Bray CONTROLS
A Division of BRAY INTERNATIONAL, Inc.

Bray/McCannalok Valve Applications

Sales Resource Manual

Bray/McCannalok Valve Applications

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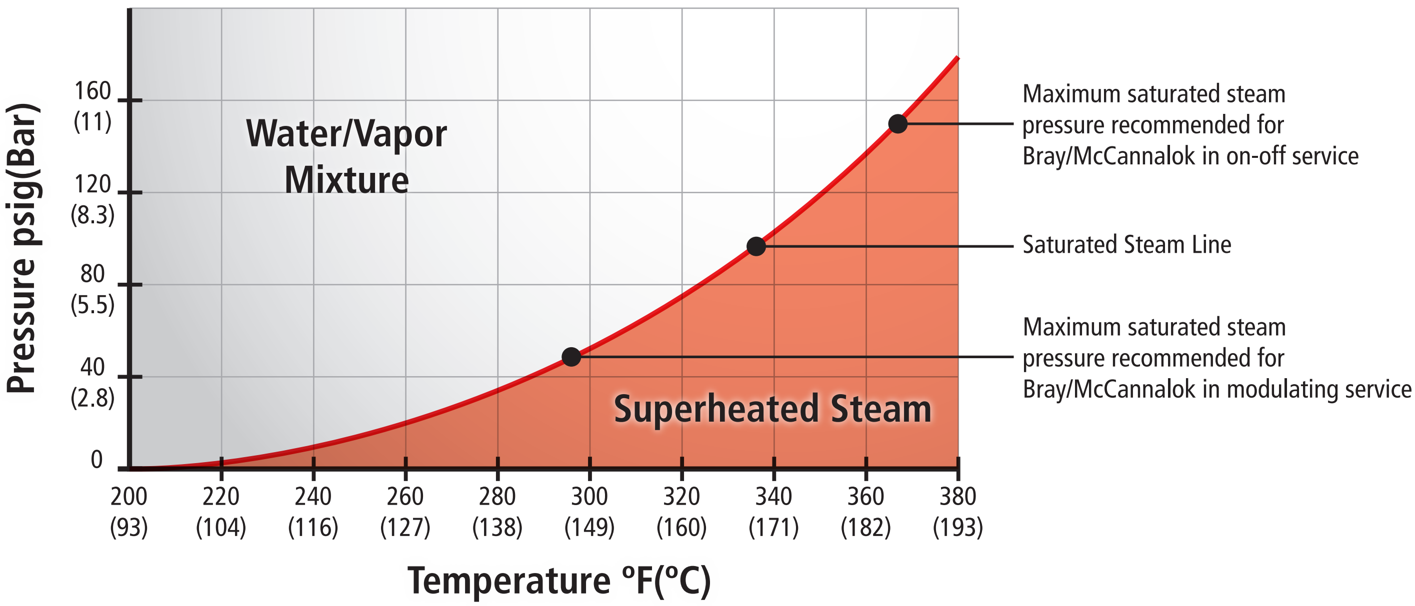
Steam Service

I. Introduction

Steam may be defined simply as the vapor or gaseous state of water. Water in an open vessel will boil at 212°F (100°C). at standard atmospheric pressure of 14.7 psia (1.01 Bar) or 29.92 inches (760 mm) of mercury. No matter how vigorously it is heated, the boiling water will not get any hotter than 212°F (100°C). The extra heat is used to change water to steam and this steam will also be at 212°F (100°C).

If the top of the vessel is sealed, as in a boiler, the water will begin to boil at 212°F (100°C) and the steam vapor will fill the space above the water. Now the temperature of the boiling water will increase as heat is added, and the pressure in the vessel will also increase. The "saturated" steam just above the liquid will again remain at the temperature of the water just below. The chart shows the combinations of pressure and temperature that result in saturated steam. Any combination to the left or above the curve will be a water service. Saturated steam will fall on the curve. Anything below or to the right will be superheated steam.



II. Saturated Steam

Most steam services are called "saturated steam." However, droplets of water will form as heat is lost or used in the system. Traps are used to collect this water phase, but some water droplets will always be carried along in the stream. These droplets or actual slugs of water impinge on valve surfaces at high velocity. Seating surfaces are subject to this abrasive attack at all times. The greatest destructive effect occurs at the moment of opening and closure. At this point all of these droplets are forced through the tiny opening between mating closure surfaces. The cam action of the Bray/McCannalok disc moves it quickly out of contact and away from the seat so that this very critical "just open" position is brief compared to other types of valves.

III. Lower Quality Steam

Steam containing considerable amounts of liquid water may be graded according to the amount of liquid water in the steam. A steam carrying 10% water would be 90% quality; steam containing 30% water would be 70% quality, etc. This steam may be extremely destructive to valves and piping, especially on the downstream side of the valve. At this point the release of pressure allows the water droplets to flash to steam, either within the valve or just downstream from the valve. This effect may also be evident at elbows, tees or other fittings that may introduce pressure variations.

IV. Flashing Hot Water

Pressurized hot water may produce many of the same effects seen in lines handling wet or low quality steam. Consider a system handling water at 60 psig (4.1 Bar) with a temperature of 300°F (149°C). The steam chart assures that this is water. Note, however, that a pressure drop of about 10 psi (0.7 Bar) will allow the water to flash to steam. This is a steam application even though the apparent service is water at fairly low pressure.

V. Superheat

If ordinary saturated steam is heated to temperatures above the saturation point in a secondary operation, the steam is said to be superheated. Consulting the chart again, assume 50 psig (3.4 Bar) steam at 325°F (163°C). Note that 50 psig (3.4 Bar) steam would be saturated at about 300°F (149°C). In this case the steam has 25°F (14°C) of superheat. The valve would simply be handling a hot gas as long as superheat is maintained. Some superheat is desirable and valve service life will be improved, but only if this superheat is maintained at the valve. This ideal rarely exists in practice.

VI. Throttling Services

The very nature of throttling service dictates conditions unfavorable to extended valve life. First, effective modulation requires that the modulating valve absorb a fairly high percentage of the available absolute pressure. A 30% drop will provide good control. At higher pressures this 30% figure results in high pressure drop through a valve that is intentionally operated in a partially open position. If the service requires a wide range of flow rates, the valve must have sufficient flow capacity (Cv) to handle the maximum and minimum flow rates required. Steam throttling range should be limited to a 5:1 flow rate when using standard butterfly valves. Pressure-temperature combinations allowed should fall well within the RTFE seat limits shown in Bray/McCannalok Technical Manual No. 1023.

VII. Bray/McCannalok Butterfly Valves

The suitability of any valve for any particular steam application must be evaluated in light of all known service conditions. The standard Bray/Mcannalok valve will handle many industrial and commercial steam services. The valve may be recommended for on-off service up to 150 psig (10.3 Bar) saturated steam. Modulating service should be limited to a 5:1 flow rate and up to 50 psig (3.4 Bar) only.

Vacuum Service

I. Vacuum Service Ranges:

Atmospheric Pressure:	760 mm Hg (absolute)
	or 0 inches Hg (vacuum)
	or 14.7 psi (absolute) (1.01 Bar)
Low Vacuum:	760 mm Hg (absolute) to 25 mm Hg (absolute)
	or 28.95 inches Hg (vacuum)
	or .484 psi (absolute) (0.033)
Medium Vacuum:	25 mm Hg (absolute) to 10^{-3} mm Hg (absolute)
	or 1 x 10^{-3} Torr
	or 1 micron
High Vacuum:	10^{-3} mm Hg (absolute) to 1 x 10^{-6} mm Hg (absolute)
	or 1 x 10^{-6} Torr
	or 1 x 10^{-3} micron
Very High Vacuum:	1 x 10^{-6} mm Hg (absolute) to 1 x 10^{-9} mm Hg (absolute)
	or 1 x 10^{-9} Torr
	or 1 x 10^{-6} micron

II. Design Features

The inherent design features of the Bray/McCannalok valve make it ideally suited to vacuum service.

Seating - The cam action of the offset stem drives the disc tightly into the seat, compressing a completely encapsulated O-ring.

Stem Seals - Multiple stem seals provide tight seal under vacuum conditions.

Completely Unlined - No plastic or elastomeric liners are used. Potential outgassing or ballooning of such liners is eliminated.

Single Seat - There is virtually no internal cavity space. Rapid pump down and blank off are assured with the valve in the open or closed position. Standard off-the-shelf Bray/McCannalok valves with RTFE seats are recommended for vacuum service down to .02 mm Hg absolute pressure, or 20 microns. This pressure level covers many industrial vacuum services without special preparation.

Specially prepared valves are recommended for vacuum service down to 1 x 10^{-3} mm Hg or 1 micron absolute pressure. Under favorable conditions these valves serve well in the high vacuum range, down to 1 x 10^{-6} mm Hg absolute pressure. The retainer end of the valve should be placed on the high vacuum side of the line.

After selection, the parts are degreased and protected from further contamination until assembled in a clean area. No lubricants are allowed on “wetted” parts. Seat, stem seals, and metal surfaces are checked with the valve pressurized in each direction in turn. No leakage is allowed.

III. Ordering

Specify “preparation for vacuum service.” Common construction would be Carbon Steel body, RTFE seats and 316 Stainless Steel trim. Other metals may be used where chemical factors may require more special materials. Specify vacuum level and/or other conditions that may aid in preparation and proper material selection.

HVAC Systems

I. Introduction

The regulation of flow of large volumes of hot, condensed, chilled and "fire" water in the heating, ventilating and air conditioning systems of large buildings represents a significant application potential for Bray/McCannalok high performance butterfly valves. The valves have been very successfully employed in HVAC systems of buildings where large pipe line sizes and line pressures up to 450 psig (31 Bar) are encountered, usually in buildings over 25 stories in height and exceeding one-half million square feet of floor space. In these applications the valve offers the end user very significant savings in space, weight, and installation costs.

II. Applications

ASME Class 150 (285 psig [20 Bar] maximum rating - Carbon Steel) and ASME Class 300 (740 psig [51 Bar] maximum rating - Carbon Steel) Bray/McCannalok butterfly valves find primary use as main stop valves, block valves or as throttling valves for damping or "balancing" water flow. They may also be used to control pump suction or discharge or as block or bypass valves in conjunction with system strainers.

Service conditions for chilled water will generally be 40-45°F (4.5-7°C) at pressures up to 60 psig (4.1 Bar). Conditions for hot water systems can run as high as 450 psig (31 Bar), but temperatures will usually not exceed 350°F (177°C).

Consult Bray/McCannalok Technical Manual 1023 for specific pressure/temperature ratings and limitations.

III. Material Recommendations

Carbon Steel valves with RTFE seats are recommended for HVAC water service. Specify Carbon Steel trim for On/Off service, and 316 Stainless Steel trim for throttling applications.

Caustic Service

I. Introduction

Caustic services may include a wide variety of operating conditions and concentrations of alkaline compounds. In general, the common "caustics" would be the hydroxides of sodium, potassium and calcium. Ammonia solutions and the alkaline carbonates may be placed in the same general category.

Under most conditions of handling, the caustics are not highly corrosive to ordinary carbon steel and are not aggressive to RTFE seating materials. For such service an all carbon steel valve could be specified with RTFE seats.

Higher concentrations of sodium and potassium hydroxide require higher temperatures to prevent solidification of the line fluid. These higher concentrations and temperatures are some what more corrosive to Carbon Steel, though some users may accept these higher corrosion rates in preference to the cost of more resistant materials such as Stainless Steel or Nickel.

Calcium hydroxide is usually handled as a slurry, so erosion becomes a more important factor than corrosion. RTFE seats would be recommended for these applications.

High purity caustic that must not be contaminated by iron presents a unique problem. Even though the corrosion rate of Carbon or Stainless Steel may be quite acceptable, the iron contamination in the caustic cannot be tolerated. Nickel must be used for all wetted metal parts of valves handling high purity caustic.

II. Design Features

The general design features of the Bray/McCannalok valve are as desirable in caustic as they would be in any other service.

1. Bubble tight seating to full ASME Limits in Class 150, 300 or 600. The RTFE seat with encapsulated O-ring is protected from dynamic fluid flow by the seat retainer.
2. The cam action of the eccentric disc drives it firmly into the seat at closure, but removes it from contact with the seat in the first few degrees of rotation.
3. Multiple stem seals provide long, trouble-free service.
4. Composite stem bearings of 316 Stainless Steel with TFE/glass fabric liners assure very firm stem support under all line conditions.

No special preparation is required for caustic services. However, caustic service may include a wide variety of service conditions. The valve materials must be selected for sufficient corrosion resistance or to meet purity requirements.

Sour Gas Service

Ref: NACE Standard MR0175

I. Introduction

Stress corrosion is a general term for corrosion accelerated by localized tensile stresses. In metals, stresses can be produced as internal stresses by cold working, welding, unequal cooling, unequal heating and internal structural changes. External stresses normally are produced by loads or operating stresses (line pressure piping strain.)

In contact with corrosive media, the resultant surface tension in the exposed metal will result in small cracks which widen and deepen as the stress concentrates at their base. As more metal is exposed to corrosive media and as stress and corrosion interact, failure occurs. This insidious type of destruction has been observed in almost all metals and alloys, in chemical environments specific to the metal involved. Time required for failure may vary from a matter of minutes to years and may occur in one unit, but be absent in other identical units in the same service.

Stress corrosion of metals in contact with hydrogen sulfide (H_2S) is a well-known and specific form of this phenomena. It is particularly acute in petroleum production and pipeline services where loss of equipment function or a compromise of pressure boundary integrity is intolerable.

II. Sour Services

In general, the terms "sour service" or "sour gas" service as currently employed by the petroleum-petrochemical industries will refer to fluid or gaseous streams containing hydrogen sulfide (H_2S) at partial pressures greater than .001 atmospheres, and "SSC" will refer to "sulfide stress cracking" of the type previously described. Materials of construction of equipment applied to services of this type are normally subject to stringent specifications that limit the selection of metallic materials to those that have been found resistant to SSC. As a minimum, **NACE Standard MR0175 (2002)** will normally be invoked, and certification of valve materials to this standard will be required.

NACE STANDARD MR0175 "MATERIAL REQUIREMENTS, MATERIALS FOR VALVES FOR RESISTANCE TO SULFIDE STRESS CRACKING IN PRODUCTION AND PIPELINE SERVICE."

This standard, approved by the National Association of Corrosion Engineers, covers the material requirements for metals found to be resistant to sulfide stress cracking (SSC) for valves for petroleum production and pipeline service. The material requirements of NACE MR0175 (2002) can and have been met by Bray/McCannalok butterfly valves.

This standard essentially recognizes the fact that the most common and effective method of combating metal stress corrosion is by heat treating to relieve internal or residual stresses. In addition to the specification of heat treatment or annealing, the standard also lists the ferrous and non-ferrous metals and alloys that are acceptable in SSC environments and that may be employed as valve materials of construction.

As applied to Bray/McCannalok butterfly valves, the essentials of this standard are as follows:

1. **Critical Valve Components:** Defined as any part of the valve which upon failure would prevent the valve from being restored to operating condition or that would compromise the integrity of the pressure containment system. Table 1 lists the component parts of Bray/McCannalok butterfly valves that we consider "critical" and the materials employed when NACE MR0175 is specified.
2. **Hardness:** When NACE MR0175 is specified, the maximum hardness of Carbon and Stainless Steel components listed in Table 1 (except 17-4PH) will be HRC 22 (Brinell Hardness Number 235). 17-4PH Stainless Steel will be in the range of HRC 29-33.
3. **Free-Machining Steels:** Rephosphorized, resulfurized and/or lead free machining steels are not acceptable for use in critical parts and are not used for these components in Bray/McCannalok butterfly valves intended for these services.
4. **Plating:** The use of plating (i.e., nickel, chromium, cadmium, electroless nickel, etc.) over non-approved base materials to attempt to prevent SSC is not acceptable. Plating applied to materials that are satisfactory for use in sour environments, however, is allowable subject to agreement between the producer and user.
5. **Certification:** Bray/McCannalok valve shipments will be accompanied by written certification that the material requirements of NACE MR0175 have been met.

III. Ordering

Bray/McCannalok Valves for sour gas service are available in wafer or single flange configuration in ASME Classes 150, 300 and 600 and in the materials of construction and combinations indicated in Table 2 (Pg. 10). Certain valve sizes in ASME Classes 300 and 600 require derating due to the use of NACE approved materials. Consult your local Bray representative for details.

IMPORTANT:
The customer must specify the operating temperature and pressure ranges.

Table 1

APPLICABLE PARTS	MATERIAL	
Body	Stainless Steel	ASTM A351 Gr. CF8M
	Carbon Steel	(C1)*ASTM A516 Gr. 70 (to -50°F [-46°C])
	Carbon Steel	(CS)*AISI 1023-1029 (to -20°F [-29°C])
Disc	Stainless Steel	ASTM A351 Gr. CF8M*
Stem	17-4PH Stainless Steel	ASTM***, ASTM A564 Gr. 630
Taper Pin	316 Stainless Steel	ASTM 276 Type 316, Cond. A Cold Finish
Seat Retainer	Stainless Steel	ASTM A351 Gr. CF8M
	Carbon Steel	(C1)* ASTM A516 Gr. 70 (to -50°F [-46°C])
	Carbon Steel	(CS)* AISI 1023-1029 (to -20°F [-29°C])
Gland Retainer	Stainless Steel	ASTM A351 Gr. CF8M
	Carbon Steel	(CS) AISI 1012-1019
Gland Ring	316 Stainless Steel	ASTM 276
Disc Spacer	316 Stainless Steel	ASTM 276
Gland Retainer Bolting	Studs: 316 Stainless Steel	ASTM A193-B8M
	Nuts: 316 Stainless Steel	ASTM A194 Gr. 8M
Bearing Assembly	316 Stainless Steel	with TFE & Glass Fabric Liner

*Manganese Phosphate treated for temporary surface rust protection
**Hard chrome plated
***Double aged at 1150°F (621 °C)

Metals Acceptable for SSC Environments

Table 2

CARBON STEELS

AISI	ASTM	OTHER
1010-1045	A216 Gr. WCC, WCB A36 A105 A106 Gr. A&B A181 Gr. I&II A182 Gr. F1 A225 Gr. B A285 Gr. B&C A333 Gr. 1 A352 Gr. LCA,LCB,LCC,LC1 A515 A516 A541 Gr. C11&C14 A350 Gr. LF1&LF2	API 6A Type 1&4

LOW ALLOY STEELS

AISI	ASTM	OTHER
8620-8640 4130-4145	A487 1,2,4,5,8,9 A193 A194 A217 Gr. WC1 A441 A537 Gr. A A182 Gr. F22	API 6A Type 2&3

CHROMIUM SS - FERRITIC SS

AISI	ASTM	OTHER
405 430		

CHROMIUM SS - MARTENSITIC SS

AISI	ASTM	OTHER
410	A351 Gr. CA15 A351 Gr. CA15M	

PH SS

AISI	ASTM	OTHER
	A638 Gr.660(A286) A453 Gr.660(A286)	17Cr-4Ni

AUSTENITIC SS

AISI	ASTM	OTHER
302 304 304L 310 316 317 321 347		Alloy 20Cb3

NONFERROUS ALLOY

AISI	ASTM	OTHER
	A637 Gr.Inconel X-750 A494(Hastelloy C) B164(Monel Alloy 400) B127 (Monel Alloy 400) B166 (Inconel 600)	Cobalt Base Castings (Stellite) MP35N Monel Alloy K 500

NOTE: Materials listed in these tables shall only be used under the conditions outlined in the text of NACE standard MR0175 (2002) and applicable Bray/McCannalok specifications.

Chlorine Service

I. Introduction

Basic Bray/McCannalok valves have design features which are ideally suited to the requirements of chlorine service.

II. Sealing and Seat Construction

The thermal expansion characteristics of liquid chlorine have traditionally called for special seat construction in order to vent the valve cavity. Valves with internal cavities, such as ball valves, depend on a highly controlled flexure of upstream seating surfaces in order to prevent dangerous buildup of pressure in the valve cavity. Another more positive method to prevent pressure buildup simply bypasses the upstream seat to create a valve that will seal in only one direction. Either method depends on creation of a controlled leak in a known direction with tight closure maintained in the other direction.

The Bray/McCannalok seat assures safe bubble tight closure in both directions because there is only one shut-off point. There is no cavity for pressure buildup. Belleville springs and heavy section stem seals provide constant compression for positive seal tightness around the stem. Long maintenance-free operation is assured.

III. Materials

Materials of construction for dry chlorine would usually call for a Carbon Steel body, RTFE seats and Monel trim (stem, disc, taper pins.) Addition of varying amounts of moisture may be accommodated by a stepwise change to more resistant materials. Starting with a maximum of .015% Alloy 20, Monel or Nickel and Hastelloy C in that order. Hastelloy C will handle 0.2 moisture with little effect and has reasonably good resistance at higher percentages or in chlorine solutions.

Titanium is unique in that it may not be used in dry chlorine, but is very resistant to wet chlorine and solutions of chlorine, chlorine dioxide or hypochlorites. At least 0.2% moisture should be present at ambient temperatures to prevent possible explosive reaction. At higher temperatures even more moisture must be present, up to 1.5% at 300°F (149 °C).

IV. Preparation

All work is performed in accordance with Bray procedures. Special preparation involves careful selection of individual parts free of all surface defects in sealing surfaces. Any burrs are removed to avoid possible reaction with chlorine. Valves are assembled in a clean area. A very minimum of fluorocarbon lubricant is used or a completely dry assembly may be specified. Shell and seat tests are performed with clean, dry, oil-free air or nitrogen. After testing, the valves are again placed in sealed plastic bags to maintain cleanliness in shipment and storage.

V. Ordering Information

To order, select body and trim materials for the type of chlorine service with RTFE seats.

Oxygen Service

I. Introduction

All organic and most inorganic materials will react with oxygen at some particular pressure and temperature condition. The reaction may be as mild as simple oxidation or as violent as fire and even explosion. The reaction may become dangerous at very high oxygen pressures.

The temperatures encountered in ordinary oxygen service are generally well below the ignition temperatures of the common materials of valve construction. The danger of combustion exists in materials being ignited by localized higher temperatures or "hot spots" from other sources. A few such conditions include:

1. Rapid opening of valve which may cause high temperature through adiabatic compression of the low pressure gas at the valve outlet.
2. Combustible contaminants carried in the gas stream at higher velocity which may ignite on contact and trigger further ignition of higher burning materials.
3. Heat generated by friction between two metal valve surfaces may cause a hot spot igniting one of the materials.

Any external leakage may produce serious fire hazards by exposure of dust, grease or other organics to locally concentrated oxygen. From the above, it is evident that care must be taken in the selection of valve materials, in the preparation and assembly of the valve and particularly in the application of the valve.

II. Materials

Metals - The selection of metals should be based on their resistance to ignition, their susceptibility to oxidation and their non-sparking characteristics. Resistance to galling and frictional heating is also important where parts may rub together under high pressure. The more common metals in general order of decreasing resistance to ignition are Copper and Copper alloys, Nickel and Nickel-Copper alloys, Stainless Steel (316), and Carbon Steel.

Although Carbon Steel is quite frequently used, it should be kept in mind that it is susceptible to oxidation particularly in the presence of moisture, it is not a nonsparking material and it is low on the list of resistance to ignition.

The Bronzes and other Copper alloys, as well as austenitic Stainless Steel, are by far the more preferable materials. When Carbon Steel bodies are used, the recommended trim would be Stainless, Monel, Nickel or Bronze.

Non-Metals - The commonly recommended seat material used for oxygen service is RTFE. Oxygen compatible lubricants are generally restricted to the fluorocarbon type. Ordinary petroleum base lubricants are not satisfactory and are particularly hazardous because of their high heat of combustion and high rate of reaction.

III. Special Features

Where high pressure oxygen is involved, the high velocity created at the moment of closure tends to erode the seat. The pressure sealed seat and eccentric disc design of the Bray/McCannalok valve affords excellent protection for the seat with complete freedom from metal contact. Bubble tight seating is assured. The multiple stem seals assure long leak free service.

Another very important feature which should be incorporated in all valves handling oxygen is a means for safe discharge of possible electrostatic potential. In all Bray/McCannalok valves a grounding washer is used on the stem. The internal diameter of the washer bears on the stem while the outside diameter contacts the stuffing box to form a metallic junction between the stem and the body, thereby providing a path of electrostatic potential leak-off.

IV. Preparation and Assembly

Probably the most important single item is the cleanliness of the valve and the system. Any ignition in oxygen service can occur not only from sparking or localized hot spots from the metal contact, but from oxygen contact with hydrocarbon oils and greases, particles of metal or other sources of fine combustible material. It is necessary, therefore, to thoroughly clean all components of valves to be used in oxygen service. Internal body surfaces are vapor blasted or hand ground or wire brushed where necessary to obtain a smooth, particle free surface. Sharp edges and burrs are removed from all metal parts which come in contact with oxygen. The parts are then vapor degreased or hot detergent washed followed by hot trisodium phosphate solution, rinsed in clean water and dried with oil free air.

Soft parts are washed in a detergent solution, thoroughly rinsed and then dried. The work area and all tools for assembly are kept clean.

There are two levels of inspection and assembly depending on the end use or customer requirements:

1. Commercial Oxygen – where equipment must be free of grease, dirt and oil to prevent combustion (i.e. steel production, metal cutting and welding, etc.)
2. Critical Oxygen – Where ultra-cleanliness of the oxygen itself must be maintained (i.e. breathing oxygen, fuel cell oxygen or when customer specifies this level of cleanliness for other services.)

For commercial oxygen service the parts are visually inspected under a bright light and must be free of any loose particles or visual evidence of oils, grease, etc. Cleanliness is confirmed by wiping with a clean white filter paper. Assembly is done in a clean area of the shop and leak tests performed with clean dry air. Finished valves are tagged and heat sealed in polyethylene bags.

For critical oxygen service the parts are sent to a clean room where tools and fixtures have also been thoroughly cleaned in detergent. Authorized personnel in lint free clothing and gloves inspect the parts under ultra-violet light for contamination. After assembly and testing with clean dry air, the valves are further tested for external leakage using a Halogen leak detector. Finished valves are specially tagged and certified and heat sealed in polyethylene bags with VPI (Vapor Phase Inhibitor) paper.

V. Ordering Information

All models of Bray/McCannalok valves with RTFE seats may be used for oxygen service. Carbon Steel is not recommended for elevated temperatures or for "critical" services as defined above. When ordering, specify commercially clean gaseous oxygen service or critical gaseous oxygen service as required. Valves will be prepared in accordance with Bray procedures for these applications.

For low temperature oxygen services, commercial or critical qualities, please consult your local Bray representative.

VI. Warning

The careful selection of materials, the special deburring, the care taken in cleaning, assembly, testing and packaging valves for use in oxygen is of little consequence if the system in which the valves are to be used is not "oxygen clean". Foreign matter such as weld slag, weld rod particles, dirt or oils if carried into the valve may be locally heated through contact or trapping between moving parts. The hot-spot created may at high oxygen pressures be enough to start a rapid sublimation of the RTFE seats and may even attack some metals like Carbon Steel.

Seawater & Brine (High Chloride) Applications – Recommended Materials

The materials recommended herein are based upon critical design criteria inherent in Bray's High Performance butterfly valve design of the seat, disc and stem. If any High Performance butterfly valve design does not meet the minimum design requirements stated below, then not only are these recommended materials not applicable but the High Performance valve design is not recommended for Seawater, Brine and other High Chloride applications.

Recommended Materials Selection for Bray/McCannalok High Performance Butterfly Valves

A. The following Materials Selection Table identifies the disc, body, stem and taper pin materials which should be selected based upon the Chlorides (ppm). Generally, seawater has a Chloride ppm of approximately 17,000 while brine is generally considered to be equal to or greater than a Chloride (ppm) of 20,000. Specific comments are as follows:

1. For Chlorides (ppm) less than 20,000 ASTM A995 Grade 4A Duplex Stainless Steel is preferred with an ASTM A479 Type 316N Stem.
2. For Chlorides (ppm) less than 30,000 ASTM A995 Grade 5A Super Duplex Stainless Steel is preferred with an ASTM A479 Type 316N Stem.
3. For Chlorides (ppm) less than 40,000 ASTM A351 CK3MCuN (254SMO) is preferred with an ASTM A479 Type 316N Stem.
4. For Chlorides (ppm) less than 55,000 once again ASTM A351 CK3MCuN is preferred, but with an ASTM A479 AL-6XN Stem.
5. For Chlorides (ppm) less than 100,000 ASTM A494 CW2M Hastelloy is preferred with an ASTM C276 Stem.

Where stem material ASTM A479 Type 316 N is selected it is to achieve the corrosion resistance of 316 Stainless Steel and the greater physical properties of 316 N Stainless Steel to maintain the relevant ASME rating.

Materials-Selection*

Chloride (ppm)	Disc	Body	Stem	Taper Pins & Disc Spacers
<20,000	ASTM A995 Gr.4A	ASTM A995 Gr.4A	ASTM A479 Type 316N	ASTM A479 Type 316N
<30,000	ASTM A995 Gr.5A	ASTM A995 Gr.5A	ASTM A479 Type 316N	ASTM A479 Type 316N
<40,000	ASTM A351 CK3MCuN	ASTM A351 CK3MCuN	ASTM A479 Type 316N	ASTM A479 Type 316N
<55,000	ASTM A351 CK3MCuN	ASTM A351 CK3MCuN	ASTM A479 Type AL-6XN	ASTM A479 Type AL-6XN
<100,000	ASTM A494 CW2M	ASTM A494 CW2M	ASTM C276 UNS N10276	ASTM C276 UNS N10276

*Other materials are available upon request.

Equivalent-Material References and Specifications

Reference ASTM #	Reference UNS #	Reference DIN #	Generic Name	Tensile Strength Min (psi)	Yield Strength Min (psi)	Elongation
ASTM A 126 Class B	F12102	0.6030	Cast Iron	31,000	-	-
A536 Gr. 65-45-12	F33100	D4512	Ductile Iron	65,000	45,000	12%
A494/A 494M Gr. CW2M	N26455	2.4610	Hastelloy C276, or C4C	72,000	40,000	20%
A479/A Type 316	S31600	X5CrNiMo 17 13 3	316 Stainless Steel	75,000	30,000	30%
A479 Type 316N	S31651	X6CrNiMoTi122E	Stainless Steel	80,000	35,000	30%
B 148 Grade 958	C95800	-	Nickel Al. Bronze	85,000	35,000	15%
A995/A 995M Gr. 4A	J92205	1.4462	Duplex 4A	90,000	60,000	25%
A351-CK3MCuN	J93254	1.4547	254SMO	94,250	43,500	35%
A995/A 995M Gr. 5A	J93404	1.4469	Super Duplex 5A	100,000	75,000	18%
A479 Type AL-6XN	N08367	X1 NiLrM.CuN 25-20-6	Austenitic Stainless Alloy	108,000	53,000	47%