Control Valve Standards

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Standards - Abbrevations

- **ASME** – American Society of Mechanical Engineers
- **ASTM** – American Society for Testing and Materials
- **IEC** – International Electrotechnical Commission
- **ISO** – International Organization for Standardization
- **NACE** –National Association for Corrosion Engineers
- **FCI** – Fluids Control Institute
- **ISA** – Instrument Society of America (Now Known as Instrumentation, Systems, and Automation Society)
- **NEMA** – National Electrical Manufacturer's Association
- **CSA** – Canadian Standards Association
- **DIN** – Deutsches Institut fur Normung (German Institute for Standardization)
- **CEN** – European Committee for Standardization
- **BS** – British Standards

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American Society for Mechanical Engineers

- Founded in 1880
- ASME is a non-profit professional organization
- Codes and Standards, Knowledge and Community, Centers, Institutes, and Strategic Management
- Art, Science and practice of Mechanical and Multidisciplinary Engineering and Allied Sciences throughout the world.
- Mission - Better enable mechanical engineering practitioners to contribute to the well-being of humankind

American Society for Mechanical Engineers

- ASME B 16.5: Pipe flanges and flanged fittings for NPS ½ inch to 24 inches.
- ASME B16.10: Face-to-Face and End-to-End Dimensions of Valves (Face-to-Face Dimension not covered)
- ASME B16.34 : Valves - Flanged, Threaded, and Welding End - Pressure-Temperature Ratings, Sizes, Dimensions, Tolerances, Materials, Marking, Pressure Testing, Requirements for special class Valves and Non-Destructive Examination requirements.
- ASME B16.47: Large Diameter Steel Flanges, NPS 26 Through 60
- ASME B31.1: Power piping code
- ASME B31.3: Process piping code

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American Society for Testing and Materials

- ASTM Internationals- was formed a century ago
- ASTM - One of the largest voluntary standards development organizations for technical standards for materials, products, systems, and services
- ASTM International - have an important role in the information infrastructure that guides design, manufacturing and trade in the global economy
- The standards on Material is widely used in Control Valve Industry.
- ASTM A216 grade WCC, ASTM A217 grade WC9, ASTM A351 CF8M etc.

International Electrotechnical Commission

- IEC - founded in 1906 and currently based in Geneva, Switzerland
- Its function is to coordinate, design, and publish international standards in fields related to electronics, including telecommunications
- International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology"
- IEC standards cover a vast range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy, ..

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International Electrotechnical Commission

Most of the IEC standards are based on ISA standards:

- IEC 60534-1: Control Valve Terminology and Considerations
- IEC 60534-2: Flow capacity Sizing Equations for incompressible fluids
- IEC 60534-3: Dimensions, Face to Face dimensions for flanged, two-way control valves
- IEC 60534-4: Inspection and routine testing
- IEC 60534-5: Marking
- IEC 60534-7: Control Valve Data Sheet
- IEC 60534-8-1: Noise Considerations- Laboratory measurement of noise generated by aerodynamic flow.
- IEC 60534-8-2: Noise Considerations- Laboratory measurement of noise generated by hydrodynamic flow.
- IEC 60534-8-3: Noise Considerations- Control valve aerodynamic noise prediction method

International Organisation for Standardization

- ISO - world's largest developer and publisher of International Standards.
- ISO is a network of the national standards institutes of 157 countries with a Central Secretariat in Geneva, Switzerland, that coordinates the system.
- ISO is a non-governmental organization that forms a bridge between the public and private sectors.
- ISO enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society.
- ISO 5752(1982), Metal valves for use in flanged pipe systems –Face-to-face and centre

National Association for Corrosion Engineers

- Founded in1943
- Mission-to protect people, assets, and environment from the effects of corrosion.
- NACE International is involved in every industry and area of corrosion prevention and control, from chemical processing and water systems to transportation and infrastructure protection.
- NACE International serves its members by:
  - Setting standards for the corrosion industry
  - Disseminating the latest technology worldwide through peer-reviewed journals and technical papers

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National Association for Corrosion Engineers

- NACE MR0175:
  - It has been in place since 1975 and till 2002, it was addressing Sulfide Stress Corrosion
  - Cracking in materials used in Oil Field Equipment
  - In late 2003, it was majorly revised and also NACE MR0175/ISO 15156 came into existence. This new NACE Standards addresses Chloride stress corrosion cracking
  - (SCC) as well as Sulfide stress corrosion cracking (SSC) in materials used in Oil and Gas Production. Many environmental restrictions were included in these standards.
- NACE MR0103:
  - Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments

Fluids Controls Institute

- FCI – formed in 1921
- FCI - An association of manufacturers of equipment for fluid (liquid or gas) control and conditioning.
- The institute is organized into product-specific sections which address issues that are relevant to particular products and/or technologies
- FCI 70-2-1991, Control Valve seat Leakage

Instruments Systems and Automation

- Formerly known as Instruments Society of America
- ISA - Founded in 1945
- ISA is a leading, global, nonprofit organization that is setting the standard for automation
- Based in Research Triangle Park, North Carolina, ISA develops standards
- ISA has standards committees for symbols and nomenclature used within the industry, safety standards for equipment in non-hazardous and hazardous environments, communications standards.
- To permit interoperable equipment availability from several manufacturers, and additional committees for standards on many more technical issues of importance to the industry

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Instruments Systems and Automation

- Flow Equations for Sizing Control Valves - ISA-75.01.01-2002 (60534-2-1 Mod)
- Control Valve Terminology - ISA-75.05.01-2000 (R2005)
- Control Valve Capacity Test Procedures - ISA-75.02-1996
- Face-to-Face Dimensions for Flanged Globe Style Control Valve Bodies - ISA-75.03-1992
- Laboratory Measurement of Aerodynamic noise generated by Control Valves - ISA-75.07-1987
- Inherent Flow Characteristics and Rangeability of Control Valves - ISA-75.11-1985(R1991)
- Method of Evaluating the Performance of positioners with Analog Input Signals - ISA-75.13-1996
- Hydrostatic Testing of Control Valves - ISA-75.19-1995

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National Electrical Manufacturers Association

- NEMA -Created in 1926 by the merger of the Electric Power Club and the Associated Manufacturers of Electrical Supplies
- It provides a forum for the standardization of electrical equipment, enabling consumers to select from a range of safe, effective, and compatible electrical products.
- Development of technical standards that are in the best interests of the industry and the users of its products
- Establishment and advocacy of industry policies on legislative and regulatory matters that might affect the industry and those it serves
- Collection, analysis, and dissemination of industry data
- Promote safety in the design, manufacture and use of electrical products.
- ICS 5, Part 3, Clause 9

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Canadian Standards Association

- The Canadian Standards Association is a not-for-profit membership-based association serving business, industry, government and consumers in Canada as well the global marketplace.
- As a solutions-oriented organization, works in Canada and around the world to develop standards that address real needs, such as enhancing public safety and health
- Advancing the quality of life. Helping to preserve the environment. Facilitating trade.
- Helps people understand standards through education and information products and services.

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Deutsches Institut fur Normung

- DIN - The German Institute for Standardization, develops norms and standards as a service to industry, the state and society as a whole.
- A registered non-profit association, DIN has been based in Berlin since 1917.
- Through its standards and handbook DIN facilitates the international exchange of goods and services
- It encourages cooperation in the realms of intellectual, scientific, technological, and economic activity.

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Comité Européen de Normalisation

- CEN - founded in 1961 by the national standards bodies in the European Economic Community and EFTA countries.
- Now CEN is contributing to the objectives of the European Union and European Economic Area with voluntary technical standards
- Promotes free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement.
- CEN is a non-profit making technical organization set up under Belgian law.

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British Standards

- British Standards are produced by BSI British Standards
- Over time the standards developed to cover many aspects of tangible engineering, and then engineering methodologies including quality systems, safety and security.
- British Standards is a non-profit distributing organization
- British Standards works with manufacturing and service industries, businesses, governments and consumers to facilitate the production of British, European and international standards.

Approval Agencies

- ATEX
  - French “ATmospere EXplosible” (explosive atmosphere)
- CE
  - French “Conformite Europeene” (European Conformance)
  - Indicates that a product fulfills all essential safety and environmental requirements in European directives
  - Does not address use in hazardous locations
- CSA
  - Canadian Standards Association
  - Certification in hazardous location within Canada
- Ex, XP
  - Certification of Explosion proof in Europe , fireproof elsewhere
- FM
  - Factory Mutual Research Corporation
  - Determines whether equipment and materials used in hazardous locations meet National Electrical Code standards for safety and reliability.

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NACE Application

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Sulfide Stress Cracking (SSC)

- Combined action of Tensile stress and H2S (Corrosive medium)
- Hydrogen formed in Corrosion process embrittle the material.
- H2S promotes the entry of hydrogen atoms in base metal

Corrosion: The chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.

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The Basics of Sulfide Stress Cracking

- Hydrogen ions are a product of many corrosion processes.
- These ions pick up electrons from the base material producing hydrogen atoms.
- At that point, two hydrogen atoms may combine to form a hydrogen molecule.
- Most molecules will eventually collect, form hydrogen bubbles, and float away harmlessly.

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The Basics of Sulfide Stress Cracking

- Some percentage of the hydrogen atoms will diffuse into the base metal and embrittle the crystalline structure.
- When the concentration of hydrogen becomes critical and the tensile stress exceeds the threshold level, SSC occurs.
- H2S does not actively participate in the SSC reaction; sulfides promote the entry of the hydrogen atoms into the base material

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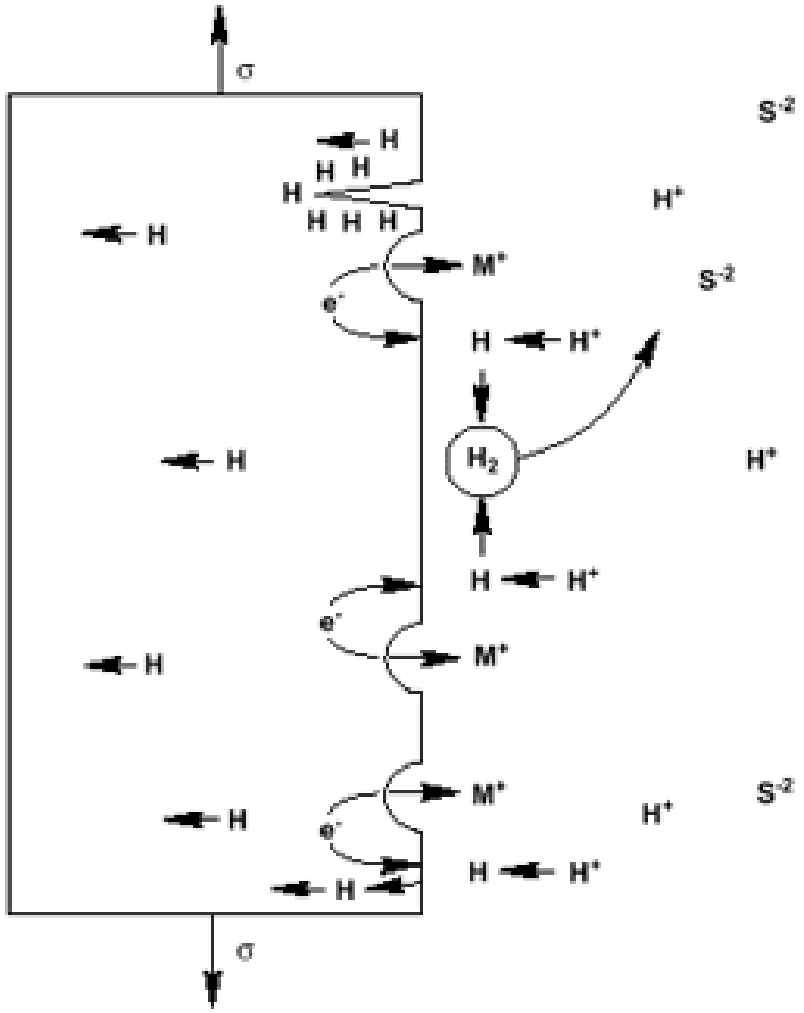
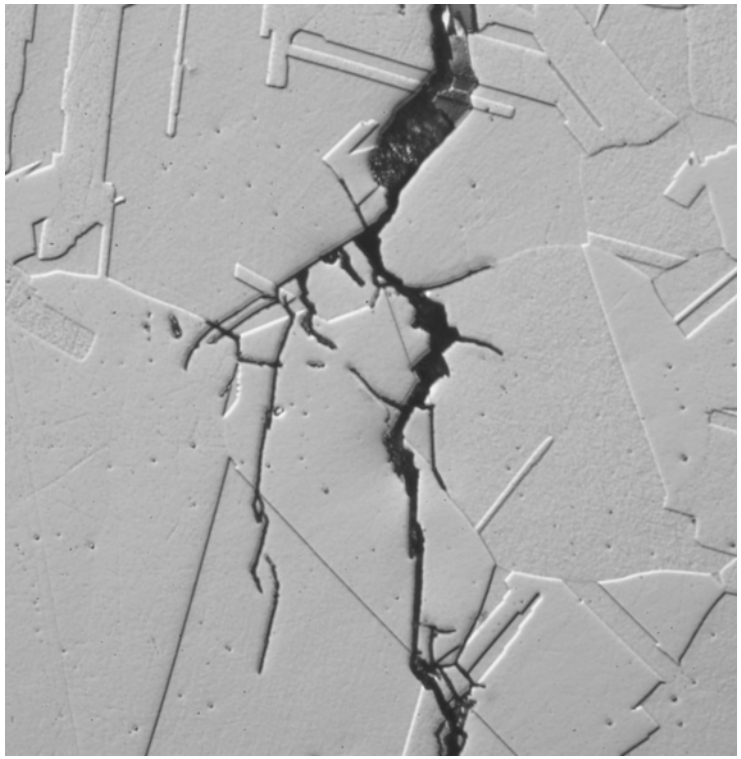
The Basics of Sulfide Stress Cracking





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General susceptibility to SSC increase

- Tensile Strength
- Sour Environment
- Susceptible material

- **NACE MR0175** -"Sulfide Stress Corrosion Cracking Resistant Materials for Oil & Gas Field Equipment"
- Applies only to oil field equipment pipelines and oilfield processing facilities where H_2S is present

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MR0175-2002

- Applies to Oil & Gas production facilities
- Classifies Materials as
  - Acceptable
  - Not Acceptable
- Standard specifies:
  - Proper Materials
  - Strength levels
  - Heat Treatment

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MR0175-2002 Acceptable Materials

Body Materials

- SA216 grades - WCB & WCC
- SA352 grades - LCB & LCC
- Max. allowable Hardness: 22 HRC

Martensitic Stainless Steels

- 410 SST – Double tempered to max. Hardness of 23 HRC
- CA6NM SST – Cast version of 410 SST Specifies HT procedure ,Post Weld Heat Treatment (PWHT) required
- 416 SST – not allowed due to presence of Sulphur

Austenitic Stainless Steels

- All 300 series SST are acceptable
- PWHT of 300 series- not required
- Max. allowable Hardness: 22 HRC
- Free of Cold work to resist SSC
- Exceptional resistance to SSC in Annealed condition.

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MR0175-2002 Acceptable Materials

17-4 PH SST

- S17400 (Max. Hardness 33 HRC). For S17400, NACE specifies 2 different Heat Treatments

  - H1150 (heat to 1150 ° F/4hrs and air cooling+ reheat to 1150 ° F/4hrs and air cooling)
  - H1150M (heat to 1400 ° F/4hrs and air cooling + reheat to 1150 ° F/4hrs and air cooling)

- CB7Cu-1(Cast 17-4PH) in the double H1150 condition is approved by NACE 2002 for internal valve components with maximum allowable Hardness as 30 HRC

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MR0175-2002 Acceptable Materials

- **Boltings :-**

  a) Non-Exposed bolting – ones which does not comes in contact with process fluid e.g. body bonnet bolts, etc. Generally, B7 bolts and 2H nuts are used for non-exposed bolting.

  b) Exposed bolting – one which comes in contact with the process fluid e.g., Bolted seat rings, valves buried underground, etc. Generally, B7M bolts and 2HM nuts are used for exposed bolting as the maximum hardness shall be maintained as 22 HRC.

- **Springs :-**

  Difficult to comply with NACE due to the min. hardness requirement. Hence, Double PTFE packing is preferred.

- **Stem Materials :-**

  316 SST Annealed – not used due to its low strength. Hence, Nitronic 50 stem is used for NACE applications to Hardness of 35 HRC

NACE Standards Released in 2003

- NACE MR0175-2002 -used for both Oil & Gas production and Refinery Sour environments although it is intended to be used only for Oil & Gas field equipments
- **NACE MR0175/ISO 15156** (NACE MR0175-2003)– "Petroleum and natural gas industries-Materials for use in H_2S-containing Environments in Oil and Gas production" (Applicable to SSC & Chloride Stress Cracking in Oil & Gas production facilities)
- **NACE MR0103** - Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments (Applicable to SSC in Refinery Sour Environment)
- There is quite a lot of difference between acceptable materials per NACE MR0175-2002 and NACE MR0175-2003. Many Environmental restrictions were forced in 2003 revision.

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Why Create a new Document

- MR0175 revision – scope expansion to cover chloride stress corrosion cracking
- Lack of refinery-specific Standards for materials resistant to sulphide stress cracking
- Methods of applying MR0175 varied considerably within the refining industry
  - Refineries have never been included in the scope of MR0175
  - Definition for sour environment in MR0175 did not coincide with sour environments in refineries
  - Application ranged from never specifying MR0175 to specifying MR0175 for all application containg H_2S

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Comparison between NACE MR0175/ISO15156 and MR0175-2002

- Environmental restrictions on all Corrosion Resistant Alloys (CRAs) except Carbon Steels and Low Alloy Steels in terms of
    1. H_2S partial pressure
    2. max. temp
    3. ppm Chlorides
    4. presence of free sulphur

  Whereas prior standards list materials as ‘acceptable’ or ‘not acceptable’

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Comparison between NACE MR0175/ISO15156 and MR0175-2002

S.No	MR0175/IS015156	MR0175-2002
1	Adresses both sulfide stress cracking and chloride stress cracking	Adresses only sulfide stress cracking
2	Requires new welding procedure qualification records to ensure the hardness in the weld deposit and base metal heat affected zone	Consider only hardness of the base metal and welded portion
3	Environmental restrictions on all CRA`s except carbon steels and low alloy steels. Limits are in terms of partial pressure, maximum temperature, ppm chlorides and presence of elemental sulphur	Listed materials as acceptable or unacceptable
4	316SST is allowed with environmental restictions. Temperature 140 deg F(60 degC)and 15 psia(100 kPa) H2S partial pressure with no elemental sulphur	No environmental restrictions
5	DuplexSST required ferrite testing to ensure ferrite content of 35 to 65%	Ferrite testing is not required
6	Shafts and stems are considered as pressure retaining components in addition to boltings	Boltings only considered as pressure retaining components in apart from body
7	17-4PH 1150 DHTR, Monel 550, Inconel X750 are prohibited as pressure retaining parts including bolting, shafts and stems	17-4PH 1150 DHTR, Monel 550, Inconel X750 are allowed as pressure retaining parts

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Comparison between NACE MR0103 and MR0175-2002

S.No	NACE MR0103	NACE MR0175-2002
1	Addresses Sulphide Stress Cracking (SSC) in Refinery Sour environments	MR0175-2002 is applicable to SSC in Oil & Gas production equipments
2	Imposes no environmental restrictions	Imposes no environmental restrictions
3	End user to determine whether environment is Sour	-
4	Exposed bolting must be explicitly stated	-
5	New Weld PQR for Carbon Steel Welds & Alloy Steel Welding procedure follows Rockwell & Vickers Hardness survey and hence more stringent	Alloy Steel welding procedure follows only Rockwell Hardness Survey
6	17-4 PH H1150 – Not allowed for use in Pressure retaining bolting But, allowed for use in Shafts and stems.	Its allowed for use in Boltings in addition to shaft and stem.
7	It requires Ferrite testing to ensure Ferrite content of 35 - 65%.	Ferrite test not required
8	Welding reqt. are much more stringent than MR0175-2002 & MR0175/ISO	-
9	Nitronic 50 - allowed in Solution Heat treated, Hot- rolled or Strain hardened	Nitronic 50 - allowed only in Strain hardened condition

NACE Standard

Upstream (Oil & Gas Production)	Downstream (Refinery)
Contains CO2	Contains dissolved NH3
Low pH Value	High pH Value
Environmentcontains H2S and promotes Sulphide stress corrosion Cracking	Environmentcontains H2S and promotes Sulphide stress corrosion Cracking
Contains Chlorides that makes the material easily susceptabile to Chloride Stress Cracking	Rarely contains Chloride

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Application of MR0103

- MR0103 allows decision based upon:
  - Sour service definition guideline
  - Plant Experience
  - Risk based analysis

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