ISO 21457 Materials selection and corrosion control for oil and gas production systems

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Basis

- The NWIP (N977) was circulated 2007-02-23 and was approved 2007-05-25, as ISO 19910.Later changed to ISO 21457.)

Nominated persons from each country:

- Brazil: Luciana Farias Hörlle, Jeffrey Lowe, Petrobras.
  Arlindo Charbel, ABNT (Secretary)
- France: Thierry Cassagne, Total. (Ed Valentine)
- Italy: Tiziana Cheldi, Eni.
- Japan: Tsuneaki Kobayashi, JISF Standardization Center
- Netherlands: Ken Welsh, Shell.
- Norway: Ragnar Mollan, StatoilHydro (Convenor) Stein Olsen, StatoilHydro
  Ola Farstad, Consultant to StatoilHydro
- Qatar: Saif S. Al-Naimi, Qatar Petroleum
- United Kingdom: Andrew Leonard, BP Raman Patel, HSE
- United States: Peter Sandy, Marathon Oil,Maarten Simon-Thomas, Shell (Bruce Miglin) Richard Thompson, Chevron (John Farraro), Michael Surkein, ExxonMobil Gary Devlin, Cameron (Rick Faircloth)

Objective – ISO/NP 21457

- Better quality and more cost effective solutions.
  - Less manhours used in projects, both by oil company and engineering contractors.
  - Less need for company and project specifications.
    - By implementing the materials requirements currently used by the industry in the standards, the need for material requirements in company and projects specifications would be reduced.
      This would create a more predictable situation for suppliers, manufacturers and contractors.
- The ambition is to cover as much as possible of normal needs, say some 80%.

Schedule

- Proposed schedule defined by the ISO TC67 Secretariat:
  - CD: 05-2008
  - DIS: 05-2009
  - FDIS: 03-2010
  - Publication 05-2010.
- Meetings held in Houston, Texas June 2007; Paris, France November 2007; Rio de Janeiro, Brazil February 2008 and Oslo, Nohrway June 2008.
- Committee Draft (CD) distributed by ISO secretariat 28 July 2008 for comments within 28 October 2008, through the national standardisation bodies of the participating nations in ISO TC67.
  (Deadline to provide comments to the national standardisation bodies may typically be some 2-3 weeks prior to the ISO deadline.)

Scope

- This ISO standard applies to hydrocarbon production, injection, processing and utility systems. This includes all equipment from and including the well head, to and including pipeline for stabilized products. Downhole components are excluded.
- Guidance is given for:
  - corrosion evaluations;
  - materials selection for specific applications and/or systems;
  - performance limitations for specific materials;
  - corrosion control;
  - qualification of materials and manufacturers.

Internal corrosion evaluation

- Listing of mechanisms, brief descriptions, general recommendations:
  - "CO_2 corrosion is one of most common corrosion mechanisms that occur on carbon steels in production systems. CRAs are regarded as immune to this type of corrosion for most conditions, but some of the "lower" grades, such as stainless steel type 13Cr may suffer from corrosion for high temperatures and low pH. CO_2 corrosion can lead to both localised and general corrosion. The most important parameters for CO_2 corrosion are temperature, partial pressure of CO_2, pH, content of organic acids and flow conditions. Several models for prediction of CO_2 corrosion on carbon steel are available, and the model to be used should be agreed with the end user."
- Parameters
  - pCO_2, pH_2S, pH, organic acids, elemental sulphur, oxygen, mercury ….

External corrosion evaluations

- Mechanisms, (general/local corrosion, SCC)
- “A range of temperature limits that have typically been applied to avoid chloride SCC for some CRAs is presented. The lower temperature limit represents cracking in the “worst case situation” at high tensile stresses and at concentrated chloride salt levels experienced when seawater is continuously evaporated. The lower temperature limits are mostly based on laboratory experiments, but there are very few field cases that show cracking at these conditions. Many operators have used higher critical temperature limits that are represented by the higher temperature value in table 1. Extensive field experience over many years has shown that very few SCC failures have occurred on uncoated pipes when these higher temperature limits have been used.”

Materials selection for specific applications and/or systems

- Description of each system
  - **Produced water system:** “There are several corrosion mechanisms that can occur in produced water systems and the materials selection is influenced strongly by operating experience. The produced water systems can be complex, and oxygen contamination may occur in some circumstances as described in 4.2.3.12. Seawater ingress from drain systems has also been experienced. Some produced water systems can support bacterial activity, especially if the sulphate concentration is high due to break though of seawater from previous seawater injection. In such circumstances, microbial corrosion is the main integrity threat for carbon steel. Oxygen ingress and MIC will strongly influence the effectiveness of the chemical inhibition.
    The typical materials for produced water systems are given in Table 4.”

Typical materials for produced water systems

Equipment	Materials
Wellhead equipment/X-mas trees (for injection systems)	Carbon or low alloy steel with alloy 625 on all wetted surfaces
Piping,	Carbon steel, Type 316, Type 22Cr duplex, Type 6Mo, GRP
Vessels and equipment	Carbon steel with and without internal organic coating [a], Type 316, Type 22Cr duplex.
Pumps and valve body/bonnets	Carbon steel, Type 316, Type 22Cr duplex, carbon steel internally clad with alloy 625.

Material	Typical limitations	Equipment
Carbon steel with internal non metallic lining (Such as organic coating combined with cathodic protection, rubber, PE)	Temperature is limited to the selected type of linings.	Vessels, valves, piping
Type 25Cr duplex	Maximum operating temperature 20°C. Maximum chlorine 0,7 mg/l (ppm).	Vessels, valves, piping, pumps
Type 6Mo	Maximum operating temperature 20°C. maximum residual chlorine 0,7 mg/l (ppm).	Vessels, piping
Alloy 625	Maximum operating temperature 30°C. Maximum residual chlorine 0,7 mg/l (ppm).	Equipment, valves, piping
Alloy C276/C22	Maximum operating temperature 40°C. Maximum residual chlorine 0,7 mg/l (ppm).	
Alloy 686/59/C2000	Maximum operating temperature 60°C. Max. residual chlorine 0,7 mg/l (ppm).	
Titanium Grade 1 and Grade 2	*Unchlorinated:* maximum temperature 95°C [a]. *Chlorinated:* maximum temperature 85°C.	Equipment, valves , piping
Reinforced elastomer pipe	Maximum operating temperature 70°C.	Piping
GRP – (epoxy resin)	Maximum temperature 95°C. Maximum velocity 5 m/s.	Vessels, piping
NiAl bronze	Not applicable.	Pumps and valves
CUNi 90/10	Maximum velocity 2,5 m/s.	Piping [b]

Corrosion control

- Corrosion inhibitors
  - “Parameters that may strongly influence the feasibility of chemical inhibition of production systems are temperature, flow conditions, H2S content and compatibility with other chemicals. For produced water systems, contaminants such as oxygen and MIC should also be considered. These parameters should be defined in the design basis. “

Basis

- In an OGP meeting in London 7-8 February 2007, where 12 oil companies participated, it was agreed to send a New Work Item Proposal (NWIP) for preparation of a standard for Materials Selection and reestablishment of WG8 to ISO TC67.
- The NWIP (N977) was circulated 2007-02-23 and was approved 2007-05-25, as ISO 19910.
  (Later changed to ISO 21457.)
- The result of the voting (N980) was that
  - 11 P-members voted ”Yes”,
  - Denmark and UK voted ”Abstain” and
  - US and Japan voted ”No”.
- A lot of comments were given to the proposed standard, and most comments came from the US.

Initial Participants - WG8 and ISO/NP 21457

Nominated persons from each country:

- Brazil: Luciana Farias Hörlle, Jeffrey Lowe, Petrobras.
  Arlindo Charbel, ABNT (Secretary)
- France: Thierry Cassagne, Total. (Ed Valentine)
- Italy: Tiziana Cheldi, Eni.
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  Stein Olsen, StatoilHydro
  Ola Farstad, Consultant to StatoilHydro
- Qatar: Saif S. Al-Naimi, Qatar Petroleum
- United Kingdom: Andrew Leonard, BP
  Raman Patel, HSE
- United States: Peter Sandy, Marathon Oil
  Maarten Simon-Thomas, Shell (Bruce Miglin)
  Richard Thompson, Chevron (John Farraro)
  Michael Surkein, ExxonMobil
  Gary Devlin, Cameron (Rick Faircloth)

WG8 Scope

- To provide advice to ISO/TC 67 subcommittees and work groups on the selection of Standards for materials, corrosion control, welding and joining and NDE, either ISO or others as appropriate at the time;
- To analyse the current and pending ISO/TC 67 design and equipment standards for references to materials, corrosion control, welding and joining and NDE requirements in order to determine the gaps and overlaps;
- To identify possible new work items to fill the gaps;
- To propose rationalisation where overlaps exist, for example by identifying possible new work items to harmonise the overlaps;
- To assist in the prioritisation of work items for materials, corrosion control, welding and joining and NDE;
- To propose the initiation of new work items that are directly relevant to ISO/TC 67 and that are specifically in the fields of materials, corrosion control, welding and joining and NDE, and to recommend where in ISO the work could be done most efficiently;
- To propose liaisons, on behalf of ISO/TC 67, with other ISO TCs covering materials, corrosion control, welding and joining and NDE, where it is necessary to ensure that the needs of ISO/TC 67 are met.

Objective – ISO/NP 21457

- Develop an ISO standard for material selection for upstream operations. (“Oil and gas production systems”)

  Thereby achieving:

  - Better quality and more cost effective solutions.
  - Less manhours used in projects, both by oil company and engineering contractors.
  - Less need for company and project specifications.
    - By implementing the materials requirements currently used by the industry in the standards, the need for material requirements in company and projects specifications would be reduced.
      This would create a more predictable situation for suppliers, manufacturers and contractors.

Scope of work

- At first NORSOK standard M-001 and other relevant documents. (Ref. NWIP)
- Now the document has the following main contents:
  - Focus on corrosion evaluations, internally and externally.
  - Provides material selection guidelines and recommendations for subsea production systems, pipelines/flowlines, topside production fascilities and onshore terminals.
- The following is not be covered:
  - Materials selection for wells.

Schedule

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Some issues related to other ISO standards

- Material requirements in product standards takes priority over those given in ISO 21457. This has been reflected in the wording.
- There will be no conflicts between this standard and other similar standards such as ISO 15156 for sour service, and they will be referenced.

ISO Hierarchy – Relevant for material requirements

Materials requirements in ISO Product standards

- ISO 13628-1, Subsea production systems.
  (New proposed Amendments 1&2, Clause 6 and Annex L.)

Example for production trees:

- ISO 10423 (API 6A), Surface trees
- ISO 13628-4, Subsea trees

Materials requirements in ISO Material Selection Standards

- New Material Selection Standard, ISO 21457
- ”Sour service” standard, ISO 15156, Part 1-3.
- Non-metallic materials, ISO 23936, Part 1-5.

How should the ISO materials selection standard function?

Activity	Oil company/ End user	Engineering Contractor
ISO standard development and maintenance	**X**	**X**
Project Design Basis	X	
Conceptual engineering materials selection	X	X
Front end engineering design materials selection	(X)	X
Basic engineering	(X)	X
Detailed engineering		X

Equipment suppliers are not intended to be main users of the standard.

Functional ↔ Detailed Technical Requirements

- How much technical details should be in the new ISO materials selection standard?
  - A similar level as the oil companies consider is necessary as basis for contracts, thereby minimizing the need for company and project specifications.
- The draft standard refers to materials that are generally available, with properties that are known and documented. The standard allows other materials to be evaluated, their properties documented and, if suitable, for these other materials to be used.
- The ambition is to cover as much as possible of normal needs, say some 80%.