# Materials

## Materials of LESER Safety Valves

# Objectives of this Presentation.



This presentation shall be a general guideline for the **selection of materials** for safety valves. Criteria influencing the material selection are:

- general function of the individual valve component (pressure retaining, guiding, etc.)
- material codes and standards
- pressure and temperature ratings
- corrosion, resistance to chemical wear
- wear, erosion

An overview about commonly used materials for safety valves is provided with information on their applications and limits as well as codes and standards regulating material requirements.

**Application criteria influencing the material selection**

The criteria that generally influence the material selection of safety valve components are:

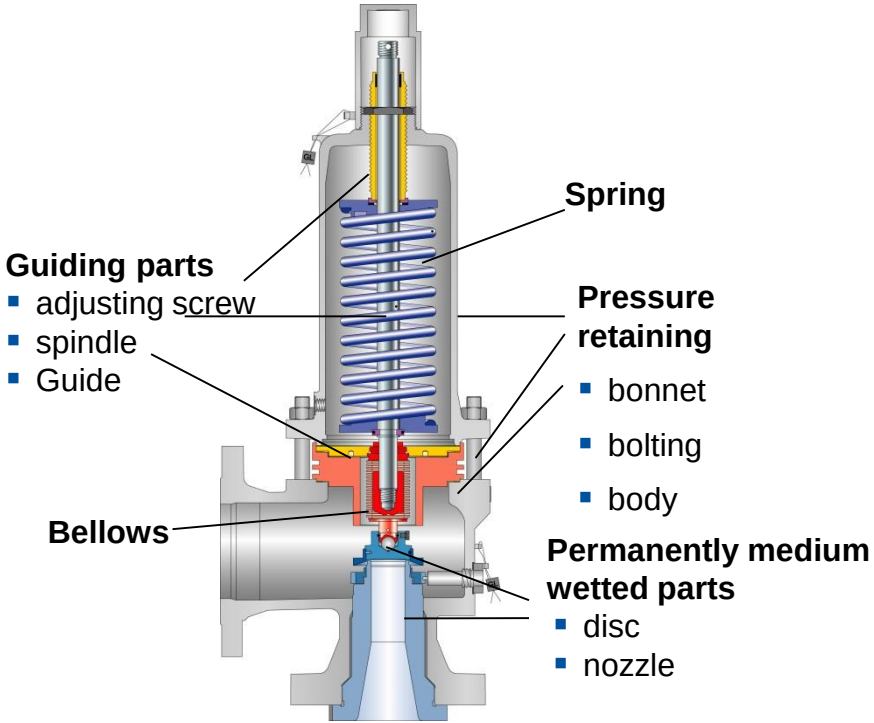
- pressure
- temperature
- corrosive media or environment
- applicable codes and standards

**Critical parts for material selection:**

- ***pressure retaining parts*** – retaining the inlet pressure (body) or outlet pressure (bonnet) including body-to-bonnet bolting
- ***guiding parts*** – providing alignment of the disc to the nozzle, spindle must be moveable at all times
- ***permanently medium wetted parts*** – parts permanently in contact with the medium, also providing tightness of the valve
- ***spring*** – providing the force to keep the valve closed
- ***bellows*** (balanced design only) – providing back pressure compensation and/or corrosion/temperature protection of the guiding part and spring

# **Fundamentals.** Critical Parts for Material Selection.





# **Fundamentals.** Full Nozzle versus Semi Nozzle.

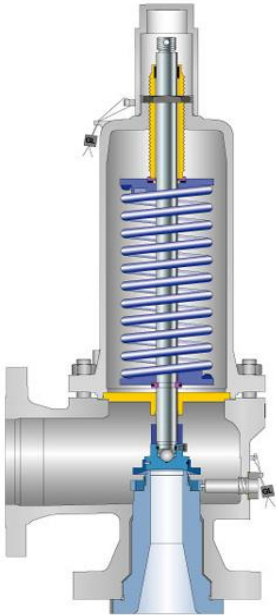


**Full nozzle designs:**

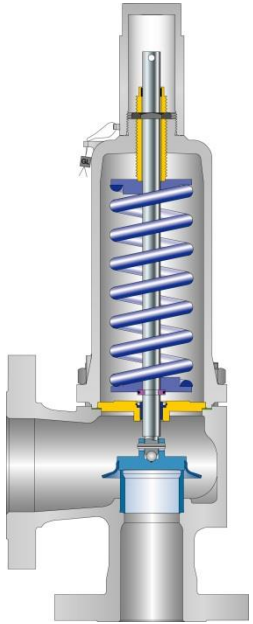
All **permanently wetted** components are typically from corrosion resistant **stainless steel.**

**Semi nozzle designs:**

The body which is normally **carbon** steel is also **permanently wetted**.



Full Nozzle
Design Type 526



Semi Nozzle
Design Type 441

- The inlet piping material can be taken as a rough guideline for the selection of the safety valve body material.

- If the **inlet piping material** is from **carbon steel**, a safety valve with **carbon steel body** will be sufficient in most cases.

- If the inlet piping material is stainless steel, the body material for semi nozzle designs should also be stainless steel.

## ASME VIII

- Acc. to ASME VIII – Div. 1: “UG 136(b)(3):
  “Materials used in bodies, bonnet or yokes, and body-to-bonnet or body-to yoke bolting, shall be listed in ASME II and this Division (ASME VIII – Div.1).”
- “Code Cases”, e.g.: 1750-20

## PED 97/23

The requirements for the main pressure-bearing parts are defined in PED 97/23/EC, Annex 1, 4. Materials, section 4.2. (b):
“The manufacturer must provide in his technical documentation elements relating to compliance with the materials specifications of the Directive in one of the following forms:

- by using materials which comply with harmonized standards,
- by using materials covered by a European approval of pressure equipment materials in accordance with Article 11,
- by a particular material appraisal”

**EN 13445-2 Unfired pressure vessels – Part 2: Materials**

EN 13445-2 specifies the requirements for materials for unfired pressure vessels and supports which are covered by EN 13445-1.

This Part deals with the general philosophy on materials, material grouping and low temperature behavior in relation to room temperature performance.

**EN 1503, Valves - Materials for bodies, bonnets and covers**

part 1: Steels specified in European Standards

part 2: Steels not specified in European Standards (ASTM standards)

**EN 12516, Industrial valves – Shell design strength –**
**Part 1: Tabulation method for steel valve shells**

Refers to material standards for pressure vessel steel

- European standards: Sheet and plate: EN 10028 -1 through -7, castings: EN 10213-2 through -4, forgings: EN 10222 – 2 through -5
- ASTM standards: e.g. castings: ASTM A-216, ASTM A-351, sheet and plate: ASTM A-240, bar: ASTM A-479

# Material Groups.



## CAST IRON

- **Cast Iron**

  Typical materials: 0.6025 (GG-25)

- **Ductile Iron**

  Typical materials:

  0.7043 (GGG-40.3) ASME  SA-395 Gr 60-40-18

## CARBON STEEL

- **Carbon Steel**
  Typical materials:
  1.0460 / SA105 1.0619 (GP240GH) / ASME SA-216 WCB

- **High Temperature Carbon Steel / Chrome Molybdenum Steel**
  Typical materials: 1.7357 (G17CrMo5-5) / ASME SA-217 WC6

- **Low Temperature Carbon Steel**
  Typical materials: ASME SA-352 LCB

## STAINLESS STEEL

- **Ferritic Stainless Steel**
  Typical material: 1.4104
- **Austenitic Stainless Steel**
  Typical material:
  1.4404 / ASME SA 479 316L,
  1.4408 / ASME SA 351 CF8M
- **Martensitic Stainless Steel**
  Typical material:
  1.4122 / MT440 hardened
- **Super Austenitic Stainless Steel**
  Typical materials:
  Alloy AL-6XN, ASME SB 691, UNS N08367
  254SMO, ASME SA-479, UNS S31254

## DUPLEX STAINLESS STEEL

- **Duplex = Ferritic & Austenitic** grain structure
  at the same time (60/40 to 40/60)

- Types: Lean Duplex, 22Cr Duplex, 25Cr Super Duplex, Hyper Duplex

  **- 22 Cr Duplex Stainless Steel**
  Typical Materials:
  Casting: ASME SA-995 Gr 4A / CD3MN / 1.4470
  Bar: ASME SA-479 / ASME SA 182 F51 / UNS S32205 / 1.4462

  **- 25 Cr Super Duplex Stainless Steel**
  Typical Materials:
  Casting: ASME SA-995 Gr 6A / CD3MWCuN / 1.4508
  Bar: ASME SA 479 / ASME SA-182 F55 / UNS S32760 / 1.4501 Safurex

# Material Groups.



- **NICKEL BASE MATERIALS**
  Typical Materials: Hastelloy , Inconel, Incoloy, Monel
- **PURE METALS**
  Typical materials: Nickel, Titanium, Zirkonium, Tantalum

# Standard Materials for LESER Valves.



| Part | Material Group | Product from | EN Material | ASME/ASTM Material | Notes |
|---|---|---|---|---|---|
| **Body / Bonnet** | Cast Iron | Casting | 0.6025 | Cast Iron | max. PN 16 |
| | Ductile Iron | Casting | 0.7043 | SA 395 – 60-40-18 | max. PN 40, ANSI 300 |
| | Carbon Steel | Casting | 1.0619 | SA 216 – WCB/WCC | |
| | Carbon Steel | Plate | 1.0460 / 1.0425 | SA 105 | Type 441XXL only |
| | Carbon Steel | Casting | – | SA 352 – LCB/LCC | Type 526 |
| | High Temp. C.S. | Casting | 1.7357 | SA 217 – WC6 | |
| | Chome Steel | Bar | 1.4104 | N/A | Compact Performance within PED only |
| | Stainless Steel | Casting | 1.4408 | SA 351 – CF8M | |
| | Stainless Steel | Bar, Forging, Pipe | 1.4404 | SA 479 / SA 182 / SA 312 – 316L | bonnets, inlet body Compact Performance |
| | Stainless Steel | Bar | 1.4435 – B2 | SA 479 – 316L | Series 48X, low Delta Ferrite |
| | High Temp. C.S. | Casting | 1.4581 | SA 351 – CF10M | Series 458 only |
| | High Temp. C.S. | Bar, Forging, Pipe | 1.4571 | SA 479 / SA 182 / SA 312 – 316Ti | Type 441XXL only |

# Standard Materials for LESER Valves.



| Part | Material Group | Product from | EN Material | ASME/ASTM Material | Notes |
|---|---|---|---|---|---|
| **Bonnet Spacer** | Stainless Steel | Bar | 1.4404 | SA 479 – 316L | |
| | Carbon Steel | Bar | 1.0460 | SA 105 | |
| **Nozzle** | Stainless Steel | Investm. Casting | 1.4408 | SA 351 – CF8M | |
| | Stellite | Investm. Casting | 1.4408 / Stellite | SA 351 – CF8M Stellite | |
| | Stainless Steel | Bar | 1.4404 | SA 479 – 316L | |
| | Stellite | Bar | 1.4404 / Stellite | SA 479 – 316L Stellite | |

- 1.0619/ WCB, 1.4408/ CF8M: Industry standard casting materials
  LCB for low ambient temperatures
  1.7357/ WC6 for high temperature applications

# Standard Materials for LESER Valves.



| Part | Material Group | Product from | EN Material | ASME/ASTM Material | Notes |
|---|---|---|---|---|---|
| **Disc** | Chome Steel | Bar | 1.4122 | MT 440 | optional |
| | Stainless Steel | Bar | 1.4404 | SA 479 – 316L | |
| | Stellite | Bar | 1.4404 / Stellite | SA 479 – 316L Stellite | |
| **Studs** | Carbon Steel | Stud | 1.1181 | | |
| | Carbon Steel | Stud | 1.7225 | SA 193 – B7 | |
| | High Temp. Alloy | Stud | 1.7709 | SA 193 – B16 | |
| | Stainless Steel | Stud | 1.14401 | SA 193 – B8M | |
| **Nuts** | Carbon Steel | Nut | 1.0501 | | |
| | High Temp. Alloy | Nut | 1.7258 | SA 194 – 7M | |
| | Stainless Steel | Nut | 1.4401 | SA 194 – 8M | |
| **Spindle** | Chome Steel | Bar | 1.4021 | 420 | |
| | Stainless Steel | Bar | 1.4404 | 316L | |
| | Stainless Steel | Bar | 1.4404 tenifer | 316L tenifer | for higher pressure stainless steel valves |

1.4404/ 316L: Common standard disc material LESER prefers hardened chrome steel 1.4122/ MT440 for carbon steel valves because of higher hardness and longer life time.

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# Standard Materials for LESER Valves.



| Part | Material Group | Product from | EN Material | ASME/ASTM Material | Notes |
|---|---|---|---|---|---|
| **Spring** | Chome Steel | Bar | 1.1200 | Carbon Steel | |
| | High Temp. Alloy | Bar | 1.8159 | High Temp. Alloy | |
| | High Temp. Alloy | Bar | 1.7102 | High Temp. Alloy | |
| | Stainless Steel | Bar | 1.4310 | 302 | |
| | Inconel | Sheet | 2.4669 | Inconel X-750 | |
| **Bellows** | Stainless Steel | Sheet | 1.4571 / 1.4404 | 316Ti / 316L | bellows flange and tailpiece from 316L |
| | Inconel | Bar | 2.4856 / 1.4404 | Inconel 625 / 316L | Type 526 only |
| | Elastomer | | EPDM FDA | EPDM FDA | Series 48X |

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# Standard Materials for LESER Valves.



| Part | Material Group | Product from | EN Material | ASME/ASTM Material | Notes |
|---|---|---|---|---|---|
| **Spring** | Chome Steel | Bar | 1.1200 | Carbon Steel | |
| | High Temp. Alloy | Bar | 1.8159 | High Temp. Alloy | |
| **Gasket** | Graphite / S.S. | Gasket | Graphite / 1.4401 | Graphite / 316 | |
| | Reinforced PTFE | Gasket | Gylon | Gylon | optional |

- **Spring.** Optional Inconel X-750 spring for NACE applications of high temperature service
- **Bellows.** Inconel 625 bellows is industry standard for API series valves

In line with the “API High Alloy Concept” LESER also offers high alloy materials like Duplex, Super Duplex and Nickel based materials as standard materials with short delivery times.

# **Material Certificates & Traceability.** Types of Material Certs, EN 10204.



| **Test Report 2.2** |
| --- |
| Document in which the manufacturer declares that the products supplied are in compliance with the requirements of the order and in which he supplies test results based on non-specific inspection. |
| **Inspection Certificate 3.1** |
| Document issued by the manufacturer in which he declares that the products supplied are in compliance with the requirements of the order and in which he supplies test results.<br>The test unit and the tests to be carried out are defined by the product specification, the official regulation and corresponding rules and / or the order.<br>The document is validated by the manufacturer's authorized inspection representative, independent of the manufacturing department. |
| **Inspection Certificate 3.2** |
| Document prepared by both the manufacturer's authorized inspection representative, independent of the manufacturing department and either the purchaser's authorized inspection representative or the inspector designated by the official regulations and in which they declare that the products supplied are in compliance with the requirements of the order and in which test results are supplied. |

**Please note:**

The majority of material certificates used by LESER are 3.1 because 2.2 is not specific enough and 3.2 is cost and time consuming.

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# **Material Certificates & Traceability.** Double Material Certificates.



Every pressure retaining or containing component like body, bonnet, nozzle, disc supplied by LESER is double material certified acc. to the applicable EN material standard and the corresponding ASME II material.
That means chemical composition and mechanical properties of the supplied material fulfills EN and ASME II requirements at the same time.

| EN Material | ASME Material |
|---|---|
| 0.7043 | SA-395 – 60-4-18 |
| 1.0619 | SA-216 – WCB/WCC |
| 1.4408 | SA-351 – CF8M |
| 1.7357 | SA-217 – WC6 |
| 1.4404 | SA-479 – 316L [1)] |
| 1.0460 | SA 105 |

1): 4-fold certification 1.4404/316L / 1.4401/316 is under preparation

# **Material Certificates & Traceability.** Traceability of Materia.



- In accordance with national and international standards every pressure containing part of LESER safety valves is marked permanently. The marking ensures the material identification and the material traceability as a minimum. **Material traceability** is ensured by a **four digit LESER material code number**. This number in combination with the material designation allows to identify the correct material certificate for the individual part.
- Material certificates can easily be downloaded from the LESER homepage under “Certifcates”
- If a material certificate is requested for an individual part after the valve was supplied please use the request form “Request for material test report” from the LESER homepage. For detailed questions please contact certificate@leser.com .


| Part | Disc | Explanation |
|---|---|---|
| 1 | GL1 | Name of the laboratory authorized expert |
| 2 | 1.4404/316L | Material designation DIN / ANSI |
| 3 | CODE 3924 | Material code number |

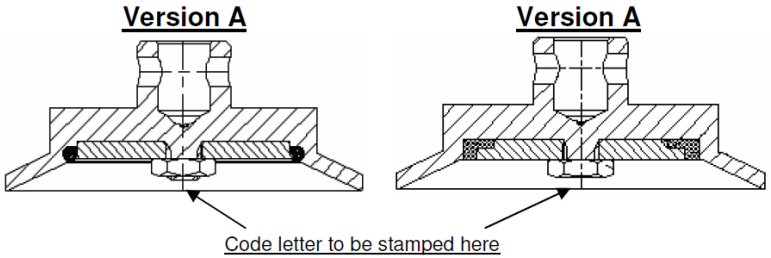
# **Material Certificates & Traceability.** Markings Soft Seal Material on the Disc.

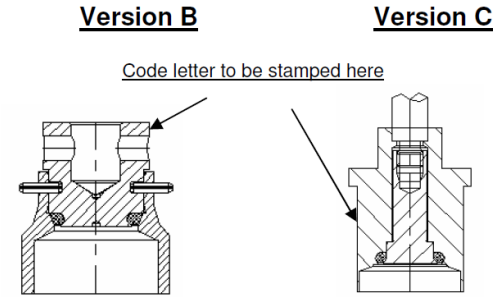


- In case of a soft sealing disc the soft sealing material is marked by a code letter on the disc as described below. In addition the LESER NGA nameplate is marked with the same code letter.
- **Soft seal material marked by a code-letter**

  - K = CR (Neoprene)
  - D = EPDM
  - L = FKM (Viton)
  - N = NBR (Perbunan)

There are three possibilities to mark the material code of the soft sealing on the disc. Basically the code letter is stamped underneath the disc.

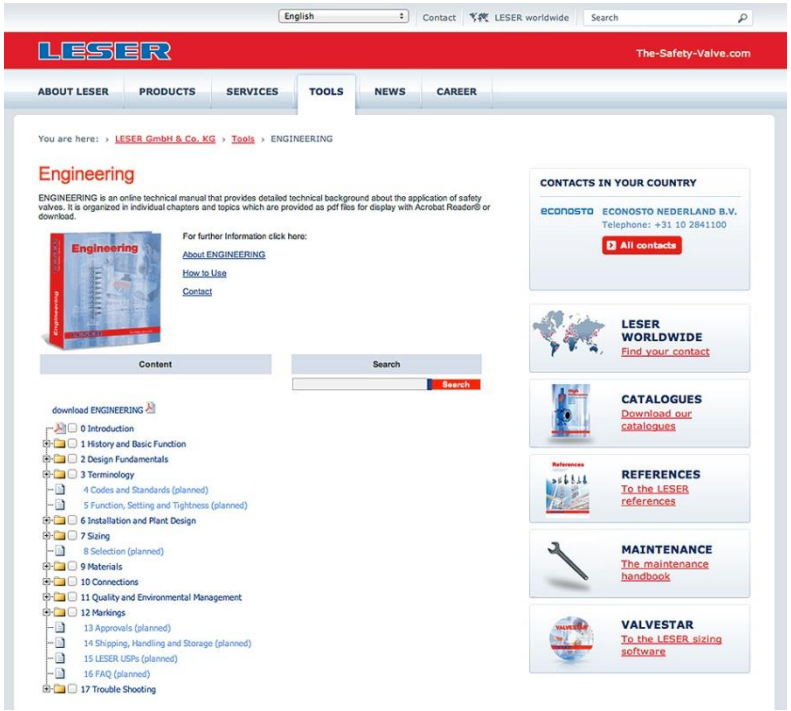


# **Material Certificates & Traceability.** Further Markings on the Safety Valve.



Type and location of further markings on the safety valve are explained in the ENGINEERING Handbook Chapter 12 Markings on the LESER homepage. www.leser.com/en/tools/engineering



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# PREN.



**Pitting resistance equivalent numbers** (PREN) are a theoretical way of comparing the pitting corrosion resistance of various types of stainless steels, based on their chemical compositions.

PREN = %Cr + 3,3*%Mo + 16*%N (+1,65*%W).

This number can be used to rank different materials but does not provide an absolute value for corrosion resistance and is not applicable in all environments.

| Typical Ranges of PREN | |
|---|---|
| Material | PREN |
| 300 Series stainless steel | 20 – 25 |
| Duplex stainless steel | 30 – 40 |
| Super Duplex<br>Super Austenitic | > 40 |

PREN > 40 is considered to be resistant against sea water.

# CE.



The **Carbon Equivalent** (CE) is used for rating of weld-ability of ferritic low alloy steels. It takes into account the equivalent additive effects of carbon and other alloying elements on a particular characteristic of a steel.

| | |
|---|---|
| **CE ≤ 0,35** | good weldability |
| **0,35 ≤ CE ≤ 0,65** | preheating required before welding |
| **CE ≥ 0,65** | the material is considered to be not weldable |

A commonly used formula to calculate the Carbon Equivalent is based on a publication of the International Institute of Welding (IIW) [Technical Report 1967, IIW Doc. IX-535-67]:

**CE = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15**

Besides the above further formulas can be found in the literature.

# UNS = Unified Numbering System.



The Unified Numbering System (UNS) is an alloy designation system widely accepted in North America.

It consists of a prefix letter and five digits designating a material composition.

A prefix of S indicates stainless steel alloys, C for copper, brass, or bronze alloys.

A UNS number alone does not constitute a full material specification because it establishes no requirements for material properties, heat treatment, form, or quality.

| UNS Series | Metal Type(s) |
|---|---|
| A00001 to A99999 | Aluminium and alumnium alloys |
| C00001 to C99999 | Copper and copper alloys |
| F00001 to F99999 | Cast irons |
| G00001 to G99999 | AISI and SAE carbon and alloy steels (except tool steels) |
| J00001 to J99999 | Cast steels (except tool steels) |
| N00001 to N99999 | Nickel and nickel alloys |
| R00001 to R99999 | Reactive and refractory metals and alloys |
| S00001 to S99999 | Heat and corrosion resistant (stainless) steels |

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**Materials**

Thank you for your attention.