



1. Effectivity

All aircraft equipped with air-driven gyroscopic flight instrument systems equipped with a vacuum system manifold valve.

2. Purpose

To provide basic guidance on the maintenance and system functional checks of the vacuum system manifold valve which is found installed in twin engine aircraft with two engine-driven vacuum pumps and in single engine aircraft equipped with one engine driven pump and one standby electrically driven pump (See Figure 1).



Figure 1 Typical manifold check valves

3. Background

Loss of the instrument vacuum or pressure system can result in the loss of air-driven gyro flight and navigation instruments and subsequent loss of control under IFR conditions. Accident investigations into fatal twin and single-engine fixed wing aircraft accidents by the NTSB and ATSB have attributed the loss of control to the loss of all air-driven gyroscopic instruments while flying in instrument meteorological conditions (IMC). For dual vacuum pump systems it should be considered that the symptoms of a double vacuum pump failure may be also caused by a single pump failure in conjunction with a failed vacuum manifold check valve.



1H5 Series (all dash numbers) — Check Valve Manifolds (Vacuum System)

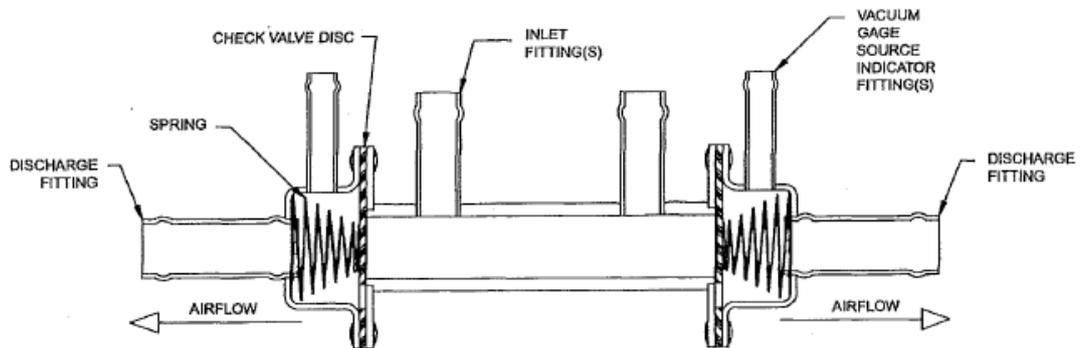


Figure 1
(1H5-2 Shown)

Figure. 2 Typical vacuum system manifold valve.
(Ref. FAA SAIB [CE-01-29R1](#))

Total loss of vacuum or pressure supply to all air-driven gyroscopic navigation and flight reference instruments can occur in twin engined aircraft when both pumps fail at the same time, or when just one pump (or one engine) fails and the critical check valve in the vacuum system manifold fails. Single engined aircraft equipped with a back-up vacuum pump will also suffer total vacuum system failure if the engine and/or pump fails and the critical check valve in the vacuum system manifold fails, even though the standby vacuum pump is running.

‘Dry’ air pumps

The self-lubricating (dry) air pump typically used to provide a ‘vacuum’ (or pressure) source is prone to unanticipated failure (see AWB 37-003 for more information). While an operating vacuum pump may provide some indication of declining performance via wear indicators, “teletemp” indicators, declining vacuum pressure gauge readings and warning lights, etc. a vacuum manifold valve failure can remain undetected until an emergency situation arises.

Manifold functional test – Twin engined aircraft

The manifold valve is intended to automatically isolate or seal off the massive air leak introduced by the non-functioning air pump, and allow the functioning air pump continue to provide power for the air-driven instruments. However, should the manifold valve be unserviceable at the time one pump or engine fails, the result is the loss of vacuum or pressure supply to all air driven gyroscopic flight and navigation instruments.

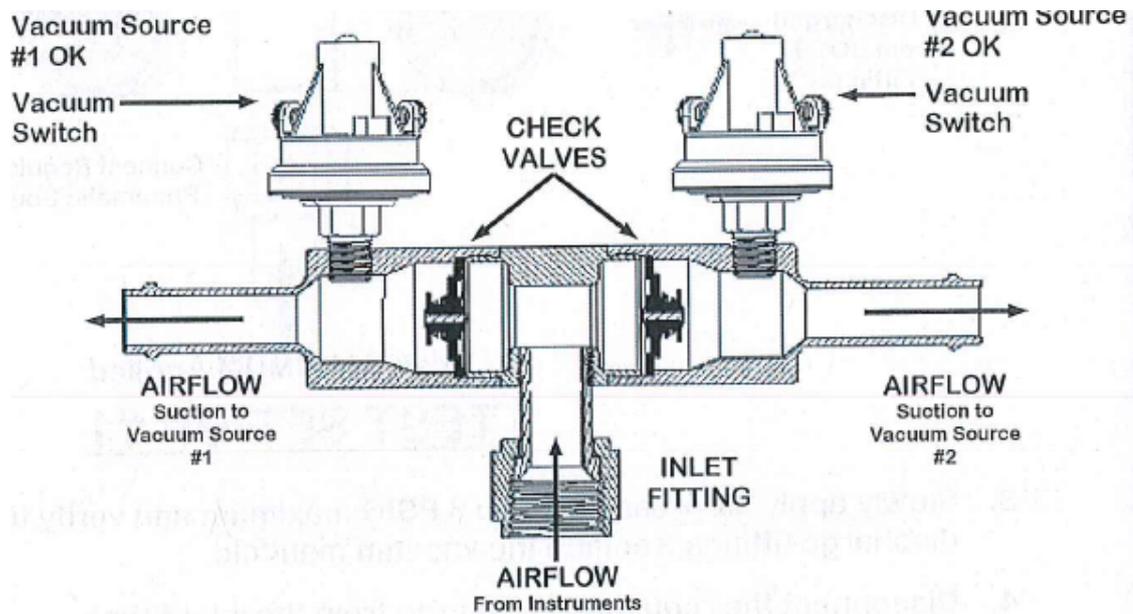


Figure. 3 Typical vacuum system manifold valve.
(Ref. Tempest [SL-006](#))

Although the aircraft and manifold valve manufacturers provide periodic functional bench testing requirements and a retirement life for the manifold valve by Service Letter or in the aircraft maintenance schedule, manifold valve failure may still go undetected while in service between such inspections. This is because if both engines, each equipped with a serviceable vacuum pump are started in short succession, the isolation function of the manifold valve is not specifically tested, due to the vacuum sources quickly becoming 'balanced', extinguishing the system failure indicators.

Vacuum manifold functional test – Twin engined aircraft

To ensure the vacuum or pressure manifold is working correctly, start one engine and check that the vacuum/pressure is established before starting the other engine. At the end of the run, shut down the engine that was started first and let the other engine keep running.

Such continual checking is justified, even when the manufacturer's bench test and retirement life is adhered to, because the manifold valve typically uses 'rubber' flaps and seals which deteriorate at an unpredictable rate due to variations in factors such as heat, air pollution and contamination - from a failed pump for example. A failed manifold valve may also allow in-flight contamination of the serviceable pump with failed dry air pump particles and cause the failure of the remaining operating pump (for more guidance see AWB [37-003](#)).



Vacuum manifold functional test – Single engined aircraft

A recent development to improve the reliability of the vacuum or pressure source for air-driven gyro instruments in single engined aircraft, has been the introduction of the emergency electrically-powered vacuum pump. The advantage is that should the engine fail or the engine driven vacuum pump fail, instrument power can be restored for short time via a standby vacuum pump driven by an electric motor.

Where a standby vacuum pump is installed in a single-engined aircraft, a vacuum manifold valve is used to seal off the non-functioning pump as in twin engined aircraft. Shortly after engine start, it should become immediately apparent if the engine-driven pump and one side of the vacuum manifold valve is functioning correctly or not. However, the electrically driven stand-by vacuum pump should also be periodically operated when the engine is not operating, to ensure the stand-by system will function as intended in an emergency. Standby vacuum pumps typically have an operating hours' Time Before Overhaul (TBO) or retirement life and a calendar retirement life.

Vacuum pump replacement planning – twin engine aircraft.

The pilot of a twin engined aeroplane operating under IFR conditions reported problems with the gyro instruments shortly before a fatal crash. The ATSB identified that a likely cause of loss of the air-driven gyro flight reference instruments could be attributed to a double vacuum pump failure, on the basis that both vacuum pumps had nearly reached the vacuum pump manufacturer's recommended overhaul/retirement life of 500 flight hours.

While 'dry' vacuum pumps may still fail unpredictably well before they have reached their recommended overhaul or replacement life, consideration should be given to separating or staggering the vacuum pump overhaul or retirement thresholds to reduce the possibility of a double pump failure.

CASA IFR operational requirements for gyro instruments. CAO 20.18.

In order to address gyro instrument system reliability issues, CASA CAO 20.18 requires that aircraft engaged in IFR operations have duplicated attitude gyro instruments with a duplicated or independent power supply for all gyro flight and navigational instruments. CAO 20.18 also mandates warning systems to advise the pilot when the primary gyro instrument power source has failed.



4. Recommendations

CASA recommends that all pilots, operators, owners and maintainers:

1. Conduct functional checks of twin-pump vacuum systems as described in this AWB and/or manufacturer's data during engine runs, and particularly when anticipating IFR operations.
2. Manage twin engine aircraft vacuum pump retirement lives to ensure both pumps on the same aircraft do not come close to the end of their retirement or Time Before Overhaul (TBO) at approximately the same time.
3. Perform periodic operation of the standby vacuum pump in single engined aircraft to ensure proper function of the stand-by system, including the manifold valve, particularly if anticipating IFR operations.
4. Adhere to the applicable manufacturer's flight hour and calendar bench test, overhaul and retirement lives for vacuum pumps and manifold valves.

5. Useful links

The following websites have useful information and were correct at the time of publication:

[FAA SAIB CE-01-29R1](#)

[Tempest Service Letter SL-006](#)

6. Related CASA AWBs

[AWB 37-003](#) – Dry Vacuum Pumps

[AWB 31-008](#) – Gyroscopic Instrument Reliability

7. Reporting

Defects and malfunctions in relation to vacuum system components should be reported to CASA by email to SDR@casa.gov.au or via the on-line CASA defect reporting system.



Aircraft Gyro Instrument Vacuum / Pressure
Systems Functional Testing

AWB 37-002 **Issue** : 1
Date : 9 April 2015

8. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

Airworthiness and Engineering Standards Branch
Standards Division
Civil Aviation Safety Authority
GPO Box 2005, Canberra, ACT, 2601