DETECÇÃO E DIMENSIONAMENTO DE TRINCAS EM COMPONENTES DE CALDEIRAS – APLICAÇÃO DE TÉCNICAS ELETROMAGNÉTICAS, ULTRASSÔNICAS e EMISSÃO ACÚSTICA

TRINCA INTERNA EM TUBULÃO DE CALDEIRA **– EA / US_PA / ECT**

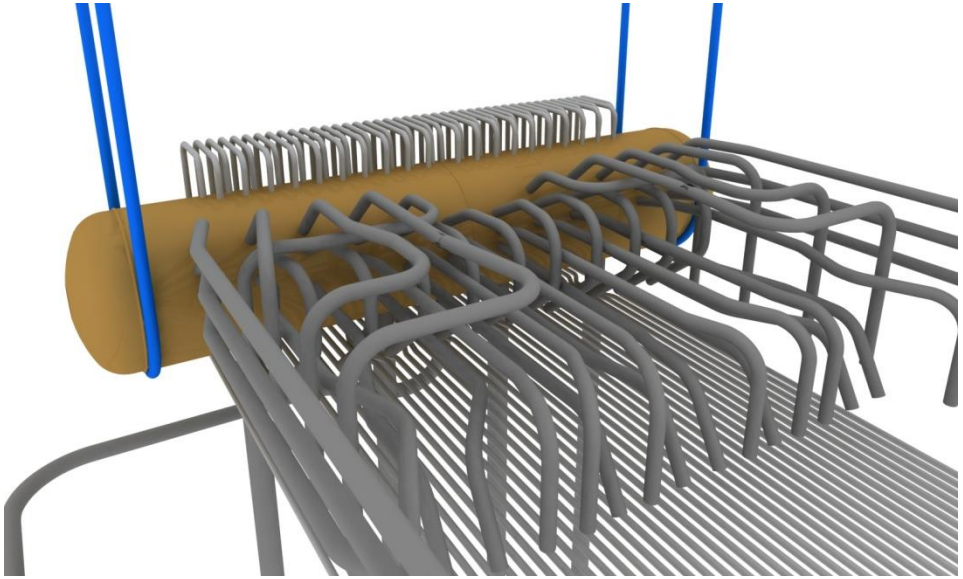
TRINCAS DE FADIGA TÉRMICA EM COLETORES E TUBULAÇÕES – **EA / ECT / US_PA / US_TOFD**

TRINCA INTERNA EM TUBO DA FORNALHA – **US_PA**

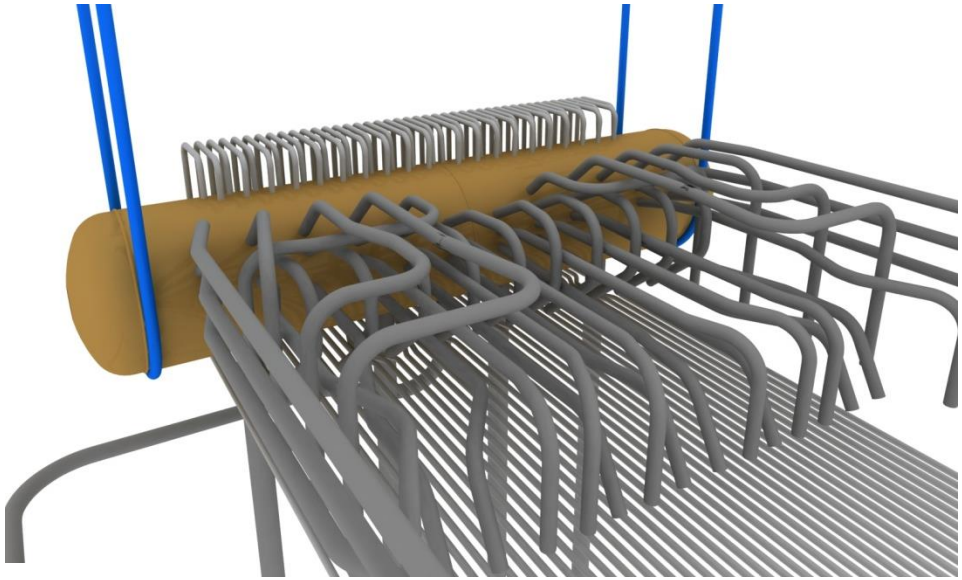
TRINCAS DE FLUÊNCIA-FADIGA em TUBULAÇÕES – **EA / ECT / US_PA / US_TOFD / "boat samples" / REPLICAS**

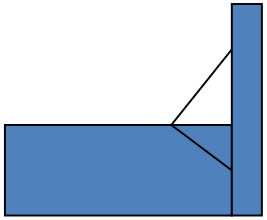
TRINCA INTERNA EM TUBULÃO DE CALDEIRA **– EA / US_PA / ECT**

TUBULÃO

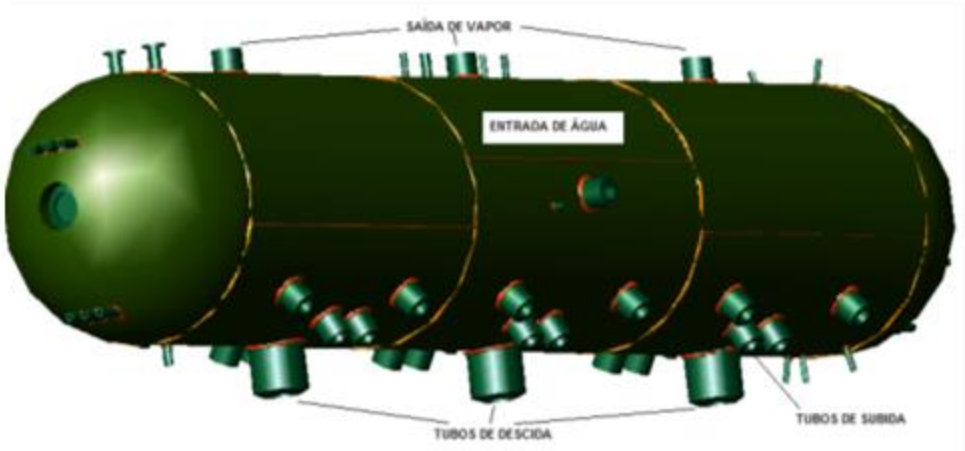


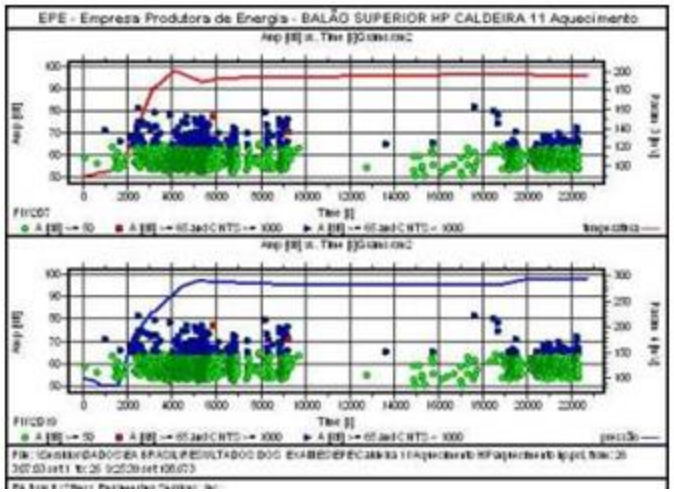
TUBULÃO

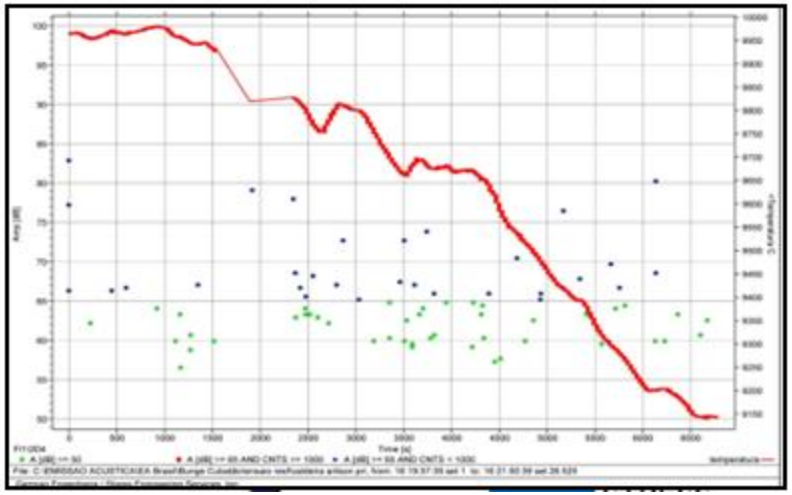




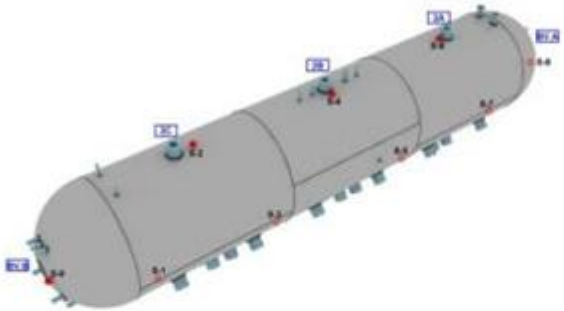
EA

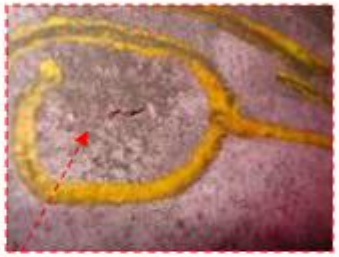

SAÍDA DE VAPOR
ENTRADA DE ÁGUA
TUBOS DE DESCIDA
TUBOS DE SUBIDA

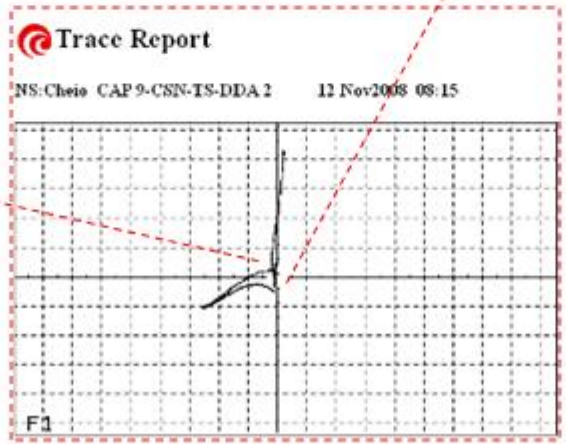

EPE - Empresa Produtora de Energia - BALÃO SUPERIOR HP CALDEIRA 11 Aquecimento



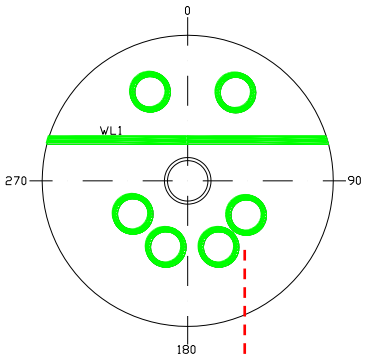
EXAMES SUPERFICIAIS – ECT / PM / LP / ACFM

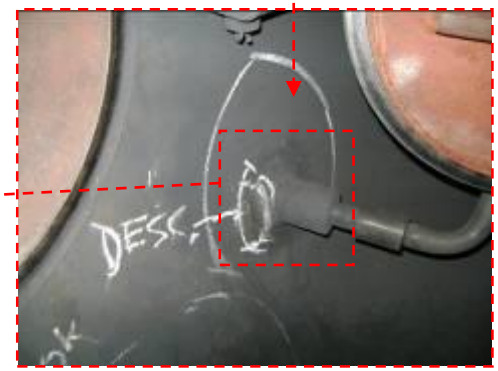




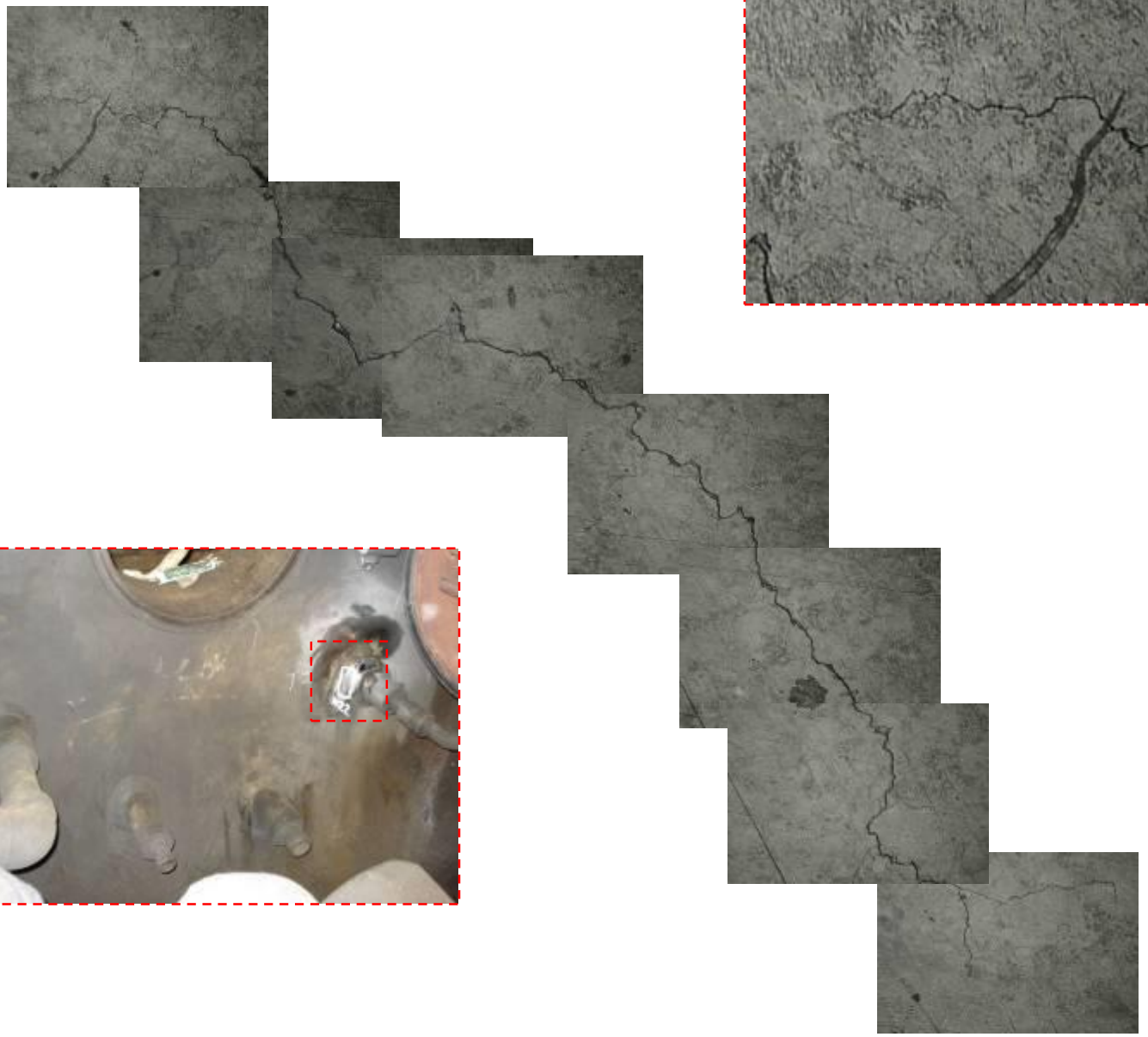


MACROGRAFIA - RÉPLICAS



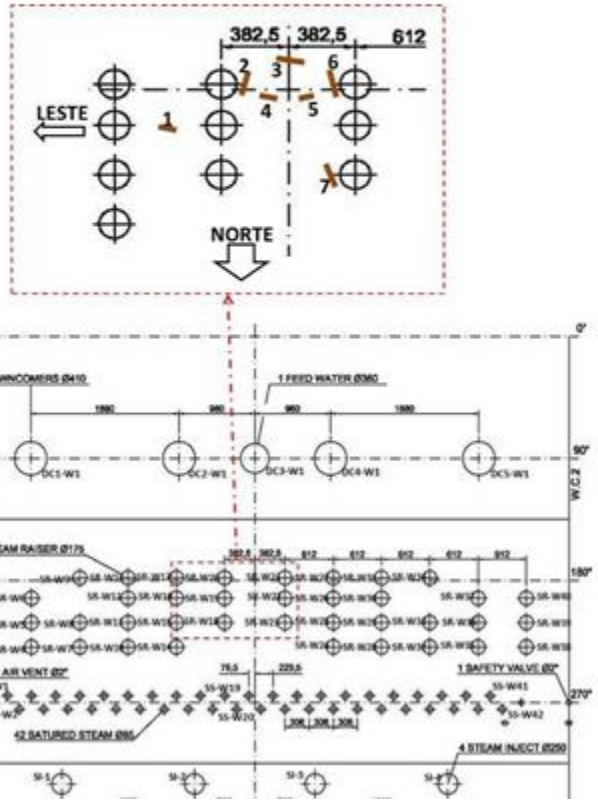


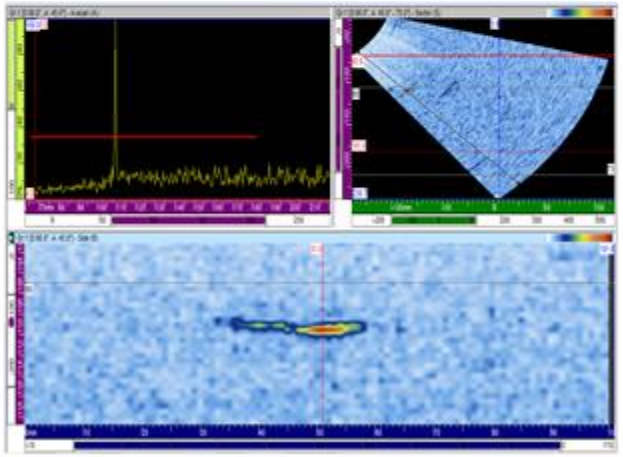
MACROGRAFIA - RÉPLICAS



US_PA PARA DIMENSIONAMENTO e CÁLCULOS

Drum

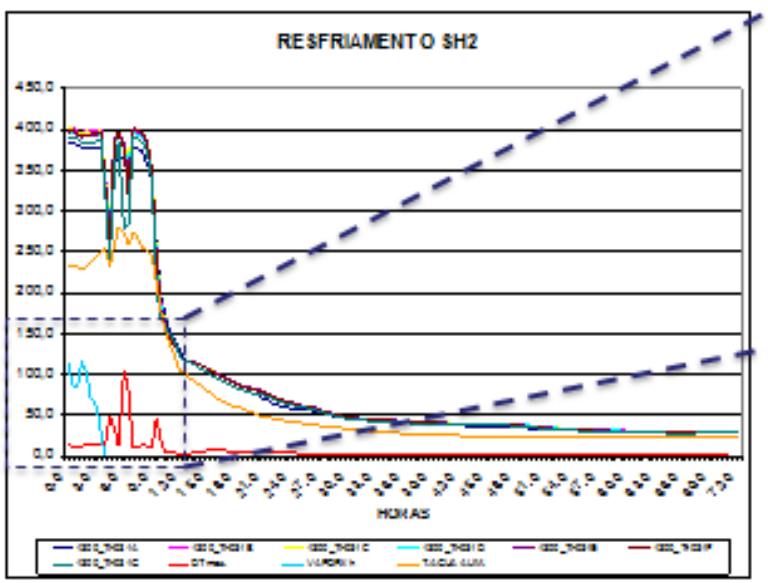


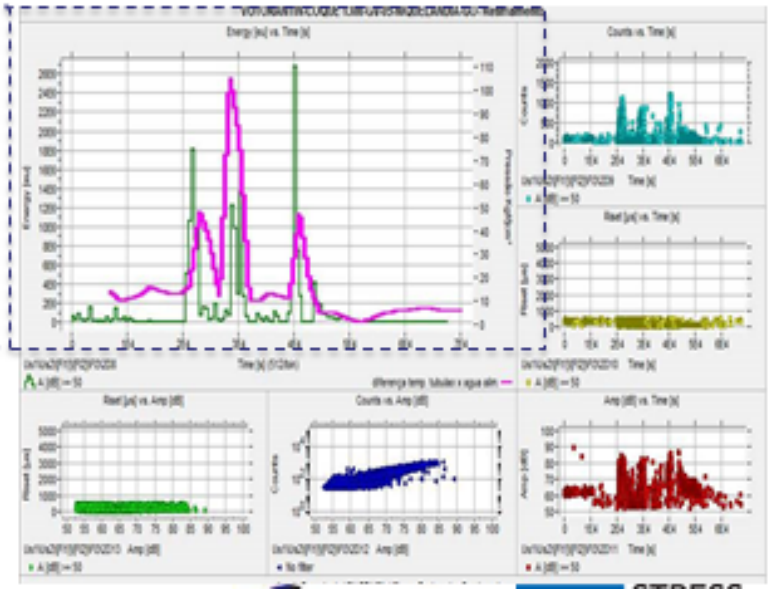


TRINCAS DE FADIGA TÉRMICA EM COLETORES E TUBULAÇÕES – **EA / ECT / US_PA / US_TOFD**

TRINCAS DE FADIGA TÉRMICA EM TUBULÕES, COLETORES E TUBULAÇÃO

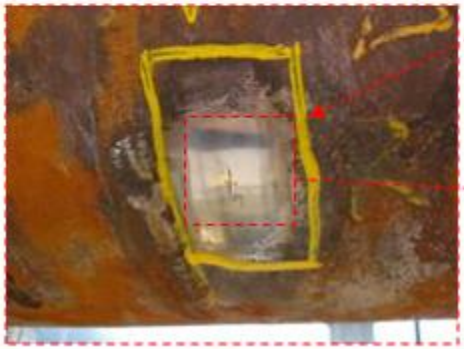
Strong correlation between AE data and thermal stresses parameters (pressure, temperature)

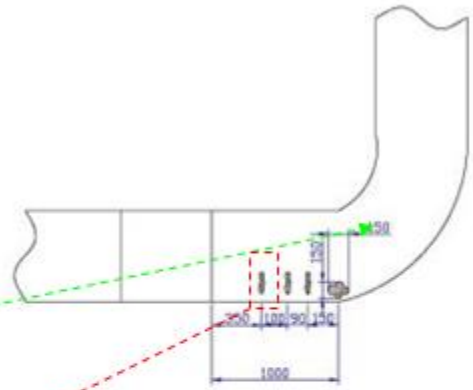




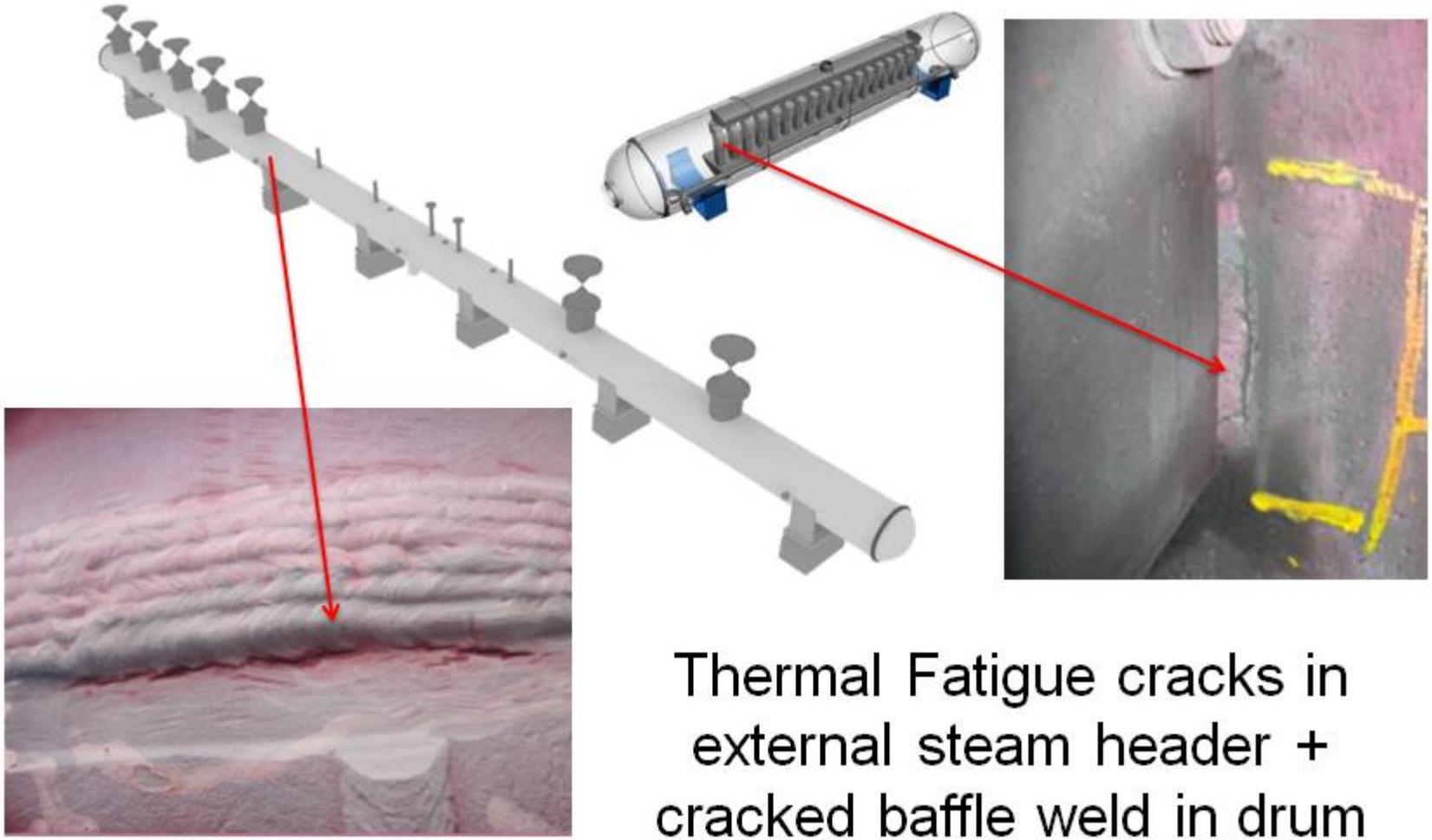
TRINCAS DE FADIGA TÉRMICA EM DESSUPERAQUECEDORES

BEND OF THE DESSUPERHEATER





Thermal fatigue cracks in ext piping



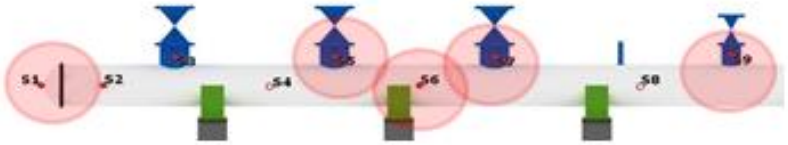
Thermal Fatigue cracks in external steam header + cracked baffle weld in drum

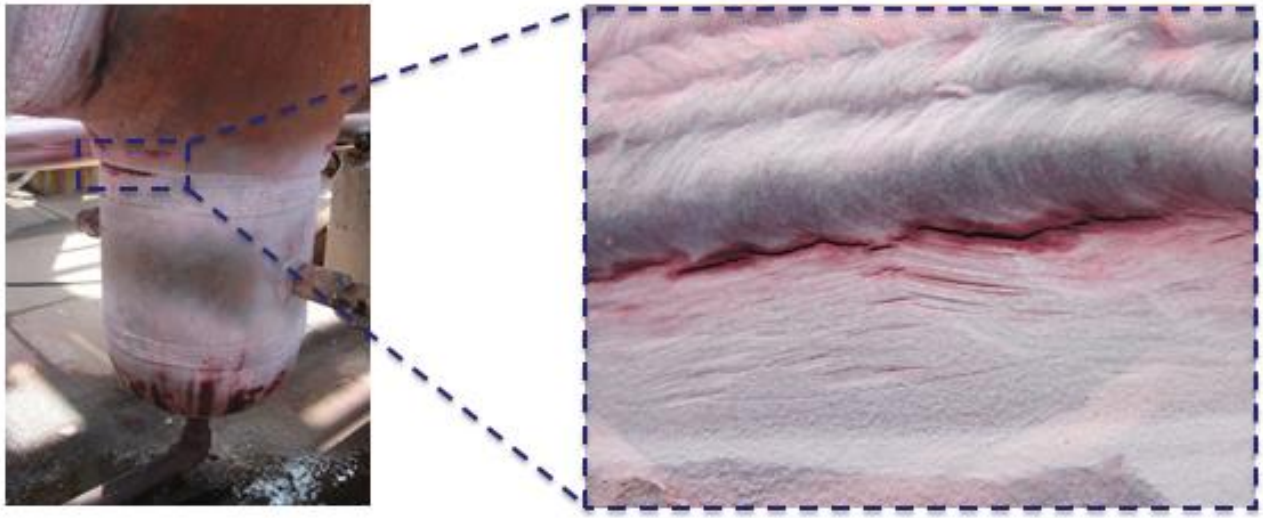
Mechanism: **Thermal Fatigue** [6]

Damage: **Cracks**

Susceptible areas: **Headers & piping**

Advanced NDT – **Acoustic Emission**





TRINCA INTERNA EM TUBO DA FORNALHA – **US_PA**

TRINCAS de CORROSÃO FADIGA em TUBOS da FORNALHA

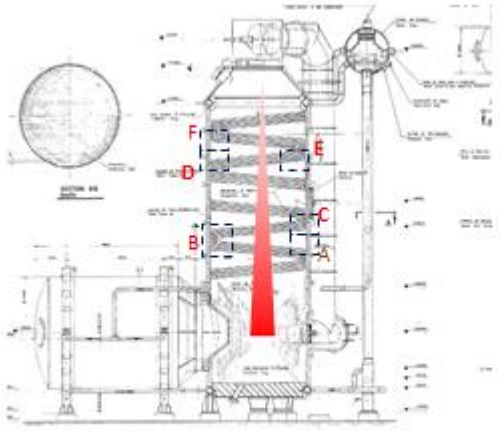
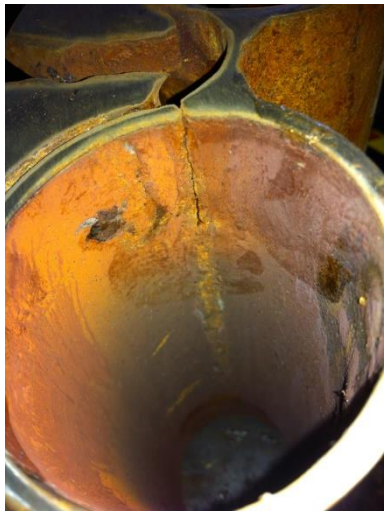
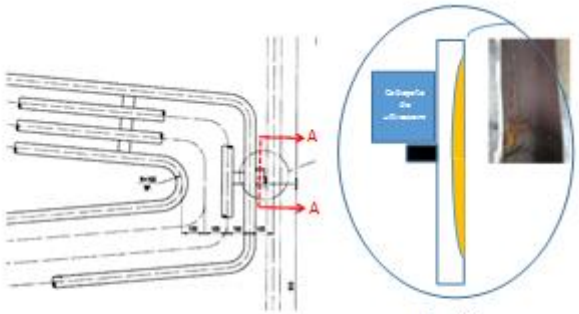


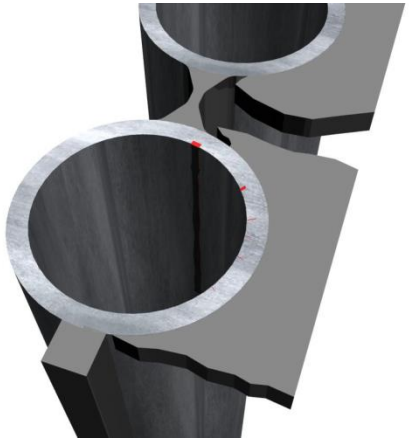
Figura 16 - Locais com limitação para aplicação deste procedimento





Corte A-A
Secção longitudinal da parede do tubo com trinca

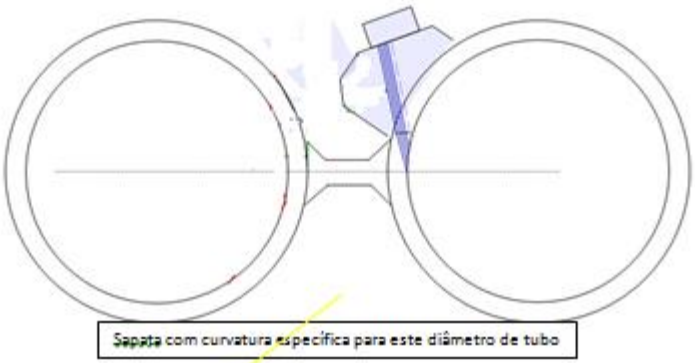
Figura 17 - Detalhes da região onde ocorrem as trincas

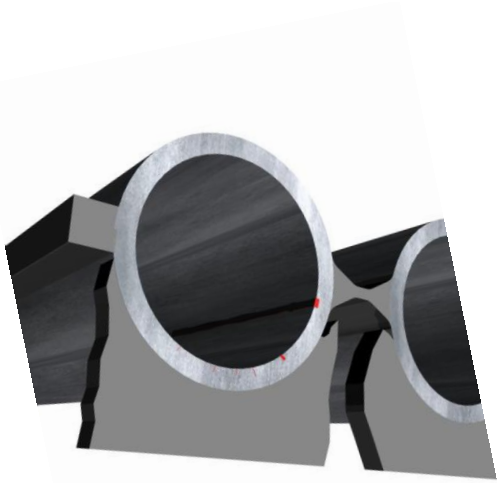


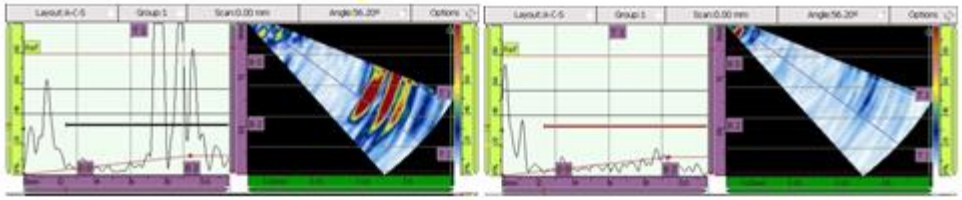
PELA SUPERFÍCIE EXTERNA É POSSÍVEL ACESSAR INDIRETAMENTE A REGIÃO DE INTERESSE

PELA SUPERFICIE INTERNA O ACESSO é DIFÍCIL e não COBRE TODA A REGIÃO DE INTERESSE

EXAME PELA SUPERFÍCIE INTERNA – US_PA (sapata curva comercial)







Região trincada

Região sem trinca

EXAME PELA SUPERFÍCIE INTERNA – US_PA (scaner e cabeçotes “water wedge” especiais)

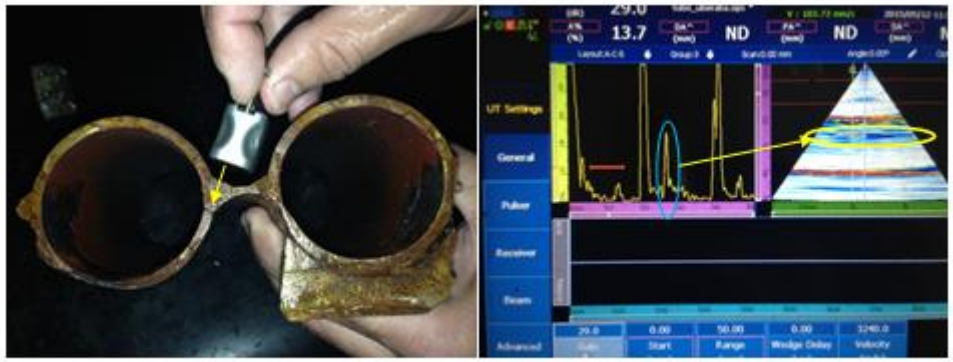
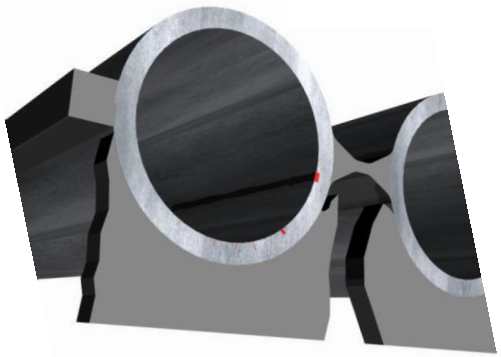
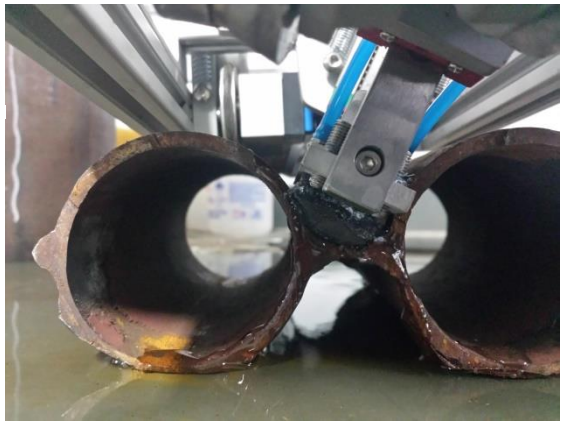
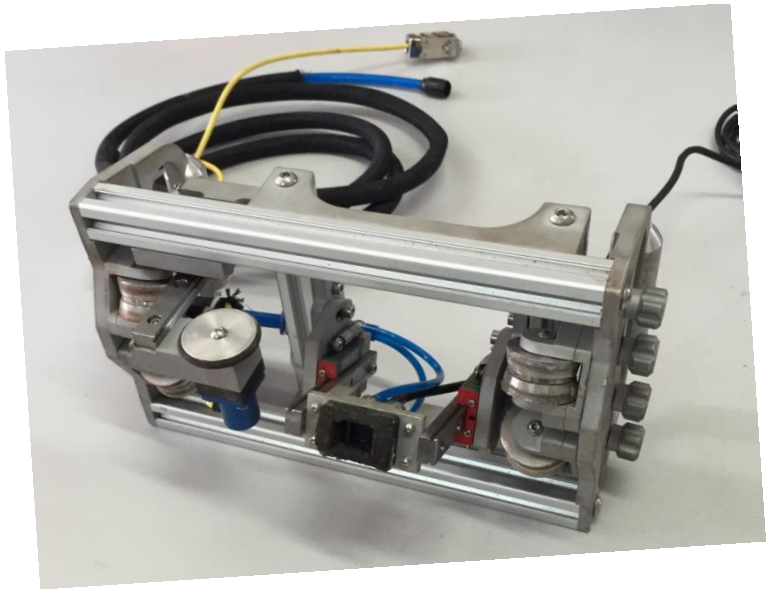


Figura 18 - Inspeção pela "face fria" dos tubos







TRINCAS DE FLUÊNCIA-FADIGA em TUBULAÇÕES –
EA / ECT / US_PA / US_TOFD / “boat samples” / REPLICAS

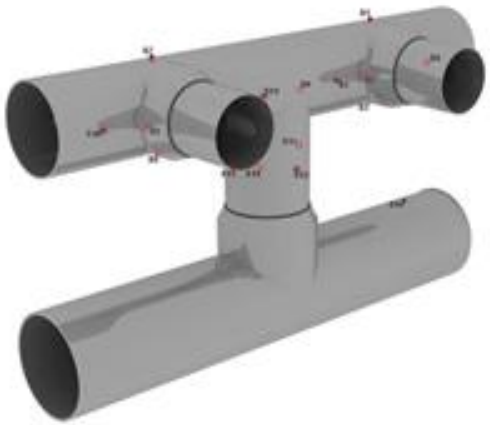
Superheated Steam Piping

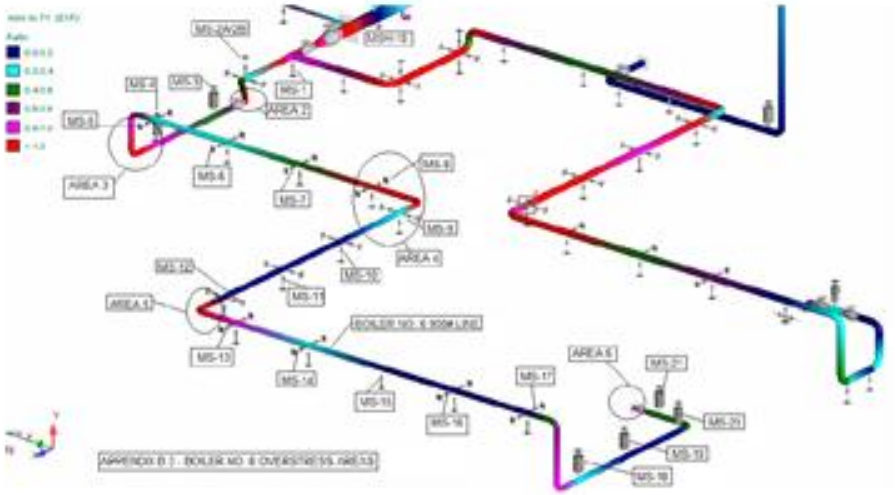
Mechanism – **Fatigue / Creep Fatigue** 7

Damage – **Cracks**

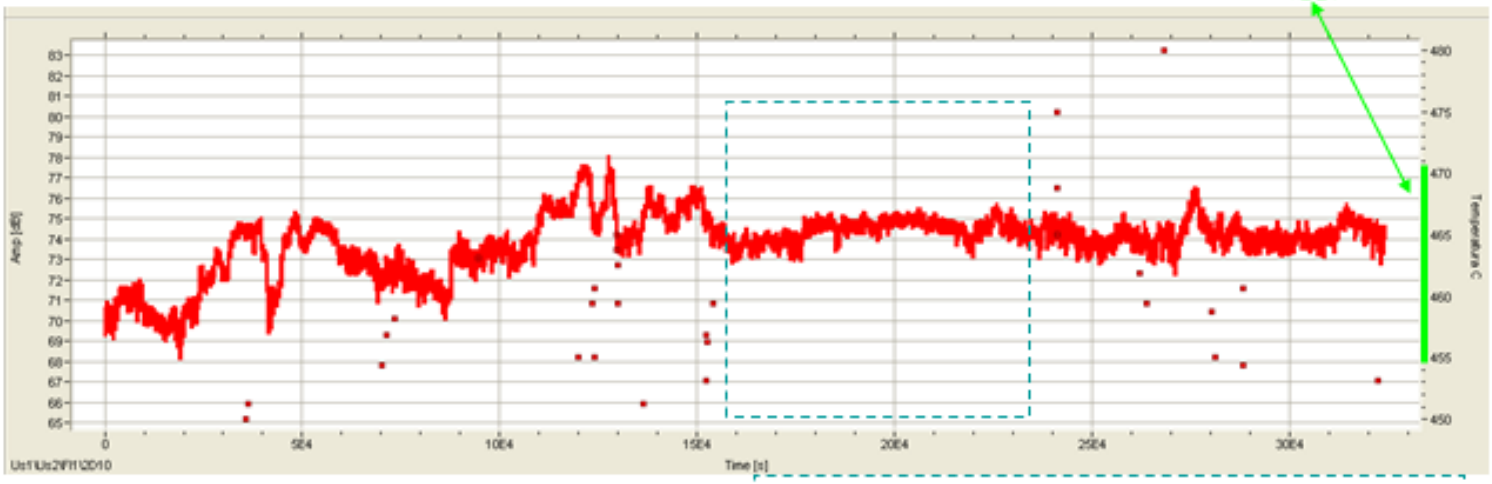
Susceptible areas: **Headers, Superheated Steam Piping**

Advanced NDTs – **Acoustic Emission, Eddy Current, PAUT, ToFD, Metallurgical Replication; Hardness**



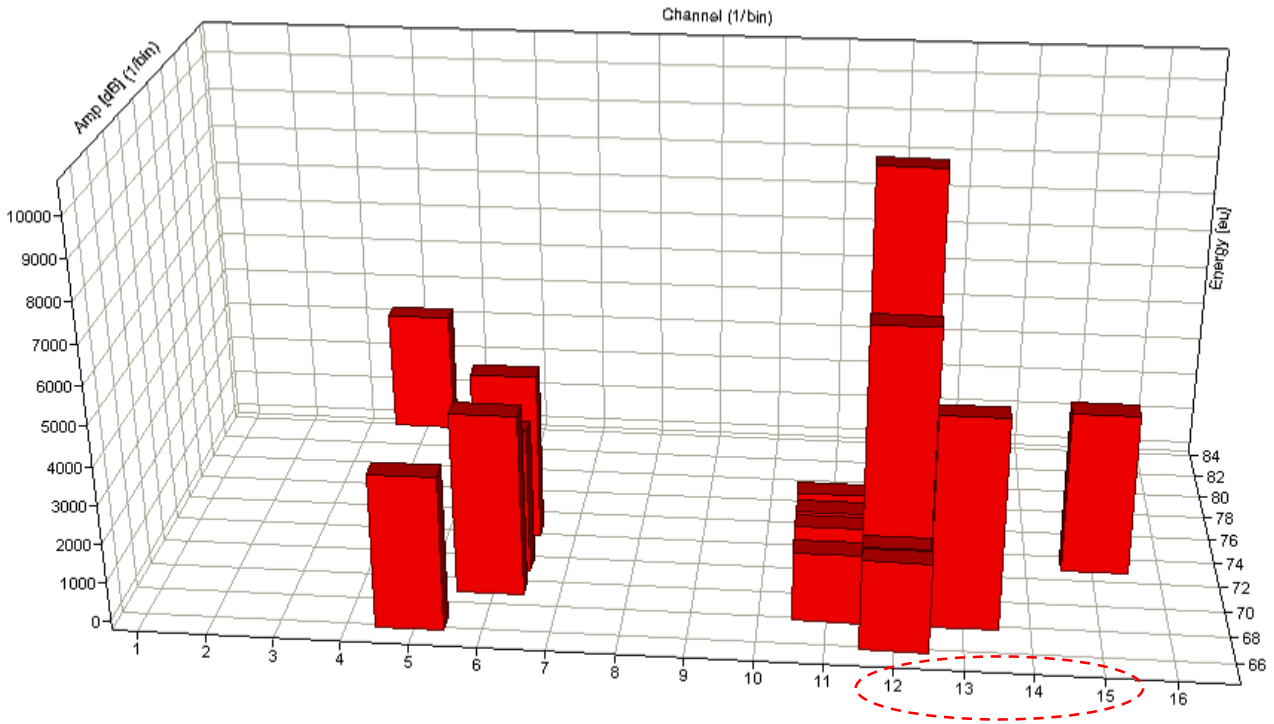


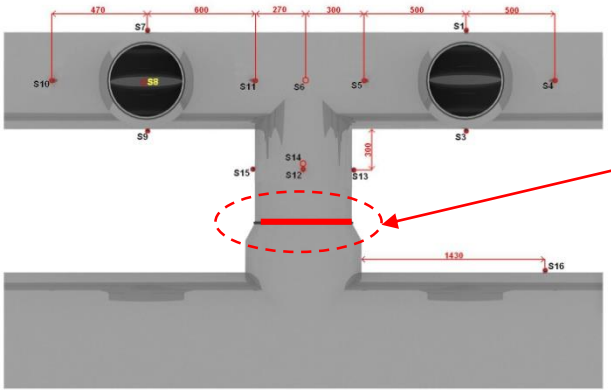
Termocouple installed in the Header. Found a variation aproximatly 60º F .



AE activity during the temperature variations

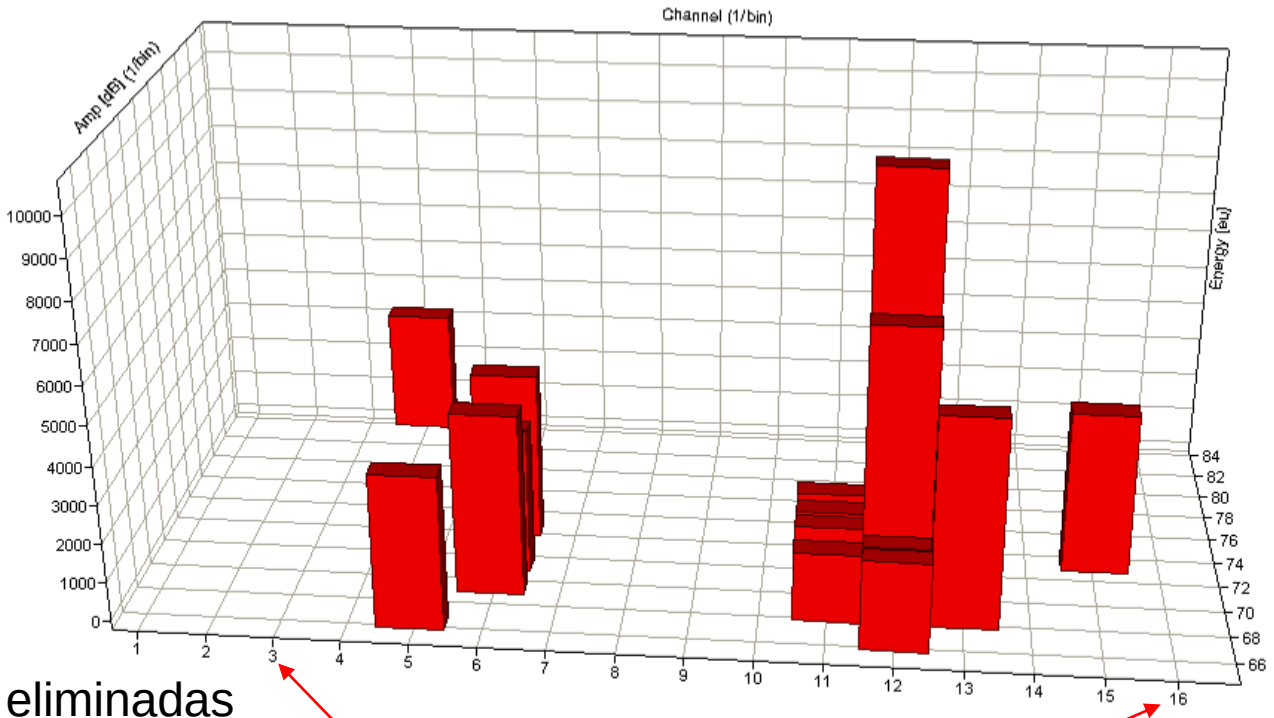
Constant temperature → No AE activity



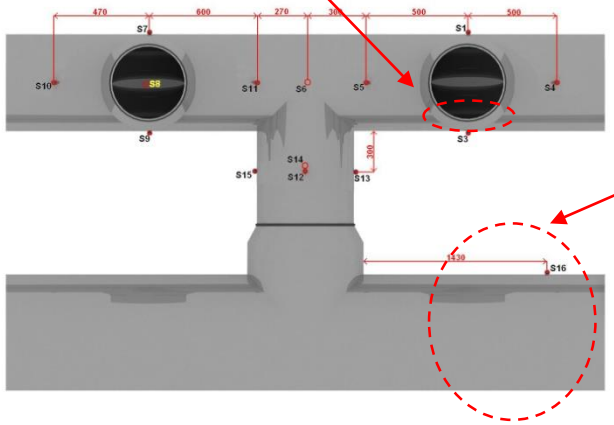


Região que contém trincas

EA x Trincas ➡ Comporta mento tipico



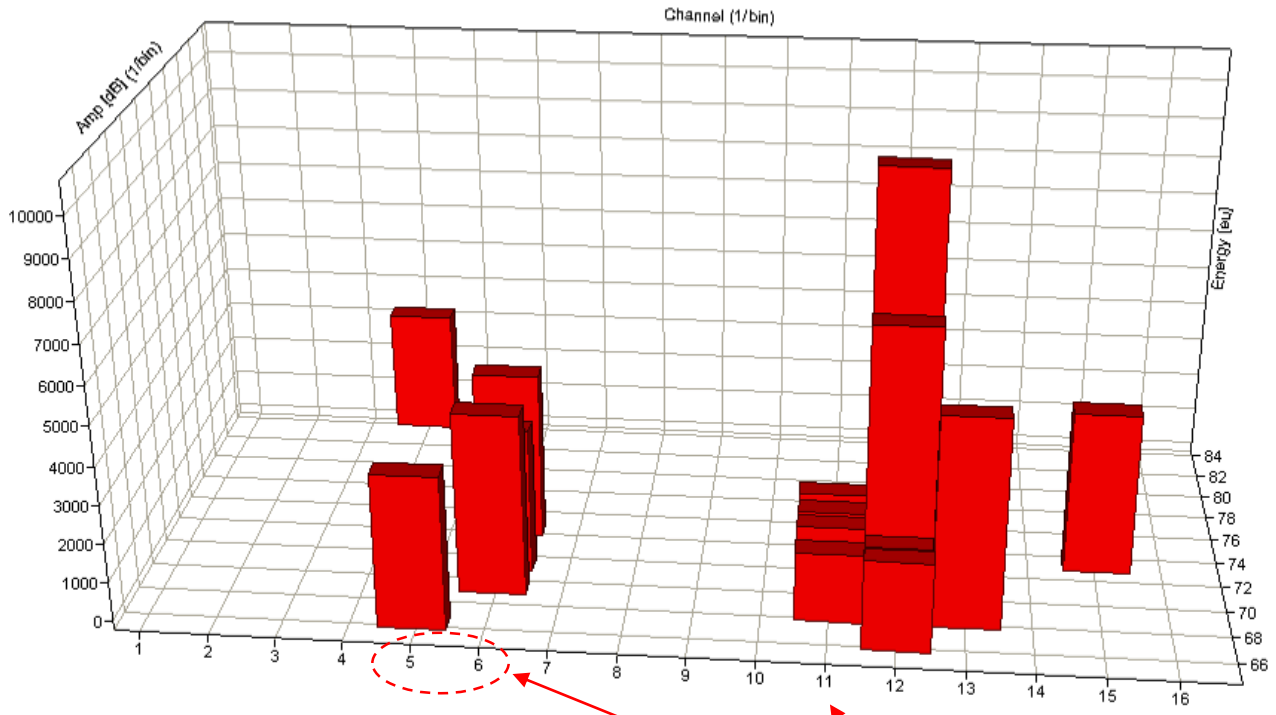
Trincas eliminadas



Região isenta de trincas

EA x Trincas

Comporta mento tipico

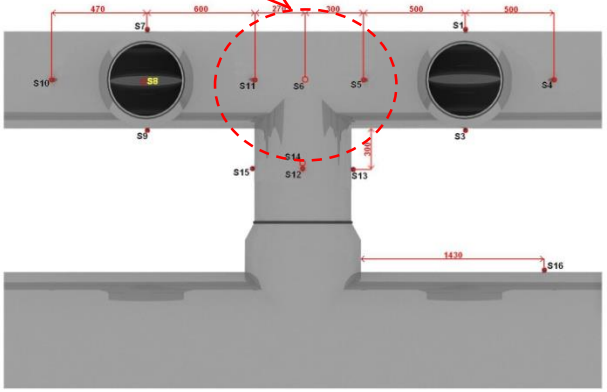


Região suspeita

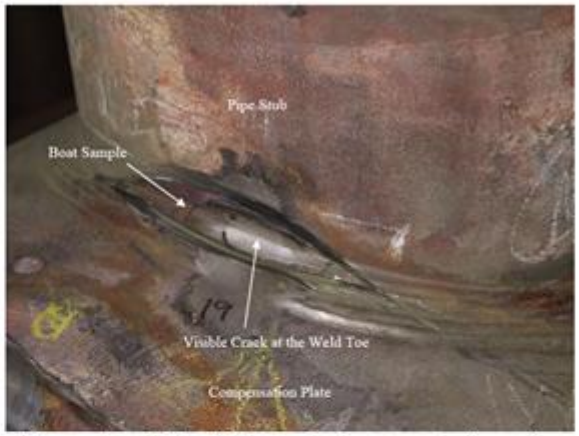
EA x Trincas

Comporta

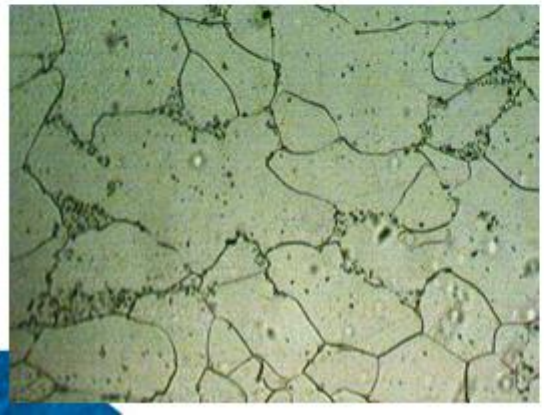
mento tipico



Non destructive Metallurgical Evaluation



Example of Boat Sample. Source: internet



Boat Sample

Araújo Engenharia em Equipamentos

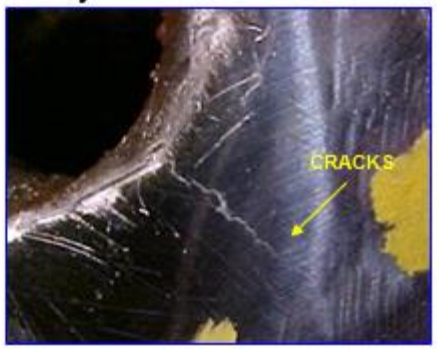
STRESS ENGINEERING SERVICES INC.

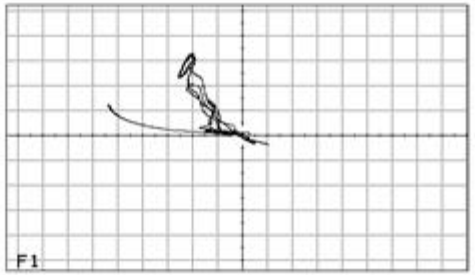
Fatigue / Creep Fatigue 7

Advanced NDT – **Phased Array & Eddy Current**

Phased Array

Eddy Current

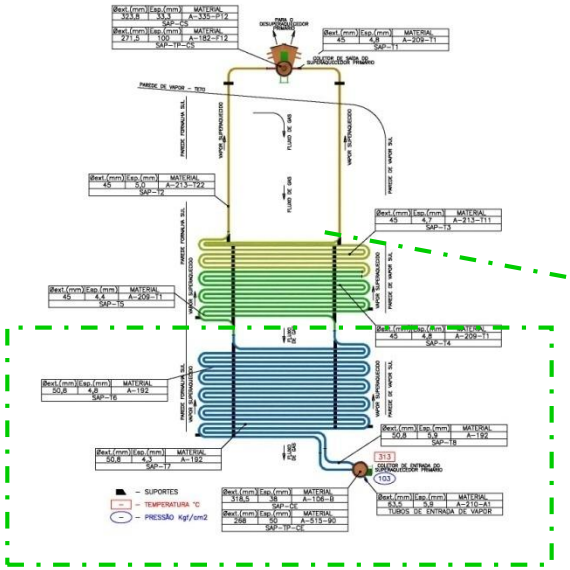




Araújo
Engenharia em Equipamentos

OBRIGADO

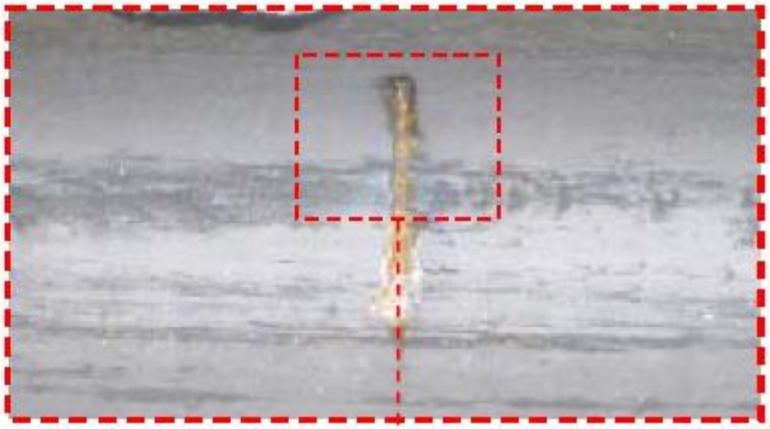
SAP – SUPERAQUECEDOR PRIMARIO



SAP – SUPERAQUECEDOR PRIMARIO

Superfície externa do trecho

Detalhe da trinca

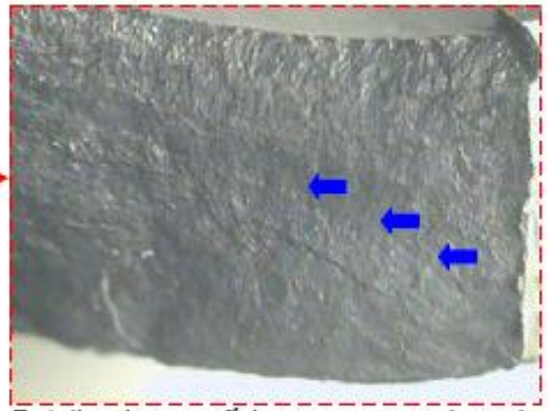


Superfície externa do trecho

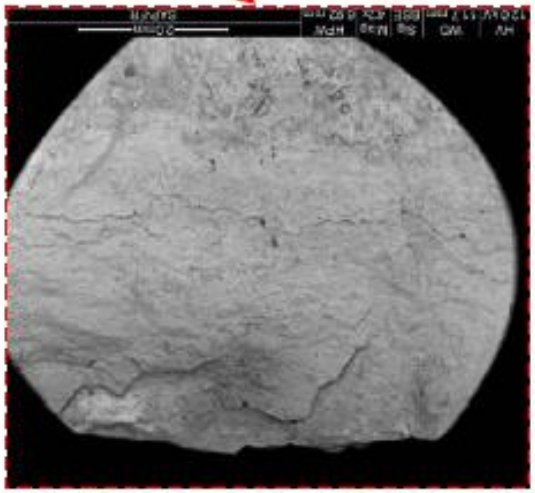
Detalhe da trinca

SAP – SUPERAQUECEDOR PRIMARIO

Superfície de fratura.

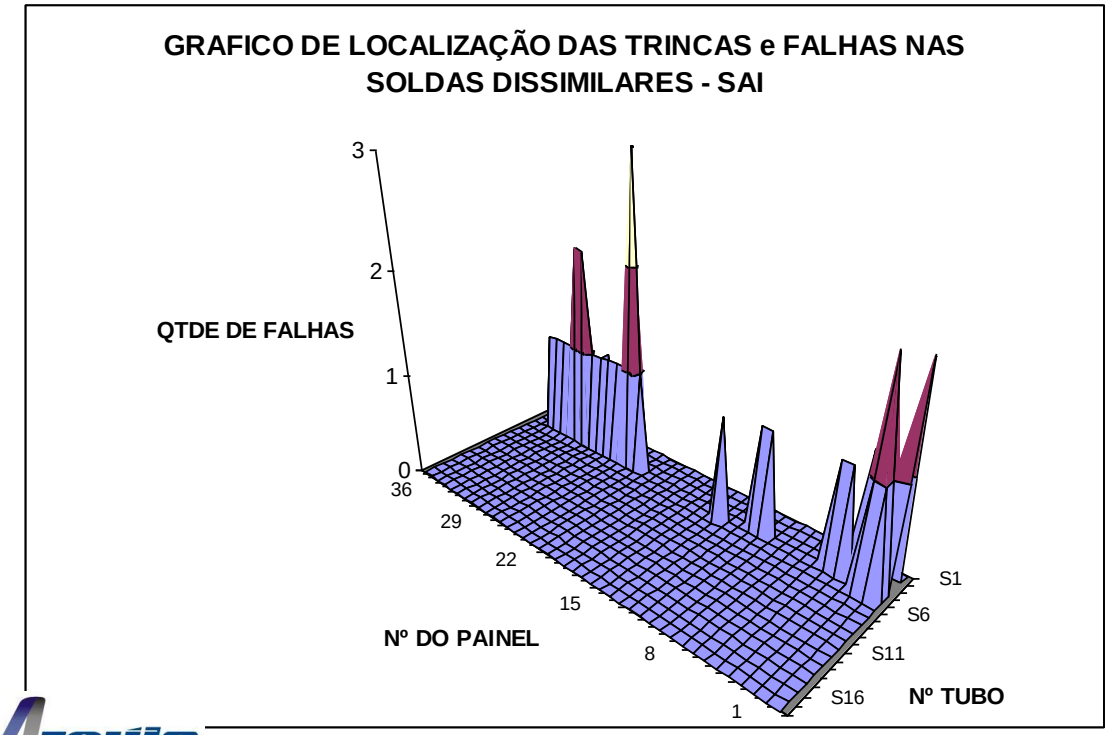


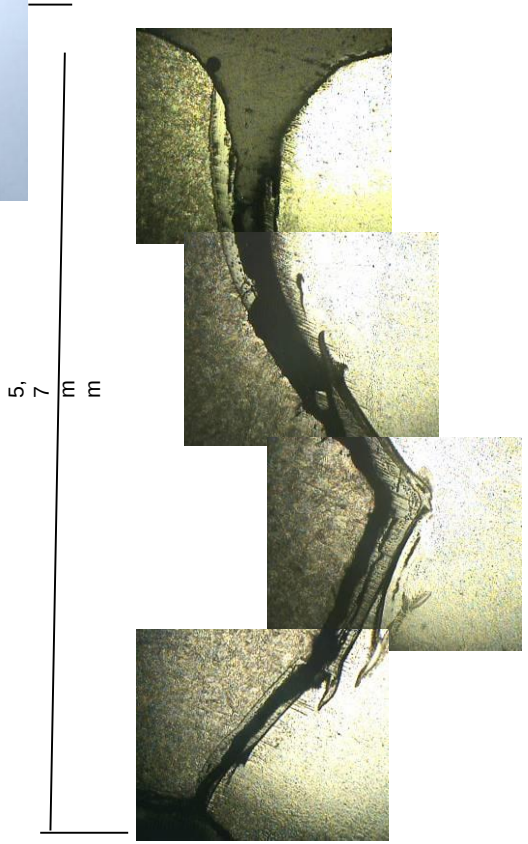
Detalhe da superfície com marcas de praia. 10X



Inicio da fratura, características fadiga. 42X

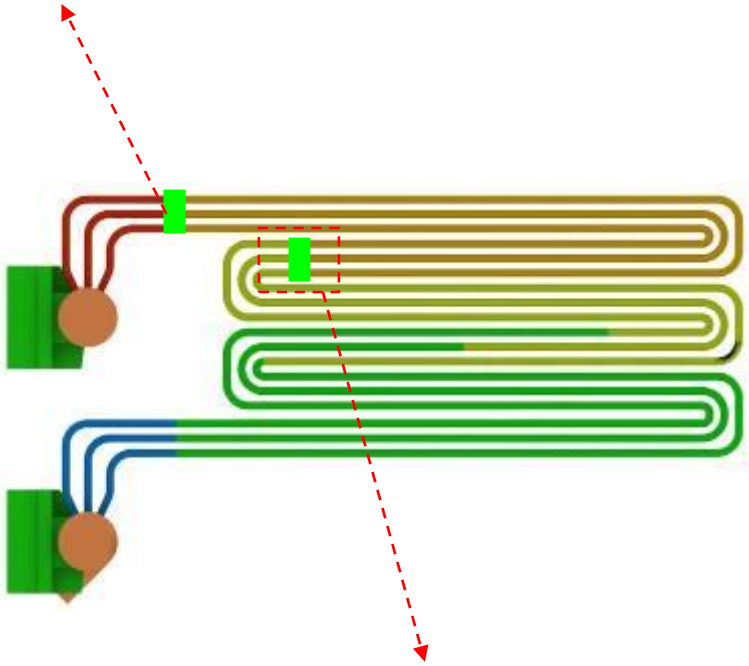
SAI – SUPERAQUECEDOR INTERMEDIARIO



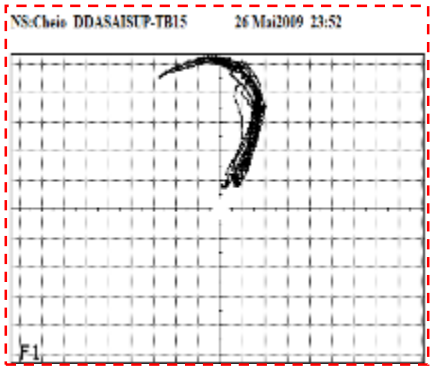


SAI – SUPERAQUECEDOR INTERMEDIARIO

REMOVER REFRATARIO



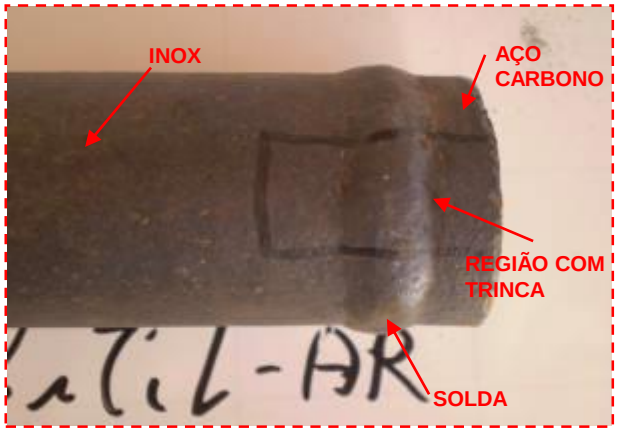
SOLDAS DISSIMILARES



TRAÇO DO ENSAIO MOSTRANDO SUPERFICIE COM DESCONTINUIDADE (TRINCA) NA SOLDA DISSIMILAR DO TUBO 2 DA SERPENTINA 15.

REGIÕES EXAMINADAS POR EDDY CURRENT

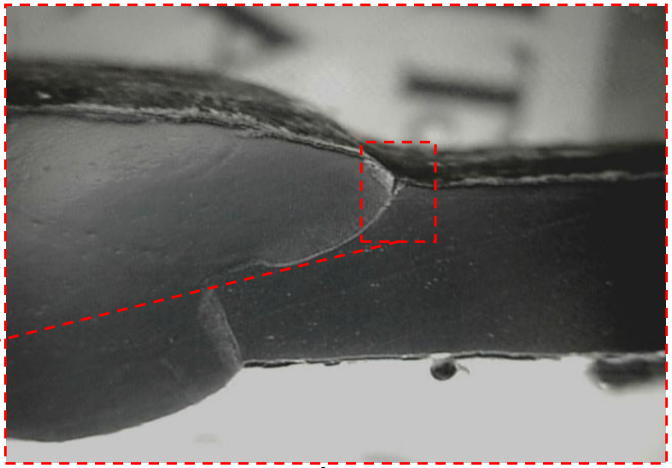
SAI – SUPERAQUECEDOR INTERMEDIARIO



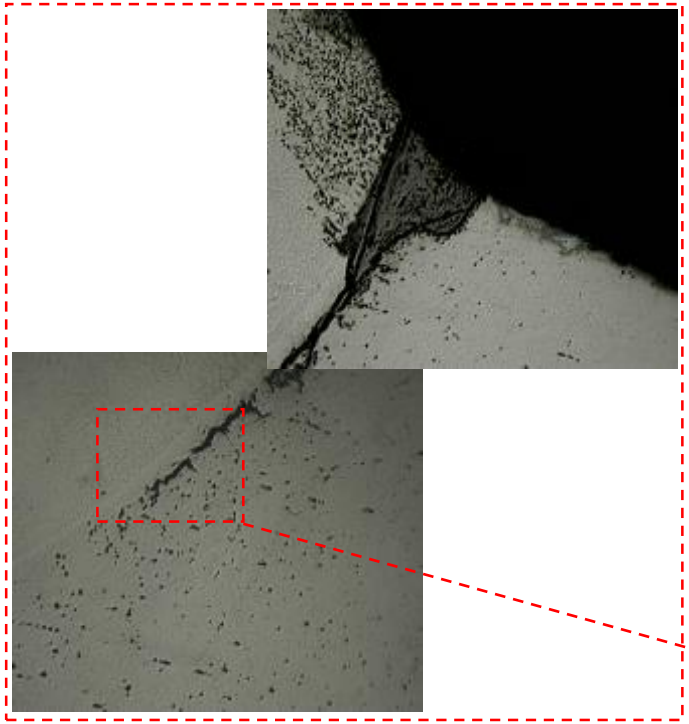
Amostra seccionada para análise micrográfica.

Macrografia da superfície com trinca

SAI – SUPERAQUECEDOR INTERMEDIARIO



Macrografia da superfície com trincas

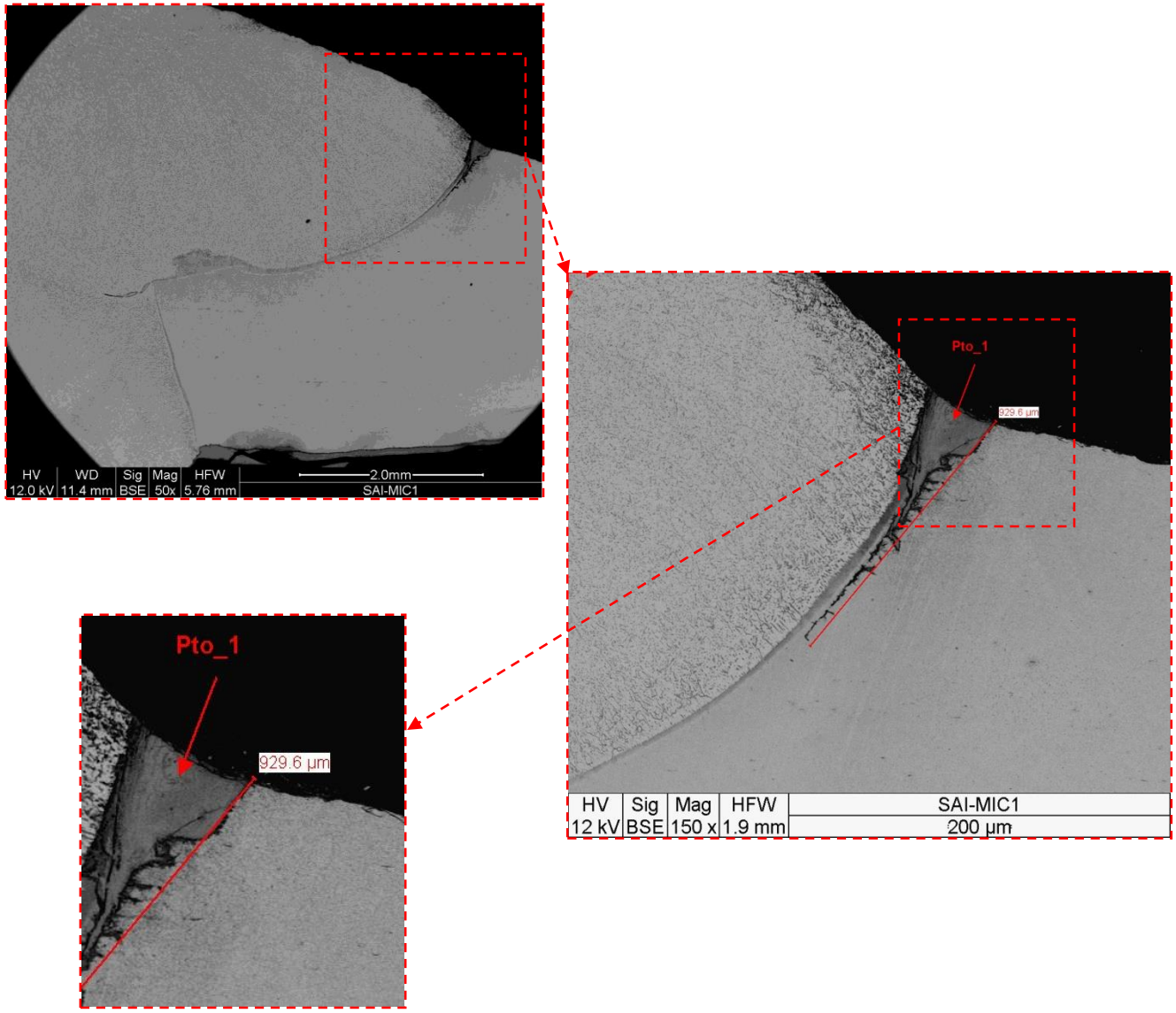


Trinca partindo da superfície do tubo em região de interface Metal Base (Aço Carbono)/ Metal de Solda. Aumento 100X.

Foto detalhe da extremidade da trinca. Aumento 400X.

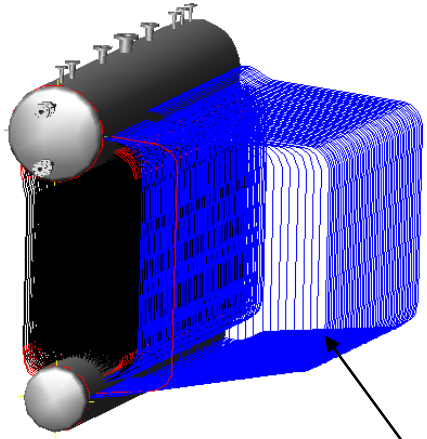
voltar

SAI – SUPERAQUECEDOR INTERMEDIARIO



TRINCAS EM TUBO DA ZONA DE CONVECÇÃO DE CALDEIRA

DANOS – TRINCAS E PITES

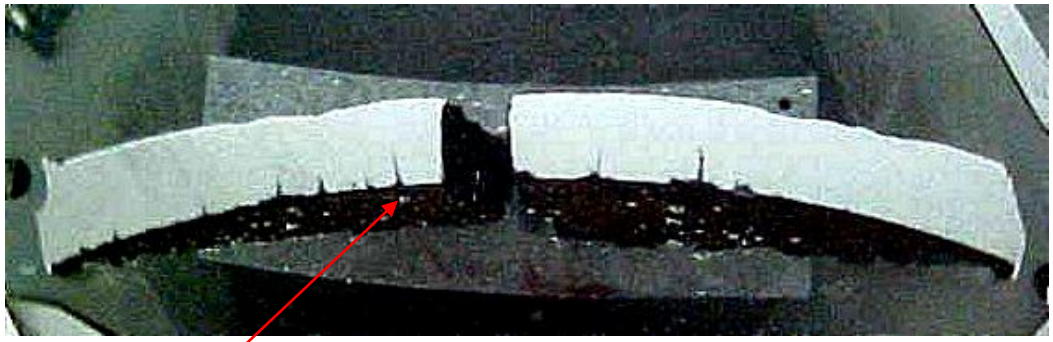


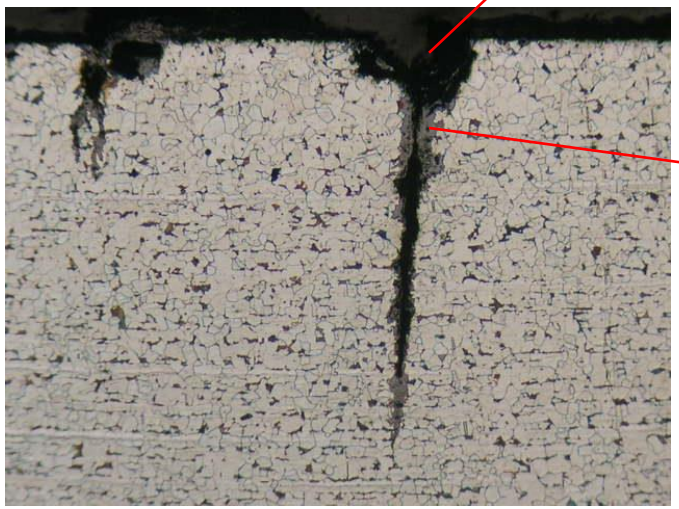
TRINCAS EM TUBO DA ZONA DE CONVECÇÃO DE CALDEIRA

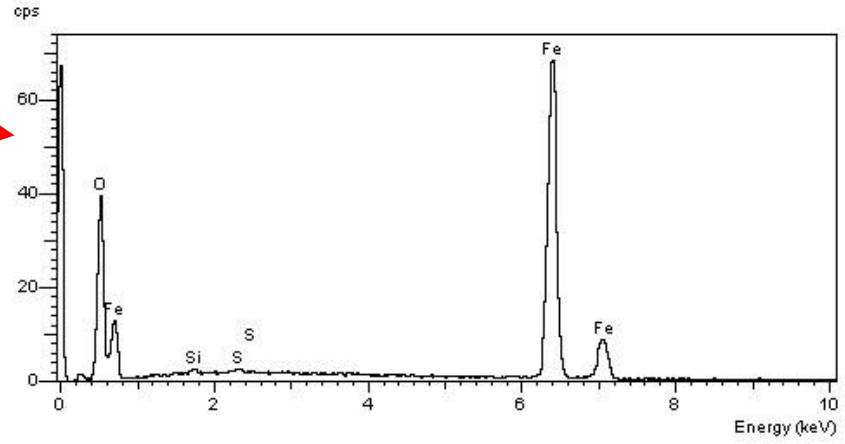
MECANISMO - CORROSÃO-FADIGA

CAUSA RAIZ - PARTIDAS DIÁRIAS

ÁGUA C/ O_2







TRINCAS EM TUBO DA ZONA DE CONVECÇÃO DE CALDEIRA

MECANISMO - CORROSÃO-FADIGA

CAUSA RAIZ - PARTIDAS DIÁRIAS

ÁGUA C/ O_2

Amostra como recebida. Tubo 6.

Parte interna do tubo.

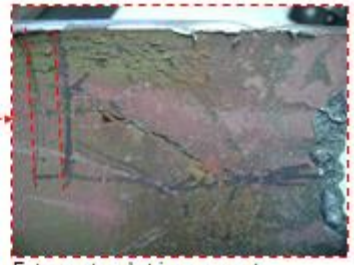


Foto mostrando trinca passante

Seccionamento do tubo.

Detalhe da fratura.