8.3.1 Lubricating fluids

8.3.1.1 Compatibility

Lubricants that contain silicone shall not be used.

8.3.2 Lubricators

8.3.2.1 Lubricator application

Components requiring lubrication shall use positive displacement, single point lubricators and shall deposit the lubricant directly into the inlet port of the device requiring lubrication.

8.3.3 Lubricator filling

Lubricator filling shall not require equipment shutdown or setting change. Lubricators shall have a 5/8-inch diameter button-head pressure fill cap.

8.3.4 ADD: Lubricant capacity

Lubricator reservoir capacity shall provide a minimum of 200 hours of operation at the recommended setting required for the application.

8.4 Shielding

8.4.1 Non-metallic bowls on fluid conditioning units REPLACE WITH:

Non-metallic bowls shall be shielded with a metal guard to avoid hazard. These bowls shall not be located in the operator's normal working position or used at an excessive temperature or in a detrimental environment.

9 Piping

9.1 General requirements

9.1.1 Fluid flow

Table 4 shows flow rates for steel tubing and table 5 shows flow rates for schedule 40 pipe.

Table 4

Outside diameter (mm)	Wall Thickness (mm)	Cv	Flow rate (SCFM)
6	1	0.2	1.6
10	1	0.028	6
12	1.5	0.56	12
20	2	1.6	35
25	2.5	3.5	75

Table 5

Schedule 40 pipe sizes and flow rates			
Nominal pipe size (Inches)	Cv	Flow rate (SCFM) 100 PSIG	Flow rate (SCFM) 60 PSIG
1/8	0.2	6	4
1/4	0.4	13	8
3/8	0.9	30	20
1/2	1.7	50	35
3/4	3.4	100	70
1	6.2	200	125
1-1/4	12.7	400	250
1-1/2	18.2	550	400
2	34	1000	800

9.1.3 Design of layout

When piping must pass over walkways, it shall be mounted a minimum of 96 inches above the walking surface.

9.2 Pipe and tube requirements

9.2.1 ADD: Global

Steel tubing shall conform to SAE J524 metric.

9.2.2 ADD: Working pressure

Working pressure of piping, fittings and fluid passages shall not exceed 25% of the manufactures rated burst pressure. (4:1 safety factor at maximum expected temperature).

9.2.3 ADD: Use of fittings

9.2.3.1 Solderless connectors

Only solderless connectors (e.g., threaded, flared, flare less, self flaring, flanged, quick disconnect

coupling, brazed, welded) or the equivalent shall be used.

9.2.3.2 Flared-type tubing fittings

Flared-type tubing fittings shall have a flare angle of 37° from the centerline, per SAE J514.

9.2.3.3 Straight thread

ISO 228 straight thread "O" ring connections are required.

9.2.3.4 Unions and "tees"

The use of unions and "tees" is discouraged.

9.3 Support of piping

9.3.2 Installation Piping shall not be used to support components.

9.3.3 Spacing of support clamps for steel tube/pipe

Tube O.D. 6,10mm = <1 meter

Tube O.D. 12,20mm = <1.5 meter

Tube O.D. 25mm = <2 meter

9.3.5 ADD: Tubing bends

Tubing bends shall be made on a tubing bender and not decrease the inside diameter of the tubing in the bend by more than 15 percent.

9.3.6 ADD: Plastic piping

Plastic piping shall be suitably protected from damage (e.g., pinching, kinking, abrasion, heat, weld flash). Plastic piping shall not be used in areas that exceed the piping manufacturer's rated temperature specifications.

9.5 Flexible hose assemblies

9.5.1 Requirements

9.5.1.1 ADD: Synthetic hoses

Synthetic hoses shall have adequate conductivity to prevent a build-up of static electrical charge. Hose installed in induction applications shall be non-conductive

9.5.1.2 ADD: Maximum permissible length

Flexible lengths shall not exceed (1) meter.

9.5.1.3 ADD: Permitted use

A hose shall be used as either a flexible conductor between a stationary and moving components or for sound attenuation.

9.5.1.4 ADD: Manufacturers recommendations

Hose connectors shall be applied per the manufacturer's specifications.

9.5.1.5 ADD: Interchangeability

Hose connectors and hose from different manufacturers shall not be interchanged.

9.5.1.6 ADD: North America

Hose shall conform to SAE J517 or ISO 1436/11.

9.5.2 Installation

9.5.2.1 ADD: Length

Hose length shall not exceed 1 meter (39.4 inches).

9.5.2.2 ADD: Termination

Hose connectors shall terminate at an anchored connector or bulkhead connector fixed to a rigid machine member.

10 Control systems

10.3 Components

10.3.5 System set up controls

For system set up, safe manual control shall be provided for each actuator from the operator control panel.

10.3.6 Two-hand controls

Two-hand controls shall also meet all of the requirements outlined in DA-2001 Delphi Specification for the Application of Safety Circuits, 3/03

10.4 Control systems with servo and proportional valves

For emergency stop, and as required by the risk assessment, a blocking valve shall be provided in the supply line to any servo or proportional valve.

10.5 Other design considerations

10.5.5 Sequence control

10.5.5.1 Sequencing by position

Sequence control shall be by position sensing. Sensing by pressure is discouraged.

10.6 Location of controls

10.6.3 Manual controls

Manual control pushbuttons shall be located where the

associated actuator may be observed when manually actuated.

10.6.4 Enclosures and compartments

Pneumatic controls (e.g. valves) and electrical control equipment with exposed electrical connections shall not be mounted in the same enclosure. Enclosures with pneumatic components mounted in them shall be vented through the bottom using a muffler.

10.6.4.2 Types of doors and covers

Doors shall swing horizontally, and shall be held closed with captive-type mechanical fasteners that require either a key or hand tools to open.

10.6.5 ADD: Pneumatic logic control systems

Use of pneumatic logic control systems require the purchaser's approval.

10.6.5.1 Logic devices

Pneumatic logic control systems are machine logic control systems that utilize pneumatic valves to perform the logic function necessary to operate the power valves with air pilot signals. Output of power valves shall not be used for machine control logic except for pressure sensing and then only if the air is suitably filtered.

10.6.5.2 Shut-off valves

Separate supply shut-off valves shall be provided for the logic and power circuits.

10.6.5.3 Pressure regulator

A separate pressure regulator (down stream of the filters) connected to the logic circuit shall be provided.

10.6.5.4 Enclosure

The logic control system shall be mounted in an enclosure with a minimum of 25% spare space.

10.6.5.5 Initiation of an action

Initiation of an action shall be done with the pressurization of a pilot line, not the exhausting of a pilot line.

10.6.5.6 Limit valves

10.6.5.6.1 Adjustments

Limit valves shall be adjustable and the adjustments shall be able to be secured.

10.6.5.6.2 Operation

Limit valves shall be capable of normally passing and normally non-passing operations.

10.6.5.7 Device color, function and arrangement

Pushbuttons, palm buttons, selector valves, pneumatic indicators, etc. shall conform to the color, functions and arrangement as shown in NFPA 79 -2007 and the DELPHI addendum DA2004 Rev. 4.0 Jan. 2007,

10.6.5.8 Pneumatic indicators

If the machine has an automatic/manual mode selector switch, pneumatic indicators that indicate when the system is in automatic mode and when the machine cycle is complete shall be provided.

10.6.5.9 Control conductor identification

Control conductors shall be identified by a number that corresponds with the conductor number listed on the control drawing. The identification number shall be permanently affixed to the conductor at each end as well as at every connector and junction. Electrical-type wire number stickers are not-acceptable.

10.6.5.10 Timing circuits

The use of timing circuits instead of position sensing devices shall require written approval by the purchaser.

11 Diagnostics and monitoring

11.1 Pressure measurement

11.1.1 ADD: Location

Visual pressure monitoring shall be located at each pressure control valve.

11.1.2 ADD: Diagnostics

It shall be the responsibility of the equipment supplier to consult with the purchasing division as to the extent and the type of diagnostics required.

14 Commissioning

14.2 Noise

Equipment shall meet the requirements of DAS-SL 1.0, Delphi Sound Level Specification, Oct 1999.

14.3 Fluid leakage

The complete pneumatic system shall be leak free under all operating conditions.

16 ADD: Air over hydraulic systems/hydraulic intensification

16.1 Intended use

These systems are intended to increase available force through pressure intensification or provide precision speed control of pneumatic circuits.

16.2 Hydraulic circuit

The hydraulic portion of the circuit shall conform to ISO 4413 and the Delphi Automotive addendum to ISO 4413, DA-2002, Sep. 2007

16.3 Air bleed-off

An air bleed-off shall be provided where the possibility of air entrapment exists in the hydraulic portion of the circuit.

16.4 Reservoirs

Reservoirs shall include a means for adding fluid without disassembling the system or components.