Boeing C-17 Transport
Eaton is a recognized leader in the aerospace industry and is a key supplier of hydraulics, fuel, conveyance and actuation products on the C-17. With this cutting edge technology, Eaton provides a broad array of products including a 4000 psi quad-redundant hydraulic system.

Two of four systems are connected using a reversible motorpump, in case of emergency shutdown of any engine. All four systems incorporate a primary and secondary engine-driven pump, part of Eaton’s Vickers® product line, ensuring a constant supply of hydraulic power during all phases of flight. Under emergency conditions, hydraulic power is generated by a ram air turbine (RAT) pump, which is deployed automatically and drives an Eaton pump.

The C-17’s unique capability to land on short runways is assisted by Eaton’s pitch trim motors. The pitch trim motors position the horizontal stabilizer during the short landings and takeoffs for optimal performance.

The C-17 hydraulic system incorporates main engine and AC motor-driven pumps as well as pitch trim and OBIGGS drive motors. Eaton also provides additional system hydraulic and pneumatic units. These include servo control valves, a brake pressure metering valve, winch modules and a cargo Air Delivery System (ADS) control manifold. Electrical equipment provided by Eaton includes the Auxiliary Power Unit (APU) air inlet actuator, ramp lock, logistic rail locks and RAT release actuator.

The C-17 is also equipped with Eaton fluid health monitoring technology. The magnetic chip collectors, electro-optic and float activated sensors and system check valves are on all secondary power systems. These products are primarily used to monitor harmful materials in the flow of hydraulic and lube fluids during the run time of the aircraft.

Other products on the C-17 include Eaton’s Aeroquip® product line of quick disconnect couplings and self sealing “B” nut fittings and hose products, including high pressure Kevlar® hoses. In addition, Eaton provides the pylon-mounted main fuel line for each engine, incorporating two quick disconnects into a convoluted hose joined with a complex bent tube.

Eaton also provides fuel boost pumps and canisters which were specifically designed for the C-17. They were designed and manufactured to provide excellent pumping performance at high climb rates and altitudes with many different types of fuel. To enhance fire safety, Eaton also provides the aircraft mounted valves that control the flow of nitrogen gas from the OBIGGS system to the fuel tanks.

The United States Air Force Boeing C-17 Globemaster III is a high-wing, four-engine, T-tailed aircraft with a rear-loading ramp. It is 174 feet in length, has a height of 55.08 feet and a wingspan of 169.75 feet. Maximum takeoff gross weight is 585,000 lbs; maximum payload is 164,900 lbs.

It was designed to expand the capability of the Air Mobility Command (AMC) by enabling the long distance transport of troops and heavy combat equipment directly to small austere landing sites. The austere landing site capability of the aircraft is further enhanced by having all systems fully independent of ground support equipment.

The Boeing C-17 also embodies Short Takeoff and Landing (STOL) technology. The unique ability to land cargo on very short airstrips and then take off again is achieved through the utilization of propulsive lift aerodynamics and advanced composite structures for lighter weight.

The aircraft is powered by four Pratt & Whitney PW2040 series (Boeing 757 Derivative) turbofan engines, designated by the Air Force as F117 PW-100, each producing 40,440 lbs of thrust, located on pylons ahead of and below the wing leading edge. Engine thrust is blown through the fully extended flaps to create additional lift. This feature is useful in short takeoff and landings, and in low speed maneuvers. The engines are also equipped with directed-flow thrust reversers capable of deployment in flight. On the ground, a fully loaded aircraft using engine thrust reversers, can back up a 2% slope.
Eaton's Boeing C-17 Systems Components

### Engine Solutions
1. Magnetic Chip Collectors
2. Differential Pressure Switch
3. Hydraulic Pressure Switch
4. Mainshaft Carbon Seals
5. Gear Box Seals

### Fuel & Inerting Systems
6. OBIGGS LP Valve
7. OBIGGS Compressor Motor
8. OBIGGS II Super Joint Assembly
9. OBIGGS HP Valve
10. Fuel Boost Pump
11. Fuel Crossfeed Gate Valve
12. Float Activated Level Sensors
13. Main Fuel Line
14. Low Flow Shutoff Valve
15. Breathers

### Hydraulic Systems
16. Engine-Driven Pumps
17. Dual Brake Metering Valves
18. AC Motorpump
19. Fluid Conveyance Line Assembly
20. RAT Pump
21. RAT Release Actuator
22. Steering & Bypass Control Valves

### Motion Control
23. Pitch Trim Motors
24. Variable Restraint Assembly
25. Gate Release Assembly
26. Ramp Lock Actuator
27. Winch Control Module
28. Cargo Rail Actuator
29. Cable Tension Arm Assembly
30. Flap/Slat Position Transmitter
31. APU Air Inlet Actuator
32. Aft/Flap Slat Module
33. Ratio Changer Actuator - Aileron
34. Rudder Cable Control Assembly
35. Aileron Load Feel Assembly
36. Rudder Load Feel Assembly
37. Trim Actuator Control, Elevator Load Feel Assembly
38. Control Stick Rudder Pedal Assembly, Park Brake Mechanism

### Other
39. Cargo Air Delivery Manifold
40. Stabilization Strut System
41. Levelmaster®

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8. OBIGGS II Super Joint Assembly
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**Hydraulic Systems**
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17. Dual Brake Metering Valves
18. AC Motorpump
19. Fluid Conveyance Line Assembly
20. RAT Pump
21. RAT Release Actuator
22. Steering & Bypass Control Valves

**Motion Control**
23. Pitch Trim Motors
24. Variable Restraint Assembly
25. Gate Release Assembly
26. Ramp Lock Actuator
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28. Cargo Rail Actuator
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37. Trim Actuator Control, Elevator Load Feel Assembly
38. Control Stick Rudder Pedal Assembly, Park Brake Mechanism

**Other**
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40. Stabilization Strut System
41. Levelmaster®

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**Hydraulic Systems**
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**Other**
39. Cargo Air Delivery Manifold
40. Stabilization Strut System
41. Levelmaster®
145/155 Series Soft Seal Ground Support Couplings

Eaton’s 145/155 series couplings have been the industry standard for ground service applications for over 50 years. During this time the design has been continuously improved to increase reliability, safety and ease of operation. Improvements have been made to include elastomeric soft seals in both the aircraft half and ground cart half to virtually eliminate fluid spillage and air inclusion during operation, and blunt start threads to prevent cross threading.

Main Fuel Line

Eaton’s main fuel line provides fuel from the engine pylon to the engine fuel pumps on each C-17 engine. The product features 2-in diameter convoluted Teflon® hoses, covered with slip-on silicon fire protection sleeves, and integrally mated with two quick disconnect coupling halves and a complex bent tube. The convoluted hose combines the routing flexibility of lightweight rubber hose with the temperature range and fluid compatibility of Teflon. The assembly can be disconnected from the pylon with no fuel spillage.

Flexible Hose Assemblies

Eaton’s hose assemblies are utilized extensively throughout the C-17 aircraft. The assemblies can be found in the hydraulic system, the oxygen system, the fuel system and lube oil system. Eaton provides lightweight Nomex braided, convoluted hose assemblies to AS1227. Kevlar reinforced Teflon® hoses to AS4623 are used in the 4,000-psi (27579 kPa) hydraulic system offering a significant weight savings over more traditional wire reinforced hose assemblies.

Low Profile, Self-Sealing Hydraulic “B” Nut Fittings

Eaton’s low profile, self-sealing hydraulic “B” nut fittings, offer a small envelope size with minimal weight. The “B” nut design is for both 4,000 psi high pressure and low pressure hydraulic systems used on the Boeing C-17.

OBIGGS II Flex-Coupling Assembly

Eaton provides its flex-coupling assembly that supports the second generation on-board inert gas generator system that replaces gas bottles used in older generation aircraft and replaces a first generation OBIGGS system.

Mainshaft Seals

Mainshaft seals are used along the aircraft engine main shaft, sealing in lubrication of the main bearings.

Gearbox Seals

Gearbox seals are installed in the engine gearbox that contains bearing lubrication which the accessories receive their power. This includes accessories that power the ancillary functions around the engine including the starter, fuel controls, fuel pumps, hydraulic pumps, and more.

Breather (supplied to Hamilton Sundstrand)

Eaton’s breather provides pressure equalization and air filtration for the lubrication circuit for the OBIGGS compressor. The filter element is made of corrosion resistant mono filament material.

Float-Activated Level Sensor

The 2E6139 float-activated liquid level sensor is located in the C-17 integrated drive generator. The sensor, weighing approximately 30 grams, provides feedback upon sensing an insufficient fluid level in the IDG.

Magnetic Chip Collectors

The C-17 engine oil system incorporates Eaton’s magnetic chip collectors for the capture of ferrous engine wear debris. These collectors have a self-closing valve which will prevent oil leaks up to 300 psig (20.69 bar), and rare earth magnets for effective debris capture over long periods of time.

System Check Valve

The C-17 integrated drive generator (IDG) contains an Eaton 2C6107 system check valve. This valve has a 10 micron sintered disc for filtering capability, and a flow restrictor that controls airflow through the valve.
Pitch Trim Actuator Motor
The C-17 pitch control is maintained by a rotary actuator located in the aircraft empennage. The pitch trim actuator motor provides positional control of the horizontal stabilizer. Two Eaton bi-directional inline hydraulic motors, with a displacement of .22 cu in/rev (3.60 ml/rev), produce a theoretical torque of 137 in-lbs at 2250 and 2550 rpm, over the power range required by the compressor output flow. Motor displacement is .598 cu in/rev (9.80 ml/rev). The weight of the OBIGGS drive motor and controls is 14.6 lbs (6.62 kg).

OBIGGS Compressor Drive Motor
The OBIGGS compressor is driven by Eaton’s inline, constant speed hydraulic motor which features integral speed control and an electrically operated shut-off valve. When 28 VDC is applied to the solenoid, the motor will rotate, creating a constant speed between 2250 and 2550 rpm, over the power range required by the compressor output flow. Motor displacement is .598 cu in/rev (9.80 ml/rev). The weight of the OBIGGS drive motor and controls is 14.6 lbs (6.62 kg).

Engine-Driven Hydraulic Pump
The unique design and construction of Eaton’s 4000 psi (27,579 kPa) pumps allow them to operate at relatively high efficiencies, thus enabling each unit to generate nearly 80 hydraulic horsepower. Additional features of the pumps include an electrical depressurization valve (EDV), a blocking valve, and an inlet boost impeller. The package also weighs less than 28 lbs dry (12.25 kg).

AC Motor-Driven Pump
Eaton provides four .42 cu in/rev (6.88 ml/rev) displacement AC motor-driven pumps per aircraft.

The AC motor-driven provide flow to each of the four aircraft hydraulic systems. This allows the aircraft to be fully checked out before flight without the need of a ground cart. The AC motor-driven is also used to power the on-board cargo loading system, and to stabilize the aircraft during loading. The variable displacement motor-driven produces up to 10 gpm (3787 L/min) at 6000 rpm. The 3-phase, 200/115 volt, 400 Hz electric motor is a dry rotor oil jacket cooled design with integral thermal annunciation. Dry weight of this complete assembly is 42.5 lbs (19.28 kg).

Cargo/Air Delivery System (ADS) Control Manifold
The cargo/ADS control manifold is designed for air drop operations and on/off loading on the ground. The cargo/ADS control manifold contains all valving necessary to control the cylinders in the aerial delivery system including the cargo ramp, ramp latches, ramp toes, and cargo door actuators. It also controls the cargo door up and down locks, the left and right drogue parachute and the deploy mechanisms, and the tow/release and drogue chute jettison mechanism. The manifold can be operated electrically from the forward loadmaster station, or manually from the rear station.

Winch Control Module
Eaton’s control module provides control of fluid flow to the hydraulic motor operated winch when commanded by the loadmaster. The module regulates hydraulic flow in response to an electrical input command from the winch control panel. The winch control module consists of a servo valve, relief valve across the motor ports, anti-cavitation make up check valve and two inlet pressure blocking valves. One is used for the winch brake release and the other is for control of the hydraulic motor dual speed feature.

Dual Brake Pressure Metering Valve Assembly
These valve assemblies are installed in the landing gear wheel well and are controlled by the pilot through a mechanical closed loop cable system. The assembly controls the hydraulic actuation pressures to the brakes as a function of input position from the rudder pedals. Included in the assembly are two force command metering valves for modulating brake pressure and a despin actuator to stop the wheels from spinning upon landing gear retraction.
The C-17 Levelmaster® provides four discrete bits of potable water level information. The assembly consists of four electro-optic sensors positioned at customer specified levels of: full, 2/3, 1/3 and empty. As liquid covers each prism point, a light is activated in a panel mounted indicator, providing level status. A press-to-test button on the indicator will energize those lights corresponding to the sensors which are not immersed in liquid.

Hydraulic Pressure Switch
This small, lightweight, extremely reliable hydraulic pressure switch is used extensively in aerospace and is qualified for both commercial and military applications. These Eaton switches are designed to be used in any fluid that is compatible with stainless steel or aluminum. The pressure switch design incorporates a snap-action electrical microswitch which is actuated by a piston-sensing element.

Fuel Crossfeed Gate Valve
Eaton’s crossfeed gate valve is a 2-1/2 inch gate valve used to control the transfer of fuel from one tank’s boost pumps to another tank’s engine. The valve assembly consists of a tank mounted body assembly, a motor operated actuator, and an actuator support assembly. The actuator, gate body, and primary seals are interchangeable and removable without draining the tank. The weight of the complete valve assembly is 4.4 lbs (2.0 kg).

High and Low Pressure Regulating Valves
Eaton’s aircraft mounted pressure valves control the flow of nitrogen gas from the Onboard Inert Gas Generation System (OBIGGS) to the fuel tanks to enhance fire safety. Pressure regulation reduces the elevated pressure of the stored gas down to the near-atmospheric levels required for the fuel tanks. Each system comprises one High Pressure Regulating Valve (HPRV) and two Low Pressure Regulating Valves (LPRV), each incorporating shut-off valves.

Rudder Ratio Changer and Door Lock Actuator
Eaton’s rudder travel actuator imparts controlled linear motion to change the rudder input to output ratio of the control mechanism. This feature is engaged when part or full manual reversion control of the aircraft surfaces is required. In this mode, the mechanical inputs to the aileron and elevator control valves are changed depending on the authority required. The actuator consists of reduction gears, a screw jack, and attached fittings that are driven by an integral 28 Vdc electric motor. The actuator is capable of having its direction reversed at any intermediate position. Stroke reversal is accomplished by reversing DC voltage polarity to the motor by means of external switching. This function removes power from the motor at each end of the stroke.

Aileron & Rudder Trim Actuator
Eaton’s actuator provides a linear output force which operates the slat hydraulic control valve and trims the aileron and rudder control systems on the C-17.

The actuator is powered by two redundant DC motors. Four linear variable differential transformers (LVDT) are mounted integrally with the actuator housing and provides position feedback to the four flight control computers. A direct gear drive permits individual or simultaneous motor operation. Each motor is locked in position by a spring loaded brake. The brake holds the actuator in place and prevents backdriving of the other motor during single motor operation. Mechanical stops limits both extend and retract travel.

Rotary Actuator
Eaton’s rotary actuator operates a reversible DC motor with an electrical brake. The brake is disengaged when electric power is applied to the motor, and engaged when power is off, preventing the output shaft from being back driven.

Rotation of the output shaft is controlled by applying voltage to the CW or CCW fields. Internal limit switches open at the end of the stroke to limit rotation of the output shaft. Internal mechanical stops limit the travel in the event of an overrun of the electrical limit switches.

Gate Release Assembly
The Eaton Gate Release Actuator is used on the C-17 aircraft to trip cargo pallet tie-downs during airborne off-loading. Operation of the actuator is electrically controlled by the aircraft loadmaster. A 28 Vdc brush-type motor, directly coupled to a ballscrew, provides the quick retraction stroke required for a clean release of the load. An internal extension spring returns the actuator to the “locked” position after electrical power is removed.
Variable Restraint Assembly

Eaton’s rotary actuators are used to adjust the release point on the variable restraint lock mechanisms on the aircraft’s aerial delivery rail.

The actuator is powered by a bi-directional 115 VAC single phase motor. The motor has an integral brake which holds the output shaft in position when power is removed. The brake is released upon re-application of power.

A film type multi-turn potentiometer is connected to the epicyclic gear train and is used to track the number of revolutions of the output shaft and displays the load setting at the sidewall control panel.

Fuel Boost Pump and Canister

Eaton’s fuel boost pump is fitted in a tank mounted canister for ease of installation and to avoid draining the tank when removing the pump.

It is specifically designed and manufactured to provide excellent pumping performance at high climb rates and altitudes with many different types of fuel. This pump has the ability to provide vapor free fuel, even at near boiling conditions, with hot volatile fuels.

Ramp Lock Actuator

Eaton’s ramp lock actuator provides control of the cargo ramp lock on the aircraft. A helical spring on the actuator helps to overcome flight loads and extends the actuator to release the ramp lock.

The actuator is operated by a 28 Vdc motor driving through a two-stage spur gear drive train into a multiplate slip clutch and a ball screw assembly. Motor direction is controlled by electro-mechanical relays that are energized and de-energized by the aerial delivery system controller. Actuator control feedback is provided by external position sensors. The multiplate slip clutch allows the actuator to be overridden in the event that power is lost to the actuator.

Cargo Rail Actuator

Eaton’s cargo rail actuator is used to perform the lock/arm/release function for the cargo pallets constrained by cargo bay logistics and aerial delivery rails on the C-17 aircraft. The actuator is operated by a 115 Vdc, 400 Hz, three-phase motor that drives a reduction gear to a ball screw and output rod. The input gear for the ball screw is located between two pairs of Belleville spring washers, which absorb the peaks of shock loads when the output contacts the mechanical stops. The actuator is available with or without a brake on the motor. The manual brake override allows the actuator to be back driven when power is removed.

RAT Deployment Actuator

Eaton’s RAT actuator is a quick, short stroke device designed to release the latch that holds the ram air turbine in stowed position, on the aircraft.

The actuator is operated by a 28 VDC motor splined directly to an acme screw. An acme nut, restrained from rotation by a spline interface with the housing, provides the linear action to position an output rod. An acme screw is held between two pairs of Belleville spring washers in contact with thrust bearings, which absorb peak shock loads when the output rod strikes the mechanical stops.

Stabilization Strut System

Eaton’s stabilization strut system is used to stabilize the aircraft for cargo loading and unloading and to jack up the rear of the aircraft for changing the main landing gear tires. The system consists of four different components, the stabilization strut, the door deployment actuator, the control manifold, and the isolation valve. The control manifold is used to operate the system manually or electronically, and maintains a set pressure in the stabilization strut as cargo is loaded. The door actuator is used to open the strut compartment door to deploy the strut.

Variable Restraint Assembly

Fuel Boost Pump and Canister

Ramp Lock Actuator

Cargo Rail Actuator

RAT Deployment Actuator

Stabilization Strut System