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Control Air Circuit Function

CAFS Control Air Circuits may be operated in three (3) air compressor pressure modes: **UNLOAD**, **FIXED** and **AUTO**.

The same basic control air circuit is used on all CAFS system units including both Eclipse™ and Eclipse™ES models.

This instruction includes descriptions and schematics showing the interaction of the control air system components in each mode as well as explanations of the workings of specific components.

The status of the control air circuit is also described when the air compressor is shutdown.

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Air Compressor Pressure Modes

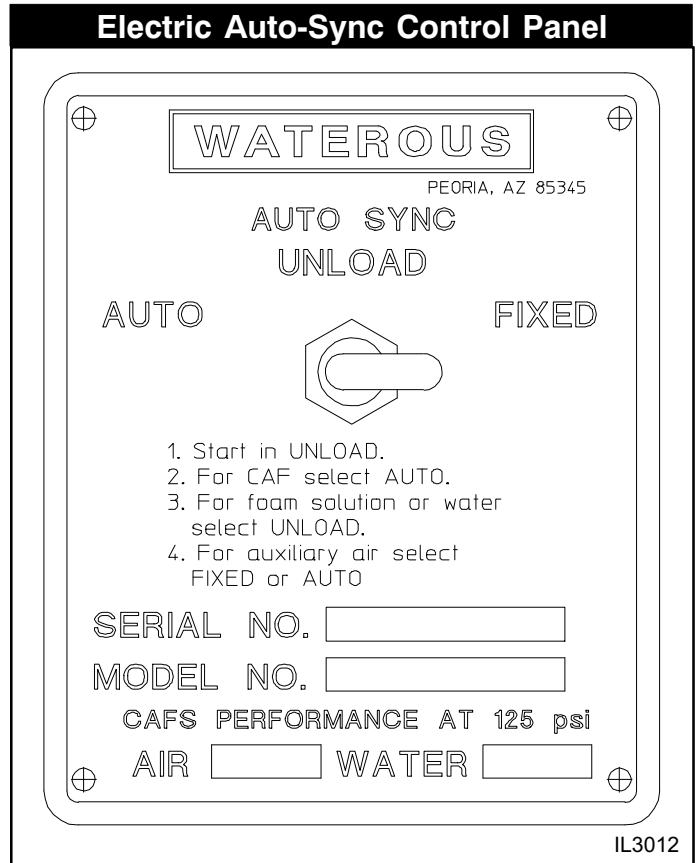
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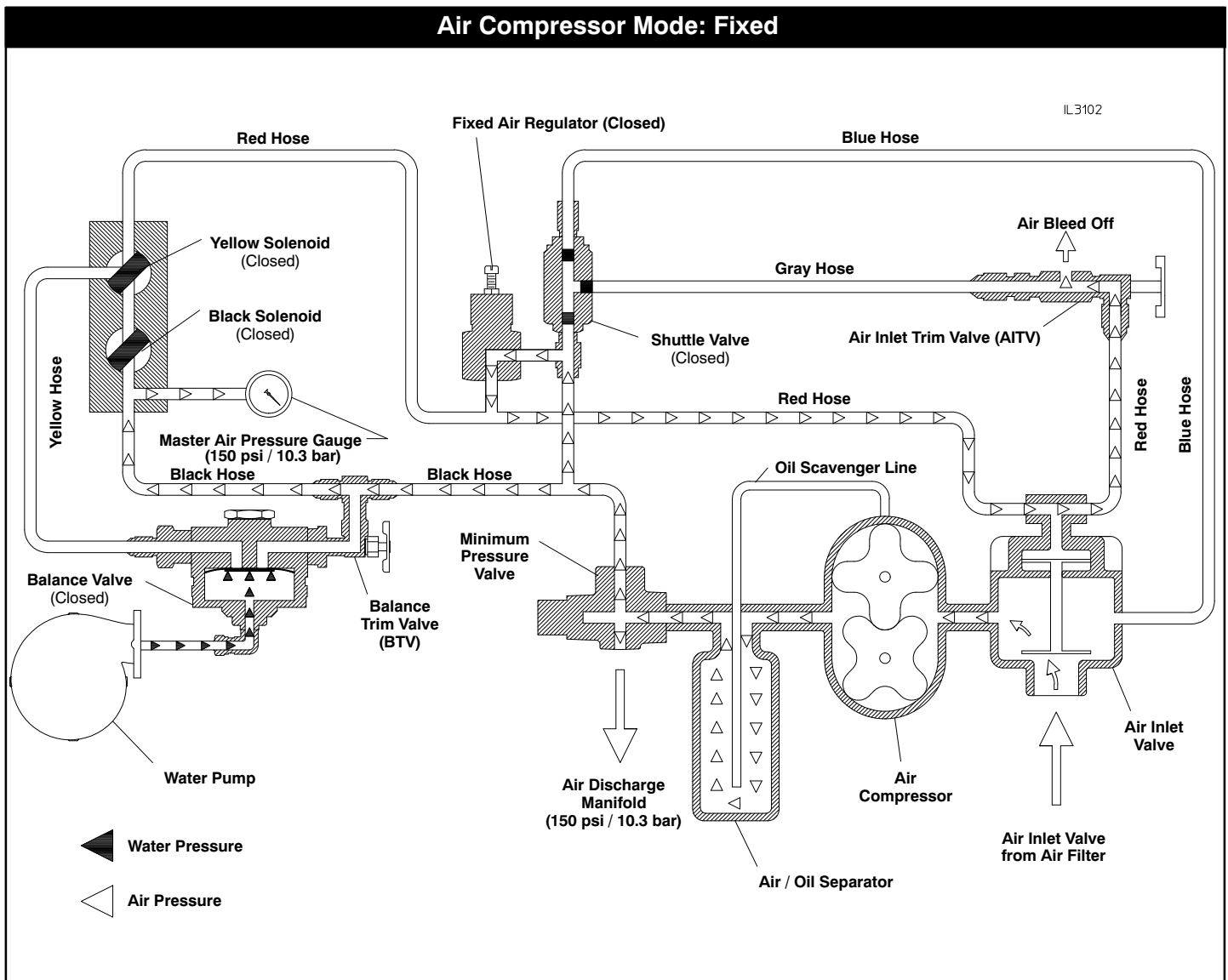
Air Compressor Pressure Mode: FIXED

Air pressure is maintained at a preset pressure setting (150 psi / 10.3 bar)

With the compressor engaged, running and the Auto-Sync control panel switched to “Fixed”, the following occurs:

- The yellow and black solenoids are energized and are CLOSED.
- The master pressure gauge registers compressor sump tank pressure.
- The shuttle valve is closed. The compressor inlet pressure is lower than the compressor discharge pressure.
- The balance valve does not directly influence the air circuit operation.
- The fixed air regulator controls the air circuit and air inlet valve (see Fixed Air Regulator Valve Function).
- If the compressor discharge air pressure is above the fixed air regulator set point (150 psi / 10.3 bar), then the fixed air regulator opens allowing the control air pressure to close the air inlet valve (see Air Inlet Valve Function). This will lower the control air pressure below 150 psi (10.3 bar). When the discharge air pressure is below the set point (150 psi / 10.3 bar), then the fixed air regulator closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 150 psi (10.3 bar).
- The fixed air regulator opens and closes as the air discharge pressure changes to maintain set pressure.

NOTE: Control air is always being released and pressure relieved through the air inlet trim valve (AITV) and out the air bleed outlet. This air release is controlled (limited) by the AITV.



Air Compressor Pressure Mode: AUTO

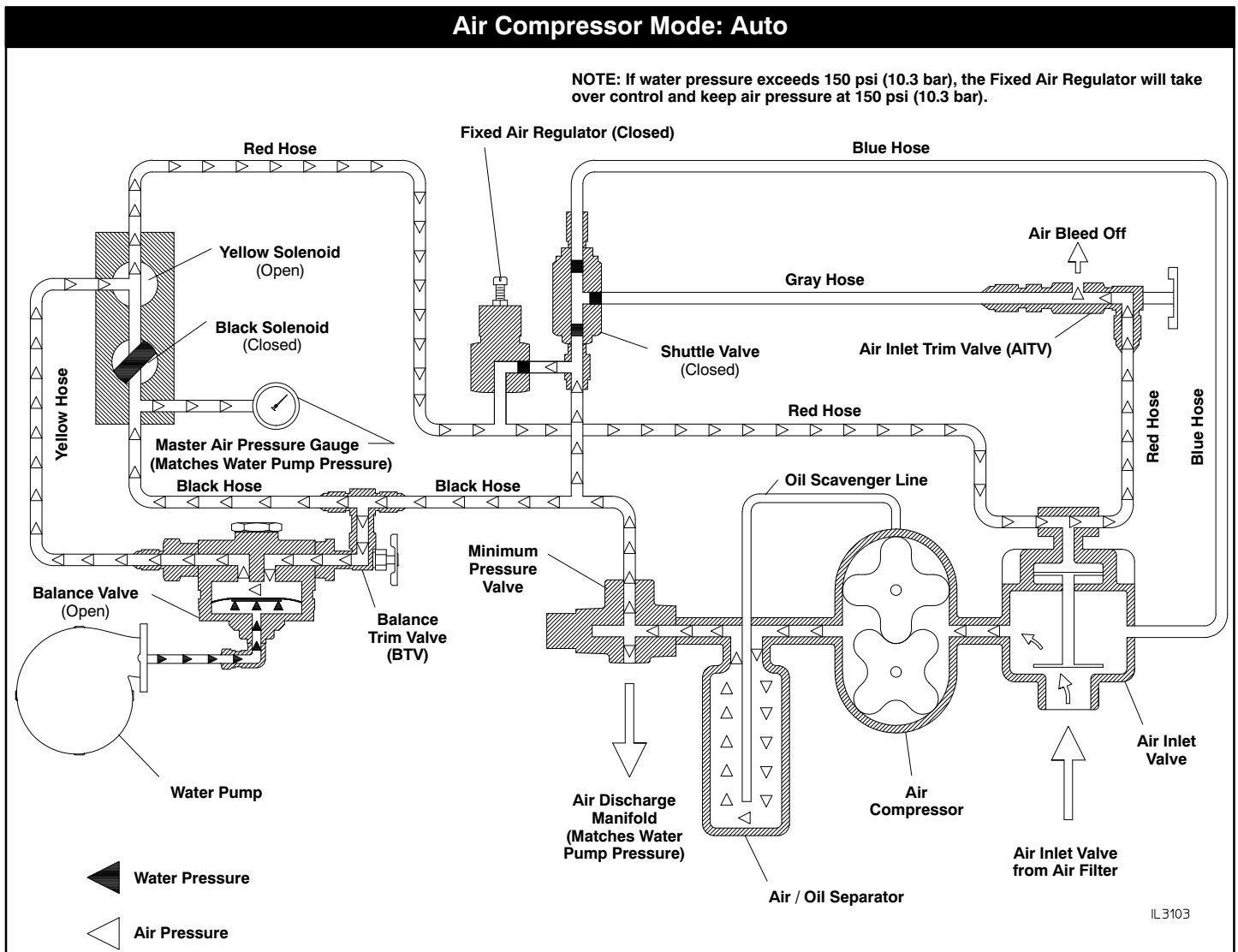
Air pressure matches water discharge pressure.

With the compressor engaged, running and the Auto-Sync control panel switched to "AUTO", the following occurs:

- The black solenoid is energized and is CLOSED and the yellow solenoid is OPEN.
- The master pressure gauge registers compressor sump tank pressure.
- The shuttle valve is closed. The compressor inlet pressure is lower than the compressor discharge pressure.
- The fixed air regulator is not the primary control device. It functions as a governor (or maximum pressure setting) in the "AUTO" mode.
- The balance valve is the primary control air regulating device in the "AUTO" mode (see Balance Trim Valve Function).
- If the compressor discharge air pressure is above water pressure (for example: 100 psi / 8.6 bar) (see Air Inlet Valve Function), then the balance valve opens allowing the control air pressure to close the air inlet valve and lowering control air pressure below 100 psi (8.6 bar). When the discharge air pressure is below the water pressure (100 psi / 8.6 bar), the balance valve closes. The control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 100 psi (8.6 bar).
- The balance valve opens and closes as needed as the air or water discharge pressure changes so the water and air pressure remain the same.

NOTE: Control air is always being released and pressure relieved through the air inlet trim valve (AITV) and out the air bleed outlet. This air release is controlled (limited) by the AITV.

NOTE: The balance trim valve (BTV) is used to calibrate the control air circuit in the "AUTO" mode. Refer to the Electric Auto-Sync calibration procedure.



Air Compressor Shutdown

When the air compressor is shutdown or disengaged, the following occurs:

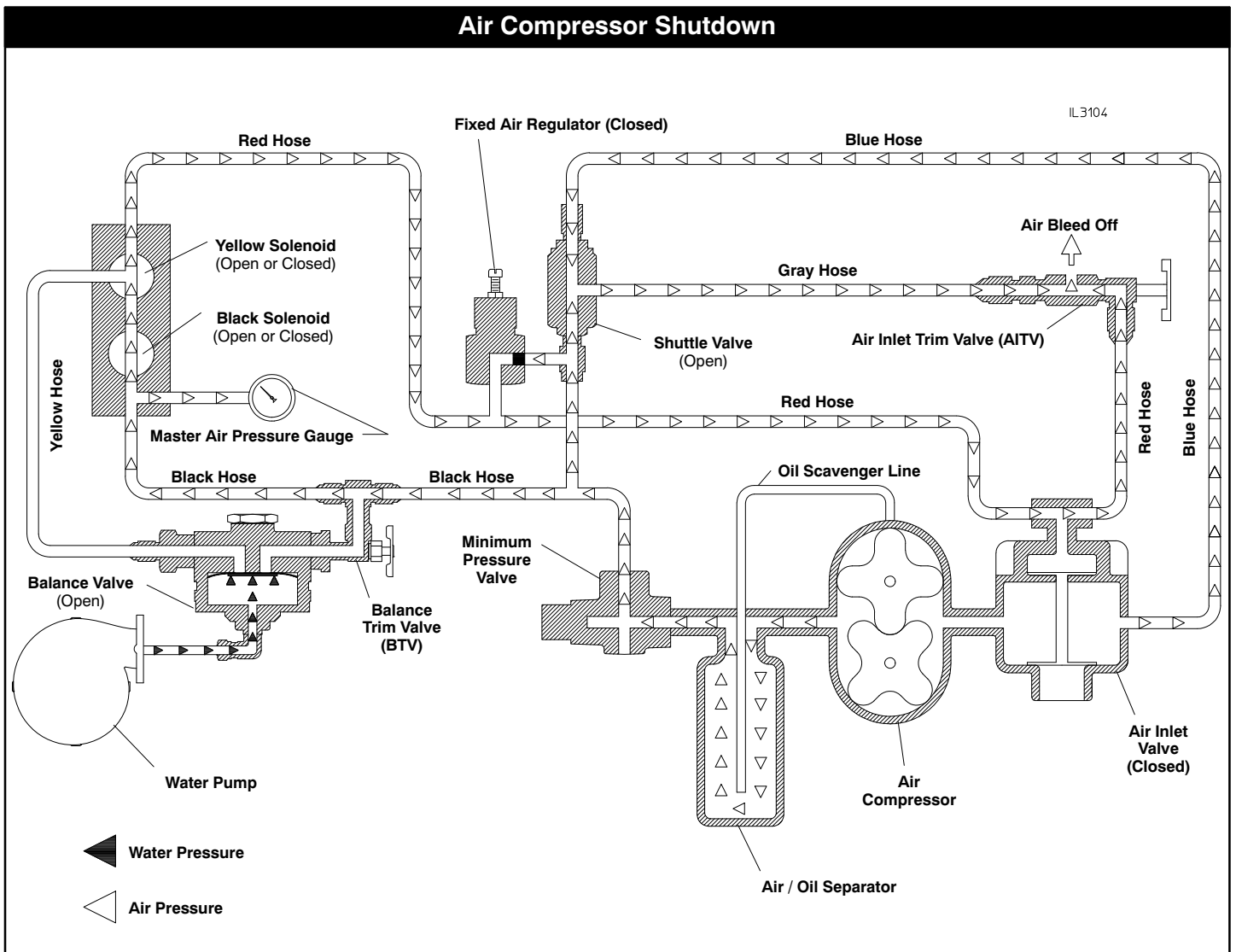
- The master pressure gauge registers compressor sump tank pressure.
- The compressor rotors stop turning and the compressor outlet and inlet pressures equalize.
- The shuttle valve sees equal pressure on the shuttle piston. Since the inlet pressure side is larger than the discharge pressure side, the shuttle valve opens (see Shuttle Valve Function).
- With the shuttle valve open, air from the compressor discharge side is allowed to exhaust through the gray air bleed outlet port. This slowly relieves all air pressure from the compressor and the sump tank.
- In shutdown, the fixed air regulator and balance valve do not control the air circuit or have any influence. They are basically bypassed.
- The auto-sync solenoids are also bypassed and it doesn't matter whether they are opened or closed. They have no influence on shutdown.

⚠ WARNING

Pressure Hazard.

May cause serious personal injury.

In shutdown, the control air circuit only relieves air stored in the compressor and sump tank. Air downstream of the minimum pressure valve is not released through the control air circuit. Pressurized air may be trapped in discharge piping and hoses.



Air Inlet Valve Function

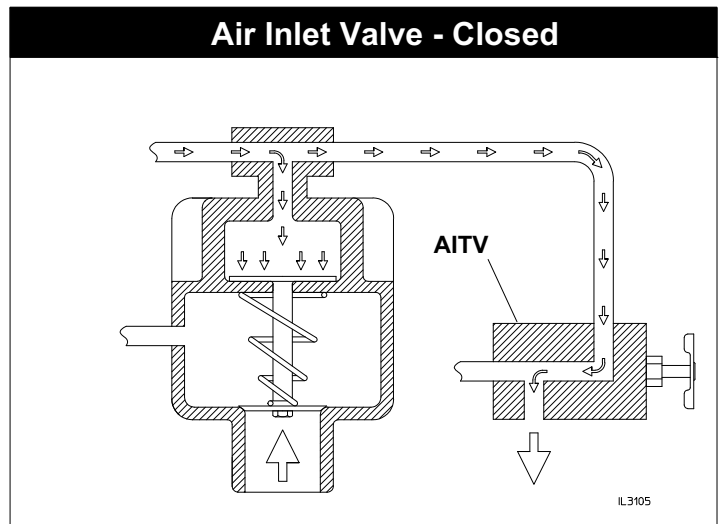
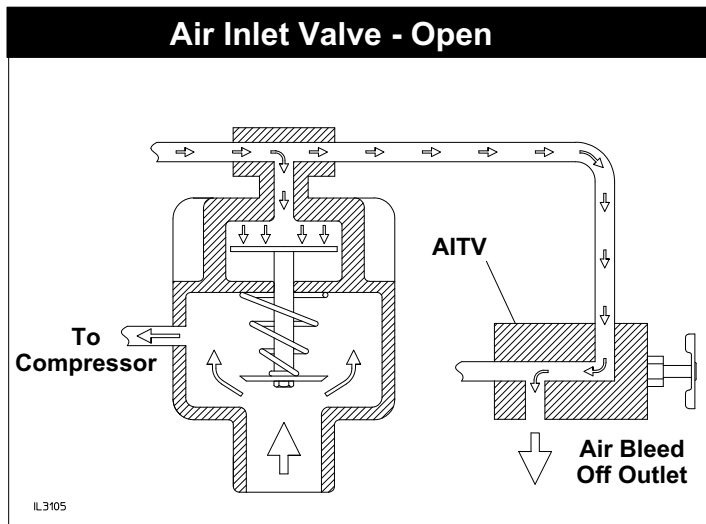
The air inlet valve is part of the control air circuit and controls the incoming air to the compressor by opening and closing. The air inlet valve operates (or follows) based on the air signal it received from the fixed regulator, the balance valve or minimum pressure valve.

The figures below show the air inlet valve in an open and closed position. Let's see how and why the valve open and closes.

When the compressor is running, there is negative air pressure behind the main valve disk, and if only a small air control pressure is on the valve's control disk, the air inlet valve opens. As long as the control air pressure is low, inlet valve remains open. With the air inlet valve open, the compressor will pull in more air resulting in more pressure and/or flow at the compressor discharge.

To stop the compressor pressure increase or restrict the compressor air flow, the air inlet valve needs to close. The air inlet valve will close when the control air pressure at the valve's control disk is high enough to overcome the inlet pressure on the main valve disk. With the air inlet valve closed, no more air can be pulled into the compressor. The discharge pressure of the compressor stabilizes and air flow stops.

In operation, the air inlet valve is constantly opening and closing (or modulating) to maintain the desired pressure called for by the control air mechanism (fixed air regulator, piloted balance valve, or minimum pressure valve). It should also be noted the air inlet valve has an air inlet trim valve (AITV) with an air bleed off outlet. This provides a means to bleed off control air continuously and at a controlled rate. The AITV is used to calibrate the air control system.



Fixed Air Regulator Function

The fixed air regulator has two primary functions in the control air circuit:

1. When the Auto-Sync is in the **“Fixed”** mode, the fixed air regulator controls the air circuit's regulation.
2. When the Auto-Sync is in the **“Auto”** mode, the fixed air regulator acts as a governor or maximum pressure limiter for the air circuit

How does the fixed air regulator work?

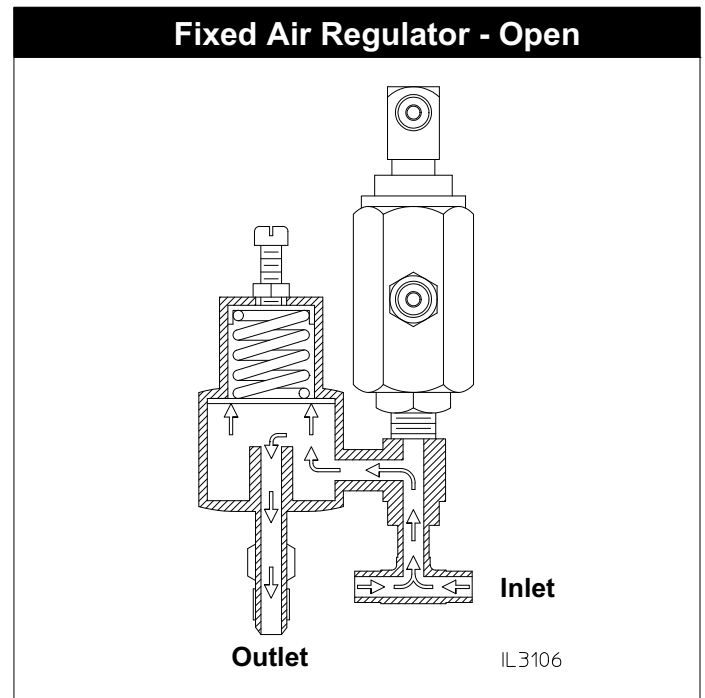
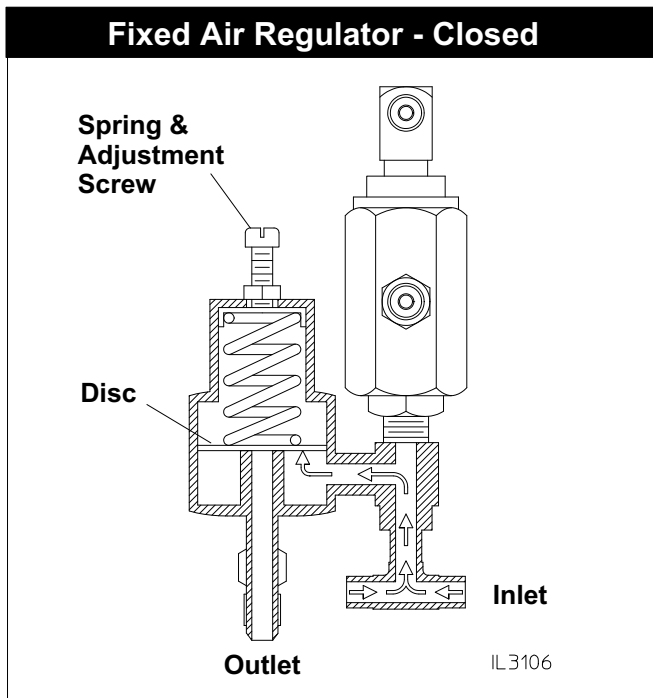
The fixed air regulator has 5 elements that work together to provide regulation: inlet, outlet, disk, spring and adjustment screw. Air enters the regulator through the inlet and applies pressure to the disk. On the backside of the disk are the spring and tension adjustment screw (the screw is used to give the spring more or less tension). The spring applies pressure to the disk and opposes the air pressure. As long as the spring tension is greater than the air pressure on the disk, the regulator stays closed and no air passes through (see Fixed Air Regulator - Closed). When the air pressure rises and becomes great enough to overcome the spring, the disk moves allowing air to pass on through the outlet (see Fixed Air Regulator - Open). Depending on how the adjustment screw is set, the spring will apply a force on the disk in which the air pressure will try to overcome and if the air pressure is high enough, air passes on through.

How does the fixed air regulator operate in the air control circuit when in the “FIXED” or “AUTO” modes?

Fixed Mode: The regulator basically operates as described above. If the compressor discharge pressure is above the fixed air regulator set point (150 psi / 10.3 bar), then the fixed air regulator opens allowing the control air pressure to close the air inlet valve. This will lower the control air pressure below 150 psi (10.3 bar). When discharge air pressure is below the set point (150 psi / 10.3 bar), then the fixed air regulator closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 150 psi (10.3 bar).

The fixed air regulator opens or closes as the discharge air pressure changes to maintain the desired fixed air pressure.

Auto Mode: The fixed air regulator functions as a governor (or maximum pressure limiter). The fixed air regulator is basically in parallel with the piloted balance valve. Although the piloted balance valve is the primary regulator in this operating mode, the fixed air regulator is in the background monitoring the discharge air pressure. If that discharge air pressure exceeds the fixed air regulator set point (150 psi / 10.3 bar), the fixed air regulator will open allowing control air to pass onto to the air inlet valve (and closing it). This insures the compressor cannot run at pressures high than that set by the fixed air regulator.



Balance Valve Function

The balance valve's primary function is regulation of the air circuit when operating the Auto-Sync in the "AUTO" mode.

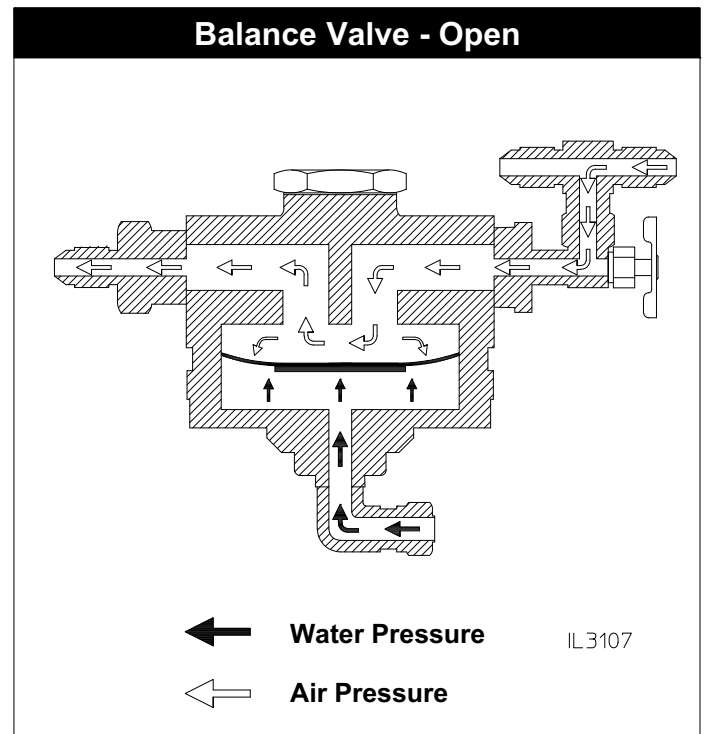
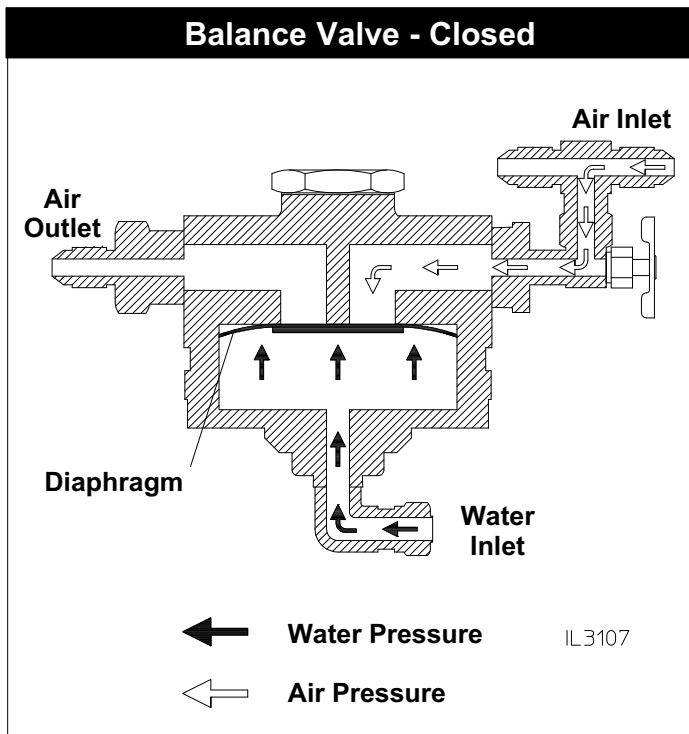
The balance valve has 5 elements that work together to provide regulation: air inlet, air outlet, diaphragm, water inlet and piloted balance trim valve (BTV) (see Balance Valve Elements)

Air enters the balance valve through the BTV and into the inlet. This applies pressure to the diaphragm. On the other side of the diaphragm is water pressure from the pump discharge. The air pressure and water pressure opposes each other against the diaphragm. As long as the water pressure is greater than the air pressure on the diaphragm, the balance valve stays closed and no air passes through. When the air pressure rises and becomes great enough to overcome the water pressure, the diaphragm moves allowing air to pass on through the outlet (see Balance Valve Open). The balance valve can be calibrated (or biased) via the BTV. See control air control circuit calibration in the maintenance manual.

How does the balance valve operate in the "AUTO" mode?

The balance valve basically operates as previously described. If the compressor discharge pressure is above water pressure (100 psi / 8.6 bar), then the piloted balance valve opens allowing the control air pressure to close the air inlet valve and lowering control air pressure below 100 psi (8.6 bar). When the discharge air pressure is below the water pressure (again 100 psi) / 8.6 bar, the piloted balance valve closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 100 psi (8.6 bar).

The balance valve opens and closes as needed so the discharge air pressure matches the pump discharge water pressure.



Shuttle Valve Function

The shuttle valve is part of the control air circuit and really only comes into play during a compressor shutdown. Its primary function is to provide a means (pathway) of relieving compressor air (pressure) and not allowing compressor oil to escape at the same time

Using the two figures below, let's go through how the shuttle valve works.

The figure on the left shows the shuttle valve in a closed position. This occurs when the compressor inlet air pressure (CIAP) is less than the compressor discharge air pressure (CDAP).

When the compressor is running, the CIAP is always 14.5 psia or less and the CDAP is 40 psig or greater (minimum pressure valve setting), allowing the shuttle valve to stay closed.

The figure on the right shows the shuttle valve in an open position. This occurs when the CIAP is equal or greater than the CDAP pressure (note the slightly larger piston surface on the CIAP side than the CDAP).

When the compressor shuts down and the rotors stop turning, the CIAP and CDAP equalize allowing the shuttle valve to open. With the shuttle valve open, air stored in the compressor/sump tank is allowed to escape from the air discharge through the shuttle valve and onto the air bleed off outlet where it is exhausted.

