



Pneumatic Fluid Power – General rules and safety requirements
for systems and their components

Addendum to ISO 4414, Third Edition, 2010-11-15

Global Common

SD-014

ISSUED	November 6, 2009
REVISED	January 26, 2026

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Foreword

This Pneumatic Fluid Power – General rules and safety requirements for systems and their components specification addendum is issued by Nexteer Automotive Corporation. The intent is to provide Nexteer Automotive Facilities with safe, well designed, reliable, and productive pneumatic 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 and safety requirements for systems and their components, third edition, 2010-11-15." For clarity, the chapter headings and hence the overall format of ISO 4414 has 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:** additional requirements to those stated within ISO 4414.
- **MODIFY:** modified requirements to those stated within ISO 4414.
- **CLARIFY:** informative text added to assist in the understanding of requirements stated within the ISO 4414.

This specification was developed by Nexteer Automotive. The mission was to develop a Nexteer Automotive specification based on a globally accepted 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 Nexteer Automation 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, Nexteer Automotive 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 Nexteer Automotive 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 Nexteer Automotive operations. The specifications were developed based solely on the equipment, operations, processes and facilities of Nexteer Automotive. These specifications should not be relied on for use at non-Nexteer Automotive operations and Nexteer Automotive 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.

1 Scope

ADD: The following:

Purpose - This specification is to be used for the purchase of equipment for manufacturing at all Nexteer Automotive Plant sites globally.

Standards - This equipment, and devices on this equipment, shall conform to international common industry standards, such as ISO.

Modifications and additions - Equipment designed specifically for Nexteer requirements, including modifications and additions to standard equipment, shall also conform to these standards.

Mandatory requirements - Mandatory requirements of this specification are indicated by the use of "shall."

Deviations - Deviations from this standard shall require advanced written approval of the Nexteer Controls Engineer and the Nexteer Purchasing Engineer (Engineer-in-Charge). Any waivers granted shall apply only to the machine in question and shall not be considered permanent.

Conflicts - The industrial equipment builder (OEM) shall call to attention of the Nexteer Controls Engineer any situation of a conflict between this standard and any other applicable code / regulation.

2 Normative references

ADD: The following Normative References:

Nexteer Automotive Specification SD-001, General Manufacturing Equipment Specifications.

Nexteer Automotive Specification SD-003, General Drawing and Manuals Specification.

Nexteer Automotive Specification SD-011, Specification for Safety Circuits.

Nexteer Automotive Specification SD-012, Design-In Health and Safety Specification.

Nexteer Automotive Specification SD-017, Design-In Ergonomics Guideline.

NR-12, Machinery and Work Equipment Safety.

Local Standards – all equipment shall comply with the latest version of any applicable federal, state, provincial, and local standards for the plant site.

CLARIFY: The Industrial Equipment Supplier is responsible for obtaining copies of all National and International Standards referenced in the specification as needed. Nexteer Automotive specifications are available on the Nexteer Data Exchange website at www.nexteerdatabexchange.com under Vendor Documents.

3 Terms and definitions

3.3 Function plate

ADD: All device tags (Example: proximity switches, position sensors, valve solenoids, pressure switches, pressure settings, fluid requirements, replacement elements, etc.) shall be clearly and durably marked with the device ID (Example: I2.3PRX, I1.2PS, OM1.1SOLP14, etc.) that matches the approved drawings. All device tags shall indicate the functional description in English and should include the language of the country of machine's destination and shall be mounted adjacent to the device they are identifying, or in a manner which clearly identifies the individual device.

CLARIFY: The device tags shall be durably marked using engraved or thermal transfer plastic (lamacoid) tags with a 1.5 mm (1/16 in) thickness at a minimum. Metal tags are also acceptable.

ADD: The following terms and definitions:

3.7 Cubic feet per minute (CFM)

Flow rate. One cubic foot of gas (air) per minute at actual conditions.

3.8 Standard cubic feet per minute (SCFM)

Flow rate. One cubic foot of gas (air) per minute at standard conditions. Nexteer has standardized for one standard cubic foot (SCFM) at the following conditions:

- Atmospheric pressure – 14.7 PSIA (1.01325 bar)
- Air temperature – 68°F (20°C)
- Relative humidity (RH) – 36%

3.9 Cv

Flow coefficient or pneumatic conductance that expresses the flow capability of a fixed orifice pneumatic device (flow differential).

$$C_v = \frac{Q}{22.48} \times \sqrt{\frac{T \times G}{\Delta P \times (P_2 + P_a)}}$$

- Cv: Flow coefficient
- Q: Air flow rate – SCFM @ 14.7 psia, 36%
- T: Air temperature (absolute) – Rankine, (R = °F + 460)
- G: Specific gravity of flowing medium – air = 1
- P₁: Inlet Pressure – Psig
- P₂: Outlet Pressure – Psig
- ΔP: Pressure drop – psi, (= P₁ – P₂)
- P_a: Atmospheric pressure – Psia

4 List of significant hazards

See Table A.1 in ISO 4414.

5 General rules and safety requirements

5.1 General

5.1.1 CLARIFY: Task-hazards are identified in a Machine Risk Assessment. The following documentation is used to support the Machine Risk Assessment process:

- SD-011, Specification for Safety Circuits
- SD-012, Design-In Health and Safety Specification
- Machine Risk Assessment Toolkit

5.2 Basic requirements for the design specification of pneumatic systems

5.2.1 Component selection

ADD: Suppliers shall follow the Nexteer Automotive Specification SD-007, Approved Components List.

5.2.2 Unintended pressures

ADD: All components shall have a minimum service rating of 1034 kPa (125 PSIG).

ADD: All regulators and relief valves shall include a gauge installed where it is easily read and labeled with the proper pressure setting.

ADD: A pressure sensor shall be installed if a loss of pressure will create a hazard to personnel or the equipment.

5.2.3 Mechanical movements

MODIFY: Vertical and inclined pneumatic actuators may require additional devices such as pilot operated check valves, brakes or locks, counter-balance weights, shot pins, or similar devices to prevent hazardous or undesired movement. Refer to Nexteer Automotive Specification SD-011, Specifications for Safety Circuits, and the Machine Risk Assessment specific requirements and clarification.

5.2.4 Noise

ADD: All pneumatic equipment shall meet the requirements of Nexteer Automotive Specification SD-018, Sound Level Specification. This requires the sound level to be below 80 dB(A).

5.2.6 Operational and functional requirements for pneumatic systems

ADD: Peak air flow calculations shall be completed and submitted at time of pneumatic design review. The flow rate shall be in SCFM and be documented on the pneumatic designs. A 10% spare flow capacity shall be added to resulting peak air flow. A Nexteer SCFM calculation tool can be provided, or online tools can be referenced to complete this calculation.

ADD: All pressure units shall be in both standard (psi) and metric (bar) units. Example: 70 psi (4.8 bar). Equipment destined for China shall have pressure units in MPa. Example: 70 psi (0.48 MPa).

ADD: Ambient temperature - Equipment shall be designed to operate in an ambient temperature range of 15°C (59°F) to 40°C (104°F) unless otherwise specified.

5.2.8 Positive isolation from energy sources

CLARIFY: Pneumatic shut-off valve intended use - manually actuated valve, that when actuated is to block incoming pneumatic energy and relieve downstream pneumatic energy. Used as an isolation device to perform pneumatic lockout. This shall not be confused as an emergency stop device.

MODIFY: The pneumatic shut-off valve shall have provisions for locking in the "OFF" position only.

ADD: Exhausting of this pressure shall not create a potential hazard to personnel, uncontrolled motion, or damage to the equipment.

ADD: If isolation is required downstream of the main pneumatic shut-off valve, SD-007 approved pneumatic shut-off valves shall be used. Ball valves shall not be used for this purpose.

5.2.9 Location of components and controls

ADD: Pneumatic shut-off valve location shall:

- Be located between 0.4 m (16 in) and 1.6 m (63 in) from the working surface. Refer to Nexteer Automotive Specification SD-012, Design-In Health and Safety Specification.
- Be located outside of hazardous areas to minimize the time and travel required for a proper system / safety lockout and restart.
- Be mounted so the exhaust is directed away from personnel operating the shut-off valve.
- Be located as close as possible to the electrical disconnect. Additional valves that are used to isolate subsystems downstream of the main pneumatic shut-off valve are an exception.

5.2.12 Airborne hazardous substances

ADD: Reclassifiers shall be used on the exhaust ports of all lubricated systems.

5.4 Specific requirements for components and controls

ADD: All actuators shall be sized and components selected based on a maximum operating pressure of 70 psig (4.8 bar, 0.48 MPa) unless otherwise specified in writing.

5.4.1 Air motors and semi-rotary actuators

5.4.1.2 Mounting

ADD: ISO mounting configurations shall be used whenever possible and rotary actuators shall not be used as a positive position stop.

5.4.1.3 Load and speed considerations

ADD: Rotary actuators shall be equipped with cushions for deceleration control to eliminate shock from circuits and equipment. Rotary actuators with external cushions used in conjunction with three-position, open-center exhaust valves require further consideration due to possible drifting of the actuator when the valve is in the center position. See three-position valve section below for further guidance.

5.4.2 Cylinders

5.4.2.6 Alignment

ADD: Self-aligning couplings shall NOT be intended to compensate for improper alignment and shall only be used when tooling is guided.

5.4.2.7 Adjustable stroke end stops

ADD: Cylinders shall be equipped with internal pneumatic or external hydraulic cushions for deceleration control to eliminate shock caused by circuits and related equipment.

5.4.2.8 Piston rod material, finish and protection

MODIFY: The piston rod material and finish shall be selected to minimize wear, corrosion, foreseeable damage and meet the requirements listed below.

- All piston rods shall be equipped with rod wipers and scrapers.
- Pistons shall be positively locked to the piston rod.
- The cylinder rod connector end shall be male.
- Cast iron piston rings shall not be used.

5.4.2.10 **ADD:** Grippers

Springs

Grippers with springs shall not be used when the operator is frequently exposed (E2) to the gripper motion. Refer to Machine Risk Assessment for additional guidance.

Gripper springs shall be provided on all applications that require control of the part to be maintained when air is exhausted to the gripper actuator (Example: pneumatic lockout or 3-position open center valve). If losing control of the part does not cause a hazard, does not damage the part, and does not disrupt production, then using a gripper without a spring may be considered.

Purge Port (vent port)

Applications with dirty environments shall use grippers with purge ports. A separate in-line regulator shall be used to provide low air pressure to the purge port preventing actuator damage. Refer to gripper manufacturer requirements for pressure setting.

Labeling

Grippers with internal springs to either spring to close or spring to open resulting in stored mechanical energy, a caution tag shall be provided adjacent to the gripper and added on the lockout placard. This tag shall also be present in the pneumatic prints near the actuator.

5.4.2.11 **ADD:** Clamps

Toggle clamps

Toggle clamps shall be used when it is crucial to keep part location in fixture for certain processes because they maintain clamping force when air is removed

Swing clamps

Swing clamps may be considered when loss of clamping force will not cause a hazard, interrupt process requirements, and will not damage tooling or product due to losing clamping force when air is removed.

5.4.3 **Valves**

5.4.3.1 **Selection**

ADD: Suppliers shall follow the Nexteer Automotive Specification SD-007, Approved Components List.

ADD: Valves shall be externally pilot operated through the #14 port.

ADD: Manifolds are required for applications requiring more than 4 valves. When less than four valves are needed, the use of individual sub-base mounted valves should be considered.

ADD: Manifolds shall have a maximum of 10 directional control valves per manifold, with 8 or less preferred. Any manifold with more than 8 valves requires a review of the machine layout showing manifold location and line lengths. Conductor line lengths shall be taken into consideration when determining the number of valves on a manifold to minimize system exhaust time. Conductor line lengths should be kept as short as possible.

ADD: Multiple actuators supplied by one valve.

Multiple actuators supplied by one valve require the Fluid Power Engineer's prior approval and require air calculations as to not exceed the flow capacity of the valve.

Do NOT use multiple actuators on a single valve if the application requires:

- Individual control of each actuator.
- Short stop time distances. Multiple actuators exhausting through one valve will increase safeguard mounting distances.
- Actuators need to move at the same time. Actuators may start, and finish strokes at different times based on sticky conditions, faulty seals, and uneven wear. This would require constant adjustment of flow controls.
- Full force of each actuator needs to be applied at the same time. Side loading could occur if actuators reach their working position at different times causing rocking or tipping.

The use of a single PO check circuit is preferred; however, the number of PO check circuits shall be assessed. Having a PO check circuit for each actuator on a single valve could be wasted cost and increases the number of flow controls to adjust. However, separate PO check circuits may be needed if independent manual exhausting is required. Actuators with PO check valves may drift down at different rates based on leakage.

The number of flow controls shall be assessed. If the actuators do not need synchronized motion, then a single set of flow controls should be used to save costs and prevent constant setting of flow controls.

5.4.3.2 Mounting

ADD: Directional valves shall be mounted with their main and pilot spools mounted in the horizontal plane with the mufflers located at the bottom of the manifold. Manifolds listed in SD-007 that have mufflers on the side when the valves spools are horizontally mounted are acceptable.

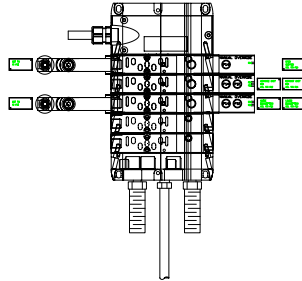


Figure: 5.4.3.2

5.4.3.3 Manifolds

5.4.3.3.3 Mounting

ADD: Valves should be mounted below their actuator, when possible, to flush any contamination brought in by the actuator out the exhaust path, rather than continually cycling at the actuator.

5.4.3.3.5 **ADD:** Location

Shall be located outside of the operator's normal workspace and protected from the plant environment.

Shall be readily accessible and located outside of machine safeguarded areas where practicable. If this is not possible, the manifolds shall be easily located from outside the safeguarding.

5.4.3.3.6 **ADD:** Labeling

Manifolds shall be identified by a reference number-device combination using the standard designator "MAN". The number shall be a unique reference number indicating where the device is located on the electrical drawings. This unique reference can consist of a line, sheet and grid, or sheet and unique number. Example:

Manifold 1200MAN Located on sheet 12 of electrical drawings.

The manifold shall be clearly and durably marked on the equipment adjacent to the manifold with the device ID matching what is shown in the electrical drawings.

5.4.3.4 Valve control mechanisms and related operating devices

5.4.3.4.2 Electrically operated valves

5.4.3.4.2.1 Electrical connections

ADD: The number 12 coil, or 2 port, shall always control the home position of the actuator and the number 14 coil, or 4 port, shall always control the work position.

ADD: Manifolds shall be properly grounded as required by the manufacturer.

5.4.3.4.2.4 Manual override

ADD: Manual overrides shall be flush and non-locking. Provisions, such as protection caps, are allowed to meet this requirement.

5.4.3.6 Quick-exhaust valves

ADD: Quick exhaust valves shall be installed on all lock/brake applications. The valve shall be installed as close to the brake as possible and may be threaded directly to the actuator port.

ADD: Quick exhaust valves shall not be used to decrease stopping times to allow a safeguard to be moved closer to a hazardous motion.

5.4.3.7 Flow-control valves

ADD: Meter-in flow controls are required for all applications with actuator strokes 50 mm (2 in) or greater. Consideration may be given to not using flow controls on applications with strokes less than 50 mm.

ADD: Meter-out flow controls are required for Nexteer PO check circuits to regulate exhausting of trapped air and prevent uncontrolled movement. Refer to PO check circuit section 5.4.3.10 below for additional guidance.

ADD: Applications with heavy loads (Example: fixtures with heavy tooling) may require both ports of the actuator to have meter-in and meter-out flow controls to provide braking for fast-moving applications where inertia is a factor. Refer to Nexteer Specification SD-1038 for additional information on automatic operator interface safety door speed control.

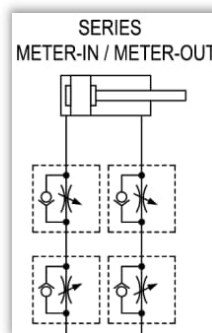


Figure: 5.4.3.7

5.4.3.8 Three-position valves

ADD: Three-position, open-center valves are preferred for all applications. Refer to Nexteer Automotive Specification SD-011 for additional information on valve selection.

ADD: Blocked center valves are not permitted.

ADD: When controlling actuators using shock absorbers with a three-position, open center valve, unintended motion when the valve is centered is possible. If unintended motion is undesirable, the following options should be considered.

- Using cushions instead of shock absorbers (preferred).
- Using a two-position detented valve, based on SD-011 allowance.
- Using dual PO checks (typically not allowed and least preferred).

5.4.3.9 **ADD:** Pilot operated check valves (PO checks)

Function

Traps air pressure between the pilot operated check valve and the actuator piston, stopping and maintaining the actuator position. This air pressure is not vented by the safety exhaust valve or the pneumatic shut-off valve when performing pneumatic lockout. PO check seal, piston seal, rod seal, fittings or line leaks can cause motion that needs to be considered during the machine design and risk assessment.

Intended use

PO check valves shall only be used on vertical applications and shall only be installed in the actuator lowering motion port. Refer to Nexteer Automotive Specification SD-011 for additional information. PO checks used in the pneumatic systems shall be documented on the lockout placard. Reference Nexteer lockout placard and Nexteer Automotive Specification SD-012 for examples.

Considerations

Actuators may not require a PO check circuit based on the application. For example, spring raised pallet stops and toggle clamps typically do not require PO check valves. This is allowed if the process is not affected by the drifting of the actuator and is documented in the machine risk assessment.

Dual pilot operated check valves

Dual PO checks (one on each actuator port) are not allowed due to the potential for unexpected motions if the valve is worn, faulty or does not seal correctly.

Labeling

PO check valves trap air pressure between valve and actuator resulting in stored pneumatic energy, a caution tag shall be provided adjacent to the PO check valve and added on the lockout placard. This tag shall also be present in the pneumatic prints near the check valve.

5.4.3.10 **ADD:** Pilot operated check valve (PO check) circuits

General requirements

Refer to Nexteer Automotive Specification SD-011, Specification for Safety Circuits, when a PO check circuit is required.

Components

- #1. Meter-In Flow Control – Installed on the top actuator port. Provides speed control when lowering actuator.
- #2. Meter-Out Flow Control – Shall be installed between the PO check valve and the actuator. Provides speed control when lowering actuator and exhausting trapped air pressure.
- #3. Manual Override – Installed between meter-out flow control and PO check valve. Provides a means to manually exhaust trapped air pressure.
- #4. PO Check Valve – Installed between the meter-in flow control and the manual override. Traps air pressure between check valve and bottom of actuator maintaining position when directional control valve or safety shutoff valve exhaust the rest of the circuit.
- #5. Meter-In Flow Control – Installed between PO check valve and directional control valve. Provides speed control when raising actuator.

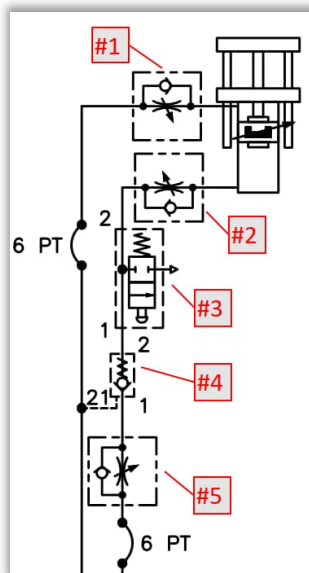


Figure: 5.4.3.10.1

Installation

PO check valve shall be installed as close to the actuator's lower port as possible to avoid actuator bouncing.

PO check circuit manual override shall be readily accessible to allow for maintenance purposes.

Conductors between the lower actuator port and the PO check valve shall be rigid and threaded together or hard line, such as steel tubing or reinforced braided hose with compression fittings. Flexible conductors with push-in fittings are not allowed. This reduces the chance of an uncontrolled lowering motion if the line was ever compromised.



Figure: 5.4.3.10.2

5.4.3.11 **ADD:** Safety-rated exhaust (blocking) valve

Function

3/2 normally closed safety-rated dual valve with internal monitoring and feedback sensor, automatic reset. When electrical command signal is removed, valve shifts to spring returned position resulting in blocking the supply pressure and exhausting pressure from the hazardous portion of the machine. Internal monitoring is performed by the valve assembly and valve malfunction will result in a safe condition. Valve diagnostic status signal is provided for connection to a PLC input.

Intended use

The safety-rated exhaust valve provides redundancy in the pneumatic air supply circuit to block the air supply to hazardous motion and exhaust downstream air pressure in the event the directional control valve fails to shift. Refer to Nexteer Automotive Specification SD-011 for additional information.

Installation

Safety-rated exhaust valves listed in SD-007 shall be mounted vertically with the pilot solenoids on top.

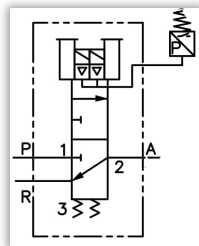


Figure: 5.4.3.11

5.4.3.12 **ADD:** 5/3 valve, double solenoid, open center

Function

When electrical command signal is removed, valve shifts to spring center position resulting in blocking the supply pressure and exhausting pressure from the hazardous portion of the machine.

Intended use

Double solenoid three-position valves with an exhaust center shall be used for control of actuators with strokes exceeding 76 mm (3 in) and for stopping the actuator motion by removing the electrical command signal. The stop time of the actuator depends on the weight of the load and longer stop times may occur when actuators have high inertia loads.

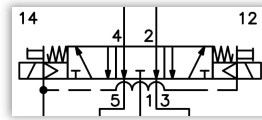


Figure: 5.4.3.12

5.4.3.13 **ADD:** 5/2 valve, double solenoid, detent

Function

When electrical command signal is removed, valve holds last electrical commanded position resulting in the hazardous motion continuing until full stroke is reached or dwell in its current end of travel location unless air to the valve is supplied from a safety exhaust valve.

Intended use

Double solenoid detented valves are allowed for control of actuators with strokes less than 76 mm (3 in) when the desired action is to maintain the last commanded position. Example applications include grippers, shot pins, and clamps.

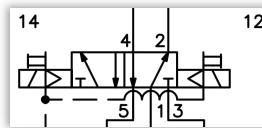


Figure: 5.4.3.13

5.4.3.14 **ADD:** 5/2 valve, single solenoid, spring offset

Function

When electrical command signal is removed, valve shifts to spring return position resulting in the motion reversing direction until the end of stroke is reached unless air to the valve is supplied from a safety exhaust valve.

Intended use

Single solenoid spring offset valves are allowed for control of actuators with strokes less than 76 mm (3 in) when the desired action is a return to the home position on loss of the electrical command signal. Example applications include conveyor pallet stops and part escapements.

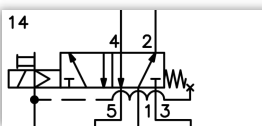


Figure: 5.4.3.14

5.4.3.15 **ADD:** 5/2 valve, single solenoid, spring offset with internal spool monitoring

Function

When electrical command signal is removed, valve shifts to spring return position resulting in the motion reversing direction and continuing until the end of stroke is reached unless air to the valve is supplied from a safety exhaust valve. These valves have spool monitoring sensors indicating the position of the valve spool to ensure spool responds to the electrical command signal.

Intended use

Single solenoid spring offset valves with spool monitoring are intended to be used for safety applications. Example applications include rod locks and rail brakes.

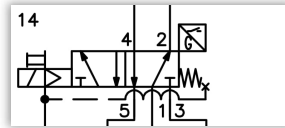


Figure: 5.4.3.15

5.4.3.16 **ADD:** 3/2 valve, dual 3-way solenoid, normally closed, normally closed

Function

When electrical command is removed, pilot pressure returns the valves to the home position.

Intended use

Dual 3-way solenoid valves are allowed for control of actuators with strokes less than 76 mm (3 in) when the desired action is to relax or return to the home position on loss of the electrical command signal. Example applications include conveyor pallet stop motions to save cost and manifold footprint.

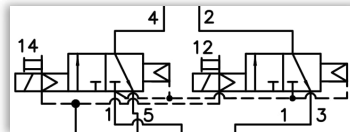


Figure: 5.4.3.16

5.4.4 Air-preparation components

5.4.4.1 General

ADD: Supplying multiple pieces of equipment with the same air preparation components is not allowed.

ADD: A relieving regulator shall be installed on the supply to each machine and shall be set to a maximum of 70 psi (4.8 bar). Pressure regulation shall be used for efficient and economical system performance.

5.4.4.2 Filtration

5.4.4.2.2 Nominal filtration rating

ADD: General applications – pneumatic equipment designed to be operated on non-lubricated air shall have a non-clogging separator meeting ISO 8573-1 :2010 [5:8:4] at a minimum. Nexteer's standard 40 and 5 micron filter combination meets this requirement based on ISO 8573-1, annex A.3.2.2.

ADD: Sensitive applications – Applications including air gauging and linear scales shall meet ISO 8573 class 1.3.2 at a minimum.

ADD: Servo or proportional valves – full flow, non-bypassing filtration shall be used in the supply line preceding a servo or proportional valve.

5.4.4.2.3 Deterioration of filter performance

ADD: A pressure sensor shall be installed in the most downstream position within the main air preparation unit.

5.4.4.2.4 Provisions for maintenance

ADD: The replacement element part number shall be identified adjacent to the filter housing and on the pneumatic drawings next to the symbol.

5.4.4.2.5 Drains

ADD: Manual drains only.

ADD: A minimum of 0.2 m (8 in) clearance between the floor and filter drain valves are required to allow room for a collection container.

NOTE: Water in a pneumatic system will alter the volume, which will affect pressure, flow, and response of the system.

5.4.4.3 Lubrication

ADD: Non-lubricated, also defined as pre-lubricated for its intended service life, circuit designs shall be considered for every application. The use of in-line lubricators is discouraged and requires the Fluid Power Engineer's prior approval.

5.4.4.3.1 Application

MODIFY: Systems shall be designed for dry service. This means the components shall be pre-lubricated for their intended life cycle.

ADD: Where lubrication is required, only single point lubrication is permitted. Mist style lubrication is not permitted.

ADD: Air motors shall have single point positive injection type lubricator. See lubrication requirements further in this document.

5.4.4.3.2 Compatibility of lubricating fluids

ADD: Lubricants shall be compatible with the components being manufactured. Lubricants that contain silicone shall not be used. Refer to GM LS1 and LS2 Specifications and Nexteer's Master Chemical List for approved lubricants.

5.4.4.3.3 Lubricators

ADD: Lubricator filling shall not require an equipment shutdown or a setting change. Lubricators shall have a 5/8-inch diameter button-head pressure fill cap. Lubricator reservoir capacity shall provide a minimum of 200 hours of operation at the recommended setting required for the application.

5.4.4.5 Shielding of air preparation components

ADD: Filter bowl shall be provided with metal shields.

5.4.4.6 Mounting

Air preparation components shall be readily accessible and suitably protected from potential damage. Air preparation units shall be mounted between 0.7 m (28 in) and 1.6 m (63 in) above the service level. They shall be rigidly mounted and installed level with the floor surface.

Air preparation components shall be arranged in a left-to-right air flow configuration, as required by components listed in SD-007.

5.4.4.7 **ADD:** Location

Air preparation components shall not be in the operator's normal working area and be located outside of safeguarded areas and installed to allow accessibility to its components for easy service, adjustments and monitoring.

5.4.4.8 **ADD:** Drip leg

The main air supply shall incorporate a drip leg to separate water and large contaminants from entering the machine's air system.

Drip legs may be purchased from the manufacturer per SD-007 approved components list or may be custom fabricated using schedule 40 black iron pipe, with a required diameter of 1-1/4 in and with a length of at least 18 in.

The bottom of the drip leg shall include a drain valve meeting requirements detailed in 5.4.4.2.5 above.

5.4.5 Piping and fluid passages

5.4.5.1 General requirements

ADD: Polyurethane tubing and hose shall be protected from damage (e.g. pinching, kinking, abrasion, heat, weld flash) and shall be restrained in the event it pulls out of the fitting. Polyurethane tubing and hose shall not be used in areas that exceed the manufacturer's rated temperature specifications.

ADD: Aluminum pipe systems are allowed when suitably protected to prevent damage.

ADD: Galvanized pipes are not allowed. Galvanized coating particles are susceptible to breaking off contaminating the air system.

ADD: The table below indicates the conductor designations that shall be included with the conductor size and shown near each pneumatic conductor in the pneumatic drawings.

- Example: 3/4 inch pipe with NPT threads used for the air drop = 3/4" NPT P
- Example: 10 mm plastic tubing = 10mm PT
- Example: 1/2 inch steel tube = 1/2" ST
- Example: R12 steel tube = R12 ST

Conductor Type	Designation
Pipe	P
Hose	H
Steel Tube	ST
Polyurethane Tube (plastic tube)	PT
Aluminum Pipe	AP

Table: 5.4.5.1

ADD: Tubing bends shall be made on a tubing bender to not decrease the inside diameter of the tubing in the bend by more than 15%.

ADD: Line lengths between the valve and the actuator should be less than 1.8 m (72 in) with 0.9 m (36 in) or less preferred. A 3 m (120 in) maximum tubing length is only allowed with the Fluid Power Engineer's prior approval. Reasons to minimize line lengths:

- Increasing line length increases air volume to be exhausted. As volume increases, the stop times of actuators increase.
- To obtain proper exchange of fluid, the volume in the actuator shall be at least twice that of the line connected to the directional control valve. If this is not met, contamination that comes in from the actuator will not be able to escape the system, until fully exhausted. This will cause contamination to continually cycle at the actuator, thus causing premature failure.
- Utility costs will increase to refill the extra volume of pressurized air.

5.4.5.7 Piping across access ways

ADD: When piping must pass over walkways, it should be mounted a minimum of 2.4 m (96 in) above the walking surface.

5.4.5.9 Hose assemblies

5.4.5.9.1 General requirements

ADD: Hose should only be used for flexing, constant vibration applications, or for other approved applications outlined in this document.

5.4.5.9.2 Installation

ADD: Hose shall be mounted and anchored to eliminate abrasion against other surfaces, especially when used in flexing or vibration applications. If location does not prevent abrasion, a form of shielding shall be installed to provide protection.

ADD: Hose shall not use splices to extend length.

ADD: Bend radius must not exceed manufacturer's recommendations

ADD: Conductor

Standard hose sizes shall be 3/8 in (10 mm), 1/2 in (12.5 mm), 3/4 in (19 mm), 1 in (25 mm), 1-1/2 in (38 mm), and 2 in (51 mm) inner diameter.

Hose lengths shall be as short as possible. Excess hose shall be coiled and secured to the machine structure and not rest on the factory floor or walkway.

ADD: Fittings

Straight hose fittings shall be used wherever possible. Angled fittings are not preferred and should only be used to prevent kinking where the hose bending radius is exceeded.

5.4.5.11 Failure of hose assemblies and plastic piping

CLARIFY: Velocity fuses are required on the inlet supply side of 3/4 in (19 mm), or larger hose.

CLARIFY: Hose greater than 1 in (25 mm) shall have a whip restraint safety cable at the hose to barb connection.

5.4.5.12 **ADD: Polyurethane tubing (plastic tubing)**

General requirements

Polyurethane tubing used in welding and other high temperature environments, shall use tubing rated for the environment and proper covering.

Installation

Polyurethane tubing shall be mounted and anchored to eliminate abrasion against other surfaces, especially when used in flexing or vibration applications. If location does not prevent abrasion, a form shielding shall be installed to provide protection.

Polyurethane tubing shall not use splices to extend length.

Bend radius must not exceed manufacturer's recommendations.

Conductor

Standard Polyurethane tubing sizes shall be 6 mm, 10 mm and 12 mm outer diameter. Tubing size shall be selected based on table below.

Device Port Size	Optimal Polyurethane Tubing (O.D. mm)
M5	6
G1/8	6
G1/4	6, 10
G3/8	10
G1/2	12

Table: 5.4.5.12

Fittings

Straight plastic tubing fittings shall be used wherever possible. Angled fittings are not preferred and should only be used to prevent kinking where the tubing bending radius is exceeded.

5.4.5.13 **ADD:** Steel tubing

General requirements

Steel tubing is preferred over polyurethane tubing where reasonably possible because of improved rigidity and durability.

Installation

Steel tubing shall not use splices to extend length.

Bend radius must not exceed manufacturer's recommendations

Conductor

Tubing shall be seamless and meet SAE J524 or metric E235+N / St. 37.4; 1.0308 according to EN 10305.

Metric tubing is preferred for all applications and tubing size shall be selected based on table below.

Outside Diameter (mm)	Wall Thickness (mm)	Designation
6	1.0	R6 x 1
10	1.5	R10 x 1.5
12	1.5	R12 x 1.5
15	1.5	R15 x 1.5
20	2.0	R20 x 2.0
25	2.0	R25 x 2.0

Figure: 5.4.5.13

Fittings

Fittings shall meet ISO 8434-1 or 8434-2. This design incorporates a 24° tapered throat angle connection, and the nut drives the bite ring into the tube as it is tightened during assembly.

All male stud threaded fittings shall meet ISO 1179-2/3. This specifies ISO 228-1 thread stud ends with Type E, elastomeric sealing or Types G or H O-rings with retaining rings.

5.4.6 Control systems

5.4.6.2 Pressure regulation

ADD: All regulators or relief valves shall include a gauge installed where it is easily read and shall include a function tag adjacent to the gauge indicating the proper pressure setting.

ADD: Regulators shall be used on all actuators where the loads may require pressure adjustment.

ADD: Pressure regulators shall be set to the lowest pressure required for proper operation and no more.

ADD: Individual single station valve regulators, also known as sandwich regulators, shall only be used when required. For example, it can be justified to install a sandwich regulator for an actuator performing a pressing operation, while having one for every pallet stop is not justified.

ADD: Regulators with a built-in bypass check valve shall be used to reduce exhaust times.

5.4.6.3 Adjustable control mechanisms

ADD: 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.

5.4.6.7 Manual set-up controls

ADD: For system setup, safe manual control shall be provided for each actuator from the operator control panel, HMI.

5.4.6.8 Two-hand controls

ADD: Two-hand controls shall meet all requirements outlined in Nexteer Automotive Specification SD-011, Specification for Safety Circuits.

5.4.6.10 Control systems with servo or proportional valves

ADD: For emergency stop functionality, and as required by the Machine Risk Assessment, a safety exhaust (blocking) valve shall be provided in the supply line for any servo or proportional valve.

5.4.6.14 Location of controls

5.4.6.14.1 Manual controls

ADD: Manual hardwired or HMI soft buttons shall be located where the associated actuator may be observed when manually actuated.

5.4.6.14.2 Enclosures and compartments

ADD: Pneumatic controls (for example: 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.

5.4.6.14.3 Height

ADD: Pneumatic control device installation height shall be between 0.4 m (16 in) and 2.0 m (79 in) above servicing level. Refer to section 5.2.9 above for pneumatic shut-off valve specific height requirements.

5.4.7 Diagnostics and monitoring

5.4.7.1 Pressure measurement

ADD: Analog gauges shall meet the following requirements:

- For general purpose, 3.0% Full Scale (FS) accuracy or better.
- For push-in style sandwich regulators, 5.0% Full Scale (FS) accuracy or better.
- For testing applications 0.25% Full Scale (FS) accuracy or better.

ADD: Visual pressure monitoring shall be located at each pressure regulator.

ADD: Pressure sensors shall have local digital display and when required, a visual readout from the HMI display for remote monitoring.

5.4.7.3 **ADD: Flow measurement**

Flow sensors shall have local digital display and when required, a visual readout on the HMI display for remote monitoring.

5.4.7.4 **ADD: Actuator position monitoring**

Both integral sensors (mounted to body of actuator) and sensors that monitor tooling movement are common practice. If risk of tooling disconnecting from itself exists, sensors shall be used to monitor the tooling, not the actuator. Reference SD-004, section 9.2.3.6 for motion position monitoring requirements.

5.4.8 Pneumatic Silencers

ADD: Pneumatic safety systems and components shall have sufficient capacity as not to restrict the exhausting of the system.

ADD: Sintered bronze and paper elements shall not be used.

ADD: Where practicable, mufflers shall be located on the bottom of the device to allow for purging of contamination.

NOTE: Restricted mufflers can cause increased exhaust times causing poor machine performance. This can also cause increased stop times of pneumatic motions.

5.4.9 Seals and sealing devices

ADD: Threaded pipe connections shall use thread sealant.

ADD: BSPP (G) threaded components with face seals do not require thread sealant.

ADD: RTV, Teflon tape, and horsehair shall NOT be used to seal threaded connections. Liquid or paste thread sealant shall be used. Thread sealants listed in Nexteer Automotive Specification SD-007, Approved Components List shall be used.

5.4.10 Receivers and surge tanks

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

ADD: Pneumatic inlet or outlet connections shall not be made through the bottom of the tank. This is reserved for a drain connection only.

ADD: 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.

CLARIFY: Tanks shall conform to the following:

Region	Standard
Brazil	Brazilian Regulatory Standard: NR-13 – Boilers and Pressure Vessels
China	China National Standard: GB 150 – Pressure Vessels
Europe	Pressure Equipment Directive (PED) 2014/68/EU - Simple Pressure Vessels Directive (SPVD) 2014/29/EU - Unfired Pressure Vessels EN/13445
North America	ASME BPVC Rules for Construction of Pressure Vessels - Section VIII-Division 1-2023
Other	Follow local applicable government pressure vessel codes

Table: 5.4.10

5.4.11 ADD: Ports and threads

Threads

The following connection terminology shall be used to identify piping and component requirements:

Thread Designation	Definition	Sealing
BSPP (G)	British Standard Pipe Parallel According to standard ISO 228-1, British Standard Pipe Tapered (Example: 1/8 BSPP thread = G1/8)	O-ring gasket or a sealing washer
BSPT (R)	According to standard ISO 7-1, National Pipe Thread Tapered (Example: 1/8 BSPT thread = R18)	Liquid or paste thread sealant required. Some components may come with a pre-coated thread sealant.
NPT	According to ANSI B1.20.1 Pipe Threads, General Purpose, Inch (Example: 1/2 NPT thread = 1/2 NPT)	
M	Metric Threads, Parallel Threads According to ISO 68-1 (Example: metric thread, diameter 5mm, pitch of 0.8mm = M5x0.8)	O-ring gasket or a sealing washer

Table: 5.4.11

All pneumatic threads downstream of the plant air drop connection to the machine shall meet ISO 228-1, BSPP (G) thread.

- Exception: BSPT (R) threads are permitted on mufflers.
- Exception: Some components may require deviation to use NPT or BSPT ports. Same threaded fittings shall then be used to connect that component. A transition from NPT or BSPT to BSPP will have to be made to connect to rest of the system.

Ports

All pneumatic device ports shall meet ISO 1179-1.

All pneumatic stud ends for push-in fittings shall meet ISO 1179-2/3 or with captive elastomer sealing method.

Thread adapters are required to prevent cross-threading. Their location shall be shown in the pneumatic drawings and part number listed in the parts list.

5.4.12 ADD: Air blow-off

The two automatic compressed air blow-off solutions allowed are engineered air nozzles and air knives. Air nozzles optimize energy use and enable quiet and efficient blowing typically designed for single point use. Air knives include the same benefits as air nozzles but often have a larger form factor including multiple nozzles to account for larger objects while generating evenly distributed coverage.

Considerations

Wherever possible, a high-volume low pressure electric blower shall be used in place of compressed air to conserve energy.

Blow-off sound levels shall not exceed 80 dB(A). Reference Nexteer Automotive Specification SD-018, Sound Level Specification. Air nozzle and air knife manufacturers document sound levels, operating at lower blow-off air pressures can reduce the sound level if needed to meet the 80 dB(A) requirement.

Pressure

A separate upstream regulator shall be used to control blow-off pressure.

Air blow-off devices shall be limited to a maximum of 30 psi (2 bar) to prevent injury. Higher pressures may be used if the air nozzle or air knife includes a pressure reducer or a relief device designed to reduce the air pressure to less than 30 psi in the event of a total blockage (dead ended).

Mounting

Air blow-off circuits shall be installed downstream of the pneumatic shut-off valve.

Nozzles

Air nozzles and air knives should be secured in the correct position for proper air flow and direction. In applications where specific air flow and direction are required for product quality, air nozzles and air knives shall be fixed.

Engineered air nozzles and air knives shall be used in place of standard nozzles, metal lines, or holes drilled in pipes.

Control

Solenoid valves shall be used to enable automatic blow-off circuits only when required for energy efficiency.

6 Verification of safety requirements and acceptance testing

CLARIFY: Equipment leak tests shall be performed to ensure proper air system functionality and efficiency.

CLARIFY: Reference Nexteer Automotive CSE Fluid Power Design Approval checklist CSE-507 and Fluid Power Construction checklist CSE-508 for additional acceptance requirements.

7 Information for use

7.2 Final information

a) Final circuit diagrams

ADD: The functional description for each device shall be shown adjacent to its symbol. This applies to all pneumatic control's devices including, but not limited to solenoids, position sensors, pressure sensors and flow sensors. For PLC inputs, the functional description shall indicate the state of the device when the input is ON or energized. Functional descriptions shall be in present or past tense. Motion terminology shall have the verb prior to the noun (Raise Press) and position, or status terminology shall have the noun prior to the verb (Press Raised). Functional descriptions shall be consistent throughout the documentation.

NOTE: For further examples, refer to Nexteer Automotive Specification SD-004 Electrical Specification for Industrial Machinery Addendum to IEC 60204-1 Section 17.

b) Parts List

ADD: Actuator detail numbers shall not be included in the controls drawings pneumatic parts list as they are already documented in the machine drawings pneumatic parts list and part codes are listed in each actuator description on the control's pneumatic drawings.

ADD: When two lines cross, the jumper or crossover symbol shall be used.

ADD: Design Drawings - Refer to Nexteer Automotive Specification SD-003 for documentation requirements.

ADD: Above each actuator symbol the following items shall be present:

- Actuator description
- Actuator manufacturer
- Actuator part code
- Actuator bore, rod, stroke dimensions in mm (some actuators are rod less and this value may be ignored).
- Port size and thread type.

ADD: A settings tag shall be present for each pneumatic device that has the option for adjustment or requires setup. The tag shall be shown directly adjacent to its symbol in the pneumatic drawings.

ADD: Conductor size and type shall be labeled on the circuit diagram next to each conductor.

ADD: In circuit diagrams, hose or flexible conductors shall use a flexible symbol.

ADD: In the circuit diagrams, actuators shall be drawn in the same orientation as they are mounted on the equipment.

ADD: In circuit diagrams, actuators shall be drawn in the home position.

7.4 Marking and identification

CLARIFY: Refer to Nexteer Automotive Specification SD-001, General Manufacturing Equipment Specification Section 3 for device tag requirements.

CLARIFY: Refer to Nexteer Automotive Specification SD-004, Electrical Specification for Industrial Machinery Addendum to IEC 60204-1 Section 16 and 17 for device tag requirements.

8 Identification statement (reference to ISO 4414 International Standard)

9 **ADD:** Air over hydraulic systems / hydraulic intensification

Intended use

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

Hydraulic circuit

The hydraulic portion of the air/oil circuit shall conform to ISO 4413 and Nexteer Automotive Specification SD-013, Hydraulic Fluid Power Rules Relating to Systems – Addendum.

Clamp or work holding circuits

Where these circuits are used for clamping or work holding, the valves used shall be leak free or bubble tight. Traditional hydraulic valves are not permitted.

Air bleed-off

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

Reservoirs

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

10 **ADD:** Assembly Lines

Conductors

For assembly lines that have their own integrated header, hose is preferred to be used between the header tap to each assembly line station air preparation assembly. This is to make assembly / disassembly, and connection / disconnection of stations to / from the assembly line more efficient. Hose shall run with the contours of the machine framing located in a manner to minimize damage.

The header is preferred to be steel pipe for rigidity and durability; however, an aluminum pipe system is allowed when suitably protected to prevent damage.

Air Preparation

For assembly lines that have their own integrated header, a drip leg, pneumatic shut-off valve, a 40-micron filter, pressure regulator and pressure sensor shall be provided upstream of the header.

For assembly line stations, a drip leg, pneumatic shut-off valve, 5-micron filter, pressure regulator, and pressure sensor shall be provided upstream of the station pneumatic system.

Header

Integrated headers are preferred for assembly line applications.

Integrated headers shall slope or pitch downward in the direction of air flow to route water and other contamination away from stations tapped off the header. The lowest point(s) shall have a drain valve to allow evacuation of any contamination.

Integrated headers shall have tee fittings strategically installed for planned and future stations. Tee fittings shall be pointed upwards so as not to allow water and other contamination into the air supply.

Conveyor motion manifolds

Pneumatic conveyor motions should be grouped together on manifolds separate from station pneumatic motions.

Pneumatic conveyor motion valve manifolds shall have a dedicated upstream regulator to allow reduced supply pressure to help save operational costs.

11 **ADD:** Brakes and Locks

Refer to the Nexteer Automotive Specification SD-011, Specification for Safety Circuits Section 3.22 for brake and lock application requirements. Load stopping (brakes) are used for control of suspended vertical load safety applications while load holding (locks) are used for process requirements.

Brakes and locks shall be applied within the ratings specified by the manufacturer. If the load surpasses the rating of the brake or lock, redesign, weight reduction, different part number, or another means of stopping or holding is required.

A separate control valve shall be used to operate the brake or lock. If a safety exhaust (blocking) valve is required per the Machine Risk Assessment for associated actuator with the brake or lock, the safety exhaust shall also supply the valve that controls the brake or lock.

The valve controlling the brake or lock shall use the same electrical power that controls the actuator valve.

The machine logic shall first disengage the brake/lock, allow for a short delay (Example: 0.2 seconds), and then command the actuator to lower or raise.

Brake and lock pneumatic circuit monitoring requirements are also found in SD-011. The most common circuit monitoring approach is using a motion valve spool position sensor. A second form of monitoring is installing a pressure switch between the rod lock or rail brake and the quick exhaust. A less common approach is using a LVDT to monitor tooling position. If LVDT senses movement while the brake/lock is engaged, the logic must indicate the brake/lock has failed.

Annex List

A. List of significant hazards (informative)

B. Form for collecting pneumatic system and component data to ensure conformance with ISO 4414 (informative)

C. **ADD:** Thread Practices

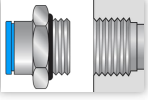
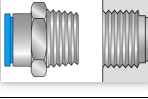
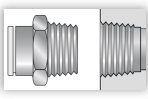

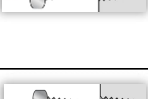
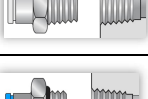
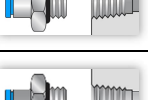
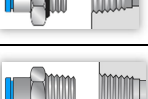
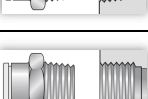
Nexteer Approval	External Threaded Device	Internal Threaded Port	Visual	Comments / Notes
Allowed	BSPP	BSPP		
Not Allowed (with exceptions)	BSPT	BSPP		Muffler / silencer applications only
	NPT	NPT		Some components may require deviation to use NPT ports. NPT fittings shall then be used to connect that component. A transition from NPT to BSPP will have to be made to connect to rest of the system. Requires the Fluid Power Engineer's prior approval.
	BSPT	BSPT		Some components may require deviation to use BSPT ports. BSPT fittings shall then be used to connect that component. A transition from BSPT to BSPP will have to be made to connect to rest of the system. Requires the Fluid Power Engineer's prior approval.
Not Allowed	NPT	BSPT		These thread combinations are not good practice and can increase the chance of air leakage, cross-threading, or damaged components.
	BSPP	BSPT		
	BSPP	NPT		
	BSPT	NPT		
	NPT	BSPP		

Table: C.1

D. **ADD:** Energy Efficiency Considerations (Cost Savings)

D.1 Optimal System Pressure

Though running at increased or at non-optimal pressures may cause the machine acceleration rate, cycle time, to increase, it causes unnecessary wasted energy and premature machine wear-and-tear. Industry testing has confirmed that optimal machine running pressure is 65-70 psi (4.5-4.8 bar). Nexteer machines shall be designed to operate at a max of 70 psi (4.8 bar).

D.2 Conveyor Motion Manifold Pressure

Since most conveyor motions do not need to run at 70 psi (4.8 bar), installing a single upstream regulator to reduce pressure to the entire manifold of conveyor motions is encouraged.

D.3 Secondary Actuator Regulator

If the load on an actuator's retract side is minimal, adding a second regulator to the rod side reduces air consumption and shock to the system when the cylinder completes the retract stroke. Cycle time will be slightly reduced.

D.4 Air Preparation Filter Maintenance

Undersized or dirty filter elements cause less efficient systems, consuming additional energy. Machine personnel may resort to increasing regulator pressure to overcome this issue. In doing so, energy is wasted. Replacing filter elements on a regular basis prevents this issue.

D.5 Muffler Maintenance

Clogged mufflers and re-classifiers cause poor machine response. Machine personnel may resort to increasing regulator pressure to overcome this issue. In doing so, energy is wasted. Replacing or cleaning mufflers or re-classifiers on a regular basis prevents this issue.

D.6 Pneumatic System Maintenance (Leakage)

A poorly maintained system can result in significant energy costs. For example, a single leak or multiple leaks that are the equivalent in size of a 1/16-inch diameter orifice operating at 100 psi, could result in several hundreds of dollars lost per year depending upon the cost of energy in the region. Regular air leakage tests and repairs should be conducted.

E. **ADD:** Machine Air Supply Drop (Plant Responsibilities)

E.1 Tee Fitting Tap

The tee fitting tap connected to the plant header shall point upwards.

E.2 Air Drop Header Connection

The air drop shall first raise a minimum of 10" from the header tee fitting before being routed downward to the machine to discourage water and contaminants from entering the equipment's air supply. Connections to the bottom of the header will act as a drain, increasing the level of contamination to the machine and is not permitted.

E.3 Tap Off Plant Header

The tap off the plant header shall include a ball valve to be able to plug or disconnect the machine's air drop from the plant header.

E.4 Air Drop Conductor

Pipe is preferred for the machine air drop because of durability. Galvanized pipe is not allowed. If pipe is selected, minimum size to be used is $\frac{3}{4}$ inch. Any smaller pipe can flex given large drop lengths. A $\frac{3}{4}$ inch pipe is suitable to supply the majority of Nexteer machines SFCM air demand. SCFM calculations will determine if a larger size is needed.

Flexible hose is permitted as the air drop conductor but not recommended due to inevitable deterioration. A whip-restraint device (whip-check) shall be installed located where the hose is connected to the machine rigid conductor.

Polyurethane tubing as the air drop conductor is not allowed.

The air drop conductor size should match the size of the machine's main air supply connection point.

A ball valve (with exhaust) shall be installed upstream of the drip leg and accessible without using a ladder. This ball valve is to be only used when the machine is being first connected to the air drop, the machine is being moved, or if the drip leg or air preparation assembly needs maintenance. This valve is for Nexteer maintenance personnel only and is not to be used for machine pneumatic lockout. The pneumatic shut-off valve in the air preparation assembly performs the lockout function.

A tee fitting with a quick disconnect coupling should be installed to allow for temporary maintenance or to read air drop pressure. This air access port shall not be used for permanent machine production purposes. This shall be placed between the ball valve and the machines air preparation unit with preference to mount close to the ball valve.

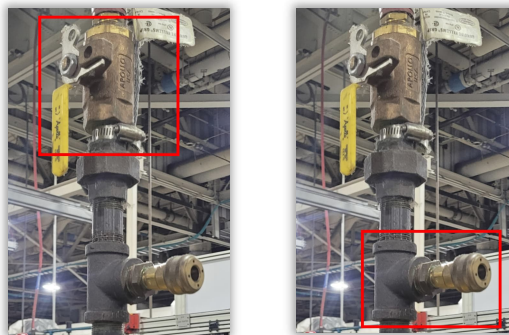


Figure: E.4

RECORD OF REVISIONS

Revision No	Date	Section	Description
001	06NO09	ALL	Initial release of SD-014 based on Delphi Pneumatic Fluid Power Rules Relating to Systems – Addendum to ISO 4414, 1998 Edition.
002	01JN14	ALL	Update based on Nexteer Pneumatic Fluid Power Rules Relating to Systems – addendum to ISO 4414, 2010 Edition.
003	10DE20	ALL	Reformatted for consistency – updated based on content.
004	26JA26	ALL	Major Update
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