A Compendium of Inquiries and Interpretations for NACE MR0175/ISO 15156

5 February 2022
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Foreword


The ISO 15156 Maintenance Panel was set up to maintain this widely used standard after publication.

The Maintenance Panel has dealt with several hundred inquiries for help with interpretation of the standard. Many of these inquiries and the responses provided are reproduced below. The inquiries and responses are listed in the order of the sections of NACE MR0175/ISO 15156-1, -2, and -3 to which they refer.

The responses represent a consensus of the members of the ISO 15156 Maintenance Panel and should not be construed to reflect the opinions of ISO or the Association for Materials Protection and Performance (AMPP), their officers, directors, or members.

In some cases, the problems identified by the inquiries have led, after a ballot of experts from the Maintenance Panel, AMPP TG 299 and the members of ISO/TC67/WG7, to the publication of Technical Corrigenda or Technical Circulars.

Direct requests for amendment of the standard are also dealt with by ballot in the same way and can, if successful, also become parts of Technical Circulars.

These documents are incorporated into the standard during the regular revision processes. Revisions are normally carried out within a five-year cycle. The latest edition of NACE MR0175/ISO 15156 was published in 2015; the latest edition of ISO 15156 was published in 2020. The Technical Circulars published since that time can be found via:

www.iso.org/iso15156maintenance Item 03 or https://store.nace.org/standards

Notes:
Requests for interpretation or proposals to amend the standard by ballot should be sent to Maintenance_Panel@ampp.org. Ballot proposal forms can be found at www.iso.org/iso15156maintenance Item 16.

When an inquiry has been resolved by Corrigendum or Circular during the life of the current edition of the Standard, the Inquiry and the reference to the appropriate Corrigendum or Circular is provided.

This Compendium is usually updated at least once per year and new additions to the compendium since the last edition are shown in a green font.
Introduction

This February 2022 edition of the Compendium includes the following changes:

- Inquiries dealt with during 2019, 2020, 2021, and to date in 2022 and thought to be of wider interest to document users;

- Revision of some language to reflect the 2021 merger of NACE International and SSPC to form the Association for Materials Protection and Performance (AMPP).

The Compendium retains all the inquiries that are relevant to the text of the current edition of the Standard.

All earlier versions of the Compendium are retained for future reference.
Interpretations: General

Address for requests for interpretations of any part of NACE MR0175/ISO 15156

QUESTION:
Is a NACE office available in Italy or in other European countries?

(MP INQUIRY #2003-26 Q5)

ANSWER:
All inquiries should be transmitted to the ISO Maintenance NACE Headquarters in Houston, Texas (Maintenance.Panel@nace.org). The Maintenance Panel has an international membership. Details of its current membership can be obtained from the above address.

QUESTION:
I am writing about one question which is not clear for me after reading “NACE MR0175/ISO 15156”
My question is: whether this standard is applicable for valve casting material as ASTM 216WCB or not? I have read many time this standard, but just mentioned for pipe, and fitting products. Regarding attached file I have confused should I do HIC and SSC test on the valve casting components or not?

Could you please deal with the question and let me know how I can find clear idea?

Reference to Valve Magazine 18 January 2011 Materials Q&A

(MP INQUIRY #2016-05)

ANSWER:
Answer 1: If NACE MR0175/ISO 15156 is a requirement for the product then NACE MR0175/ISO 15156-2 Section 1 with Table 1 defines applicability. Valve materials are not listed in NACE MR0175/ISO 15156-2 Table 1 as a permitted exclusion. Therefore, valves must comply with the standard.

Question 2: If yes, is ASTM A216 Grade WCB compliant? ASTM A216 grade WCB is a low carbon steel with 250 MPa (36 ksi) minimum yield strength in one of the following conditions: annealed, normalized or normalized & tempered.

Answer 2: NACE MR0175/ISO 15156-2 Annex A Section A.2 lists the general compliance requirements for carbon and low alloy steels (including castings). One of the requirements of A.2.1.2 is that the hardness must be 22 HRC maximum. ASTM A216 Grade WCB could be compliant with the addition of the maximum hardness limit.

Question 3: Am I required to perform HIC and SSC test on the valve casting components?

Answer 3: If all the requirements of NACE MR0175/ISO 15156-2 Annex A Section A.2 are met then Section A.2.1.1 states “Carbon and low-alloy steels, products and components that comply with A.2 are, with stated exceptions, qualified in accordance with this part of ISO 15156
without further SSC testing. Nevertheless, any SSC testing that forms part of a materials manufacturing specification shall be carried out successfully and the results reported." NACE MR0175/ISO 15156-2 Clause 8 defines the need to perform HIC testing. As noted in Clause 8, castings with less than 0.025% Sulfur mass fraction are not normally considered sensitive to HIC or SOHIC.

**Scope of NACE MR0175/ISO 15156**

**QUESTION:**
Can you please clarify if metal additive manufacturing (also referred as 3D printing) is a manufacture process considered within the scope of NACE MR0175 / ISO 15156?

If the answer is negative, can you clarify if a material/alloy that is listed in NACE MR0175/ISO 15156 as acceptable for a certain environment and under certain metallurgical conditions is also considered acceptable when processed by 3D printing provided hardness limits are observed? E.g. if alloy UNS N07718 is listed as acceptable in the cast condition to a maximum hardness of 40HRC, would a N07718 component processed by 3D printing and with hardness below 40HRC is considered to meet the requirements of NACE MR0175 / ISO 15156?

*(MP INQUIRY #2016-03)*

**ANSWER:**
Q1: Is metal additive manufacturing (also referred to as 3D metal printing) a manufacturing process defined or included in NACE MR0175/ISO 15156?
A1: 3D metal printing/metal additive manufacturing is not defined in NACE MR0175/ISO 15156.

Q2: If the answer to Q1 is no, would a currently listed alloy be acceptable for a specific application if manufactured through 3D printing and final hardness limits were within requirements of NACE MR0175/ISO 15156?
A2: In itself, this is not sufficient because 3D metal printing/metal additive manufacturing is not defined as an acceptable process route.

Q3: If the answer to Q2 is no, would UNS N07718 manufactured through 3D printing be acceptable within the restrictions of the cast condition for UNS N07718 in NACE MR0175/ISO 15156-3 Table A.31 or Table A.32?
A.3: The same answer to Q2 applies here; it is not known whether the 3D printed condition is equivalent to the cast condition defined for this alloy. To be acceptable, the production route would need to qualify in accordance with NACE MR0175/ISO 15156-3 Appendix B.

**QUESTION:**
Crude oil storage and handling facilities operating at a total absolute pressure below 0.45 MPa. My understanding of the above paragraph is that, it includes only dead oils with no gas in equilibrium. If any gas is in equilibrium with a crude (operating less than 0.45 MPa) which contains HzS more than 0.3kPa (in the gas phase), the whole system is considered as sour. I need your advice for my understanding, if correct or not?

*(MP INQUIRY #2009-14)*
ANSWER:
Crude oil storage and handling facilities means that it is dead oil and H₂S/CO₂ have been removed. The very low residual amount is considered negligible. This is the reason why these facilities are permitted exclusions from the standard. However, it is up to the user to check that these statements are true for the considered facilities.

QUESTION:
Water handling facilities (less than 0.45 MPa) I really don’t know what does it mean? It means that the possibility of corrosion is low enough to be excluded from the standard requirements? Or the consequence of the problem is minimum? Can we conclude from the above paragraph that, low pressure water handling facilities, has no gas to be released which may produce SSC or any hydrogen problems?

(MP INQUIRY #2009-15)

ANSWER:
Water handling facilities have typically low service pressure, a near neutral pH and they usually contain trace amounts of H₂S. Consequently, their sour service severity is quite low. However, it is the responsibility of the user to check whether these assumptions are correct for the particular equipment considered.

QUESTION:
Some buyers in the U.S. are requesting equipment to ISO 15156, and then saying that the supplying company has to be ISO registered, i.e., has ISO 9002 in place (quality standard).

As far as I know these are unrelated issues; a supplier to ISO 15156 does not have to be ISO 9002 registered.

Can the Maintenance Panel confirm that ISO 9002 is not a requirement for supply to ISO 15156?

Is there an equivalent U.S. standard to ISO 9002?

(MP INQUIRY #2009-25)

ANSWER:
ISO 9002 is NOT referenced in any of the ISO 15156 parts. That means ISO 9002 is not necessary to comply with ISO 15156.

If ISO 9002 is part of a contract between two business parties, ISO 9002 becomes a requirement based on the contract, not based on ISO 15156.

In addition, ISO 9002 has been replaced by ISO 9001: Quality management systems-Requirements.

There are no widely accepted American equivalents to either ISO 9002 or ISO 9001.
QUESTION:
Kindly clarify does NACE MR-0175/ISO 15156 specifies the Hardness requirement for ASTM A350 Grade LF2 material.

(MP INQUIRY 2017-01)

ANSWER:
NACE MR0175/ISO 15156 does not dictate the hardness requirements that may be present in other standards. The standard does define material requirements and use limits as they relate to environmental cracking in the presence of H2S. ASTM A350 LF2 requires the hardness to be 197 HB maximum and this meets the requirements for carbon steel forgings in NACE MR0175/ISO 15156-2. Please refer to Clause A.2.1 and the sub-clauses beneath it for carbon and low alloy steels.

Certification and Compliance to NACE MR0175/ISO 15156

QUESTION:
Is it the intent of NACE MR0175/ISO 15156-2 that material manufacturers state on the Material Test Certificates that material conforms to the NACE standard even though no operating criteria are known?

(MP INQUIRY 2006-13)

ANSWER:
Certification requirements are outside the scope of the standard and there are no stipulations concerning certification in NACE MR0175/ISO 15156.

The compliance with the NACE/ISO standard of a material for use in H2S-containing environments in oil and gas can only be assessed for the material in its final product form and this may differ metallurgically from that of the material supplied by the materials manufacturer. In addition, compliance with the standard also depends on the cracking mechanisms that have to be considered.

NACE MR0175/ISO 15156-2, Clause 9, Annex E (Informative) and NACE MR0175/ISO 15156-3, 7.2, Annex C (Informative) make some suggestions on how materials manufacturers and other suppliers might mark their materials to indicate the evaluation (testing) that they have carried out.
Interpretations related to NACE MR0175/ISO 15156-1

Clause 3

QUESTION:
I need your help with the definition of CRAs in Part 3 of MR0175/ISO 15156.

The "corrosion-resistant alloys" is very general and does not specify whether or not the definition includes the Fe-based alloys or not. More than that, the term CRA is used together with "other alloys" making it even more confusing.

ANSWER:
NACE MR0175/ISO 15156-1, Paragraph 3.6 contains a definition of "corrosion-resistant alloy" (CRA). It reads: "alloy intended to be resistant to general and localized corrosion of oilfield environments that are corrosive to carbon steel." This is taken from EFC 17.

"Other Alloys" are those not covered by the definitions of carbon steel or CRA. For example, copper is not considered resistant to general corrosion but is considered in NACE MR0175/ISO 15156-3.

3.1.3

QUESTION:
NACE MR0175-1, clause 3.13
HSC describes cracking in metals that are not sensitive to SSC but which can be embrittled by hydrogen when galvanically coupled, as the cathode, to another metal that is corroding actively as an anode.
The term "galvanically induced HSC" has been used for this mechanism of cracking.

It means HSC is the same as "galvanically induced HSC" and different from SSC.

But in NACE MR0175-1 clause 3.23
SSC is a form of hydrogen stress cracking (HSC) and involves the embrittlement of the metal by atomic hydrogen that is produced by acid corrosion on the metal surface.

It means SSC is a type of HSC.

The words from two paragraphs are contradictory.
I think the words should be understood as below.
There are two types of HSC.
One is "galvanically induced HSC", it is abbreviated as GHSC, because in NACE MR0175-3, clause 3.7, the definition galvanically induced hydrogen stress cracking that results due to the presence of hydrogen in a metal, induced in the cathode of a galvanic couple, and tensile stress (residual and/or applied)
The other one is "Sulfide induced HSC" i.e. "Sulfide Stress Crack" (SSC) because in NACE MR0175-1 clause 3.23, the definition is as below.

SSC is a form of hydrogen stress cracking (HSC) and involves the embrittlement of the metal by atomic hydrogen that is produced by acid corrosion on the metal surface.

Hydrogen uptake is promoted in the presence of sulfides. The atomic hydrogen can diffuse into the metal, reduce ductility and increase susceptibility to cracking. High strength metallic materials and hard weld zones are prone to SSC.

Please help me if my understanding about HSC, GHSC, and SSC right or not?

(MP INQUIRY #2016-02)

ANSWER:
We thank you for your inquiry and agree that there is some confusion in the notes to these definitions. The HSC includes cracking in metals that are not sensitive to SSC but which can be embrittled by hydrogen when galvanically coupled, as the cathode, to another metal that is corroding actively as an anode. The term "galvanically induced HSC" has been used for this mechanism of cracking. We believe that this can be clarified by a ballot on our definitions; we are initiating the ballot process.

Clause 5

QUESTION:
Using NACE MR0175-ISO 15156-1, Clause 5, Paragraph 9 and NACE Interpretation MP INQUIRY #2009-05 Part 1 as references. Based on the fact that most metal rupture discs are plastically deformed during manufacturing and all metal rupture discs plastically deform when they burst, are metal rupture discs outside of the scope of NACE MR0175-ISO 15156?

(MP INQUIRY #2011-08)

ANSWER:
No. Permitted exclusions are listed in ISO 15156-1 Table 1. When ISO 15156 is specified, components, including rupture discs, must comply with the materials and conditions listed in the standard or qualified in accordance with Annex B.

QUESTION:
Unfortunately answer #2011-08 left my organization at a loss. This answer does not address the fact that NACE MR0175-ISO 15156-1, Clause 5 states:

This part of ANSI/NACE MR0175/ISO 15156 applies to the qualification and selection of materials for equipment designed and constructed using conventional elastic design criteria. For designs using plastic criteria (e.g. strain-based and limit-states designs), use of this part of ANSI/NACE MR0175/ISO 15156 might not be appropriate and the equipment/material supplier, in conjunction with the equipment user, shall assess the need for other requirements.

This response does not address the issue that rupture discs plastically deform which is at the heart of and the basis of the previous inquiry. Metal rupture discs are made
to order product that plastically deform as part of the manufacturing process and will plastically deform when they burst (fail) when exposed to an overpressure process condition.

(MP INQUIRY #2012-04)

ANSWER:

Here is the Maintenance Panel’s response:
• The answer previously given has been confirmed to be correct by the Maintenance Panel (MP).
• The MP also confirms there is no conflict with the reply given for Inquiry 2009-05.
• Since the rupture disk is not a “Table A.1 exclusion,” it must either meet the material requirements in Annex A or be approved by the end user based on laboratory testing or field history. Confirming compliance with the material requirements in Annex A may be difficult for a rupture disk. However, it may be possible to demonstrate that the same raw material sheet with plastic deformation equivalent to worst-case locations on the rupture disk have metallurgical properties well within the material requirements in the standard.

Additional comments from other MP members:
1. On the issue of plastic deformation during manufacturing:
   - Whether the material is plastically deformed in fabrication is not the issue here.
   - Plastic deformation during manufacturing is irrelevant to clause 5, paragraph 9.
2. On the issue of deformation during rupture:
   - Plastic deformation occurs when they burst, but then they’re intended to burst.
   - The rupture disk functions within its elastic limit during the pressure-containing (bulk) of its service life. They are not designed to operate after additional in situ deformation (i.e., no strain-based design). Plastic deformation on failure is incidental to the function.
   - The purpose of the wording in Part 1 Section 5 is to cover design criteria where the material is expected to function beyond the elastic limit in service without failing (strain-based designs for pipelines being a prime example). Bursting disks do not fall into this category, either being plastically deformed (cold worked) prior to service or suffering from plastic deformation incidental to failure (albeit failure is part of the function of the bursting disc in cases of over pressurization) in service."

Clause 6

QUESTION:
My customer has some swab tanks that were manufactured in 1953; they are made of rolled 1/2-inch plate A283C; the tank is 84 in. in diameter and is rated for 100-psi service. The question is given the following conditions does this tank meet NACE MR0175? According to Section A2.1.6 the requirement that all rolled or deformed material must be stress relieved and have a hardness of 22 HRC max. The problem is we cannot or have no documentation as it relates to the heat treat of the plate post welding. yet when tested the material meets the A283C requirements and the hardness are in the 120-127 HB. Ultrasonic testing as part of a corrosion survey on
the tank was performed and all was in order. Engineering approval was granted on the status of the vessel as a pressure vessel under the ABSA (Alberta Boilers Safety Association). This tank is 52 years old, is in excellent condition, and the customer wants to have more current documents on the tank as it relates to its status as an ABSA pressure vessel and it's NACE MR0175.

With all this information can a determination be made that this material in its current state is suitable as a material that qualifies as a NACE MR0175/ISO 15156-compliant material? Using the long life, performance, and the mechanical data gathered can this determination be made? If so, can these criteria be used to establish a basis for performing future work on this exact style of tank?

*(MP INQUIRY #2005-31)*

**ANSWER:**
The ISO 15156 Maintenance Panel cannot advise on the suitability of this tank for use in sour service.

It is the responsibility of the equipment user to assess the suitability of the material and to ensure compliance with NACE MR0175 / ISO 15156.

Consideration of the following could contribute to any evaluation of suitability you undertake:

- For some equipment NACE MR0175/ISO 15156-2, Table 1 allows the equipment user to categorize equipment as a "Permitted exclusion" where the operating pressure does not exceed 0.45 MPa (65 psi).

- NACE MR0175/ISO 15156-1, Clause 6 and in particular 6.2 d) offer some guidance on the fitness for purpose evaluation of materials in existing equipment.

**QUESTION:**
"ANSI / NACE MR0175/ISO 15156-3:2015, Clause 6.1 indicates
"Qualification based on satisfactory field experience is also acceptable. Such qualification shall comply with ANSI/NACE MR0175/ISO 15156-1."

ANSI/NACE MR0175/ ISO 15156-1, Clause 8.2 indicates “A material may be qualified by documented field experience.”

Q1: “My best magic question for your panel: If a material, such as UNS N08800, was qualified by previous NACE version can this previous document be considered a “documented field experience” as required per ANSI/NACE MR0175/ ISO 15156-1, Clause 8.2 and Clause 9(c)(3) and provide evidence for continued use?”

“My follow up question. If, in the future, a material should be removed from ANSI/NACE MR0175/ ISO 15156-2, or -3 ANNEX A…. Does NACE publish information related to its reason for removal?"

*(MP INQUIRY #2019-05)*
ANSWER:
A1: In order to be qualified by field experience, all requirements in Clauses 8.1, 8.2 and 9(c) shall be fulfilled. Please note that the requirements for inclusion in NACE MR0175/ISO 15156 may have been changed since the old listing, which may lead to that testing performed in the past not being appropriate anymore.

Response to followup question: There is no publication from NACE other than the change in the standard.

Clause 7

QUESTION:
Base Material

In accordance to NACE MR0175/ISO 15156, Part 1, Item 7, 3rd paragraph, "no additional laboratory testing of materials selected in these ways is required."

In accordance to NACE MR0175/ISO 15156, Part 2, Item B.1, letter "a," "Some carbon and low alloy steels described or listed in A.2 might not pass some of laboratory . . ."

In our understanding, NACE Standards TM0177 and TM0284 are used to qualify new materials that are not previously included in NACE MR0175. If we are using materials previously included in NACE MR0175, it is not necessary to test them according to NACE TM0177 and TM0284.

We would like you to confirm if our interpretation below is correct and if not give us the correct interpretation.

(MP INQUIRY #2005-08 Q1)

ANSWER:
See response posted under ISO 15156-2, B.1 below.

Clause 8

QUESTION:

We are using the following materials for manufacturing of valve components. In reference to the clause A.12.1 of NACE MR0175/ISO 15156-3:2003, no any special requirements are specified to these materials for use in SOUR environment. We wish to know what shall be the chemical, physical, hardness properties and heat treatment requirements for using these materials in SOUR service environment. Valve Components:
Stem – ASTM B150 UNS C63200.
Ball – ASTM B148 UNS C95800.

(MP INQUIRY #2009-12)

ANSWER:
For these materials, there are no 15156 restrictions on chemistry, hardness or heat treatment. However, note that these materials can undergo severe weight loss corrosion. They may also be susceptible hydrogen stress cracking when galvanically coupled to steel. It is up to the user to decide if qualification of these materials is necessary in the applicable sour service environment. § 8 of NACE MR0175/ISO 15156 Part 1 indicates how these materials can be qualified.

8.2

QUESTION:
When materials in an existing field are replaced, what criteria should be used? Paragraph 8.2 of ISO 15156-1 provides some criteria for qualification, but it is not clear what approach should be used for materials that have been in use with no problems, but documentation does not exist.

ANSWER:
NACE MR0175/ISO 15156-1 Paragraphs 6.2, 8.1, 8.2, and 9.0 provide a complete description of the documentation required for two years’ successful field service. Documentation has always been required.

QUESTION:
I need some clarifications on the clause 8.2 of the MR0175/ISO 15156-1 (Qualification based upon field experience).

“A material may be qualified by documented field experience”--"the duration of the documented field experience shall be at least two years. . . "

What kind of documentation is expected? We need to know exactly what to ask from the end user. Is a letter describing the conditions for which the material qualified for the past two years enough?

ANSWER:
NACE MR0175/ISO 15156-1, Paragraphs 6.2, 8.1, 8.2, and 9.0 provide a complete description of the documentation required for two years’ successful field service. Documentation has always been required.

QUESTION:
What do we (the equipment manufacturer) do with this documentation? Does it have to be filed with NACE? If yes, is this our responsibility?

ANSWER:
a) The equipment user is responsible for the preparation of the required documentation (see NACE MR0175/ISO 15156-1, Clause 9, Paragraph 1 to support the use of a material in a plant on the basis of field experience. It would also be in the
equipment user’s interest to keep copies of this documentation in their records in case they are challenged to prove they are responsible operators. The equipment manufacturer can choose to retain a copy for future reference.

b) The equipment user may feel that they would wish to make the decision to file the information with NACE given that this would involve their actual field conditions rather than laboratory test conditions.

c) It is not the responsibility of the equipment manufacturer to file information with NACE, unless they choose to. This may be the case because the equipment manufacturer has made the effort to compile a non-proprietary database that they believe supports the use of alloys for their equipment under the conditions documented by the process in Question One.

QUESTION:
If filing with NACE is not required, do we have to verify the claims or can we just provide the materials as requested by the end user? 

(HP INQUIRY #2004-05 Q3)

ANSWER:
The manufacturer can provide this information to a user, but it is the user’s responsibility to determine the operating conditions and select the appropriate materials. It is the manufacturer’s responsibility to meet the metallurgical requirements of the appropriate alloys in NACE MR0175/ISO 15156.

QUESTION:
How should existing equipment affected by changing materials requirements in later editions of the standard be handled? 

(HP INQUIRY #2005-10)

ANSWER:
By convention, a new version of the standard is not applied retrospectively to equipment built to the previous version of the standard valid at the time of equipment construction.

New requirements in the latest version may be applied retrospectively by an equipment user or mandated for retrospective application by a regulatory authority.
Interpretations related to NACE MR0175/ISO 15156-2

Table 1

**QUESTION:**
The referenced specification cites, in Table 1, p2, Permitted exclusions. One of those permitted exclusions is: “Surface and Intermediate casing.”
May I interpret the referenced specification to allow the use of P110 surface and intermediate casing, made up with P110 couplings, in H2S (sour gas) environments at all temperatures and all concentrations?

(MP INQUIRY #2018-05)

**ANSWER:**
The referenced specification cites, in Table 1, p2, Permitted exclusions. One of those permitted exclusions is: “Surface and Intermediate casing.” May I interpret the referenced specification to allow the use of P110 surface and intermediate casing, made up with P110 couplings, in H2S (sour gas) environments at all temperatures and all concentrations?
Response: Referenced exclusion in Table 1 (ISO 15156-2: 2015) is applicable to a very specific type of equipment, which is Drilling, well construction and well-servicing equipment, and not for production equipment in the presence of H2S. Surface and casing strings (and couplings for coupled pipe) are always cemented in place; this is necessary to isolate the water bearing formations. This also usually the case for intermediate strings with a few exceptions. These casing strings do not normally see production (with H2S) and, when in the few cases for intermediate strings, it is just for gas to drive artificial lift (no liquids and not sour).

**QUESTION:**
ISO 15156 Table 1 provides a non-exhaustive list of equipment to which this part of ISO 15156 is applicable, including permitted exclusions. Among the exclusions are:
a. The “Water-handling facilities operating at a total absolute pressure below 0,45 MPa (65 psi)”.
a. What are the fundamentals of such exclusions in this standard?
b. Can they be ALWAYS excluded independently of the H2S amount, HCN, pH, material strength, etc.?

Question comes because HIC damage could be present regardless of the pressure. Also SSC might be expected in the Welds/HAZ in not PWHT CS at H2S >670ppm and 65 psi (sour service).

There is a perceived danger with this interpretation, as the current tendency to minimize H2S flaring and to comply with the environmental regulations is to by-pass the H2S scrubbers moving the waste water from a non-sour service in the original design (<50 ppm H2S) to sour service ranges (up to 1000 ppm H2S). Because the standard doesn’t establish any boundary, it looks acceptable to do so.

b. “Water injection and water disposal equipment”.

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c. Usually the water injection works at a very high pressure (i.e. 90 bars in our facilities and original design 50 ppm H2S). Such case is already considered sour service (PpH2S>0.3 kPa). What are the fundaments to permit exclusions under this standard then?

**ANSWER:**
ISO 15156 Table 1 provides a non-exhaustive list of equipment to which this part of ISO 15156 is applicable, including permitted exclusions. Among the exclusions are “Water-handling facilities operating at a total absolute pressure below 0.45 MPa (65 psi).”

Question 1: What are the fundaments of such exclusions in this standard?
Answer 1: The exclusions are historical and based on successful applications over many decades.

Question 2: Can they be ALWAYS excluded independently of the H2S amount, HCN, pH, material strength, etc.?
Answer 2: Table 1 of NACE MR0175/ISO 15156 does not impose any limits on the equipment with permitted exclusions unless otherwise noted at the bottom of Table 1.

Question 3: Usually the water injection works at a very high pressure (i.e. 90 bars in our facilities and original design 50 ppm H2S). Such case is already considered sour service (PpH2S>0.3 kPa). What are the fundaments to permit exclusions under this standard then?
Answer 3: The User has the responsibility to ensure that materials selected are suitable for the intended service (see Warning paragraph under Part 1: General principles for selection of cracking-resistant materials). You have the responsibility to determine whether your application is safe under intended service conditions; you may wish to employ a consultant to assist you in your evaluation.

**QUESTION:**
MR0175 part 2, Table 1: Does the intent to only load in compression, regardless of resultant stresses, fulfill the requirement for exclusion?

**ANSWER:**
The exclusion applies to components loaded in compression. It does not apply to equipment, assemblies, or aggregate parts loaded in compression. However, due to part geometry, constraint, bending, friction, or other factors, local stresses within a single component may have a significant tensile element. In such cases the likelihood of environmental cracking, and its consequences, shall be considered before invoking this exemption.

**QUESTION:**
Regarding Table 1 in NACE MR0175/ISO 15156-2 is it defined what field facilities and field processing plants include? Would this include a SAGD plant?
Also, when using below 65 psi for exclusion does this stand true for all: liquid, vapour, or mixed streams, also in Table 1?  

(MP INQUIRY #2010-01)

ANSWER:
SAGD plant is not specifically included in Table 1 because it is not a “conventional” technique of oil production. However, it is up to the user to determine if some parts of a SAGD process may fit with the listed permitted exclusions. Please refer to answer to Inquiry #2009-14 for the second part of the question.

QUESTION:
“Q1: Can you help to define the term “permitted exclusion?”

“Q2: Why is wireline equipment considered a permitted exclusion?”

Followup questions:

“I have some follow-up questions for you.”

“Q3: Can you clarify the second statement in A1 below? Is it correct to say that “the requirements may not be applicable for the permitted exclusions?”

“Q4: Regarding A2 below, are these requirements applicable to downhole Wireline logging tools and the wireline cable itself?”

(MP INQUIRY #2019-07)

ANSWER:
A1: Permitted exclusions are products where the standard does not need to be applied. Consequently, the requirements may not be suitable for the permitted exclusions.

A2: In general, the exclusions are historical and based on earlier experience at that time, and/or special consideration due to specifics around equipment use, including but not limited to unlikely exposure to sour conditions. Please be aware that wireline lubricators and lubricator connecting devices are not permitted exclusions (note c of Part 1, Table 1). Also, inquirer is reminded that it is up to the user to check that these statements are true for the considered equipment, and its intended use.

Response to follow-up questions Q3 and Q4: The listed equipment under permitted exclusions is out of the scope of the standard. Whether the requirements apply or not should be agreed between the service provider and the end user. It is correct to state that “the requirements may not be applicable for the permitted exclusions.” Please note that it is the responsibility of the equipment user to determine whether or not the service conditions are such that NACE MR0175 / ISO 15156 series applies, see Section 5 in NACE MR0175 / ISO 15156 Part 1.

3.14

QUESTION:
Definition of pressure-containing parts: “Those parts whose failure to function as intended would result in a release of retained fluid to the atmosphere. Examples are valve bodies, bonnets, and stems.”

Are stems always defined as pressure-containing parts, regardless of features that by design keep the stem intact?
Example #1: Internal entry stems for ball valves that have a shoulder that rests against the body around the stem bore.
Example #2: Shafts for butterfly valves that have a retaining ring holding the shaft inside the valve.

Answer:
NACE MR0175/ISO 15156 cannot interpret design issues.

Clause 5

5.2

Question:
Does requiring/specifying steel compliance to ANSI/NACE MR0175/ISO 15156-2 in a purchase order include resistance to HIC as well as other forms of sulfide cracking, or must HIC resistance be specifically required separately in the purchase order?

Answer:
ISO 15156 / NACE MR0175 covers all cracking mechanisms caused by H2S to be addressed for materials exposed in production environments. This includes HIC/SWC as stated in the scope for Part 2. Section 8 in ISO 15156 / NACE MR0175 Part 2 describes how carbon and low alloy steels shall be evaluated for their resistance to HIC/SWC. Test procedures and acceptance criteria to evaluate the resistance of carbon and low-alloy steels to HIC/SWC are described in B.5. As only flat-rolled carbon steel products are susceptible to HIC/SWC, section 5.2 requires that “requirements for HIC resistance” are provided in the purchasing specification. Note that a list of information must be included in the purchase order (note also the use of the word “shall” in the section) that includes “requirements for HIC resistance”.

5.3.1.4

Question:
Is a welding consumable with a nickel content of 1.03% acceptable or is 1.00% the maximum allowed?

Answer:
For carbon and low-alloy steels, 1% nickel has been set to be the maximum to avoid SSC. However, a value above 1% could be used if it is qualified as stated in A.2.1.4. It is not the role of the Maintenance Panel to give an opinion on a specific metallurgical issue.

Clause 7

7.1, Clause 8

QUESTION:
I have two questions concern hydrogen induced cracking.

Question 1. Clause 7 of the standard is headed "Qualification & selection of C and low alloy steels with resistance to SSC, SOHIC and SZC"
Clause 7.1.1 concerns SSC only in low partial pressure of H2S. There is no mention of the other forms of cracking.
Clause 7.1.2 has three footnotes: NOTE 1 deals with SSC, NOTE 2 concerns SOHIC and SZC and NOTE 3 concerns HIC and SWC.

Should these three NOTES be applied to Clause 7.1.1 too?

Question 2. Clause 8 deals with the evaluation of C and low alloy steels for their resistance to HIC/SWC. It indicates that a few ppm of H2S must be considered during an evaluation of a steel. But have the steels that meet the requirements of Appendix A.2 been deemed to have been evaluated for HIC/SWC and so do not need additional HIC testing?

Answers:
Question 1 – The applicability of Notes 1, 2, and 3 is for the entire Clause 7.1 and not restricted to Clause 7.1.2.

Question 2 - Materials described in Annex A.2 may require additional testing to confirm resistance to SOHIC, SZC, and/or SWC. This shall be determined by the equipment user and can be influenced by factors such as whether the material was produced as a flat rolled carbon steel product and the steel chemistry (see clause 8).

7.1.2

QUESTION:
Risks of HIC (and SWC) are mentioned in Clause 7.1.2 / Note 3, and reference is made to Clause 8. Clause 8 underlines that HIC shall be considered as potential risk in sour service even if only trace amounts of H2S are anticipated. This is puzzling, and I’d like you to help me on clarification:

What does “trace amount” refer to? Is there a certain threshold?
Is HIC not applicable as potential risk if the partial pressure of H2S is below 0.3 kPa (refers to Clause 7.1.1)? This interpretation is derived by the fact that HIC is not mentioned in Clause 7.1.1. On the other hand, this interpretation – on first sight – is not reasonable: As there is no threshold for H2S with regard to HIC (Clause 8), HIC - from my point of view – must considered as risk, and should be mentioned already in Clause 7.1.1.

The present ISO design implies that HIC only is of concern if Clause 7.1.2. is applicable. And this – in turn – is a contradiction to Clause 8.

Please (1) clarify the misunderstanding / misinterpretation from my side and (2) advise on how to handle the risks of HIC in case of Clause 7.1.2:
Is Clause 8 valid or not?

(MP INQUIRY #2016-11)

ANSWER:
This inquiry pertains to Risks of HIC (and SWC) that are mentioned in NACE MR0175/ISO 15156-2 Clause 7.1.2 / Note 3 with reference to Clause 8. Clause 8 underlines that HIC shall be considered as potential risk in sour service even if only trace amounts of H2S are anticipated.

Question 1: What does “trace amount” refer to? Is there a certain threshold?

Answer 1: This is not defined in NACE MR0175/ISO 15156-2.

Question 2: HIC is not mentioned in Clause 7.1.1. Is HIC not applicable as potential risk if the partial pressure of H2S is below 0.3 kPa (refers to Clause 7.1.1)? Is Clause 8 Valid considering that Clause 7.1.1 does not list HIC?

Answer 2: The NOTES in Clause 7.1 apply to both Clauses 7.1.1 and 7.1.2; for HIC and SWC, you are referred to Clause 8.

QUESTION:
NACE MR0175 / ISO 15156-2 Para 7.1.2 says "If the partial pressure of H2S in the gas is equal to or greater than 0.3kPa (0.05psi), SSC-resistant steels shall be selected using A.2" Could I please get clarification regarding the sour service H2S partial pressure cut-off value as NACE MR0175 / ISO 15156 use both imperial and metric units. The conversion of 0.05 psi is 0.345 kPa. Please clarify if the H2S pp cut-off for sour service is 0.3 kPa or 0.345 kPa (conversion from 0.05 psi).

(MP INQUIRY #2009-18)

ANSWER:
The value was rounded off when converting from 0.05 psi. This limit is actually not a very sharp and accurate value and this is why 0.3 kPa value was taken as a practical engineering value. Note, however, that even below this H2S partial pressure, some materials can be susceptible to SSC as stated in 7.1.1. This means that in principle there is no cut-off value for sour service. It is just that below this value, only particularly
sensitive steels can be susceptible to SSC. It is up to the user to make sure that the steel used is resistant below 0.05 psi (0.3 kPa).

7.1.2, A.2.2.3.3, Table A.2, and Table A.3

**QUESTION:**
In Table A.3, is there a maximum hardness value for AISI 4130 Q & T with (140 ksi) yield for temperatures > 80°C?

(MP INQUIRY #2016-06)

**ANSWER:**
4130 is not listed in Table A.3.

**QUESTION:**
Sub-clause 7.1.2 says SSC Resistant Steels for partial pressures equal to or above 0.3 kPa (0.05 psi) can be selected using A.2.

a) If criteria, like temperature, hardness are met, do we assume that for all partial pressures above 0.05 psi the suggested SSC-resistant materials could be used? E.g., SSC-resistant materials mentioned in Table A.2 and Table A.3.

b) What are the acceptable pH and Cl- limits?

c) Does A.2.2.3.3 cover L80 type 1?

d) For low-alloy steels described in Section A.2 of this standard, what are the cases where injection of corrosion inhibitors is required, both for downhole casings/tubing and surface pipelines?

(MP INQUIRY #2005-14)

**ANSWER:**
a) This is correct.

b) No limits of pH and Cl- have been formally defined for carbon and low-alloy steels. Any combinations of chloride concentration and in situ pH occurring in production environments are considered acceptable. Metal loss corrosion, which can be influenced by both pH and chlorides, is not the subject of the standard.

c) No, this grade is covered in Paragraphs A.2.2.3.1 and A.2.2.3.4.

d) NACE MR0175/ISO 15156 does not cover the use of corrosion inhibitors. The use of any kind of corrosion inhibitor is not considered to allow any relaxation of the requirements for cracking resistance of materials in sour service.

**QUESTION:**
I was wondering if you could assist me in interpreting the partial pressure limitation for Carbon Steels referenced in part 2 section 7.1.2 and A.2.
Is there a partial pressure max limit for carbon steels? If so, where is the reference in NACE MR0175/ISO 15156?

(MP INQUIRY #2010-09)

ANSWER:
The partial pressure mentioned in Section 7.1.2 is the partial pressure of H\textsubscript{2}S in the gas phase in equilibrium with the water in the production fluid. Annex C gives information on how to calculate H\textsubscript{2}S partial pressure.

Regions 1, 2, and 3, Figure 1, cover usual conditions above 0.3 kPa. Note 1 mentions the unknown performance of steels above 1 MPa. The maximum partial pressure limit for carbon steels depends on many variables as noted in 15156-2 Clause 6. Currently a NACE TM0177 test with 100 kPa H\textsubscript{2}S, ~2.7 pH, room temperature, 50 g/L NaCl is considered to cover all normal production conditions for carbon steels.

7.2.1

QUESTION:
“In reference to ISO 15156-2:2015 Section 7.2.1, it is understood that SSC-susceptible carbon and low-alloy steels were defined as grades having hardness values > 22 HRC, and that the threshold H2S partial pressure (PH2S) associated with environmental severity for SSC was 0.05 psia, with the caveat that cracking could occur at PH2S < 0.05 psia for certain high-strength grades.”

Questions:
Q1. “Is the above statement essentially correct?”

Q2. “Under what test conditions, and with which specific methodologies, were used to establish the original 0.05 psia H2S threshold-of-concern?”

(MP INQUIRY #2020-02)

ANSWER:
A1. No, it is not correct. In order for the material to be considered to be acceptable, all requirements in Section A.2.1.2 need to be fulfilled. Note, however, that even below this H2S partial pressure, some materials can be susceptible to SSC, as stated in 7.1.1. This means that in principle, there is no cut-off value for sour service. It is just that below this value, only particularly sensitive steels can be susceptible to SSC. It is up to the user to make sure that the steel used is resistant below 0.05 psi (0.3 kPa).

A2. Please note that the Maintenance Panel only answers questions concerning interpretation of the wording of the document and cannot answer historical questions. The inquirer is referred to publications in the open literature.

7.2.1.1 and Note 2 of A.2.1.1
**QUESTION:**
Material SA-203 grade D contains 3.5 % Nickel content. As per NACE MR0175/ISO15156-2, para.A.2.1.2, base material with nickel more than 1%wt nickel is not suitable for sour service.

Based on para 7.2.1.1 and note 2 of A.2.1.1 (annex A) of NACE MR0175/ISO 15156-2,

Can we use material SA-203 grade D (HIC) for pressure vessels in sour service application?

(MP INQUIRY #2022-01)

**ANSWER:**
For carbon and low-alloy steels, 1% nickel has been set to be the maximum to avoid SSC. However, a value above 1% could be used if it is qualified as stated in A.3.1. It is not the role of the Maintenance Panel to give an opinion on a specific metallurgical issue.

7.2.1.2

**QUESTION:**
There is ambiguity between two passages, they contradict, paragraph 7.2.1.2 “SSC regions of environmental severity” of NACE MR0175/ISO 15156-2:2009 (E) to Paragraph 8, “Evaluation of carbon and low alloy steels for their resistance to HIC/SWC” of NACE MR0175/ISO 15156 – 2:2009 (E)

The paragraph 7.2.1.2 for Region 0 – For pH2S <0.3 kPa (0.05 psi) “ Normally, no precautions are required for the selection of steels for use under these conditions, whereas paragraph 8, says even trace amounts of H2S and shall consider HIC/SWC testing of these products” In addition the Sulfur restriction in the chemistry of.003% maximum.

(MP INQUIRY #2012-09)

**ANSWER:**
“Your quoted passages of the standard are not contradictory. The standard provides different qualification requirements for different materials and different potential cracking modes. Clause 7 is for “- - steels with resistance to SSC, SOHIC, and SZC.” 7.2.1.2 & 7.2.1.3 are only applicable to SSC. Clause 8 is for “Evaluation of carbon and low alloy steels for their resistance to HIC/SWC”. For carbon steel products made from rolled plate, in addition to consideration of SSC resistance, HIC/SWC shall be considered (clause 8) and SOHIC and SCZ should be considered (clause 7.2.2).”

7.2.1.2, Fig.1

**QUESTION:**
There is the sentence in the note 1 of Figure 1 in ISO 15156-2: "The discontinuities in the figure below 0.3 kPa (0.05 psi) and above 1 MPa (150 psi) partial pressure H₂S reflect uncertainty with respect to the measurement of H₂S partial pressure (low H₂S) and steels performance outside these limits (both lower and higher H₂S)." I understand the above sentence, and if I will use the carbon steel and low-alloy steel in the sour service above 1 MPa (150 psi) of partial pressure of H₂S, what can I do? Should I require a special laboratory test imitating the H₂S partial pressure and pH in the service for SSC of the carbon steel and low-alloy steel? Which solution can I use in the special laboratory test?

NACE TM0177 A solution or the imitating solution in the service?

(MP INQUIRY #2005-17)

ANSWER:
The following response must be seen in the context of NACE MR0175/ISO 15156-2, Clause 7.

1. NACE MR0175/ISO 15156-2, Fig. 1 is a schematic definition of Regions of environmental severity with respect to SSC of carbon and low alloy steels. As mentioned in Paragraph 7.2.1.4, qualification for the use of a material not listed in Annex A for use in one or more of the Regions of Fig. 1 is always dependent on reported field experience or laboratory testing.

There is little documented evidence that describes the SSC resistance of carbon and low alloy steels in H₂S-containing environments outside the H₂S limits of Fig. 1. The Note quoted reflects this.

2. The equipment user must decide whether the listing of a steel in Annex A serves as an adequate guide for its behavior in H₂S-containing field environments that might be more severe with respect to SSC than those represented by the SSC testing methods normally used; see Annex B.1a).

For qualification for a specific application all the test conditions must be at least as severe, with respect to the potential mode of failure, as those expected to occur in field service.

QUESTION:
Does NACE MR0175/ISO 15156 require production casing to be sour service compliant if the containment string of tubing is a sour service grade and the bottom hole temperature (below the packer) satisfies the casing material operating temperature? For example—a sour gas well with a H₂S partial pressure of 0.10 psi (0.007 bar), P-110 casing, L-80 tubing, and a bottom hole temperature of 300 F (150 C).

Supporting Information:
Related information can be found in NACE MR0175/ISO 15156-2, Table 1, page 2. Production casing is not excluded from meeting the requirements of ISO 15156.
ISO 15156-1/NACE MR0175, Section 6, which is reproduced in part below with the relevant parts underlined.

6. Evaluation and definition of service conditions to enable material selection
6.1 Before selecting or qualifying materials using other parts of NACE MR0175/ISO 15156, the user of the equipment shall define, evaluate and document the service conditions to which materials may be exposed for each application. The defined conditions shall include both intended exposures and unintended exposures which may result from the failure of primary containment or protection methods. Particular attention shall be paid to the quantification of those factors known to affect the susceptibility of materials to cracking caused by H₂S.

(MP INQUIRY #2010-12)

ANSWER:
1) As stated in your inquiry the secondary barrier must also be sour service and follow the requirements of NACE MR0175/ISO 15156.
2) A casing grade can be used under severity 3 of the diagram Fig. 1 of § 7.2.1.2. provided its working temperature is always above the minimum temperature given in ISO 15156-2 Table A.3. This can only be true if the material is well defined (API grade) and its temperature is always above the minimum temperature. According to Table A.3 if P110 is at a temperature ≥80°C (175°F) it can be used in Region 3 of the diagram Figure 1 of §7.2 in ISO 15156-2. It is up to the equipment user to establish that all intended and unintended exposure conditions are covered.

Figure 1

QUESTION:
As stated in Part 1 Clause 5: "Qualification, with respect to a particular mode of failure, for use in defined service conditions also qualifies a material for use under other service conditions that are equal to or less severe in all respects than the conditions for which qualification was carried out. " The diagram Fig 1 Part 2 defines the severity in terms of the main environmental parameters, i.e., H₂S partial pressure and pH but other parameters (temperature, stress level ...) must also be considered.

It is the equipment user's responsibility to ensure the service conditions are equal or less severe "in ALL respects."

(MP INQUIRY #2009-23, Part 1)

ANSWER:
1. This interpretation is correct for SSC qualification only since this diagram applies to SSC. If a material is qualified at a point in the diagram, it will be qualified for any conditions less severe than these conditions, i.e., higher pH and/or lower H₂S partial pressure.
2. The diagram Fig 1 Part 2 defines the severity in terms of the main environmental parameters, i.e., H₂S partial pressure and pH but other parameters (particularly stress level, temperature ...) must also be considered.
3. It is the equipment user's responsibility to ensure the service conditions are equal or less severe "in ALL respects."
4. Guidance is also given in Part 1 Clause 5: "Qualification, with respect to a particular mode of failure, for use in defined service conditions also qualifies a material for use under other service conditions that are equal to or less severe in all respects than the conditions for which qualification was carried out".

**QUESTION:**
The second part of my question is whether or not the same reasoning applies to laboratory testing. If laboratory testing defines a pH and H₂S partial pressure point on the graph, is the material deemed suitable for anything "northwest" of the box created by the same two lines described above?

*(MP INQUIRY #2009-23, Part 2)*

**ANSWER:**
Yes, provided all parameters are the same: metallurgy, environment…

**QUESTION:**
The third part of my question relates to qualifying a material to Region 3. Table B.1 describes the test conditions that are to be used to qualify materials for Regions 1, 2 and 3. For Region 3, the H₂S partial pressure is set at 100 kPa. As such, if that test were performed, the "north" line drawn would be at 100 kPa. If the answers to my first 2 questions are yes, then this does not allow the material to be used at any H₂S partial pressure greater than 100 kPa, as the point would be “east” of the 100 kPa line. Is that correct?

*(MP INQUIRY #2009-23, Part 3)*

**ANSWER:**
Yes, provided all parameters are the same: metallurgy, environment … 100 kPa was taken as all conditions because it is the accepted NACE TM0177 Standard test representative of severe conditions and it represents a worst case of the very large majority of field conditions. However, there are fields that have higher partial pressures in H₂S and it is up to the equipment user to decide in this case if 100 kPa is as severe as the maximum H₂S partial pressure encountered in this field.

7.2.1.3

**QUESTION:**
I am preparing a “position” document regarding SSC on behalf of my company. I am trying to understand the NACE definition for sour/non-sour (with relation to NACE MR0175). The definition of sour service is provided by NACE. That states, “exposure to oilfield environment that contain H₂S and can cause cracking by the mechanisms addressed by this part . . .” However, this needs further qualification as the environmental conditions (degree of H₂S and pH) may determine whether cracking can result. This is found in 7.2.1.3 of part 2 within NACE MR0175/ISO 15156, the document that refers to carbon steel (ISO 15156-2). For environments with a partial pressure of H₂S below 0.3 kPa (0.05 psi) the document states, “Normally, no precautions are required for the selection of steels for use under these conditions”
ANSWER:
There is no “non-sour” limit as some steels can still be susceptible below the limit of 0.05 psi (0.3 kPa).

QUESTION:
While not explicitly stated, the implication of that statement is that an environment with a partial pressure below 0.3 kPa is regarded as “non-sour.” This is reinforced later, where Annex C, C.2 defines H2S partial pressure isobars to determine “if a system is sour.” Line 1 of Figure C.1 (0.3 kPa) identifies the demarcation between “sour” and “non-sour” conditions (referred to as being in accordance with Option 1, where environments below 0.3 kPa require no precautions), while lines 2-5 identify the degree of sourness (Option 2—prequalification of material or specific testing needs to be performed).

ANSWER:
In addition for CRAs, 15156-3 has no defined “non-sour” limit. Due to the wide range of environmental cracking resistance of CRAs, particularly those not listed in 15156-3, a non-sour limit would be so low (i.e., minimum detection level) that it would be useless.

7.3.2 and 7.3.3

QUESTION:
Section 7.3.2 of Part 2 of NACE MR0175/ ISO 15156 states that when hardness of parent metals are taken, after welding, using the Rockwell C method, as long as no individual reading is greater than 2HRC above the specified value, you are allowed to average several readings in close proximity. For example, if you punch a 23HRC (where 22 HRC max is the requirement), you can take 3 or 4 reading (e.g. 21, 21, 22, 22) and if the average does not exceed 22, the test is valid and the qualification or procedure is successful. When using the HV5, HV10 or HRC 15N scales, the document is silent on averaging.

If you look on the ASTM E140 conversion chart, 22 HRC is approximately 250 HV, and 20 HRC is approximately 234HV. In this hardness range there is basically a 16HV difference that equates to 2 HRC—or 8 HV points for every 1HRC point. It does not seem to make any technical sense to reject a weld procedure for being off say, 1 2 or 3 HRV points, which would amount to less than 0.5 HRC points. It seems to that averaging a few points (for example, if you punched a 252HV in one area) would be the logical and prudent thing to do.

The basic question would be is there anything preventing someone from averaging HRV values right now? If there is, does the group feel that a formal ballot would be warranted?
ANSWER:
The referee hardness tests in for proving out isolated hard readings is not currently addressed in NACE MR0175/ISO 15156. A successful ballot would be required to add this into the standard.

QUESTION:
Does the MR0175/ISO 15156-2, 7.3.2 also apply to low-alloy martensitic steels such as CA6NM which is in fact considered a CRA (MR0175/ISO 15156-3)?

ANSWER:
No, it does not. Please see ISO 15156-3, 6.2.1 and ISO 15156-3, A.6.2, Table A18.

QUESTION:
Do NACE MR0175/ISO 15156-2, 7.3.2 “Parent metals” and NACE MR0175/ISO 15156-3, 6.2.1 “Hardness of parent metals” apply to machined forgings or are they meant to be applied to weldment parent metals only?

ANSWER:
The requirements listed in NACE MR0175/ISO 15156-2 Section 7.3.2 apply to the parent materials applicable to part 2; carbon and low alloy steels and cast irons. The parent materials include forgings. See also sections A.2.1.2 and A.2.1.3 of Annex A for additional requirements. The requirements listed in NACE MR0175/ISO 15156-3 Section 6.2.1 apply to parent materials applicable to part 2; CRAs and other alloys. The parent materials include forgings.

QUESTION:
Typically, when an indentation fails the micro hardness test several additional indentations are made and measured in the same area as the suspect indentation on the same weld test coupon. The results are then averaged. If the additional indentations average is acceptable, the survey is considered acceptable. This is in line with the NACE MR0175 Part 2 Section 7.3 “Hardness” paragraph 7.3.2 “Parent Materials” which allows additional hardness readings in the adjacent areas of a failed hardness reading. Logically, the same testing methodology would apply to welds, even though it is not specifically stated in the standard and subsequent paragraphs of Part 2. I would like to clarify if the above is acceptable with regards to Vickers HV 10 micro hardness testing / re-testing requirements for welds while conforming to NACE MR0175 Section 7.3.3 Welds.

ANSWER:
Maximum acceptable hardness values for carbon steel, carbon-manganese steel and low-alloy steel welds are given in Table A.1.

No individual readings above these limits are acceptable for welds.

7.3.3

QUESTION:
Seal welding of vent holes on saddle plates welded to pipe. We have provided vent holes on saddle plates in accordance with ASME B31.3. We have used these saddle plates at support locations as a protective shield to pipe. Now we would like to close the vent hole by seal welding after completion of saddle welding with pipe and carrying out PWHT. Permanent closing of vent hole is required to avoid corrosion in offshore conditions. Service is crude oil with H₂S, i.e., NACE MR0175/ISO 15156 is applicable.

Kindly advise us about the acceptance of seal welding for these service conditions.

(MP INQUIRY #2005-21)

ANSWER:
The ISO 15156 Maintenance Panel cannot provide guidance on the acceptability of seal welding in this application.

It is the responsibility of the equipment user to decide whether NACE MR0175/ISO 15156-2 is applicable to these seal welds. The applicability of this standard is described in Clause 1, Scope.

If this standard is considered applicable then the seal welds must comply with the requirements of NACE MR0175/ISO 15156-2, 7.3.3 or NACE MR0175/ISO 15156-3, 6.2.2.

Figure 2, Table A.1

QUESTION:
Ref Part 2 Figure 2 Butt Weld Survey method for Vickers Hardness Measurement. Location points 17, 18 & 19. What are the acceptance criteria? Table A.1 only provides acceptance for the Weld Cap and Root. As the area is not exposed should the acceptance level be 275 HV 10?

(MP INQUIRY #2009-04)

ANSWER:
Since it is not at the cap the acceptance level should be 250 HV 10 unless it is proven that it can be relaxed. For now there is no demonstrated evidence to show that 250 Hv can be relaxed at location points 17, 18, and 19 of Part 2 Figure 2.

7.3.3.2

QUESTION:
Is it acceptable to use HV 500g (microhardness) testing for NACE applications for WPS qualification? I understand that Paragraph 7.3.3.2 of NACE MR0175/ISO 15156 Part 2 says that hardness testing shall normally be carried out using HV 10kg or HV 5kg, which is our usual practice.

FYI, the hardness testing was done with HV 500g on CSA Z245.1 Grade 359 pipe material.  

(MP INQUIRY #2006-08)

ANSWER:  
Yes, subject to the agreement of the equipment user. Please see NACE MR0175/ISO 15156-2, Para. 7.3.3.2.

QUESTION:  
Section 7.3.3.2 states:

"The HRC method may be used for welding procedure qualification. . . And the welding procedure specification includes post-weld heat treatment"

and Clause A.2.1.4 states:

"As-welded carbon steels, carbon manganese steels and low alloy steels that comply with the hardness requirements of Table A.1 do not require post weld heat treatment."

It is confusing whether the latter statement implies that an as-welded carbon steel, carbon manganese steel, or low alloy steel would require a PWHT if only HRC hardness testing is performed. Per Section 7.3.3.2, I would say yes it does require PWHT. But if the as-welded hardness survey meets the 22 HRC limit then doesn't the as-welded material "comply with the hardness requirements of Table A.1 as stated in clause A.2.1.4?"  

(MP INQUIRY #2011-14)

ANSWER:  
For carbon, carbon manganese, and low alloy steels hardness testing for welding procedure qualification (PQR) may be performed by the HRC method only if the design stress does not exceed 2/3 SMYS and PWHT is perform. If PQR hardness testing is performed by the 7.3.3.2 specified HV or HR15N methods, the restrictions for design stress and PWHT are not required.

QUESTION:  
My understanding is that according NACE MR0175 – ISO 15156-2, during Welding Procedure Qualification for Weld Overlay the hardness profile can be HRC method instead of HV10, if the design stress does not exceed two-thirds of SMYS and the welding procedure specification includes post-weld heat treatment. The profile should be according to Figure 6, and in case the values are below 20HRC it can be done HRB hardness for this points, since HRC scale below 20HRC loses accuracy. Below you can see the highlighted parts from the standard.
Could you please confirm if my understanding is correct?

**ANSWER:**
NACE MR0175 / ISO 15156-2 deals with requirements and recommendations for the selection and qualification of carbon and low-alloy steels for service in equipment used in oil and natural gas production and natural gas treatment plants in H₂S-containing environments.

The hardness of parent materials and of welds and their heat-affected zones play important roles in determining the SSC resistance of carbon and low alloy steels. Hardness control can be an acceptable means of obtaining SSC resistance.

It is correct that the Vickers method (HV10 or 5) shall be used in order to record the hardness figures during WPQR, while the Rockwell method may be used as per paragraph 7.3.3.2 of NACE MR0175 / ISO 15156-2. However, the NACE MR0175 / ISO 15156-2 only recommends the use of Vickers and/or HRC. The use of other hardness testing methods shall require the agreement of the equipment user.

**7.3.3.3**

**QUESTION:**
We have one WPS Qualified in butt joint and Hardness survey done according to NACE MR 0175 (7.3.3.3 Figure 2) on Butt weld coupon.

Is it correct that we cannot use the above WPS in a fillet weld joint, because the fillet weld hardness survey is not carried out.

**ANSWER:**
The applicability of weld procedure qualification tests for specifications is in accordance with the welding codes. For fillet welds, a hardness survey shall be in accordance with NACE MR0175/ISO 15156-2, Clause 7.3.3.3, Fig. 3. The use of butt weld hardness tests to qualify a fillet welding application is not specifically addressed in NACE MR0175/ISO 15156-2. The requirement of NACE MR0175/ISO 15156-2 is that the hardness values in the weld and heat affected zones remain in compliance. You may need a consultant to assist you in this determination.

**QUESTION:**
Per 7.3.3.3 Using the Vickers or Rockwell 15N measurement methods, hardness impressions 2, 6, and 10 should be entirely within the heat-affected zone and located as close as possible to, but no more than 1mm from, the fusion boundary between the weld overlay and HAZ."

Is a correct interpretation that when welding dissimilar metals such as corrosion resistant overlays on low alloy steels, the phrase, "as close as possible to, but no more than 1mm from, the fusion boundary" means that the indentation should be no less
than 3x the mean diagonal length of the indentation from the fusion boundary as is required for adjacent indentations in ISO 6507-1:1998?

Note: ISO 6507-1:1998 is referenced by NACE/ISO 15156-2 in the first paragraph of Section 7.3.3.2 (Hardness testing methods for welding procedure qualification).

ANSWER:
The ISO 15156 Maintenance Panel cannot provide an interpretation of the ISO 6507-1:1998 in relation to the minimum distance of hardness indentations from the boundary between the base metal and the overlay weld.

As stated in ISO 15156-2, 7.3.3.2 and ISO 15156-3, 6.2.2.2.2 hardness measurements can also be carried out using a smaller indentation load, for example HV5 rather than HV10, and in many cases this will allow compliance with the requirements of ISO 15156-2, Fig. 6.

It is important to recognize that there will be a gradient in HAZ hardness in any case, and thus measurements too far from the fusion boundary could be un-conservative.

In all cases it is the task of the equipment user (and hence the supplier) to ensure that the hardness values measured are the most representative possible of the cracking resistance of the welded material in any sour service it is expected to experience.

7.3.3.4

QUESTION:
About welds, in accordance with NACE MR0175/ISO 15156, Part 2, Item 7.3.3.4, "hardness acceptance criteria for welds," "weld hardness acceptance criteria for steels selected using option 1 (see 7.1) shall be as specified in A.2.1.4. Alternative weld hardness acceptance criteria may be established from successful SSC testing of welded samples. SSC testing shall be in accordance with Annex B."

So, in our understanding, if our welding procedure qualifications (WPSs) are qualified in accordance with NACE MR0175/ISO 15156, Part 2, Item A.2.1.4, it is not necessary to test them according to NACE TM0177.

We would like you to confirm whether our interpretation below is correct and if not give us the correct interpretation.

ANSWER:
Your interpretation is correct.

QUESTION:
NACE MR0175/ISO 15156 and NACE TM0177--WELDS
On the other hand, if we make the test in accordance with NACE TM0177 in our WPSs that are previously qualified to conform to NACE MR0175/ISO 15156, what kind of results will we have? Will we have necessary or redundant results?

(MP INQUIRY #2005-08Q3)

ANSWER:
A manufacturer may choose to qualify a welding procedure specification in accordance with ANNEX B. Testing welds acceptable in accordance with A.2.1.4 is an optional activity chosen by the manufacturer to confirm resistance to cracking. This is not necessarily a redundant result depending on the anticipated service conditions and the selected test environment, the results could be used

-to confirm that the hardness control specified in A.2.1.4 is adequate to prevent sulfide stress cracking

-or to define alternative weld hardness control requirements that will not lead to sulfide stress cracking when the requirements of A.2.1.4 are not met.

Clause 8

QUESTION:
We are trying to interpret the NACE/ISO requirements for pressure vessel plate material. The NACE/ISO standard leaves the option of HIC testing with the client, as it appears. In accordance with the standard, the condition in which the HIC testing becomes mandatory should be based on some criteria other than H2S partial pressure. We would appreciate it if you can guide in giving the other conditions if sulfur and phosphorous content are controlled in accordance with NACE/ISO. Does HIC become mandatory due to non-uniformity of sulfur and phosphorous in the material due to steelmaking process even if the limit of these elements are maintained? Are there other reasons such as chloride environment?

(MP INQUIRY #2005-04)

ANSWER:
The statements in ISO 15156-2, 8 "Evaluation of carbon and low-alloy steels for their resistance to HIC/SWC" are based on the extensive experience of the experts who drew up the requirements of the standard.

They serve as a warning to the equipment user that damage to products from some flat-rolled carbon steel types due to HIC has been common and the risk of attack must be considered when selecting such materials for sour service. (See ISO 15156-1, 3.19 for definition of sour service in this context.) They also provide some indications of the types of flat-rolled carbon steel likely to give satisfactory resistance to HIC.

The overall aim of ISO 15156-2, Clause 8, is to ensure that materials that give satisfactory HIC performance in sour service can be selected. It is not the intention of this Clause to provide detailed information that can lead to the qualification, without testing, of HIC-resistant steels.
If, in accordance with NACE MR0175/ISO 15156:2, Clause A.2.2.2, Paragraph 3, the HIC resistance of flat-rolled plate is uncertain then the equipment user can elect to carry out HIC testing, possibly for use in an application-specific environment. Testing in accordance with Annex B.5 is proposed as a means of qualifying the material to ISO 15156-2.

Testing is not necessary if the equipment user can document that he has evaluated the risk of HIC failure of his equipment and considers the risk acceptable.

**QUESTION:**
According to NACE MR0175/ISO 15156, Part 2, Paragraph 8, HIC test is not mandatory for carbon steel SMLS pipe. But what about maximum sulfur content? Do we have to apply maximum sulfur content requirement to carbon steel regardless of HIC test?

*(MP INQUIRY #2005-15)*

**ANSWER:**
There are no requirements for the control of the chemistry of any elements to prevent HIC in NACE MR0175/ISO 15156. Some guidance concerning acceptable sulfur levels is given in Section 8 of NACE MR0175/ISO 15156 Part 2. For seamless products, testing can also be performed according to Table B.3 if deemed necessary.

**QUESTIONS:**
It appears that ISO 15156-2 is ambiguous in defining the acceptance criteria for HIC testing. Section B.5 and Table B.3 refer to NACE TM0284. This TM prescribes CLR, CTR, and CSR results to be reported for each of the three sections taken from a specimen and also as the average per specimen.

Q1. Could you please confirm that the intention of Section B.5 and Table B.3 is that the requirements of NACE TM0284 for the evaluation of test specimens should be followed and that CLR, CTR, and CSR should be calculated and reported for each section and the average for each test specimen.

Table B.3 does not specify if the criteria apply to the single section numbers or to the averages per specimen or to the averages over a series of specimens. The last of these was suggested recently to us, for qualification purposes, by a materials manufacturer.

ISO 3183-3 (the successor to API 5L) uses the same CLR, CTR, and CSR values as criteria as ISO 15156 but in addition it mentions that averages per specimen should be measured against the acceptance criteria (not single section numbers). I think it is common practice to apply this approach.

If one decides that the acceptance criteria are to be applied to single sections, I do not believe that using, in addition, the same criteria for the average per specimen yields any useful additional information (because it is less restrictive), but it does no harm either.
If, however, one decides that the acceptance criteria are to be applied only to the average per specimen, I am of the opinion that an additional condition should be imposed for single section results or for single crack lengths, for instance, no single crack length should exceed 5 mm, as part of the overall acceptance requirements.

Q2. Are the acceptance criteria intended to apply to the test results of both single section and the average per specimen?

Q3. Is the intention that, in coming to a qualification the CLR, CTR, and CSR values be calculated by averaging the results for a series of specimens?

Q4. If they are intended to apply to only the average per specimen, what additional requirements should be placed on the results of single section results?

(MP INQUIRY #2006-11)

ANSWERS:
A1. Yes.

A2. The referenced standard, NACE TM0284, Paragraph 8.4, requires the (calculation and) reporting of test results for each of three sections and the average for each test specimen. The application of the acceptance criteria to single section and/or the average for a specimen is subject to agreement between equipment user and the manufacturer.

A3. See Answer A.2 above, the referenced standard NACE TM0284 makes no mention of calculating results by averaging the results for a series of test specimens.

A4. The Maintenance Panel is unable to comment on issues that would involve an extension of the requirements of the standard. Any materials purchaser is free to add requirements beyond those required or made optional by the standard.

Any amendment proposal to extend the requirements for single section test results must be submitted in accordance with the requirements outlined in:-

01. Introduction to ISO 15156 maintenance activities (Annex C) of the web site www.iso.org/iso15156maintenance.

QUESTION:
“In accordance with ANSI/NACE MR0175/ISO 15156-2:2015(E), Chapter 8, 2nd paragraph limits the maximum level of sulfur in the steel as the following statement.

- Quote
The probability of HIC/SWC is influenced by steel chemistry and manufacturing route. The level of sulfur in the steel is of particular importance, typical maximum acceptable levels for flat-rolled and seamless products are 0.003% mass fraction and 0.01% mass fraction, respectively. Conventional forgings with sulfur levels less than 0.025% mass fraction, and castings, are not normally considered sensitive to HIC or SOHIC.
- End of Quote

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Question 1: Are the specified %S contents above applicable to the chemistry from the result of product analysis only or from both heat analysis and product analysis? In other words, if the %S from product analysis for welded pipe product is below 0.003%, but the %S from heat analysis is slightly above 0.003% (e.g., 0.005%), is this product considered as acceptable in a point of NACE MR0175 view?

Question 2: There are no clear statement in NACE MR0175/ISO 15156-1/2/3 whether the limitation of chemistries in various materials are apply to the result of heat analysis or product analysis or both. Please clarify which of chemistry analyses are the baseline of chemistry evaluation.”

(MP INQUIRY #2020-06)

ANSWER:
A1: MP can only give an interpretation of the wording in the standard and cannot judge whether a product is acceptable or not. Please see answer to question 2 regarding product and heat analysis.

A2: You are correct that there is no statement in NACE MR0175 / ISO 15156 if the limitations are based on the heat analysis or product analysis. It is up to the product specification or agreement between the equipment manufacturer and equipment user regarding which analysis should be used.

Annex A

A.2.1, A.2.2.4

QUESTION:
I have a query in respect to the identification of the sour environment for deciding whether a bolting alloy shall conform to the general requirements of A.2.1 as required by A.2.2.4, where the bolting material is denied direct atmosphere exposure.

An example best illustrates my question.

In a pressure containing piping or vessel, it is clear that the partial pressure of H2S within the pressure containment determines whether the piping or vessel is exposed to sour service.

Flange bolting is located outside the vessel and the piping and flange protection systems are seldom pressure containing enclosures. If a leak occurs the partial pressure of H2S will be reduced according to the ratio of the external pressure (typically 1 atm or 100 kPa) to the total pressure internal to the vessel.

My question then is whether it is the partial pressure of H2S in the external environment or the partial pressure of H2S in the internal environment that is used to determine whether the bolting material is in sour service.

(MP INQUIRY #2011-12)

ANSWER:
The equipment user is responsible for defining the intended service environment and selecting materials in accordance with this standard.

A.2.1.1

**QUESTION:**
NACE MR0175 /ISO 15156 does not mention clearly about sulfur restrictions for carbon steel forgings and castings to ASTM-A105 and ASTM-A216 respectively.

These two specs are work-horse of any oil/gas processing industry. Almost 75% to 90% of materials of construction would fall into these specifications. For example: flanges and fittings and valves and rotating machinery casings.

The paragraph A.2.1.3 states:

A.2.1.3 Carbon steels acceptable with revised or additional restrictions

In addition to the restrictions of A.2.1.2, some carbon steels are acceptable subject to the revised or additional restrictions as follows.

a) Forgings produced in accordance with ASTM A 105 are acceptable if the hardness does not exceed 187 HBW.

Please note: In the original standards ASTM -A105 allows sulfur up to 0.040% and ASTM A 216 allows sulfur up to 0.045%.

However, NACE MR0175/ISO 15156, Section 8 says: Conventional forgings with sulfur levels less than 0.025 %, and castings, are not normally considered sensitive to HIC or SOHIC.

The above statement means ASTM A 105 forgings are acceptable, if sulfur is limited to 0.025% and hardness to 187 HBW.

Castings have no additional sulfur limit other than specified in the base spec. (for example: 0.045% for ASTM-A216).

The document has reference to many casting and forging grades, but, these two grades are not adequately covered. ASTM A 216 is not covered at all.

It would be appreciated if NACE clearly makes mention of these two important materials with limitations if any clearly stated. Would such changes be possible?

*(MP INQUIRY #2007-05)*

**ANSWER:**
It is outside the scope of the standard to provide information concerning the "limitations" of ASTM A 105 and ASTM A 216 in the specific form you request.
Many steels, including ASTM A 216, are not individually listed in NACE MR0175/ISO 15156-2. As stated in A.2.1.1 General, Para. 3: "The majority of steels that comply with the general requirements of A.2 are not individually listed; however, for convenience, some examples of such steels are listed in Table A.2, Table A.3 and Table A.4." A.2.1.1 deals only with sulfide stress corrosion resistance.

Where any possible additional restrictions are mentioned (as is the case in Section 8 in relation to HIC/SWC resistance), they refer to any carbon or low alloy steel to which the text might apply.

Table A.1

**QUESTION:**
I am writing to you to ask for clarification regarding NACE MR0175/ISO 15156-2

We have a part here which was welded and PWHT and the subsequent hardness check revealed a hardness on the weld cap of 243 Brinell. Our engineering department dispositioned this as acceptable in accordance with Table A.1, as Section A.2.1.4 suggests that "Acceptable maximum hardness values for carbon steel, carbon manganese steel, and low-alloy steel welds are given in Table A.1." An independent Competent Body, Lloyds Register, however, has pointed out that Table A.1 mentions "Hardness test locations for welding procedure qualification" utilizing Vickers and Rockwell hardness techniques. Can you please therefore confirm if NACE compliant production welding can be accepted in accordance with this Table, or is it merely for weld procedure qualification.

**ANSWER:**
Hardness measurements must be performed according to § 7.3.3 using Vickers hardness HV 10 or 5 or Rockwell 15N methods. Brinell hardness method is subject to the acceptance of the equipment user.

Table A.1 applies to qualification and production hardness values. However since 243 Brinell is above 250 HV or 22 HRC but below the alternate weld cap limit of 275 HV it requires “equipment user” acceptance and also to obey the two other listed requirements in Table A.1.

**QUESTION 1:**
Table A.1 of ANSI/NACE MR0175/ISO 15156-2 specified the Max. hardness value for C, C-Mn and alloy steel welds. For the HV5 method, maximum hardness of weld metal of unexposed weld cap is 275HV, Whether this hardness requirement of weld cap (275HV) applies to hard-facing overlay weld?

**ANSWER 1:**
Please note that In Table A.1, the hardness requirements are different for different welds. For a weld overlay, the requirement is 250 HV. The Maintenance Panel cannot
give an answer if your hard-facing overlay weld is a butt weld, repair weld or weld overlay, and thus which requirement applies in your case.

**QUESTION 2:**
We noted "A.2.1.5 b) The maximum hardness and/or other properties of the weld deposit shall comply with the requirements of ANSI/NACE MR0175/ISO 15156-3 or this part of ANSI/NACE MR0175/ISO 15156, as applicable." However, The maximum hardness of most weld consumables for hard-facing overlay weld weren't specified in ANSI/NACE MR0175/ISO 15156. In this case, how to determine the acceptance criteria of weld metal hardness for hard-facing overlay weld?

**ANSWER 2:**
Please note that Section 7.3.3.4 states that “Alternative weld hardness acceptance criteria may be established from successful SSC testing of welded samples. SSC testing shall be in accordance with Annex B in ANSI/NACE MR0175/ISO 15156-2.”

**Table A.2**

**QUESTION:**
NACE MR0175/ISO15156 Table A.2 footnote (b) states that UNS S31603 shall be in the solution-annealed and quenched condition ……

Question: Do welds need to be solution annealed after welding if the base metals were all solution annealed and the filler metal is of an ER/E316L type?

The operating condition is around 1000 psig at 80F. The H2S partial pressure is 40 psi, chloride content around 2000 ppm, pH around 4.85.

**ANSWER:**
Question 1: Regarding UNS S31603 and 15156-3 Table A.2 Footnote (b), this footnote states that the UNS S31603 shall be in the solution annealed and quenched condition. Do welds need to solution anneal after welding if the base metals were all solution annealed and the filler metal is of the E/ER316L type? The operating condition is 1000 psig at 80F with 40 psi partial pressure H2S, 2000 ppm chloride and pH about 4.5.

Answer 1: The 15156-3 Table A.2 does not specifically address the requirements for weldments. Note Clause 6.2.2.1 that states that “the metallurgical changes that occur when welding CRAs and other alloys can affect their susceptibility to SSC, SCC and/or GHSC. Welded joints can have greater susceptibility to cracking than the parent material(s) joined.” The required documented evidence for welding PQRs is defined in Clause 6.2.2 sub-clauses. You may want to employ a consultant to assist you with your application.

**QUESTION:**
1. Under Table A.2 – ‘Environmental and materials limits for austenitic stainless steels used for any equipment or components’, in the notes section under the sub heading ‘b’, which apply to grade UNS S31603 (316L), is the following statement ‘the material shall be free from cold work caused by shaping, forming, cold reducing, tension,
expansion, etc. after the final solution annealing and quenching treatment. My question is, why is this statement also not applicable to other types of austenitic stainless steels described in paragraph A.2 (under sub heading ‘a’ above)?

2. Following on from question 1 above, if a material is dual certified as 316/316L (UNS S31600/S31603), what category of Table A.2 will it be designated under? i.e. will it be deemed under category A.2 (note ‘a’) or as UNS S31603 (note ‘b’)? Or both?

(MP INQUIRY #2016-19)

ANSWER:
Under ISO 15156-3 Table A.2, in the notes section under the sub heading ‘b’, which apply to grade UNS S31603 (316L), is the following statement ‘the material shall be free from cold work caused by shaping, forming, cold reducing, tension, expansion, etc. after the final solution annealing and quenching treatment.

Question 1: Why is this statement also not applicable to other types of austenitic stainless steels described in paragraph A.2 (under sub heading ‘a’ above)?
Answer: The words present in note “b” are in accordance with a successful ballot to extend the use limits of UNS S31603. The extension of these use limits was accompanied by a more descriptive definition of what constitutes cold work.

Question 2: If a material is dual certified as 316/316L (UNS S31600/S31603), what category of ISO 15156-3 Table A.2 will it be designated under?
Answer: The alloy meets and applies to both “a” and “b” as applicable. Note the paragraph in ISO 15156-3 Clause A.2.1 which states “It is common industry practice to dual certify 300 series stainless steels as standard grade and low carbon grade such as S31600 (316) and S31603 (316L). The environmental limits given for low carbon 300 series stainless steels are acceptable for the dual certified grades”.

QUESTION:
Chloride con column is "see remark"- which is any combination of chloride concentration and in situ pH occurring in production is acceptable.
E.G. TABLE A.2, S31600 can resist 5000 mg/h Chloride concentration??

How to understand these figures? or they are same service, means 5000 mg/l is only valid for temp less than 93 oc, PH2S less than 10.2 kPa??

(MP INQUIRY #2017-06)

ANSWER:
Q1: Regarding 15156-2 Table A.2 for UNS S31600, the remarks section defines acceptance for any chloride and in situ pH. Can UNS S31600 be acceptable with a chloride content of 5000 mg/L?

A1: Table A.2 permits any level of chloride for austenitic stainless steels defined in Clause A.2 with the following restrictions: temperature shall be no higher than 60°C, the partial pressure of H2S shall be no higher than 100 kPa and no elemental sulfur. Note that the material restrictions defined in note a in Table A.2 also apply.

Q2: How do I understand these figures in Table A.2?
A2: We cannot provide consulting services. You may need to employ a consultant to help your understanding of these material and application limits.

QUESTION:
Question No. 1
Could you please define the word "Qualification."

In our understanding, qualification is required for new materials that are not listed in Table A.2 of NACE MR0175/ISO 15156-2. We would like you to confirm that our interpretation is correct and if not what is your position?

(MP INQUIRY #2009-01)

ANSWER:
Table A.2 of ISO 15156-2 gives examples of materials that can be qualified provided they comply with Paragraph A.2.1. If not listed in Table A.2, materials must be assessed in the terms of the requirements given in Annex A as explained in Paragraph 7 of Part 1. Again it is up to the equipment user to decide if materials need further qualification through testing or field experience as explained in Paragraph 8 of Part 1.

QUESTION:
I had a question about the spec and was hoping to get my question cleared up. For NACE MR0175/ISO 15156 part 2, on page 21 Table A.2 shows tubular products that can comply with A.2.1 (from my understanding of the wording, it stating “can” does not necessarily mean it always does).

ASTM A106 states hot-finished pipe does not require heat treatment (if heat treated, it states a temp); so am I correct in believing that in order to comply with NACE MR0175, a hot-finished pipe under ASTM A106 gr B would still need to be heat treated as per A.2.1.2?

(MP INQUIRY #2019-01)

ANSWER:
Depending on pipe dimensions, ASTM A106 - Grade B allows for either hot finished or cold drawn or hot finished only. Thus, when cold drawing is used during manufacture it will then require heat treatment to meet both ASTM and NACE MR0175/ISO 15156-2, Clause A.2.1.2 requirements. In the context of the aforementioned clause, hot finished would be equivalent to a hot-rolled heat treatment condition.

QUESTION:
Q1. Provided via Word attachment: "Does the statement in section A.2.2 Note C of table A.2 permit use of all three of the common conditions provided the hardness is below 35 HRC? In other words, does it restrict use of Cold Worked material meeting 35HRC max?"

Q2. Subsequent follow-up question received from inquirer: "We are almost there…. 
The industry is confused on how to interpret the words (hot/cold-rolled) as presented in the MR0175 document

I’m just trying to get a clarification since as you point out the conditions as written are not defined….”

"Based on the below answer it would say to me that either hot rolled or cold worked is acceptable under 35HRC

I’m confused by the extra word “hot” – is that a typo?

(MP INQUIRY #2019-04)

ANSWER:
A1. Please note that the terms "hot rolled" and "hot worked" are not defined in NACE MR0175 / ISO 15156. The Maintenance Panel only interprets NACE MR0175 / ISO 15156 and cannot interpret other standards' wording or their definitions."

A2: The question refers to A.2.2 Note C of Table A.2. The condition of hot rolling before cold working must be fulfilled. This means that for any equipment and/or components, Table A.2 allows that material for use in hot rolled hot and cold worked condition with a maximum hardness of 35 HRC.

Note: Please note that Table A3 has been changed that is included in the background for the question, see ISO 15156-3:2015/Cir.2:2018(E). The current wording for valve stems, pins and shafts is:
- UNS S20910 at a maximum hardness level of 35 HRC may be used in (1) the as-hot worked condition, (2) the solution annealed condition or (3) the solution annealed condition followed by cold-working. Note that the cold worked condition shall be preceded by solution annealing.

Response to inquirer’s followup question: The MP has responded that the extra “hot” in the response to Q2 is indeed a typo. The response should read as follows:

A2: The question refers to A.2.2 Note C of Table A.2. The condition of hot rolling before cold working must be fulfilled. This means that for any equipment and/or components, Table A.2 allows that material for use in hot rolled and cold worked condition with a maximum hardness of 35 HRC.

QUESTION:
“NACE MR0175/ISO 15156 Part 2 Table A.2 lists API Specification 5L grades: A and B and X-42 through X-65 as compliant to requirements for SSC-resistant carbon and low-alloy steels since ever; however, API 5L had an introduction of Appendix H for additional provisions for pipes ordered for sour service since the adoption of ISO3183 in 2007”

Q1. “Are pipes manufactured prior the introduction of Appendix H still compliant to the current NACE MR0175/ISO15156?”
ANSWER:
Clause A.2.2 of ANSI/NACE MR0175/ISO 15156 Part 2 refers to the API Specification 5L grades in your inquiry as “examples of tubular products that can conform with A.2.1.” API Specification 5L pipe manufactured prior to 2007 can meet the product requirements of ANSI/NACE MR0175/ISO 15156, provided the requirements of ANSI/NACE MR0175/ISO 15156 Part 2 clause A.2.1 and its subclauses were met (for parent metal and, for seam welded product, the seam weld).

QUESTION:
“In regards to the section in the standard that covers austenitic stainless (Footnotes from Table A2) for austenitic stainless steels, there is a sentence that refers to cold worked product that enhances mechanical properties and that this is not acceptable. When the standard states cold worked are they referring to condition B or strain hardened product or are they referring to any cold drawn or cold finished product? There seems to be conflicting views from the mills on this matter and I am trying to find out from the source what they mean by this.”

ANSWER:
It is correct the footnote in Table A.2 says that austenitic stainless steel from material types described in A.2 shall “be free of cold work intended to enhance their mechanical properties…” Please note that cold work is defined in clause 3.7 in NACE MR0175 / ISO 15156 as "plastic deformation of metal under conditions of temperature and strain rate that induce strain hardening, usually, but not necessarily, conducted at room temperature." If the cold work increases the strength, the product is no longer "...free of cold work intended to enhance mechanical properties..." If this is the case, laboratory tests would be required for acceptance in accordance with Annex B as specified/agreed by/with the equipment user according to the intended service.

The Maintenance Panel only gives interpretation of the standard and can’t give recommendations regarding products.

QUESTION:
Table A.2 states the maximum Chloride conc for Austenitic Stainless steel materials like SS31600 (> 50 mg/l) & SS31603 (50000 mg/l) with respect to the max temperatures / pH. Shall we consider these combinations of max Chloride Concentration as max limit for Chloride Stress Corrosion Cracking (CLSCC)?

ANSWER:
The ANSI/NACE MR0175-ISO 15156-3 standard offers guidance on materials for use in H₂S-containing environments in oil and gas production (environments are oxygen-free).

Table A.2 permits any level of chloride for austenitic stainless steels defined in Clause A.2 with the following restrictions: temperature shall be no higher than 60 °C, the partial pressure of H₂S shall be no higher than 100 kPa and no elemental sulfur. Note that the material restrictions defined in Note a in Table A.2 also apply. For a maximum Chloride concentration of 50mg/L, these materials have been used without restrictions on temperature, pH₂S, or in situ pH in production environments. No limits on individual parameters are set in the standard, but some combinations of the values of these parameters might not be acceptable.

For UNS S31603 compliant with Table A.2 Note b, environmental limits (temperature, H₂S partial pressure, chloride concentration, and pH) are stated in the table. No data has been submitted to assess acceptable service in the presence of elemental sulfur, though. The current values that are in the document are based on successful ballots and history. Any combination of parameters out of the above limits shall be tested and agreed with the end-user.

A.2.1.2

QUESTION:
Apologies that I did not clarify the question at the beginning. This is regarding AISI 4130 that is in compliance with NACE MR0175/ ISO 15156-2 A.2.1.2, which stated that:
“Carbon and low-alloy steels are acceptable at 22 HRC maximum hardness provided they contain less than 1 % mass fraction nickel, are not free-machining steels and are used in one of the following heat-treatment conditions:
a) hot-rolled (carbon steels only);
b) annealed;
c) normalized;
d) normalized and tempered;
e) normalized, austenitized, quenched, and tempered;
f) austenitized, quenched, and tempered.”

The 1st paragraph of Section 7.2.1.4 stated that “Referring to the regions of severity of the exposure as defined in Figure 1, steels for region 1 may be selected using Clause A.2, A.3 or A.4; steels for region 2 may be selected using Clause A.2 or A.3; and steels for region 3 may be selected using Clause A.2.” My interpretation on this statement is that steel that is in compliance with Clause A.2 is suitable for region 1, 2 and 3. Hence, AISI 4130 mentioned above is suitable for Region 1, 2 and 3. Do you agree with me?

Furthermore from my understanding, Region 1, 2 and 3 as shown in Figure 1 below include any combinations of pH value and H₂S partial pressure. Therefore, is it true that the AISI 4130 mentioned above can be rated as EE with no H₂S limit? 3. Do you agree with me?

(MP INQUIRY #2018-04)
ANSWER:

Response: Cr-Mo low-alloy steels maybe suitable for Regions 1, 2 and 3 as long as they meet the general requirements as described in Clause A.2.1 and other specific requirements as described in Clauses A.2.2 and A.2.3. Similarly, other requirements as specified in Clauses A.3 and A.4 for SSC region 2 and 1; respectively, are also applicable. Generally, materials that meet the most strict requirements of Clause A.2 would be expected to meet the requirements of Clauses A.3 and A.4.

Furthermore, from my understanding, Region 1, 2 and 3 as shown in Figure 1 below include any combinations of pH value and H2S partial pressure. Therefore, is it true that the AISI 4130 mentioned above can be rated as EE with no H2S limit?

Response: Your interpretation is incorrect. Cr-Mo alloys that meet the aforementioned requirements would be acceptable within the boundaries shown in Figure 1 (ISO 15156-2: 2015), where Region 3 is limited to 150 psia H2S due to uncertainties on steel performance above this limit.

Corrected Response: Yes, AISI 4130 in compliance with the requirements of ISO 15156-2:2015 Clause A.2 can be used with no H2S limits per Figure 1. However, see Figure 1: NOTE 1 for a cautionary statement regarding uncertainties with respect to steel's performance.

QUESTION:
I am currently attending one of the NACE corrosion training in Houston and was hoping to get help on the interpretation on Annex A section A.2.1.2 where it talks about fibre deformation greater than 5%. Is this referring to surface strain when a residual tension stress is applied as a result of manufacturing processes?

A.2.1.6 Cold deformation and thermal stress relief
Carbon and low-alloy steels shall be thermally stress-relieved following any cold deforming by rolling, cold forging or other manufacturing process that results in a permanent outer fibre deformation greater than 5%. Thermal stress relief shall be performed in accordance with an appropriate code or standard. The minimum stress-relief temperature shall be 595 °C (1 100 °F). The final maximum hardness shall be 22 HRC except for pipe fittings made from ASTM A234 grade WPB or WPC, for which the final hardness shall not exceed 197 HBW.

ANSWER:
YES

QUESTION:
--Does the term “hot rolled” referred to in Paragraph A.2.1.2 only apply to sheet or plate material and as such cannot be applied to the forming of butt weld fittings?

ANSWER:
Yes, “hot rolled,” in the view of the Maintenance Panel, does not apply to the forming of butt weld fittings.

**QUESTION:**
Often my company is asked by customers to certify our forgings to NACE MR0175. It is my understanding from them that our competition (including imports), certifies to MR0175 without normalizing and consequently we are pressured to do the same. We have three presses, two are fed by gas-fired furnaces, and one is with induction heaters. The gas heat forgings are typically heated to 2,300 to 2,350°F and forged on a 900T or 3500T open die press in a tooling pot, then still air cooled to ambient. The forgings heated by induction are heated to similar temperatures but only a portion of a bar and the flange end is forged close to shape, then air cooled in still air.

Customers can order these forgings in the "as forged" or "normalized" condition per SA105. My question is do we have to normalize the forgings coming from either forging process in order to certify to NACE MR0175? The problem is interpretation of NACE MR0175/ISO 15156-2:2003(E), page 17, Annex A, Paragraph A.2.1.2. The heat-treated condition "hot-rolled" is not clearly understood and competitors with similar processes interpret that if the entire raw material piece prior to forge, let's call it a mult, is taken to 2,300 to 2,350°F prior to forge that this satisfies the "hot-rolled" definition.

We have contended that our products need to be subsequently followed with a normalizing cycle after being fully cooled to ambient in order to be certified to NACE and that neither of the forging processes listed above satisfies the definition of "hot-rolled" process.  

**(MP INQUIRY #2005-25)**

**ANSWER:**
Hot-forged material does not meet the intent of NACE MR0175/ISO 15156-2, A.2.1.2a).

An exception to this statement is given in A.2.1.3a).

Other hot-forged materials would have to be treated according to one of the five other heat-treatment conditions described in Paragraph A.2.1.2 to comply with this standard.

As a consequence, ASTM A 105 material is acceptable in the "as-forged" condition not because it is equivalent to a "hot rolled" condition in A.2.1.2, but because it is a permitted exception in A.2.1.3.a.

**QUESTION:**
Would a forged ASTM A105 Class 150# flange in the non-normalized condition be in accordance with NACE MR0175 and NACE MR0103?

**(MP INQUIRY #2009-08)**

**ANSWER:**
We can only answer for NACE MR0175/ISO 15156, not for NACE MR0103.
AS FORGED is not an acceptable condition in A.2.1.2. Both requirements of A.2.1.2. and A.2.1.3 of Part 2 must be fulfilled for ASTM A 105 flanges to meet NACE MR0175/ISO 15156.

**QUESTION:**

“My question is concerning hardness limits for carbon steels in ISO 15156-2.

Section A 2.1.2 indicates that carbon steels with less than 1wt% Ni, and that are not free-machining, are acceptable for a variety of specified heat treatment conditions, provided the hardness is less than 22HRC (250HV).

Later on, section A 2.1.3 that some carbon steels have additional restrictions:

- Forgings according to ASTM A105 are acceptable if the hardness does not exceed 187 HBW (about 197HV).
- Wrought pipe fittings to ASTM A234 grade WPB and WPC are acceptable if the hardness does not exceed 197HBW (208HV about).

The reason for this reduced hardness limit concerning SSC resistance for forgings is not clear. For example ASTM A105 specified exactly the same maximum hardness limit. Moreover no comment is given regarding any welds present in forgings or wrought pipe fittings, i.e. the reader refers to the later section A 2.1.4 which seems to indicate that a higher hardness of 250HV10 would be suitable.”

Q1. “Could the panel kindly offer some guidance?”

*(MP INQUIRY #2020-01)*

**ANSWER:**

It is correct that there are no specific requirements for welding for forgings according to ASTM A105 except those in section A 2.1.4. However, for the parent material of the forging according to ASTM A105, the hardness limit of 187 HBW applies. The limits in section A 2.1.4 are applicable only on weld metal and the heat affected zone. Welding and weld-hardness determinations shall be performed in accordance with 7.3.3. Hardness acceptance criteria within this section (sub-section 7.3.3.4) states that for carbon steel selection according to option 1, the welding limits of section A.2.1.4 are applicable; whereas for carbon steel selection according to option 2, weld-hardness acceptance criteria may be established from successful SST testing of welded samples in accordance with SSC testing requirements in Annex B.

Please note that the Maintenance Panel only answers questions concerning interpretation of the wording of the document and cannot answer historical questions.

**QUESTION:**

“ANSI/NACE MR0175/ISO 15156-2:2015 states in A.2.1.2 Parent metal composition, heat treatment and hardness that “Carbon and low-alloy steels are acceptable … and are used in one of the following heat-treatment conditions:
a) hot-rolled (carbon steels only);
b) annealed;
c) normalized;  
d) normalized and tempered;  
e) normalized, austenitized, quenched, and tempered;  
f) austenitized, quenched, and tempered.”

Low temperature carbon steel castings LCB and LCC acc. to ASTM A 352 are typically supplied in the “quenched and tempered” heat treatment condition in order to meet the impact test requirements at -46°C.

However “quenched and tempered” is not one of the above mentioned acceptable heat treatments acc. to ANSI/NACE MR0175/ISO 15156-2:2015. Acceptable heat treatments that include quenched and tempered also include austenitized, which is not suitable for LCB/LCC.

Question: May LCB and LCC acc. to ASTM A 352 in the quenched and tempered condition be used in applications acc. to ANSI/NACE MR0175/ISO 15156-2:2015, provided that all other requirements acc. to ANSI/NACE MR0175/ISO 15156-2:2015 are met?

The same question applies to ANSI/NACE MR0103/ISO 17495:2015, where the same heat treatment requirements are defined in section 13.1.1 Requirements for all carbon and alloy steels”

(MP INQUIRY #2020-03)

ANSWER: In order to be acceptable according to Section A.2.1.2, all requirements in Section A.2.1.2 must be fulfilled, including the heat treatment. Hence, a quenched and tempered steel needs to be austenitized or normalized and austenitized as well. For other metallurgical conditions, the requirements in Option 2 in Section 7.2 apply.

The Maintenance Panel cannot answer a question related to ANSI/NACE MR0103/ISO 17495:2015; such questions must be submitted to the committee in charge of the standard. Please contact NACE staff for contact details.”

QUESTION: “1% max mass fraction Ni content is required for steels in Section A.2.1.2 of NACE MR0175/ISO 15156-2 (2015) along with 22 HRC max hardness for use in sour service. Quenched and tempered steel grades with strength that can have hardness above 22 HRC max such as T95, P110, Q125 and proprietary grades with 140 ksi max yield strength or Normalized grades such as N80 are allowed for sour service based on additional temperature restrictions in Table A.3 of NACE MR0175/ISO 15156-2 (2015). There is no explicit reference to 1% max mass fraction Ni content with respect to these grades in NACE MR0175/ISO 15156-2. So can it be confirmed that clause A.2.1.2 does not apply to the temperature limited grades in Table A.3?”

(MP INQUIRY #2020-12)

ANSWER:
It is correct that there is no further requirements about Ni-content in Table A.3 which is a part of clause A.2.2 in ISO 15156-2 (2020). However, in clause A.2.2.1, it is stated that the general requirements in A.2.1 shall apply to any product form if the requirement is not modified in A.2.2. Since no modification regarding Ni-content is given in Table A.3, the requirement of containing less than 1% mass fraction nickel in A.2.1.2 shall be applied.

A.2.1.2 and A.2.2.2

**QUESTION:**
We are trying to identify the MR0175 hardness requirements for P1, Group 2 Carbon Steel (and not A105 or A234) for Pipe, Plate, Fittings, and Pressure vessels.

The source of confusion:
a) A.2.1.2 identifies a hardness requirement of Rc 22.
b) A.2.2.2 states that P-No 1, Group 1 pressure vessel steels are “acceptable.”

Theory A supports a requirement of Rc 22 max.
Theory B supports that “acceptable” means “acceptable at any hardness,” i.e., there is no maximum hardness requirement for P-No 1, Group 2 material.

Which theory is correct? (Note: Our part of interest, a rupture disc holder, seems to fit under both “Pipe, plate and fittings” and “Pressure Vessel.”)

**(MP INQUIRY #2015-01)**

**ANSWER:**
The Section A.2.2 pertains to the application of the general guidelines to product forms such as pipe, plate and fittings. Section A.2.2.1 states that “Except as modified below, the general requirements of A.2.1 shall apply to all product forms”. There are no exceptions listed in Section A.2.2.2 and Table A.2 that permits exception to the 22 Rockwell C hardness limit. The requirement for 22 Rockwell C maximum remains in effect.

**QUESTION:**
ANSI/NACE MR0175/ISO 15156-2 allows "hot rolled" as a heat treatment condition for carbon steels in A.2.1.2 (a). What about flanges, fittings, seamless pipe, etc which are not produced by rolling? Should “hot rolled” be interpreted as "hot formed" for product types other than plate? There is an allowance in A.2.1.3, and abundant evidence of satisfactory performance in service, of A105 and A234 WPB/C flanges and fittings which are supplied “hot formed”.

**(MP INQUIRY #2015-09)**

**ANSWER:**
Carbon steels that are hot formed are acceptable for flanges & fittings as further limited by A.2.1.3. ASTM A105, as described in A.2.1.3, includes the application for forged pipe and flanges. Other standards may be acceptable if they are equivalent with respect to the limitations of process, composition, mechanical property and hardness in compliance with the relevant ASTM A105 or ASTM A234 standard.
A.2.1.4

QUESTION:
ISO 15156-2 Annex A.2.1.4 differentiate between “carbon steel”, “carbon manganese steel” and “low-alloy steel”. The terms “carbon steel” and “low-alloy steel” are defined in ISO 15156-1, but not “carbon manganese steel”. What is the definition of “carbon manganese steel” in the scope of NACE MR0175?

(MP INQUIRY #2017-23)

ANSWER:
Although not directly defined in ISO 15156-1, the definition of carbon manganese steel is inferred in the definition of carbon steel. As described, these alloys may contain up to 1.65 mass percent Mn. The MP will discuss the need to provide a separate definition or enhance the definition in ISO 15156-1. However, a technical ballot would need to be submitted to make any suggested changes.

QUESTION:
Regarding new revision of NACE MR0175/ ISO15156-2 (2015) Section A.2.1.4, I have following question:

- On 2009 revision: minimum post weld heat treatment temperature (PWHT) shall be 1150 F for Carbon and Low Alloy Steel. With the changes on 2015 “ A minimum PWHT at 1150F shall be used for low alloy steel”, is minimum PWHT temperature at 1150 F apply to Carbon Manganese steel as well or this temperature is just applicable to Low Alloy steel?
- If minimum PWHT temperature at 1150 F is not applicable to Carbon Manganese steel, is there any minimum PWHT temperature requirement applicable to carbon manganese steel?

(MP INQUIRY #2017-13)

ANSWER:
Q1: Regarding NACE MR0175/ ISO15156-2 (2015) Section A.2.1.4, the 2009 revision states that the minimum post weld heat treatment temperature (PWHT) shall be 1150 F for Carbon and Low Alloy Steel. The 2015 revision states “ A minimum PWHT at 1150F shall be used for low alloy steel”. Does the minimum PWHT temperature at 1150 F apply to Carbon Manganese steel as well or this temperature is just applicable to Low Alloy steel?

A1: The 1150F requirement is specific to low alloy steels. Note that carbon and carbon manganese steels still are required to comply with the hardness requirements as defined in Table A.1 when the SMYS exceeds 52 ksi. As noted in Clause A.2.1.4, as-welded carbon steels, carbon-manganese steels and low-alloy steels that comply with the hardness requirements of Table A.1 do not require post-weld heat treatment.

Q2: If minimum PWHT temperature at 1150 F is not applicable to Carbon Manganese steel, is there a minimum PWHT temperature requirement?
A2: There is no specific defined PWHT minimum temperature defined for carbon and carbon-manganese steels. The PWHT requirement is that it must yield a product that complies with the other requirements defined by NACE MR0175/ISO15156-2 Clause A.2.1.4

**QUESTION:**
Per A.2.1.4 "Tubular products with an SMYS not exceeding 360 MPa (52ksi) and listed in Table A.2 are acceptable in the as-welded condition. For these products, hardness testing of welding procedures may be waived if agreed by the equipment user". Is a correct interpretation that all hardness testing is being waived for tubular products with an SMYS not exceeding 52ksi in the as-welded condition if as agreed by the equipment user?

(MP INQUIRY #2006-01Q1)

**ANSWER:**
No, tubular products listed in Table A.2 with an SMYS not exceeding 360 MPa (52 ksi) are acceptable in the as welded condition. For these products hardness testing of WELDING PROCEDURES may be waived if agreed by the equipment user.

**QUESTION:**
A.2.1.4 Welding, Paragraph 6 states: "Carbon steel and low-alloy steel weldments that do not comply with other paragraphs of this subclause shall be stress-relieved at a minimum temperature of 620 °C (1150 °F) after welding. The maximum weld zone hardness, determined in accordance with 7.3, shall be 250 HV or, subject to the restrictions described in 7.3.3, 22 HRC."

This particular paragraph does not refer to Table A.1 (Maximum acceptable hardness values for carbon steel, carbon-manganese steel and low-alloy steel welds), which states that weld cap hardness can be 275 HV with limitations.

Could NACE please clarify if Table A.1 should or should not be applicable for stress-relieved weldments. Which hardness value 250 HV or 275 HV shall be applicable for weld cap hardness of stress-relieved weldments?

(MP INQUIRY #2011-01)

**ANSWER:**
Table A.1 gives maximum acceptable values for carbon steel, carbon-manganese steel and low alloy steel weldments. It is applicable to welds whether they have been post weld heat treated or not.

**QUESTION:**
"ISO 15156-2 subclause A2.1.4 Welding has the following two paragraphs: ""Carbon steel and low-alloy steel weldments that do not comply with other paragraphs of this subclause shall be stress-relieved at a minimum temperature of 620 °C (1150 °F) after welding. The maximum weld zone hardness, determined in accordance with 7.3, shall be 250 HV or, subject to the restrictions described in 7.3.3, 22 HRC"".
Welding consumables and procedures that produce a deposit containing more than 1 % mass fraction nickel are acceptable after successful weld SSC qualification by testing in accordance with Annex B.

Based on this, I interpret the requirements as follows:

If there are weldments with Ni contents greater than 1% mass fraction, they can be accepted if the weld procedures are successfully tested to SSC qualification in accordance with Annex B. Alternately, weldments with Ni contents greater than 1% mass fraction shall be acceptable if stress-relieved at a minimum temperature of 620 °C (1150 °F) after welding. The maximum weld zone hardness, shall be 250HV or 22 HRC in that case.

Please can you confirm the interpretation.

(MP INQUIRY #2013-07)

ANSWER:

The intent of the next to last paragraph in A.2.1.4 (15156-2, Annex A) dealing with the 620C (1150F) SR option does not negate the requirement in the following paragraph which requires SSC qualification testing regardless of SR if the weld deposit is >1% Ni.

QUESTION:

"There is a statement "Welding consumables and procedures that produce a deposit containing more than 1 % mass fraction nickel are acceptable after successful weld SSC qualification by testing in accordance with Annex B." in NACE MR0175-2 / ISO 15156-2 section A.2.1.4.

Dissimilar welding between carbon steel to stainless steel will definitely have consumables & deposit higher than 1% Nickel.

All sections in NACE MR0175 / ISO 15156 does not clearly describe dissimilar welding, the question is, when carbon steel & stainless steel parent metal are compliant with NACE MR0175 / ISO 15156, does dissimilar welding between them need to be qualified per Annex B or not?"

(MP INQUIRY #2020-08)

ANSWER:

Section A.2.1.4 only addresses welding of carbon and low alloy steels. Dissimilar welding between carbon steel & stainless steel is not specifically addressed in NACE MR0175 / ISO 15156. It is up to the equipment manufacturer and user to decide how qualification shall be performed.

A.2.1.4 and A.2.1.5

QUESTION:

It is understood that the section A.2.1.5 and Table A.1 of NACE MR0175 / ISO 15156-2 and section A.13.1 of NACE MR0175 / ISO 15156-3 for cladding, lining and overlay deal with the cladding, lining and overlay of the overall internal surface of a carbon steel component and in contact with the fluid.
In the case of CRA girth welding of a clad pipe, it is understood that the above mentioned sections are not applicable to the carbon steel HAZ of the CRA girth weld (except the portion which crosses the carbon steel HAZ of the overlay). See below figure.

Could you confirm that our understanding is correct?

![Diagram of girth weld with CRA overlay and carbon steel HAZ]

**ANSWER:**

NACE MR0175/ISO 15156-2 Section A.2.1.5 does permit the waiver of the maximum hardness requirements in accordance with NACE MR0175 / ISO 15156-3 Section A.13.1. The NACE MR0175 / ISO 15156-3 Section A.13.1 define the conditions and requirements for waiving the maximum hardness. Specifically, the user must demonstrate and document the likely long term integrity of the cladding or overlay. The long term integrity can be affected by (1) application of heat or stress-relief treatments, (2) environmental cracking under intended service conditions, (3) other corrosion mechanisms, (4) mechanical damage and (5) dilution of the overlay.

**QUESTION:**

We have weld overlays (Inconel 625 filler metal with SAW process) applied to low-alloy ferritic steel valves (ASME/ASTM A 352 Gr LCC). The steel valve is used on wet gas wellhead production platform with operating temperatures at 93°C, operating pressure of 145 bar with vapor fraction of H₂S (177 kg-mol/h) and CO₂ (877 kg-mol/h). Hardness tests were performed on the as-welded condition. The results achieved were well below the 250 HV criteria of Table A.1 of NACE MR0175/ISO 15156-2. Since the hardness results complied with the requirements of Table A.1 of NACE MR0175/ISO 15156-2, we believe and understand that the valve does not require postweld heat treatment after the weld overlay. Having met the hardness criteria after overlay we believe that we met the requirements of the following paragraphs of NACE MR0175/ISO 15156-2: -Paragraph A.2.1.5 and -Paragraph A.2.1.4

Question: Is our interpretation of Paragraphs A.2.1.5 and A.2.1.4 of NACE MR0175/ISO 15156-2 correct based on the above-stated specific application and
conditions and that the valves overlayed with Inconel 625 consumables do not require postweld heat treatment?

(Material Inquiry #2004-11)

**ANSWER:**
Paragraph A.2.1.4 states (in the third sentence):
“As welded carbon steels, carbon manganese steels, and low-alloy steels that comply with the hardness requirements of Table A.1 do not require postweld heat treatment.”
Paragraph A.2.1.5 states: “Overlays applied by thermal processes such as welding . . . are acceptable if they comply with one of the following: (a) The heat-treated condition of the substrate is unchanged, i.e., it does not exceed the lower critical temperature during application of the overlay. (b) The maximum hardness and final heat-treated condition of the base metal substrate comply with A.2.1.2 and, in the case of welded overlays, A.2.1.4.

Therefore, your interpretation is correct. Provided your weld procedure qualification complies with the hardness requirements in A.2.1.4 and A.2.1.5, no postweld heat treatment is required.

**A.2.1.5**

**QUESTION:**
NACE MR0175/ISO 15156-2:2015 A.2.1.5 limits the maximum allowable case depth for nitriding to 0.006”. Case depth is not defined in NACE MR0175/ISO 15156 and there are multiple definitions of case depth that are possible. Which of the following definitions of case depth is intended here?

a) The total case depth (determined by metallographic analysis)
b) The effective case depth, based on a difference of 50 HV between core and case
c) The effective case depth, based on a difference of 10% between core and case
d) The effective case depth, based on manufacturer spec of case hardness criteria
e) Other – if so, please explain

(Material Inquiry #2016-01)

**ANSWER:**
The measurement of case depth is not defined in NACE MR0175/ISO 15156. Adding a definition of the measurement criteria requires a ballot.

**QUESTION:**
ANSI/NACE MR0175/ISO 15156-2, Section A.2.1.5, Surface Treatments, Overlays, Plating, Coatings, Linings, etc.

This section states that metallic coatings, such as electroless nickel plating, are not acceptable for preventing SSC.

It was my understanding that the qualification of a plated part was dependent on the base metal. If the base metal is in conformance with MR0175 then the part can be
qualified regardless of what plating or coating may be applied. Is my understanding correct?  

(MP INQUIRY #2011-13)

ANSWER:
The application and use of metallic plating that does not affect the ISO 15156 compliant base material is not prohibited. No metallic platings are listed as acceptable or unacceptable in ISO 15156 but the use of any surface treatments to prevent SSC is not acceptable.

QUESTION:
For NACE MR0175 compliant products, is Carburizing an acceptable surface treatment process?  

(MP INQUIRY #2013-04Q1)

ANSWER:
Carburizing is not currently permitted in ISO 15156 except in conjunction with the permitted exclusions in Table 1 of ISO 15156-2. These exclusions are associated with specific equipment that is loaded in compression and equipment that is outside the scope of ISO 15156.

QUESTION:
If Carburizing is not considered the same as Nitriding in paragraph A. 2.1.5, is it acceptable to have carburized surface treatment (where the surface hardness will be well over HRC 22 hardness) but the core to meet the maximum average hardness of 22 HRC?  

(MP INQUIRY #2013-04Q2)

ANSWER:
Carburizing is not permitted regardless of core hardness except as noted in Q1.

QUESTION:
If Carburizing is acceptable surface treatment method, can the max hardness (HRC 22) and Nickel content (max 1%) of the core of carburized part be allowed to be higher than what NACE MR0175 allows?  

(MP INQUIRY #2013-04Q3)

ANSWER:
Not applicable.

QUESTION:
Will "Nitro-Carburizing" be allowed surface treatment with the same status of "Nitriding"? If it is allowed, would the NACE requirement be the same as Nitriding or it would be different?  

(MP INQUIRY #2013-08)
ANSWER:
As ISO 15156 is written today, the acceptable surface treatment has been defined solely as nitriding below the lower critical temperature.

Additional response to query submitter: We believe that you have identified an area where our standard ISO 15156 does not accurately define what has been accepted practice in the Oil & Gas Industry.

It has been common practice to use salt bath, liquid or ion nitriding including nitrocarburizing and carbonitriding for a wide variety of applications. The two key elements that have been constant through the years are that the maximum case depth has been defined as 0.15 mm (0.006") and the process temperature is below the temperature where any new transformation products are formed; this is the lower critical temperature for the alloy being processed.

The only application problems that we are aware of are when the nitriding (and related) processes are applied to areas where the local yield strength is exceeded; in these areas the plastic deformation has resulted in local breaks or cracks through the hardened surface due to the reduced ductility that is associated with the higher hardness.

The MP will propose a ballot to clarify the description of acceptable processes.

Note that this ballot will need to be successful before this is an approved process listed in ISO 15156.

A.2.1.6 and A.2.2.3.4

QUESTIONS:
I got a A513 DOM tubing that we use for sour service. MFR of tubing proposed that, tubing will be stress relief annealed at 1100F after cold drawing....BUT it will not be stress relief annealed after rotary straightening...

MR0175 part 2, A.2.1.6 has a statement that "Cold rotary straightened pipe is acceptable only where permitted in applicable ISO or API product standards, see A.2.2.3.4"...
A.2.2.3.4 says following: If tubulars and tubular components are cold-straightened at or below 510 ºC (950 ºF), they shall be stress-relieved at a minimum temperature of 480 ºC (900 ºF).

a) A.2.2.3.4 is for downhole applications only. Mine is topsides. So i believe i can ignore A.2.2.3.4 (not sure why its referenced under A.2.1.6). is that correct interpretation?

b) Is Cold rotary straightening considered a risk for SSC.

C) Bottom line being, MFR says HRC 22 will be achieved. Isn't that enough?

(MP INQUIRY #2021-10)
ANSWERS:
Yes, A.2.2.3.4 can be ignored for this particular request, but the requirements of A.2.1.6 (minimum stress relief temperature of 1100 °F after outer fiber deformation in excess of 5%) still apply.

Cold rotary straightening with an outer fiber deformation > 5% is considered a risk, unless there is a specific exception already in the document for higher cold work, such as there is for certain grades of line pipe in A.2.1.6 with hardness below 190 HBW.

Other than the line pipe exceptions in A.2.1.6, the document does not make exceptions for cold work in excess of 5%. Therefore, if the fiber deformation exceeds 5% or the line pipe exceptions in A.2.1.6 are not met, this specific application is not in compliance. Otherwise, SSC qualification testing or documented field experience must be shown to demonstrate compliance.

A.2.2.1, A.2.2.2 and A.2.2.3

QUESTION:
We need a clarification on MR0175/ISO 15156 Part 2, Annex A. We are a manufacturer of temporary pipe work, flowlines, etc., for sour gas service in well testing and process use in a surface application.

As such we believe Paragraphs A.2.1 through A.2.4 and Table A.1 with a hardness limit of 22 HRC are applicable in these circumstances.

However, pipe suppliers in this region tell us that 26 HRC is acceptable in such applications. I believe the 26 HRC limit is only applicable to material used in a downhole application as in Paragraph A.2.2.3, etc. (i.e., not a surface application) and that this is in error in terms of our usage.

(MP INQUIRY #2005-23)

ANSWER:
ISO 15156-2, A.2.2.1 indicates that carbon and low alloy steels for use in any product form must comply with the requirements of A.2.1 which include the hardness requirement of maximum 22 HRC for the parent material. Exceptions to this rule are named specifically in other paragraphs of Annex A.

Welds in such materials shall comply with the requirements of A.2.1.4 that also refers to Table A.1 that sets hardness requirements for welds.

Sub-clause A.2.2.2 provides examples of materials that can comply with A.2.1, including some examples of tubular products in Table A.2.

Sub-clause A.2.2.3 addresses downhole components only.
The standard allows materials, such as AISI 4130, to be qualified at higher hardness than 22 HRC for possible use as pipe in sour service by laboratory testing in accordance with Annex B and Table B.1 or on the basis of field experience as described in ISO 15156-1, 8.2. Welds must be shown to comply with the requirements of Paragraph 7.3.3.4.

A.2.2.2 and A.2.2.3

QUESTION:
We have a request for interpretation of item A.2.2.3.3 of ISO 15156-2. It states that “tubulars and tubular components made of Cr-Mo low alloy steels (UNS G41XX0, formerly AISI 41XX, and modifications), if quenched and tempered in the tubular form, are acceptable if the hardness does not exceed 26 HRC. These products should be qualified by SSC testing in accordance with B.1 using the UT test.”

We use AISI 4130 tubes in the quenched and tempered condition for drilling riser P-lines (choke, kill and booster lines) and have at present a hardness limit of HRC 22. The relaxation of above hardness requirement to HRC 26 would be helpful in production of the pipes as well as weldments.

(MP INQUIRY #2010-04)

ANSWER:
Paragraph A.2.2.3.3 of ISO 15156-2 is applicable to downhole casing, tubing, and tubular components used in region 3 of the diagram in Paragraph 7.2. Materials for P-lines in drilling risers are not included in Paragraph A.2.2.3.3. Materials for P-lines used in Region 3 are hardness limited to HRC 22. The point you raise concerning Inquiry 2005-23 is valid since testing according to Table B.1 in Annex B is one of the accepted qualification methods. Testing can be used to qualify any material/application (including 4130/P-lines in drilling risers) provided it is performed according to ISO 15156 requirements.

ANSWER:
Question: In Table A.3, is there a maximum hardness value for AISI 4130 Q & T with (140 ksi) yield for temperatures > 80°C?

Answer: 4130 is not listed in Table A.3.

A.2.2.3.

QUESTION:
NACE MR0175-2 = ISO 15156-2 / Annex A does quote 4130 grades
A.2.2.3.2 Tubulars and tubular components made of Cr-Mo low-alloy steels (UNS G41XX0, formerly AISI 41XX, and modifications), if quenched and tempered in the tubular form, are acceptable if their hardness does not exceed 30 HRC and they have SMYS grades of 690 MPa (100 ksi), 720 MPa (105 ksi), and 760 MPa (110 ksi). The maximum yield strength for each grade shall be no more than 103 MPa (15 ksi) higher than the SMYS. SSC resistance shall be demonstrated by testing each test batch and shall comply with B.1 using the UT test.
A.2.2.3.3 Tubulars and tubular components made of Cr-Mo low-alloy steels (UNS G41XX0, formerly AISI 41XX and modifications), if quenched and tempered in the tubular form, are acceptable if the hardness does not exceed 26 HRC. These products should be qualified by SSC testing in accordance with B.1 using the UT test.

→ Shall we consider that §A.2.2.3.2 applies only for hardness 26 < hardness ≤ 30 HRC and §A.2.2.3.2 applies only for hardness 22 < hardness ≤ 26 HRC?
→ §A.2.2.3.2 doesn’t quote “test batch”: Shall we consider that SSC results are considered as valid for any similar applications?
→ Shall we assume that any grade 4130 with hardness ≤ 22 HRC if Q&T in the tubular form is acceptable without additional testing as soon as it meet NACE MR0175 chemical composition requirements (mainly S ≤ 0.025 % in lieu of 0.040% for ASTM A519)?

(MP INQUIRY #2018-02)

ANSWER:
The requirements in A.2.2.3.2 go beyond just the specification of max hardness of 30 HRC as noted in the clause. Applicable limits for AYS are also indicated. SSC resistance in this case shall be demonstrated by testing as indicated in the clause.

→ A.2.2.3.3 doesn’t quote “test batch” and uses only “should”: Are SSC results valid for any similar applications if tested once for material meeting A.2.2.3.3 requirements?

If requirements are met in accordance to the more strict criteria applicable to materials of higher hardness (and additional yield strength requirements) than the ones applied in A.2.2.3.3, then those materials will also be considered acceptable for the lesser material condition (i.e. lower hardness). As noted in the clause, the word should implies a recommendation rather than a strict requirement as long as the rest of the requirements in Clause A.2 (and all-inclusive sub-clauses as applicable) are satisfied. Please read more on this below.

→ Are any grade UNS G41XX with hardness ≤ 22 HRC if Q&T in the tubular form, acceptable without additional testing as soon long as it meet NACE MR0175 chemical composition requirements (mainly S ≤ 0.025 %,....)?

As noted in Clause A.2.1.1 (second paragraph) “Carbon and low-alloy steels, products and components that comply with A.2 are, with stated exceptions, qualified in accordance with this part of ISO 15156 without further SSC testing. Nevertheless, any SSC testing that forms part of a materials manufacturing specification shall be carried out successfully and the results reported. “Therefore, tubular materials with hardness ≤ 22 HRC that meet general and specific requirements in Clause A.2 (and all-inclusive sub-clauses as applicable) are acceptable without further testing. Please also note that chemical composition is not the only requirement that needs to be met. As noted in Clause A.2.1.1 – third paragraph, “The majority of steels that comply with the general requirements of A.2 are not individually listed; however, for convenience, some examples of such steels are listed in Table A.2, Table A.3 and Table A.4.”

Also,
NACE MR0175-2 = ISO 15156-2 ed 2015
7.2.1.4 SSC regions 1, 2 and 3
Documented field experience may also be used as the basis for material selection for a specific sour-service application; see ANSI/NACE MR0175/ISO 15156-1.

→ Is there an official & recognized list associated to NACE MR0175-2 = ISO 15156-2 ed 2015 for material qualified upon field experience?

There is no official record that tracked and documented field experience.

**QUESTION:**
“I have a query with regards to NACR MR-01-75 Section A2.2.3.

Reference – NACE MR-01-75 Part 2, Section A.2.2.3 (downhole casing and any tubing and tubular components), accepts low alloy materials with higher yield as long as –
• The material is quenched and tempered in a tubular form and
• The hardness does not exceed 30 HRC

According to some drill pipe riser’s manufacturers

• These crossovers fall under the category of Drill pipe X-overs. Low alloy steel with these special requirements are used for Drill pipe risers.

I would imagine the riser manufacturers’ interpretation of section A.2.2.3 is that this is applicable for downhole casing and ‘any’ tubing and tubular components. Hence, riser crossovers fall under ‘any’ tubular components.

However, to my understanding, this section applies to downhole equipment as “downhole casing, downhole tubing and downhole tubular components”, like drill collars, drill pipe, crossovers etc and NOT riser components. To me it make more sense because, according to NACE MR-0175, drilling equipment is not protected through metallurgy, but by controlling the drilling mud. This is laid out in section A2.3.2.3.

If I assume section A2.2.3 applies to riser components, riser crossovers etc, then why does NACE allow 30 HRC for riser crossovers, when all other subsea equipment is limited to 22 HRC??

Although, I do not agree, but if the first explanation is correct, then we can manufacture this crossover using a 100,000 psi yield material with 30HRC hardness and still be NACE compliant. Can you please confirm what is NACE’s stance on this?

*(MP INQUIRY #2020-04)*

**ANSWER:**
Please note that Table 1 of NACE MR0175 / ISO 15156 Part 2 lists permitted exclusions. “Equipment only exposed to drilling fluids of controlled compositions” and “Drilling riser systems are permitted exclusions.” Hence, drilling risers and riser crossovers are permitted exclusions. Equipment listed as permitted exclusions is outside the scope of ISO 15156. The Maintenance Panel cannot analyze the design of equipment or comment on hardness limits for equipment outside of the scope of the
A.2.2.3.2 and A.4

QUESTION:
This question regards to mild sour service conditions and where C110 grade steel would fall into the standard (it is my understanding is that it is currently going to ballot to be added expressly to MR0175/ISO15156).

By section A.2.2.3.2 C110 is qualified for any SSC region at greater than 150°F (65 C) , yet, section A.4 seems to indicate that C110 would be fine at any temperature in Region 1. The flow chart in B.2.1 describes the process and the question is whether we can select any steel that is listed in Annex A (includes steels in A.2, A.3 and A.4) for Region 1?

(MP INQUIRY #2015-07)

ANSWER:
The Table A.3 with the temperature constraints is part of Section A.2.2.3 for Downhole casing, tubing and tubular components; the temperature restrictions of this Table apply to Section A.2.2.3.2. The user of the document may use A.4 to qualify those steels that may not comply with Sections A.2 or A.3 using the UT test as specified in Section B.1 for each test batch. Figure 1 addresses pH and H2S partial pressure without the limitations that are associated with minimum temperatures for higher strength steels.

A.2.2.4

QUESTION:
Does NACE MR0175/ISO 15156-2, Paragraph A.2.2.4 apply to Gr. 660 flange bolting materials or only to carbon and low alloy steel bolting materials in Part 2?

(MP INQUIRY #2005-09Q1)

ANSWER:
Paragraph A.2.2.4 only applies to materials in Part 2. See also response to MP Inquiry #2005-09Q2 posted under ISO 15156-3, Table A.26.

A.2.3.2.1

QUESTION 1:
What does the MR0175 define as a shear blade?

(MP INQUIRY #2015-05rev1 Q1)

ANSWER 1:
No. NACE MR0175 does not define the term “shear blades.”

QUESTION 2:
MR0175 states “The suitability of shear blades that do not comply with this annex is the responsibility of the equipment user”. Does the equipment user taking responsibility for the suitability of the shear blades make the shear blades compliant with MR0175?

(MP INQUIRY #2015-05rev1 Q2)

ANSWER 2:
No. Blowout preventer shear blades are included in the list of equipment that has permitted exclusions in Part 2 Table 1 and Part 3 Table 1. In Part 2 Section A.2.3.2.1, the cautionary note is there to alert the end user that the shear blades can be susceptible to SSC.

A.2.3.2.2

QUESTION:
The title of Paragraph A.2.3.2.2 in NACE MR0175/ISO 15156-2 is “Shear rams.” This section allows the use of rams made from quenched and tempered, Cr-Mo, low-alloy steels up to a maximum hardness of 26 HRC provided the composition and heat treatment are carefully controlled and supporting SSC testing is performed. The text of this section does not limit these provisions to just shear rams; however, the section title would imply that only shear rams are covered by its provisions. This apparent shear ram restriction was not in previous revisions of the standard. It is important to ram manufacturers as well as end users that all Cr-Mo, low-alloy steel rams, not just shear rams, be allowed up to 26 HRC to ensure maximum hang-off capacity and for anti-extrusion purposes. Do the provisions of A.2.3.2.2 apply only to shear rams or can they be applied to other types of rams as well?

(MP INQUIRY #2004-16)

ANSWER:
The requirements for Cr-Mo, low-alloy steel rams in A.2.3.2.2 in NACE MR0175/ISO 15156-2 are not intended to be restricted to shear rams only, but may be applied to other types of rams as well. This is consistent with all previous revisions of MR0175.

A.2.4.1

QUESTION:
Question 1: Section A.2.4.1, part 2 (ANSI/NACE MR0175/ISO 15156-2:2015) states “Ferritic ductile iron in accordance with ASTM A395 is acceptable for equipment unless otherwise specified by the equipment standard” - does this imply that its use is acceptable for pressure-containing parts?

Question 2: Are there any partial pressure limits that would apply to using ferritic ductile iron in accordance with ASTM A395?

(MP INQUIRY #2017-02)

ANSWER:
Answer 1: There is no restriction in ANSI/NACE MR0175/ISO 15156-2 regarding using ferritic ductile iron in accordance with ASTM A395 for pressure containing components. Note that there may be restrictions on using this material from other
standards such as API standards that are outside the scope of ANSI/NACE MR0175/ISO 15156-2.

Answer 2: There are no partial pressure limits with respect to H2S for cast irons but note the warning that precedes the Scope of ANSI/NACE MR0175/ISO 15156-2. This warning states: Carbon and low-alloy steels and cast irons selected using this part of ISO 15156 are resistant to cracking in defined — H2S-containing environments in oil and gas production but not necessarily immune to cracking under all service conditions. It is the equipment user’s responsibility to select the carbon and low alloy steels and cast irons suitable for the intended service.

A.2.4.1 and Table A.5

QUESTION:
In NACE MR0175/ISO 15156 Part 2, Paragraph A.2.4, ductile iron ASTM A 536 is listed in Table A.5 as acceptable materials for drillable packer components for sour service. However, it is not mentioned in Paragraph A.2.4.1. Can we use this material for pressure-containing parts, i.e., valve stems?

ANSWER:
No, ductile iron ASTM A 536 is not listed in A.2.4.1 and may not be used for pressure-containing parts.

A.2.4.3

QUESTION:
I have a query regarding material suitability on a recent enquiry to supply a nodular iron screw compressor.

NACE Standard MR0175 accepts ferritic ductile iron to ASTM A 395. My question is if our existing in-house standard of ASTM A 536 Grade 60/40/18 will comply as a direct alternative. On the face of it tensile strength, elongation are similar at 415N/mm2 and 18%!

ANSWER:
The ISO Maintenance Panel cannot advise on materials selection issues. The role of the Maintenance Panel is solely to ensure that NACE MR0175/ISO 15156 (the current edition of NACE MR0175) is clear in its stated requirements and is kept up-to-date.

Should you wish, the procedure to propose an amendment to the standard to include ASTM A 536 Grade 60/40/18 is described in

"01. Introduction to ISO 15156 Maintenance Activities" on the Web site

www.iso.org/iso15156maintenance.

Annex B
B.2.2.2

QUESTION:
We have a question on interpretation of clause B.2.2.2 e) in annex B of MR0175 / ISO 15156-2:2015.

Third paragraph says: Re-testing is permitted as follows. If a single specimen fails to satisfy the acceptance criteria, … two further specimens may be tested.

If after HIC testing a 0.5” plate to TM0284, two specimens out of three fail to satisfy the acceptance criteria, is it permitted to test four further specimen in order to qualify the batch?

As a new source could be necessary depending on this interpretation, a prompt reply would be much appreciated, if possible.

(MP INQUIRY #2017-21)

ANSWER:
MR0175 / ISO 15156-2:2015 – Annex B, Clause B.2.2 Qualification of manufactured products; this clause allows for re-testing in the event of one of the required triplicate specimens (per test batch) failing to satisfy the acceptance criteria. In addition, the clause also states that the cause of the failed performance shall be investigated. If in fact the material is found to conform to the manufacturing specification then two further specimens may be tested. However, it is not implied that multiple specimens may be subject to re-testing for a given batch. The particular paragraph closes with the statement that further retests shall require the purchaser’s agreement.

Table B.3

QUESTION:
For HIC test, NACE MR0175/ISO 15156-2, Table B.3 is not clear regarding the acceptance criteria to be taken into account. We usually understood that "CLR, CTR, CSR" to be taken into account is the average of the values measured from one test specimen as defined in NACE Standard TM0284, Paragraph 4.2.1. What is your position?

(MP INQUIRY #2005-26Q2)

ANSWER:
ISO 15156-2, B.5, Paragraph 3 makes clear that where no requirement is given NACE TM0284 shall be followed.

B3.2

QUESTION:
“The question is for a test program ballot for a cold worked, solid solution nickel base alloy. Section B.3.2 of Part III indicates that for these materials consideration should be given to “well ageing” and anisotropy, but no guidance is provided. I reviewed the
C22HS ballot which I believe was the most recent for this type of product and it doesn’t appear that such considerations were made.”

Question: “Can the Maintenance Panel provide any guidance or current thinking on this before we get started?”

(MP INQUIRY #2020-11)

ANSWER:
According to Section B.3.2, consideration shall be given so that testing of appropriately aged samples of alloys that can age in service, particularly HSC testing of downhole materials that can be subject to ageing in service (“well ageing”) is conducted. Not all materials are prone to well ageing, and the balloter shall consider if this needs to be taken into account for the balloted material.

Section B.3.2 consideration shall be given to that cold-worked alloys may be anisotropic with respect to yield strength and for some alloys and products, the susceptibility to cracking varies with the direction of the applied tensile stress and consequent orientation of the crack plane. It is the balloter's responsibility to consider if testing needs to be performed in a certain direction and then according to Section B3.3 choose a test specimen suitable for this direction, for example tensile specimen or C-rings.

The Maintenance Panel has no guidelines based on processing earlier ballots. However, a balloter may, during processing of a ballot, be asked to explain the balloter’s considerations if there are any concerns. Please note that a potential ballot can be presented at a Maintenance Panel meeting for comments before submitting the ballot.

B.4.2.3

QUESTION:

1. Question: Application of section B4 (Test procedures to evaluate the resistance of carbon and low-alloy steels to SOHIC and SZC).

Our Interpretation: Section B4 applies to SOHIC/SZC only. Where SSC is required section B3 applies.

2. Question: clause B.4.2.3 (Evaluation and acceptance criteria for FPB test specimens) third paragraph: “Sections produced in these ways shall be examined for possible ladder-like HIC features and other cracks related to SOHIC or to soft zones of a weld (SZC). No ladder-like HIC features nor cracks exceeding a length of 0.5 mm in the length of 0.5mm in the through thickness direction are allowed”.

Our Interpretation: the word “nor cracks’ refers to cracks associated to SOHIC and SZC only. Other than ladder-like, SOHIC and SZC including single HIC (no ladder-like) types of cracks exceeding in length the 0.5mm are accepted.
**ANSWER:**

1. **Question:** Application of section B4 (Test procedures to evaluate the resistance of carbon and low-alloy steels to SOHIC and SZC).

   Our Interpretation: Section B4 applies to SOHIC/SZC only. Where SSC is required section B3 applies.

   **Response:** Section B.4 applies only to the evaluation of resistance to SOHIC and SZC as indicated, but per B.4.1 the "materials shall have been qualified with respect to SSC resistance for the design conditions prior to the SOHIC/SZC evaluation." which is B.1 - B.3

2. **Question:** clause B.4.2.3 (Evaluation and acceptance criteria for FPB test specimens) third paragraph: "Sections produced in these ways shall be examined for possible ladder-like HIC features and other cracks related to SOHIC or to soft zones of a weld (SZC). No ladder-like HIC features nor cracks exceeding a length of 0.5 mm in the length of 0.5mm in the through thickness direction are allowed".

   Our Interpretation: the word "nor cracks' refers to cracks associated to SOHIC and SZC only. Other than ladder-like, SOHIC and SZC including single HIC (no ladder-like) types of cracks exceeding in length the 0.5mm are accepted.

   **Response:** Part of the referenced text is incorrect as noted above. The missing component in your interpretation is the last part of the paragraph "No ladder-like HIC features nor cracks exceeding a length of 0.5 mm in the through thickness direction are allowed." Thus, the paragraph does not infer what you indicate is your interpretation.

**QUESTION:**

This inquiry for help with interpretation concerns the clause NACE MR0175/ ISO 15156-2 B.4.2.3 Evaluation and acceptance criteria for FPB test specimens.

1) It is written “Damage developed on the tensile side of a specimen in the form of blisters less than 1 mm below the surface, or on the compression side regardless of the depth of the blister, may be disregarded for the assessment of SOHIC/SZC but shall be reported”

   **Question:** Does this means that Damage developed on the tensile side of a specimen in the form of blisters MORE than 1 mm below the surface has to be considered as not allowed/not acceptable or should only be reported as “blisters more than 1 mm below the surface”? (See below) Example 1: No blisters deeper than 1mm in the tension side are allowed (?)

2) It is written “No ladder-like HIC features nor cracks exceeding a length of 0.5 mm in the through thickness direction are allowed”
Question: Are cracks developed inside an area affected by a blister disregarded for the assessment (cf. example 2 picture)? In other words: Shall the damage in example 2 be reported as:
A) a blister?
B) a crack?
C) a blister and a crack?

(MP INQUIRY #2016-12)

ANSWER:
Question 1: “Damage developed on the tensile side of a specimen in the form of blisters less than 1 mm below the surface, or on the compression side regardless of the depth of the blister, may be disregarded for the assessment of SOHIC/SZC but shall be reported”. Does this means that Damage developed on the tensile side of a specimen in the form of blisters MORE than 1 mm below the surface has to be considered as not allowed/not acceptable or should only be reported as “blisters more than 1 mm below the surface”?

Answer 1: Blisters greater than 1 mm below the surface are not acceptable.

Question 2: “no ladder-like HIC features or cracks exceeding a length of 0.5 mm in the through thickness direction is allowed”. Are cracks developed inside an area affected by a blister disregarded for the assessment (cf. example 2 picture)? In other words: Shall the damage in example 2 be reported as:
A) a blister?
B) a crack?
C) a blister and a crack?

Answer 2: if both cracks and blisters are present as defined Clause B.4.2.3, they both need to be reported.

B.4.3

QUESTION:
During the last ISO/TC 67 plenary meeting on 2012-09-19/20 in Rio the UK delegation had a request to the ISO 15156 MP regarding ISO 15156-2.

Following resolution was taken and is in the minutes:
Resolution 2012/08 (Rio de Janeiro, 2012)
The British delegation, noted that ISO 15156-2 includes a reference to the British publication OTI 95 635, Testing method to determine the susceptibility to cracking of line pipe steels in sour service. This publication is about 20 years old and the British delegation would request the ISO 15156 Maintenance Panel under WG 7 to review whether this British publication is still needed and if so to develop an international standard on this subject, so that the British publication could be withdrawn.

Additional information:
• OTI 95 635 can be found via: http://www.hse.gov.uk/research/otipdf/oti95635.pdf
• The document is mentioned only in ISO 15156-2:

B.4.3 Full pipe ring tests
Full pipe ring tests may be used. The document HSE OTI-95-635 describes a test and acceptance criteria.

NOTE Residual stress has been shown to play an important role in the initiation of SOHIC and SZC. It is sometimes considered that such stresses in field situations are better represented in large-scale specimens.

and in Bibliography
[27] HSE OTI-95-635 7), A test method to determine the susceptibility to cracking of line pipe steels in sour service

(MP INQUIRY #2012-10)

ANSWER:
Developing a new international standard is outside the scope of the Maintenance Panel. The British publication is still assumed to be technically relevant, but the OTI 95 635 reference will be removed if the publication is withdrawn.

Annex C

QUESTION:
NACE MR0175/ISO 15156, Part 2, Annex C, Section C.1 states that “The partial pressure of H2S may be calculated by multiplying the system total pressure by the mole fraction of H2S in the gas.” Does the word “may” permit other methods, such as incorporating the effects of non-ideal gas behavior, to calculate partial pressure for determining material selection?

(MP INQUIRY #2004-08)

ANSWER:
Yes. Please note: Annex C as a whole is "informative" rather than "normative" and is therefore not mandatory.

QUESTION:
What is NACE's intent when it comes to H2S partial pressure? i.e., when calculating the H2S partial pressure per Annex C.1 and C.2 in NACE MR0175/ISO 15156-2, should the operating or design pressure be used in the calculations? I believe operating pressure should be used. Could you please confirm?

(MP INQUIRY #2009-21)

ANSWER:
15156-1 Para 6.1 states that the user shall define the service conditions including unintended exposures (e.g., resulting from failure of primary containment). These service conditions become the basis for calculating H2S partial pressure. It is up to the
user to decide whether to use operating or design pressure for partial pressure calculations.

**QUESTION:**
“With the publication of ISO 15156-2:2015/Cir.1:2017 Annex C, it is now permissible to assess environmental severity on the basis of H2S fugacity, activity, and/or dissolved concentration. It is understood that these modern sour severity metrics may better represent the true chemical activity of H2S at high total pressures, compared to the traditional partial pressure metric. This policy change raises the following questions:”

Q1. “Does Annex C now permit the user to assess environmental severity of a high-pressure hydrocarbon-rich sour field environment by the modern sour severity metric of their choice?”

Q2. “Is it permissible to scale the results of an environmental severity assessment of a high-pressure system to an equivalent low total pressure laboratory environment having the same environmental severity for designing sour qualification tests?”

Q3. “Can any of the modern sour severity metrics be used to scale the material-specific safe use H2S partial pressure limit, determined from a low-pressure ANSI/NACE TM0177-2016 compliant environmentally assisted cracking (EAC) test, to an equivalent safe use limit for a high-pressure system?”

Q4. “Can the 0.05 psia H2S sour service threshold, understood to be referenced to near atmospheric total pressure (defined in section 7.1 of ANSI/NACE MR0175/ISO 15156-2:2015), also be scaled with total pressure by any modern sour severity metric?”

**(MP INQUIRY #2020-09)**

**ANSWER:**
A1. Yes. For a gas phase, users may employ H2S fugacity rather than partial pressure for characterization of the severity of the production environment. Alternatively, users may employ H2S concentration or chemical activity in the aqueous phase to characterize the severity of the production environment. The thermodynamic equation of state and model must be validated by the equipment user validated to ensure that it accurately reflects the severity of the production environment. Clause 6.1 in ISO 15156-1:2020 recommends to use non-linear thermodynamic rules for gas-free high pressure oil wells.

A2. Yes, for gas phase, fugacity may be used instead of partial pressure to characterize the environmental severity of the production environment to define the test environment representing field service and reduce excess severity. For aqueous phase, the equipment user needs to demonstrate that the severity of the environment is properly taken into account, which generally includes detailed thermodynamic analysis.

A3. No guidance is given in ISO 15156 for scaling limits based on total pressure to the use of non-linear thermodynamic rules, please see Note 2 of clause 6.1 in ISO 15156-1:2020. ISO 15156-2:2020 C.1.2 states equipment users may employ H2S fugacity
rather than partial pressure to characterize the environmental severity of the production environment and to define the test environment representing field service. Application or adjustment of the severity regions and prequalified H2S exposure limits to a severity metric other than partial pressure is the responsibility of the end user.

A4. Please see A3.
Interpretations related to NACE MR0175/ISO 15156-3

General

QUESTION:
Please be informed that as per NACE MR0175/ISO 15156, Super duplex stainless steel material can be used for temperature up to 232 deg. C and partial pressure of H2S 3 Psi maximum with any combination of chloride concentration and in situ pH occurring in production environment is acceptable. However, based on API 938-C, the experimental data of critical pitting and crevice critical temperature of super duplex stainless steel material (Grade 2507) indicates that the maximum temperature it can be used as 80 deg. C and 50 deg. C respectively. Hence, would like to solicit the clarification on discrepancy in temperature limit for using of super duplex stainless material.

(MP INQUIRY #2017-17)

ANSWER:
Revised Question: Regarding NACE MR0175/ISO 15156-3 Tables A.24 and A.25, super duplex alloys are listed for service up to 232C and 3 psi H2S with no limits on chloride and in-situ pH, the attached section of API 938-C shows lower maximum temperatures (80C and 50C respectively for pitting and crevice corrosion). Please explain the discrepancy.

Answer: NACE MR0175/ISO 15156-3 is a document that addresses environmental cracking in the presence of H2S; the standard title defines “Materials for use in H2S containing environment in oil and gas production”. The standard does not currently address pitting and crevice corrosion. The current values that are in the document are based on successful ballots and history. Note that the tables state “production environments” which are oxygen-free. The subject of API Technical Report 938-C is “Use of Duplex Stainless Steels in the Oil Refining Industry. You may need to employ a consultant to assist you with your particular application.

QUESTION:
The age hardening temperature midpoint in Centigrade for UNS S17400 and UNS S15500 in Tables A.27, A.28, A.29 and A.30 is 620 C; should be 621 C.

NACE MR0175-3 2015

In Centigrade, 634 °C max.

For comparison, NACE MR0103-2015:

In Centigrade, 635 °C max.

I believe the intent is to adhere to the Fahrenheit range of 1125 - 1175 F, or 1150 +/- 25 F.

By direct conversion, 1125 - 1175 F = 607.2 – 635 C, which is 621 +/- 14 C. Not 620 +/- 14 C. NACE MR0103 has it right, NACE MR0175-3 is off by 1 degree.
Note that in Table A.28 for UNS S45000, it has it correct as 621 C.

Why does this one degree matter? When a heat treater reports age hardening temperature in Centigrade as 635 C, in Centigrade it meets MR0103, but not MR0175 and therefore it is not acceptable for NACE MR0175 service. When converted to Fahrenheit it meets both.

Additionally, in Table A.29 for USN S15700, c) has 560 C = 1150 F. But 560 C = 1040 F. 565 C = 1150 F. That too should be corrected to 565 C to match ASTM A564 Table 4, and I note that there is no tolerance, or min./max. stated in this table, but maybe that is OK.

What steps need to be taken to initiate this change?

(MP INQUIRY #2017-09)

ANSWER:
Background: There are inconsistencies and errors in the specified age hardening temperatures and ranges for precipitation hardening stainless steels.
1. For UNS 17400 and UNS 15500, NACE MR0175-3 Tables A.27 (S17400 only), A.28 and A.30 specify age hardening temperatures as (620 + 14) °C [(1150 +- 25) °F]
   Note that 620 °C = 1148 °F; 621 °C = 1150 °F
   For comparison, NACE MR0103 (clause 13.9.2.3 & 4) specifies age hardening for these same materials as 621 °C + 14 °C (1 150 °F ± 25 °F)

2. For UNS S45000, NACE MR0175-3 Table A.27 specifies (620 + 8) °C [(1150 + 15) °F].
   For UNS S45000, NACE MR0175-3 Table A.28 specifies (621 + 8) °C [(1150 + 14) °F].
   For UNS S15700, NACE MR0175-3 Table A.29 specifies 620 °C (1150 °F) (no range specified).
   For UNS S45000, NACE MR0175-3 Table A.30 specifies (620 + 8) °C [(1150 + 15) °F].

   For comparison, NACE MR0103 (clause 13.9.2.5) specifies age hardening for UNS S45000 as 621 °C (1 150 °F) (no range specified)
   For comparison, NACE MR0103 (clause 18.6.2) specifies age hardening for UNS S15700 as 621 °C (1 150 °F) (no range specified)

Q1: Is it correctly understood that the occurrences in MR0175-3 of 620 °C in Table A.27, A.28, A.29 and A.30 are in error and those should be changed to 621 °C?

A1: For BOTH UNS S17400 and UNS S45000, NACE MR0175-2002 has 620°C AND NACE MR0175-2003 has 621°C. In NACE MR0175/ISO 15156-2003, UNS S17400 has 620°C and UNS S45000 has 620°C in Tables A.27 and A.30 but 621°C in Table A.28. The 1150°F in the heat treatment of both these materials is a constant and the technical basis. This is a conversion issue. The conversion equation is T°C = (T°F - 32) x 5/9. Using this equation, 1150°F becomes 621.1°C. 621°C is the correct conversion for these materials in Tables A.27, A28 and A30.
The conversion issue for UNS S15700 and UNS S15500 respectively in Tables A.29 and A.30 is identical and the correct conversion from 1150°F is 621°C.

**QUESTION:**
I need your help with the definition of CRAs in Part 3 of MR0175/ISO 15156.

The "corrosion-resistant alloys" is very general and does not specify whether or not the definition includes the Fe-based alloys or not. More than that, the term CRA is used together with "other alloys" making it even more confusing.

**(MP INQUIRY #2004-12)**

**ANSWER:**
NACE MR0175/ISO 15156-1, Paragraph 3.6 contains a definition of "corrosion-resistant alloy" (CRA). It reads: "alloy intended to be resistant to general and localized corrosion of oilfield environments that are corrosive to carbon steel." This is taken from EFC 17.

"Other Alloys" are those not covered by the definitions of carbon steel or CRA. For example, copper is not considered resistant to general corrosion but is considered in NACE MR0175/ISO 15156-3.

**Clause 5**

**QUESTION:**
Q1. NACE MR0175/ISO 15156-3: 2009(E), Clause no: 5, Page no:5
What does “Exposure temperature” mean? Design or operating Temperature?

**(MP INQUIRY #2015-02 Q1)**

**ANSWER:**
Answer1: "The equipment user shall define the exposure temperature"

**Clause 6**

**6.2.1**

**QUESTION:**
Our company has understood that NACE MR0175/ISO 15156, Table A.2 required the maximum specified hardness for austenitic stainless steels be satisfied at any location on bar stock (e.g., at locations considered significant by the user). Since cold-finished bars frequently have surface hardness values above the maximum specified in MR0175, we have declined to certify these products as compliant to the specification. We appear to be in the minority, or perhaps the only stainless bar producer that interprets the standard in this way. We routinely find competitors’ cold-finished stainless bar in the marketplace certified to MR0175 based on a mid-radius hardness even though the surface hardness is above the maximum permitted in the standard.
We realize this is a long-standing issue, but would like to clarify the hardness requirements of the Table A.2. We understand the logic in requiring the material meet a hardness maximum at any location (e.g., surface) in order to provide a predictable level of stress corrosion cracking resistance. Yet the standard does not clearly state, for example, that meeting surface hardness is a requirement. Please clarify the hardness requirements of MR0175 to allow all stainless bar producers to provide a uniform product to this standard.

(MP INQUIRY #2003-06)

ANSWER:
NACE cannot provide assistance in specifying where to take hardness impressions and readings for this alloy or for any other alloy. This is because NACE MR0175/ISO 15156 is not a quality assurance document. It is the responsibility of the alloy supplier to meet the hardness requirements and metallurgical requirements of the austenitic stainless steels in Table A.2.

QUESTION:
Do NACE MR0175/ISO 15156-2, 7.3.2 “Parent metals” and NACE MR0175/ISO 15156-3, 6.2.1 “Hardness of parent metals” apply to machined forgings or are they meant to be applied to weldment parent metals only?

(MP INQUIRY #2014-03)

ANSWER:
The requirements listed in NACE MR0175/ISO 15156-2 Section 7.3.2 apply to the parent materials applicable to part 2; carbon and low alloy steels and cast irons. The parent materials include forgings. See also sections A.2.1.2 and A.2.1.3 of Annex A for additional requirements. The requirements listed in NACE MR0175/ISO 15156-3 Section 6.2.1 apply to parent materials applicable to part 2; CRAs and other alloys. The parent materials include forgings

6.2.2

QUESTION:
For the cast austenitic and duplex stainless steels there is no specific mention of a requirement for post weld heat treatment in Part 3 that discusses welding of these alloys. However, there is a statement in the application of these alloys that they are only acceptable in the solution annealed and quench condition. In my opinion, the as welded condition does not meet the intent of being solution annealed and quenched. So can these alloys be used in the as welded condition?

(MP INQUIRY #2009-03)

ANSWER:
These alloys can be used in the as welded condition provided they meet the requirements of Paragraph 6.2 of ISO 15156-3 and the corresponding Tables in Annex A. In particular Paragraph 6.2.2 indicates that welding PQRs shall include documented evidence of satisfactory cracking resistance.
6.2.2.2.2

**QUESTION:**
Per A.6.3 "The hardness of the HAZ after welding shall not exceed the maximum hardness allowed for the base metal, and the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable."

Per Table A.23 note (b) "Low-carbon, Martensitic stainless steels either cast J91540 (CA6NM) or wrought S42400 or S41500 (F6NM) shall have 23 HRC maximum hardness..."

Per 6.2.2.2.2 "Hardness testing for welding procedure qualification shall be carried out using Vickers HV 10 or HV 5 methods in accordance with ISO 6507-1 or the Rockwell 15N method in accordance with ISO 6508-1. The use of other methods shall require explicit user approval."

However, neither a Vickers nor Rockwell 15N acceptance criteria is specified for Martensitic Stainless Steels. Furthermore, ASTM E140 does not provide a hardness conversion for Martensitic Stainless Steels. Thus, there is neither a Vickers nor Rockwell 15N acceptance criteria.

Is a correct interpretation that the acceptable hardness test method for qualification of Martensitic Stainless Steels is the Rockwell C Method, regardless of the applied stress, and without the need for explicit user approval?  
*(MP INQUIRY #2006-01Q3)*

**ANSWER:**
No, ISO 15156-3, 6.2.1, Para. 2 states "The conversion of hardness readings to and from other scales is material dependent; the user may establish the required conversion tables".

7.2

**QUESTION:**
Following ISO 15156-3 Section 7.2 Marking, labeling and documentation, it is indicated that material complying with ISO 15156 shall be made traceable. This section confirms that suitable documentation can ensure acceptable traceability without listing the documentation required.

Could you please clarify what are the documents required to ensure acceptable traceability of material complying with ISO 15156?  
*(MP INQUIRY #2014-10)*

**ANSWER:**
Required documents to ensure acceptable traceability shall be agreed with the equipment user.
**Annex A**

**QUESTION:**
My employer manufactures pressure sensing devices that have a very small sensing diaphragm welded to a threaded port. I am hoping you can provide some clarification regarding welding of dissimilar metals. I am employing the material hardness limits for specific materials from Annex A of ISO 15156-3 in conjunction with the weld survey locations specified in 7.3.3.3 of ISO 15156-2. I believe the hardness requirements are clearly interpreted if welding dissimilar metals by use of a third weld-filler metal. Hardness requirements can be clearly applied to each of the weld survey locations for all three involved parent materials. However, I do not know how to apply the hardness requirements when two materials are welded directly together without the use of a third weld-filler metal.

1. If the two materials have different hardness limits, what is the hardness requirement for the weld survey locations within the weld metal region (non parent material nor HAZ regions)?
2. Is the hardness limit governed by the higher of the two material limits or the lower of the two?
3. Can you tell me where I can find clarification in these standards or where I can direct my question?

4. On an unrelated note, I would like to suggest a minor improvement to table A.1 of ISO 15156-3 Annex A. In Table A.6, Note-B defines the table applicable to “...diaphragms, pressure measuring devices and pressure seals.” Table A.1 would be improved if “A.6” was specified in the first column (Austenitic stainless steel) for the row designated for “Diaphragms, pressure measuring devices and pressure seals”.

(MP INQUIRY #2014-04)

**ANSWER:**
1. The hardness requirements for each material shall be met for both the base metal and HAZ. The standard does not specify requirements for the fusion line hardness between two dissimilar metals with different maximum hardness requirements. Qualification by successful laboratory testing in accordance with Annex B of ISO 15156-3 is required. Qualification based on satisfactory field experience is also acceptable. Such qualification shall comply with ISO 15156-1.
2. See answer to point 1
3. See answer to point 1.
4. This is an editorial improvement and this will be changed.

**A.1.3**

**QUESTION:**
If I want to ballot a new alloy to be used in the acceptable environments described in Table A.32 of NACE MR0175/ISO 15156, which environmental test conditions should be used to qualify for “Any combination of hydrogen sulfide, chloride concentration, and pH” at 135°C (275°F) with elemental sulfur? The same question applies to Table A.34.
QUESTION:
In general, for the tables listed in Annex A of NACE MR0175/ISO 15156, what should the environmental test conditions be to qualify a new alloy where the “Remarks” in the respective tables state “Any combinations of temperature, partial pressure H2S, chloride concentration, and pH”?

ANSWER:

The wording “Any combination of temperature, pH . . . Is acceptable” in various tables of NACE MR0175/ISO 15156-3 indicates that previous (early) editions of NACE documents had no environmental limits set for the alloys mentioned. The alloys were not tested to procedures laid out in later editions of NACE Standard MR0175 but instead “grandfathered” into the standard (i.e., they were added to the various early editions by common consent and common experience of good performance). No formal environmental limits were established and listed.

The process for the addition of an alloy to later editions of MR0175 included laboratory testing under defined environmental conditions, which resulted in the environmental limitations for the alloy as listed in NACE MR0175/ISO 15156. This process will continue to be used for future additions of alloys to NACE MR0175/ISO 15156.

Any proposal for additions/changes to NACE MR0175/ISO 15156 will be subject to a ballot/approval process.

See also ISO 15156-1, 6 and ISO 15156-3, 6

A.1.5.1

QUESTION:
We have some 316 stainless steel housings with a large through bore machined. Inadvertently this bore was machined oversize. We would like to flame spray build up the surface with 316 or 316L stainless material and remachine to size. As we understand the standard, 316 and 316L stainless are both included in a lengthy list of materials accepted for direct exposure to sour gas. As we intend to apply stainless to stainless for the purpose of remachining to dimension and not as a corrosion-inhibiting coating, would this process be acceptable and compliant with the NACE Standard MR0175/ISO 15156?

ANSWER:
1.0 Flame spraying as a coating for corrosion resistance over a base material that is resistant to sulfide stress cracking is acceptable within the requirements of NACE MR0175/ISO15156 Part 2 Paragraph A.2.1.5 when applied over carbon steels and of Part 3 Paragraph A.1.5.1. In the case of your inquiry, the 316 or 316L base materials are acceptable coating substrates if they conform to
the metallurgical requirements of Part 3 Table A.2 and are used within the environmental restrictions of this table for any equipment.

2.0 If this application of flame spray is for the replacement of material that will be load bearing of tensile stresses, then the inquiry is not currently addressed by NACE MR0175/ISO15156. NACE/ISO have not been balloted with data to demonstrate that the 316 SS or 316L SS deposited flame spray coating has the same cracking resistance as the materials referenced in Part 3 Table A.2, which are assumed to be in the cast or wrought conditions.

**QUESTION:**
For NACE MR0175 compliant products, is Carburizing is an acceptable surface treatment process?

**(MP INQUIRY #2013-04Q1)**

**ANSWER:**
Carburizing is not currently permitted in ISO 15156 except in conjunction with the permitted exclusions in Table 1 of ISO 15156-2. These exclusions are associated with specific equipment that is loaded in compression and equipment that is outside the scope of ISO 15156.

**QUESTION:**
If Carburizing is not considered the same as Nitriding in paragraph A. 2.1.5, is it acceptable to have carburized surface treatment (where the surface hardness will be well over HRC 22 hardness) but the core to meet the maximum average hardness of 22 HRC?

**(MP INQUIRY #2013-04Q2)**

**ANSWER:**
Carburizing is not permitted regardless of core hardness except as noted in Q1.

**QUESTION:**
If Carburizing is acceptable surface treatment method, can the max hardness (HRC 22) and Nickel content (max 1%) of the core of carburized part be allowed to be higher than what NACE MR0175 allows?

**(MP INQUIRY #2013-04Q3)**

**ANSWER:**
Not applicable.

**QUESTION:**
Will "Nitro-Carburizing" be allowed surface treatment with the same status of "Nitriding"? If it is allowed, would the NACE requirement be the same as Nitriding or it would be different?

**(MP INQUIRY #2013-08)**
ANSWER:
As ISO 15156 is written today, the acceptable surface treatment has been defined solely as nitriding below the lower critical temperature.

Additional response to query submitter: We believe that you have identified an area where our standard ISO 15156 does not accurately define what has been accepted practice in the Oil & Gas Industry.

It has been common practice to use salt bath, liquid or ion nitriding including nitrocarburizing and carbonitriding for a wide variety of applications. The two key elements that have been constant through the years are that the maximum case depth has been defined as 0.15 mm (0.006”) and the process temperature is below the temperature where any new transformation products are formed; this is the lower critical temperature for the alloy being processed.

The only application problems that we are aware of are when the nitriding (and related) processes are applied to areas where the local yield strength is exceeded; in these areas the plastic deformation has resulted in local breaks or cracks through the hardened surface due to the reduced ductility that is associated with the higher hardness.

The MP will propose a ballot to clarify the description of acceptable processes.

Note that this ballot will need to be successful before this is an approved process listed in ISO 15156.

A.1.5.2

QUESTION:
ISO 15156-3:2015 says about threading:
A.1.5.2 Threading

Threads produced using a machine-cutting process are acceptable.

Threads produced by cold forming (rolling) are acceptable on CRAs and other alloys if the material and the limits of its application otherwise comply with this part of ISO 15156.

Is the meaning:

a) it is acceptable in general to use a material that comply with the ISO 15156 series and produce a thread by cold forming with the material

or

b) specific tests are required on the thread produced by cold forming. If yes, which specifications and which threshold values shall be used?  

(MP INQUIRY #2016-17)

ANSWER:
a) it is acceptable in general to use a material that comply with the ISO 15156 series and produce a thread by cold forming with the material.

Answer: Threads produced by cold forming are acceptable as long as the final threaded product meets the requirements, including chemical composition mechanical properties, etc.) of the specific material (employed for its manufacture) as described in ISO 15156-3:2015

or

b) specific tests are required on the thread produced by cold forming. If yes, which specifications and which threshold values shall be used?

Answer: Qualification of CRA materials (including manufactured products) that do not meet the requirements of ISO 15156-3:2015 shall be done per ISO 15156-3:2015 Annex B. It is the manufacturer responsibility (in close collaboration with the end user) to define a suitable testing plan to ensure that the final manufactured product is appropriate and fit-for-purpose for the intended sour service application.

A.1.5.3

QUESTION:
Section A.1.5.3 of ANSI/NACE MR0175/ISO 15156-3:2015 states “Cold deformation of surfaces is acceptable if caused by processes such as burnishing that do not impart more cold work than that incidental to normal machining operations (such as turning or boring, rolling, threading, drilling, etc.).” - Would cold-finishing be acceptable for an annealed material that is limited to 22 HRC max hardness?

(MP INQUIRY #2017-03)

ANSWER:
Cold finishing is acceptable only if the cold work is no more than that that would be incidental to normal machining operations. The hardness restrictions for the material remain as specified in ANSI/NACE MR0175/ISO 15156-3:2015.

Tables A.1, A.2 and A.6

There is a Materials selection Table A.1 in the standard under A.1.6. Here there are the points under any equipment and components and the additional tables for Instrumentations and Control devices, for example.

QUESTION 1:
The question here is whether the requirements for any equipment and components always apply and the additional tables are additional or whether, for example, A.6 applies here instead of A.2 for austentic stainless steel?

QUESTION 2:
What applies if there is a dash in the table? Does the requirement (example A.2) then apply to any equipment and components or another/no requirement?

(MP INQUIRY #2021-09)
ANSWER 1:
ANSI/NACE MR0175 – ISO 15156:2020 edition, Part 3, Table A.1 provides a guide to materials selection tables for any equipment or component. It also provides a guide to additional materials selection tables for specific named equipment or components when other, less restrictive, environmental, or metallurgical limits may be applied.

Instrumentation and Control devices are listed in Table A.6 and Austenitic Stainless Steels for any equipment or component are listed in A.2. Table A.6 for instrumentation and control devices basically refers you to Table A.2 for Austenitic stainless steels environmental and materials limits. In Table A.2, guidance is offered for the material group but also for individual alloys.

ANSWER 2:
The dash " – " included in some cells in Table A.1 only denotes material group / specific equipment or component combinations for which there is not an associated Table showing additional environmental and materials limits.

The applicability of Table A.6 to specific components must be agreed between the user and manufacturer. The information in these tables reflects the knowledge available, usually from laboratory tests or service experiences, at the time the standard was published, and it is the user’s responsibility to verify that the material is acceptable for the intended service.

A.1.6

GENERAL REMARKS:
The following remarks are prompted by questions related to NACE MR0175/ISO 15156-3, Table A.2, Table A.18, and Table A.23.

As indicated in ISO 15156-3, A.1.6, the Tables of Annex A fall into two groups: those for the selection of materials for "Any equipment or component" and a second group for specific named equipment or components when other, less restrictive environmental and metallurgical limits may be applied as an alternative.

The scopes and contents of the Tables of ISO 15156-3, Annex A are not interdependent.

(MP INQUIRY #2004-23)

Table A.2

QUESTION:
With reference to NACE MR0175 / ISO 15156-3 (2015), I am querying one of the comments under Note b (applicable to UNS S31603) in the notes section of Table A.2 which states; “after the final solution annealing and quenching treatment, hardness and cold work incidental to machining or straightening shall not exceed the limits imposed by the appropriate product specification”.

The product specification ASTM A479 does not state a maximum hardness limit for UNS S31603. Cold drawing is permitted for straightening purposes under
Supplementary Requirement S5 (related to SCC resistance) of ASTM A479, which ties in with 'cold work incidental to straightening' stated in your NACE MR0175 / ISO 15156-3 (2015) standard. However, due to their being no hardness limit and also no clear limit on the amount of cold work (other than for straightening purposes) in this ASTM A479 product specification, what is your definition of these limits? Do we assume a maximum limit of 22 HRC stated under note ‘a’ in Table A.2? Also, can a limit be placed on the material’s maximum yield and tensile strength (that correlates with the amount of permitted cold work) that does not compromise the material’s resistance to SCC?

(MP INQUIRY #2016-04)

ANSWER:
Q1: Referring to 15156-3 Table A.2, what is the definition of cold work limits for UNS S31603 with respect to straightening in accordance with ASTM A479 Supplement S5?

A1: The cold work limit is not defined in Table A.2 only that the material shall be free of cold work intended to enhance mechanical properties.

Q2: With the straightening cold work, can we assume that the hardness limit of 22 HRC applies?

A2: Correct, the maximum hardness is 22 HRC.

Q3: Can a limit on the material’s maximum yield and tensile strength be placed on the material that corresponds to the maximum permitted cold work?

A.3: The maximum yield and tensile is not defined. During our discussions on the ballot regarding cold work of UNS S31603 and Table A.2, there was a lot of agreement that the maximum “specified minimum yield strength (SMYS)” needed to correspond to that of the annealed without cold work condition. However, there was not sufficient consensus to define what this maximum SMYS should be.

QUESTION:
As per Technical Circular 3 of ISO 15156 Part 3, Table A.2, parent material selected for our site condition complies with note (a) of Table A.2. This parent material will comply with requirement of maximum 22HRC. It is not mentioned in note (a) if this maximum hardness requirement should be verified before or after shaping, forming, cold reducing, tension, expansion, etc… Could you please clarify?

(MP INQUIRY #2014-11)

ANSWER:
Hardness requirement of maximum 22 HRC shall be verified after cold working. Note that cold working intended to enhance the mechanical properties is prohibited.

QUESTION:
Q2. NACE MR0175/ISO 15156-3: 2009(E) Table A2 & NACE MR0175/ISO 15156-3: 2009/Cir.2:2013(E), Table A2
Which Temperature has to be considered against Column no:2 of Table A.2, Operating or Design Temperature?

Q3. NACE MR0175/ISO 15156-3: 2009(E) Table A2 & NACE MR0175/ISO 15156-3: 2009/Cir.2:2013(E), Table A2
As long as the partial pressure of H2S is below 15 psi and Flowing medium temperature is below 140 DEG F Any combinations of chloride concentration and in situ pH occurring in production environments are acceptable and materials as suggested under clause A2 “Austenitic stainless steels” can be selected.

(MP INQUIRY #2015-02 Q2 & Q3)

Answer2: “The temperature column in Table A.2 (and for all other tables) defines the maximum exposure temperature in combination with the limits for partial pressure of H2S, chloride and pH. The equipment user shall define the exposure temperature. The equipment manufacturer may define an operating temperature range or safe use maximum temperature for a specific product.”

Answer3: “As long as your definition of “Flowing medium temperature” is “exposure temperature” your interpretation is correct. Note that these materials shall be of type described in A.2, shall be in the solution-annealed and quenched, or annealed and thermally-stabilized heat-treatment condition, be free of cold work intended to enhance their mechanical properties, and have a maximum hardness of 22 HRC.

QUESTION:
We are now in the detailed engineering design phase of a sour gas refinery, and we have implemented NACE MR0175/ISO 15156 for design purposes. NaCl (sodium chloride) will come to the refinery through three-phase flow pipeline from offshore, after liquid separation in slug catcher; then the sour gas will go to gas treatment units for further processing. Table A.2 refers to chloride content in aqueous solution as mg/L; my question is in sour gas treatment units in which we use austenitic stainless steel, what are the criteria for the limitation of application of austenitic stainless steel? My idea is we have to comply with the first row of Table A.2. There is no means to identify the chloride content in the gas stream.

(MP INQUIRY #2004-21)

REVISED ANSWER 2005-09-01:
It is assumed in Table A.2 that this is a mixed-phase environment with both a gas phase and a liquid phase. This is always true throughout the document.

The operator is responsible for determining the service conditions, including chloride content (see ISO 15156-1, 6.1) and the ISO Maintenance Panel cannot provide advice.

As mentioned in ISO 15156-3, A.1.3, Paragraph 2: “The tables show the application limits with respect to temperature, pH2S, Cl, pH, S. These limits apply collectively.”

However, if, as an equipment user, you feel that ISO 15156-3, Table A.2 does not address your expected field conditions you have the freedom to test materials under
alternative environmental limits and to use the outcome of successful tests to justify the use of a material outside the limits set in the standard. (See ISO 15156-3, 6.1, Para. 5.)

QUESTION:
I have a technical query related MR0175/ISO 15156 and the use of 316 stainless steel for sour service application. This standard imposes restrictions on the use of 316 SS in environments operating above 60°C.

My question is can 316 SS be used above 60°C for non-stressed vessel internals or for items such as thermowells located into sour lines or vessels? I ask this because I note that the standard need not be applied to parts loaded in compression (Table 1). The implication may be that parts have to be stressed for SCC to be an issue.

As a similar situation to vessel internals and thermowells, please could you advise on the use of 316 stainless steel for valve internals in a sour application, operating above 60°C. Of particular interest is the use of solid 316 SS balls for ball valves.

(MP INQUIRY #2005-03)

ANSWER:
1.0 The scope of NACE MR0175/ISO 15156 Part 3, Paragraph 1, Sentence 1 defines the applicability of the standard. The standard need not be applied for equipment not covered by this sentence. In addition, in Table 1, parts loaded in compression are included among those considered to be "permitted exclusions." SCC requires a tensile stress (applied and/or residual) to occur. There is no provision for any of the alloys in the standard for a threshold tensile stress below which failure cannot occur.

2.0 The Maintenance Panel cannot analyze the design of equipment. It is up to the manufacturer and equipment user to agree whether or not the scope or any of the listed exclusions in Table 1 apply for a given design.

QUESTION:
For round bar stock 304/316 SS material, does the NACE MR0175 Rockwell C 22 max hardness requirement refer to the hardness anywhere on the raw material or does it refer to the hardness measured at mid-radius, which is the location where ASTM standards require the hardness measurement to be made?

For 304/316 austenitic stainless steel MR0175 indicates that the hardness must be Rockwell C 22 max as long as the material was not hardened to enhance mechanical properties. The hardness on 304/316 SS round bar typically varies with radial position. The material typically has the highest hardness readings at the outer surface and lowest in the center. ASTM standards define hardness measurements for bar stock to be taken at mid-radius. In purchasing raw material, the hardness readings reported are at mid-radius.

(MP INQUIRY #2006-05)

ANSWER:
The Maintenance Panel cannot comment on the hardness test locations specified in ASTM standards.

These materials, when used for sour service, must comply with all the requirements of NACE MR0175/ISO 15156-3, Table A.2. The definition of the hardness testing location is outside the scope of the standard, but hardness requirements must be met regardless of the chosen test location.

**QUESTION:**
Clause A.2.1 lists the required elements and ranges for austenitic stainless steels. Alloys S20100, S20200 and S20500 listed in table D1 do not meet the specified limits nor are they covered by individual approval. Is there any reason for these materials being listed in the aforementioned table?

*(MP INQUIRY #2009-19)*

**ANSWER:**
These alloys do not meet the requirements of A.2 so they are not covered by the ISO 15156-3 austenitic stainless steel limit tables. Annex D as stated in the standard is for information only. It is not a list of approved materials.

**QUESTION:**
NACE MR0175 restricts the use of SS316L in sour service for chlorides above 50 ppm and temperature greater than 60 deg. C (Table A2.2 in Part 3). This is fine in isolation. However, should these restrictions be applicable in the case of sour service valves with SS316L trim and CS body construction wherein SS316L is cathodic to CS and the latter will protect the former from SSCC? Many valves with such material combinations have been used successfully in oil and gas industries.

*(MP INQUIRY #2012-08)*

**ANSWER:**
The standard does not permit the exception you describe. If you have field history to support a change to the standard, you may submit a ballot. The field data should be supported with some corrosion testing data to technically justify the ballot and help in the ballot review process. The ballot process is described in the document “Ballot proposal form in MSWord format”. This document is located on the ISO MP webpage at the following link:
http://isotc.iso.org/livelink/livelink?func=ll&objId=3340364&objAction=browse&sort=n ame

**QUESTION:**
"Table A.2 lists material types and individual alloy UNS numbers. UNS S31600 and S31603 appear below the listing for "Austenitic stainless steel from materials type described in A.2""
S31600 and S31603 comply with the requirements for material described in A.2 Why are S31600 and S31603 listed separately from the other austenitic stainless steels?
Do S31600 and S31603 have different environmental limitations than other austenitic stainless steels?"  

(MP INQUIRY #2013-06)

**ANSWER:**  
-Clause A.2 materials permit less highly alloyed grades than S31600 and S31603.  
-Yes

**QUESTION:**  
We have a client that wishes us to use UNS S17400 double age-hardened stainless steel for the valve stem on some 4.1/16-in. 5k gate valves (basically because we have some in redundant stock and can deliver far quicker than the nickel alloy version of stem we currently use).

He does, however, want the valves to comply with API 6A material class DD and the latest version of NACE MR0175. Where there is slight ambiguity is with the use of UNS S17400 for valves and choke components (excluding bodies and bonnets) with an allowable partial pressure of 0.5 psi (ref. Table A.27).

Is it correct to assume that this additionally excludes valve stems because these are specifically dealt with in Table A.3, or can valve stems be used manufactured from UNS S17400 (in the required treated condition), as they are a valve component, with an allowable partial pressure of 0.5 psi in accordance with Table A.27?  

(MP INQUIRY #2006-07)

**ANSWER:**  
No, Table A.3 does not preclude the selection of other materials for valve stems.

Please see Table A.1.

In general, materials for equipment or components may be chosen from Tables for "Any equipment or component" or from Tables for specific named equipment or components when other, less restrictive environmental and metallurgical limits may be applied as an alternative.

For the specific example of UNS S17400 valve stems, they may be selected using Table A.27 subject to the environmental and metallurgical limits of this Table.

**QUESTIONS:**  
I have an application where I am supplying a pipeline from a gas compressor to a turbine generator. The pipe is 10 in. in diameter and contains natural gas with H₂S. The H₂S concentration is 250 ppm by volume. The gas is pressurized to 475 psi @152°F. I would like to know what table from Annex A this pipe would fall under. The material I would like to use is 304L SS, which satisfies the requirements in A.2. I would appreciate any guidance you can provide with this subject.
ANSWERS:
1a) NACE MR0175/ISO 15156-3, Table A.6 provides environmental and materials limits for austenitic stainless steels used in compressors. NACE MR0175/ISO 15156-3, Table A.2 applies to austenitic stainless steels used for any equipment or components.

b) The limits on austenitic stainless steels in NACE MR0175/ISO 15156-3, Table A.6 (when compared to those of NACE MR0175/ISO 15156-3, Table A.2) are based upon industry experience with these alloys in compressors.

c) The latest editions of API Standard 618 for Reciprocating compressors and API Standard 617 for Axial and Centrifugal compressors define the scope of equipment associated with the compressor environment including accessories, instrumentation, and piping systems.

d) It is the user's responsibility to determine if the pipe mentioned in your inquiry is directly associated with the compressor and experiences the same service environment as inferred for compressors in NACE MR0175/ISO 15156-3, Table A.6.

e) The Maintenance Panel cannot review individually designed equipment and pressure stations to make this interpretation.

2a) The manufacturer and user may consider documenting previous experience with pipelines in accordance with NACE MR0175/ISO 15156-1, Paragraphs 8.2 and 9.0.

b) NACE MR0175/ISO 15156-1:2001 provides minimal requirements for these issues and the user is ultimately responsible for ensuring the alloy in final fabricated form has adequate resistance to the types of cracking listed in the Scope 1.0 of NACE MR0175/ISO 15156-1:2001.

3. The ISO Maintenance Panel cannot comment on the suitability of using the 304L SS materials compared to alternative alloys.

QUESTION:
I am requesting a clarification of intent for comments included in Tables A.2 and A.6

In both of these tables there is a statement "these materials shall also be in the solution-annealed and quenched condition."

It is my interpretation that this was a requirement for the base material and was not intended for a fabricated part, e.g., a welded compressor housing.

We have to complete some fabrications and believe the required heat treatment will cause cracking and distortion of the part--however, a part must meet the requirements of MR0175/ISO 15156.

ANSWER:
You are correct. NACE MR0175/ISO 15156-3, Tables A.2 and A.6 apply to base materials only. The requirements for welding are given in NACE MR0175/ISO 15156-3, A.2.3, "Welding of austenitic stainless steels of this materials group."

**QUESTION:**
ISO 15156-3 Table A.2 lists “Austenitic stainless steel from material type described in A2” and also specifically lists UNS 31603. The maximum temperature limit for UNS 31603 is given as 149°C. By contrast, there is no maximum temperature limit for “Austenitic stainless steel from material type described in A2” if chloride level ≤ 50 ppm. Given that this grouping includes the generally inferior 304 stainless steel; it seems contradictory that UNS 31603 cannot be used without a maximum temperature limit when chloride level ≤ 50 ppm. Clarification would be appreciated.

**(MP INQUIRY #2014-08)**

**ANSWER:**
The limits given in two upper rows in Table A.2 apply for all materials as defined in A.2.1. This will include UNS 31603. The limits given specifically for UNS 31603 in rows 3 to 5 in the 2009 edition and rows 3 to 8 in the 2014 Technical Circular 3 to Part 3 of ISO 15156 further extend the limits for this material for temperatures above 60°C and for chloride content above 50 mg/l.

**Table A.2 (cold work)**

**QUESTION:**
With the exception of UNS S31603, Table A.2 of Part 3 of the standard for austenitic stainless steels requires a solution anneal and quench or thermal stabilization along with no cold-work intended to enhance mechanical properties. I have a 316 st/st (UNS S31600) part that we spec 1/4 hard temper, but still falls under the max hardness requirement of HRC 22. My mechanical engineer tells me 1/4 hard in essence means cold-working the material to increase its properties. My question is: Can we do 1/4 hard if we still meet the hardness requirement? I am looking to comply with Annex A.2 and Tables A.2 & A.6 for this part.

**(MP INQUIRY #2006-14)**

**ANSWER:**
No, ¼ hard temper UNS S31600 does not comply with the conditions set out in the notes to Tables A.2 and A.6 as it is used to purposely enhance the mechanical properties of the alloy by cold working.

**QUESTION:**
We're a manufacturer of expansion joints and flexible hoses and since we get more and more often inquiries regarding bellow according to MR0175 we purchased a copy of this standard some time ago. Since our bellows standard material is austenitic
stainless steel, we paid particular attention to Table A.2 (attached) where there some notes about cold work and maximum hardness. Our understanding of these notes is that to meet this particular requirement we have to perform a heat treatment of the bellows after cold forming and to check the maximum hardness to be not higher than 22 HRC. Could you please tell me if our understanding is correct or what is the right method to follow to satisfy the requirements of MR0175 when the subject is cold formed bellows?

(MP INQUIRY #2012-03)

ANSWER:
Table A.2 is applicable to austenitic stainless steels used for ANY components. There may be other applicable tables depending on the end use of the bellows (e.g. Table A.7 for gas lift service).
If Table A.2 is the applicable table, the requirements for material conditions, hardness limit and cold forming are stated in A.2.
The MP is restricted to providing interpretations of the standard’s requirements and may not provide direction beyond this scope.

QUESTION:
We are a manufacturer of rupture discs (as a pressure relief or activation device) and other safety devices. 316L is a fairly common material of construction for our rupture discs. In the process of manufacturing 316L rupture discs, we always form/bulge them after solution treatment at the mill. Following the forming/bulging operation, we sometimes anneal the parts at a temperature several hundred degrees below the solution anneal temperature. We do not solution anneal after bulging/forming.
Our annealing temp is not high enough to erase the effects of the cold working we have imparted as a result of the forming/bulging.
Other times, our manufacturing process requires that we do not anneal the rupture disc at all, after forming/bulging. This allows us to control the burst pressure and burst tolerance of the rupture disc. The manufacturing operator has the discretion to decide if the rupture disc will be annealed or not annealed in order achieve the rupture disc performance needed for a particular order. A solution anneal of 316L will erase all effects of any cold work and "reset" the material.
In reference to MR0175, Part 3, Technical Circular 2 (2013), Table A.2, Note b, page 7:
We would like to propose that if we can demonstrate that we have NACE-compliant hardnesses for 316L (Rc 22 max) after our forming/bulging process, that these discs would meet MR0175 requirements.
When all other NACE requirements have been satisfied, we believe that the final hardness is the last hurdle. If the material meets hardnesses requirements regardless of any prior cold work, then the parts should be considered MR0175 compliant. Thank you for your kind consideration.

(MP INQUIRY #2014-05)

ANSWER:
The limits given in rows 3-8 in Table A.2 apply for UNS S31603 provided that all the requirements given in Note b are fulfilled.
If the increased strength resulting from forming operations is required for the design, the product is no longer free of cold work intended to enhance mechanical properties. If this is the case, laboratory tests would be required for acceptance in accordance with Annex B.

Additional response provided June 3, 2014: Note that the charge of the Maintenance Panel (MP) is to give interpretations to the existing standard and the MP does not rule on queries that are outside of this charge.

The topic of cold work and UNS S31603 has generated a lot of discussion with resultant ballots over the last few years. The NACE MR0175/ISO 15156 document prohibits cold work for this alloy intended to increase mechanical properties. This is defined in the notes section of Tables A.2 and A.6. The recent ballot data has demonstrated the susceptibility of the alloy to environmental cracking when higher design strength levels are utilized as a result of cold working.

**QUESTION:**
Requirement from NACE MR 0175-3 Table A.2

The stress corrosion cracking resistance of all austenitic stainless steels of the material type described in A.2 can be adversely affected by cold working.

a These materials shall
— be in the solution-annealed and quenched or annealed and thermally-stabilized heat-treatment condition,
— be free of cold work intended to enhance their mechanical properties, and
— have a maximum hardness of 22 HRC.

Question 1: "Is Above requirement applicable to 316SS (UNS S31600) alone or it is applicable to 316L (UNS S31603) also?"

Requirement from NACE MR 0175-3 Table A.2

b UNS S31603 shall be in the solution-annealed and quenched condition when used in environments outside the limits imposed for the material type (i.e. in the top two rows), but within those given specifically for S31603. The following conditions shall apply:
— the material shall be free from cold work caused by shaping, forming, cold reducing, tension, expansion, etc. after the final solution annealing and quenching treatment;
— after the final solution annealing and quenching treatment, hardness and cold work incidental to machining or straightening shall not exceed the limits imposed by the appropriate product specification.

Question 2: "Is cold drawn UNS S31603 bars/plates can be used for specific limits as the above statement requires material should be free from cold work?"

(MP INQUIRY #2019-02)

**ANSWER:**
Response to Question 1: The requirements delineated in Note a apply to all austenitic SS, which would include UNS S31600 and UNS S31603, when used within the limits
described in the first two rows of Table A.2. However, the use of UNS S31603 outside of the limits described in the first two rows of Table A.2 (but within the limits specifically identified for UNS S31603) shall comply with additional requirements as shown in Note b.

Response to Question 2: Use of UNS S31603 shall conform to the specific requirements described in Note b, which includes an expanded explanation of the different forms of cold work (including cold reducing, which is a form of cold drawing) that are not allowed after final solution annealing and quenching treatment.

Please see MP Inquiry #2016-19, which is relevant to the present query.

**QUESTION:**
I am writing to you again in order to clarify other paragraph of the NACE MR0175/ISO-15156-3, specifically third consideration of the Note b-Table A.2: “After the final solution annealing and quenching treatment, hardness and cold work incidental to machining or straightening shall not exceed the limits imposed by the appropriate product specification”

In our case the material is CS + 316L CLAD under API Standard 5LD Scope and we have a doubt with the reference of the appropriate product specification indicates in the consideration mentioned above.

In our interpretation, appropriate product specification for CRA material CLAD (SS316L) should be ASTM A-240 according to ASTM A-264; however, our supplier’s interpretation is the following: “The appropriate product specification for cladded pipes is the international API 5LD (4th)".

The API 5LD indicates a 310HV10 of hardness value for SS316L CLAD in all locations, while the hardness value for SS316L according to A-240 is 217HB, although 22HRC can be acceptable by NACE MR0175/ISO15156-3.

Q1: Our question is: What interpretation does the NACE committee have as the appropriate product specification?

Q2: Moreover, we have an additional question with respect H2S-service by laboratory testing (Annex B of the Standard): Is this test also applicable for 316L Clad material?

(***MP INQUIRY #2019-03***)

**ANSWER:**
Response to Q1: "ISO 15156 does not define all applicable product specifications. However, it is the manufacturer’s responsibility to meet the metallurgical requirements of the appropriate alloys in NACE MR0175/ISO 15156. Consult NACE MR0175/ISO 15156-3: 2015 Clause A.13 for additional comments on the use of corrosion-resistant claddings."

Response to Q2: "Qualification of CRA materials (including cladding) that do not meet the requirements of NACE MR0175/ISO 15156-3:2015 shall be done per NACE MR0175/ISO 15156-3:2015 Annex B. It is the manufacturer responsibility (in close collaboration with the end user) to define a suitable testing plan to ensure that the final manufactured product is appropriate and fit-for-purpose for the intended sour service application."
A.2.2, Table A.4

**QUESTION:**
In the latest NACE MR0175 there are two component categories "Instrument tubing and associated compression fittings,..." and "Diaphragms, pressure measuring devices and pressure seals." To which category does the Bourdon tube belong?

**ANSWER:**
Bourdon tubes are not specifically addressed in NACE MR0175/ISO 15156.

The Maintenance Panel cannot meet your request to categorize Bourdon tubes between "Instrument tubing and associated compression fittings,..." and "Diaphragms, pressure measuring devices and pressure seals."

In all cases the material selected must be acceptable to the equipment user for their service conditions.

Tables A.2 and A.4

**QUESTION:**
In Part 3, Table A.4 it shows S31600 stainless, but not S31603 stainless (316Lss). Also, our equipment is a flowmeter which is not specifically referred to anywhere in the standard, so do I treat it as a fitting? As for the bolt material, ASTM A354/ UNS K04100, I don’t see this material anywhere in any of the 3 parts, but I believe it goes into the Part 3 category. This is where I also need help.

**ANSWER:**
Table A.2 applies for austenitic stainless steels whose composition are defined in §A.2. It includes low C 316L SS. In this case it can be either Table A.2 that applies to any equipment or components or another Table that applies to the specific equipment or component. It is up to the user to determine which Table to use. Your last point cannot be answered as the MP does not do consulting work.

**QUESTION:**
"The question regarding the "ANSI/NACE MR0175/ISO 15156-3:2015" refers to Instrumentation Products (Valves, Manifold acc. to MSS SP-99 and MSS SP-105), adapters,…"

Table A.2 — Environmental and materials limits for austenitic stainless steels used for any equipment or components states:

b UNS S31603 shall be in the solution-annealed and quenched condition when used in environments outside the limits imposed for the material type (i.e. in the top two rows), but within those given specifically for S31603. The following conditions shall apply:
— the material shall be free from cold work caused by shaping, forming, cold reducing, tension, expansion, etc. after the final solution annealing and quenching treatment;

For small instrumentation valves it is very standard, that they are manufactured from cold drawn bar material (bar, flat, hex material). Those materials (even round bar smaller than appr. 25mm (1")) are only available in the solution-annealed and cold drawn condition. So this material does not fulfill the requirement of table A.2 (…any equipment).

But there is also a table

Table A.4 — Environmental and materials limits for austenitic stainless steels used in surface applications for control-line tubing, instrument tubing, associated fittings, and screen device.

UNS S31600 stainless steel may be used for compression fittings and instrument tubing even though it might not satisfy the requirements stated for any equipment or component in Table A.2.

Question 1:
Do our small instrumentation valves and manifolds fall under this paragraph of Table A.4, where compression fittings and instrument tubing may be used even though it might not satisfy the requirements stated for any equipment? If not, what is the reason for this?

Otherwise we (and all the instrumentation valve manufacturers around the globe) would have to machine parts like a stem of diameter ø3/8" (ø9,5mm) out of a round 1 1/4" (32mm), as the round material 1" (25mm) and below is only available in the solution annealed and cold drawn condition.

Question 2:
Is the phrase "instrument tubing" referring to the tube only or to all components assembled to the instrumentation tubing (like the compression fittings)?

ANSWER:

A1. Table A.4 specially refers to compression fittings and instrumentation tubing and the terms are not defined in ISO 15156. The Maintenance Panel can only answer on interpretation of the standard and cannot give any statement regarding your products and cannot give an answer to the reason since it is an historical question. Valves and manifolds are not considered "associated fittings."

A2. The term "instrument tubing" refers to the tubing. Please note that compression fittings are specified separately in Table A.4. "UNS 31600 stainless steel may be used as compression fittings and instrumentation tubing even though it might not satisfy the requirement stated for any equipment or component in Table A.2."

A.2.3
QUESTION:
The statement I’m referring to is in NACE MR0175, Part 3, Sect A.2.3 Welding of austenitic stainless steels of this material group and the statement reads “the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable.” It would be greatly appreciated if you could provide some clarification as to what the standard is referring to by the “maximum hardness limit of the respective alloy” and where I can find these values.

(MP INQUIRY #2017-10)

ANSWER:
The maximum consumable hardness applies to the corresponding base metal (UNS number composition). This has been defined as the maximum hardness that is listed in NACE MR0175/ISO 15156 for that UNS number or meets one of defined alloy classes that is in the NACE MR0175/ISO 15156. The question that you ask does not have a defined answer if the consumable used does not correspond to an existing UNS or does not fit one of defined alloy classes that is in the NACE MR0175/ISO 15156 standard. For a better understanding of weld cracking resistance requirements and especially for this latter case, you are directed to ISO 15156-3, Clause 6.2.2 where the cracking resistance of weldments are addressed.

QUESTION:
My stainless steel sheet material qualifies to Section A.2. I am forming this sheet into tubes and (longitudinally) welding the formed tube without filler metals using an automatic arc welding process (ASTM 249/ASTM 269). After welding the tube is fully annealed per ASTM. My hardness values are all below 22 HRC as required.
A. Is my welded and annealed tubing bound to the welding requirements of A.2.3 and 6.2.2?
B. After annealing, if I now butt weld two ends of the tubing above using the orbital weld (no filler metal) process (no additional anneal), am I now bound to A.2.3 and 6.2.2?

(MP INQUIRY #2004-19 Q2)

ANSWER:
A. Yes, this is still a weld even if it was made without filler materials.
B. Yes.

QUESTION:
In Section of Part 3: Table A.2 (austenitic stainless steel) states:
"These materials shall also
-be in the solution-annealed and quenched, or annealed and thermally stabilized heat-treatment condition,
-be free of cold work intended to enhance their mechanical properties, and
-have a maximum hardness of 22 HRC."

Whereas for welding in Section A.2.3 it is stated that:
"The hardness of the HAZ after welding shall not exceed the maximum hardness allowed for the base metal, and the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable."
I addition Section 6.2.2.2.2 states that "Hardness testing for welding procedure qualification shall be carried out using Vickers HV 10 or HV 5 methods in accordance with ISO 6507-1 or the Rockwell 15N method in accordance with ISO 6508-1. The use of other methods shall require explicit user approval."

Q1. Please clarify how the requirement for 22 HRC is interpreted in light of this, i.e., what Vickers (HV 10 or HV 5) or Rockwell (15N) value should be used as a maximum for weld HAZ and weld metal?

On an associated point, for solid-solution nickel-based alloys (Section A.4) and duplex stainless steels (Section A.7) there are no hardness requirements for materials in the solution-annealed condition (with the exception of one HIP duplex stainless steel alloy). The relevant sections (A.4.3 and A.7.3) on welding state:

"The hardness of the HAZ after welding shall not exceed the maximum hardness allowed for the base metal, and the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable".

Q2. Please confirm that the interpretation that NACE MR0175/ISO 15156 therefore places no hardness restrictions for welds in these materials is correct.

(MP INQUIRY #2005-13)

ANSWER:
(1) NACE MR0175/ISO 15156 provides no guidance for hardness conversion from the Vickers to the Rockwell scales for the austenitic stainless steels, which is then left to an agreement between the manufacturer and the equipment user possibly based on conversion tables made using empirical data; see ISO 15156-3, 6.2.1, Paragraph 2.

(2) There are no hardness limits for the HAZ of welds of corrosion-resistant alloys when there are no hardness limits in the tables or the text of the document for the base materials.

For the weld metal, any hardness limit depends on any hardness limit set for the alloy used as consumable. For matching consumables for solid-solution nickel-based alloys (Section A.4) and duplex stainless steels (Section A.7) there are no hardness limits for weld metal.

A.3

TABLE A.3

QUESTION:
Q1. NACE MR0175 Part 2 Table A.3 references “Proprietary Grades” for three temperature ranges. There is no definition of “proprietary grades” in NACE MR0175. However, this suggests that not all materials will be adequate despite meeting the
Table A.3 mechanical / product form requirements. Is there an accepted definition of “proprietary grade”?

Q2. Table A.3 is entitled “Environmental conditions for which grades of casing and tubing are acceptable”. A.2.2.3.1 refers to Table A.3 in the context of ISO 11960 and API 5CT grades. Other sections of A.2.2.3, not directly referencing table A.3, refer to tubular components as well as casing and tubing. Is Table A.3 restricted to Casing and Tubing?

ANSWER:
Q1. NACE MR0175 Part 2 Table A.3 references “Proprietary Grades” for three temperature ranges. There is no definition of “proprietary grades” in NACE MR0175. However, this suggests that not all materials will be adequate despite meeting the Table A.3 mechanical / product form requirements. Is there an accepted definition of “proprietary grade”?
A1: Proprietary grade as a term does not have a definition in NACE MR0175/ISO 15156-2. NACE MR0175/ISO 15156-2 Table A.3 defines what constitutes the proprietary grades and specifically references clauses A.2.2.3.2 and A.2.2.3.3.

Q2. Table A.3 is entitled “Environmental conditions for which grades of casing and tubing are acceptable”. A.2.2.3.1 refers to Table A.3 in the context of ISO 11960 and API 5CT grades. Other sections of A.2.2.3, not directly referencing table A.3, refer to tubular components as well as casing and tubing. Is Table A.3 restricted to Casing and Tubing?
A2: NACE MR0175/ISO 15156-2 Table A.3 is restricted to tubular components including casing and tubing. Tubulars are noted in the column for temperatures less than 65°C (150°F) and well as the referenced clauses A.2.2.3.2 and A.2.2.3.3.

QUESTION:
Q1. Can UNS S20910 be used in the condition specified in table A.3 for choke valve stems as well as valve stems?

Q2. Can UNS S20910 be used in the hot rolled or solution annealed and hot rolled condition at a maximum of 35HRC at the limits specified in Table A.3?

ANSWER:
A1. Yes, table A.3 includes choke valve stems since chokes are considered to be a type of valve in the Oil & Gas Industry.

A2. UNS S20910 can be used for the applications in Table A.3 in the hot rolled or solution annealed and hot rolled conditions as long as the hardness does not exceed 35 HRC.

QUESTION:
Our customer does not understand the NACE the same way as we do regarding the use of Nitronic 50 "hot worked" when applying Table A.3 (see document attached). It is only a matter of interpretation of the NACE and we are convinced that on the contrary Nitronic 50 should be used "hot worked" and can be used "cold worked" if preceded by an annealed treatment.

The only way to convince them that they can use Nitronic 50 hot worked for their application, would be if we have someone from NACE who would certify that our interpretation above is correct.

(MP INQUIRY #2014-09)

ANSWER:
The following interpretation can be given for use of UNS S20910:

“The note in Table A.3 permits the use of UNS S20910 in the solution annealed and cold worked condition provided that the hardness does not exceed 35 HRC. The solution annealed condition is also acceptable.

Also, refer to Table A.2 which permits use of listed materials for any equipment or components. This Table contains the following note “S20910 is acceptable in the annealed or hot rolled (hot/cold worked) condition at a maximum hardness of 35 HRC”.

If your question is of whether UNS S20910 is acceptable in hot worked conditions for the limits listed in Table A.3, we would ask you to re-phrase your inquiry to specifically ask for this. The standard is not using expressions such as “should be used” or “can be used” for limits given in the tables.

Note that the answer to this is not clearly given in the standard and we will need some time to discuss the answer to this with the Maintenance Panel for the ISO 15156 / NACE MR0175.

QUESTION:
Is UNS S20910 acceptable in hot worked conditions for the limits listed in Table A.3

(MP INQUIRY #2014-09R)

ANSWER:
The Table A.3 permits cold working to 35 HRC as long as the material has a solution annealing cycle that precedes it. The UNS S20910 is acceptable per the applications of Table A.3 in the hot worked condition that is subsequently solution annealed and cold worked to 35 HRC. The UNS S20910 is acceptable per the applications of Table A.3 in the hot worked condition as long as it is free of cold work intended to enhance mechanical properties and has a maximum hardness of 35 HRC. The condition of UNS S20910 in the hot worked condition followed only by cold working that enhances mechanical properties is not addressed in Table A.3; changing Table A.3 to permit this condition would require a successful ballot.

A.3 and A.4

QUESTION:
In several paragraphs of both NACE MR0175 and ISO 15156 it is stated that materials (e.g., austenitic SS) are acceptable if they are free of cold work intended to enhance their mechanical properties or is stated "in the annealed or solution-annealed condition only" (e.g., Ni-based only).

Question: Is there a limit to what is considered cold work, e.g., 5%, or is any cold work whatsoever included?

(MP INQUIRY #2003-28 Q1)

ANSWER:
NACE MR0175/ISO 15156-3 does not prohibit all cold work of the austenitic stainless steels; it prohibits cold work intended to enhance mechanical properties. A limit for the percentage of cold work is not provided.

QUESTION:
In order to decrease the danger of low stress creep we slightly overstress superaustenitic SS and Ni-based alloy valve bodies during hydrotesting. This overstressing causes a "cold deformation" of 0.2-0.5%. We do not use the cold deformation in order to enhance the mechanical properties!

Is this practice allowed under the rules of NACE MR0175/ISO 15156?

(MP INQUIRY #2003-28 Q2)

ANSWER:
Hydrotesting the austenitic stainless steels to the appropriate industry or design code is acceptable.

QUESTION:
Your name was given to me as someone that might be able to help sort out an issue that was raised by one of my co-workers. At one point many years ago, alloy 600 (UNS N06600) was included in MR0175 as a specific alloy that could be used in NACE applications. For some reason along the way with the revisions between 2002/2003 and the changeover to ISO 15156, it has been left out or removed on purpose. However, I was not able to find out specifically what happened to alloy 600. A friend did a search of ISO 15156 and found a query on the same topic (2011-03 on UNS N06600) with the same question as mine. The proposed response was as listed below:

"N06600 is not listed in 15156 as an acceptable alloy. There is currently a ballot proposal to introduce UNS N06600 back into NACE MR0175/ISO 15156 Standard. According to ISO 15156 rules this ballot will have to pass votes from the Maintenance Panel and the Oversight Committee to be accepted". No records of the proposed ballot were found. Not sure what happened to this. I was told that my inquiry should be sent to you to be able to get the formal inquiry recorded and entered into the NACE system so that the Maintenance Panel would be able to investigate. I do appreciate your help. If you have any questions, please let me know.

(MP INQUIRY #2014-06)
ANSWER:
Item 4 in Minutes of meeting from San Antonio MP meeting: Nickel Alloy 600 ballot. Alloy 600 was in the previous version of MR0175 and left off in translation into 15156. The proposal was to relist without limits in annealed conditions with 35 HRC maximum. The ballot submitter was asked to resubmit with data or use history; we have not had a reply as of this meeting.

Tables A.5 and A.27

QUESTION:
“I would like to ask you about hardness requirements of ring gaskets made of precipitation-hardening stainless steels (UNS S17400). The ring gasket is not an API standard ring gasket such as R, Rx or BX. It has a different design.

In table A.27 / ISO 15156-2015 for UNS S17400 it specifies in note (a) that UNS S17400 shall have a maximum hardness of 33 HRC / 107 HRB. And in table A.5 it is specified hardness for austenitic stainless steels. I am not sure which table is applicable for ring gaskets made of precipitation-hardening stainless steels (UNS S17400).”

Q1. “Is table A.5 applicable for this ring gasket, which is made of precipitation-hardening stainless steels?”

Q2. “And the second question is the ring gasket made of austenitic stainless steels (UNS S17400) covered in table A.27?”

(MP INQUIRY #2020-10)

ANSWER:
A1. No, Table A.5 is only applicable to the austenitic stainless steels listed in the table. UNS S17400 is not listed in Table A.5. UNS S17400 is not considered an austenitic stainless steel in ISO 15156. Clause A.2 requires a minimum Ni content of 8% for austenitic stainless steels. ISO 15156 considers UNS S17400 as a martensitic precipitation-hardened stainless steel.

A2. UNS S17400 is included in Table A.27. Table A.27 covers martensitic precipitation-hardened stainless steels used for wellhead and christmas tree components (excluding bodies and bonnets), valves and chokes (excluding bodies and bonnets), and packers and other subsurface equipment. Ring gaskets used in the applications mentioned in the previous sentence are covered, but otherwise not.

Table A.6

QUESTION:
Our inquiry is regarding Table A.6, in which the material and environmental limits for instrumentation and control devices are described. The note b in Table A.6 only provides an indication of possible components that fall in this category (diaphragms,
pressure measuring device and pressure seals). However, we do not fully understand if the following instruments also fall in this category.

- pressure gauges (with bourdon tube or diaphragms)
- diaphragm seals/chemical seals
- electronic pressure transmitters
- electric and mechanical temperature measuring devices
- Accessories
  - Restrictor
    - Overpressure protector
    - Thermowell (solid machined, fabricated)
    - Syphon
    - Cooling tower

Do you agree that the above mentioned instruments fall in the category as noted in Table A.6.?

(MP INQUIRY #2011-02)

**ANSWER:**
Table A.6 includes instrumentation and control devices that have been used so far without known failures in sour service. It is up to the Manufacturer to assess if the use of austenitic stainless steel instrumentation and control devices used for compressors are included in Table A.6. The Maintenance Panel cannot give advice on specific design issues. The applicability of Table A.6 to specific components must be agreed between the user and manufacturer. You are encouraged to submit a ballot to revise/clarify Table A.6. This ballot should include field history as prescribed in 15156-1 clause 8.2.

**QUESTION:**
“I’m searching for some guidance on two particular tables in MR-0175 15156:-3:2015 standard. Would you be able to provide information/thoughts for the following?

For my scenario, I’m interested in using pressure measuring device in varying harsh environments which connect via ASME Class 600# 316 stainless steel (S31600) and 316L stainless steel (S31603). I see Table A2 relates to “any equipment or component” and lists environmental limits which I may need to exceed. However, I also find Table A6 which does not “Instrumentation and control devices include… pressure measuring devices…” where “These materials have been used for these components without restrictions.. in production environments. No limits on individual parameters are set, but some combinations of the values of these parameters might not be acceptable”.

Two questions:
Q1. “I’m curious if Table A6 limits are applicable to the device internals or do the limits also extend to the connecting flange as it is part of the measuring device.”

Q2. “Do you have any guidance on combination of limits for Table A6?”

(MP INQUIRY #2021-03)
ANSWER:
A1. It is the user’s responsibility to determine if the flange mentioned in your inquiry is directly associated with the measurement device and experiences the same service environment as inferred for it in NACE MR0175/ISO 15156-3, Table A.6. The Maintenance Panel cannot review individually designed equipment and expected conditions to make this interpretation.

A2. The information reflects the knowledge available, usually from laboratory tests or service experiences, at the time the standard was published, and it is the user’s responsibility to verify that the material is acceptable for the intended service. The Maintenance Panel cannot give further guidance.

A.3.2, Table A.8

QUESTION:
We have a query about Hardness of SS-254SMO (Grade) S31254 (UNS Number). We used ASTM A182 Gr F44 in Valve Components (Seat ring and Bonnet Bush).

As per Nace MR 0175 Hardness doesn’t specify for the UNS S31254 material. But Nace MR 0103 Stated that 35 HRC (Max).

Please clarify the below.

1. Nace MR 0175 Hardness not specified for SS-254SMO (Grade) S31254 (UNS Number) – Correct or Not?
2. Referring Nace MR 0103 specified for SS-254SMO (Grade) S31254 (UNS Number) – 35 HRC (Max) – Please confirm.

(MP INQUIRY #2017-18)

ANSWER:
The applicable tables for the subject alloy are A.8 thru A.11. As shown in Table A.8, there are no hardness requirements for material in solution-annealed condition used for any equipment or components; however, the cast version of UNS S31254, which is UNS J93254 (solution heat-treated and water-quenched condition), has a maximum hardness of 100 HRB. Table A.9 for downhole tubular components and packers and other subsurface equipment indicates that the material shall be in the solution-annealed and cold-worked condition with a maximum hardness of 35 HRC.

QUESTION:
We have requirement of 6Mo valves for one of our ongoing projects wherein we need to use A 351 CK3MCuN (J 93254) body material.

With reference to Table A-8 of NACE MR0175/ISO-15156 - 2003 Environmental and materials limits for highly alloyed austenitic steels used for any equipment or components ) we have following clarification:
Table A - 8 lists the above material J 93254 (ASTM A 351 CK3MCuN) can be used for any combinations of temperature, pH_{2S}, chloride concentration and in situ pH occurring in production environments are acceptable.

We understand that forging grade equivalent of above J 93254 which is UNS 31254 will also be qualified under these conditions.

Please confirm /clarify the whether forging grade equivalent of J 93254 which is UNS 31254 will also be qualified?

(MP INQUIRY #2006-12)

**ANSWER:**
Table A.8 is the subject of an amendment proposal that has been accepted by the ISO 15156 Maintenance Panel, by NACE TG 299 (ISO 15156 Oversight Committee) and by ISO TC67 WG7 and will now go forward for publication.

The revision involves limits being placed upon the application of UNS J93254. Publication of this document can be expected within the coming year.

**QUESTION:**
Shouldn’t it have the same material restrictions of all type 3b materials, and be able to be used under the conditions stated in both entries for materials type 3b, and not only according to the first entrance? Otherwise, could you kindly explain the reason of this difference in limits, with such a similar chemical composition?

(MP INQUIRY #2018-03)

**ANSWER:**
Materials requirements for sour service are not solely based on chemical composition as there are other metallurgical conditions that directly impact their resistance and, thus, their specific sour service limits. Cast vs. wrought materials is an example of such differences in terms of metallurgical conditions that affect their resistance and as such need to be qualified accordingly. A ballot with the required testing data in compliance with NACE MR0175/ISO 15156-1 and NACE MR0175/ISO 15156-3, Appendix B or field experience data as described in NACE MR0175/ISO 15156-1 would be needed to extend current limits.

**QUESTION:**
We are doing a pipe skid system that requires ASME B31.3 and NACE MR0175 as project requirements. According to A.3.2 of NACE MR0175, Table A.8 lists some material UNS numbers. We are wondering what NACE means by “type 3a” and “3b” (max temp 140 deg F). The pipe we were contemplating using was ASTM A312 Gr TP 316. According to another chart we saw that the equivalent URN (UNS) number for A312 is S30940. What therefore is the maximum temperature rating on S30940 (ASTM A316 Gr TP316). Our application is on frame oil where the design values are -18 to 160 deg C, 300 lb.

(MP INQUIRY #2010-12)
ANSWER:
The definition of materials type 3a and 3b is given at the bottom of Table A.8. It is based on alloy chemical composition. The temperatures given in the tables are the maximum known acceptable values with the given H2S partial pressure, pH, and chlorides limits. The alloys UNS S31600 and S30940 you are referring to are austenitic stainless steels and are covered by Table A.2 and Clause A.2. The MP does not answer questions concerning specific applications.

A.3.2, Table A.8 and Table A.9

QUESTION:
We have a question regarding the meaning of a sentence in Paragraph 4.4 in MR0175-2003. This same sentence is repeated in Paragraph 10.2.1.

The paragraph states:
Highly alloyed austenitic stainless steels in this category are those with Ni% + 2 Mo% >30 and 2% Mo minimum.

A1. Does the statement mean that there are essentially two groups in this category? Such that . . .
One qualifying group consists of materials that contain N% + 2 Mo% >30
Another qualifying group consists of any austenitic stainless steel with 2% Mo minimum (such as 316, 317).

A2. Or does the statement mean that there must be a minimum of 2% Mo in the Ni% + 2 Mo% >30 requirement?

Since the environmental restrictions in Paragraph 4.4 are the same as in 4.2 (where most austenitics are acceptable), I assume #A1 is the correct interpretation since this would allow for inclusion of 316 and 317.

(MP INQUIRY #2003-15)

ANSWER:
Your answer A2 is correct. The chemistry requirements are additive.

QUESTION:
NACE Standard MR0175-2003 has two different highly alloyed austenitic SS families, one (Paragraph 4.4) with Ni% + 2 Mo% >30 (and Mo>=2%) and one (Paragraph 4.5) with PREN >40. Both have two different ranges for temperature, partial H2S partial pressure, and maximum chloride content. Which environmental limits have to be used for materials applicable for both categories like UNS S31254?

(MP INQUIRY #2003-19 Q1a)

ANSWER:
If UNS S31254 has a PREN >40, then the less restrictive environmental limits in Paragraph 4.5 apply.

**QUESTION:**
Paragraph 4.4 in MR0175 identifies "Highly Alloyed Austenitic Stainless Steels with Ni% + Mo>30 and 2% Mo minimum" as a category. Is it intended by the standard writers that the two conditions be both present? In other words, is it Ni% + Mo>30 with 2% Mo minimum? Or is the 2% Mo minimum another defined material group in the category? I believe it to be the former as I am not aware of highly alloyed austenitic stainless steels only defined by the term "2% Mo minimum."

*(MP INQUIRY #2003-20 Q1)*

**ANSWER:**
Paragraph 4.4 in NACE Standard MR0175 is a single alloy category defined by the additive requirements of Ni% + Mo% >30 and 2% Mo. Both requirements for chemistry must be met.

A.4, Table A.12

**QUESTION 1:**
What Types in Table A.12 cover UNS N08825?
*(MP INQUIRY #2015-08)*

**ANSWER 1:**
UNS N08825 meets type 4a and 4c in Table A.12.

**QUESTION 2:**
Is UNS N08825 resistant to sulfur without limitations on pH, temperature, pH2S and chloride? In the remarks column in Table A.13 the following is stated: “…some combinations of the values of these parameters might not be acceptable”. How should this be interpreted?

*(MP INQUIRY #2015-08)*

**ANSWER 2:**
Table A.14 currently states that Type 4c alloys including UNS N08825 are resistant to sulfur under any combination of conditions up to and including 132°C (270°F). Note that recent discussions in the Maintenance Panel have highlighted that the term “sulfur resistant” is not adequate (conservative) in itself and there is activity currently underway defining levels of resistance that are determined through three different test techniques and resultant 3 groups (#1 where successful tests were conducted using 1 g/l dissolved sulfur, #2 where there is direct exposure to solid sulfur – applicable below 110°C and #3 direct exposure to liquid sulfur – applicable for temperatures above 110°C). The user is cautioned that even though there are no environmental limits currently defined below 132°C for UNS N08825, there could be some combinations of parameters including elemental sulfur form (i.e. physically dissolved, solid or liquid) that may not be acceptable.
QUESTION:
I am looking for a definitive interpretation of NACE MR0175 concerning nickel-based alloys. My company produces alloy 20 (UNS N08020). The standard ASTM/AMS/UNS composition is listed in Table D3 on pg. 65 showing a Mo range of 2.0-3.0.

Section A.4 of MR0175 contains Table A.12--Materials types of solid solution nickel-based alloys. This table does not list any specific alloys, but it does list the minimum Mo (which I assume is for compliance with the standard) at 2.5%.

Does that mean that in order to certify our 20Cb3 to MR0175 the heat must have at least 2.5% Mo, even though the acceptable Mo range is 2.0-3.0?

If so, what is the impetus behind requiring a higher Mo range than is standard for the alloy?

(MP INQUIRY #2011-07)

ANSWER:
You are correct, a minimum of 2.5% Mo is required for N08020 to be compliant with Table A.12, material types 4a and 4c. Heats of N08020 not meeting the 2.5% Mo minimum may be acceptable as "Highly alloyed austenitic stainless steels" under the limits provided in Tables A.8, A.9, and/or A.11.

The 2.5% Mo restriction for N08020 is similar to the PREN restrictions for Duplex Stainless steels. The full chemistry ranges of the UNS numbers listed in the Annex D tables are for reference only.

QUESTION:
(Summary of an extended inquiry)
We produce a highly corrosion resistant NiMo 16 Cr 16 Ti alloy to the German TUV Specification 429 09.2002 Material No 2.4610. Could you please confirm that this material complies with the requirements for materials Types 4b and 4e of NACE MR0175/ISO 15156:2009 Part 3 Annex A Table A.12?

(MP INQUIRY #2014-01)

ANSWER:
If, in addition to the TUV specification, this material also satisfies the requirements of UNS N06455 with a minimum chromium content of 14.5%, it does comply with the requirements for Type 4b and 4e provided the metallurgical conditions defined in Table A.12 are also fulfilled.

Table A.13

QUESTION:
Is Alloy N06625 (Name - Alloy 625) material meet NACE MR0175/ISO 15156-3, Table A.13 if forged material is quenched off the hammer as opposed to performing a separate annealing?
ANSWER:
It is up to the Manufacturer to determine if alloy 625 is annealed under these conditions. It is not the role of the MP to answer metallurgical questions. If alloy 625 is annealed then it meets requirements of Table A.13.

QUESTION:
We have CW6MC and UNS06625 materials for use in valve components. It falls under the category 4a or 4b according to NACE MR0175 Part 3- table A.12. The heat treatment requirement for these solid solution nickel based alloys is mentioned in table A.13. The Chemical composition for these alloys is mentioned in table D.3 in NACE MR0175 Part 3, but there is no specific requirement for hardness in table A.13. For Solution annealed and cold worked condition Hardness is specified in NACE MR0175 Part Table-A.14.

Kindly clarify whether hardness is specified for solid solution nickel alloys in annealed or solution annealed condition (Table A.13)?

ANSWER:
There is no hardness limit requirement for Type 4a and 4b materials unless otherwise noted for specific alloys in ISO 15156-3 (2015) Table A.13. If Alloy 625 (wrought or cast solid-solution) is in the solution-annealed or annealed condition then it meets the requirements of Table A.13 (Ref: A Compendium of Inquiries and Interpretations for NACE MR0175/ISO 15156 – Inquiry #2009-02)

A.4.2, Table A.14 and A.33

QUESTION:
(a) NACE MR0175/ISO 15156-3, Sub-clause A.4.2, Table A.14 permits sulfur at 300°F in any H₂S partial pressure, but not at 425°F. Where, if anywhere, between 425°F and 300°F are alloys in this category sulfur-resistant? If an oil-company client has a well with bottom-hole temperature of 350°F with produced brine that contains sulfur, will an alloy like 2550 (UNS N06975) be sufficiently resistant, or (b) must C-276 (UNS N10276) be deployed?

ANSWER:
(a) In some cases the comparisons you make are not strictly valid because the data sets for the materials considered vary in the H₂S limits, in the temperature limits, and in the metallurgical limits that are imposed. It is thought that the limits given are conservative and further testing could demonstrate that the true limits are less restrictive than those shown.

ANSWER:
(b) UNS N10276 would be acceptable.
Table A.14

QUESTION:
We have some springs made from Alloy 625 which is exposed to a H2S environment. When we have tested the hardness on them they have been about 48-55HRC. The limit set in MR0175 for Alloy 625 is 40HRC (Part 3 Table A.14), so we exceed this value. However, the value of 40HRC is not specific for springs and when reviewing the harness limits for Elgiloy for springs the limit is 60HRC (Part 3 Table A.39), but Elgiloy for any equipment it is 35HRC (Part 3 Table A.38). I believe there is a similar story for other materials like X-750. My question is if Alloy 625 is used as a spring can a higher hardness than 40HRC be used for it?

(MP INQUIRY #2013-09)

ANSWER:
You are correct in that alloy 625 – cold worked alloy type 4d has a maximum hardness for any equipment or component of 40 HRC with the additional limitation of 150 ksi maximum yield strength per NACE MR0175/ISO 15156-5 Table A.14. Unfortunately, a spring-application condition of this alloy with higher hardness and strength level does not currently exist in the standard. Please refer to NACE MR0175/ISO 15156-3 Clause 6 and Annex B, use of this material in a spring hardness condition requires either (1) a successful ballot to include the alloy & condition in the standard, (2) laboratory qualification tests that demonstrate a successful application and this is reviewed and approved by the User for the intended application or (3) qualification by satisfactory field experience that is documented and meets the requirements of NACE MR0175/ISO 15156-1 especially Clause 8.2.

QUESTION:
1. NACE MR0175/ISO 15156 Table A.14 (Environmental and materials limits for annealed and cold worked, solid-solution nickel-based alloys used as any equipment or components) at the bottom indicates "The maximum hardness value for these alloys in these applications shall be 40 HRC."

2. ISO 13680 Table C.27 (Example for PSL-2 product mechanical properties at room temperature) indicates Mean Hardness Number of 33 or 35 HRC depending on the grade (Category 3).

These are vastly different values--I appreciate your thoughts.

(MP INQUIRY #2010-10)

ANSWER:
The MP can only answer about NACE MR0175/ISO 15156 Standard. The maximum hardness values correspond to the maximum hardness values of the tested materials. The MP cannot comment on hardness values from other ISO standards like ISO 13680.

A.4.3
See A.2.3, MP inquiry #2005-13
QUESTION:
This question relates to NACE MR0175/ISO 15156 Part 3, Appendix A, Paragraph A.4.3. Is the hardness testing survey required as part of the welding procedure qualification for solution heat-treated nickel-based alloys welded with solid-solution nickel-based weld metal? In accordance with A.4.3 there are no hardness requirements.

A.4.3 Welding solid-solution nickel-based alloys of this materials group. The requirements for the cracking-resistance properties of welds shall apply (see 6.2.2).

The hardness of the HAZ after welding shall not exceed the maximum hardness allowed for the base metal, and the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable.

There are no hardness requirements for welding solid-solution nickel-based alloys with solid-solution nickel-based weld metal.

Is the hardness testing survey required as part of the welding procedure qualification for solid solution nickel-based alloys (as addressed in NACE MR0175/ISO 15156-3, A.4) welded with solid-solution nickel-based weld metal?

(MP INQUIRY #2006-06)

ANSWER:
No.

A.5.1

QUESTION:
NACE MR0175/ISO 15156-3 section A.5.1 and Table D.5, concerning ferritic stainless steels, refer to “some alloys of this type” Given that Table D.5 is stated to not be all-inclusive, can I rightfully construe that any stainless alloy that meets the definition of “ferritic stainless steel” under definition 3.6 can be used under the conditions of Table A.17?

(MP INQUIRY #2013-10Q1)

ANSWER:
Yes, any stainless steel that meets the definition of "ferritic stainless steels" under 3.6 can be used under conditions of Table A.17.

QUESTION:
NACE MR0175/ISO 15156-3 sections A.2.1, A.3.1, and A.6.1 each forbid the use of their respective steels in “free-machining” grades. However, this requirement is notably lacking in section A.5.1 regarding ferritic stainless steels. Can I rightfully construe that there is no mistake here, and that free-machining ferritic stainless grades are therefore allowed under the conditions of Table A.17?

(MP INQUIRY #2013-10Q2)
ANSWER:
Even though not specifically stated in the current standard, no free machining ferrous alloys including stainless steels are acceptable. This applies also for ferritic stainless steels.

SUPPLEMENTARY INFORMATION
A search through historical answers to interpretations has revealed two instances where the interpretation has been that free machining covers all ferrous alloys including stainless steels and these are unacceptable; there have been no interpretations that have permitted the use of free machining steels including ferritic stainless steels. We will investigate wording changes through ballot or editorial means to clarify this.

A.6.2, Table A.18

QUESTION:
Material grade S41425 is listed as not being sulfur resistant in Table A.18 — “Environmental and materials limits for martensitic stainless steels used for any equipment or components”, ANSI/NACE MR0175/ISO 15156-3:2015(E). For the column ‘Sulfur resistant?’, it says ‘No’.
I wanted to confirm that was indeed a correct designation, and not an error.

(MP INQUIRY #2016-13)

ANSWER:
No and it is not a misprint.

QUESTION:
My inquiry concerns CA6NM: Earlier editions of the NACE standard contain a note stating that the hardness correlation in ASTM E 140 doesn’t apply to CA6NM and that for this material the maximum permissible value (in Brinell) is 255 BHN.

In NACE MR0175/ISO 15156-3, this statement is no longer used. However, Paragraph 7.3.2 of NACE MR0175/ISO 15156-2 stipulates that users can establish hardness correlations for individual materials. Please see below:

Quote
For ferritic steels EFC Publication 16 shows graphs for the conversion of hardness readings, from Vickers (HV) to Rockwell (HRC) and from Vickers (HV) to Brinell (HBW), derived from the tables of ASTM E 140 and BS 860. Other conversion tables also exist. Users may establish correlations for individual materials.

Unquote

Finally the questions:
Is CA6NM acceptable per MR0175/ISO 15156 at a hardness of max 255 BHN which has been (empirically) determined to be the equivalent of 23 HRC (but which on the ASTM E 140 scale corresponds to about 25 HRC)?
**ANSWER:**
The prescribed hardness limit of 23 HRC for CA6NM in Table A.18 in NACE MR0175/ISO 15156-3 utilizes the Rockwell C scale as the basis for acceptance. Conversions to other hardness scales are no longer included in the standard. Other hardness scales may still be used provided a correlation can be shown between the scale used and the prescribed Rockwell C scale for the particular material being tested. As stated in Paragraph 6.2.1 of NACE MR0175/ISO 15156-3, conversion between hardness scales is material-dependent. The ISO Maintenance Panel cannot make this conversion for you. The user may establish the required conversion tables.

**QUESTION:**
I have a question regarding NACE MR0175/ISO 15156-3. On Table A.18, the heat treatment requirements for CA6NM and F6NM are listed. Is this the only approved heat treatment? If we follow this heat treatment initially, are other heat treatments allowed as long as they do not exceed the original? We're trying to find out if a supplemental stress relieve is acceptable to try and lower the material hardness.

**ANSWER:**
Only the heat treatments listed are currently acceptable. Other heat treatments may be qualified in accordance with the requirements of NACE MR0175/ISO 15156-3 Annex B.

**QUESTION:**
In Part 3, A.6.2, Table A.18, under note a) it lists the cast equivalents of the wrought alloys (CA15, CA15M) but under note c) it says cast or wrought S42000 but does not mention the cast equivalent CA40. So, the question is: can I say UNS J91153 is compliant with NACE?

**ANSWER:**
Early versions of MR0175 did not include UNS S42000 in either the cast or wrought form but S41000 and the cast alloys CA15 and CA15M were included. Wrought S42000 was balloted in 1994. When ISO 15156 was being developed, the statement including "cast or wrought S42000" was added. There was previously a cast version of S42000 (J91201) but that has been withdrawn from the UNS numbering system. Since a cast version of S42000 was never balloted and the casting alloy your inquiry specifies (J91153) is chemically different from S42000, it is not correct to claim that J91153 meets ISO 15156-3. A ballot would be required to change this. See ISO 15156-3 Annex B for CRA testing and ballotling guidance. The ballot form is available on the ISO Web site www.iso.org/iso15156maintenance in the document "Introduction to ISO 15156 Maintenance Activities" Annex C.

A.6.2, Table A.18 and Table A.23
QUESTION:
Inconsistency between Table A.18 and A.23 of Para. A.6.2 in NACE MR0175/ISO 15156-3. Table A.18 allows martensitic stainless steels for any equipment or component, but Table A.23 excludes casing and tubing hanger and valve stems. What is the meaning of any equipment or component? Does any equipment or component from Table A.18 exclude casing and tubing hangers and valve stems?

(MP INQUIRY 2004-23 Q2)

ANSWER:
No, ISO 15156-3, Tables A.18 and A.23 set different H2S limits for the same selection of martensitic stainless steels. The other environmental limits are the same.

Table A.18 addresses the use of the materials under the environmental limits of this table. "Any equipment or component" includes wellhead and tree components and valve and choke components, and casing and tubing hangers and valve stems. Table A.23 allows the use of the same selection of materials for wellhead and tree components and valve and choke components under a less restrictive set of environmental conditions but excludes casing and tubing hangers and valve stems under these less restrictive conditions.

Please see Table 1 of NACE MR0175/ISO15156-3 for the list of equipment covered by this standard and also "General Remarks" under ISO 15156-3, A.1.6 of this "Inquiries and interpretations" document.

A.6.2, Table A.19

QUESTION:
Is the maximum hardness limit for ISO 11960 L-80 Type 13 Cr tubing used as a downhole tubular component, packer, and other subsurface equipment in accordance with NACE MR0175/ISO 15156 the maximum hardness as specified in the latest edition of ISO 11960?

Note: ISO 11960 is also designated as API 5CT.

Note: ISO 11960 currently specifies 23 HRC as the maximum hardness for L-80 Type 13 Cr tubing.

Discussion: NACE MR0175/ISO 15156-3, Table A.19 lists ISO 11960 L-80 Type 13 Cr and two other materials as begin acceptable for "downhole tubular components, packers, and other subsurface equipment."

There are notes in this table that specify the maximum hardness limits of the other two materials, individually. However, there is no note to specify the maximum hardness limit of ISO 11960 L-80 Type 13 Cr tubing.

This seems to indicate that ISO 11960 becomes the controlling document for L-80 Type 13 Cr, and therefore the maximum hardness for ISO 11960 L-80 13 Cr tubing is currently 23 HRC as specified in Table C.6 and Table E.6 of ISO 11960.
ANSWER:
Your interpretation is correct.

As a general rule during the preparation of ISO 15156, the unnecessary repetition of information provided in cited sources was avoided.

A.6.2, Table A.19, A.20 and A.21

QUESTION:
I need to clarify a confusion about NACE MR0175/ISO 15156-3.

Why are tubing and subsurface equipment in Tables A.19 and A.20, respectively, treated as two separate categories? Tubing itself is subsurface equipment so why is it treated separately? Moreover, K90941 as mentioned in Table A.20 is recommended for subsurface equipment under any H2S partial pressure but not for tubing, exposed to the same condition; why? L-80 type 13 Cr is more cracking-resistant material than K90941; still it is not recommended for subsurface equipment apart from tubing; why?

We are in a process of developing a sour gas field and purchased a copy of this standard to be a guideline for material selection. We need answers to these questions so we can select the most appropriate material for downhole casing/tubing.

ANSWER:
NACE MR0175/ISO 15156-3 reflects the experience of the oil industry and its experts in the use of materials in sour service over many years.

The separation of materials into Tables A.19, A.20, and A.21 allowed convenient grouping of the data available.

In some cases the differences you identify reflect the availability of different product forms manufactured from the different materials.

As indicated in the title of Table A.19, ISO 11960 L80 type 13Cr is acceptable for other subsurface equipment (other than tubing) providing the material fully meets the applicable material requirements of ISO 11960 L80 type 13Cr. Additionally as indicated in the title and notes of Table A.21, 420 (modified) having the chemical composition of ISO 11960 L80 type 13Cr is acceptable for packers and subsurface equipment.

In all cases the data presented reflect successful laboratory testing of an alloy or successful field experience with the alloy used in the product form listed.

For martensitic alloys not listed in Tables A.19, A.20, and A.21 qualification of the alloy for use in accordance with ISO 15156-3 can be carried out in accordance Annex B.
A.6.2, Table A.22

QUESTION:
In accordance with Table A.22 of NACE MR 0175 / ISO 15156-3 “Environmental and materials limits for martensitic stainless steels used as compressor components for compressor impellers in H2S-containing environments, S41500 steel is recommended. Please clarify the requirements of Notes "c" of Table 22, namely:
- in laboratory SSC tests, shall exhibit a threshold stress ≥95% of the actual yield strength (AYS);
- if the design stresses for the product are less than the actual yield strength (AYS) by a factor of 1.5, what stress level are allowed to be used in laboratory tests for SSC.

(MP INQUIRY #2017-08)

ANSWER:
Q: Regarding 15156-3 Table A.22 for UNS S41500, footnote "c" states if used for impellers, the alloy shall exhibit a threshold stress ≥ 95% of actual yield strength in the anticipated service environment. If the design stresses are less than the actual yield strength by a factor of 1.5, what stress level is allowed in laboratory tests to demonstrate compliance?
A: Table A.22 requires the 95% threshold stress of the actual yield strength with no provision for lower acceptable stress levels; product/component design stresses are generally not covered by NACE MR0175/ISO 15156. You may need to employ a consultant to assess the limits and how to assess for your material and intended application.

QUESTION:
In NACE MR0175/ISO 15156 -3, Table A.22 lists the "Environmental and materials limits for martensitic stainless steels used as compressor components." The maximum partial pressure requirement for H2S directs you to see Remarks, and the Remarks state "Any combination of temperature, partial pressure of H2S, chloride concentration and in situ pH occurring in production environments are acceptable."

Does this remark indicate that conformance to the NACE MR0175/ISO 15156 is required for any amount of H2S? I am looking for clarification as to what "acceptable conditions" is referring to. As a centrifugal compressor manufacturer, we often build compressors for process gases which are a hydrocarbon mix containing a few parts per million or trace amounts of H2S.

(MP INQUIRY #2010-06)

ANSWER:
Conformance to the Standard is required for any trace amount of H2S. In the case of Table A.22 the listed martensitic stainless steels can be used in any production environment provided they are in conformance with the metallurgical requirements indicated in the lower part of the Table. Note that item c) in Table A.22 requires a resistance in the anticipated service environment of at least 95% of the actual yield
strength of the impeller material using Annex B for laboratory testing. Qualification requirements to ISO 15156 are listed in §8 of NACE MR0175/ISO 15156-1.

Tables A.23 and A.24

**QUESTION:**
PM HIP materials are used in valve components. The reason we are doing this is that casting quality of high alloy material has been poor and lead times long. The required casting repair process is very expensive as well.

Our questions:
1. Do these PM HIP materials fulfill the standard requirements of sour service if they have the same chemical and mechanical properties and heat treatment as their wrought or forged counterparts?
2. Do the same environmental limits apply for PM HIP materials as specified for the corresponding wrought alloys in the referred tables?

**ANSWER:**
HIP materials have been separately listed so far as in Tables A.24 and A.33. Their resistance to sour service must be demonstrated by material qualification testing in accordance with ISO 15156-3 Annex B.

Table A.27

**QUESTION:**
With regards to using precipitation hardened stainless steel (typically UNS S17400, commonly known as 17-4 or 17-4 PH Stainless steel), the restriction of H2S partial pressure is 0.5 psi in some cases.

If a seal gasket (metallic seal ring) is made out of 17-4 stainless steel and used in an assembly, say for example, to be used in wellhead and christmas tree components, will the H2S partial pressure limitation of NACE MR-01-75/ISO 15156-3 2015, Table A27 still apply? If yes, then in that case, according to API 6A, the equipment will only be classified to a trim level of -0.5, like DD-0.5 or EE-0.5 etc.

Or
Will NACE MR-01-75 not apply to seal rings and gaskets which only gets loaded in compression (reference NACE MR-01-75/ISO 15156-1 and -2 2015, Table 1)?

**ANSWER:**
According to Table 1, loaded in compression is a permitted exclusion. For permitted exclusions, is it up to the manufacturer and the equipment users to evaluate any restrictions. If the component is not loaded in compression, all requirements in Table A.27 apply, including the restrictions of allowable stress in Note b. “The use of UNS S17400 is restricted to those applications where the sustained stress is no more than
50% of the specified minimum yield strength (SMYS) or 380 MPa (55 ksi), whichever is less. The use of UNS S17400 is acceptable for wellhead valve trim where the stem is subjected to higher stress levels for very short periods of time during actuation; other or longer stress duration applications are prohibited above 50% of the specified minimum yield strength (SMYS) or 380 MPa (55 ksi), whichever is less." Please note that Table A.27 has been changed in a Technical Circular, ANSI/NACE MR0175/ISO 15156-3 Technical Circular 2 (2018) and also included in ISO 15156-3:2020. The Maintenance Panel only interprets that standard and cannot give recommendations if the component is a permitted exclusion or not.

A.7.3


QUESTION:
This request is related to ISO 15156 / NACE MR0175 part 3, A.7.3 Welding of duplex stainless steels.

"The hardness of the HAZ after welding shall not exceed the maximum hardness allowed for the base metal, and the hardness of the weld metal shall not exceed the maximum hardness limit of the respective alloy used for the welding consumable."

Q1: In Table A.24 there are no hardness limit for solution-annealed and liquid-quenched or rapidly cooled duplex stainless steels. Does this mean that there is no defined hardness limit for the HAZ to be used for qualification of the welds?

Q2: Or, do the hardness limits given in relevant ASTM standards apply? E.g. ASTM A790/A928/A240.

ANSWER:

Q1: In Table A.24 there are no hardness limit for solution-annealed and liquid-quenched or rapidly cooled duplex stainless steels. Does this mean that there is no defined hardness limit for the HAZ to be used for qualification of the welds?

A1: It is correct that in Table A.24 there is no hardness limit for solution-annealed and liquid-quenched or rapidly cooled duplex stainless steels. Hence, there is no requirements for welds in NACE MR0175 / ISO 15156. It should be noted that NACE MR0175 / ISO 15156 does not list hardness limits for other causes than cracking mechanisms defined in the document. For other properties please consult the appropriate material standard or specification.

Q2: Or, do the hardness limits given in relevant ASTM standards apply? E.g. ASTM A790/A928/A240.

A:2 Advice regarding which other standard(s) that may apply for a particular product is not covered by NACE MR0175 / ISO 15156.
QUESTION:
The question is in regard to Appendix A.7 of NACE MR0175/ISO 15156-3. In A.7.3 third paragraph, it requires that "the microstructure ... shall have grain boundaries with no continuous precipitates". Is there any guidance as to what continuous means? For example, does it mean continuous throughout the microstructure?

Our laboratory has reported suspected continuous precipitates "at some locations".  

(MP INQUIRY #2005-18)

ANSWER:
There is no definition of "continuous precipitates" in the standard. An acceptance criterion or other quantitative limit shall be agreed between the manufacturer/supplier and the equipment user.

As noted in the WARNING above ISO 15156-3, Scope, it is the equipment user's responsibility to select the CRAs and other alloys suitable for the intended service. This responsibility includes the selection of specific quality requirements when none are given by the standard.

QUESTION:
ISO 15156-3, A.7.3--Regarding metallographic examination of the microstructure:

a) Do closely spaced spheroidal precipitates such as grain boundary carbides constitute continuous precipitates?
b) At what spacing would closely spaced spheroidal precipitates be considered continuous?
c) Are the quantification of precipitates (intermetallic phases, nitrides, carbides) to be evaluated as a volume fraction relative to the bulk sample?
d) In cases where only grain boundary precipitates are observed, is the quantification to be made as a volume fraction relative to the bulk sample or as a lineal fraction relative to grain boundary length?
e) In the absence of intermetallic phases and nitrides, does 1 vol.% represent the maximum allowable carbide precipitate content?
f) What is a suitable recommended practice or standard by which to perform this quantification?

(MP INQUIRY #2005-28)

ANSWER:
a), b), e)
For NACE MR0175/ISO 15156-3, A.7.3 it is the responsibility of the equipment user and the manufacturer to set the quantitative standard they wish to follow when this goes beyond the guidance given.

c), d), f)
It is the responsibility of the equipment user and the manufacturer to agree on the method and acceptance criteria for the measurement of precipitates.

QUESTION:
Query relating to ISO 15156-3:2015 Technical Circular 3:

“The statement has been added to Table A.24:
“No limits on pH are set, but some values might not be acceptable.”

Q1: “Could you please provide a formal explanation to this and clarify whether there are ranges of conditions (e.g. where Chloride content < 100000 mg/l and pH ≥ 4) where these materials would be acceptable with no need for testing.”

Q2: “Would ballot test reports be available for review?”

Subsequent followup question from inquirer:
“Thank you for your responses to the queries.

Would it be possible to expand on the response to question 1:

The new wording in Technical Circular 3 has a significant impact on materials selection for oil and gas installations: We have been using wrought and cast duplex stainless steels in H2S service within the limits of the current NACE standard with no service-related problems for over 20 years. The new wording casts doubt on suitability of these duplex product forms without corrosion testing to the maximum permitted conditions in each case. It also implies that qualification testing should be carried out for every new development, even when previously acceptable to the current standard. For example, based on the amended Table A.24, the use of a super duplex wrought product (40 <PREN≤45) in a H2S containing environment with a maximum design temperature of 100°C, a maximum H2S partial pressure of 5 kPa, a maximum chloride concentration of 50000 mg/l and a minimum pH of 4 (no free sulphur present) is no longer supported by ISO 15156-3:2015/Cir.3:2019. These relatively moderate process conditions would now have to be tested to prove full acceptability to ISO 15156-3:2015/Cir.3:2019.

If recent testing has identified conditions where there is potential for SSCC, would it be possible to limit the restriction, "No limits on pH are set, but some values might not be acceptable" to the extreme ranges only (e.g. very high Chloride content/ very low pH, or HIP only)?”

(MP INQUIRY #2019-06)

ANSWER:
A1: Table A.24 was updated when a ballot for HIP:ed material was introduced in the table. Wording such as the former in Table A.24 "Any combination of chloride concentration and in situ pH occurring in production environments is acceptable" is currently not used and replaced wording with a cautionary note such as the one used in Table A.24 in Technical Circular 3: "No limits on pH are set, but some values might not be acceptable." However, the intention is not to make changes in interpretation of which pH is acceptable and restrict the current use. It shall be noted that a limit on chloride content has been introduced in the Technical Circular. The Maintenance Panel cannot give advice on when there is a need for testing of a material.

Q2: “Would ballot test reports be available for review?”
A2: Please contact NACE Staff if you are interested in obtaining copies of the ballots.

Response to subsequent followup question: Please note that the Maintenance Panel only provides interpretations of the wording of the document and we cannot give consultancy or respond on comments. A change of the wording in the cautionary note requires a ballot.

A.8, Table A.26

QUESTION:
Material S66286 may be used according Table A.26. In the note is written “UNS S66286 shall have a maximum hardness of 35 HRC and shall be in either the solution-annealed and aged or solution-annealed and double-aged condition.”

According ASTM A638 and ASTM A453 is Grade 660 UNS S66286 and Grade 662 UNS S66220. But the heat treatment differs:
- (UNS S66286) ASTM A638 Grade 660 type 1 and 2 Heat treatment: solution-annealed and aged, see ASTM A638 Table 3
- ASTM A453 Grade A and B Heat treatment: solution-annealed and aged, see ASTM A453 Table 4
- ASTM A453 Grade C and D Heat treatment: solution-annealed and double aged condition, see ASTM A453 Table 4

(UNS S66220) ASTM A638 Grade 662 Heat treatment: solution-annealed and double aged condition, see ASTM A638 Table 3
- ASTM A453 Grade 662 A and B Heat treatment: solution-annealed and aged, see ASTM A453 Table 4

My questions:
1. Table A.26 I read that the table is for bolting (ASTM A453) and bar materials (ASTM A638). Is this correct?
2. If ASTM A638 is applicable and based on the note below the table, the table A.26 suggest that UNS S66220 (ASTM A638 Grade 662) is also applicable. Is this correct?

ANSWER:
Question 1: Regarding UNS S66286 and 15156-3 Table A.26, does this Table apply to bolting (ASTM A453) and bar (ASTM A638) materials?

Answer 1: The Table has no restrictions on product form. UNS S66286 is required by Table A.26 to be in the solution annealed and aged or solution annealed and double aged condition with a maximum hardness of 35 HRC.

Question 2: If ASTM A638 is included in 15156-3 Table A.26, then is UNS S66220 (Grade 662) also included in Table A.26.

Answer 2: 15156-3 Table A.26 only applies to UNS S66286; this Table does not include UNS S66220.
QUESTION:
What grade of stainless steel meeting NACE requirements can be used for a tubing hanger when the pH is <3.5?

My interpretation based on understanding of NACE MR0175/ISO 15156-3 Section A.8 Table A.26 is that only UNS S66286 is acceptable. Could you please confirm my statement or correct it?

(MP INQUIRY #2004-13)

ANSWER:
UNS S66286 is the only precipitation-hardenable stainless steel that is acceptable for tubing hangers in environments with pH <3.5. The martensitic stainless steels are also not acceptable for environments with pH <3.5.

QUESTION:
Table A.26 limits the precipitation-hardened austenitic steel UNS S66286 to 150°F and 15 psi H2S when chlorides are present.

a) Can this material be used at higher temperature if no chlorides are present?

(MP INQUIRY #2005-02 Qa)

ANSWER:
No, it may not. The table states that the temperature restriction is for "Any combinations of chlorides . . . " NACE MR0175/ISO 15156-3 does not define the expected performance of UNS S66286 in environments containing no chlorides.

QUESTION:
Does NACE MR0175/ISO 15156-3 Table A.26 apply to Gr. 660 material used in subsea bolting applications external to the production wellbore environment when indirectly heated above 150°F?

(MP INQUIRY #2005-09Q2)

ANSWER:
Table A.26 does not apply to Grade 660 material used in subsea bolting applications external to the production wellbore environment.

A.8.2, Table A.27

QUESTION:
We have a concern around potential conflicts between tables A.27 and A.28, in the context of the use of 17-4PH stainless steel for API 6A chokes, in terms of how we rate the choke (for example, EE 0.5).

Title of A.27 Environmental and materials limits for martensitic precipitation-hardened stainless steels used for wellhead and christmas tree components (excluding bodies
and bonnets), valves and chokes (excluding bodies and bonnets), and packers and other subsurface equipment

Title of A.28 Environmental and materials limits for martensitic precipitation-hardened stainless steels used as non-pressure-containing internal-valve, pressure-regulator, and level-controller components and miscellaneous equipment

Table A.27 has a limit for 17-4 of 0.5psi, while Table A.28 has no such limit. Our question is: for choke internal components, would we be bound by the restrictions of Table A.27, or Table A.28? Some of the choke internal components are non-pressure containing, so we are wondering if the more liberal allowance of Table A.28 would apply to them.

(MP INQUIRY #2018-08)

ANSWER:
We would like to clarify that we do not observe conflicting information between the content of ANSI/NACE MR0175/ISO15156-Parte 3:2015, Tables A.27 and A.28.

In Table A.27 a max H2S partial pressure limit of 0.5 psi is explicit for UNS S17400 (compliant with heat treatments as described under bullet “a” in the table notes) for production environments with pH ≤ 4.5 applicable to wellhead and Christmas tree components (excluding bodies and bonnets), valves and chokes (excluding bodies and bonnets), and packers and other subsurface equipment.

In Table A.28 no such limit is explicit for UNS S17400 compliant with information detailed under bullets “a” and “b” in the table notes and Remarks detailed in the last column of the table for non-pressure-containing internal-valve, pressure regulator, and level controller, and miscellaneous equipment.

It is up to the agreement between the end user and the manufacturer to establish the applicability of the H2S partial pressure limit in Table A.27 or any other suitable limit to the non-pressure containing components within the choke internals for their particular application. End user and manufacturer should agree if any experimental evaluation is required to demonstrate that the combination of H2S partial pressure, temperature and chlorides is acceptable for their specific application.

QUESTION:
Based on NACE paper 03133, the cause of failure of UNS N07750 was identified as sensitization of the material when it was exposed to a temperature of around 2000°F and cooled slowly. The paper points to the lack of defined quality control procedures, specifically the definition of Solution Heat Treatment. This no longer seems to be the case as Table A.27 of NACE MR0175-3 lists very specific heat treating process requirements for UNS S17400.

If the heat treatment of UNS N07750 were properly controlled per a well-defined standard such as AMS 5667, would this material be acceptable for qualification by lab testing or field experience?
Or are there additional causes to doubt this materials ability to resist hydrogen embrittlement or SSC?

(MP INQUIRY #2016-16)
ANSWER:
Question 1: If the heat treatment of UNS N07750 were properly controlled per a well-defined standard such as AMS 5667, would this material be acceptable for qualification by lab testing or field experience?
Please review Clause 6.1 of ISO 15156-3. You may test in accordance with Annex B of ISO 15156-3 and, with successful tests, the alloy would be acceptable for use with the agreement of the end-user for the application. The documentation requirements for these tests shall be in accordance with ISO 15156-1 Clause 9. You may also use field experience noting the requirements of ISO 15156-1 Clause 8.2 with the documentation requirements of Clause 9.

NACE Corrosion 2003 Conference Paper 03133 demonstrated a sensitization of X750 alloy at grain boundaries as the root cause of embrittlement. Question 2: are there additional causes to doubt this materials ability to resist hydrogen embrittlement or SSC?
There are known cases of embrittlement in this alloy due to hydrogen charging. We do not know whether some or all the reported instances were due to sensitization.

QUESTION:
Reference: NACE MR0175/ISO 15156-3 Table A.27--Environmental and materials limits for martensitic precipitation-hardened stainless steels used for wellhead and christmas tree components (excluding bodies and bonnets), valves and chokes (excluding bodies and bonnets) and packers and other subsurface equipment

API 6A makes a distinction between hangers and body components. NACE MR0175/ISO 15156 doesn't define either. This has led to some confusion regarding whether or not UNS S17400 material may be used as hangers in a sour environment.

Q1. Does the exclusion of wellhead "bodies and bonnets" in Table A.27 also mean that hangers are excluded?

Q2. Are hangers considered "subsurface equipment" in the context of Table A.27?

Q3. Does Table A.27 prohibit the use of UNS S17400 material for hangers in sour service?

(MP INQUIRY #2005-12)

ANSWERS:
A1. No, it does not.

A2. In the context of Table A.27, hangers are more commonly considered to be covered by the term "wellhead and christmas tree components."

A3. No, it does not provided the environmental limits and metallurgical requirements of Table A.27 are followed.

See also response to MP Inquiry #2006-07 posted under ISO 15156-3, Table A.3.
We have a requirement to supply NACE-compliant control valves for the oil and gas industry. One of our internal components is a part made from UNS S17400 (17-4 PH), details of which are described in Table A27 of Part 3 of the standard.

NACE MR0175/ISO 15156-3 states this material should have a maximum hardness of 33 HRC, after one of the following heat treatment processes:

**HEAT TREATMENT (DOUBLE AGE-HARDENING PROCESS)**
1) - SOLUTION-ANNEAL AT 1040±14°C AND AIR COOL OR LIQUID-QUENCH TO BELOW 32°C;
   - FIRST PRECIPITATION-HARDENING CYCLE AT 620±14°C FOR 4 HRS MINIMUM AT TEMPERATURE, THEN AIR-COOL OR LIQUID-QUENCH TO BELOW 32°C;
   - SECOND PRECIPITATION-HARDENING CYCLE AT 620±14°C FOR 4 HRS MINIMUM AT TEMPERATURE, THEN AIR-COOL OR LIQUID-QUENCH TO BELOW 32°C
2) - SOLUTION-ANNEAL AT 1040±14°C AND AIR COOL OR LIQUID-QUENCH TO BELOW 32°C;
   - FIRST PRECIPITATION-HARDENING CYCLE AT 760±14°C FOR 2 HRS MINIMUM AT TEMPERATURE, THEN AIR-COOL OR LIQUID-QUENCH TO BELOW 32°C;
   - SECOND PRECIPITATION-HARDENING CYCLE AT 620±14°C FOR 4 HRS MINIMUM AT TEMPERATURE, THEN AIR-COOL OR LIQUID-QUENCH TO BELOW 32°C.

Ultimately we are trying to establish if these components are still compliant and if not, what we can do to rework the parts. Other materials such as 316 state an annealing process, but there is not one for UNS S17400. In addition, the components are “delicate” in design so post-machining heat treatment is probably not desirable due to component distortion.

What does the hardness of 33 HRC refer to, wrought bar or finished component?

What, if anything, can we do to rework these parts if the hardness value refers to the finished (machined) condition?

**ANSWER:**
The 33 HRC max. hardness is applicable to the finished component. The MP does not provide consulting service for material processing issues.

**A.8.2, Tables A.27, A.28 and A.30**

**QUESTION:**
Use of SST 17-4 PH UNS S17400 material for NACE is listed in NACE MR0175/ISO 15156-3, Tables A.27, A.28, and A.30. Only Table A.27 contains limitations for partial pressure \( \text{H}_2\text{S} \) and PH.

Questions:

(1) For surface safety relief valves with internal components made of SST 17-4 PH heat treated and hardness tested to limits specified, do the limits of Table A.27 or A.28 apply? Internal components are considered non-pressure retaining by definition 3.4 in Part 2. However, failure of an internal component can cause release of service fluid to the valve outlet. It is assumed for NACE applications that safety relief valves for NACE service would not be vented to atmosphere.

(2) Does Part 3 Table A.28 only apply to subsurface equipment or does it apply to all valves?

**ANSWER:**
The equipment user is responsible for defining the intended service environment and selecting materials in accordance with this standard.

**A.8.2, Table A.28**

**QUESTION:**
Can you provide clarification on NACE MR0175/ISO 15156-3, Table A.28: “UNS S17400 … has been used in service tool applications at the surface when stressed at less than 60% of its minimum specified yield strength under working conditions.” This Table also lists “Internal Components for Valves, Pressure Regulators, and Level Controllers”. What exactly do service tool applications encompass?

**ANSWER:**
This paragraph is intended to apply to components that are temporarily installed at the surface as part of routine well servicing. For example, components of wireline valves used during a wireline job are considered as service tools.

**A.8.2, Table A.30**

**QUESTION:**
NACE MR0175/ISO15156-3, Table A.30: Are wrought UNS S17400 and S15500 martensitic precipitation-hardenable stainless steels that meet the hardness and heat-treat requirements of this Table acceptable for use in compressors in sour environments with no environmental limits with respect to chloride content, partial pressure of \( \text{H}_2\text{S} \), temperature, and free elemental sulfur?

**QUESTION:** If the answer to the former question is no, what are the specific environmental limits?

**ANSWER:**
Yes, they are acceptable with no environmental limits in accordance with NACE MR0175/ISO 15156 Table A.30. No data have been submitted to verify resistance to cracking in the presence of elemental sulfur.

A.9

QUESTION:
Inconel X750 (UNS N07750) is a precipitation hardened nickel based alloy that is listed in tables A.35 and A.36 as a valid material for non-pressure containing components and springs.
This material was previously listed in NACE MR0175-2002 as an approved Nickel-Chromium alloy. It is still listed in NACE MR0103 as an approved precipitation-hardenable Nickel alloy.

a) Is the correct interpretation that this material is prohibited from use as a pressure boundary component for any NACE MR0175 application under any conditions?
b) If yes, can you provide any explanation for why it was removed? Was there testing or a ballot submittal to justify its exclusion?

(MP INQUIRY #2016-15)

ANSWER:
Question 1: Is the correct interpretation that this material is prohibited from use as a pressure boundary component for any NACE MR0175 application under any conditions?

Answer: Yes, that is the correct interpretation.

Question 2: If yes, can you provide any explanation for why it was removed? Was there testing or a ballot submittal to justify its exclusion?

Answer: The alloy was removed in the NACE MR0175 2003 rewrite and this was carried over in NACE MR0175/ISO 15156 in 2003. We cannot provide a definitive answer as to why it was removed but we know that the alloy is susceptible to hydrogen embrittlement and there have been some failures with the alloy. Please review the subject in “H2S Corrosion in Oil & Gas Production: A Compilation of Classic Papers, NACE, 1981” and NACE Corrosion 2003 conference paper 03133.

A.9 Table A.31

QUESTION:
Regarding precipitation hardened Nickel based alloys, Tables A.31 to A.34 all have the heading ‘Environmental and materials limits for precipitation-hardened nickel-based alloys used…….’ The heading gives the impression that all materials listed in the Tables A31. to A.34 are precipitation hardened type Nickel based alloys only, however in the notes sections in the Tables, the alloys are allowed to be in other conditions i.e. in Table A.32, wrought UNS N07718 is allowed to be in four different heat treated conditions including a solution-annealed condition, and a hot-worked condition (both of these conditions do not involve any age / precipitation-hardening). If a Nickel alloy does not have any age / precipitation-hardening heat treatment applied
to it, does this not make it a solid-solution type alloy, and therefore should be covered by Tables A.12 to A.16 of the NACE standard instead?

(MP INQUIRY #2016-08)

**ANSWER:**
Question: If UNS N07718 precipitation hardened nickel base alloy in NACE MR0175/ISO 15156-3 is in the solution annealed condition, is this Table A.32 still applicable or should it be considered a solid solution nickel base alloy and Table A.14 would be applicable?

Answer: UNS N07718 is considered to be a precipitation hardened nickel base alloy regardless of the heat treated condition; Table A.32 is the applicable Table as opposed to Table A.14.

**A.9.2, Table A.32**

**QUESTION:**
Our question relates to ISO 15156-3, Table A.32:
How should the table be interpreted in terms of the maximum allowable temperature for applications with less than 30 psi partial pressure of H₂S?

For example, in its current layout the table prohibits the use of UNS N07718 at temperatures higher than 450°F at any H₂S pressure below 30 psi.

(MP INQUIRY #2005-20)

**ANSWER:**
ISO 15156-3, Table A.32 does not qualify UNS N07718 for use at higher temperatures than 450°F.

The limits on temperature, H₂S, Cl⁻, pH, and sulfur defined in some of the tables of ISO 15156-3, Annex A apply collectively and reflect the knowledge available, usually from laboratory tests, at the time the standard was published. There were no data available related to the use of UNS N07718 at any temperature higher than 450°F.

ISO 15156 allows the qualification and use of materials, to an equipment user's requirements, outside the limits stated in the tables. (See ISO 15156-3, Figure B.1, Column 2.)

A qualification to define an alternative temperature limit for UNS N07718 for a partial pressure of H₂S less than 30 psi must be carried out in accordance with ISO 15156-3, Annex B.

**QUESTION:**
We are having some discussions with a user who tells us that Table A.32 ‘Environmental and materials limits for precipitation-hardened nickel-based alloys used for any equipment or component’ can be referred to for spring materials, and therefore Inconel N07718 can be used for spring as long as it is solution-annealed and aged to a maximum hardness of 40 HRC.
However the Table A.36 ‘Environmental and materials limits for precipitation-hardened nickel-based alloys used as springs’ does not list N07718.

How should I interpret these tables for nickel-based alloys springs? Can I follow table A.32?

(MP INQUIRY #2013-03)

**ANSWER:**

Materials listed in 15156-3 Table A.32 are acceptable for “any equipment or component” including springs. Other materials from other “any equipment or components” tables may also be acceptable for springs if used within the metallurgical and environment limits specified in the applicable tables.

**QUESTION:**

“we are having some in-house discussion with Nace MR0175 requirement for springs in Inconel X718 (N07718), that Table A.32 ‘Environmental and materials limits for precipitation-hardened nickel-based alloys used for any equipment or component’ can be also referred to spring materials, and therefore Inconel N07718 can be used for springs as long as it is solution-annealed and aged to a maximum hardness of 40 HRC.”

Q1. “Is the interpretation correct that springs made of Inconel X718 may be used acc. to table A.32, although this material is not listed in Table A.36?”

Q2. “If yes, can springs only be used up to a maximum hardness of 40HRC acc. to table A.32, or just as specified for X750, up to a maximum hardness of 50HRC?”

Q3. “Is there an official agreement/statement on how to proceed with springs in material Inconel X718 according to Nace?”

(MP INQUIRY #2019-08)

**ANSWER:**

A1. Table A.32 lists materials that can be used as any equipment or component which includes spring materials if the spring comply with all requirements in Table A.32. Please note that the final component, in this case the spring, must meet the requirements in Table A.32. Table A.36 lists materials that can be used as springs within the metallurgical and environment limits specified in the table. Ref (MP INQUIRY #2013-03)

A2. The hardness requirements in each table are restricted to the material listed and environment limits specified in each table.

A3. No, the standard is the official information regarding ANSI/NACE MR0175 / ISO 15156. The equipment user is responsible for defining the intended service environment and selecting materials in accordance with this standard. It is the manufacturer’s responsibility to meet the metallurgical requirements of the appropriate alloys in ANSI/NACE MR0175/ISO 15156. It is up to the agreement between the end user and the manufacturer to ultimately establish the applicability of requirements in Table A.32 for their particular intended use. The end user and manufacturer should
agree if any experimental evaluation is required to demonstrate suitability of the materials/component for the intended service.

Table A.39

QUESTION:
The main obstacle we foresee is that in Section A.10 Table A.39, Environmental limits for cobalt-based alloys used as springs, we see that the requirements for UNS R30003 are:
- Shall be cold worked
- [Shall be] age-hardened
- [Shall be] maximum 60 HRC
- This requirement means, in our interpretation, that after the cold working, and age hardening, we must be able to prove that the HRC hardness of the end product falls at or below 60 HRC.
- This presents a problem – due to the geometric constraints of spring design, the area presented for hardness examination can be both very narrow and thin. This drives testing to either Knoop or micro-Vickers hardness. This means we are relying on a conversion, like ASTM E140 Table 3, to approximate hardness. ASTM very clearly states that converted values are approximate, and may not be accurate.
- ASTM E140 also lacks a conversion table that covers high nickel alloys in the range up to 60 HRC.

So, my question to you is,
In what way is conformance to NACE MR0175:3 Table A.39 able to be assessed, for springs of small cross section which cannot be tested with the standard 150kgf HRC hardness test?

Additionally, can the material also be considered compliant without age-hardening?
Are there corrosion issues related to non-age hardened cobalt alloys?

(MP INQUIRY #2017-07)

ANSWER:
Q1: Regarding 15156-3 Table A.39 for UNS R30003, we believe that the limitations for the alloy as springs are (1) shall be cold worked, (2) shall be in the age-hardened condition and (3) shall have a maximum hardness of 60 HRC.

A1: Your interpretation is correct.

Q2: How do we prove compliance to the 60 HRC limit when (1) the geometry prevents use of HRC and (2) suitable hardness measurements such as Vickers (DPH) or Knoop can be used but there are no published conversion Tables such as ASTM E140 that apply to this alloy/hardness range?

A2: This is outside the scope of NACE MR0175/ISO 15156 but there is no prohibition from you developing hardness conversions based on test data. You may need to employ a consultant to help you with this.
Q3: Additionally, can UNS R30003 also be acceptable in the cold worked condition without age-hardening? Additionally, are there any corrosion issues with the non-age hardened cobalt base alloys?

A3: There was a recent successful ballot to NACE MR0175/ISO 15156-3 Table A.40 that once published will permit the use of the UNS R30003 in both the cold worked and the cold worked + aging conditions. However, Table A.39 does not include the as cold worked condition without subsequent age hardening. The inclusion of this as-cold worked condition to Table A.39 would require a successful ballot to NACE MR0175/ISO 15156. Regarding the corrosion comparison between age hardened and non-age hardened cobalt base alloys, we cannot provide consulting services. You may need to employ a consultant.

QUESTION:
1) Does NACE MR0175 / ISO 15156 apply when areas of a spring are plastically deformed (not more than 1 or 2% strain)?

2) Why does NACE MR0175 / ISO 15156, Part 3 specifically demand age-hardening although age-hardening typically increases the hardness of UNS R30003? Is this because problems were reported when the material was not age-hardened, because data is only available for age-hardened material, or another reason?

(MP INQUIRY #2009-05)

ANSWER:
1) NACE MR0175/ISO 15156 does not apply to design made with plastic deformation criteria, as written in Paragraph 5 of Part 1. Qualification through testing or field experience may be used to qualify this type of design but this will be outside the limits of the standard.

2) In Table A.39 the cold worked + age hardened condition of UNS R30003 was the only condition originally balloted and accepted.

A.12

QUESTION:
I have a couple of question for committee ISO/TC 67, with respect Table A.12 of the Standard NACE MR 0175/15156-3
1.- Materials types in Table A.12 only consider nickel based alloys indicated in Table D.3 or others nickel alloys can be considered (for instance CAST CX2MW-UNS N26022)?
2.- Solution annealed casting as metallurgical condition should be considered in Table A.12 or Table A.14?

(MP INQUIRY #20108-07)

ANSWER:
Question 1: Materials types in Table A.12 only consider nickel based alloys indicated in Table D.3 or others nickel alloys can be considered (for instance CAST CX2MW-UNS N26022)?

Answer 1: Annex D is informative and not meant to be all encompassing as long the material being considered meets the specific requirements laid out in the document

Question 2: Solution annealed casting as metallurgical condition should be considered in Table A.12 or Table A.14?

Answer 2: Table A.12 describes the alloy types based on chemical composition and depending on the specific alloy type and application, all applicable requirements (including metallurgical state) are prescribed in Tables A.13 and A.14.

**QUESTION:**
Because UNS C72900 and C96900 are copper alloys, are they, by definition, covered by NACE MR0175/ISO 15156-3, A.12 which basically states copper alloys are suitable for use without restriction other than as noted in the footnote, which informs the user that such materials may exhibit accelerated general weight-loss corrosion in some sour environments?

**ANSWER:**
Yes, the UNS C72900 and UNS C96900 copper alloys are included in NACE MR0175/ISO 15156-3, A.12.

**QUESTION:**
“My question is related to the Alloy Type 4e (as defined in Table A.12) pH2S, pH, T limits.

Table A.14 indicates that at 132°C any combination of hydrogen sulfide, chloride concentration, and in situ pH in production environments is acceptable for Cold-worked alloys of types 4c, 4d and 4e complying with the hardness (40HRC) and strength (180ksi) requirements indicated into the related notes”

“Does the “any” may contains some upper limits for Type 4e at 132°C? Could the panel offer some guidance?”

**ANSWER:**
You are correct in that Alloy Type 4e compliant with the metallurgical condition described in Table A.12 as well as maximum hardness and yield strength limits specified in the notes of Table A.14 up to a max T of 132 °C has environmental limits as specified in the remarks column of Table A.14: “Any combination of chloride concentration and in situ pH occurring in production environments is acceptable.” The information reflects the knowledge available, usually from laboratory tests or service experiences, at the time the standard was published and it is the user's responsibility to verify that the material is acceptable for the intended service.
The Maintenance Panel cannot answer questions for environments outside production environments.

**QUESTION:**
From ISO 15156-3 Section A.12 as shown below it is stated that some copper alloys are sensitive to GHSC.

Is it up to the material manufacturer to determine if GHSC is an issue?

Are there any defined tests? Something similar to e.g. ASTM F519?

We have not been able to find parameters that would exclude certain copper alloys, and help narrow the material selection.

**ANSWER:**
It is correct that note 2 in Section 2 of ISO 15156-3 says that some copper alloys are sensitive to GHSC. Since ISO 15156 gives no further information and a note is informal, it is up to the materials producer, in agreement with the equipment user, to determine whether GHSC can occur.

In Annex B, section B.8, the test method for GHSC in ISO 15156 is described, and it is up to the materials producer, in agreement with the equipment user, to judge if this test method is appropriate.

**A.13.1**

**QUESTION:**
The first sentence of Clause A.13.1 states:
“The materials listed and defined in Clauses A.2 to A.11 may be used as corrosion-resistant claddings, linings or as weld overlay materials.” The fifth paragraph of Clause A.13.1, as stated below, recognizes that dilution of the weld metal with the substrate occurs during welding.
“Dilution of an overlay during application that can impact on its corrosion resistance or mechanical properties should be considered.”

Discussion: While the composition of a starting filler metal electrode may meet the composition requirements of an applicable UNS alloy listed in Clause A.2 to A.11, the as-deposited filler metal may be diluted (as noted in the fifth paragraph of A.13.1) to the point where it no longer falls within the applicable UNS alloy’s composition range. For example, a starting electrode for a 625 weld overlay may meet the composition requirements of UNS N00625, but API 6A, 625 overlay made to class FE10 allows an iron content in the as-deposited filler metal of up to 10.0% which exceeds the 5.0% maximum iron limit in UNS 06625.
Q1: “Does the as-deposited filler metal have to comply with the UNS composition of the starting electrode?”

Q2: “If the answer to Q1 is yes, then what locations within a weld must meet the UNS composition allowing for some dilution?”

Q3: “Does a 625 overlay made to the prescribed API 6A requirements for FE10 meet NACE MR0175/ISO 15156?”

(MP INQUIRY #2013-02)

ANSWER:
A1. ISO 15156-3 does not state anything specific about the composition of the as-deposited filler metal. It does state that dilution can affect the corrosion resistance. The purpose of an overlay has historically been for corrosion resistance and not cracking resistance. If the enquirer wishes to consider the overlay as a barrier for cracking resistance, a ballot is required to define cracking limits for a specific as-deposited composition for a defined location within the weld.

A2. This issue is not addressed by this standard. See answer to Q1.

A3. The standard does not define the cracking limits for as-deposited filler material beyond the UNS compositions. See answer to Q1.

QUESTION:
Further to the interpretation responses given to MP Inquiry #2013-02, is it to be taken that the heat treatment condition of the as deposited weld metal, that will also not comply with heat treatment requirements for certain materials listed in A.2 to A.11, will result in the same response, i.e. the cracking resistance is not addressed in the standard? If this is the case, should a note not be added to the standard to suggest to users that, if they are also seeking cracking resistance for the deposited weld overlay, then they should be looking to an Annex B methodology, or a documented field experience basis, to qualify the cracking performance?

(MP INQUIRY #2021-05)

ANSWER:
It is correct that NACE MR0175 / ISO 15156-3 does not address the cracking resistance for as deposited materials, including impact of heat treatments. If the Inquirer wishes to consider the overlay as a barrier for cracking resistance, a ballot is required to define cracking limits for a specific as-deposited composition for a defined location within the weld.

Testing according to Annex B or the use of documented field experience according to NACE MR0175 / ISO 15156-1 clause 8.2 should be performed.

Addition of a note to the standard will require a ballot. Ballot form and instructions can be found here - LINK.
Annex B

B.8

QUESTION:
Can you confirm our company’s interpretation of the testing described in ANSI/NACE MR0175/ISO 15156-3:2009 Annex B, Section B.8? Our interpretation is that the GHSC testing described in B.8 is for qualification of CRA’s for H2S-service by laboratory testing; this testing in B.8 is qualification testing for including the CRA in the standard and it is not intended to be routine/quality control testing that must be performed on every heat of CRA that is produced at a mill.

ANSWER:
Section B.8 defines the additional requirements/changes to SSC testing for GHSC testing. There is no implied limitation on the application of these tests. The type of tests and the frequency of “periodic” testing to confirm the resistance to cracking for quality control purposes is not defined in ANSI/NACE MR0175/ISO 15156-3 and, these tests, if required, shall be agreed between the manufacturer and the purchaser. The subject of production route qualification is covered in Section B.2.3 “Qualification of a defined production route”.

Annex D

Table D.2

QUESTION:
I would like to focus your attention in the phosphorus composition of the J93254 (CK3MCuN). According to table D.2 in NACE MR0175/ISO 15156-3:2015, it is 0.45, whereas in ASME SA351 table 2, it is 0.045. It might be a mistake.

ANSWER:
NACE MR0175/ISO 15156-3, Appendix D is informational. We will correct the error upon review in the next opportunity. Changes to Appendix D are considered to be editorial in nature.

QUESTION:
It is our understanding of NACE MR0175/ISO 15156 that provided ASTM A 995 Grade 4A (UNS J92205) 22 Cr duplex stainless steel complies with the material limits of Table A.24 of Annex A, it can be selected for use in H2S-containing environments provided the environmental limits given in Table A.24 are not exceeded.

ANSWER:
Your understanding is correct.
Q2 It does not ALSO have to be listed in Annex D Table D7, which we believe is for information only and lists only SOME duplex stainless steels.  

(MP INQUIRY #2006-04Q2)

ANSWER:  
You are correct.

Table D.3

Inquiry: UNS N08029 seamless tube is specified in ASTM B668-14. According to ISO 15156-3 Table A.12, UNS N08029 belongs to materials type 4c. However the material is not included in ISO 15156-3 2015 Annex D, Table D.3 - Chemical compositions of some solid-solution nickel-based alloys. Based on our testing using constant load and SSR (at least duplicate specimens), this material passed the tests in the sour environments outside of the limit for material type 4c.

Question 1: What would be done in order to include UNS N08029 in standard ISO 15156-3, Annex D, Table D.3?

Question 2: We are thinking of additional testing, to propose new limit through NACE Ballot. Are the data points "A" and "B" enough for extending the acceptable limit to the yellow area in the attached figure?

Question 3: Is one of the testing methods enough to propose the new limit, using constant load or SSR per NACE TM0177 or MR0198?

Question 4: Is 1 g/l sulfur ok to represent the environment with elemental sulfur? 

(MP INQUIRY #2016-14)

Answer 1: Table D.3 is an informative table and adding a material that complies with type 4c is not a technical change. This can be added to the document at the next opportunity or Technical Circular at your request once a formal request for the editorial change is submitted.

Answer 2: Please refer to 15156-3 Annex B especially B.2.4. To extend the limits, you will need test data (in accordance to B.3 and for applicable cracking mechanisms in Table B.1) from a minimum of three separately processed heats. Since the alloy is cold worked to achieve mechanical properties note that B.3.2.c states that the following shall be considered “the directional properties of alloys because cold-worked alloys may be anisotropic with respect to yield strength and for some alloys and products, the susceptibility to cracking varies with the direction of the applied tensile stress and consequent orientation of the crack plane”.

Answer 3: Please refer to B.3.3. Generally, constant load tests are preferred for homogeneous materials. For constant load and constant displacement (constant
deformation) tests, a test duration between 90 and 180 days should be considered. You can augment the data with SSRT test results.

**Answer 4:** This has been one of subjects recently discussed in the Maintenance Panel. The requirements for testing with elemental sulphur have not been fully defined but use of 1 g/L S0 is severely limiting. Please see NACE Corrosion 1995, Paper 47 for more details and guidance as to the appropriate methodology which will depend on the expected physical state of the elemental sulfur for the application conditions.

**QUESTION:**
For the interpretation question of NACE spec MR0175-3, table D.3 Inco 625 alloy chemistry. I believe it is a "typo" but need your concurrence or interpretation if it is not a "typo".

Table D.3 as attached below lists Inco 625 chemistry as Nb max weight % 3.15 to 4.15. Typical Inco 625 would have Tantalum in addition to Niobium and typical mill chemistry would specify Nb + Ta as 3.15 % to 4.15 % instead of Nb only. Industry standard spec ASTM B446 chemistry for Inco 625 bars specifies Nb + Ta as 3.15 to 4.15% instead of Nb only.

So the question to you (or to NACE) is as follows:

1. Is it a "typo" in the NACE spec and it should be interpreted as Nb + Ta as 3.15% to 4.15% instead of Nb only as specified in the MR0175 spec?

2. If it is not "typo", is there any technical reason why Tantalum would not be accepted as part of standard Inco 625 chemistry?

**ANSWER:**
1) No. 15156-3 Annex D is an INFORMATIVE annex. ISO 15156 specifies material requirements for specific material groups or UNS numbers. The chemistries of these UNS numbers are established by the international standards organizations that maintain the UNS. Annex D lists chemical composition data using the values and elements defined by UNS. It should be noted that the compositions listed in Annex D have no effect on the NORMATIVE composition limits in Table A.12.

2) The scope of the MP is limited to interpretation to wording in ISO 15156. The technical reason for tantalum not being included in Annex D for UNS N06625 is, as stated above, the standard adopted the UNS chemistries.

**QUESTION:**
“The UNS N08028 Ni range is 30.0-34.0. In Table D.3, Ni of N08028 is listed at 29.5-32.5. Could you tell me why there is a difference between UNS and Table D.3?”

**ANSWER:**
Please note that Annex D is informative and Section D1 states that the user is encouraged to check the accuracy of the information. MP cannot answer any historical
questions if there was a deviation when Annex D was originally made. Since Annex D is informative, an eventual change in the SAE-ASTM standards is not monitored. This may result in Annex D not being updated. It should be noted that the compositions listed in Annex D have no effect on the NORMATIVE composition limits. The Ni-range of UNS N08028 in ISO 15156 is an error. The UNS composition is the correct one.