Safetygram-31

Cylinder Valve Outlet Connections

Introduction

The Connections Standards Committee of the Compressed Gas Association (CGA) is responsible for assigning standard connections for specific gases and establishing detailed dimensions for the manufacture of these connections. The main purpose for establishing such standards is to prevent interconnection with non-compatible gases and to provide continuity among manufacturers. Assigned connections also prevent interconnection of the same gas at incompatible pressures.

There are four basic groups of valve outlet connections: (1) connections for general, industrial compressed gas service; (2) connections for self-contained breathing apparatus (SCBA) service; (3) connections for ultra-high-integrity service; and (4) pin-indexed connections for medical gas service. Although this Safetygram addresses connections only for industrial compressed gas service and ultra-high-integrity gas service, much of this information also applies to the other two groups.

In North America, outlet connections are usually designated by a three-digit number preceded by the letters CGA, the acronym for the Compressed Gas Association, for example, CGA 350. Sometimes an ultra-high-integrity connection is preceded by a "DISS" designation rather than the more common CGA designation. DISS is the acronym for Diameter Index Safety System.

Typical Connections

A typical connection consists of three or four parts depending on whether it is a bullet-nose or a gasketed connection. A bullet-nose connection consists of a valve outlet, a nut, and a nipple. The nut is placed on the nipple so the shoulder of the nipple rests against the pushing surface of the nut. The nut has straight threads that engage the mating threads on the valve outlet and pull the nipple against the sealing surface of the valve outlet. No sealing takes place at the threads. The gas-tight seal takes place between the nipple and the valve outlet seat at a very small contact circle where they touch. The success of this connection depends on the surface condition of both the nipple and the valve outlet sealing area at the point of contact.

Some bullet-nose connections have a soft tipped nipple or an O-ring on the nipple to improve the seal. This allows the connection to be made without a wrench, using a nut equipped with a handwheel. These connections are called hand-tight connections.

A gasketed connection has four parts: the valve outlet, a nipple, a nut, and a gasket (or washer). The nipple of the gasketed connection is not bullet-shaped as in the bullet-nose connections, but is flat to compress the gasket. The valve

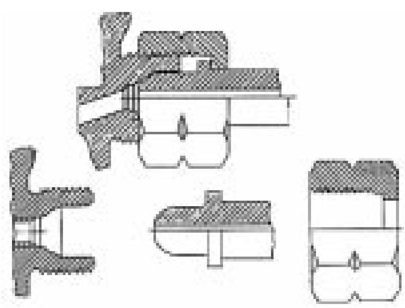

Fig. 1 A typical bullet nose connection.

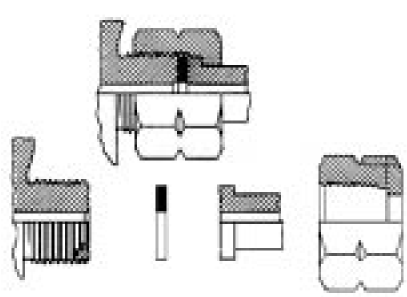

Fig. 2 A typical gasket connection.

outlet sealing area is also flat. The nut fits on the nipple so the shoulder of the nipple rests on the pushing surface of the nut. The washer is placed on the flat surface of the nipple inside the nut. The straight threads of the nut engage with the mating threads of the valve outlet and are tightened to compress the gasket between the two sealing surfaces.

Standard industrial valve outlet connections are designed to provide a "bubble-tight" connection, which refers to leak-checking the connection with a soap solution or by immersing it in water. Bubbles indicate a leak. Leak detection solutions vary in their ability to detect leaks. However, leakage rates for standard connections range from 1×10^{-3} to 1×10^{-5} cc of helium per second. Slower leak rates can be obtained with these connections depending on surface finishes, gasket materials, and mechanical condition. However, achieving slower leak rates can be difficult and inconsistent, one of the primary reasons why the ultra-high-integrity outlet connections were developed.

Force Required for Seal

One of the most confusing issues concerning outlet connections is how much force one should apply to achieve a seal without damaging the connection. There are many variables that affect the force required to achieve an acceptable seal. For bullet-nose connections, the variables include materials of construction, contact surface conditions, thread condition, and machining quality. Materials of construction influence several aspects of the connection. Harder materials, such as stainless steel, have less lubricity than other metals, which causes higher friction in the thread engagement. Lubricity also affects the durability of the sealing surfaces, as well as the ability of those surfaces to mate and seal, i.e., harder materials of construction are much harder to seal. These materials are also often harder to machine making it more difficult to produce smooth threads.

The surface finish and condition at the point of sealing contact are also critical. Softer materials, such as brass, are more easily damaged, yet are also more malleable, so they can actually deform to minimize imperfections. Machining quality is usually not a problem with the sealing surfaces of outlet connections, but it may impact the threads. This is especially true for the harder materials of construction. Their thread surfaces may be rough and can cause higher-than-normal friction or even galling when making and breaking connections. Damaged or badly worn threads can also cause problems with sealing.

Table 1: Torque Recommendations for Bullet Nose Connections

Valve Material	Nipple Material	Recommended Torque
Brass	Brass	35–45 ft/lb.
Brass	Stainless Steel	35–50 ft/lb.
Stainless Steel	Brass	35–50 ft/lb.
Stainless Steel	Stainless Steel	35–60 ft/lb.
All Materials	"Hand-Tight"	8–15 ft/lb.

Some bullet-nose connections have soft tips or O-rings on the nipples. The nuts on these connections usually have handwheels mounted on them. These connections are sometimes referred to as "hand-tights" because they are designed to be connected and sealed without the use of tools.

If your connection requires more force than the values suggested in Table 1, inspect the connection for marred, dirty, or worn sealing surfaces or worn or damaged threads. Replace any damaged or worn connections.

Washer Materials for Gasketed Connections

With gasketed connections, the material of construction of the washer is important, both for compatibility with the gases in use and for its mechanical properties. Washer materials are non-metallic or metallic. Non-metallic gaskets can be made from many different materials. The most common CGA washers are made from fiber, nylon, PTFE (Teflon®) or CTFE. A typical metallic washer is made from lead or softened copper. Each material has its advantages and disadvantages. The first requirement for a gasket is compatibility with the product being handled. Some of the other properties to be considered are leak integrity, permeation, cold flow, off-gassing, particle shedding, and cost. The tightening force required for gasketed connections is somewhat dependent on the washer material being used.

Air Products recommends specific washer materials for certain applications. Nylon gaskets are recommended for medical yoke connections, while fiber washers are commonly used in carbon dioxide service. PTFE is compatible with most gases and is the most common washer material used with specialty gases. However, PTFE has some properties that can make it a poor choice for a washer material. It has a tendency to cold-flow. Cold flow occurs when pressure is applied to the material, and it flows away from the pressure. This can cause leaks to develop as the washer moves, reducing the sealing pressure on the washer. The flowing washer material can also restrict flow paths and jam in the connection threads. PTFE is also permeable to moisture and oxygen, which can cause microcontamination in sensitive processes.

When PTFE washers are used in systems using water-reactive acidic or basic gases, their moisture can cause the formation of corrosive acids or alkaline liquids in the system. For most specialty gases, CTFE is recommended over PTFE because it is less permeable to oxygen and moisture, and evidences less cold flow. This leads to better leak integrity and allays contamination concerns. In some applications, PTFE mixed with a solid filler material—such as calcium fluoride or brass—is used to reduce the cold flow and permeation rates of the PTFE. This is especially important when PTFE washers are being used in acid gas service where the elimination of moisture contamination is critical. Lead or annealed copper washers are most often used in fluorine and other reactive fluoride service.

For best results, install a new washer with every cylinder change.

For many gasketed connections, overtightening can result in the washer being compressed into the bore of the connection, limiting or

Table 2: Recommended Torque Values for Tightening Washer Materials

Gasket Material	Recommended Torque
Fiber	20–30 ft./lb
PTFE	15–25 ft./lb
CTFE	20–35 ft./lb
Lead	30–45 ft./lb
Copper	35–45 ft./lb

even stopping the flow of gas. Overtightened washers can be distorted into the connection's threads, making disassembly or washer removal difficult. To prevent this from happening, avoid excessive tightening force and install a new gasket with every cylinder change. Gasketed connections do not mechanically bond the valve and connection with the same force as bullet-nose connections. This means if the downstream equipment twists or vibrates, these connections are more likely to develop leaks than bullet-nose connections.

DISS Connections

Ultra-high-integrity service or DISS connections are designed for applications where the requirements for system leak integrity are very high, primarily in the semiconductor industry. A DISS connection is a gasketed type that consists of the valve outlet, nut, nipple, and gasket. The sealing contact surfaces are much more sophisticated than those of a general, industrial connection. The washer is usually made of annealed nickel and has a highly polished surface. The sealing points on the nipple and valve outlet are comprised of highly polished torroidal beads. When the nut is screwed to the valve threads, it pulls the nipple into the valve outlet compressing the washer between the two beads. The beads are driven into the washer allowing the polished beads to form a crush seal onto the washer.

The key to successful sealing of the DISS connection is the extremely smooth finish of the sealing surfaces. These surfaces must be protected to maintain high leak integrity. It is essential to use a new gasket each time the connection is tightened because the softened nickel washer becomes hardened after each compression.

Controlled tightening torque or force is another critical element with successful DISS connections. Sufficient force is required to push the metal sealing surfaces into the washer; too much force will damage the bead surfaces. Thus, torque wrenches should be used for tightening DISS connections. The recommended tightening torque is 35 foot-pounds with a nickel DISS washer and 12 to 15 foot-pounds for a CTFE washer. Slightly higher forces may be used without immediate damage to the connection components, but nickel washers should never be tightened with more than 45 foot-pounds of force. If a required seal can be achieved without exceeding 45 foot-pounds

Table 3: Torque Guidelines for Sealing CGA Outlet Connections

CGA Connection	Recommended Torque		Maximum Torque	
Number	ft–lb	NM	ft–lb	NM
110 (washer)	10	14	15	20
165	8	11	10	14
170 (washer)	10	14	15	20
180 (washer)	10	14	15	20
182	15	20	25	34
200	25	34	35	47
280	25	34	35	47
290	30	41	45	61
295	25	34	35	47
296	35	47	50	68
300	35	47	50	68
320 (washer)	20	27	30	41
326	25	34	35	47
330 (washer)	20	27	30	41
346	35	47	50	68
350	35	47	50	68
410	35	47	50	68
440	40	54	55	75
450	40	54	55	75
500	35	47	50	68
510	35	47	50	68
520	35	47	50	68
540	40	54	60	81
555	40	54	60	81
580	40	54	60	81
590	40	54	60	81
621	35	47	50	68
622	35	47	50	68
624	35	47	50	68
625	35	47	50	68
626	35	47	50	68
660 (washer)	30	41	45	61
670 (washer)	30	41	45	61
678 (washer)	25	34	35	47
679 (washer)	25	34	35	47
705 (washer)	40	54	60	81

NOTE: The CGA data in Table 3 are based on testing conducted in a laboratory environment using new connecting parts. Due to the infinite number of variables, a connection in the field may vary from these results. Therefore, the end user must verify the leak integrity of a connection before putting any cylinder into service based on the data in this table.

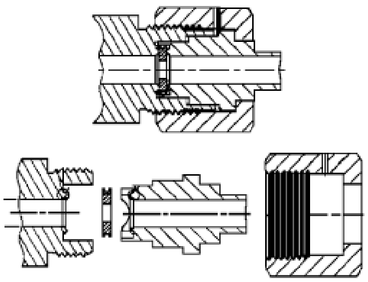

Fig. 3 Typical Ultra High Integrity Connection, (Diameter Index Safety System, DISS)

of force, the connection can be used. If an adequate seal cannot be made, try a new washer. If the new washer does not work, replace the connection.

CGA Technical Support

The CGA has published two technical bulletins: "TB-14: Torque Guidelines for CGA Outlet Connections" and "Guidelines for the Proper Handling and Use of Ultra-High-Integrity Service Connections." Both are available without cost. Order them from CGA through the association's Fax-on-Demand System at +1 (800) 827-5242 or from their web site at www.cganet.com or by calling +1 (703) 412-0900.

Torque guidelines in Table 3 are from CGA's Technical Bulletin TB-14.

Outlet Seals Critical

Outlet seals are an important part of many valve outlets. They are designed to provide a secondary seal in the event the cylinder valve develops leakage through the valve seat. The outlet seals are designed to safely contain full cylinder pressure.

Remember, Department of Transportation (DOT) regulations require that outlet seals be installed on many products. It is also extremely important that they be reinstalled when the cylinder is removed from service. Outlet seals are as important as the outlet connection; make sure that any gaskets required are present and in good condition. Make sure that any outlet seal is properly tightened to the same torque requirement as the CGA connection for the particular valve outlet. If the gasket is not present or must be replaced, select a replacement compatible for the product involved. If you do not have a gasket, contact your supplier for a replacement.

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  Phone: +1 (703) 412-0900
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  1 Batterymarch Park, P.O. Box 9101
  Quincy, MA 02269-9101
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