

**APPLICATION CONSIDERATIONS**

<b>TIGHT SHUTOFF</b>	All cryogenic valves require tight shutoff for efficiency and minimizing energy loss. Critical applications may require absolute zero cryogenic leakage to prevent expensive systems damage or fatalities.
<b>CRYOGENIC TEMPERATURES</b>	Valve construction and materials will need to withstand temperatures as low as -425°F (-254°C) for Liquid Hydrogen, including ductility and weld qualifications per ASME B31.3. A sufficient length, robust bonnet extension from seamless material designed to ASME B16.34 and ASME B31.3 is required to ensure the stem seal is maintained.
<b>TEMPERATURE FLUCTUATIONS</b>	Valves may need to operate through significant temperature fluctuations during engine cooling, purging, filling, and venting; as well as ground support fluid distribution and tank storage.
<b>VIBRATIONAL CONSIDERATION</b>	For critical applications, the valve assembly shall be designed to operate at ±2 G horizontal (lateral and axial) and ±3 G vertical transportation loads simultaneously.
<b>HOSTILE AMBIENT ENVIRONMENT</b>	Valve assemblies and actuators may be exposed to rocket propellant residue and/or sea spray near coastal waters. Therefore, consideration to minimize deterioration and ATEX certification for electrical components is required.
<b>THERMAL AND PRESSURE CYCLING</b>	Robust construction is required for all materials and components of the valve, with consideration of a thermal and pressure cycle life of up to 7,000 cycles.
<b>PROCESS PURITY AND CLEANLINESS</b>	Contaminants can cause leakage or make the valve difficult to operate. The sealing surface finish must be maintained as the slightest imperfection can lead to unacceptable leakage during service. For fluid purity and safety, valve materials must not shed particles and must be precision cleaned to ISO 14952. For oxygen system compatibility and safety, the valve design and materials must be compatible with oxygen to avoid ignition hazards and selected to conform to industry and customer standards.
<b>FUGITIVE EMISSIONS</b>	Valves in cryogenic services—especially hydrogen—require all connections to be emission leakage resistant to prevent safety and environmental impacts. Impermeable seal materials, improved mating surface finishes, concentric serrations, live loading, oversized fasteners, and backup seals are typical requirements.
<b>ENERGY EFFICIENT CONSTRUCTION</b>	All cryogenic valves must be constructed with minimal thermal mass and surface area—particularly for the bonnet extension—to provide reduced heat loads to the system.
<b>EFFECTIVE FLOW CHARACTERISTICS</b>	Valves must have a comparatively high C <sub>v</sub> , minimal pressure drops, and broad turndown characteristics to provide efficient and effective flow control.
<b>INSTALLATION ORIENTATION</b>	Cryogenic valves with a PTFE packing should not be installed more than 45° from vertical. Beyond this position, seal failure from cryogen contact increases. Support is required when heavy actuators are installed off the vertical position, as the overhanging mass can put a strain on the bonnet bolts and the bonnet itself.
<b>RELIABLE OPERATION</b>	For process safety and efficiency, valves need to operate reliably and provide long-term cycling and tight closure performance from ambient to cryogenic temperatures.
<b>LIMITED MAINTENANCE</b>	Valves in aerospace services are typically required to perform flawlessly for a minimum of 5 years between maintenance cycles.

CONTACT SALES@SCOREVALVES.COM FOR MORE INFORMATION

**APPLICATION DETAILS**



Spaceflight launch and ground support facilities within the aerospace industry provide transport capabilities for human and equipment payloads to Earth's orbit and beyond. These programs continue to undergo rapid development with new launch and test facilities requiring new and updated infrastructure to support the government and private sector's fast-growing economic activities.

Cryogenic fuels and oxidizers such as liquefied natural gas (methane), liquid hydrogen, and liquid oxygen, as well as non-cryogenic fuels such as hydrazine and rocket propellant-1 (kerosene), are used as propellants at launch and test facilities. Gaseous and liquid nitrogen are used for system precooling and purging.

SCORE VALVES' cryogenic and non-cryogenic triple offset butterfly valves are used for isolation and control in both ambient and cryogenic temperatures within these aerospace systems.

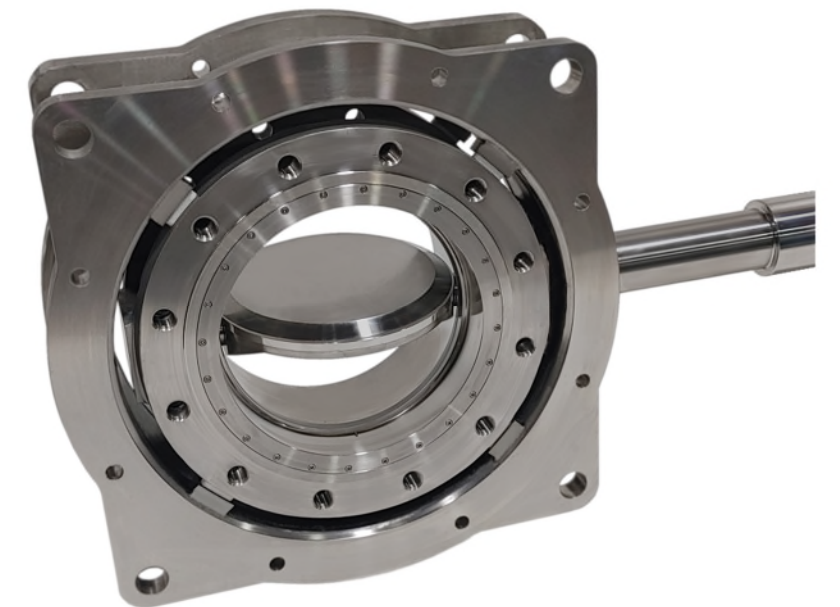
**OUR EXPERIENCE**

SCORE VALVES has 35+ years of engineered product experience and expertise in the aerospace industry with NASA Kennedy Space Center, NASA Stennis Space Center, Arnolds Air Force Base, Lockheed Martin Corporation, McDonnell Douglas, MDS Aero Support Corporation, Aerojet Rocketdyne, and most other major private spaceflight companies.

Our industry-proven install base for control and isolation valves includes wind tunnel flow and pressure control; safety-critical applications such as launch pad sound and vibration suppression, NASA mobile launchers, and rocket engine test stands in venting, purging, and fuel and oxidant loading systems; and ground support systems for distribution and storage.

**OUR CAPABILITIES**

- › Manufactured to exceed the highest aerospace industry standards by our engineering staff who are knowledgeable and experienced in aerospace material, design, testing, cleaning, and code requirements for all media types
- › Proud to provide **ZERO LEAKAGE CRYOGENIC** replacement valves for legacy Royal-Hadley butterfly valves
- › Vacuum jacketed options are available to improve liquid quality, reduce product losses, and eliminate the need for mechanical insulation
- › Common sizes and configurations are stocked for quick delivery and system integration
- › Specialty and BAM-certified materials, precision cleaning, in-house testing, and third-party cryogenic testing
- › Options and accessories include standard and increased C<sub>v</sub> capabilities, quick cycle upgrades, emergency shutdown upgrades, and manual, pneumatic, electric, or hydraulic actuation with positioners, limit switches, position indicators, solenoids, and regulators

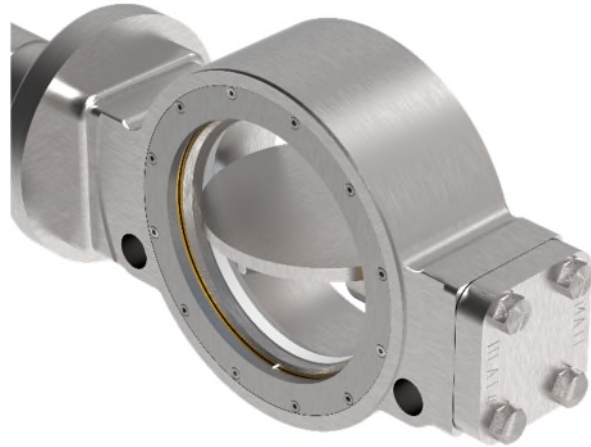


## SCORE VALVES TRIPLE OFFSET SOLUTIONS

The SCORE VALVES triple offset butterfly valve's non-rubbing, resilient to metal or metal to metal, torque seated design, and material selection, combine to provide a custom, economical, and compact solution to meet the extreme requirements of aerospace applications while delivering high efficiency, reduced downtime, and lower capital expenditure.

Our triple offset butterfly valve can be customized to suit any aerospace customer's demanding application needs. Below are examples of typical configurations for valves in such applications.

### RESILIENT REPLACEABLE SEAT CONFIGURATION



- › Zero leakage at cryogenic temperatures using gaseous helium as a testing medium
- › PCTFE replaceable seat
- › Additional FEP, TFM, or fluoropolymers replaceable seat options
- › A351 CF8M / 316 SST solid disc with integrated seal ring
- › Hardsurfaced sealing options include Stellite® 21, Stellite® 6, Nitronic® 60, or Ultime®

### METAL REPLACEABLE SEAL CONFIGURATION



- › Bubble-tight leakage at cryogenic temperatures using gaseous helium as a testing medium
- › Integral 316 SST seat
- › Hardsurfaced integral seat options include Stellite® 21, Stellite® 6, Nitronic® 60, or Ultime®
- › A351 CF8M / 316 SST disc with a stainless steel and RPTFE laminated replaceable seal ring
- › Other metal and fluoropolymer seal ring combinations available

### INFORMATION COMMON TO BOTH CONFIGURATIONS

<b>CRYOGENIC FLOW LOOP PERFORMANCE</b>	Tested with "great results in LH2 for shutoff." (–quoted by a private spaceflight company)
<b>SEAT / SEAL LIVE LOADING</b>	Live-loaded connections compensate for contraction during thermal cycling.
<b>IMPERMEABLE SEALS</b>	Impermeable seal materials are standard to ensure minimized emissions leakage.
<b>PRESSURE GRADE MATERIALS</b>	A351 CF8M / 316 SST stock with optional stainless and Monel® grades.
<b>SHAFT DESIGN</b>	Nitronic® 50 or 17-4 PH DH1150 SST one-piece, blow-out proof design in conformance to API 609.
<b>SHAFT INTEGRITY AND RELIABILITY</b>	All torsional connections use robust square keys in conformance with API 609.
<b>BEARINGS FOR MAXIMUM SUPPORT</b>	Heavy-duty bearings close to the disc provide optimum support for the valve shaft.

### INFORMATION COMMON TO BOTH CONFIGURATIONS (CONTINUED)

<b>TRUE TRIPLE OFFSET DESIGN</b>	True triple offset, cone-in-cone, non-rubbing design, as preferred by the cryogenic industry.
<b>BIDIRECTIONAL DESIGN</b>	Available to full ASME Class pressure ratings in both preferred and non-preferred directions.
<b>PACKING MATERIAL</b>	PTFE with a two-piece rocker-style packing gland minimizes external emission risk.
<b>SHELL PROOF TEST</b>	100% of valves receive a hydraulic shell test to B16.34 and a pneumatic shell test.
<b>THERMAL SHOCK INTEGRITY</b>	Valves have been thermal shock tested using liquid nitrogen inside the valve to EN 12567.
<b>SPECIAL IN-HOUSE TESTING</b>	Cryogenic, high temperature, cycle, and actuator leak testing to industry standards.
<b>RELIABILITY AND NDE</b>	Reliability and NDE are standard to ASME B16.34, B31.3, and/or customer requirements.
<b>PRODUCT QUALITY CONTROL</b>	ISO 9001 QMS, permitted engineering practice, and customer-audited processes and facility.
<b>LARGE SIZE AND PRESSURE RANGE</b>	2" to 96", ASME CL150 to CL1500, in wafer, lugged, double flanged, butt-weld, and clamp end style available upon request with common sizes available from stock.
<b>CAVITIES MINIMIZED</b>	Fully machined internal surfaces for minimized cavities and particle entrapment.
<b>FLOW C<sub>v</sub> AND CHARACTERISTICS</b>	Streamlined disc profile minimizes pressure drop and increases C <sub>v</sub> for a turndown ratio approaching 100:1 with a modified equal percentage flow curve.
<b>MATERIAL DUCTILITY</b>	All materials selected for ductility with components designed for cryogenic service to ASME B31.3, BS 6364, MSS SP-134, ISO 28921, ISO 21011, and customer specifications.
<b>BONNET EXTENSION LENGTH</b>	Bonnet extension lengths are as per MSS SP-134, BS 6364, and ISO 28921. Bolt-on lengths from 12" to 24" are available from stock in 2" increments, with specialty lengths and welded joint options available upon request.
<b>BONNET MATERIAL MINIMIZED</b>	Bonnet extension dimensions and thicknesses are selected to minimize outer surface area to reduce heat gain and operating costs, as well as to reduce support infrastructure.
<b>OXYGEN SERVICE DESIGN AND MATERIAL COMPATIBILITY</b>	Design, material, manufacture, and cleaning for oxygen service valves conform to industry standards including MSS SP-138, CGA G-4.1, CGA G-4.4, NFPA 53, NASA specifications, and BAM conformity testing. Monel® trim material is available from stock.
<b>VACUUM JACKETING OPTION</b>	To reduce system heat load by eliminating conduction—using low conductivity radial supports—and convection, a vacuum jacketing is available in weld end, "dresser" clamp, and flanged options to suit preferences. Valve design options are available which eliminate any joints within the jacket and allow service and repair of the trim through the body port.
<b>PACKING MATERIAL OPTIONS</b>	PTFE material to ASTM D4745 or fire-safe BAM-certified graphite packing available.
<b>PACKING DESIGN OPTIONS</b>	Double set, monitor port, live loading, and low emission per ISO 15848 and API 641 available.
<b>CONCENTRIC RAISED FACE FINISH OPTION</b>	Concentric raised face finish option available to industry standard ASME B16.5, as well as customer-specific requirements, including NASA KSC-STD-Z-0009.
<b>BACKUP / SECONDARY BODY JOINT CONNECTION OPTION</b>	A backup/secondary gasket is available to provide emission and leakage control and redundancy in the event of a single seal leak. Oversize fasteners are typically used to further reduce any fastener-to-seal load losses during thermal and/or pressure cycling.
<b>PRECISION CLEANING OPTIONS</b>	Precision cleaning to MSS SP-138, ISO 14952, KSC-C-123, or customer specification available.
<b>FLOW CAPACITY C<sub>v</sub> OPTIONS</b>	Body seat size and disc profile can be engineered to customize flow and C <sub>v</sub> . Flow loop confirmational testing options are available for precise process control applications.
<b>QUICK CLOSE OPTION</b>	Emergency shutdown and quick close options are available with increased torsional strength to maintain performance when the closure is less than two seconds.
<b>COMPLEMENTARY ACTUATION AND CONTROLS</b>	ISO 5211 and MSS SP-102 valve-to-actuator mounting patterns allow for the consistent installation of actuation and control packages to suit customer requirements.
<b>BUY AMERICA AND CONTROLLED SOURCING</b>	Valve supply and sourcing are available to conform to the <b>Buy America Act</b> for material Country of Origin controls, as well as customer-specific demands.