SAE Aerospace
An SAE International Group

# AEROSPACE INFORMATION REPORT

AIR4782A

Issued 1994-02
Revised 2008-08

Superseding AIR4782

# Hydrant Valve and Coupler Historical Background

RATIONALE

This revision adds websites to some of the reference documents.

## 1. SCOPE

This SAE Aerospace Information Report (AIR) presents historical information and background data related to hydrant valves and couplers used in worldwide ground refueling of commercial aircraft (hereafter generically referred to as hydrant devices). Military hydrant devices are not included since their mission requirements demand approaches that may differ.

### 1.1 Purpose

The purpose of this document is to provide definitions, background and educational information for use by design engineers, users of the systems and other interested parties who are involved with hydrant devices and associated equipment.

### 1.2 Field of Application

Soon after World War II, the military techniques for underwing refueling of turbine-engined aircraft were adopted for use on commercial aircraft. Advantages include significantly improved safety, convenience and rapidity of refueling.

Refueling systems for commercial aircraft evolved to comprise five basic elements, as follows:

a. Hydrant systems (or supply systems)

b. Hydrant couplers (hydrant system to servicer systems)

c. Servicer system (hydrant to aircraft)

d. Aircraft couplings (service systems to aircraft fuel systems)

e. Aircraft fuel systems



Element (d), the aircraft couplings, are now true worldwide standards, having been adopted for military and commercial aircraft of all countries, and controlled by international standard documents.



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This document applies to the hydrant valve portions element (a), the entire element (b) and applicable portions of element (c). Some references to other elements are included, where pertinent.

## 2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 2.1 API Publications

Available from American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070, Tel: 202-682-8000, http://api-ec.api.org.

API Bulletin 1584API Standard for Four Inch Hydrant Systems Components and Arrangements

### 2.2 IP Publications

Available from Library and Information Department, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, England, FAX 71 255 1472.

No Number Aviation Hydrant Pit Systems - Recommended Arrangements for - Part I New Facilities, Part II Replacement of Obsolete Valves in Small Pit Boxes - August, 1990

### 2.3 Military Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MS24484 Adapter, Pressure Fuel Servicing, Nominal 2.5-inch Diameter

MS29514 Flange, Adapter Locking, Pressure Fuel Servicing\

### 2.4 ANSI Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI B16.5 Pipe Flanges & Flanged Fittings

### 2.5 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org or from International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41-22-749-01-11, www.iso.org.

ISO/DIS 45:1990 Aircraft Pressure Refueling Connections

### 2.6 Definitions

AIRCRAFT REFUELING ADAPTER: A part of the aircraft fuel system, it is the mating portion of the quick disconnect by which the Hydrant Servicer (Nozzle) is connected to the aircraft. This connection is dimensionally in accordance with MS24484, MS29514, ISO 45, and NATO STANAG 3105. The latter two documents are international standards to assure interchangeability.

DEADMAN CONTROL: The manual capability of open-close control of flow through the Hydrant System and Hydrant Servicer by an operator. This feature requires the operator to hold a switch or valve in a predetermined position to keep flow through the system. The valve, being held by the operator, normally controls the application of an air reference pressure to the Deadman Control Valve. The switch may control a solenoid valve that releases the application of air pressure to the Deadman Control Valve. Release of the switch or valve will automatically stop flow.

EXCESS-FLOW CONTROL: Some Hydrant Valves or Hydrant Couplers include a feature that will automatically stop flow through the system if the flow rate exceeds a predetermined value. Some such units have the capability of having two such settings, high and low settings, to accommodate aircraft of different capacity. This is intended to prevent a major spill of fuel in case of an intake hose rupture and is sometimes used to supplement other emergency shut down devices such as deadman and lanyard operated controls.

HOSE END CONTROL VALVE OR REGULATOR: A direct acting pressure control device that is mounted as an integral part of the Underwing Nozzle.

HYDRANT COUPLER: The mechanical quick connection between the Hydrant Servicer and the Hydrant Valve. The Hydrant Coupler may include various control features or may be a simple quick coupling.

HYDRANT PIT: A covered small chamber containing the hydrant system pipe terminus, hydrant valve, and associated equipment. The pit is strategically located to provide access to the aircraft underwing Refueling Adapter.

HYDRANT SERVICER: Also called Hydrant Cart or Hydrant Dispenser. A vehicle, self-propelled or towable, that contains the necessary equipment to allow for connection to the Hydrant Valve and the aircraft refueling adapter. The Hydrant Servicer may include, but not be limited to, intake hose, outlet hoses, booster pumps, meters, filter separators or monitors, pressure control systems, and other equipment necessary for effecting an accurate, safe and rapid refueling of the aircraft.

HYDRANT SYSTEM (or AIRPORT FUEL SYSTEM): A Hydrant System consists of three basic elements:

a. Tank farm or storage facility.

b. Piping and controls required to connect the Tank Farm with the apron mounted hydrant valves.

c. Hydrant pits and valves.

The hydrant system provides a consistent source of fuel from a remotely located storage facility or tank farm to the refueling apron or parking positions of the various aircraft to be refueled.

HYDRANT VALVE: The terminus of the hydrant system piping system that will provide as a minimum quick coupling capability with a hydrant coupler and may provide controls (pressure, on-off, excess-flow, etc.).

NOZZLE or COUPLING: The quick connection utilized to attach the Hydrant Servicer outlet to the aircraft Refueling Adapter. There may be one or more [normally no more than four] Nozzles per each Hydrant Servicer. The Nozzle may or may not have an integrally attached Hose End Control Valve.

OVERSHOOT CONTROL: The capability of controlling the volume of fuel passing through the refueling system following the initiation of a Deadman Closure is Overshoot Control.

PRESSURE CONTROL: Aircraft refueling systems are designed to accept a safe pressure at the connection to the aircraft (Nozzle or Coupling). This pressure is automatically achieved by Pressure Control utilizing a number of different approaches. It may be accomplished by or combination of the Hydrant Pit Valve, Hydrant Coupler, Line Mounted Pressure Control Valve, or by a Hose End Control Valve (mounted as a part of the Nozzle).

PRESSURE CONTROL VALVE: Usually a line mounted valve that provides remote regulation of pressure and, as required, surge control, deadman control, and/or overshoot control.

PRODUCT SELECTION: A design feature of the hydrant valve and coupler that keys the two units to mate only if both halves (hydrant valve and coupler) are the same. The API Bulletin 1584 specifies the type and control of dimensions to assure compatibility of all manufacturers' couplers for the 4 in units. There are two different product selection methods available on the 2-1/2 in units, one used in the United States (and influenced areas) and one used in Europe (and influenced areas). They are not compatible with each other.

PUMPS: Pumps are utilized in Hydrant Systems, normally at the tank farm pumping station to provide the pressure within the Hydrant System to move the fuel from the tank farm to the aircraft parking position. Pumps may also be used on Hydrant Servicers where the pressure inherently is too low to accomplish the refueling task in the appropriate manner.

REFUELING TRUCK, REFUELER or FUELLER: A vehicle that is used to refuel an aircraft, normally self-propelled, that contains the same basic equipment as mentioned for HYDRANT SERVICER and the fuel supply is contained within an on-board tank.

SURGE CONTROL: Airframe manufacturers limit the amount of transient peak fuel pressure measured at the Aircraft Refueling Adapter. Ground equipment also must anticipate the aircraft valving closures and also limit the amount of peak pressure buildup at the Aircraft Refueling Adapter. The capability to limit the magnitude of the peak pressure is Surge Control.

UPLIFT: The amount of fuel input into an aircraft at a single refueling operation.



## 3. HYDRANT VALVES

### 3.1 Background

Some hydrant systems were developed, in the mid-1950s, for use in providing aviation gasoline or turbine fuels to propeller type aircraft. Some of the gasoline systems are still in use today, having been subsequently converted to turbine fuel application. However, the major development of hydrant systems followed the introduction of larger, jet-engined aircraft, and allowed the delivery of larger volumes of fuel to be accomplished relatively quickly. The turbine aircraft required uplift capacities that were greater than the capacity of a single refueling truck. Another compelling reason for the development of hydrant systems was the desire to limit the size of the vehicles parked around an aircraft during servicing. Safety was also a major consideration. A hydrant system is generally considered a safer method of refueling than is a refueling truck. Life cycle costs for hydrant systems may be lower than for refuelers depending upon the number of vehicles and size of the system.

Valves utilized in hydrant systems throughout the world can be categorized by types and sizes.

#### 3.1.1 Hydrant Valve Types

There are three general types of hydrant valves that have been and/or are in service at the commercial airports of the world:

a. Hydrant Valves with No Controls: These units, although utilized as hydrant valves, are essentially simple quick coupling adapters used only to connect the hydrant pipe line terminus to the hydrant coupler. All controlling of flow, including deadman, is achieved elsewhere from the pit. In an emergency situation, this type of device, having no closure controls, can only be closed by a proper disconnect. This type, therefore, is considered less safe than either of the other two and should not be utilized for any system design.

b. Hydrant Valves with Minimum Controls (normally on/off shutoff) Located on the Actual Unit within the Pit: These types of valves can be air or lanyard operated or a combination of both. The other major controls for the system (pressure and/or excess-flow control) are located external to the hydrant valve, normally within the mating coupler or further downstream in the line.

c. Hydrant Valves with All Controls (pressure, deadman and/or excess-flow) Located on the Actual Unit within the Pit: Since all controls are located within the hydrant pit valve, the mating coupler is a simple straight-through type unit with no controls other than the manual open and close handle.

3.1.2 Hydrant Valve Sizes

There are three basic sizes (outlet connections) still in operation. The inlet size is normally either 4 or 6 in bolt flanges to mate ANSI B16.5 type flanges.

a. Bayonet type 2-1/2 in international aircraft adapter type connection. This size of hydrant valve has been furnished with all controls or with air or lanyard type shutoff controls only. This valve size is used where smaller, lighter servicer inlet components and hose are desired and flow rates are less than 750 U.S. gpm (2839 l/min).

b. Reverse bayonet (slots in lieu of lugs) type 3-1/2 in connection (commonly called a 4 in unit). This type of hydrant valve, although still utilized in some parts of the world has been almost universally replaced by the 4 in API size below.

c. API 4 in connection in accordance with API Bulletin 1584. This is the most prevalent type of unit utilized today. It is available in either of the types noted in 3.1.1.

3.2 Hydrant Valve Functions and Configurations

Hydrant valves and/or couplers serve to provide various functions within the refueling system. The following discussion is divided into the two prevalent types of hydrant vales in use today.

3.2.1 Hydrant Valves with Integral Controls

Hydrant valves with all controls located integrally with the valve usually will include such features as pressure and deadman control and may include excess-flow control. This type of valve normally requires connection to a reference air pressure from the hydrant servicer to achieve the various control features. A fuel sense line, originating at the fuel sense point on the hydrant servicer, where remote sensing is utilized, will also be connected to the hydrant valve. The connection of these two lines will normally be accomplished by a quick disconnection, the fuel line being a dry break type connection. The hydrant valve responds to the pressure sensed at the sense point (maybe a Venturi) to provide the desired control pressure. The desired control pressure will be achieved as a function of the reference air pressure provided to the hydrant valve. Certain reference air pressure, applied to the valve, also provides the hydrant valve with the deadman capability. That is, the hydrant valve will only open with the application of a certain minimum of air reference pressure. The absence of this air pressure causes the valve to automatically close. On some models, the hydrant valve was designed to react to a sudden change in sensed fuel pressure and close to assist in the reduction of surge pressure in the system downstream of the sense point.

Excess-flow control, if utilized, may be achieved by internal sensing means that utilize the pressure loss of an internal sensing device, velocity detectors, or other internal sensing means. At a predetermined sensing level related and calibrated to the desired excess-flow rate, the device will act on the main valve to cause it to close and remain closed until the excess-flow control device is manually reset. Excess-flow control is available with either a single set (flow rate) point or dual set points.

A simple (no controls) hydrant coupler is normally utilized with this type of valve, however, some operators will utilize couplers with controls where the maintenance of the hydrant valves is in question.