Installation, operation and maintenance instructions

Gate, globe and check valves

Doc. DT01e-D

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Summary

Parts and sentences which have been modified in the last revision of this document are written in red colour and a vertical line is placed at the right side of them.

1 GENERAL

These instructions apply to all standard valves manufactured by LVF (see enclosure A and the catalogue for further details).

2 INSTALLATION

2.1 VALVE CARE BEFORE INSTALLATION

LVF valves are carefully made from selected materials to give long, trouble-free service when properly installed in applications for which they were designed. Proper care and maintenance in the field can contribute significantly to maximum performance.
The care the valve receives between the time it is shipped by the manufacturer and installed in the piping system is important. During this period, the valve can be handled many times and can be kept in storage for long periods.
Industrial valves are not delicate, but they are mechanical devices which should be treated as such and handled with care.
LVF always provides valves with appropriate end covers to protect the end connections and to prevent foreign material from entering the valve. If at all practical, keep the valves in the original boxes with end covers in place until ready to be installed. Storing the valves off the ground and indoors is always preferable. When stored outside, valves should be off the ground and protected by a weatherproof cover.

Prior to installation, the valves and nameplates should be checked for proper identification to be sure the valve is the proper type and of a suitable pressure class (see paragraph 2.3).
Actuate the valve to check for possible damage from shipping and handling. Also, it is extremely important to inspect the interior of both the valve and the adjoining pipe for cleanliness. By far the major cause of seat leakage and seat damage is foreign material in the line.
Also, inspect end connections to be sure that pipe threads and flange faces are free from scratches, nicks, or dents.

2.2 VALVE IDENTIFICATION

All valves have a nameplate attached that include the figure number, size, pressure class and material. The valve nameplate needs to be reviewed in conjunction with the installation, maintenance, and spare parts ordering instruction in this manual (see also paragraph 13).

2.3 WORKING CONDITIONS

Valves manufactured by LVF are to be installed and assembled on the plant in the observance of the **pressure rating and design temperature** and to the test pressure values.
Moreover limit in the **working temperature** of the valves shall be observed according to the rules detailed in paragraph 14.

In order to preserve the packing best performances, LVF valves are, generally, furnished with the gland bolts loosen. Hence special care is to be placed in the tightening of gland nuts during installation, in order to get the proper packing adjustment and functionality (see paragraph 4 for details).

3 MAINTENANCE

3.1 GENERAL

Replacement of important parts as: **bodies, bonnets, stems, seats and wedges.** For these pieces is preferable to carry out the replacement in our factory or if possible in an well equipped workshop.

Maintenance on other parts, more simple to be replaced or checked, as **gland bolts and nuts, body-bonnet bolts and packing** can be carried out on site.

In any case, please contact our commercial department giving necessary information as described in section 13 to obtain correct pieces to be replaced.
After receiving follow closely instructions given in the applicable point of this manual or contact, for any hesitation, our technical department.

We will not be responsible for any damage due to carelessness on following instructions.

3.2 ROUTINE INSPECTION AND MAINTENANCE

Once the right valve is properly installed, field maintenance is of a generally routine nature and can be readily performed by the user.
The critical areas of a valve include the stem threads and those locations where leakage will most likely occur: the stem packing, the bonnet joint, the seat and the end connections.
It is desirable that a maintenance program be established which will include periodic inspection of the noted critical areas.

The most common location of a noticeable leak is at the stem seal. Leakage at the stem can usually be stopped by adjusting the packing. (see paragraph 4.3).

If leakage cannot be stopped by packing adjustment, either installation of additional packing rings (see paragraph 4.4) or a complete packing replacement (see paragraphs 4.5 and 4.6) is indicated.

4 PACKING

4.1 OVERVIEW

Special care is to be placed in the tightening of gland nuts during installation or after replacement of the packing or during periodic checks (remember that due to natural loss of elasticity of the packing along the time it is possible that tightening is necessary).
Note, on this argument, that great interest is placed today in fugitive emissions from piping components (see for example "EPA" American regulation, TA-LUFT protocol, etc.) in a way that for some places now is compulsory that valve stem emissions be monitored, being estimated one of the greater causes of atmospheric emissions from oil, petrochemical and chemical industries.
Our valves are in accordance to the main of the said regulations; however periodic check for packing adjustment and/or replacement are strongly recommended.

4.2 RECOMMENDATIONS

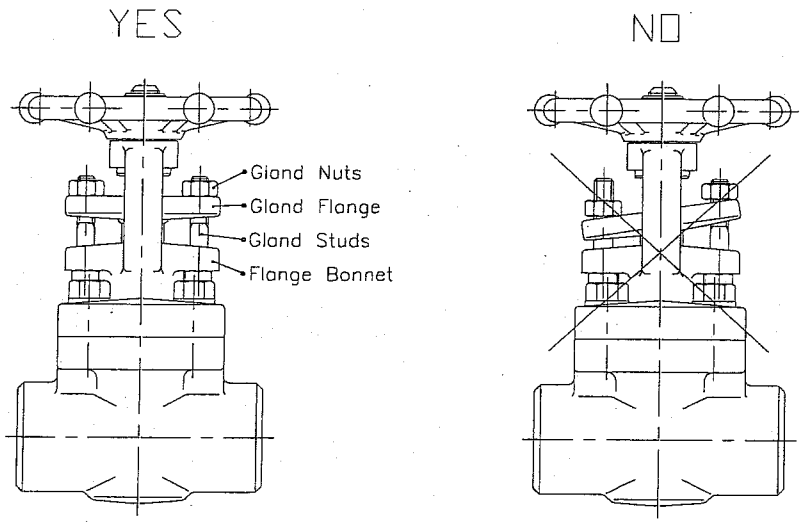
LVF valves are packed with all-purpose packing sets. This is a combination of packing using braided rings at the top and bottom of the packing chamber and flexible graphite packing in the middle section.
Packing glands should be tightened down enough to prevent leakage but not enough to develop excessive operating torque.
When the gland has advanced approximately to half way into the packing chamber, it is recommended that additional packing rings be added. To obtain best results, the stem should be thoroughly cleaned.
Replacement packing should be the same as that originally furnished. LVF valve packing are inhibited to prevent stem pitting in service.
We recommend packing be purchased from LVF to assure packing with the proper density and corrosion inhibitors is always used.

4.3 PACKING ADJUSTING

Packing glands should be tightened down enough to prevent leakage but not enough to develop excessive operating torque.
The packing adjusting is the operation by which the proper compromise is set up. It consists in loosening and/or tightening the gland bolting, taking in care some easy tricks:

- proceed to lock in a alternative way maintaining the stuffing box flange parallel to the lid flange.
- The stuffing box flange, subject to movements caused by the operator, does not lead to horizontal or rotary shifting with respect to the lid flange.

- Every now and then stroke the valve, to allow a correct settlement of the packing and, in the meantime, to check the effort to operate the handwheel.



Should the operator be convinced that described operations were carried out well but some leaks arise the packing must be replaced according to the instructions at paragraphs 4.5 o 4.6.

4.4 ADDING RINGS TO THE PACKING

When the gland has advanced approximately to half way into the packing chamber, it is recommended that additional packing rings be added.
This shall be carried out in this manner:

1. Remove packing gland bolting and free up packing gland.
2. Remove top ring of packing. This will be a braided graphite packing. Prepare chamber to accept new ring or rings of packing.
3. Split a number of packing rings of flexible graphite as required and place individual ring in packing chamber using the gland to ram the packing into the chamber.
   Stagger packing ring's separations by 90° if more than one ring is required.
   Replace top ring of braided graphite packing as required.
4. Tighten packing gland bolting evenly (follow instruction given in paragraph 4.3).
5. Open and close valve to insure free operation and to allow packing settlement. Check for an acceptable force to operate the handwheel.
6. Place valve back in service.

4.5 RE-PACKING DURING A SHUT DOWN

Long service life from modern graphitic packing requires that adequate loads be applied when repacking.
Special care is to paid for what follows:

1. All parts should be clean and not scored or pitted, especially the stem.
2. The valve internal parts and bonnet should be assembled prior to installing the packing.

3. Position split packing rings with the ends of adjacent rings rotated 90°.
4. Install in the original sequence. Standard sequence consist of:
   - Bottom Ring – Braided Ring
   - Middle Rings – Die formed expanded graphite
   - Top Ring – Braided Ring
5. Clean the gland bolts.
6. Carefully seat each individual packing ring following indication of points 3 and 4.
7. Apply the recommended torque to the gland nuts evenly without cocking the gland. See Annex "C" for recommended torques.
8. Tighten the nuts being sure that:
   - proceed to lock in a alternative way maintaining the stuffing box flange parallel to the lid flange.
   - The stuffing box flange, subject to movements caused by the operator, does not lead to horizontal or rotary shifting with respect to the lid flange.
9. Stroke the valve, then re-check the gland nut torques.

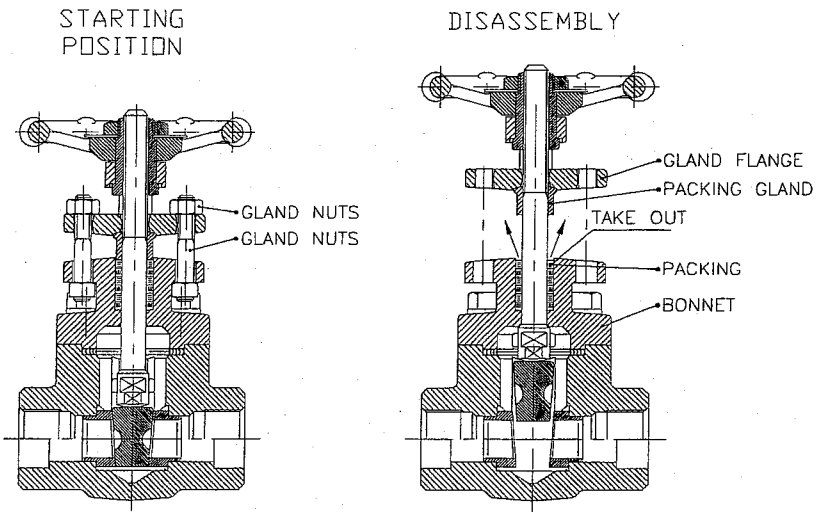
4.6 RE-PACKING THE VALVE UNDER PRESSURE

Back seating the valve and attempting to repack under pressure is hazardous and is not recommended. Rather than attempting to repack under pressure, it is preferable to use the backseat to control the stem leakage until a shutdown provides safe repacking conditions.

When required, re-packing with valve under pressure shall be carried out being sure that:

1. Proceed opening completely the valve taking care that the stem is brought back to backseat position.
2. Only when the stem is in this position, loosen the bolts of the stuffing box flange so to remove pressure from the packing pack.
3. Check that the stem is really in the backseat position ensuring that there are no losses.
4. Only now loose completely nuts and move the flange and the packing gland ring upwards. Remove packing and replace with the new one.
5. Position split packing rings with the ends of adjacent rings rotated 90°.
6. Install in the original sequence. Standard sequence consist of:
   - Bottom Ring – Braided Ring
   - Middle Rings – Die formed expanded graphite
   - Top Ring – Braided Ring
7. Carefully seat each individual packing ring following indication of points 5 and 6.

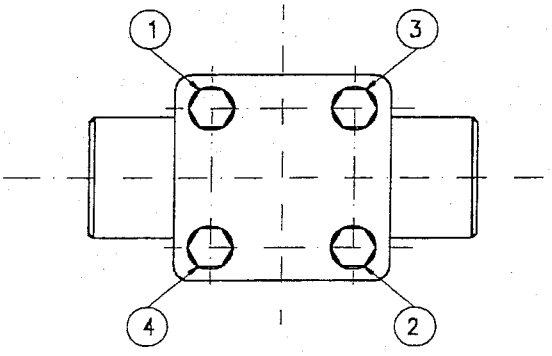
General



8. Bring the packing gland ring and the flange to the original position.
9. Tighten the nuts being sure that:
   - proceed to lock in a alternative way maintaining the stuffing box flange parallel to the lid flange.
   - The stuffing box flange, subject to movements caused by the operator, does not lead to horizontal or rotary shifting with respect to the lid flange.

5 BODY-BONNET BOLTINGS

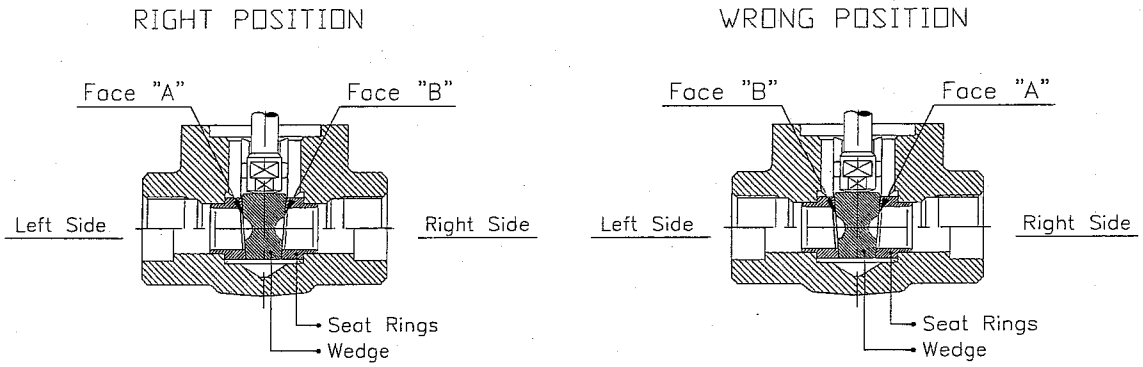
Replacement of these bolts does not require special care.
Only proceed to this operation changing one bolt at a time to prevent losses of pressure on the gasket.
If this is not possible replace the body-bonnet gasket locking bolts in a crossed way (see figure) till torque are the same of Appendix C.



6 MAINTENANCE ON BOLTED BONNET GATE VALVE TRIM

6.1 WEDGE

a) Proceed opening completely the valve taking care that the stem is brought back to backseat position.
b) loosen body-bonnet bolting.
c) Remove bonnet and extract wedge (take note of coupling side with respective seat, see figure) from the special slot of the stem.
d) Check that no incisions or marks are on holding planes. If any use fine sand paper or emery cloth to eliminate them, taking care that the original planarity of these surfaces is not modified.
e) When removed possible defects as described in point d, proceed replacing the gasket between body and bonnet, insert wedge in the slot of the stem making sure that is in the same previous couplement with surface of seats (see figure here below).
f) Proceed tightening body-bonnet bolts as described in section 5.



IMPORTANT: final situation (couplement with faces of seats) will be the same that before disassembling, being this couplement of faces obtained, during first assembling, by expanding the seats with the wedge in the operating position. In case that operator doesn't follow these instructions WE CANNOT GUARANTEE the absence of leakage: the customer is advised about the necessity to perform again the seat test according to the original test specification.

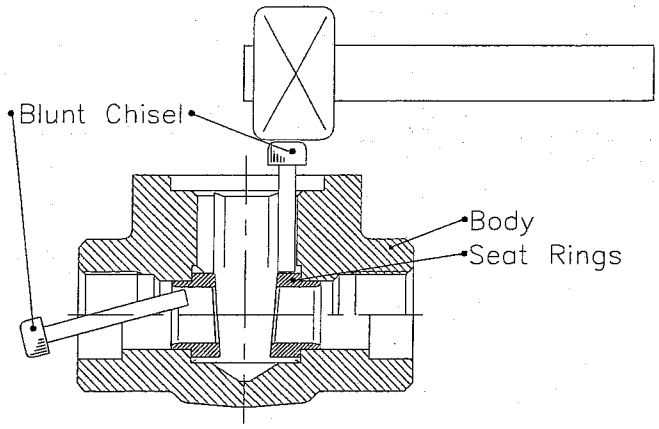
6.2 STEM

a) Proceed opening completely the valve taking care that the stem is brought back to backseat position.
b) loosen body-bonnet bolting.
c) Remove bonnet-stem group (wedge must remain in his position) and then disassemble the stem turning it in anticlockwise way.
d) Make sure that surfaces of the stem (especially the ones in contact with packing) are not damaged. If you are not in this optimal situation contact our commercial department giving information as described later to obtain a new stem and replace screwing it clockwise in the bonnet yoke sleeve.

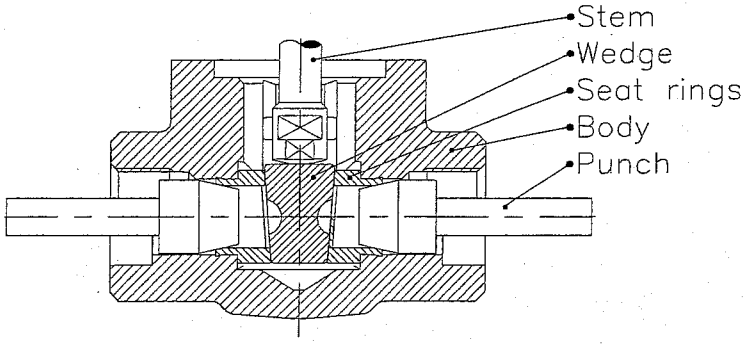
e) Replace body-bonnet gasket.
f) Insert the slot of the stem into the wedge, bring the bonnet to his original position and tighten body-bonnet bolts as described in section 5.

6.3 SEATS

No maintenance is possible on seats of gate valves but only replacement with the aid of blunt chisels and hammer after removal of bonnet and wedge (see figure),



and new seats must be assembled by expansion



Note that seats to be used for this operation, if possible, can be greater in external diameter than the original ones (due to original expansion). In this case please advise the housing diameter into the body to our commercial department in order to obtain the proper seats for replacement.
Being this replacement very difficult to be performed in non-equipped workshops, it is preferable to be carried out in our factory where this procedure will be completed by a new set of hydrostatic tests.

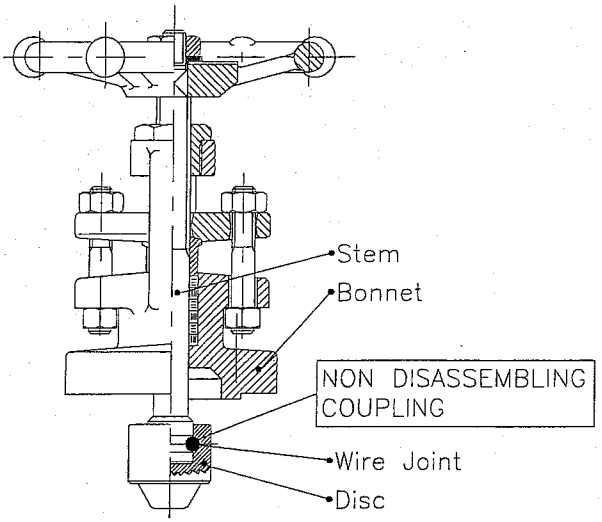
7 MAINTENANCE ON BOLTED BONNET GLOBE VALVE TRIM

7.1 DISC

LVF's globe valves do not allow the disc to be disassembled from stem.

To check seal characteristics between disc and seat we suggest the "BLUEING TEST":

a) Proceed opening completely the valve taking care that the stem is brought back to backseat position.
b) loosen body-bonnet bolting.
c) Remove bonnet with stem and disc attached and put some prussic-blue on surface of the seat.



d) Place the bonnet-stem-wedge group in the original position and tighten bolts as described in section 5.
e) Take the valve in close position, wait 20 seconds min., and repeat points a and b.
f) Remove bonnet again and check that blue trace on wedge is uniformly present on contact surface. If this is not happened there are two possibilities:
   - there are incisions or marks on holding planes. Check and, if any, use fine sand paper or emery cloth to eliminate them, taking care that the original planarity of these surfaces is not modified.
   - no repair is possible because of the great damage. Contact our commercial department giving details as described later to receive a new group stem-wedge and replace it removing the handwheel and turning it in clockwise way so that can leave the bonnet. Assemble the new one in anticlockwise way to the bonnet and put again the handwheel in the original position.
g) Replace the body-bonnet gasket.
h) Reassemble the group bonnet-stem-wedge and close bolts as described in section 5.

7.2 STEM

a) Proceed opening completely the valve taking care that the stem is brought back to backseat position.
b) loosen body-bonnet bolting.

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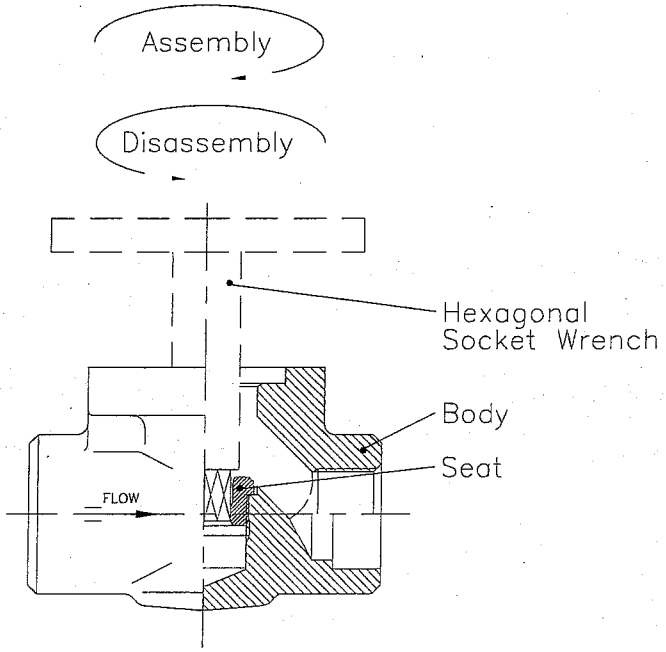
c) Remove bonnet with stem and wedge attached.
d) Make sure that surfaces of the stem (especially the ones in contact with packing) are not damaged. If you are not in this optimal situation contact our commercial department giving information as described later to obtain a new stem-wedge group and replace screwing it anticlockwise in the bonnet yoke sleeve.
e) Replace body-bonnet gasket.
Reassemble the group bonnet-stem-wedge and close bolts as described in section 5.

7.3 SEAT

Check the seat in the same way as described in point 8.1 (blueing test , points a to e).
f) Then remove bonnet again and check that blue trace on seat is uniformly present on contact surface with the wedge and that no damage has occurred. If you are not in this situation, we suggest to contact our commercial department giving details as described later to receive a new seat and replace removing the old one turning it in anticlockwise way with a proper hexagon ring wrench so that it can leave the body. Assemble the new one in clockwise way to the body .
g) Replace the body-bonnet gasket.
h) Reassemble the group bonnet-stem-wedge and close bolts as described in section 5.



8 MAINTENANCE ON BOLTED BONNET CHECK VALVE TRIM

There are three types of check valves : ball, piston and swing type.

8.1 BALL AND PISTON

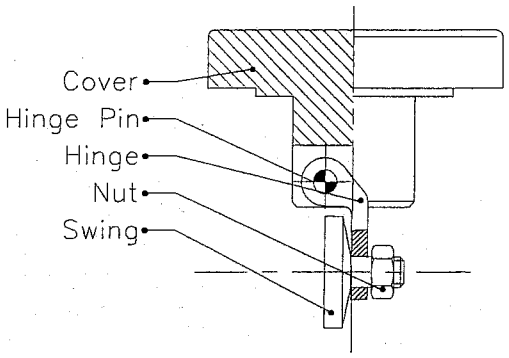
a) Disassemble the valve.
b) Visual check all contact surfaces.
c) No incisions or marks must be on holding planes. If any AND ONLY FOR PISTON use emery cloth to eliminate them, taking care that the original planarity of the surface is not modified.
d) Except for pistons as described in point c, if some damage are present contact our commercial department giving details as described later to receive a new wedge and replace it.
e) Replace the body-bonnet gasket.
f) Reassemble the valve and close bolts as described in section 5.

8.2 SEAT OF BALL OR PISTON VALVES

a) Disassemble the valve.
b) Visual check all contact surface of the seat.
c) No incisions or marks must be on holding planes. If there are damages, we suggest to contact our commercial department giving details as described later to receive a new seat and replace removing the old one turning it in anticlockwise way with a proper hexagon ring wrench (see figure in point 8.3) so that it can leave the body. Assemble the new one in clockwise way to the body .
d) Replace the body-bonnet gasket.
Reassemble the group bonnet-wedge and close bolts as described in section 5.

8.3 SWING TYPE VALVE

a) Disassemble the valve.
b) Visual check all contact surface of the swing wedge.
c) No incisions or marks must be on holding plane. If there are proceed with the aid of a hinge pin extractor to disassemble the swing from the bonnet. If possible use fine sand paper or emery cloth to eliminate them, taking care that the original planarity of the surface is not modified. If result is not satisfactory contact our commercial department giving details as described later to receive a new one. Replace the old loosening the nut and then fix the hinge again to the bonnet using the pin.
d) Replace the body-bonnet gasket.
e) Reassemble the group bonnet-wedge and close bolts as described in section 5.

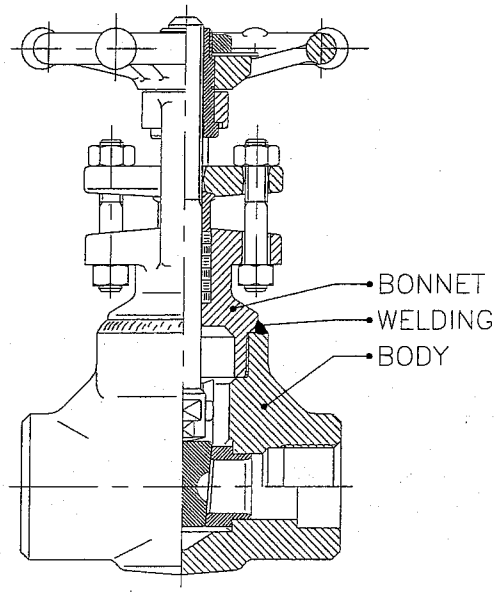


8.4 SEAT FOR SWING TYPE VALVES

As per gate valves no maintenance is possible on the seat, but only replacement as described in section 7.3.

9 GATE, GLOBE AND CHECK VALVES WELDED BONNET

The only one difference with respect to the above mentioned cases is that there is a seal weld between body and bonnet.



So no complete maintenance is for this case programmed. Is only possible a replacement of the packing and tightening of gland bolting as described for bolted bonnet valves.
But for special maintenance (not under our responsibility if not performed in our factory) is possible to remove the seal welding with machining and then, unscrewing the bonnet, proceed as per bolted bonnet valves .
After maintenance and reassembling a new seal weld is necessary (welding procedures are available).

10 VALVES WITH ELECTRIC/PNEUMATIC ACTUATOR

Valves provided or prearranged to be connected to electric and/or pneumatic actuators present the same constructive solutions of the different models (globe, trim), of the valves with manual command. The differences are in fact limited to the presence of an automatic actuator as a substitute of the handwheel.

Therefore this solution allows favourable conditions both about the availability of spare parts, and for the maintenance point of view: it is to be noticed, in fact, than all the maintenance operations described in the above paragraphs cover also the valve with automatic actuator.
For installation, maintenance and normal use regarding strictly the actuators, see the installation manuals supplied with them and making integral part of this document.

10.1 COUPLING VALVE ACTUATOR.

Valves supplied with simple predisposition to connection by actuators, are realised for getting an optimal junction between the two elements; the efficiency of this link depends, in any case, on the connection flange mounted on the actuator: make sure to match all the requirements indicated in data sheet supplied with the valve and here below summarised:

- Actuator's run
- Vertical push
- Torsion moment

The lack of observance of the data sheet requirements relieves LVF S.p.A. for any responsibility on correct behaviour of the valves.

In case of valves supplied with actuators, their substitution shall be done only after the LVF S.p.A.'s verification; the lack of observance of this indication relieves LVF S.p.A. for any responsibility on correct behaviour of the valves.

11 RECOMMENDATIONS FOR FIELD WELDING

11.1 OVERVIEW

Welding activities are special processes: codes to carry out these activities are usually referenced (see paragraph 11.2) as well as Procedure specifications (WPS) and Qualifications (PQR).
The aim of paragraph 11 is, however, to furnish general indication to support the selection of the process to adopt, and to provide auxiliary information to the ones which are stated into a typical WPS.

11.2 EVALUATION OF CODE REQUIREMENTS

Prior to welding, construction code requirements should be reviewed (ASME Section I, VIII, IX, ANSI B31.1, B31.3, etc.). Applicable code requirements may supersede these recommendations.
In the absence of specific code requirements, the guidelines of ASME Section IX are recommended for qualification.

11.3 SELECTION OF PROCESS

Based on the size of the valve and the skill of the welder, either the SMAW (stick) or GTAW (Tig) process is recommended. SMAW is generally preferred, although, GTAW offers more control (at the expense of speed) and may be preferred for ¾" and smaller valves.

11.4 SELECTION OF WELD FILLER METAL

For SMAW, use 3/32" electrode on the first pass with 1/8" for subsequent passes. 1/8" and 5/32" electrodes may be used effectively on larger valves. 3/32" type is recommended for GTAW. 1/16" and 1/8" may also be used successfully.

Care should be taken to use only SMAW electrodes that have been kept essentially free of exposure to moisture. Exposure of coated electrodes to moisture can cause high levels of hydrogen in the weld which can result in delayed cracking, especially with hardenable alloys.

To avoid such a risk follow carefully the electrode supplier instructions. When no instruction is available, the following guidelines can help:

- Electrodes should be kept in heated electrode ovens operating at 120÷150 °C when not being used.
- Limit atmospheric exposure to 8 hours maximum without reheating.
- Electrodes may be used immediately following opening of the hermetically sealed containers in which they are normally supplied.

General

11.5 SELECTING THE WELDER

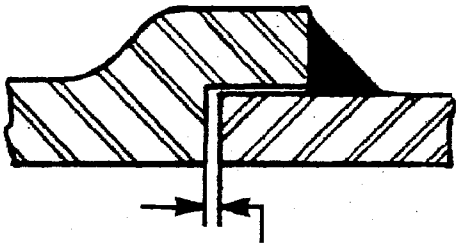
Most construction codes require a welder to qualify prior to making a production weld.
Welder performance qualification provides some assurance that the production weld will be of good quality since the welder has proven, through testing, that he can make a good weld. Care should be taken in comparing the welder's qualification with the code requirements to assure that the welder has qualified with an appropriate test for the intended production weld.

11.6 JOINT CLEANLINESS

The area in-way-of welding should be cleaned to remove, dirt, oil, and protective coatings.
This should be done prior to fit-up or residue in the joint overlap will not be removed.
Sanding, grinding, or wire brushing is usually adequate. Solvents may be necessary, if oil is to be removed.

11.7 FIT-UP (SOCKET WELD VALVES)

To avoid fracture, bottom out the pipe engagement into the socket and pull it back approximately 1,5 mm to allow for weld shrinkage. Tack welds should be contoured to allow for easy inclusion into the final weld.



1.5 mm (1/16 in.)

11.8 WELDING TECHNIQUE

- Prior to welding, the valve should be lightly closed. Where possible, attach the electrical ground to the adjoining pipe on the same side of the valve as the weld being made. Do not attach the ground to the handwheel or upper structure of the valve or arcing across the valve seating surfaces could occur.
- Where possible, welding should be done in the flat or horizontal position. Where vertical welding is necessary, progression should be upward (vertical down welding is prone to lack-of-fusion).
- A minimum preheat of 150÷180 °C is recommended for alloy steels
- A low heat input is preferred as far as allowed by the applicable welding procedure specification.

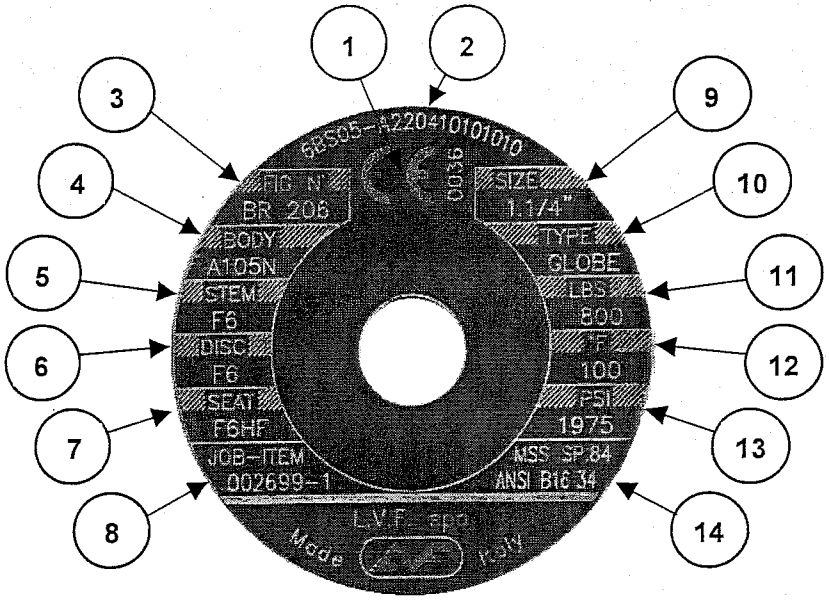
- A minimum of two layers should be used for all socket welds. This will decrease the chance of leaking even if one pass contains a weld defect.
- Due to controls on thickness and chemical composition, post weld heat treatment (PWHT) on LVF steel valves is normally rarely required. However always refer to applicable governing codes to determine if post weld heat treatment is required.

When required, it shall be carried out a localised PWHT. In this manner LVF valve's dimensions normally allow the packing to withstand without damage a not extremely high PWHT temperature. In any case check the packing capability to seal after PWHT and, if the case, replace it (see paragraph 4.5).

12 THE NAMEPLATE

Each single valve made by LVF is equipped with an identification nameplate, placed over the handwheel. Original nameplates are printed up by a customised laser machine to prevent any possibility of counterfeit or imitation.
The nameplate shows several descriptive data, the reference to the applicable design code and the working condition/limits.

The following figure shows, in the legend, the meaning of each single data.



1. Since July 2001 our nameplates bear the CE marking, which means that the valves comply with the safety requirements of European Directive 97/23/EC – PED. The Directive allows the CE logo to be applied ONLY for valves OVER ONE INCH. No logo can be shown in the other sizes.
2. TAG or Customer's identification code
3. LVF Valve's catalogue figure
4. Shell material (body, bonnet, extension...)
5. Stem material
6. Closure member material (in case of hard-facing overlay "HF" will be shown)
7. Seat material (in case of hard-facing overlay "HF" will be shown)
8. LVF job and item number
9. Nominal diameter
10. Valve's typology
11. Valve's Pressure rating
12. Ambient temperature (requested by ANSI/ASME B16.34): this is the temperature which the maximum working pressure (point 13) is referred to
13. Maximum working pressure referred to the ambient temperature (point 12)
14. Applicable Design codes

13 HOW TO ORDER SPARES PARTS

Genuine spare parts and accessories authorized by LVF serve to maintain safety and efficiency. The use of non-authorized parts may lead to personnel injury or damage to parts, and render the warranty void.

Genuine replacement parts are available for LVF current standard valves and can usually be shipped from stock. All parts are made with the same careful inspection and laboratory control given original valves and parts.

To obtain spare parts please contact our commercial department indicating the LVF job and item number.

The LVF job and item number are shown on the identification nameplate set on the handwheel (see paragraph 12) and allow us to provide all the information related both to the valve and to the spare parts.

14 SAFETY INSTRUCTIONS

This paragraph details the essential safety requirements to be taken in care by the user, according to the Annex 1 of the European Directive 97/23/CE (P.E.D.).
Moreover the **temperature** of the valves in the operating conditions shall be maintained within the limits stated by the further **paragraphs**.

14.1 REFERENCE DOCUMENTS

- European Directive 97/23/EC - PED: Pressure Equipment Devices
- LVF Procedure SQ 27: Particular material appraisal according to 97/23/EC – PED

14.2 RISK ANALYSIS

Each single sentence written in bolt characters refer to a general safety note. Otherwise a reference to the proper page of this manual is provided.

RISK	PREVENTIVE ACTION
Accidental contact with dangerous service medium (toxic fluids, high or low temperature fluids, corrosive fluids, etc.) due to a gasket or packing blow out	1) Check periodically the tightness of the bolted connections (connection flanges, body bonnet – flange etc.) – see paragraphs 3.2, and 5 2) Check periodically the tightness of the packing bolts – see paragraphs 3.2, and 4.3 3) Replace periodically gasket and packing – see paragraphs 3.2, 4.4 and 4.5 **4) Replace immediately gasket and packing after a blow out- see paragraph 4.6** **5) Use always protective clothing (masks, gloves, etc.) during all maintenance operations** **6) Predispose supplementary safety protection devices on the bolted connections** **7) Use only suitable and approved materials for gaskets and packing** **8) Avoid absolutely overpressures in the closed cavities due to the "boiler effect", installing apposite relief devices**
Accidental contact with dangerous service medium (toxic fluids, high or low temperature fluids, corrosive fluids, etc.) during the disassembly or maintenance operations	**1) Depressurise completely the valve before all the operations** **2) Open and close the valve and check the internal pressure that should be equal to external ambient pressure before to disassembly the valve.** **3) Empty and drain completely the valve before to disassemble it** **4) Drain the remaining fluid with suitable devices** **5) Vent the valve when disassembled**

RISK	PREVENTIVE ACTION
	6) Use always protective clothing (masks, gloves, etc.) during all maintenance operations
Accidental contact with dangerous service medium (toxic fluids, high or low temperature fluids, corrosive fluids, etc.) due to a leakage from valve body	**1) Check periodically the valve body for corrosion damages (pitting holes, corrosion cracks etc.)**
Structural yielding of valve body with consequent risk of contact with dangerous fluids (corrosive fluids, high or low temperature fluids, etc.) or explosion or fire.	1) Use the valves only in the prescribed pressure / temperature limits – see paragraph 2.3, 14.5 2) Consider the suitability of the material in respect with the service Medium – see Annex E. **3) Check periodically the valve body thickness for erosion or corrosion processes** **4) Predispose supplementary devices to avoid additional forces on the valve body** **5) Avoids absolutely water hammers: install apposite devices if necessary (brakes, anti – shock devices, pressure reducing devices, etc.)** **6) Avoid to submit the valve to excessive vibrations** **7) Avoid quick pressure and / or temperature changes** **8) Avoid absolutely overpressures in the closed cavities due to the "boiler effect" installing (if necessary) apposite relief devices**
Accidental contact with high or low temperature parts	**1) Use always protective clothes (gloves, etc.) during the manoeuvre and maintenance operations** **2) Predispose apposite insulation on the valve** 3) **Predispose apposite warnings about the risks of burns** **4) For cryogenic service use only valves provided with cryogenic extension.**
Fire or explosion in case of service with flammable fluids	**1) Install only EEX proof electrical devices in the area** 2) Check periodically the tightness of the bolted connections (connection flanges, body bonnet – flange etc.) – see paragraphs 3.2, and 5 3) Check periodically the tightness of the packing bolts – see paragraphs 3.2, and 4.3 4) Replace periodically gasket and packing – see paragraphs 3.2, 4.4 and 4.5 **5) During maintenance operation shut down all electrical device s in the area.** **6) Don't smoke and don't use any portable not EEX-**

RISK	PREVENTIVE ACTION
	proof electrical device in the area. 7) **Drain and vent completely the valve before to proceed with the maintenance operations**
Explosion in case of oxygen service	1) **Install and use only valves completely degreased** 2) **Don't grease any component of the valve** 3) **use valves only made with materials suitable for oxygen services (see EN 1797-1).** 4) **Install only EEX proof electrical devices in the area** 5) Check periodically the tightness of the bolted connections (connection flanges, body bonnet – flange etc.) – see paragraphs 3.2, and 5 6) Check periodically the tightness of the packing bolts – see paragraphs 3.2, and 4.3 7) Replace periodically gasket and packing – see paragraphs 3.2, 4.4 and 4.5 8) **During maintenance operation shut down all electrical device s in the area.** 9) **Don't smoke and don't use any portable not EEX-proof electrical device in the area.**

14.3 OTHER INSTRUCTIONS

Here below are provided some further instructions related to the safe use of LVF valves, as outlined by the European Directive 97/23/EC – PED.
Special consideration is given to the temperature/pressure limits in the working condition as depending by the design code (e.g. ASME, Din, BSI...) as well as by the additional safety requirements outlined by 97/23/EC Directive (PED).
Moreover additional suggestions are given to provide the end user with a guideline for the selection of the materials depending on the medium/service foreseen.

14.4 VALVE CLASSIFICATION ACCORDING TO PED

LVF has implemented, operates and maintains a quality system as described in the PED Annex III Module H.
When not otherwise stated LVF valves are designed, manufactured and tested to comply with Category III and for fluid groups 1 and 2.
According to the requirements in PED Annex II the LVF valves are marked with the CE logo as follow:

- Valves from ¼" up to 1": No CE marking is allowed
- Valves above 1": CE marking on the nameplates

Details regarding the method of CE marking for valves above 1" are given in paragraph 12.

14.5 PRECAUTIONS BEFORE INSTALLATION

Prior to the installation, the valves and nameplates should be checked for proper identification to be sure the valve is the proper type and of a suitable pressure class.
Valves manufactured by LVF are to be installed and assembled on the plant in the observance of the **pressure rating and design temperature** and to the test pressures. **Do not use valve with pressure higher than the working values stated in Annex B.**
Additional attention is to be paid to the limits in the **working temperature**, which belong from the **body/bonnet material** according to the **Annex D.**

Annex B shows the test & working pressure values for the most common materials; these values, as well as ones adopted for the not listed materials, comply with the main international standards API 598, ANSI/ASME B16.34, MSS-SP 61...

14.6 MATERIAL MECHANICAL REQUIREMENTS

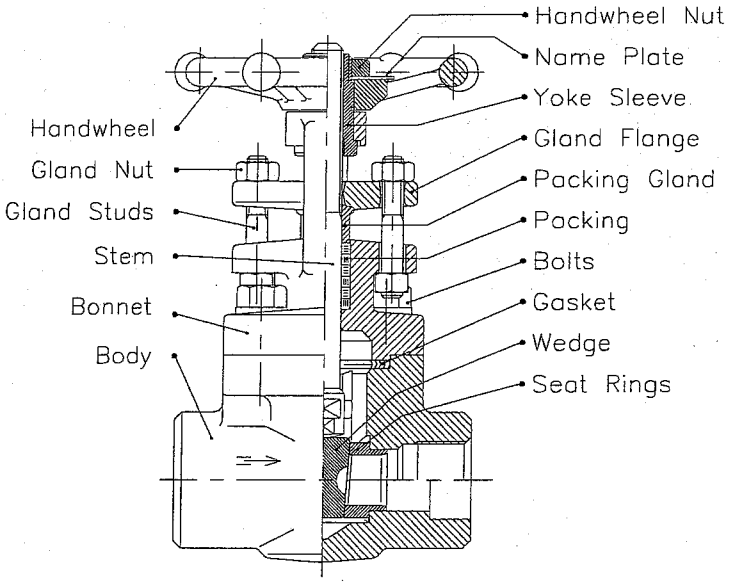
In addition to the requirements of each specific design code adopted, according to the PED – Appendix I, paragraph 7.5, "[...] a steel is considered as sufficiently ductile [...] if, in a tensile test carried out by a standard procedure, its elongation after rupture is no less than 14 % and its bending rupture energy measured on an ISO V test-piece is no less than 27 J, at a temperature not greater than 20°C but not higher than the lowest scheduled operating temperature [...]".
LVF approval, achieved through module "H", is based on a specific procedure for the Particular Material Appraisal (PMA): this procedure is aimed to verify (when no other approval is available for a material) in a statistical way, that the combination of the material/supplier is able to match the above requirements.
Such a procedure, agreed with the Notified Body, is based on mechanical tests and provide results in enough quantity to feel the material sufficiently ductile, according to the PED requirements.

14.7 LVF APPROVED MATERIALS

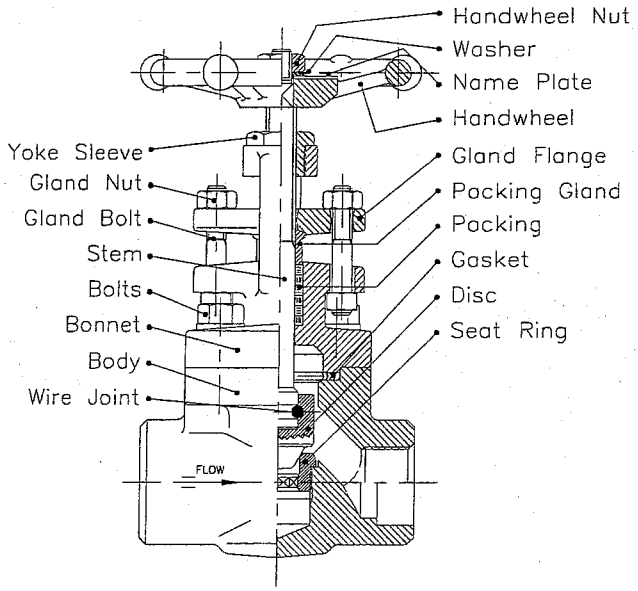
Appendix A shown a list of the main materials approved by LVF, according both to the PMA procedure and to the other internal qualification methods. The list is aimed to provide the end-user instruction about the approved main materials and their lower limit in the working temperature.

The end user is advised that misapplication of the product may result in injuries or property damage. A selection of valve components of the proper material consistent with the particular performance requirement, is important for proper application.
Examples of the misapplication or misuse of the valves include use in an application in which the pressure/temperature rating is exceeded or failure to maintain valves as recommended.

ANNEX A – VALVE S COMONENTS

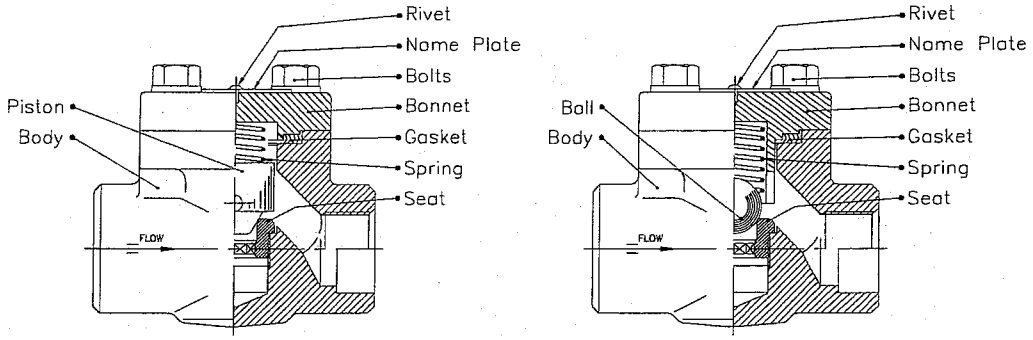


Gate valves

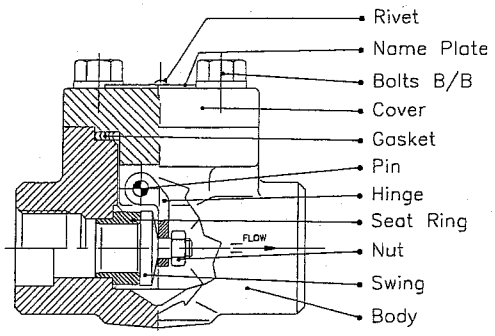


Globe valves

Annex A – Valve's Components



Piston and ball check valves



Swing check valves

ANNEX B

TEST PRESSURE RATING

HYDRAULIC TEST PRESSURE in bar

Values of pressure test according to ANSI B16.34a/1998. For rating 800 lbs the values are in accordance with API 598/1996

Material	150 Lbs		300 Lbs		600 Lbs		800 Lbs		900 Lbs		1500 Lbs		2500 Lbs		4500 Lbs	
	shell	seat	shell	seat	shell	seat	shell	seat	shell	seat	shell	seat	shell	seat	shell	seat
A105	31	22	78	57	155	115	210	150	235	175	385	285	640	470	1150	845
A350 LF2	31	22	78	57	155	115	210	150	235	175	385	285	640	470	1150	845
A350 LF3	31	22	78	57	155	115	210	155	235	175	390	286	650	475	1165	855
A182 F1	26	21	73	53	145	110	210	125	240	175	365	265	600	440	1000	790
A182 F5-F5a	31	22	78	57	155	115	210	155	235	175	390	286	650	475	1165	855
A182 F6a Cl. 2	30*	25*	80*	60*	160*	115*	210*	155*	235*	175*	390*	285*	650*	475*	1165*	855*
A182 F9	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
A182 F11	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
A182 F22	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
A182 F44	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
A182 F51-F53-F55	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
A182 F304-F304H	30	21	76	55	150	110	200	150	225	165	375	275	625	455	1120	820
A182 F304L	25	18	62	46	125	91	170	125	190	140	315	230	520	380	935	685
A182 F316-F316H	30	21	76	55	150	110	200	150	225	165	375	275	625	455	1120	820
A182 F316L	25	18	62	46	125	91	170	125	190	140	315	230	520	380	935	685
A182 F321-F321H	30	21	76	55	150	110	200	150	225	165	375	275	625	455	1120	820
A182 F347-F347H	30	21	76	55	150	110	200	150	225	165	375	275	625	455	1120	820
B381 F2	30*	21*	76*	55*	150*	110*	210*	150*	240*	175*	375*	275*	625*	455*	1120*	820*
A182 F20 (ALLOY 20)	30	22	78	57	155	115	209	155	235	175	390	286	650	475	1165	855
SANICRO 28	25*	18*	62*	46*	125*	91*	210*	125*	195*	145*	315*	230*	520*	380*	935*	685*
MONEL 400	25	18	62	46	125	91	210	125	195	145	315	230	520	380	935	685
MONEL K500	30*	21*	76*	55*	150*	110*	210*	150*	240*	175*	375*	275*	625*	455*	1120*	820*
INCONEL 600	30	21	76	55	150	110	210	150	240	175	375	275	625	455	1120	820
INCONEL 625	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
INCOLLOY 800	30	21	76	55	150	110	210	150	240	175	375	275	625	455	1120	820
INCOLLOY 825	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
HASTELLOY B	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
HASTELLOY B-2	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
HASTELLOY C-276	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855
ZERON 100	31	22	78	57	155	115	210	155	235	175	390	285	650	475	1165	855

* Values of test pressure not included in ANSI B16.34 and API 598

All above values hare been rounded up as follow: P< at 100 bar at the upper unit, P > at 100 bar at to upper 5 units.

WORKING PRESSURE RATING

A105N (note 1, 2) - LF2 (note 2)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	102	135	153	255	425	766	19	51	103	137	155	258	430	775
93	17	46	93	124	139	232	387	697	19	51	103	137	155	258	430	775
148	15	45	90	120	135	226	377	678	19	51	103	137	155	258	430	775
204	13	43	87	116	131	218	364	655	19	51	103	137	155	258	430	775
260	11	41	82	109	123	206	344	619	19	51	103	137	155	258	430	775
315	9	37	75	100	113	188	314	566	18	49	98	131	147	245	409	737
343	8	36	74	98	111	185	308	555	18	48	96	128	144	240	401	722
371	7	36	73	97	110	183	306	550	18	47	95	127	143	239	398	717
398	6	34	69	92	104	173	289	521	16	43	86	115	130	217	361	651
426	5	28	56	75	85	142	236	425	13	35	71	94	106	177	295	531
454	4	18	36	49	55	92	153	276	8	23	46	61	69	115	192	345
482	3	11	23	31	35	59	98	177	5	14	29	39	44	73	123	221
510	2	7	14	18	21	35	59	106	3	8	17	23	26	44	73	133
537	1	3	7	9	10	17	29	53	1	4	8	11	13	22	36	66

LF3 (note 3)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	103	137	155	258	430	775
204	13	48	97	129	145	243	405	729	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	103	137	155	258	430	775
315	9	41	83	111	125	208	347	625	19	51	103	137	155	258	430	775
343	8	40	81	107	121	202	338	608	19	51	103	137	155	258	430	775
371	7	39	78	104	117	195	326	587	18	48	98	130	147	245	408	735
398	6	34	69	92	104	173	289	521	16	43	86	115	130	217	361	651
426	5	28	56	75	85	142	236	425	13	35	71	94	106	177	295	531
454	4	18	36	49	55	92	153	276	8	23	46	61	69	115	192	345
482	3	11	23	31	35	59	98	177	5	14	29	39	44	73	123	221
510	2	7	14	18	21	35	59	106	3	8	17	23	26	44	73	133
537	1	3	7	9	10	17	29	53	1	4	8	11	13	22	36	66

Annex B – Test & Working Pressure Rating

F1 (note 4)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	47	95	127	143	239	398	718	18	47	95	127	143	239	398	718
93	17	46	93	124	140	234	390	702	18	47	95	127	143	239	398	718
148	15	45	89	119	134	224	374	674	18	47	95	127	143	239	398	718
204	13	44	88	117	132	220	367	661	18	47	95	127	143	239	398	718
260	11	42	85	114	128	214	357	642	18	47	95	127	143	239	398	718
315	9	41	83	111	125	208	347	625	18	47	95	127	143	239	398	718
343	8	40	81	107	121	202	338	608	18	47	95	127	143	239	398	718
371	7	39	78	104	117	195	326	587	18	47	95	127	143	239	398	718
398	6	36	73	97	109	183	305	549	18	47	95	127	143	239	398	718
426	5	35	69	93	105	175	291	524	18	47	95	127	143	239	398	718
454	4	33	67	89	100	167	279	503	17	46	93	124	139	229	389	700
482	3	31	62	82	93	154	258	464	15	40	81	107	121	202	337	607
510	2	19	38	51	58	96	161	290	9	24	48	64	72	121	202	363
537	1	11	22	30	34	56	94	170	5	14	28	37	42	71	118	212

F11 Cl. 2 (note 5)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	49	99	132	149	248	414	746	19	51	103	137	155	258	430	775
204	13	47	95	127	143	238	398	717	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	103	137	155	258	430	775
315	9	41	83	111	125	208	347	625	19	51	103	137	155	258	430	775
343	8	40	81	107	121	202	338	608	19	51	103	137	155	258	430	775
371	7	39	78	104	117	195	326	587	19	50	101	134	151	252	421	758
398	6	36	73	97	109	183	305	549	19	50	100	133	150	251	418	753
426	5	35	69	93	105	175	291	524	18	49	99	132	148	248	413	744
454	4	33	67	89	100	167	279	503	17	46	93	124	139	233	389	700
482	3	31	62	82	93	154	258	464	15	40	81	107	121	202	337	607
510	2	22	44	58	65	109	183	329	10	27	54	73	82	137	228	412
537	1	14	29	39	44	74	124	223	7	18	37	49	55	93	155	279
565	1	9	19	26	29	49	82	148	4	12	24	32	37	62	103	186
593	1	6	13	17	19	33	55	99	3	8	16	22	24	41	68	124
621	1	4	8	11	12	21	35	63	2	5	10	14	15	26	44	79
648	1	2	5	6	7	13	21	38	1	3	6	8	9	16	27	48

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

F22 Cl.3 (note 5)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	102	136	153	255	426	766
204	13	48	97	129	145	243	405	729	19	49	99	133	149	249	416	749
260	11	45	91	122	137	229	381	687	18	49	99	132	148	248	413	744
315	9	41	83	111	125	208	347	625	18	49	99	132	148	248	413	744
343	8	40	81	107	121	202	338	608	18	49	98	131	147	246	411	740
371	7	39	78	104	117	195	326	587	18	48	98	130	147	245	408	735
398	6	36	73	97	109	183	305	549	18	47	95	126	142	237	396	713
426	5	35	69	93	105	175	291	524	17	46	92	123	139	232	386	696
454	4	33	67	89	100	167	279	503	16	44	88	118	133	221	369	664
482	3	31	62	82	93	154	258	464	15	41	82	110	124	206	344	620
510	2	25	52	69	77	129	216	390	12	32	65	86	97	162	270	487
537	1	17	35	47	53	89	149	269	8	22	44	59	67	112	187	336
565	1	12	24	32	36	60	100	180	5	15	29	39	45	75	125	226
593	1	7	15	19	22	37	63	113	3	9	18	25	28	47	78	141
621	1	4	9	12	14	23	39	71	2	5	11	15	17	29	49	88
648	1	2	5	7	8	14	23	42	1	3	7	9	10	17	29	53

F5

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	102	136	154	256	427	770	19	51	103	137	155	258	430	775
148	15	49	98	131	148	246	411	740	19	50	100	133	150	251	418	753
204	13	48	97	129	145	243	405	729	18	49	99	132	148	248	413	744
260	11	45	91	122	137	229	381	687	18	49	99	132	148	248	413	744
315	9	41	83	111	125	208	347	625	18	48	97	129	146	243	406	731
343	8	40	81	107	121	202	338	608	18	48	96	128	144	240	401	722
371	7	39	78	104	117	195	326	587	18	47	94	125	141	236	394	709
398	6	36	72	96	109	182	303	546	17	45	91	121	136	227	379	682
426	5	35	69	93	105	175	291	524	16	44	87	117	132	220	366	660
454	4	33	66	88	99	166	277	499	15	41	83	111	125	208	347	625
482	3	25	51	67	76	127	212	383	12	32	63	85	95	159	265	478
510	2	18	37	50	56	94	157	283	8	23	47	63	71	118	196	354
537	1	13	27	36	41	68	114	205	6	17	34	45	51	85	142	257
565	1	9	19	26	29	49	82	148	4	12	24	33	37	62	103	186
593	1	6	13	18	20	34	57	102	3	8	17	22	25	42	71	128
621	1	4	8	11	12	21	35	63	2	5	10	14	15	26	44	79
648	1	2	4	6	7	11	19	35	1	3	5	7	8	14	24	44

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

F9

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	103	137	155	258	430	775
204	13	48	97	129	145	243	405	729	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	103	137	155	258	430	775
315	9	41	83	111	125	208	347	625	19	51	103	137	155	258	430	775
343	8	40	81	107	121	202	338	608	19	51	103	137	155	258	430	775
371	7	39	78	104	117	195	326	587	19	50	101	134	151	252	421	758
398	6	36	73	97	109	183	305	549	19	50	100	133	150	251	418	753
426	5	35	69	93	105	175	291	524	18	49	99	132	148	248	413	744
454	4	33	67	89	100	167	279	503	17	46	93	124	139	233	389	700
482	3	31	62	82	93	154	258	464	15	41	82	110	124	206	344	620
510	2	25	52	69	77	129	216	389	12	32	65	86	97	162	270	487
537	1	17	34	46	52	87	145	262	8	21	43	58	65	109	182	327
565	1	11	23	31	35	58	98	177	5	14	29	39	44	73	123	221
593	1	7	15	20	23	38	65	116	3	9	19	25	29	48	81	146
621	1	5	10	13	15	25	43	77	2	6	13	17	19	32	54	97
648	1	3	7	9	10	17	29	53	1	4	8	11	13	22	36	66

F91

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	103	137	155	258	430	775
204	13	48	97	129	145	243	405	729	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	103	137	155	258	430	775
315	9	41	83	111	125	208	347	625	19	51	103	137	155	258	430	775
343	8	40	81	107	121	202	338	608	19	51	103	137	155	258	430	775
371	7	39	78	104	117	195	326	587	19	50	101	134	151	252	421	758
398	6	36	73	97	109	183	305	549	19	50	100	133	150	251	418	753
426	5	35	69	93	105	175	291	524	18	49	99	132	148	248	413	744
454	4	33	67	89	100	167	279	503	17	46	93	124	139	233	389	700
482	3	31	62	82	93	154	258	464	15	41	82	110	124	206	344	620
510	2	26	52	70	79	133	222	399	12	32	65	86	97	162	270	487
537	1	25	49	66	75	125	208	375	11	28	57	77	86	145	241	435
565	1	24	49	66	74	124	206	372	11	28	57	77	86	145	241	435
593	1	20	41	55	62	104	173	311	9	25	52	69	77	129	216	389
621	1	15	30	41	46	76	127	230	7	19	38	51	57	96	159	288
648	1	9	19	26	29	49	82	148	4	12	24	33	37	62	103	186

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

F304 (note 6) - F304H

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
93	15	41	82	110	124	206	344	620	17	46	92	122	138	230	384	691
148	14	37	74	99	111	186	310	558	15	41	82	110	124	206	344	620
204	13	34	68	91	102	171	285	513	14	38	76	101	114	190	317	571
260	11	32	64	85	96	160	267	481	13	35	71	95	107	178	297	536
315	9	29	60	80	90	150	250	451	12	33	67	89	101	168	280	504
343	8	29	59	78	88	148	246	444	12	33	66	88	99	165	275	495
371	7	29	58	77	87	146	244	439	12	32	65	86	97	162	270	487
398	6	28	57	76	85	143	238	429	12	32	63	85	95	159	265	478
426	5	27	55	74	83	138	231	417	12	31	62	82	93	155	258	465
454	4	27	54	72	82	136	227	409	11	30	61	81	91	152	253	456
482	3	26	53	71	80	134	223	401	11	29	59	79	89	149	248	447
510	2	26	52	69	78	131	219	394	11	29	58	77	87	146	243	438
537	1	22	44	58	66	110	184	331	10	27	56	74	84	140	234	420
565	1	21	42	56	63	106	177	319	10	26	53	70	79	133	221	398
593	1	17	35	47	53	88	147	265	8	22	44	58	66	110	184	332
621	1	13	27	36	41	68	114	205	6	17	34	45	51	85	142	257
648	1	10	21	28	32	53	88	159	5	13	26	35	39	66	110	199
676	1	7	15	20	23	38	65	116	3	9	19	25	29	48	81	146
704	1	5	11	15	17	29	49	88	2	7	14	19	22	36	61	110
732	1	4	8	11	12	21	35	63	2	5	10	14	15	26	44	79
760	1	3	6	8	9	16	27	49	1	4	8	11	12	20	34	62
787	1	2	4	6	7	11	19	35	1	3	5	7	8	14	24	44
815	0	1	3	4	5	9	15	28	1	2	4	6	7	11	19	35

F316 (note 6) - F316H

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
93	16	42	85	113	128	213	355	640	18	47	95	126	142	237	396	713
148	14	38	77	102	115	192	321	578	16	43	86	114	128	215	358	645
204	13	35	70	94	106	177	295	531	15	39	78	104	117	196	327	589
260	11	33	65	87	98	164	274	494	14	36	73	97	109	183	305	549
315	9	31	62	82	93	155	259	466	13	34	69	92	104	173	289	520
343	8	30	61	81	91	153	255	459	13	34	67	90	102	169	283	509
371	7	29	59	79	89	149	249	449	12	33	66	88	100	166	278	500
398	6	29	58	78	88	147	245	441	12	32	65	87	98	164	273	491
426	5	28	58	77	87	145	242	436	12	32	65	86	97	162	270	487
454	4	28	57	76	86	144	239	431	12	32	64	85	96	160	267	481
482	3	28	57	76	85	143	238	429	12	32	63	85	95	159	265	478
510	2	26	53	71	79	133	222	399	12	31	63	84	94	157	263	473
537	1	24	48	64	72	120	200	361	11	28	57	77	86	145	241	435
565	1	23	47	63	71	118	197	355	11	28	57	77	86	145	241	435
593	1	21	42	55	63	105	175	315	9	26	52	69	78	131	219	394
621	1	16	32	43	48	81	135	244	7	20	40	54	61	102	169	305
648	1	12	25	33	38	63	106	191	6	15	32	42	47	79	133	239
676	1	9	20	26	30	50	84	152	4	12	25	33	38	63	105	190
704	1	7	16	21	24	40	66	120	3	9	19	26	29	50	83	150
732	1	6	13	17	19	33	55	99	3	8	16	22	24	41	68	124
760	1	5	10	13	15	26	43	77	2	6	13	17	19	32	54	97
787	1	4	7	10	12	19	33	60	2	5	9	13	15	25	42	75
815	1	2	5	7	8	14	23	42	1	3	4	8	10	17	29	53

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

F304L (note 7) - F316L

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	15	41	82	110	124	206	344	620	17	46	92	122	138	230	384	691
93	13	34	69	93	104	174	290	523	14	38	77	103	116	194	324	584
148	12	31	62	83	93	156	260	469	13	34	69	93	104	174	290	522
204	11	28	56	75	85	142	237	426	12	31	63	84	95	158	264	476
260	9	26	52	69	78	131	219	394	11	29	58	78	88	146	244	440
315	9	24	49	66	74	124	206	372	10	27	55	73	83	138	230	415
343	8	24	48	64	72	120	201	362	10	26	53	71	80	134	224	403
371	7	23	47	63	71	118	197	355	9	26	52	69	78	131	219	394
398	6	23	46	61	69	115	193	347	9	25	51	68	77	128	214	385
426	5	22	45	60	67	113	188	339	9	25	50	67	75	126	210	379
454	4	22	44	58	66	111	184	332	9	24	49	65	74	123	206	371

F321 (note 8) - F321H

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
93	16	44	88	118	133	222	370	667	17	46	94	125	140	234	391	704
148	15	41	82	109	123	205	341	615	9	42	83	111	125	209	349	629
204	13	37	76	101	114	190	317	570	14	38	76	101	114	190	317	571
260	11	35	71	94	106	177	295	531	13	35	71	94	106	177	295	531
315	9	33	67	89	100	167	279	504	12	33	67	89	101	168	280	505
343	8	33	65	87	98	164	274	494	12	33	66	88	99	165	275	496
371	7	32	64	85	96	160	267	481	12	32	65	86	97	162	270	487
398	6	31	63	84	94	157	263	474	12	32	64	85	96	160	268	482
426	5	31	62	82	93	155	259	466	12	32	63	85	95	159	265	478
454	4	30	61	82	92	153	256	461	12	31	63	84	94	158	263	474
482	3	30	61	81	91	152	253	456	12	31	62	83	94	156	260	469
510	2	26	53	71	79	133	222	399	12	31	62	83	94	156	260	469
537	1	24	49	65	73	123	204	368	11	28	57	77	86	145	241	435
565	1	21	43	57	64	107	179	323	10	27	56	74	84	140	234	420
593	1	18	37	49	56	93	156	280	9	24	48	64	73	122	203	365
621	1	16	32	43	48	81	135	244	7	20	40	54	61	102	169	305
648	1	12	25	33	38	63	106	191	6	15	32	42	47	79	133	239
676	1	9	19	25	28	48	80	145	4	12	24	32	36	60	101	181
704	1	7	15	19	22	37	63	113	3	9	18	25	28	47	78	141
732	1	5	11	15	17	29	49	88	2	7	14	19	22	36	61	110
760	1	4	8	11	13	22	37	67	2	5	11	14	16	27	46	84
787	1	3	7	9	10	17	29	53	1	4	8	11	13	22	36	66
815	1	2	5	6	7	13	21	38	1	3	6	8	9	16	27	48

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

F347 (note 8) - F347H

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
93	17	45	91	121	136	227	379	682	18	49	98	131	147	246	411	740
148	15	42	84	113	127	211	353	635	17	45	90	120	135	226	376	678
204	13	39	78	105	118	197	329	593	16	42	85	113	127	212	354	638
260	11	37	74	99	111	186	310	558	15	41	82	109	123	205	342	616
315	9	35	70	94	106	177	295	531	15	39	78	105	118	197	329	592
343	8	34	69	92	104	173	289	521	14	38	77	103	116	194	323	581
371	7	34	68	91	102	170	284	511	14	37	76	101	114	190	317	570
398	6	33	67	90	101	169	282	508	14	37	75	100	113	189	315	567
426	5	33	67	89	100	167	279	504	14	37	75	99	112	187	312	562
454	4	33	66	88	100	167	278	501	14	37	74	99	112	186	310	559
482	3	31	62	82	93	154	258	464	14	37	74	98	111	185	309	556
510	2	26	53	71	79	133	222	399	12	32	65	86	97	162	270	487
537	1	25	49	66	75	125	208	375	11	28	57	77	86	145	241	435
565	1	24	49	66	74	124	206	372	11	28	57	77	86	145	241	435
593	1	22	44	58	66	111	185	302	10	27	55	74	83	138	231	416
621	1	18	37	50	56	94	157	283	8	23	47	63	71	118	196	354
648	1	11	23	31	35	58	98	177	5	14	29	39	44	73	123	221
676	1	8	16	22	25	42	71	127	4	10	21	28	32	53	88	159
704	1	6	12	16	19	32	53	95	3	7	15	21	23	39	66	119
732	1	4	9	12	14	23	39	71	2	5	11	15	17	29	49	88
760	1	3	7	9	11	18	31	56	1	4	9	12	14	23	39	71
787	1	2	5	7	8	14	23	42	1	3	7	9	10	17	29	53
815	1	2	4	6	7	11	19	35	1	3	5	7	8	14	24	44

For welding end valves only. Flanged end ratings terminate at 565°C

F44 - F51 (note 9) - F53 (note 9)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
148	15	45	91	122	137	222	381	687	19	51	102	136	153	255	426	767
204	13	42	84	113	127	211	353	635	18	47	94	125	141	236	394	709
260	11	39	79	105	119	198	330	595	16	44	88	118	133	221	369	664
315	9	38	76	102	115	192	319	575	16	42	85	114	128	214	357	642
343	8	37	75	101	113	189	315	568	16	42	84	112	126	211	352	634
371	7	37	74	99	112	186	311	560	15	41	83	111	125	208	347	626
398	6	36	73	97	109	183	305	549	15	41	82	109	123	205	343	617

Annex B – Test & Working Pressure Rating

N08020: Alloy 20

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
148	15	49	98	131	147	245	409	737	19	51	103	137	155	258	430	775
204	13	46	92	123	139	232	386	696	19	51	103	137	155	258	430	775
260	11	45	90	120	135	225	376	677	19	50	101	134	151	252	420	756
315	9	41	83	111	125	208	347	625	18	48	96	129	145	242	404	727
343	8	40	81	107	121	202	338	608	18	48	96	128	144	240	401	722
371	7	39	78	104	117	195	326	587	18	47	95	127	143	239	399	718
398	6	36	73	97	109	183	305	549	17	47	94	125	141	235	392	706
426	5	35	69	93	105	175	291	524	17	46	93	124	139	232	387	698

N04400: Monel 400

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	15	41	82	110	124	206	344	620	17	46	92	123	138	230	384	692
93	13	36	72	96	109	182	303	546	15	40	81	108	122	203	338	609
148	13	34	68	91	102	170	284	511	14	37	75	101	113	189	316	569
204	12	33	65	87	98	164	274	494	14	36	73	97	110	183	306	551
260	11	32	65	87	98	163	273	491	14	36	73	97	109	182	304	548
315	9	32	65	87	98	163	273	491	14	36	73	97	109	182	304	548
343	8	32	65	87	98	163	273	491	14	36	73	97	109	182	304	548
371	7	32	65	87	98	163	273	491	14	36	73	97	109	182	304	548
398	6	32	64	85	96	161	268	484	13	35	72	95	107	179	300	540
426	5	31	63	84	94	157	263	474	13	35	70	94	105	176	294	529
454	4	23	46	62	70	116	195	350	11	30	61	81	91	152	254	457
482	3	16	34	45	51	85	141	255	8	22	44	58	66	110	184	332

Annex B – Test & Working Pressure Rating

N06600:Inconel 600

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	103	137	155	258	430	775
204	13	48	97	129	145	243	405	729	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	103	137	155	258	430	775
315	9	41	83	111	125	208	347	625	19	51	103	137	154	257	429	772
343	8	40	81	107	121	202	338	608	19	50	101	134	151	253	421	759
371	7	39	78	104	117	195	326	587	18	49	99	132	149	249	415	748
398	6	36	73	97	109	183	305	549	18	48	97	130	146	244	407	733
426	5	35	69	93	105	175	291	524	18	48	96	128	144	240	401	722
454	4	33	67	89	100	167	279	503	17	46	93	124	139	233	389	700
482	3	31	62	82	93	154	258	464	15	41	82	110	124	206	344	620
510	2	22	45	59	67	112	187	338	11	29	58	78	88	146	244	440
537	1	14	29	39	44	74	124	223	7	19	38	51	58	96	161	290
565	1	71	19	25	28	47	79	143	4	12	24	33	37	62	103	186
593	1	6	12	16	19	32	53	95	3	8	16	22	24	41	69	124
621	1	4	9	12	14	23	38	70	2	6	12	16	18	30	50	91
648	1	4	8	11	12	21	35	63	2	5	11	14	16	27	46	83

N08800: Incoloy 800

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	18	49	99	132	148	248	413	744	19	51	103	137	155	258	430	775
93	17	45	91	121	137	228	380	684	19	51	102	135	153	254	424	775
148	15	43	86	114	128	215	358	645	18	47	96	127	144	239	400	764
204	13	41	82	110	124	206	34	620	17	46	92	123	138	230	384	720
260	11	39	79	106	119	199	332	611	16	44	88	118	133	222	370	692
315	9	39	78	105	118	197	329	593	16	44	88	117	132	220	367	667
343	8	39	78	104	117	196	326	588	16	43	87	116	131	218	364	662
371	7	38	77	103	116	194	324	583	16	43	86	115	130	216	361	656
398	6	36	73	97	109	183	305	549	16	43	86	114	128	215	358	650
426	5	34	69	93	104	174	291	524	16	42	84	113	127	212	354	645
454	4	33	67	89	100	167	279	503	16	42	84	113	127	212	353	637
482	3	31	62	82	93	154	258	464	15	41	82	110	124	206	344	635
510	2	26	53	71	79	133	222	399	12	32	65	86	97	162	270	620
537	1	25	49	66	75	125	208	375	11	28	57	77	86	145	241	487
565	1	24	49	66	74	124	206	372	11	28	57	77	86	145	241	435
593	1	22	44	58	66	111	185	333	10	27	55	74	83	138	231	435
621	1	18	37	50	56	94	157	283	8	23	47	63	71	118	197	416
648	1	14	27	37	42	70	116	210	6	17	35	47	53	88	147	354
676	1	8	17	23	26	44	74	134	4	11	23	30	34	58	96	266
704	1	4	8	11	12	21	35	63	2	5	11	14	16	27	46	174
732	1	3	6	8	10	16	28	51	1	4	8	11	13	22	36	82
760	1	2	4	6	6	11	19	35	1	3	6	8	9	15	25	66
787	0	2	4	5	6	10	17	32	1	2	5	7	8	13	23	45
815	0	1	3	4	5	8	14	25	0	2	4	5	6	11	18	33

For welding end valves only. Flanged end ratings terminate at 565°C

Annex B – Test & Working Pressure Rating

N06625: Inconel 625 (note 10) **- N08825: Incoloy 825** (note 8) **- N10276: Hastelloy C-276** (note 11)

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	19	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
93	17	51	103	137	155	258	430	775	19	51	103	137	155	258	430	775
148	15	50	100	133	150	250	418	753	19	51	103	137	155	258	430	775
204	13	48	97	129	145	243	405	729	19	51	103	137	155	258	430	775
260	11	45	91	122	137	229	381	687	19	51	102	136	153	255	426	767
315	9	41	83	111	125	208	347	625	18	49	99	132	149	249	415	748
343	8	40	81	107	121	202	338	608	18	48	97	130	146	244	407	733
371	7	39	78	104	117	195	326	587	18	47	96	127	144	239	400	720
398	6	36	73	97	109	183	305	549	18	47	95	126	143	238	397	714
426	5	35	69	93	105	175	291	524	18	46	94	125	141	236	394	709
454	4	33	67	89	100	167	279	503	17	41	93	124	139	232	387	698
482	3	31	62	82	93	154	258	464	15	32	82	110	124	206	344	620
510	2	26	53	71	79	133	222	399	12	28	65	86	97	162	270	487
537	1	25	49	66	75	125	208	375	11	28	57	77	86	145	241	435
565	1	24	49	66	74	124	206	372	11	27	57	77	86	145	241	435
593	1	22	44	58	66	111	185	333	10	27	55	74	83	138	231	416
621	1	18	37	50	56	94	157	283	8	23	47	63	71	118	197	354
648	1	12	25	33	38	63	106	191	6	16	33	44	49	83	138	249
676	1	9	20	26	30	50	84	151	5	13	26	35	39	65	109	197
704	1	7	14	19	22	37	62	111	3	9	19	25	28	48	80	145

For welding end valves only. Flanged end ratings terminate at 565°C

F904L

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	16	44	88	117	132	220	368	662	18	49	98	131	147	246	410	739
93	15	41	82	110	124	207	345	621	17	46	92	123	138	231	385	693
148	14	37	74	99	112	187	312	562	16	41	83	111	125	209	348	627
204	13	34	68	91	102	171	285	513	14	38	76	102	114	190	318	573
260	11	31	63	83	94	157	262	472	13	35	70	93	105	175	293	527
315	9	29	59	79	89	148	248	446	12	33	66	88	99	166	277	498
343	8	28	57	77	87	145	242	435	12	32	64	86	97	162	269	486
371	7	28	56	75	84	141	235	424	12	31	63	84	94	157	263	473

N08810: Incoloy 810

Temp.	STANDARD CLASS								SPECIAL CLASS							
°C	150	300	600	800	900	1500	2500	4500	150	300	600	800	900	1500	2500	4500
37	15	41	82	110	124	206	344	620	17	46	92	123	138	230	384	692
93	14	37	74	99	111	186	310	558	15	41	83	110	124	207	346	623
148	13	34	69	93	104	174	290	523	14	38	77	89	96	194	324	584
204	12	33	66	88	99	165	275	496	14	36	73	84	89	184	307	553
260	11	31	62	83	94	157	262	471	13	35	70	93	105	175	292	526
315	9	30	60	80	91	151	252	454	13	33	67	89	101	168	281	507
343	8	29	58	77	87	146	244	439	12	32	65	86	97	163	272	490
371	7	28	57	77	86	144	241	434	12	32	64	86	96	161	269	484
398	6	28	56	75	85	142	237	426	12	31	63	84	95	158	264	476
426	5	28	56	74	84	140	234	421	12	31	62	83	94	156	261	470
454	4	27	54	73	82	137	228	411	11	30	61	81	92	153	255	459
482	3	27	54	72	82	136	227	409	11	30	61	81	91	152	254	457
510	2	26	53	71	79	133	222	399	11	29	59	79	89	149	249	448
537	1	25	49	66	75	125	208	375	11	28	57	77	86	145	241	435
565	1	22	44	59	67	112	186	336	11	28	57	77	86	145	241	435
593	1	22	44	58	66	110	184	331	10	27	55	74	83	138	231	416
621	1	18	37	50	56	94	157	283	8	23	47	63	71	118	197	354
648	1	14	28	37	42	71	118	212	6	17	35	47	53	88	147	266
676	1	12	25	33	37	62	104	187	6	15	31	41	46	78	130	235
704	1	9	18	25	28	47	78	142	4	11	23	31	35	59	98	177
732	1	7	14	18	21	35	59	106	3	8	17	23	26	44	73	133
760	1	5	10	13	15	26	43	77	2	6	13	12	12	32	54	97
787	0	4	7	10	12	19	33	60	2	5	9	13	15	25	42	75
815	0	2	5	7	8	14	23	42	1	3	7	9	10	17	29	53

For welding end valves only. Flanged end ratings terminate at 565°C

Notes:

1 Upon prolonged exposure to temperatures above 426°C the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 426°C.
2 Only killed steel shall be used above 454°C.
3 Not to be used above 343°C.
4 Upon prolonged exposure to temperatures above 468°C the carbide phase of carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 468°C.
5 Permissible, but not recommended above 593°C.
6 At temperatures over 537°C, use only when carbon content is 0.04% or higher.
7 Not to be used over 426°C.
8 Not to be used over 537°C.
9 This steel may become brittle after service at moderately elevated temperatures. Not to be used over 315°C.
10 Not to be used over 648°C. Alloy N06625 in the annealed condition is subject to severe loss of impact strength at room temperatures after exposure in the range of 537-760 °C.
11 Not to be used over 676°C.

ANNEX C – RECOMMENDED TORQUE VALUES FOR BOLTING

SIZE		RATING	TYPE	GLAND STUDS PACKING	PACKING BOX BOLT TORQUE	BODY/BONNET BOLT	BODY/BONNET BOLT TORQUE
Reduced Bore	Standard Bore						
1/2"	3/8"	ALL	GATE, GLOBE & CHECK	M 8	13 NM	M 10	55 NM
3/4"	1/2"	ALL	GATE, GLOBE & CHECK	M 8	13 NM	M 10	55 NM
1"	3/4"	ALL	GATE, GLOBE & CHECK	M 8	14 NM	M 12	95 NM
1 1/4"	1"	ALL	GATE, GLOBE & CHECK	M 10	21 NM	M 12	95 NM
1 1/2"	1 1/4"	ALL	GATE, GLOBE & CHECK	M 10	21 NM	M 14	150 NM
2"	1 1/2"	ALL	GATE, GLOBE & CHECK	M 10	25 NM	M 16	230 NM
/	2"	ALL	GATE, GLOBE & CHECK	M 12	37 NM	M 20	450 NM

ANNEX D – MATERIAL WORKING TEMPERATURE LIMITS

Material designation	Min. Working Temperature	Max. Working temperature
A105N	-29°C	Not for prolonged use over 425°C
A350 LF2	-46°C	Not for prolonged use over 425°C
A182 F5	-29°C	Not for prolonged use over 650°C
A182 F9	-29°C	Not for prolonged use over 650°C
A182 F11 Cl. 2	-29°C	Not for prolonged use over 595°C
A182 F22 Cl. 3	-29°C	Not for prolonged use over 595°C
A350 LF3	-101.1°C	Not for prolonged use over 345°C
A182 F304H	-29°C	Not for prolonged use over 815°C
A182 F316H	-29°C	Not for prolonged use over 815°C
A182 F321H	-29°C	Not for prolonged use over 815°C
A182 F347H	-29°C	Not for prolonged use over 815°C
A182 F304	-196°C	Not for prolonged use over 815°C[1]
A182 F321	-196°C	Not for prolonged use over 540°C
A182 F316	-196°C	Not for prolonged use over 815°C[1]
A182 F347	-196°C	Not for prolonged use over 540°C
A182 F51	-50°C	Not for prolonged use over 315°C
A182 F53	-50°C	Not for prolonged use over 315°C
A182 F91	-29°C	-
A193 B7	+20°C	-
A193 B7M	+20°C	-
A193 B16	+20°C	-
A193/A320 B8	-196°C	-
A193/A320 B8 Cl. 2	-196°C	-
A193/A320 B8M Cl. 2	-196°C	-
A193/A320 B8M	-196°C	-
A320 L7	-101°C	-

[1] Use above 540°C only when C content is 0.04 or higher

Annex D - Material Working Temperature Limits

Material designation	Min. Working Temperature	Max. Working temperature
A320 L7M	-73°C	-
A182 F44	-196°C	Not for prolonged use over 400°C
B564 NO4400	-196°C	Up to 482°C
B381 F2	-60°C	Not for prolonged use over 315°C
A694 F60	-46°C	-
B462 N08020	-196°C	-
B564 NO6600	-196°C	Up to 648°C

ANNEX E – MATERIAL CORROSION GUIDE

CORROSIVE MEDIA	Carbon Steel	Stainless Steel 304	Stainless Steel 316	Inconel	Monel	CORROSIVE MEDIA	Carbon Steel	Stainless Steel 304	Stainless Steel 316	Inconel	Monel
Acetate Solvents, Crude	D	A	A	A	B	Ferric Nitrate, 5%	D	B	A	C	D
Acetate Solvents, Pure	C	A	A	A	A	Ferric Sulfate, 5%	D	B	A	B	C
Acetic Acid, 95%	D	B	A	A	A	Ferrous Sulfate, 10%	C	A	A	B	A
Acetic Anhydride, Boiling	D	B	A	A	A	Flourine, Dry Gas	C	C	B	A	A
Acetone	B	A	A	A	A	Flourine, Moist Gas	D	D	D	B	A
Alcohols	B	A	A	A	A	Freon, Wet	C	C	C	B	A
Amines	B	A	A	A	A	Fuel Oil, 140°F	A	A	A	A	B
Ammonia, Anhydrous	B	A	A	A	A	Furfural	B	B	B	B	B
Ammonium Hydroxide, Hot	B	A	A	A	D	Gasoline Sour	B	A	A	C	C
Ammonium Nitrate	B	A	A	A	C	Gasoline Refined	A	A	A	B	A
Aniline Hydrochloride	D	D	C	B	B	Gelatine	D	B	A	A	A
Antimony Trichloride	D	D	C	B	B	Glucose	B	A	A	A	A
Asphalt	B	A	A	A	A	Glycerine	B	A	A	A	A
Barium Chloride, 5%	C	A	A	A	A	Hydrofluoric Acid, Boiling	D	D	D	D	B
Barium Hydroxide	C	A	A	A	A	Hydrofluosilicic Acid	D	D	C	B	A
Barium Nitrate	C	A	A	B	C	Hydrogen Chloride, Dry	B	D	C	A	A
Benzene, Hot	B	A	A	A	A	Hydrogen Chloride, Moist	D	D	D	D	C
Benzoic Acid	B	A	A	A	A	Hydrogen Fluoride, Dry	C	D	C	A	A
Blood	D	A	A	A	A	Hydrogen Peroxide, Boiling	D	C	B	B	B
Bromine, Dry Gas	D	A	A	B	A	Hydrogen Sulfide, Dry	B	A	A	A	A
Bromine, Moist Gas	D	D	D	D	C	Hydrogen Sulfide, Moist	C	B	A	A	B
Buttermilk	D	A	A	A	A	Iodine, Dry	D	D	B	A	A
Calcium Bisulfite, Hot	D	C	B	D	D	Kerosene	A	A	A	A	A
Calcium Chloride, Dilute	C	B	A	A	A	Lactic Acid, 5%	D	B	A	A	B
Calcium Hydroxide, 20%, Boiling	D	A	A	A	A	Lactic Acid, 10%	D	B	A	A	B
Calcium Hydrochloride, < 2%	C	C	B	B	C	Lactic Acid, Boiling, 5%	D	C	B	B	C
Carbolic Acid, 90%	C	A	A	A	B	Lactic Acid, Boiling, 10%	D	D	B	B	C
Carbon Dioxide, Dry	C	A	A	A	A	Lead Acetate, Hot	D	A	A	B	B
Carbon Disulphide	B	A	A	A	B	Magnesium Chloride, Hot, 5%	D	C	B	A	A
Chloroacetic Acid	D	D	C	B	B	Magnesium Hydroxide	B	A	A	A	A
Chloric Acid	D	D	C	C	C	Magnesium Sulfate	B	A	A	B	A
Chlorinated Water, Sat.	D	D	C	C	C	Magnesium Sulfate, Boiling	C	A	A	C	A
Chlorine, Dry Gas	B	B	B	A	A	Mercury	B	A	A	A	B
Chlorine, Moist Gas	D	D	C	D	C	Mercuric Chloride, < 2%	D	D	D	D	D
Citric Acid, Dilute	D	A	A	A	A	Mercuric Cyanide	D	B	B	B	D
Citric Acid, Hot, Conc.	D	C	B	B	B	Methyl Chloride, Dry	D	B	B	A	A
Creosote, Hot	B	A	A	A	A	Milk	D	A	A	A	B
Cupric Chloride, 5%	D	D	C	D	D	Molasses	B	A	A	A	A
Ethyl Chloride	A	A	A	A	A	Naptha	B	A	A	A	A
Ethylene Glycol	A	A	A	A	A	Nickel Chloride	D	C	B	B	B
Ferric Chloride < 1%	D	C	B	B	C	Nickel Sulfate, Boiling	D	C	C	B	A

Annex E - Material Corrosion Guide

CORROSIVE MEDIA	Carbon Steel	Stainless Steel 304	Stainless Steel 316	Inconel	Monel	CORROSIVE MEDIA	Carbon Steel	Stainless Steel 304	Stainless Steel 316	Inconel	Monel
Nitric Acid, 20%	D	A	A	B	D	Sodium Perborate	C	A	A	A	B
Nitric Acid, Boiling, Conc.	D	D	D	D	D	Sodium Peroxide	C	A	A	A	B
Nitrous Acid	D	B	B	B	C	Sodium Phosphate, Tribasic	C	A	A	A	A
Nitrobenzene	D	B	A	B	B	Sodium Silicate	B	A	A	A	B
Oils - Miner.	B	A	A	C	B	Sodium Thiosulfate	D	B	A	B	B
Oxalic Acid, Boiling, 10%	C	A	A	A	A	Stannous Chloride, Sat.	D	D	B	B	B
Oxalic Acid, Boiling, 50%	D	D	C	B	B	Steam, 212°F	A	A	A	A	A
Oxygen	B	A	A	A	A	Steam, 600°F	C	A	A	A	A
Picric Acid	C	A	A	D	D	Sulfite Liquors	D	C	B	D	D
Potassium Bromide	D	C	B	A	A	Sulfur Chloride	D	C	D	B	B
Potassium Carbonate	B	A	A	A	A	Sulfur Dioxide, Moist	D	B	A	D	D
Potassium Chlorate	B	A	A	A	B	Sulfuric Acid, Conc.	B	B	B	B	D
Potassium Chloride	D	A	A	A	A	Sulfurous Acid, Sat.	D	B	B	D	D
Potassium Chloride, Hot	D	C	B	B	A	Tannic Acid, 10%	D	A	A	B	A
Potassium Cyanide	B	B	B	B	B	Tar, Hot	B	A	A	A	B
Potassium Sulfate, Dil.	B	A	A	A	A	Tartaric Acid, 120°F	D	B	A	A	A
Propane, Liquid & Gas	B	A	A	A	A	Toluene	A	A	A	A	A
Pyrogallic Acid	B	A	A	B	A	Trichlorethylene	B	A	A	A	A
Rosin, Molten	D	A	A	A	A	Turpentine	B	A	A	A	A
Salicylic Acid	D	B	B	B	B	Varnish, Hot	C	A	A	A	A
Silver Bromide	D	B	A	C	B	Vegetable Oils	B	A	A	A	B
Silver Chloride	D	D	D	C	B	Vinegar	D	A	A	A	A
Silver Nitrate	D	A	A	A	C	Water, Acid Mine	D	A	A	A	C
Sodium Acetate	C	A	A	A	A	Water, Boiler Feed	B	A	A	A	A
Sodium Bisulfate	D	B	B	B	A	Water, Distilled	D	A	A	A	A
Sodium Bromide, Dil.	D	B	B	B	A	Water, Salt Sea	D	C	B	B	A
Sodium Cyanide	B	B	B	B	A	Whiskey, Boiling	D	A	A	A	C
Sodium Fluoride, 5%	D	B	A	B	A	Wine	D	A	A	A	C
Sodium Hydroxide, 50%	B	A	A	A	A	Xylene, Boiling	D	A	A	A	A
Sodium Hyposulfite	D	B	A	B	A	Zinc Chloride, 5%	D	C	B	B	B
Sodium Nitrate	B	B	A	A	B	Zinc Sulfate, Boiling	D	A	A	B	A

A = Substantial resistance - Preferred material of construction.
B = Moderate resistance - Satisfactory for use under most conditions.
C = Questionable resistance - Use with caution.
D = Inadequate resistance

LVF doesn't assume any responsibility from the use of a.m. data which are purely theoretical. The user must verify the best conditions of use.