SEMINÁRIO DE PROTEÇÃO CATÓDICA: SUPERANDO DESAFIOS

Proteção Catódica de Estruturas Industriais - Corrosão sob Tensão Externa em Dutos (SCC)

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Conceitos Fundamentais de SCC

- O que é SCC?

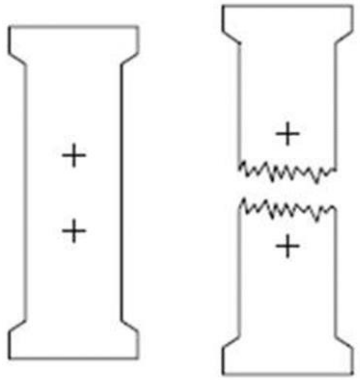
Trincamento pela ação combinada de corrosão e tensão trativa.

- Trincas comprometem a capacidade de materiais dúteis em se deformar plasticamente;

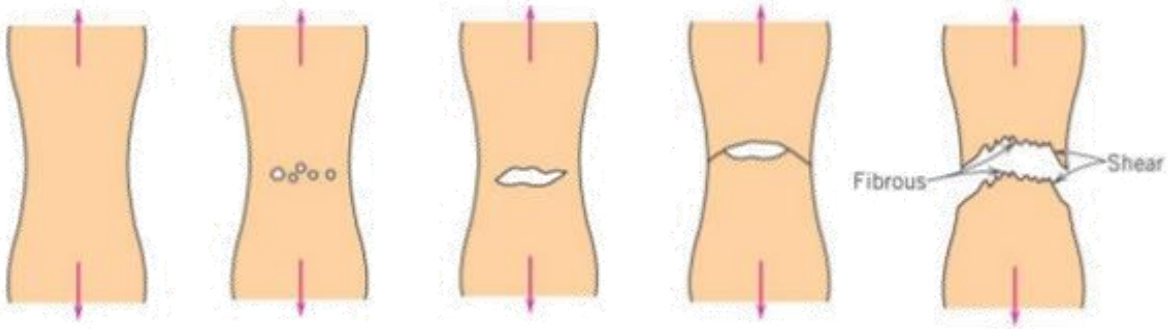
- Trincas “fragilizam” o material.

Conceitos Fundamentais de SCC

Ensaio de tração

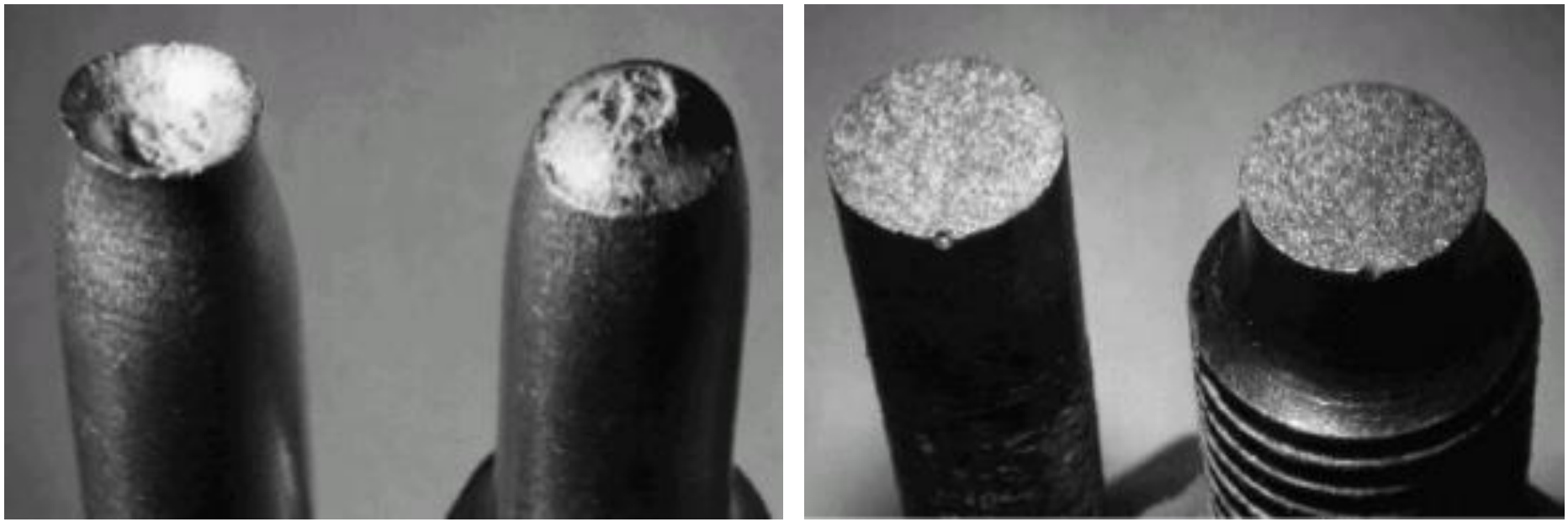


Materiais frágeis



Materiais dúteis

Conceitos Fundamentais de SCC



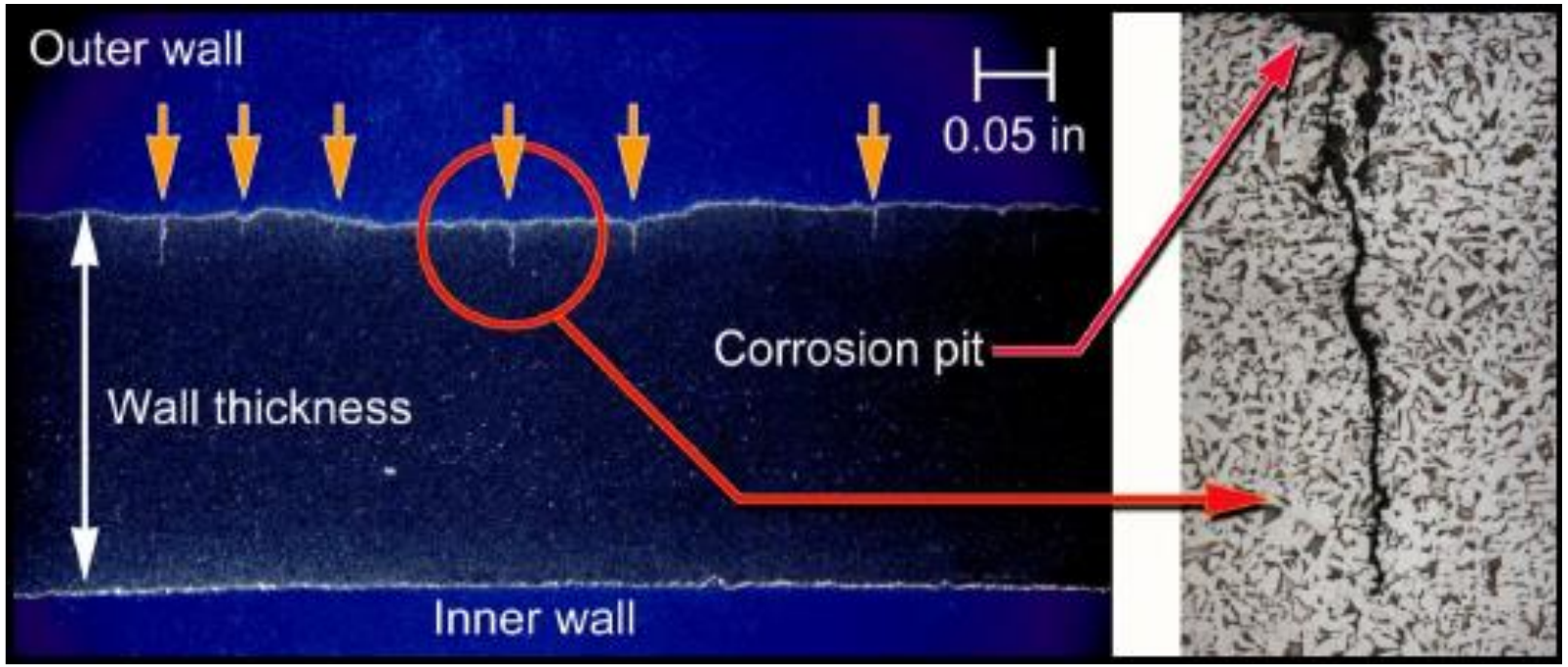
Fratura dútil x Fratura frágil

Conceitos Fundamentais de SCC

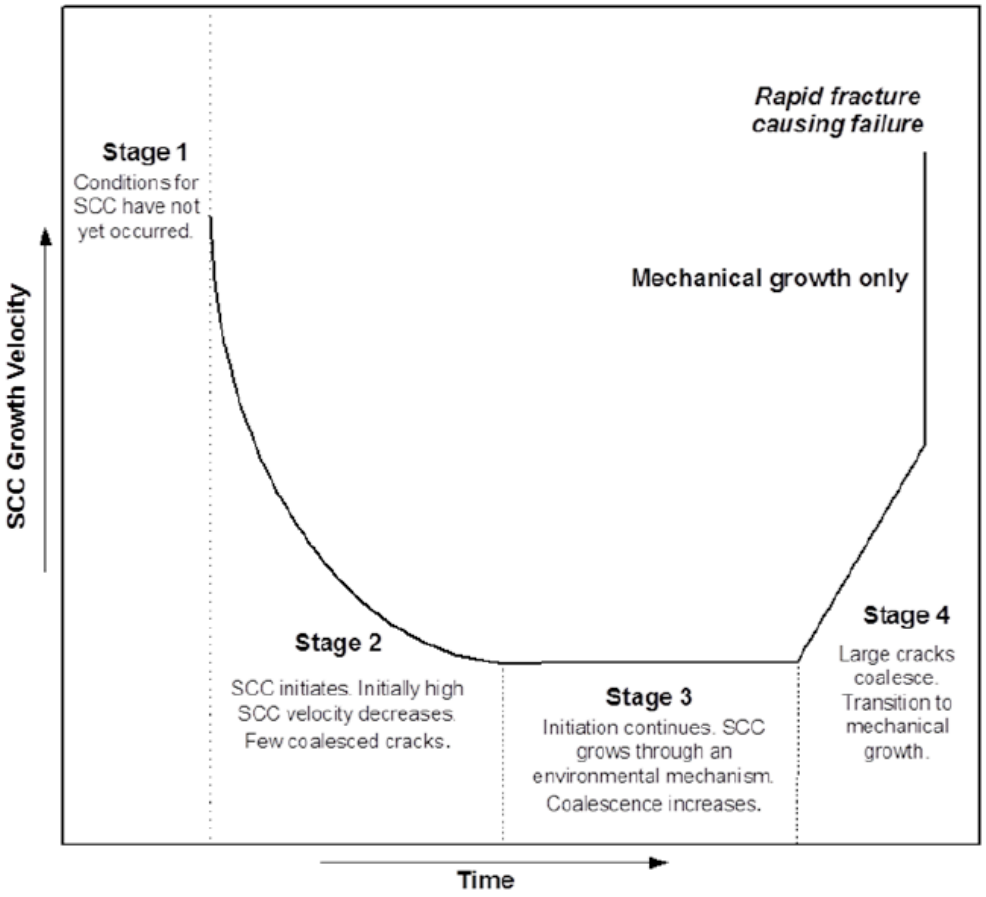
Por que se preocupar com trincas?

Conceitos Fundamentais de SCC

O que é SCC?

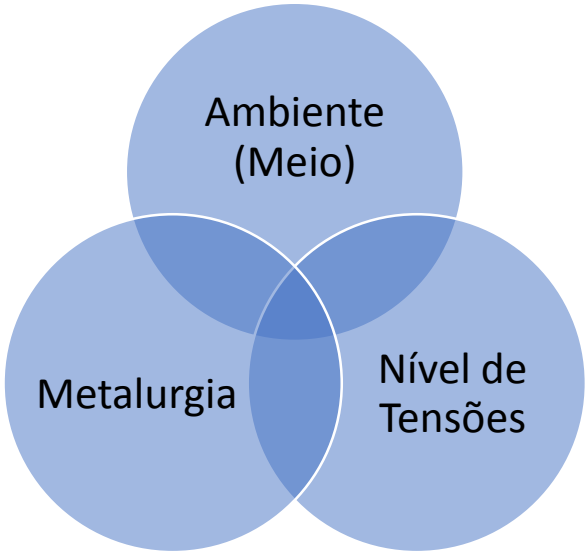


CEPA – Ciclo de Crescimento do SCC



Conceitos Fundamentais de SCC

- Revestimento com falhas ou descolamento (fita de PE, asfalto, coal-tar)
- Idade do duto
- Nível de tensões
  I. Pressão interna
  II. Curvas pronunciadas (raio curto)
  III. Variações topográficas e eventos geotécnicos



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- CP level and possibility of shielding
- Near-neutral pH SCC occurs in locations where the pipe is inadequately protected by the CP system, due either to **disbonded shielding coating or an improperly functioning CP system**. Close-interval surveys and the CP history may indicate locations of increased susceptibility.
- Experience has shown that most forms of SCC are found where **coatings partially or completely shield proper cathodic protection**. For asphalt/coal tar enamel coated pipelines, inadequate levels of CP have been used to identify SCC susceptible areas. Seasonal fluctuations in CP levels (due to moisture level changes in the soil around the pipe and anode beds) should be accounted for when examining CP data. For electrically insulating coatings, such as polyethylene tape, it is difficult to identify locations where the pipe surface is shielded by disbonded coating.

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SCC has been found beneath field applied **polyethylene tape** (Figures 2.2 and 2.3), as well as field-applied **asphalt enamel, coal tar** and some girth **weld shrink sleeves** (Section 1.4.2). No SCC has been documented for fusion-bonded epoxy (FBE), field applied epoxy or epoxy urethane, or extruded polyethylene coatings.

Ex.: Decolamento de Fita de PE

Conceitos Fundamentais de SCC

SCC externo em dutos

1965: **SCC em pH alto** – Dutos USA

1985: **SCC em pH neutro** – Dutos no Canadá

Fatores de Suscetibilidade

SCC pH Neutro:

- Tempo de operação (idade) > 10 anos
- Nível de tensão > 60% SMYS
- Revestimento externo não FBE/PE3L

Para SCC pH Alto, acrescentar:

- Temperatura > 38 °C
- Distância ECOMP < 32 km

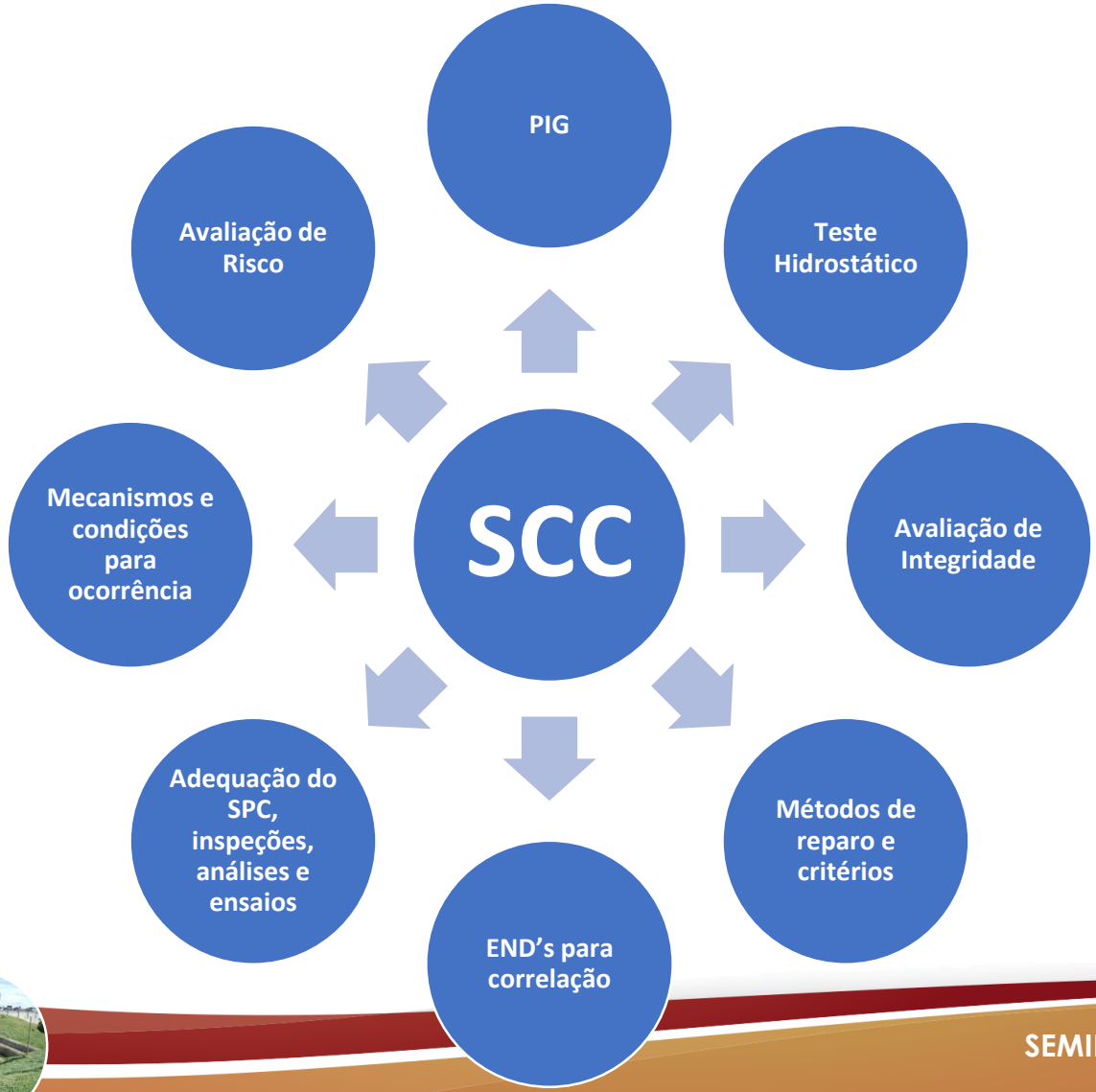
Fatores de Suscetibilidade

Dutos com suscetibilidade INSIGNIFICANTE:

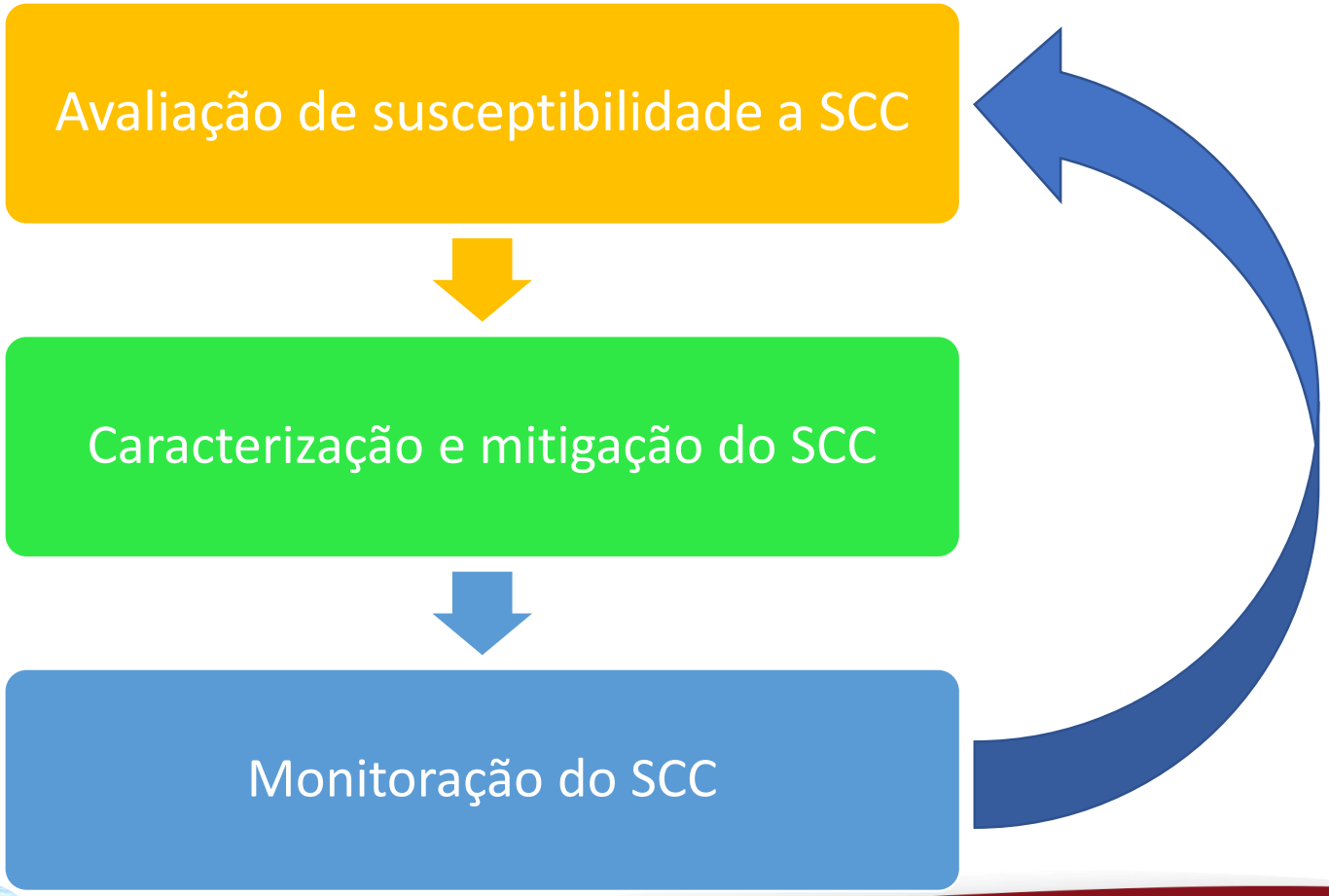
- Tempo de operação < 10 anos;
- Revestimento FBE ou PE3L;
- Nível de tensão < 30%.

Apenas uma destas condições precisa ser satisfeita!

Disciplinas para Controle do SCC



Gerenciamento de Integridade



ASME B31.8S

7.4.3 Stress Corrosion Cracking Direct Assessment (SCCDA). For the SCCDA prescriptive program, examination and evaluation of all selected locations must be performed within 1 yr of selection. ILI or pressure testing (hydrotesting) may not be warranted if significant and extensive cracking is not present on a pipeline system. The interval between subsequent examinations shall provide similar safe interval between periodic integrity assessments consistent with Fig. 7.2.1-1 and section A-3 in Nonmandatory Appendix A. Figure 7.2.1-1 and section A-3 in Nonmandatory Appendix A are applicable to prescriptive-based programs. The intervals may be extended for a performance-based program as provided in para. 7.2.5.

6.4.3 Stress Corrosion Cracking Direct Assessment (SCCDA) for the Stress Corrosion Cracking Threat. Stress corrosion cracking direct assessment can be used to determine the likely presence or absence of SCC on pipeline segments by evaluating the SCC threat. Note that NACE RP0204, Stress Corrosion Cracking (SCC) Direct Assessment Methodology provides detailed guidance and procedures for conducting SCCDA. The SCCDA pre-assessment process integrates facilities data, current and historical field inspections, and tests with the physical characteristics of a pipeline. Nonintrusive (typically terrain, aboveground, and/or indirect) observations and inspections are used to estimate the absence of corrosion protection. The SCCDA process requires direct examinations and evaluations. Direct examinations and evaluations confirm the ability of the indirect inspections to locate evidence of SCC on the pipeline. Post assessment is required to set the re-inspection interval, re-assess the performance metrics and their current applicability, plus confirm the validity of the assumptions made in the previous steps remain correct.

The focus of the SCCDA approach described in this Code is to identify locations where SCC may exist. It is recognized that evidence of other threats such as external corrosion, internal corrosion, or mechanical damage may be detected during the SCCDA process. While implementing SCCDA, and when the pipe is exposed, the operator is advised to conduct examinations for non-SCC threats. For detailed information on the SCCDA process as an integrity assessment method, see especially NACE SP0204.

Table 7.1-1 Acceptable Threat Prevention and Repair Methods

Prevention, Detection, and Repair Methods	Third-Party Damage			Corrosion Related		Equipment				Incorrect Operation	Weather Related			Manufacture		Construction				O-Force	Environment
	TPD(IF)	PDP	Vand	Ext	Int	Gask/ Oring	Strip/ BP	Cont/ Rel	Seal/ Pack	IO	CW	L	HR/F	Pipe Seam	Pipe	Gweld	Fab Weld	Coup	WB/B	EM	SCC
Prevention/Detection																					
Aerial patrol	X	X	X	...	...	...	...	...	...	...	X	X	X	...	...	...	...	X	...	X	...
Foot patrol	X	X	X	X	...	...	...	...	...	...	X	X	X	...	...	...	...	X	...	X	...
Visual/mechanical inspection	...	...	...	...	...	X	X	X	X	...	X	...	...	...	...	X	...	...	...	...	...
One-call system	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Compliance audit	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...
Design specifications	...	...	...	X	X	X	X	X	X	...	...	...	...	...	...	X	...	X	X	X	X
Materials specifications	...	...	...	...	...	X	X	X	X	...	X	...	X	X	X	...	X	...	...	...	...
Manufacturer inspection	...	X	...	...	...	...	...	X	X	...	...	...	...	X	X	...	X	...	...	...	...
Transportation inspection	...	X	...	...	...	...	...	...	...	...	...	...	...	X	X	...	...	...	...	...	...
Construction inspection	...	X	...	X	...	X	X	X	X	...	...	...	...	...	X	X	X	X	X	...	X
Preservice pressure test	...	X	...	...	...	...	...	...	...	...	...	...	...	X	X	X	X	X	X	...	...
Public education	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
O&M procedures	X	X	X	X	X	X	X	X	X	X	X	...	X	...	...	...	...	X	X	X	X
Operator training	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...
Increase marker frequency	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Strain monitoring	...	...	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	X	...
External protection	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X	...
Maintain ROW	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X	...
Increased wall thickness	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X	...
Warning tape mesh	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
CP monitor/maintain	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X
Internal cleaning	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Leakage control measures	...	X	X	X	X	X	X	X	X	...	...	...	...	...	...	...	...	X	...	...	...
Pig-GPS/strain measurement	...	...	...	...	...	...	...	...	...	...	X	...	X	...	...	...	...	...	...	X	...
Reduce external stress	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	X	X	X	X
Install heat tracing	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...
Line relocation	X	...	X	...	...	...	...	...	...	...	X	...	X	...	...	...	...	...	...	X	...
Rehabilitation	...	X	...	X	X	...	...	...	...	...	...	...	...	...	...	...	...	X	X	X	X
Coating repair	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X
Increase cover depth	X	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	X	...	...
Operating temperature reduction	...	...	...	...	...	X	...	...	X	...	...	...	...	...	...	...	...	...	...	...	X
Reduce moisture	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Biocide/inhibiting injection	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Install thermal protection	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...	...	...	...	...	...
Repairs																					
Pressure reduction	...	X	...	X	X	X	...	...	...	...	...	...	...	X	X	X	X	X	...	...	X
Replacement	X	X	X	X	X	X	X	X	X	...	X	X	X	X	X	X	X	X	X	X	X
ECA, recoat	...	...	...	X	X	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...
Grind repair/ECA	...	X	X	...	...	...	...	...	...	...	...	...	...	X	X	X	X	...	...	...	X
Direct deposition weld	...	C	C	C	C	...	...	...	...	...	...	...	...	C	C	C	C	...	...	...	...

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Pipeline attributes that may indicate susceptibility to SCC include:

- Age
- Season of original construction
- Pipe manufacturer
- Pipe diameter
- Long-seam type
- Pipe alignment (bends)
- Surface preparation
- **Coating type (primary susceptibility factor)**
- Stress concentration factors
- Location of weights and anchors
- Location of casings
- Mechanical damage
- Backfilling practices

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Operating conditions relevant to SCC include:

- Stress level
- Pressure cycling
- Temperature
- Distance downstream of the compressor or pump station
- **CP level and possibility of shielding**
- Product type

Relevant environmental conditions include:

- Terrain
- Soil type
- Drainage characteristics
- Land use
- Soil CO_2

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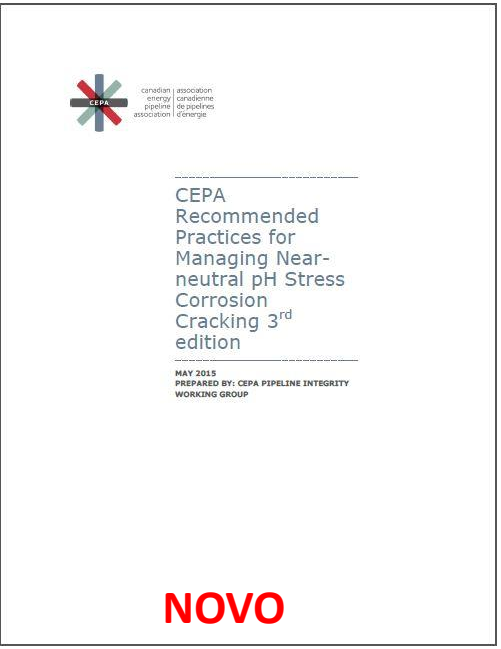
Useful pipeline maintenance data include:

- In-line inspection (ILI) data
- **Cathodic protection (CP) data**
- Excavation records
- **Coating condition**
- Leak/rupture history
- Hydrotest history

Documentos de Referência



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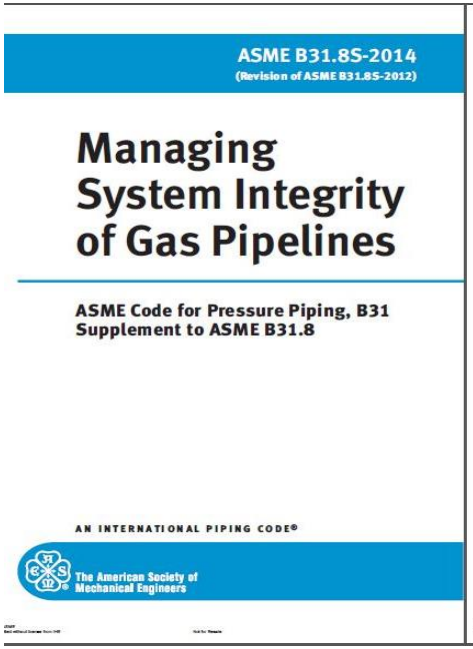

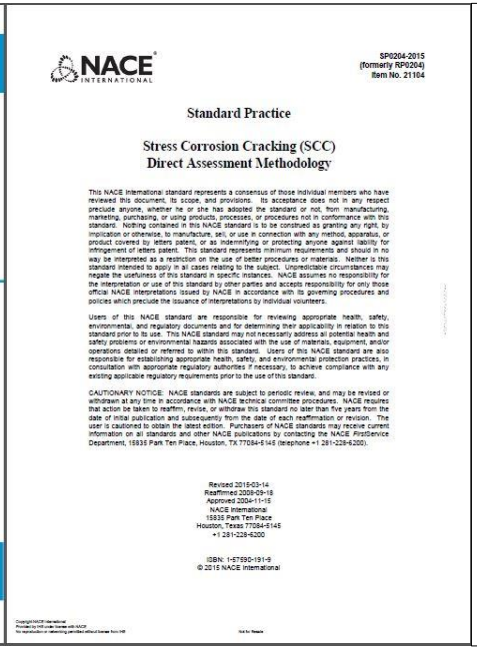

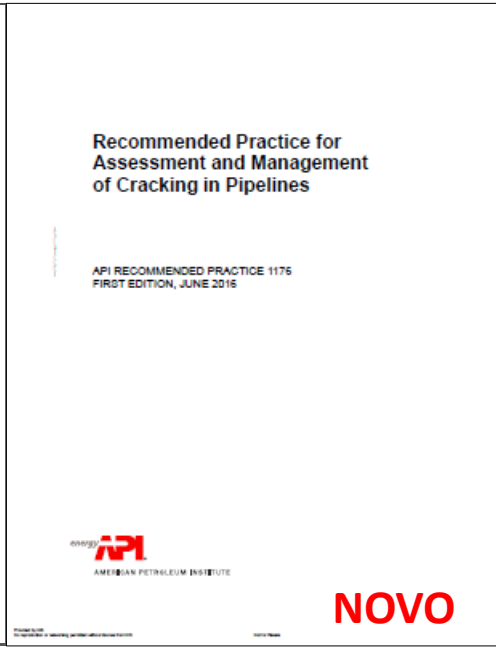

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Obrigado!