Weatherford®

ANSI NACE MR0175/ISO 15156: Materials for use in H_2S-containing environments in oil and gas production

NACE® INTERNATIONAL

THE CORROSION SOCIETY

BSEE

Bureau of Safety and Environmental Enforcement

Topics Covered

- Background on ANSI NACE MR0175/ISO 15156
- Increasing Safety of Standard – risk analysis and examples of cooperative efforts
- Changes to standard and Communication

ANSI NACE MR0175/ISO 15156

ANSI/NACE MR0175/ISO 15156 consists of the following parts, under the general title *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production*:

– *Part 1: General principles for selection of cracking-resistant materials*
– *Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons*
– *Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

- The standard provides requirements & recommendations for the selection and qualification of metallic materials for service in equipment used in oil and gas production in H_2S containing environments.
- It supplements, but does not replace, the materials' requirements of the appropriate design codes, standards or regulations.
- It addresses all mechanisms of cracking that can be caused by H_2S: sulfide stress cracking, stress corrosion cracking, hydrogen induced cracking and stepwise cracking, stress oriented hydrogen induced cracking, soft zone cracking and galvanically induced hydrogen stress cracking.

History - Development

- **1950s Equipment Failures**
- **Failure Mode Identification**
  - **SSC and SCC**
- **Industry Guidelines and Standards**
  - **NACE 1952 T-1F Report**
  - **NACE T-1B Canadian Report**
  - **NACE 1F163 and 1F166 Reports (1963 & 1966)**
  - **NACE MRO175 (Wellheads and Trees) (1975)**
  - **NACE MRO175 – 78 (All Equipment) (1978)**
  - **EFC Publications 16 and 17 (1995 and 1996)**
  - **NACE MR0175-2003 transition standard**
  - **NACE MR0175/ISO 15156 (1st issue 2003)**

Document Maintenance

- NACE **Maintenance Panel (MP) 12-15 members**
  - **Prepare addendums as needed**
  - **Prepare revisions**
  - **Prepare & publish interpretations and new data**
- **NACE Oversight Committee TG299 (OSC) 40-50 members**
  - **Ballot MP's proposed addendums & revisions**
  - **Ballot interpretations not resolved in MP**
  - **Prepare ballots for MP**
- **Both groups composed of subject matter experts and represents both users and manufacturers**

Increasing Safety of Standard – risk analysis

Task Group formed by the Maintenance Panel in 2012 to assess each section of NACE MR0175 and categorize by risk.

Task Group Members:

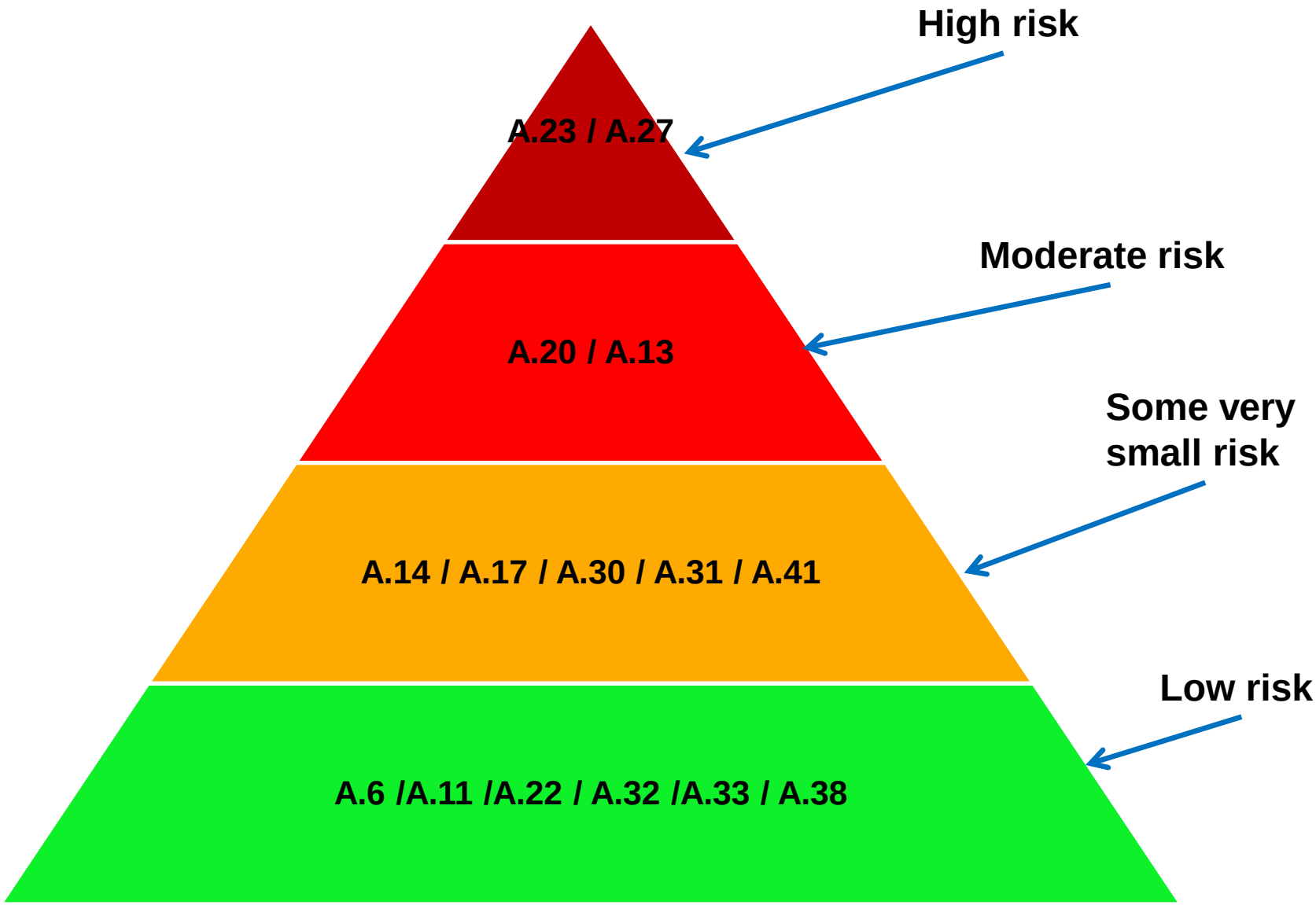
Bob Badrak – Manufacturer (Weatherford)
Bill Bailey – Manufacturer (Baker-Hughes)
Thierry Cassagne – User (Total)
Ulf Kivisäkk – Manufacturer (Sandvik)
Ardjan Kopliku – User (BP)
Stein Olsen – User (Statoil)

Each Table in document (requirements and use envelope) was reviewed for (1) risk of misinterpretation, (2) incomplete requirements, (3) consequences of failure in regards to HSE, (4) pressure containing, (5) extent of use and (6) type of equipment.

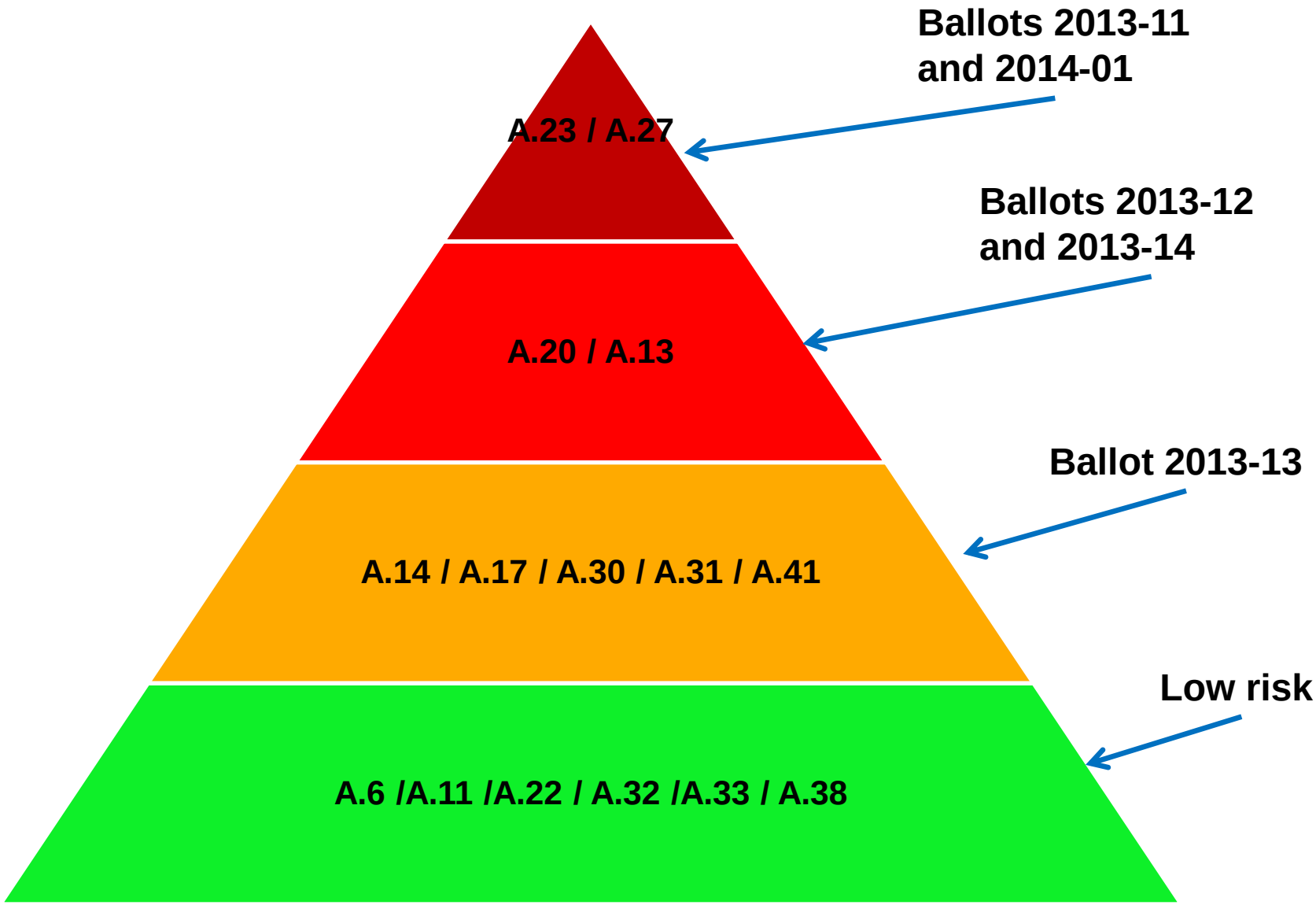
Results and recommendations presented to the Maintenance Panel in September 2013.

Editorial changes implemented and ballots written.

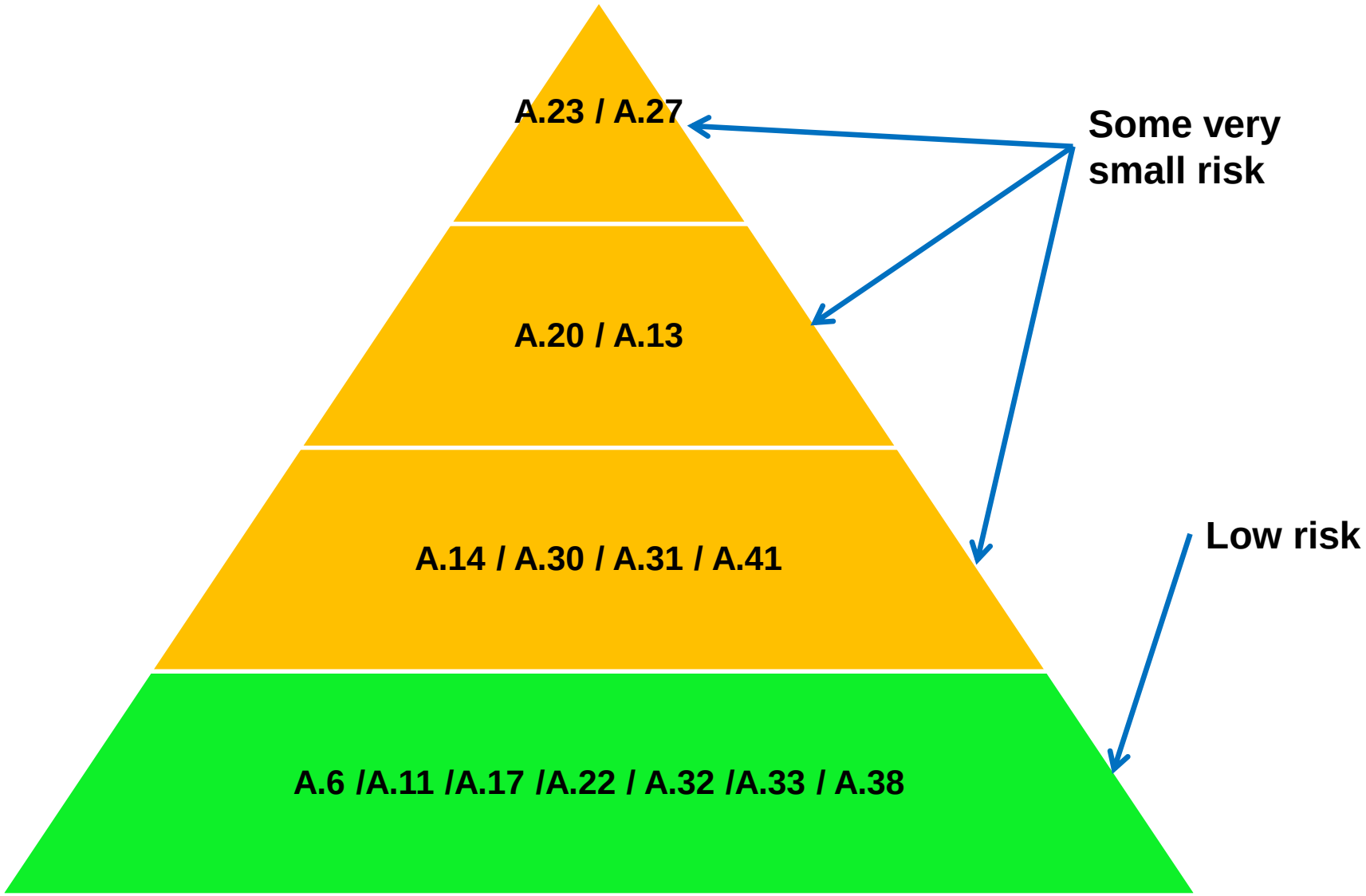
Increasing Safety of Standard – risk analysis



Increasing Safety of Standard – risk analysis



Increasing Safety of Standard – risk analysis



Increasing Safety of Standard

Continuous Improvement

- Open forum for sharing data, problems, advancements – NACE Corrosion Conference in USA. Note NACE TEG 374X.
- Open forum for sharing data, problems, advancements – EFC Eurocorr Conference in EU. Note EFC WP 13.
- Open meetings of MP & NACE TG299 (OSC) concurrently held at both NACE Corrosion and EFC Eurocorr.
- JIPs and WGs formed to investigate problems and increase knowledge.

Increasing Safety of Standard

Example #1 of cooperative efforts - Brines

- PROBLEM: Cracking observed in Super 13Cr alloys. Components affected include packers, sliding sleeves, blast joints and tubing.
- Experience shared at NACE & EFC technical information exchanges as well as other workshops.
- Individual members conducted tests to understand phenomena and a JIP was formed.
- Use limits, experience and science explored through technical forums and open literature publications.
- Results used as one of the considerations in our standards when selecting susceptible materials.

Increasing Safety of Standard

Example #1 - results of cooperative efforts - Brines

- NACE Corrosion 2003 paper 03097: Found unexpected susceptibility to cracking in completion brines. Suspected oxygen contamination.
- NACE Corrosion 2004 paper 04113: S13Cr testing in caesium formate brines.
- NACE Corrosion 2004 paper 04128: Cracking in high chloride brines with presence of H_2S. Alloys tested were low molybdenum.
- NACE Corrosion 2005 paper 05091: Application limits published for S13Cr supported by testing in variations of pH and chloride concentration.
- NACE Corrosion 2006 paper 06136: Test protocols.
- NACE Corrosion 2006 paper 06137: packer fluid tests.
- Additional papers in 2007 onward further exploring phenomena & application limits.

Increasing Safety of Standard

Example #2 of cooperative efforts – HE of High Strength Nickel Based Alloys

- PROBLEM: Cracking observed in high strength nickel based alloys that was unexpected from typically measured resistance tests and experience with nickel based alloys. Components affected include tubing hangers, cross-overs and subsea bolts.
- Experience shared at NACE & EFC technical information exchanges as well as other workshops.
- Hydrogen charging from cathodic protection and galvanic coupling. Serious problem that will affect ability to develop HPHT Oil & Gas resources. High strength materials are a necessary consequence.
- Initial results being published currently (2015).

Increasing Safety of Standard

Example #2 – initial results – Hydrogen Embrittlement of High Strength Nickel Based Alloys

- NACE Corrosion 2015 paper 3948: HE of precipitation hardened nickel base alloys
- NACE Corrosion 2015 paper 5497: Long term environmental cracking tests on precipitation hardened nickel base alloys.
- NACE Corrosion 2015 paper 5597: HIC of 718 & 725 under cathodic polarization
- NACE Corrosion 2015 paper 5853: HE behavior of high strength precipitation hardened nickel base alloys.
- NACE Corrosion 2015 paper 5911: Effects of hydrogen on high strength precipitation hardened nickel base alloys.
- NACE Corrosion 2015 paper 6053: Effect of microstructure & processing on HE of nickel base alloys.

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Example #3 Variations between other standards and ANSI NACE MR0175 / ISO 15156

- PROBLEMS: Each standards organization tackles changes to their standards differently and variations occur in requirements and methodology.
- One current example Design basis, elastic stress per NACE MR0175 versus elastic-plastic design methods such as those referenced in ASME Section VIII Divisions 2 or 3.

Increasing Safety of Standard

Example #3 DESIGN BASIS IN ANSI NACE MR0175 / ISO 15156

- Testing requirements and acceptance criteria for inclusion of materials into ANI NACE MR0175 / ISO 15156 has been based on elastic stress.
- The MP evaluated the potential for introducing elastic-plastic criteria into the document. A ballot was submitted and passed to clarify the basis upon NACE MR0175 is based.

Changes to standard and Communication

- In addition to the MP and NACE TG299, the need for changes/updating come from the worldwide oilfield materials and corrosion community.
- The need is communicated through NACE, EFC or ISO channels and are vented in open forums. These forums are the MP, NACE TG 299, NACE STG 32 or NACE TEG 374X meetings during the annual NACE Corrosion Conference and WP 13 meetings at the annual Eurocorr Conference. Other, though less frequently used avenues, are the ISO/DIN and NACE Webpage submittals including requests for interpretation.
- The requirements for successfully making changes are discussed in these forums and work is performed by individual companies, TGs or consortia.
- A ballot is prepared and submitted to the MP for circulation. The MP may require changes for improvement, accept or reject the ballot.

Changes to standard and Communication

- Once successfully past the MP, the process is repeated through the NACE TG299. There actions may be the same but any technical changes to the ballot cause it to be returned to the MP.
- Once a need to change the document is identified, the process could easily take 1 – 3 years (or more if unsuccessful during the balloting process).

Summarizing Comments

- The ANSI NACE MR0175 / ISO 15156 standard pertains to metallic materials for oilfield environments containing H_2S. The subject is environmental cracking.
- Increasing Safety of Standard – a risk analysis was performed of the standard and changes were made to remove or reduce the risk that was identified.
- The worldwide materials and corrosion community shares concerns, experience and advances in materials/technology in open forums.
- The primary venues for exchange of ideas and technology are first the NACE Conference in the USA and second the EFC Eurocorr Conference in the EU.
- When a need for change is identified, there is a defined avenue to update the standard to reflect technology advances and knowledge.

QUESTIONS?