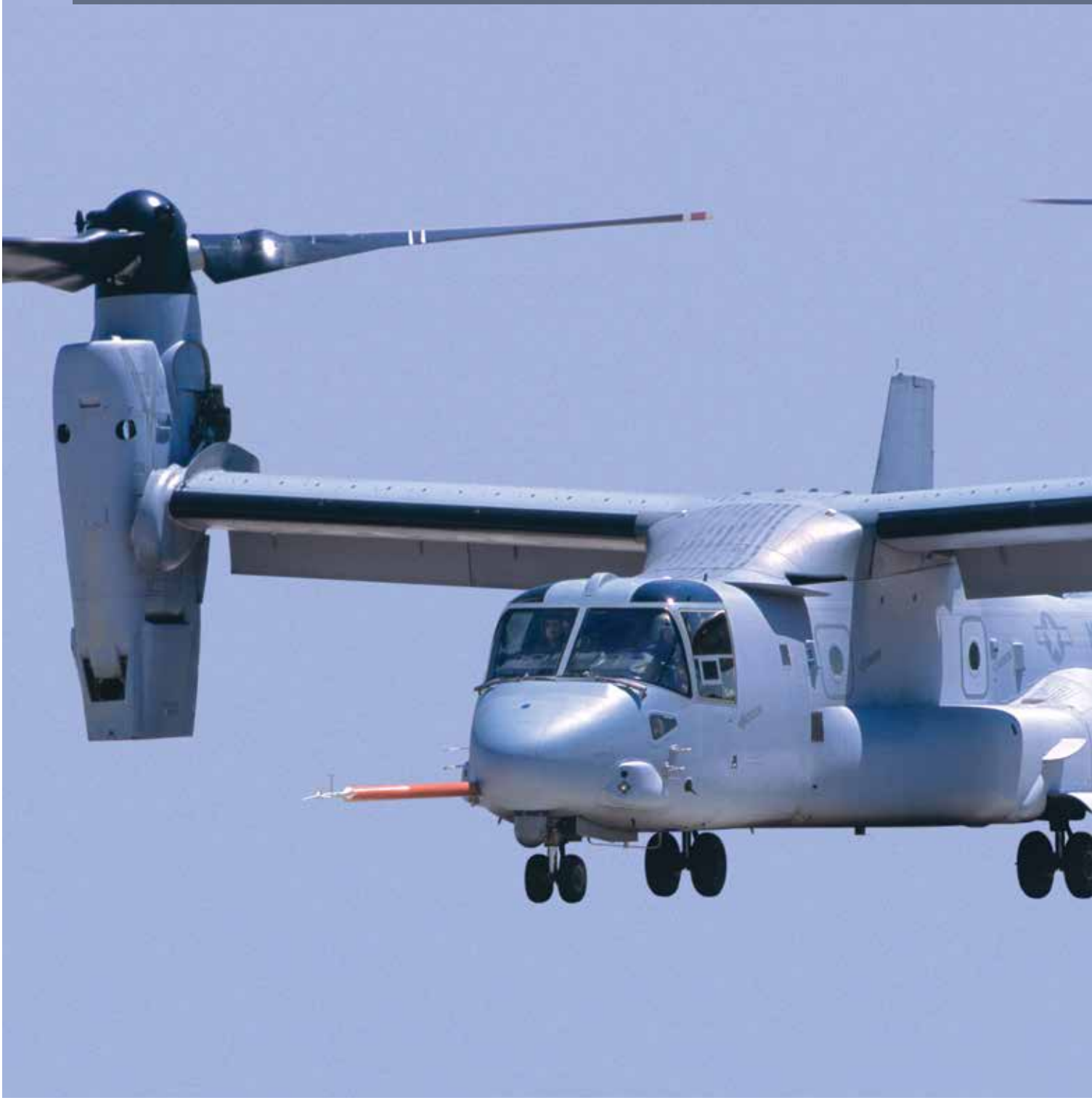
Bell/Boeing V-22 Osprey



EATON

Powering Business Worldwide

Bell/Boeing V-22 Osprey Overview
Eaton's Aerospace Group's Product Capabilities

The Bell/Boeing V-22 Osprey is the first production aircraft in the world utilizing tilt-rotor technology. The tilt-rotor allows the V-22 to takeoff and land vertically, much like a helicopter, and once airborne, transition into horizontal high-speed, high-altitude flight by tilting the wing-tip mounted engine nacelles forward 90 degrees so that the rotors function as conventional propellers.

The V-22 is the first rotocraft designed to meet the requirements of four agencies: the Marine Corps, the Air Force, the Navy, and the Special Operations Command. This highly survivable, low-maintenance combat assault aircraft will provide military services with an entirely new combat capability never before attainable. Variants of the basic design include: 1) U.S. Marine Corps MV-22B for airborne amphibious assault, 2) U.S. Navy HV-22 for search and rescue, 3) U.S. Air Force CV-22 for long-range special operations.

Other variants include a U.S. Navy anti-submarine warfare platform, a civilian commercial passenger tilt-rotor aircraft, and an AEW radar platform. The V-22 can carry 24 combat troops or up to 20,000 lbs. of cargo internally, or 1000 lbs externally, at speeds up to 275 kt. (316 mph) (twice the speed of a helicopter). The aircraft is powered by two Allison turbo-shaft engines with cross-coupled transmissions to provide power to both rotors, should one engine fail. The graphite and fiberglass rotors fold, and the wing rotates to facilitate shipboard aircraft storage. Other features include a 41% composite material airframe, 5000 psi (34,500 kPa) hydraulic system, fly-by-wire flight control systems, and digital avionics.

Eaton is a recognized leader in the aerospace industry and is a key supplier of hydraulics, fuel, conveyance and actuation products and is a key supplier on the V-22 for engine-driven pumps, inlet particle separators, primary and back-up hydraulic power drive motors (HPDU), rotor positioning actuation motors and the cargo door DC motor-pump.

Hydraulic power for flight control and utility functions is provided by three 5000 psi (34,500 kPa) variable displacement, pressure-compensated, inline piston pumps. Each unit is capable of producing 38 gpm (143 L/min.) flow at 6,000 rpm in the helicopter mode, and 33 gpm (124 L/min) flow at 5,075 rpm in the airplane mode. Each ship-set includes four Inlet Particle Separator (IPS) blowers with two mounted in each engine nacelle. The units are capable of producing airflow of 2,360 cu ft/min at 92°F (133°C) and air density of 0.063 lbs/cu ft. Unit weight is 10.0 lbs (4.54 kg).

Rotary power and motion is supplied to the pylon conversion actuator HPDU and back-up HPDU by a 5000 psi (34,500 kPa) fixed displacement, bent-axis hydraulic motor. This unit produces 4,500 in-lb torque at a rated speed of 6,700 rpm with a maximum intermittent speed of 12,000 rpm. Auxiliary hydraulic power is provided by a 3000 psi (20,700 kPa), fixed displacement, 24 VDC electric motor-driven pump. The unit converts aircraft electrical power into rotary shaft motion to drive a cantilever shaft-mounted vane pump.

Eaton also supplies modules to control fluid flow for the winch and hoist operation, the hydraulic brake master cylinder, and a parking pilot/co-pilot braking transfer module. The hydraulic fluid pressure reducer, a pressure reducer and relief valve assembly, lowers the 5000 psi (34,500 kPa) system pressure to 1860 psi (12,800 kPa) for the brake system. Eaton also provides wing stow system isolation valves and utility system isolation valves.

The winch and hoist module regulates the hydraulic flow to the winch and hoist hydraulic motors to control speed in response to an electrical input. Speed is independent of motor load. Flow is regulated on both the up and down side of the motor, thereby minimizing differential pressure while maintaining control of the motor speed. The hydraulic brake master cylinder functions as a boosted brake valve assembly when the aircraft hydraulic system is pressurized. The unit directs flow and pressure to the wheel brake cylinders. The brake pressure delivered is a function of pilot input force, which is proportional to the brake displacement. When there is no system pressure, the unit reverts to manual braking, utilizing a two-stage piston arrangement.

Eaton's park/lock valve provides isolation of fluid between the pilot and co-pilot's master cylinders and the brakes. It also has a lever and poppets so that when actuated, hydraulic pressure is locked in the brakes for parking. The unit contains maintenance-free accumulators to provide fluid for thermal compensation when the unit is in the "park" mode. Pressure switches are incorporated in both the right and left brake pressure indicators.

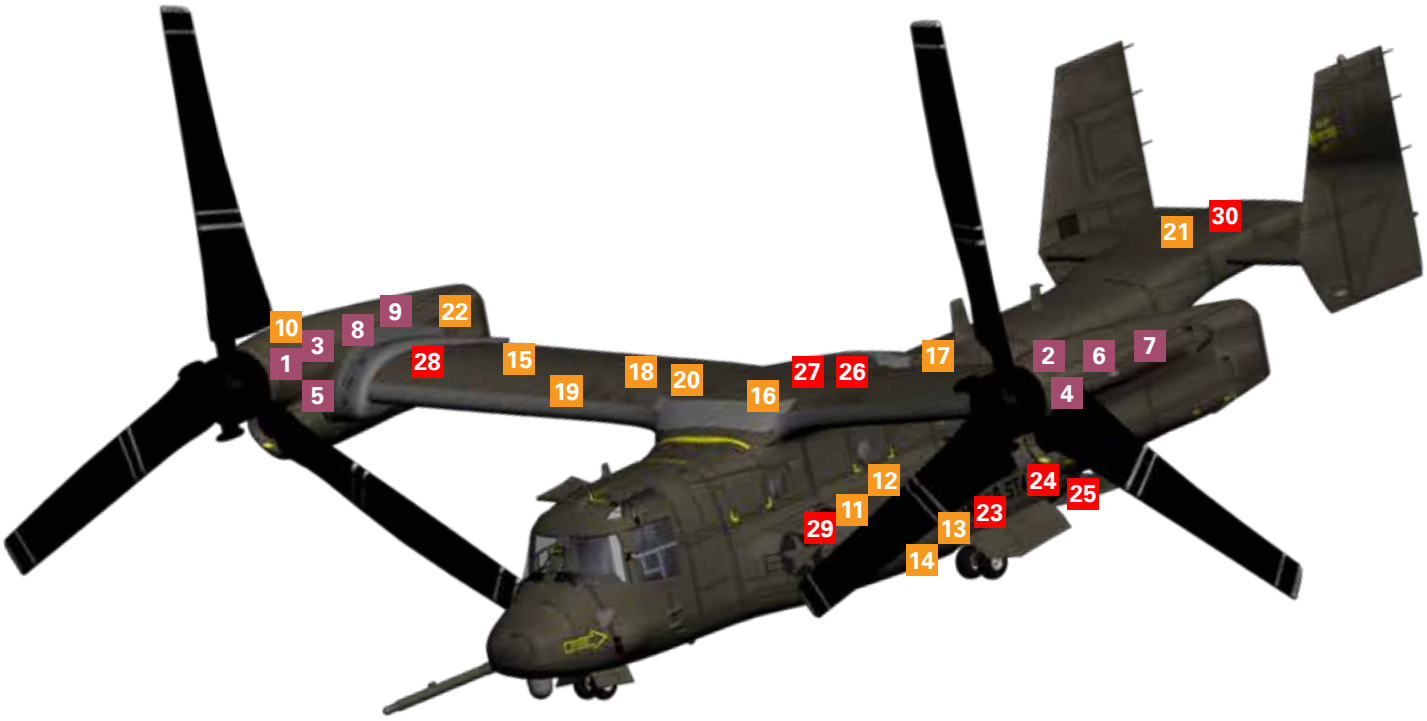
Eaton provides a wide range of additional components including inlet particle screens, sight gages, chip detectors, optical sensors, Prismalites® and Lubriclones®. Other significant parts include drain valves, check valves, float switches, drain plugs, full flow chip detectors and desiccant breathers.

Optical sensors are high-reliability, solid state switches that detect oil levels in the mid-wing, tilt-axis, and prop-rotor gearboxes. These units have no moving parts, are fully explosion-proof, and are protected from transients on the power supply line. Prismalite sight gauges make oil reservoir levels readable from above or below. A solid, dark viewing area appears when fluid covers the prism.

Eaton's Lubriclone packages are designed to monitor the critical bearings and gears in the V-22's mid-wing gearbox, prop-rotor gearbox, tilt-axis gearbox, and engines. High efficiency debris separation and concentration of all particles over 200 micrometers (and most particles between 100 and 200 micrometers) extend filter element life and enhance early failure detection capability. As an added feature, the vortex separator also removes the air from the oil, with an efficiency of 95%. The desiccant breathers remove moisture from air drawn down into the gearbox or transmission to prevent the corrosion of critical gears and bearings.

Eaton also supplies a ramp control valve, rotor brake valve, remote switching valves, and local switching isolation valves. The ramp control valve provides the means to independently operate either the ramp or the door, with either electrical commands from the cockpit or manual controls located on the valve. The rotor brake valve provides a means of preventing prop-rotor movement when the aircraft engines are shut down. The switching valves are located in the engine nacelles and provide primary hydraulic system pressure to utility hydraulic system transfer, isolation, and ground check-out functions.

Bell/Boeing V-22 Osprey Eaton Components



Engine Solutions

1. Chip Collectors
2. Chip Detector
3. Dessicant Breather
4. Inlet Particle Separator Blower
5. Prismalite
6. Lubriclones
7. Optical Sensors
8. Sight Gauge
9. Differential Pressure Gauges

Hydraulics System

10. Engine-Driven Pump
11. DC Motorpump
12. Hydraulic Fluid Pressure Reducer
13. Hydraulic Brake Master Cylinder
14. Park, Lock Transfer Module
15. Primary & Backup Hydraulic Power Drive Unit
16. Check Valve
17. Rynglok® Fittings
18. Utility System Isolation Valve
19. Local Switching Isolation Valve
20. Hose Assemblies
21. Remote Switching Valve
22. Wing Nacelle Swivels

Motion Control

23. Ball Bearing Swivels
24. Ramp Control Valve
25. Ramp Door Latch Valve
26. Wing Rotation Actuator Motor
27. Wing Stow System Isolation Valve
28. Rotor Positioning Motor
29. Winch & Hoist Module
30. Active Safety Latch V-Band Coupling

Rotor Brake Valve

The rotor brake valve has two solenoid-operated, 2-stage, 3-way, 2-position, normally closed valves, an orifice, a check valve and a relief valve. By energizing the proper solenoid with 28 VDC, hydraulic force is applied to or released from the aircraft rotor brake. The brake is applied when the aircraft engines are shut down and prevents the inadvertent rotation of the prop-rotors and their drive train components.

Active Safety Latch V-Band Coupling

The special active safety latch V-band coupling is used to secure the wing fold locking-pin assembly. The V-22 application, required a coupling that could be installed with one hand and without line of sight access during assembly. The wing fold locking pin assembly is used to secure the rotor blades during stowage of the aircraft

Check Valve

The air start check valve is used for air starting both the Auxiliary Power Units (APU) and main engines.

Hydraulic Fluid Pressure Reducer

This unit reduces system pressure from 5000 psig (34,500 kPa) to 1860 psig (12,800 kPa) for the brake system. It includes a pressure reducer and relief valve.

Winch and Hoist Module

This module regulates the hydraulic flow to the winch and hoist hydraulic motors to control speed in response to an electrical input. Speed is independent of motor load. Flow is regulated on both the up and down side of the motor thereby minimizing differential pressure while maintaining control of motor speed.

Hydraulic Brake Master Cylinder

The hydraulic brake master cylinder functions as a boosted brake valve assembly when the aircraft hydraulic system is pressurized. The unit directs flow and pressure to the wheel brake cylinders. The brake pressure delivered is a function of pilot input force, which is proportional to brake displacement. When there is no system pressure, the unit reverts to manual braking, utilizing a two-stage piston arrangement.

Wing Stow System Isolation Valve

This is a solenoid-operated, 2-stage, normally closed, 2-position, 3-way valve. When 28 Vdc is applied to the solenoid, hydraulic force is directed to the units internal spool. The spool then moves to connect upstream to downstream fluid paths. A pressure switch is incorporated for downstream pressure indication.

Park, Lock/Transfer Module

The park, lock valve provides isolation of fluid between the pilot and copilot's master cylinders and the brakes. It also has a lever and poppets so that when actuated, hydraulic pressure is locked in the brakes for parking. The unit contains maintenance-free accumulators to provide fluid for thermal compensation when the unit is in the park mode. Pressure switches are incorporated in both right and left brake pressure indicators.

Rotor Positioning Motor

Rotor positioning for aircraft storage is provided by two Eaton 5000 psi (34,500 kPa), fixed displacement, inline piston hydraulic motors. Rated speed is 5,500 rpm with a maximum intermittent speed of 15,000 rpm. Motor displacement is 0.612 cu in/rev. (1.0 ml/rev). Unit weight is 2.78 lbs (1.26 kg).

Ramp Door Latch Valve

This is a solenoid operatred 2-stage, normally open, 2-position, 3-way valve. When 28 VDC is supplied to the solenoid, hydraulic force is directed to the units internal spool. The spool moves to block the 5000 psi (34,500 kPa) and allow the latch acturators to unlatch the door.

Inlet Particle Separator (IPS) Blower

Each ship set includes four 5000 psi (34,500 kPa) IPS blowers, two mounted in each engine nacelle. Eaton's blower is capable of producing airflow of 2,360 cu ft/min at 92°F (33°C) and an air density of 0.063 lbs/cu ft. Maximum displacement is 0.0612 cu in/rev. (1.0 ml/rev) with a rated flow of 3.5 gpm (13.24 L/min) at 12,250 rpm. Unit weight is 10.0 lbs (4.54 kg).

Utility System Isolation Valve

This is a solenoid-operated, 2-stage, normally open, 2-position, 3-way valve. When 28 VDC is supplied to the solenoid, hydraulic force is directed to the units internal spool. The spool moves to block 5000 psi (34,500 kPa) and connects the utility system to the reservoir. Pressure switches are incorporated for both upstream and downstream pressure indications.

Ramp Control Valve

The ramp control valve contains two solenoid-operated, 2-stage, 3-position, 4-way valves, a solenoid operated 2-stage, 3-way valve, a pressure-reducing valve, relief valve, and pilot-operated check valve. Each of the solenoid-operated valves can also be manually operated. Using either electrical or manual control, the ramp control valve controls hydraulic flow to the actuators, which raise and lower the cargo ramp, open and close the cargo door and latch the cargo door.

Remote Switching Valve

Each remote switching valve consists of a solenoid-operated, 2-stage, 2-position, 6-way switching valve and a dual coil solenoid-operated, 2-stage, normally closed, 2-position, 3-way isolation valve. The remote switching valve performs two separate functions. As a switching valve it can transfer hydraulic power for the swashplate actuators from the primary flight control hydraulic system to the number 3 flight control/utility hydraulic system. As an isolation valve, it controls back-up hydraulic flow from the number 3 flight control/utility system to the hydraulic power drive unit, which powers the conversion actuators.

Complex Titanium Wing/ Nacelle Swivels

These swivels are designed to meet the rigorous hydraulic environment of the wing and nacelle area of the V-22. Operating at 5000 psi (34,500 kPa), these Eaton products help to deliver hydraulic fluid needed for the rotation of the engine nacelles. Manufactured from titanium material to reduce weight and envelope size, these swivels meet the exacting requirements of the V-22 program.

Wing Rotation Actuator Motor

Wing rotation power is provided by 5,000 psi (34,500 kPa) inline piston motor with 0.105 cu in/ rev (1.72 ml/rev) displacement. This motor is used in a blade fold and wing rotation sequence to prepare the aircraft for storage. The motor is installed in the mid-wing gearbox area and provides the rotary power required to drive the turret ring gear for 90 degree structure rotation. The motor weight is 2.2 lbs (1.0 kg).

Local Switching Isolation Valve

Each local switch isolation valve has two-stage, 2-position, 6-way valves, a solenoid-operated 2-stage, 2-position, 3-way valve and a spring-loaded piston type volume compensator in the isolated circuit return path. As a switching valve it transfers hydraulic power for the swashplate actuator from the primary flight control hydraulic system to the number 3 flight control/utility system. As an isolation valve it limits power from the primary hydraulic flight control system to a nacelle cutting off power to the wing/fuselage/ opposite nacelle and interconnecting the system cylinder and return ports, in the event the flight control computer detects hydraulic power system failures. In the ground checkout mode the valve transfers hydraulic power from the number 3-flight control/utility system to the primary hydraulic system.

DC Electric Motor Driven Pump

Auxiliary hydraulic power is provided by Eaton's 3000 psi (20,700 kPa), fixed displacement 28Vdc electric motor driven pump. The unit converts aircraft electrical power into rotary shaft motion to drive a cantilever shaft mounted, vane pump having a displacement of .021 cu in/rev (3.44 ml/rev.). The unit has a rated flow of 0.34 gpm (1.29 L/min) at 3,000 psi (20,700 kPa) and 0.55 gpm (2.08 L/min) at 400 psi (27,600 kPa). Unit weight is 9.8 lbs (4.45 kg).

Primary & Back-Up Hydraulic Power Drive Unit (HPDU) Motor

Rotary power and motion is supplied to the pylon conversion actuator HPDU and back-up HPDU by Eaton's 5000 psi (34,500 kPa) fixed displacement, bent-axis hydraulic motor. The unit produces 4500 in-lb. torque at a rated speed of 6700 rpm with a maximum intermittent speed of 12,000 rpm. Displacement is 0.216 cu/in/rev. (3.54 ml/rev.). Unit weight is 3.50 lbs (1.59 kg).

Engine-Driven Pump

Hydraulic power for primary flight control and utility functions is provided by three Eaton 5000 psi (34,500 kPa), variable displacement, pressure compensated inline piston pumps. Each unit is capable of delivering 38 gpm (143 L/min.) flow at 6,000 rpm in helicopter mode and 33 gpm (124 L/min) flow at 5,075 rpm in airplane mode. Other features include an eleven piston rotating group, and an integral pressure pulsation attenuator. Maximum displacement is 1.625 cu in/rev. (26.6 ml/rev). Unit weight is 22 lbs (9.97 kg).

Differential Pressure Switch

The differential pressure switch is designed for engine-mounted applications and other hostile-environment conditions.

It may be used to detect fuel or oil filter clogging or to detect low-fuel booster pump pressure and for closing a warning indicator circuit.

The switch has a high pressure port and a low pressure port. When the pressure differential between the two ports exceeds the pre-set value, the snap-action pressure element is actuated, which then operates an electrical snap-action switch. The pressure element does not move until the setpoint has been reached, thereby prolonging life and maintaining repeatability and accuracy. This design approach eliminates contact chatter during vibration.

Optical Sensors

These high-reliability, solid state level sensors detect oil levels in the mid-wing, tilt-axis, and prop-rotor gearboxes. These units have no moving parts, are fully explosion-proof and protected from transients on the power supply line.

Prismalite®

Prismalite sight gauges make oil reservoir levels readable from above or below. A solid, dark viewing area appears when fluid covers the prism. A bright, clear viewing area appears when fluid does not cover the prism.

Chip Detectors

Since metallic debris particles are conductive, these sensors are designed so that the gap between the two electrodes, when bridged by debris, acts as a switch. The V-22 utilizes these chip detectors in the engines, the five transmission gearboxes, and in several of the secondary power systems.

Lubriclones

These units are designed to monitor the critical bearings and gearsguard in the V-22's mid-wing gearbox, prop-rotor gearbox, tilt-axis gearbox, and engines. High efficiency debris separation and concentration of all particles over 200 micrometers and most particles between 100 and 200 micrometers extends filter element life and enhances early failure detection capability. As an added feature, the vortex separator also removes the air from the oil, with an efficiency of 95%.

Desiccant Breather

These breathers remove moisture from air drawn down into the gearbox or transmission to prevent corrosion of critical gears and bearings. They also indicate when a replacement is required.

Sight Gauge

The oblong window allows viewing large fluid level changes. Various materials are used to accommodate specific fluids, pressures and temperatures up to 2000°F (1093°C).

Chip Collector

Located in the oil flow in an auxiliary gearbox, these collect ferrous particles that could indicate impending failure of the component. Its self-closing valve permits withdrawal of the magnetic probe and visual inspection of the collected debris, with minimal fluid loss.

1817 Series
Low Profile Ball Bearing Swivels

Eaton's 1817 series swivels are used in the V-22 hydraulic system. These swivels, operating at 4000 psi (27,500 kPa), are designed to minimize torque and maximize service life. The swivels are manufactured from titanium material to minimize envelope size and maximize strength.

Rynglok® Fittings

The 5000 psi (34,500 kPa) high pressure hydraulic system of the V-22 aircraft requires highly capable fittings. The Aeroquip brand Rynglok® L5/R5 fittings are all Titanium, axial swage fittings that provide the link to join fluid delivery tubing, while minimizing system weight.

Fittings include permanent and Arc Seal® connections in straight elbow, and tee configurations. Rynglok® is the quickest, lightest, and most reliable means of joining high pressure hydraulic lines throughout the Osprey.

Kevlar® Hose Assemblies

Eaton's Aeroquip® Kevlar hose assemblies are utilized extensively throughout the V-22 aircraft to optimize weight reduction throughout the hydraulic system. The AE334 hose assemblies are rated for operating pressures of 5,000 psi (34,500 kPa) and can be found in the hydraulic supply system. The AE355 hose assemblies are rated to 4,000 psi (27,500 kPa) and are used in the low pressure hydraulic return system.

Wire Braided Hose Assemblies

Eaton's wire-reinforced medium pressure hose assemblies are used throughout the low pressure hydraulic, lube oil and fuel systems. The assemblies are rated for pressures up to 1500 psi (10,300 kPa) and feature a wire reinforced, Teflon® hose with light weight, low profile crimp fittings.

Convoluted Hose Assemblies

Eaton's Aeroquip convoluted Teflon hose assemblies are rated for pressures up to 1000 psi (6,900 kPa) and are used in the return side of the hydraulic system. Convoluted hose assemblies provide increased flexibility and are excellent for use where a tight bend radius is required. The hose assemblies feature Eaton's proprietary integral silicone covers to meet the fire requirements of AS1055. Incorporating this proprietary silicone compound resulted in a lighter weight, smaller diameter hose when compared to other silicone covered hoses.

Form No. C5-11F
April 2014

Eaton
Aerospace Group
9650 Jeronimo Road
Irvine, California 92618
Ph: (949) 452-9500
Fax: (949) 452-9555
www.eaton.com/aerospace