



电磁涡流无损检测技术

ELECTROMAGNET NON-DESTRUCTIVE TESTING TECHNOLOGIES

BFET | LFET | RFET | OSET

About TesTex

关于 TesTex



01.

TesTex was founded in 1987 and has become a leading provider of **Electromagnetic Non-Destructive Testing Systems**. CIMOTECH is the general agent of all TesTex's products in the Asia-Pacific region.

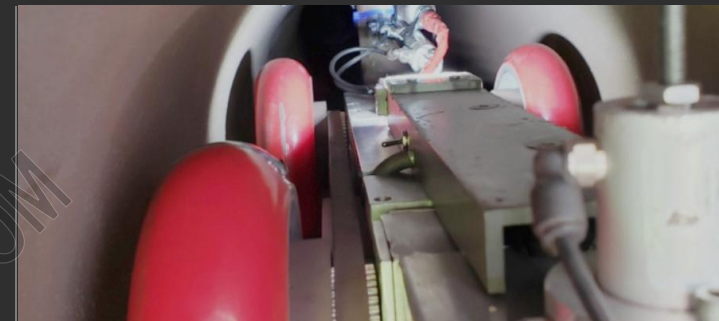
TesTex 成立于1987年，是业内领先的**电磁无损检测系统**制造商。司福斯特是 TesTex 全线产品在亚太地区的总代理。



02.

TesTex is a **full service non destructive testing company** pioneering the development and use of NDT systems for the inspection of both ferrous & non-ferrous components.

TesTex 是一家**提供无损检测全面服务的公司**，在铁磁性和非铁磁性金属元件无损检测的技术的发展和应用上处于前沿位置。



03.

TesTex is selling a full range of Electro-magnetic Technologies equipment and services. All can be **designed for special applications and projects on demand**.

TesTex 提供各种规格的电磁无损检测设备和检测服务，可根据各类**特殊应用场景和项目的需求进行定制化开发**。

Services

业务范围



销售产品

- 不拆保温层管道腐蚀检测设备
- 电磁超声检测设备
- 水冷壁管检测设备
- 全自动管道扫查设备
- 管道检测设备
- 换热器检测设备
- 管道内壁检测设备
- 超高速涡流检测设备
- 储罐检测设备
- 新一代相控阵检测设备
- 焊缝检测设备
- 常规超声探伤设备等



提供检测服务

- 管道检测
- 储罐检测
- 热交换器检测
- 炉管管壁检薄与裂纹检测等
- 各种非常规检测手段的检测任务



BFET – Crack Detection

Balance Field Electromagnet Technology
适用于裂纹检测的平衡场电磁检测技术

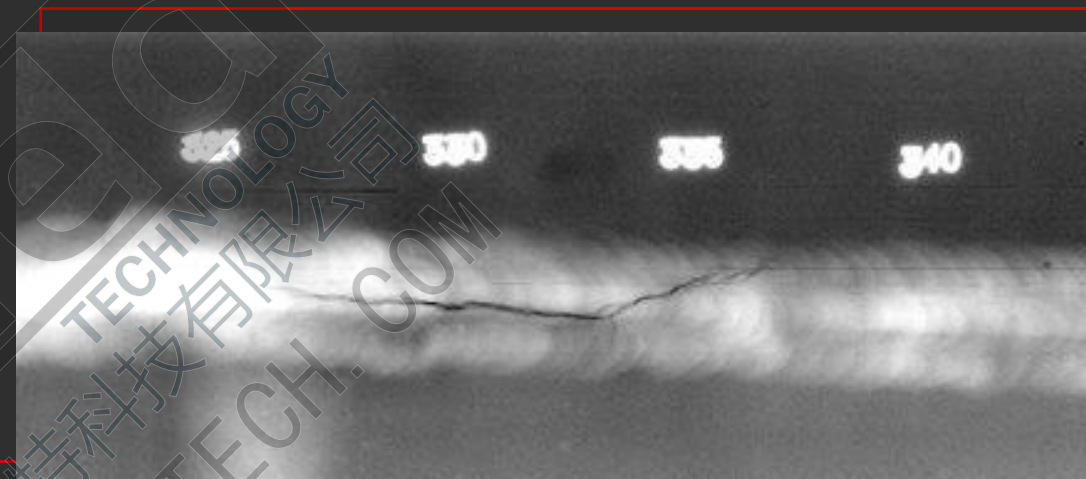
BFET for Cracking detection

用于裂纹检查的 BFET 技术



- From micro cracking to leakage: **cracking drives unpredictable situations.**

千里之堤，溃于蚁穴：微小裂纹会突然发展成无法预料的大事故。

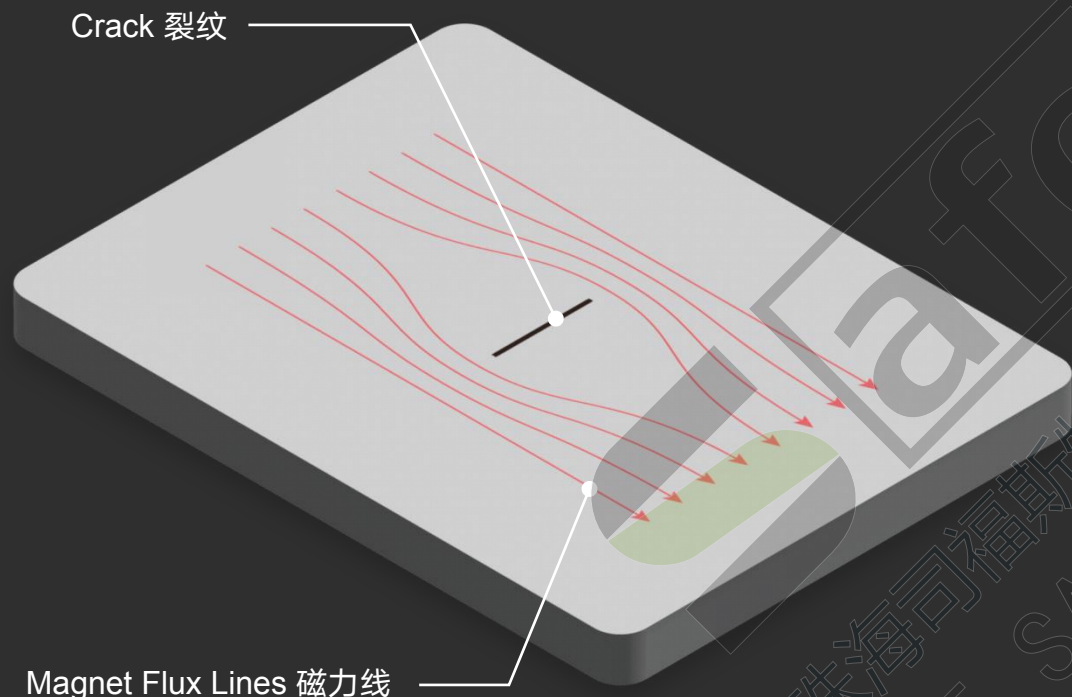


- Crack detection is very challenging for most of the UT techniques and mainly if cracking is combined with pitting and corrosion.

对于传统超声技术来说，裂纹检测是非常困难的，通常裂纹会和点蚀、腐蚀等混在一起。

Theory of the BFET probes

BFET 扫查头技术原理



Unbalanced State (defect)
非平衡状态 (有缺陷)

- Cracking and weld inspections are typically completed by traditional NDT methods such as Magnetic Particle (MT), Dye Penetrant (PT), Radiography, and specialized Ultrasonic techniques.

裂纹和焊缝检测通常采用常规的无损检测手段，例如磁粉（MT）、渗透（PT）、放射影像和专用超声技术。

- The TestTex BFET was developed as an alternative to the traditional cracking and weld NDT methods. The inspection technique can be used to detect surface and sub-surface defects in plate welds on Carbon and Stainless steel.

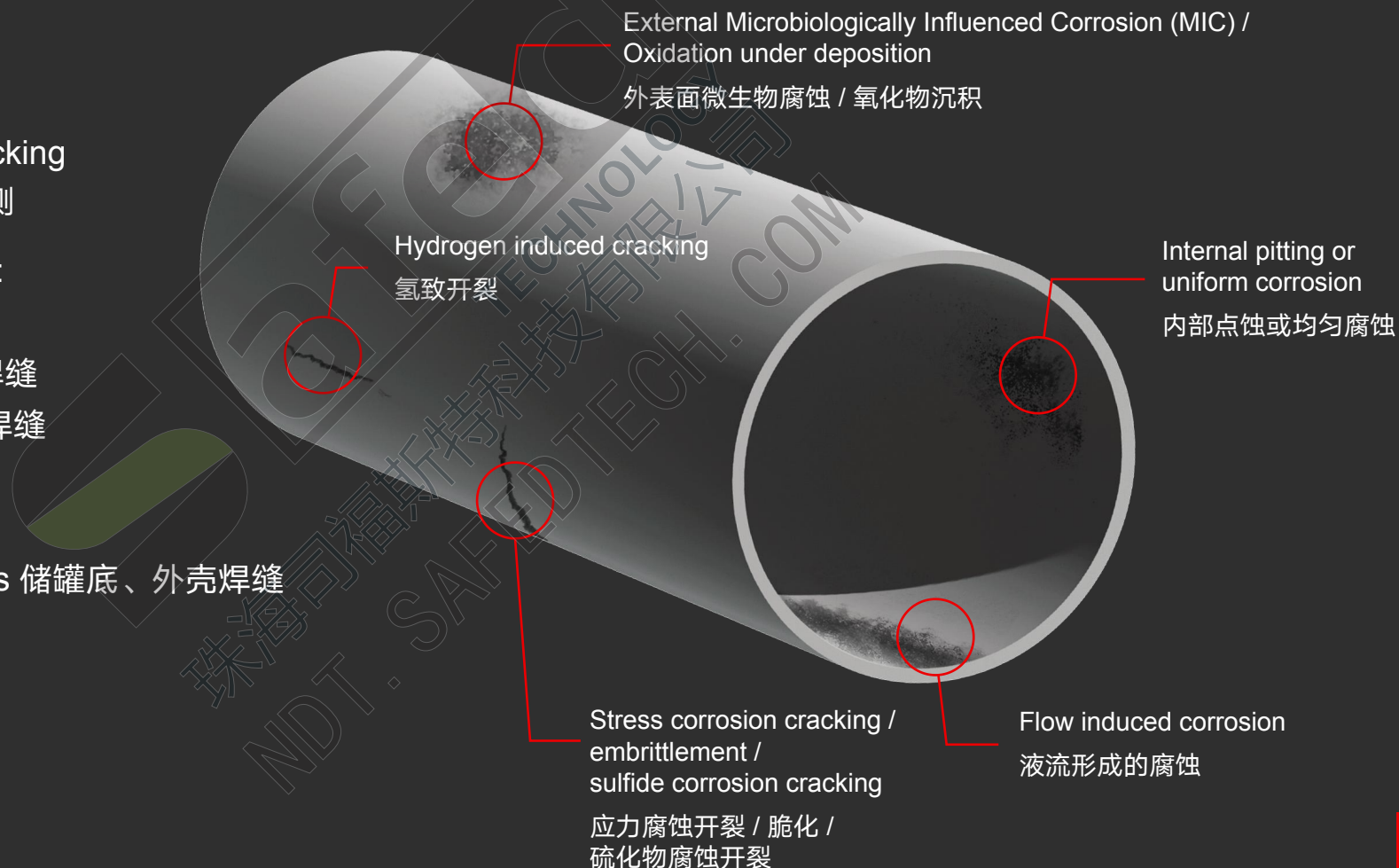
TestTex 的 BFET 技术的发展为这些传统的裂纹焊缝无损检测技术的提供了替代方案。该检测技术可用于检测碳钢、不锈钢焊缝表层及层下缺陷。

BFET for Cracking detection

用于裂纹检查的 BFET 技术

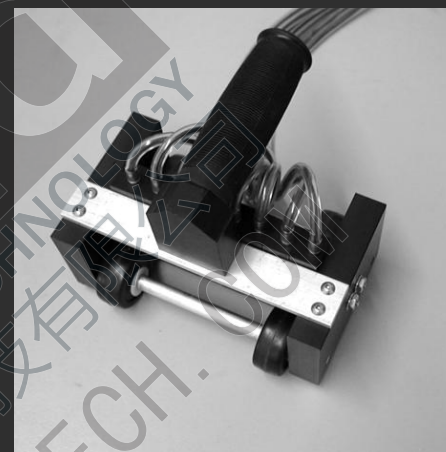
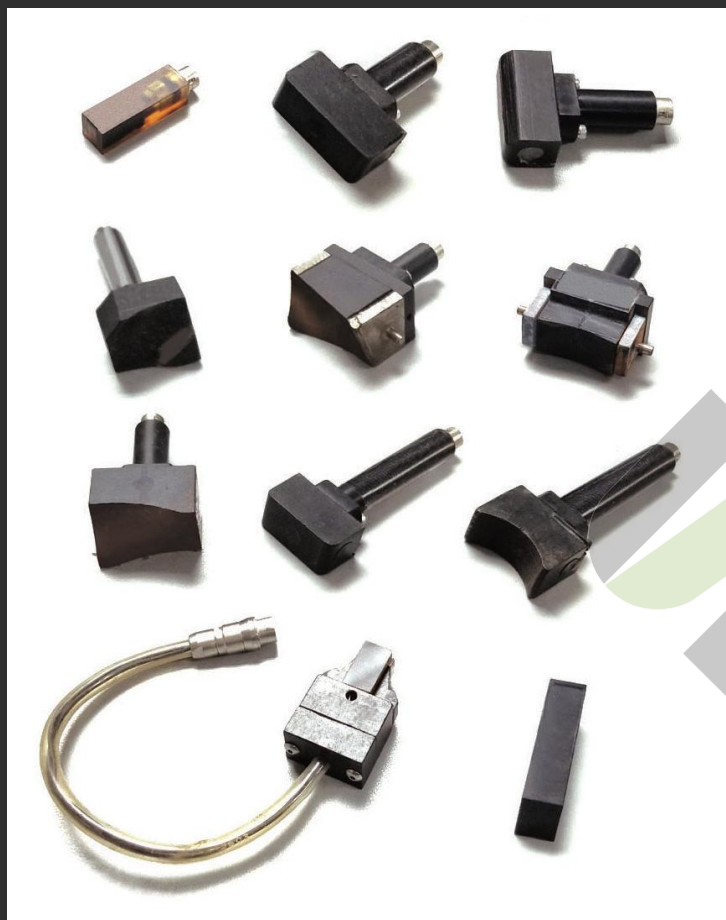


- BFET to cover all kinds of cracking
BFET 技术可覆盖各类缺陷检测
- Several applications 常见应用:
 - Pressure vessels 压力容器
 - Tube to header welds 管头焊缝
 - Dissimilar metal welds 金属焊缝
 - Windmill towers 风电塔
 - General vessels 普通容器
 - Storage tank floor/shell welds 储罐底、外壳焊缝
 - Pipelines 管道
 - Bridges – Columns 桥梁建筑
 - DA tanks DA 储罐
 -

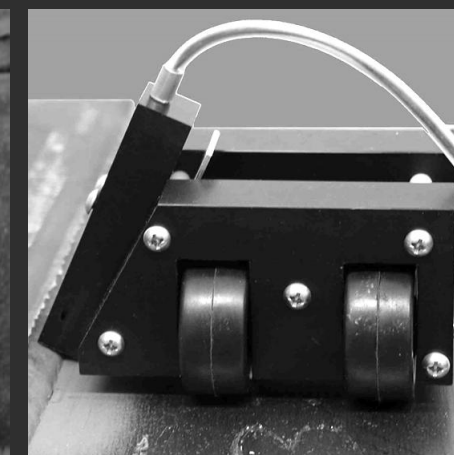


Customized BFET probes

定制化 BFET 探头



BFET Probes
specifically designed
for varies of
applications
适应各种应用场景的
定制 BFET 探头

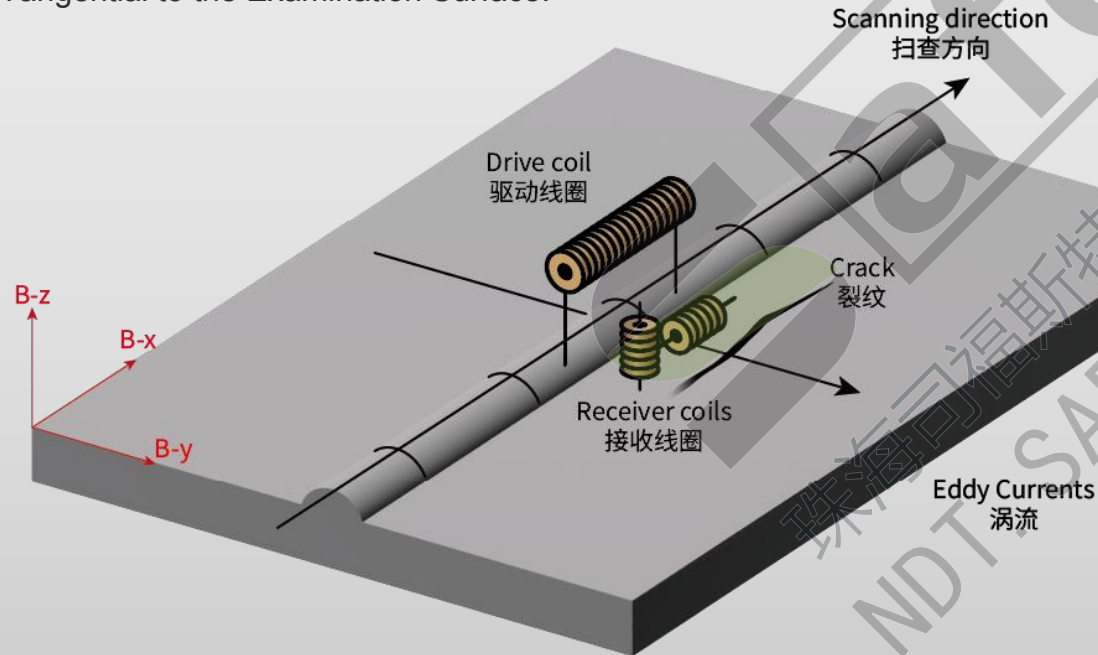


Theory of the BFET probes

BFET 探头原理

Figure XI-821-2

Example Coil Arrangement: Tangentially Oriented Driver Coil with Passive Receiver Coils Oriented Perpendicular and Tangential to the Examination Surface.



- As a derivative of Eddy Current, the Balance Field Technique (BFET) was developed to enhance the signal responses produced from smaller defects such as cracks.
作为涡流的衍生技术，BFET 旨在增强从裂纹等较小缺陷接收信号的能力。
- Two receiver coils are wound together on one bobbin. One coil is parallel to the testing plane, while the other coil is perpendicular to it.
作为涡流的衍生技术，BFET 旨在增强从裂纹等较小缺陷接收信号的能力。

BFET approved by ASME Section V

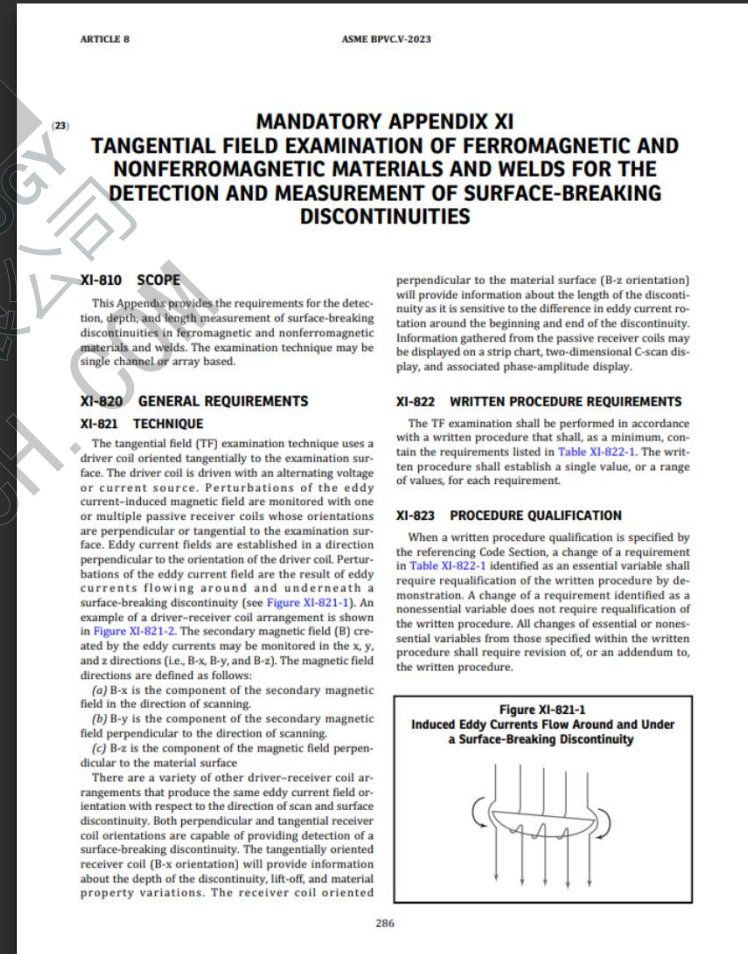
BFET 技术通过 ASME Section V 标准

BFET was incorporate in ASME V version 2023.

BFET 技术收录于 ASME V 2023 版。

On review of the technique it was established that the Tangential Eddy Current Technique and Lift off Compensation Technique use very similar electromagnetic configurations and the document was adjusted to incorporate these BFET techniques as well ACFM does not use phase information so has another appendix in the ASME.

涡流技术和提离补偿技术运用了非常类似的电磁设置，该文档是根据为了包含 BFET 技术，由于 ACFM 涡流不采用相位信息，因此 ACFM 包含在 ASME 的另一章节附件里。



BFET Inspection Benefits



BFET 的技术优势

-
- ✓ Replace Dye Penetrant and Magnetic Particle tests for a safer and clean environment
可替代渗透和磁粉检测，打造更加安全、清洁的环境
 - ✓ Detects surface and sub-surface cracking up to 9mm deep
可检测表面及下方最多 9mm 深处裂纹
 - ✓ Inspects ferrous and nonferrous metals (Stainless Steel)
可检测铁磁性和非铁磁性金属（例如不锈钢）
 - ✓ All surfaces with or without coatings (up to 15mm coating)
可检测所有无涂层及表面带有最多 15mm 厚涂层的工件
 - ✓ Test speeds is very fast up to 30cm/sec
检查快速，速度高达 30cm/秒
 - ✓ Minimal surface preparation, no couplant
仅需要最低程度的表面处理，无需耦合剂
 - ✓ 3D Viewer for better analysis of the defects
3D视图方便您更好地进行缺陷分析
 - ✓ Testex can design special probes and scanners according to specific requirements
Testex 可根据特殊需求定制探头和扫查器
-

BFET Software

BFET 软件



BFET software makes detection fast and accurate

BFET 软件使缺陷检测更加快速和精确

- Frequency range 5Hz-30KHz
频率范围 5Hz - 30KHz
- Real time data processing
实时数据处理
- Data displayed in horizontal, vertical, and impedance planes
数据按水平、垂直和阻抗来显示
- Noise and liftoff signals can be rotated away from flaw signals
噪音和提离信号可以通过旋转与缺陷信号分离
- Up to 8 channels for 3D analysis
3D 分析支持最多 8 个通道数据

BFET – the only solution on Stainless



BFET – 不锈钢检测的不二之选



- **UT / RT:** Start of CSC is too small
超声 / 射线：曲面校正（CSC）起始太小
- **PT / MT:** Ok, but too late or you need to have access to the inner side
渗透 / 磁粉：可行，但等发现为时已晚，或需要进入内部
- **AE:** Can be, but difficult on stainless steel
声发射：可能有效，但在不锈钢上较为困难

Could find INTERNAL CRACKS up to 8mm subsurface?

其他技术是否有办法探测内表面下 8mm 深处的裂纹？

The CLAW for HRSG

HRSG 检查用机械爪



The CLAW for HRSG (High Recovery Steam Generator) using BFET probes and camera

搭载 BFET 探头及摄像头的余热锅炉 HRSG 检查用机械爪

- Mechanical platform built for BFET flaw detection
专门为 BFET 缺陷检测而设计的机械式搭载平台
- Optimally orient the sensors with respect to the upper toe of the weld while allowing a rotation about the tube
优化的传感器排列，可到达焊缝上缘并绕管道旋转
- The scanner has several degrees of freedom and axes of motion for the 2 sensors to be oriented correctly as they rotate about the tube
扫描探头有若干自由角度以及多运动轴向，以便 2 个传感器在绕管道旋转时正确定向

The CLAW for HRSG

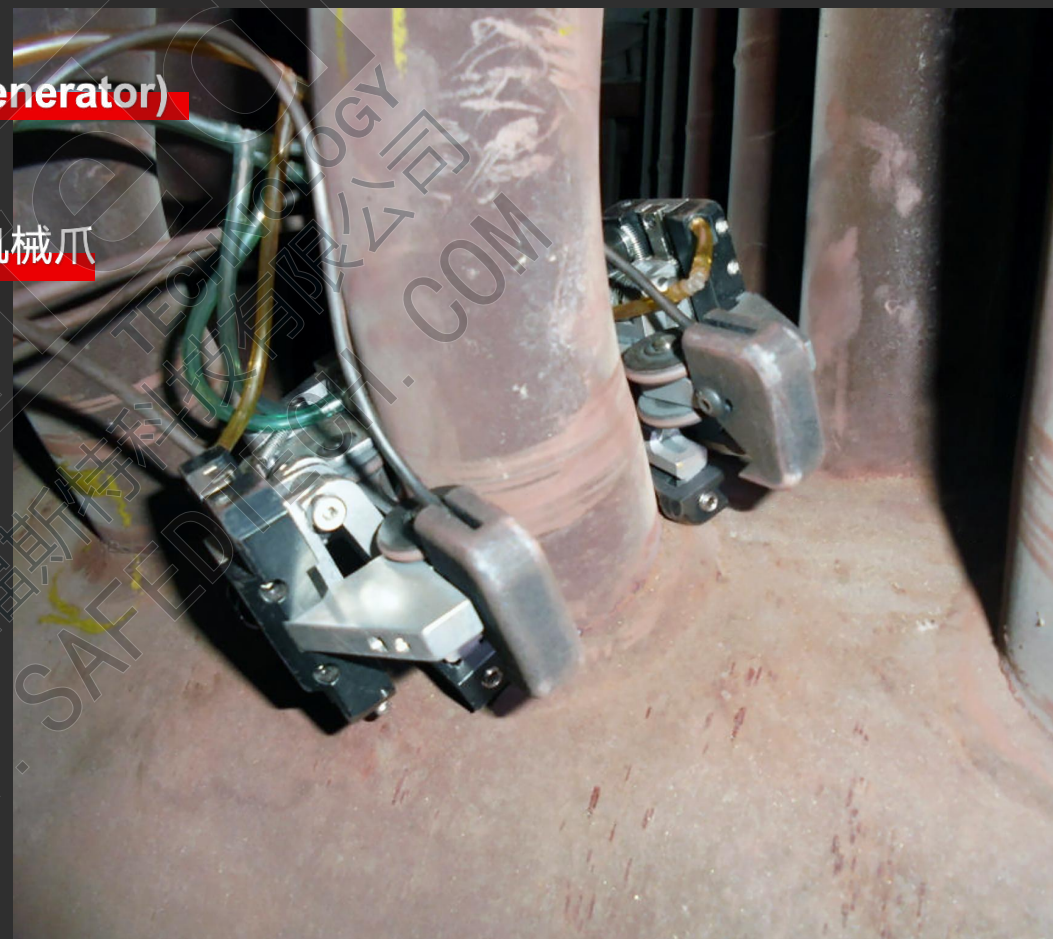
HRSG 检查用机械爪



The CLAW for HRSG (High Recovery Steam Generator) using BFET probes and camera

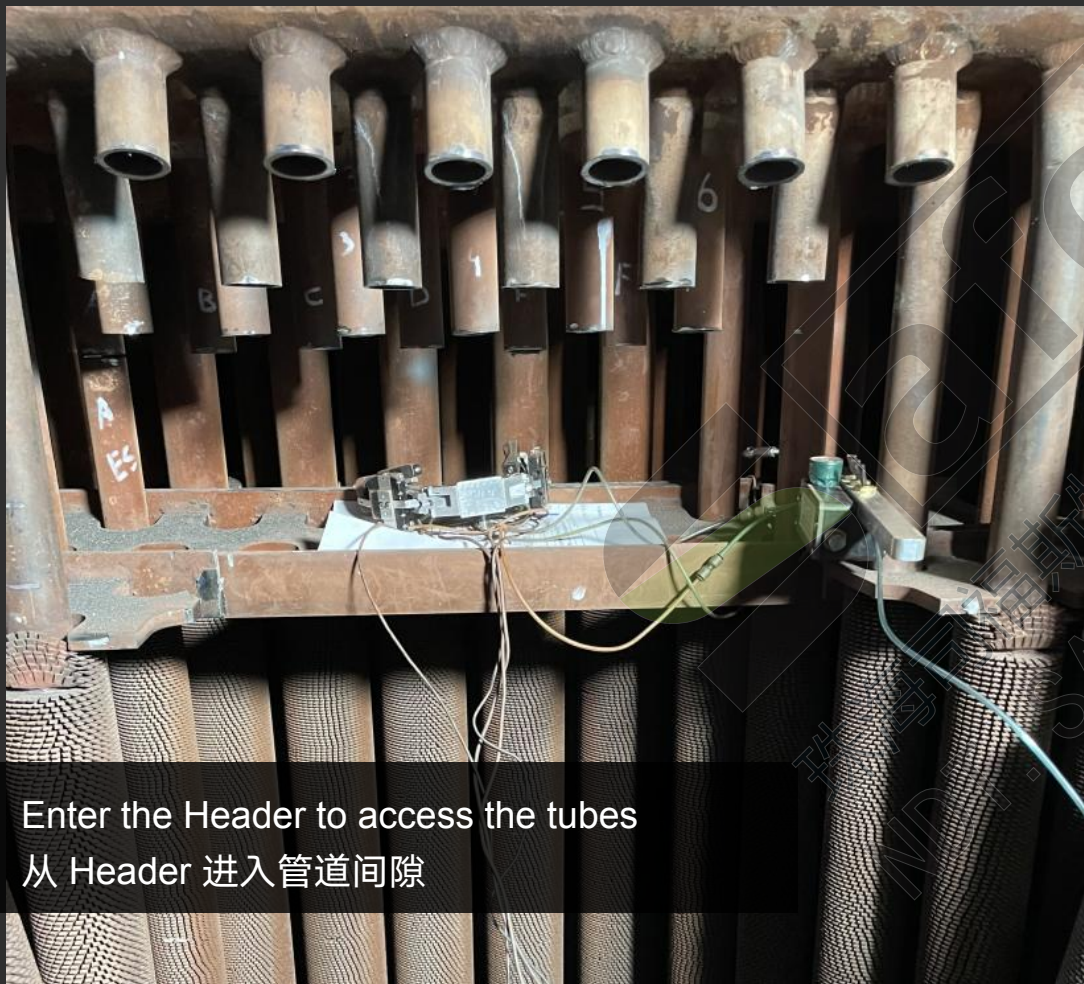
搭载 BFET 探头及摄像头的余热锅炉 HRSG 检查用机械爪

- The scanner can be unfolded to reach past the first row tubes to the second row and in some case the third row
扫描探头可以展开越过第一排管道到达第二排管道，甚至某些情况下可到达第三排
- The amplitude tells more about the size of the defect.
波形振幅可以更好地反映出缺陷尺寸
- The equipment can replay the movement combined with the video for further inspections and comparisons
设备可以结合视频回放动作，以便进一步检查和比较

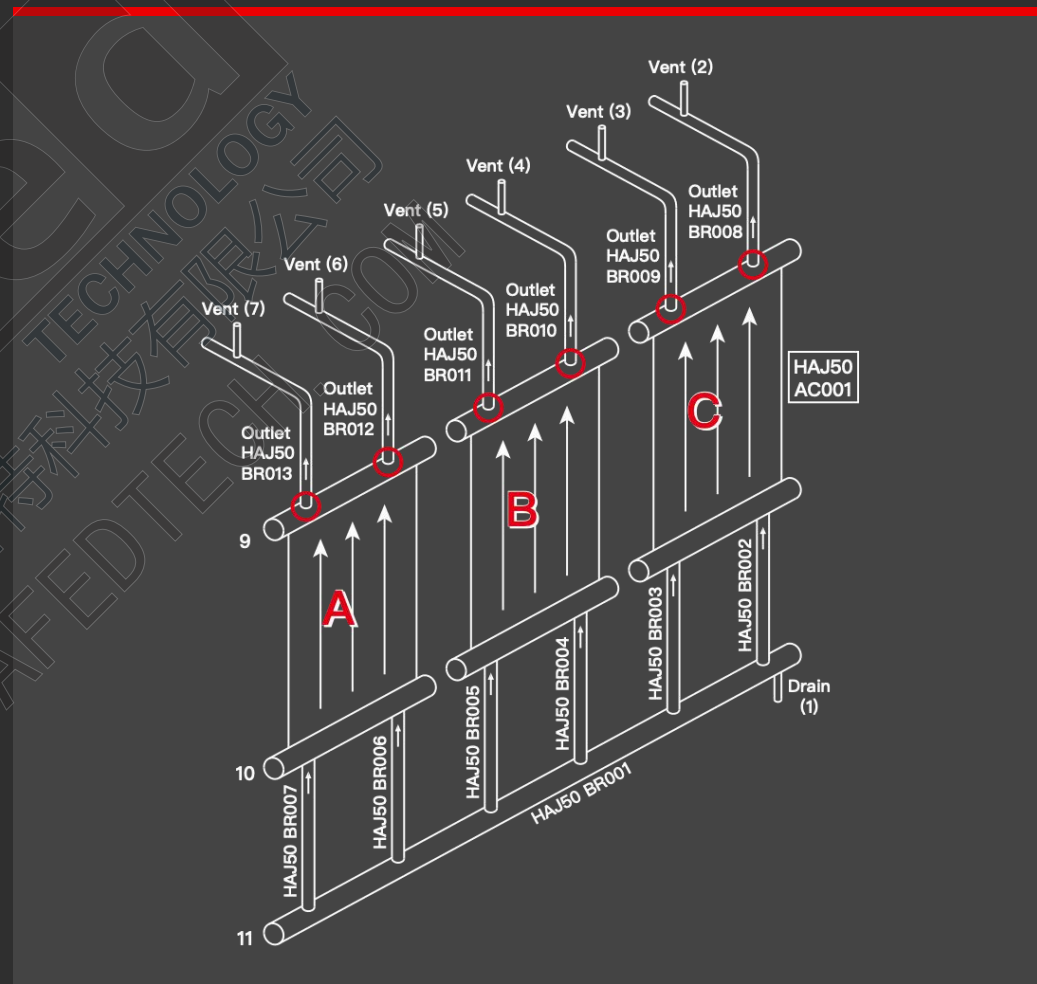


The CLAW for HRSG

HRSG 检查用机械爪

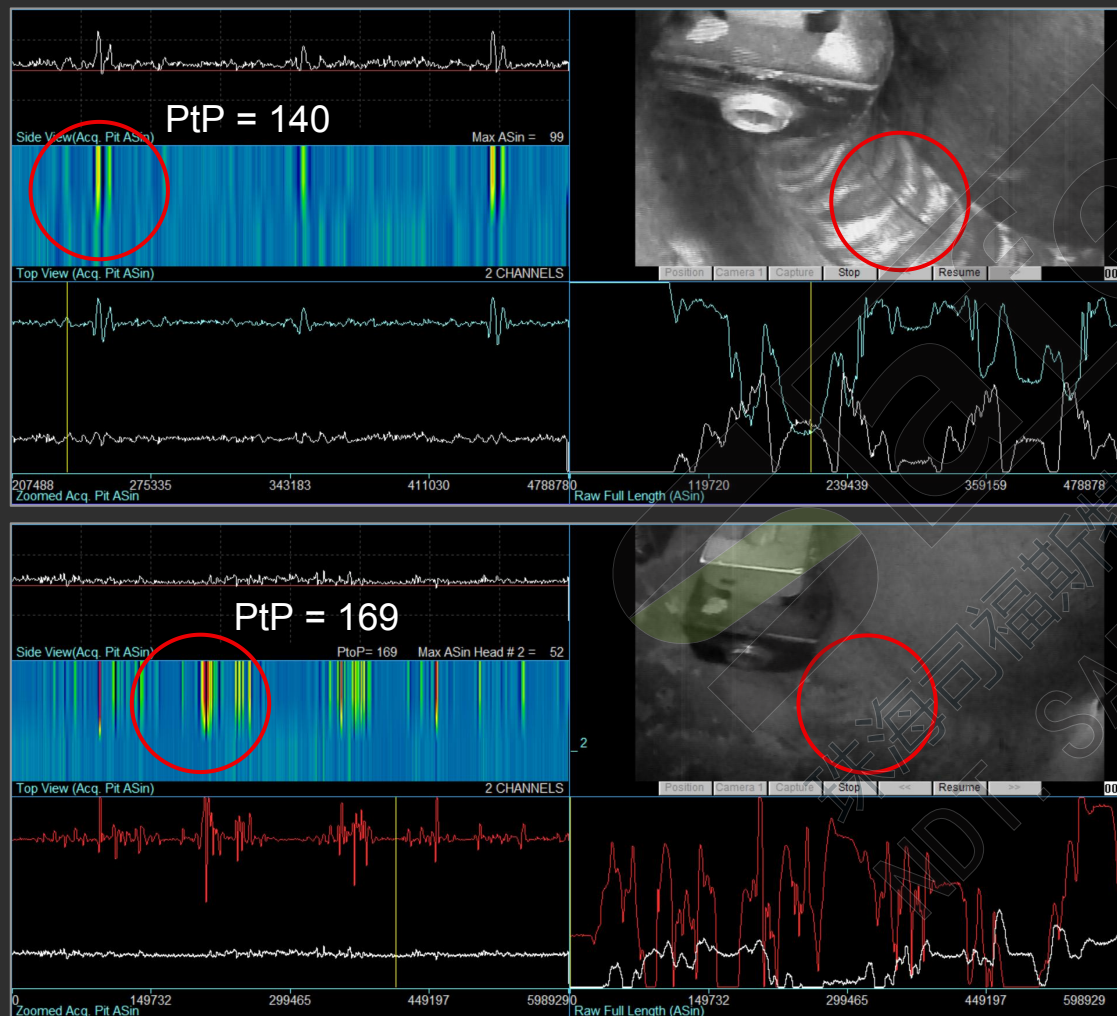


Enter the Header to access the tubes
从 Header 进入管道间隙



The CLAW for HRSG

HRSG 检查用机械爪



Calibration to get the minimal signal level
通过校准样管来确定最小的信号等级



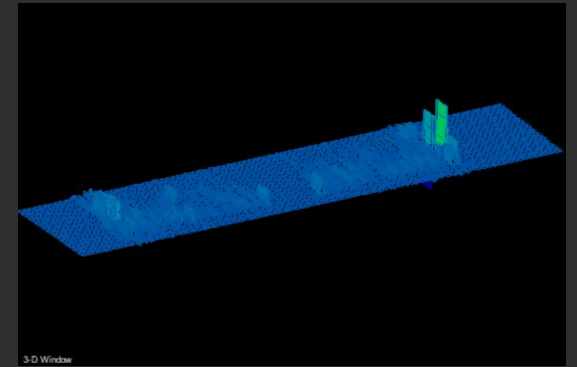
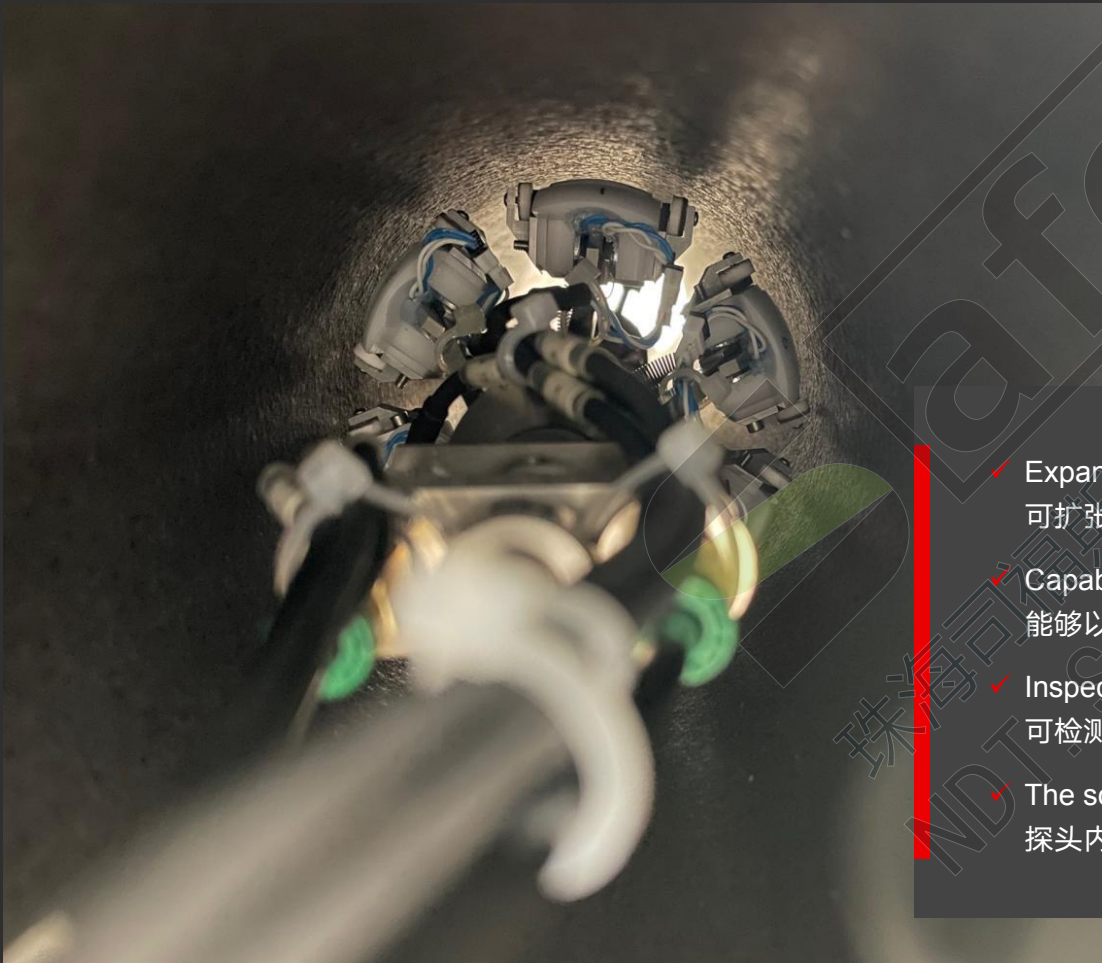
Cracking in the HAZ > 60% – length 30mm
热影响区的裂纹，深度 > 60%，长度 30mm

Example of defect with combined video and waveform
结合视频和波形的缺陷示例

BFET Expandable ID Multichannel Scanner



BFET 可扩张式内径多通道扫查器



- ✓ Expandable to cover several diameters and always keep contact with the surface
可扩张机构以适应多种内径，使探头始终紧贴内径
- ✓ Capable to detect small micro-cracking and small pittings with a speed of 30cm/s
能够以 30cm/s 的速度检测微小裂纹和点蚀
- ✓ Inspects ferrous and nonferrous metals such as Stainless Steel or Duplex
可检测铁磁性和非铁磁性金属，例如不锈钢、双相钢
- ✓ The scanner is encoded and gives combined waveform and video of the defects location
探头内置编码器，可给出缺陷位置的组合波形和视频

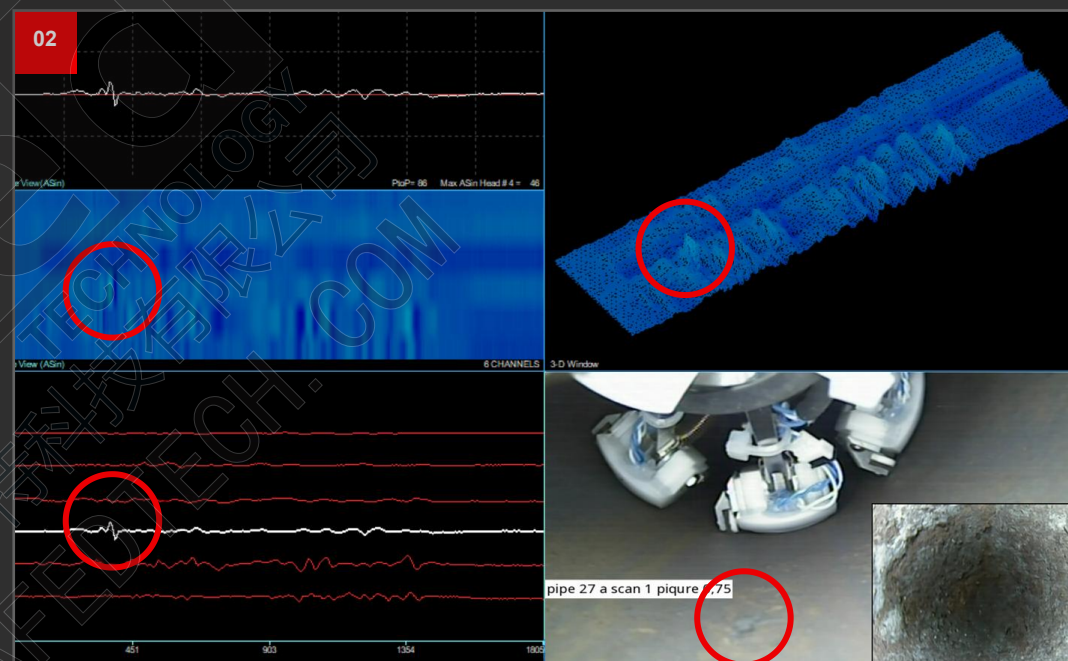
BFET Expandable ID Multichannel Scanner



BFET 可扩张式内径多通道扫查器



Cracking at 7.8m, signal value PtP: 56
在 7.8m 处检出点蚀，信号振幅 56



Pits at 0.75m, signal value PtP: 86
在 0.75m 处检出点蚀，信号振幅 86

First Tests

验证检测

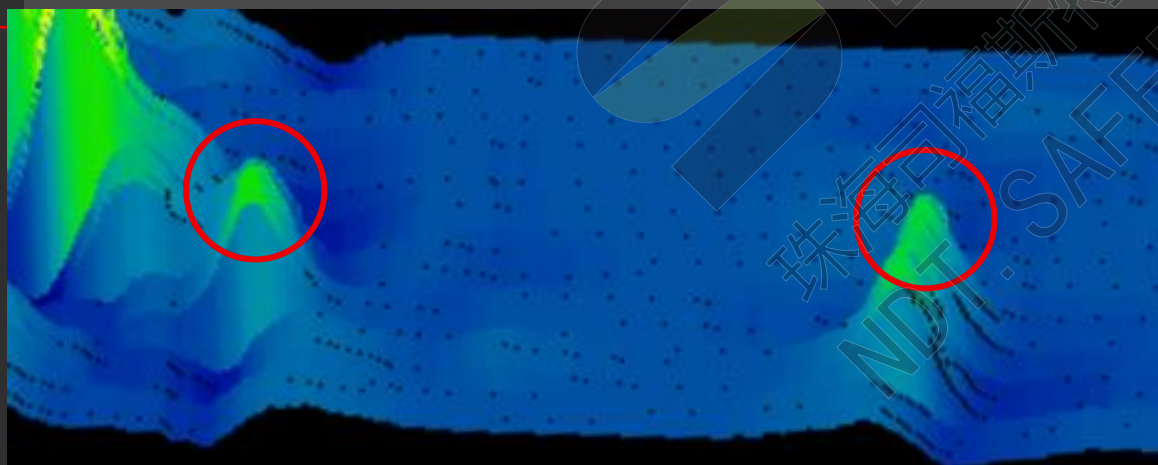


Results:

The linear probe moves inside the tube to detect external small cracking

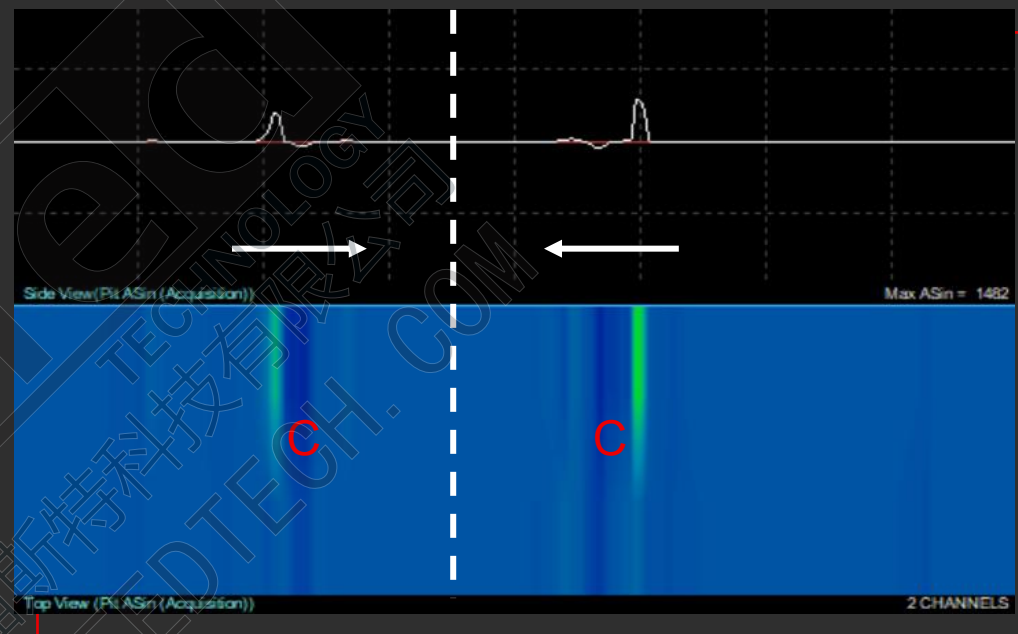
检测结果:

线性探头从管道内部伸入可检测出外部小缺陷



First Tests

验证检测



The rotating probe detects from the ID the cracking on the external HAZ

使用旋转探头可从管道内部检测到热影响区外部的微小缺陷



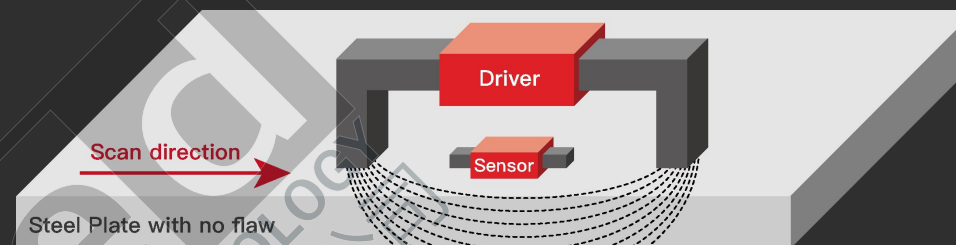
LFET – Corrosion Detection

Low Frequency Electromagnet Technology
适用于腐蚀检测的低频电磁检测技术

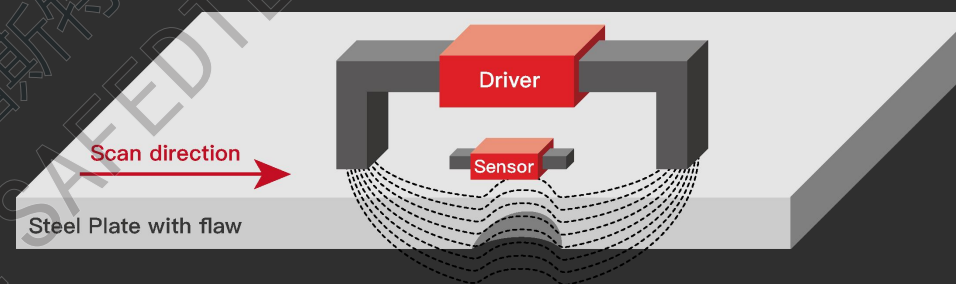
Theory of the LFET probes

LFET 扫查头技术原理

低频电磁检测技术 LFET (Low Frequency Electromagnetic Technique) 使用离散的激励和接收传感器线圈，激励线圈在较低的频率 ($\leq 10\text{Hz}$) 下激发产生一个交变电磁场，并穿透被测材料，从其一侧传导到另一侧。在没有壁厚减薄和缺陷的地方，电磁场产生一定信号强度衰减，如图1所示；当探头移动到壁厚减薄和缺陷的地方时，可以检测到一个较强的电磁场信号，如图2所示。



- With no flaw, sensor sees uniform magnetic field as probe sweeps across the plate.
在无缺陷钢板上，探头扫过时传感器接收到规则的磁场



- With flaw, sensor sees distorted magnetic field near the flaw as probe sweeps across the plate.
在有缺陷的钢板上，探头扫过时传感器接收到缺陷附近被扰乱磁场

Applications of LFET

LFET 适用场景



■ 适用场景

- 密排管道
- 水冷壁管
- 异型管件
- 小管径管道



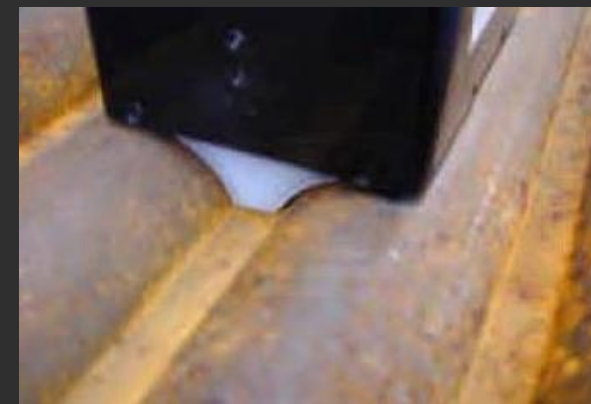
▲ 弯管扫查器



▲ 小区域扫查器



▲ 小管径扫查器



▲ 肋片扫查器

Applications of LFET

LFET 适用场景

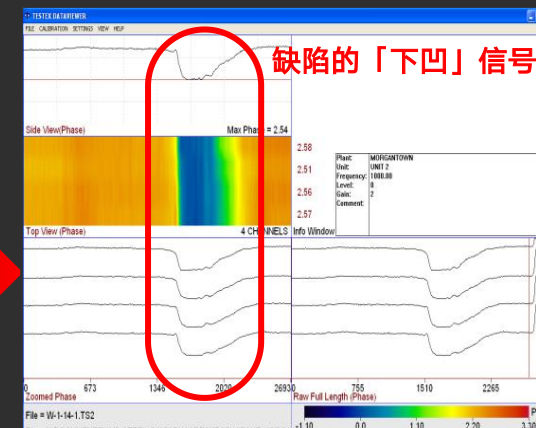


堵管检测

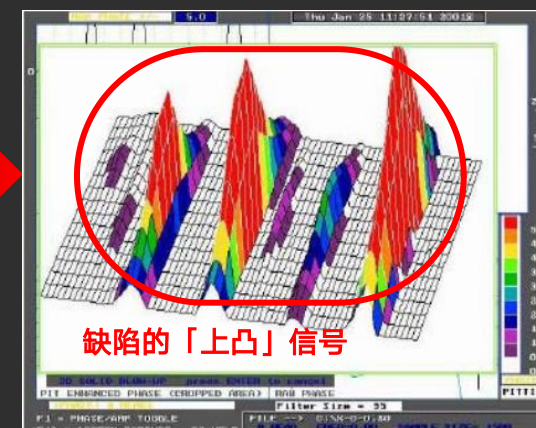
铁磁性垢物, Fe_2O_3 等



低点沉积



低点腐蚀



原理: 铁磁性垢物, 如 Fe_2O_3 、 Fe_3O_4 、 NiO 等, 具有导磁性, 增加局部磁导率 (降低磁阻), 这个特征正好与缺陷诱发的磁信号变化相反

Applications of LFET

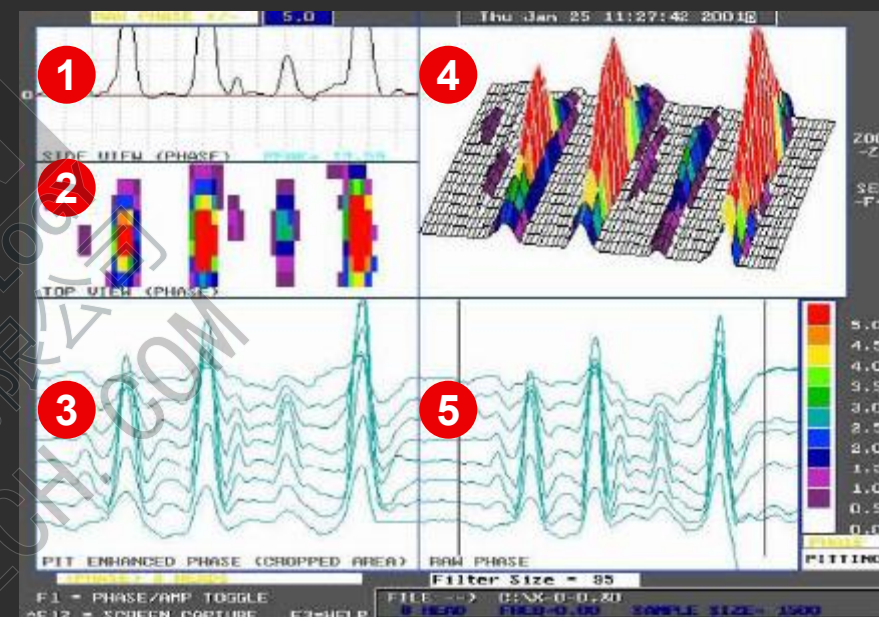
LFET 适用场景



▲ 锅炉内的水冷壁管现场



▲ 扫查器检测



▲ Full screen view of corrosion displayed by software
软件显示的腐蚀全屏视图

- ① Lateral View
侧视图
- ② Vertical View (C-Scan)
俯视图 (C-scan)
- ③ 8-Channel Data
Processing Window
8通道数据处理窗口
- ④ 3D View
3D视图
- ⑤ Raw Data Window
原始数据窗口

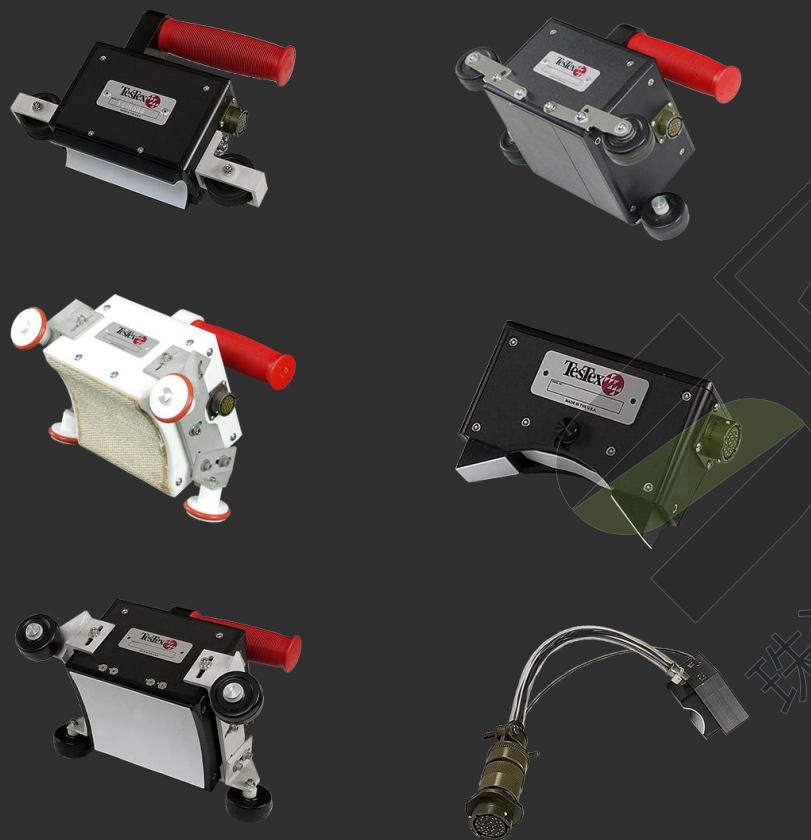
Scanners of LFET

LFET 系列扫查器



技术参数

最大可测金属厚度	19 mm
一次扫查角度	170° (DN ≤ 100 mm)
阵列通道数量	8 / 16通道
可测材料	铁磁性或顺磁性材料
可测缺陷	坑蚀、减薄、裂纹
可测内容	缺陷定位、缺陷定量 (长宽)
最大扫描速度	50 ~ 75 mm/s
抗干扰能力	油漆、镀层、锈对检测无影响
检测数据处理能力	A扫、B扫、C扫
堵管状态参数	堵塞物增量 (堵管截面积5%及以上)、 垢的干湿性、堵塞物起始位置



LFET Water Wall Inspecting System

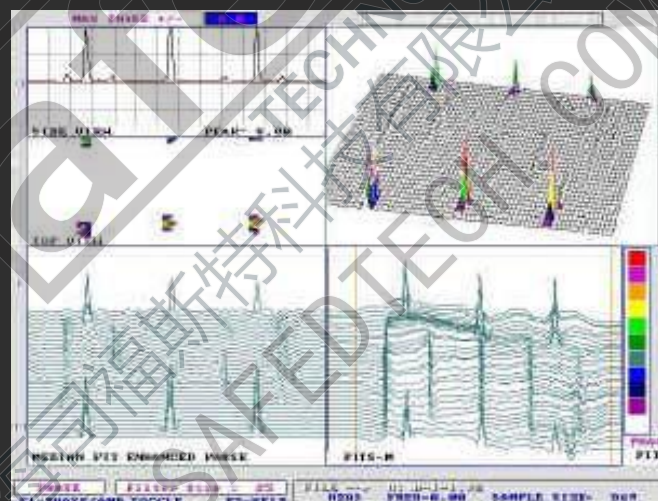
LFET 水冷壁检查系统



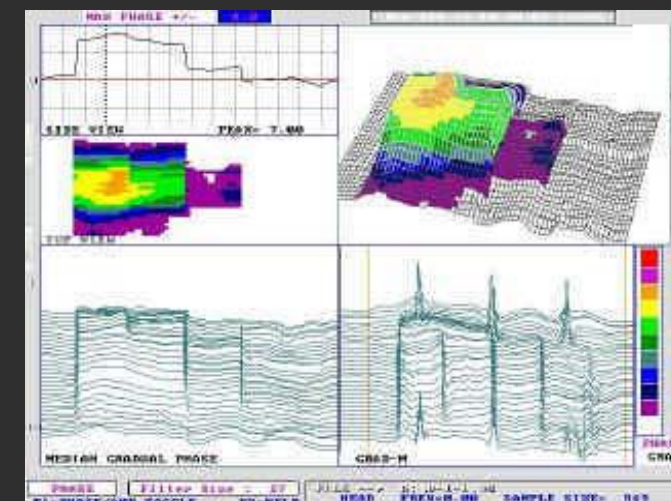
Electromagnet Imaging Technology 电磁成像技术

Defects have a volumetric shape, especially the thinning of wall thickness, whose changes must be described by three-dimensional parameters. Low-frequency electromagnetic detection has developed phase resolution technology, and various methods such as phase analysis, frequency analysis, and amplitude identification are used in signal analysis and processing, which can analyze and process the amplitude and phase changes of electromagnetic signals.

缺陷是有体积形状的，尤其是壁厚的减薄必须要用三维参量描述其变化。低频电磁检测发展了相位分辨技术，在信号的分析 and 处理中采用了相位分析、频率分析和幅值鉴别等多种方法，能够对电磁信号的幅度、相位变化进行分析处理。



▲ 点蚀
Pit



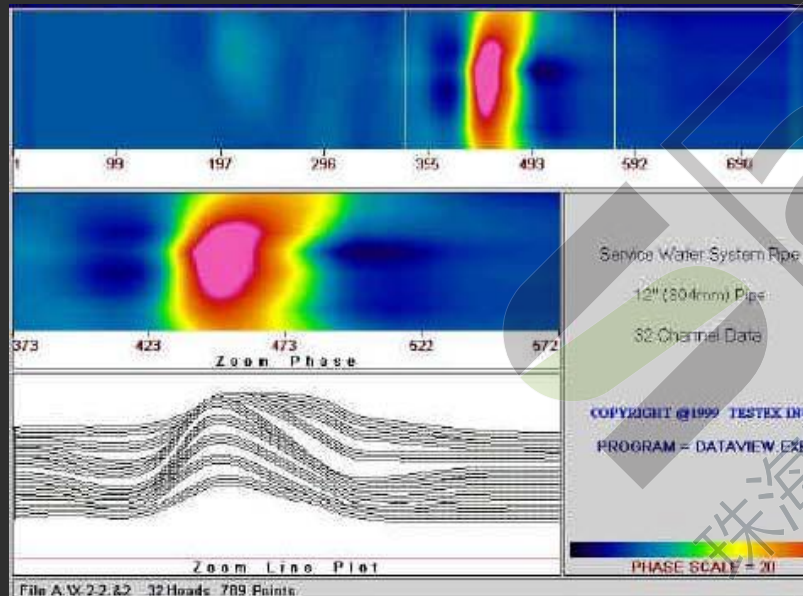
▲ 壁厚减薄
Wall loss

LFET Water Wall Inspecting System



LFET 水冷壁检查系统

Electromagnet Imaging Technology 电磁成像技术



C-scan

Meanwhile, electromagnetic three-dimensional imaging technology has been developed, and corresponding information processing technology and display methods have been developed based on the defect generation mechanism, thereby obtaining more reliable defect information, which can directly identify wall thickness thinning and pitting corrosion. In addition, its unique 3D rotation display technology can intuitively find the location of defects.

同时研发出了电磁三维成像技术，根据缺陷产生机理研究出相应信息处理技术和显示手段，从而得出更可靠的缺陷信息，可以直接分辨出壁厚减薄、点蚀。另外其独有的3D旋转显示技术，可以直观地发现缺陷的位置。

LFET Water Wall Inspecting System

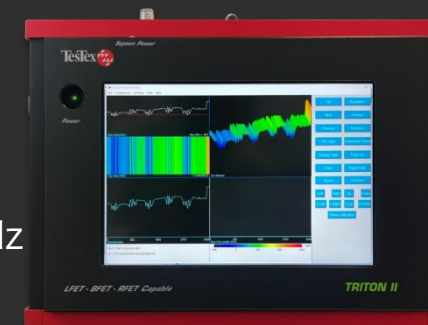


LFET 水冷壁检查系统



■ 显示控制一体机 Triton II

重量 Weight	4.9 kg
尺寸 Size	353 mm × 274 mm × 122 mm
通道数 Channels	8通道
供电电源 Power	110/220VAC (可调节) 50/60Hz
操作系统 OS	Windows 10
储存容量 Storage	128 GB



■ 扫描器 Scanner

重量 Weight	0.14 - 0.7 kg (根据应用变化)
工作频率 Frequency	3 Hz - 30k Hz
最大穿透能力	19 mm
扫描宽度	在外径 100 mm 下可达170度
探头/通道数	8/8 或 16/8



- ✓ 可以检测出≤6mm的金属钢管上30%深度直径3mm的点蚀

LFET Water Wall Inspecting System

LFET 水冷壁检查系统

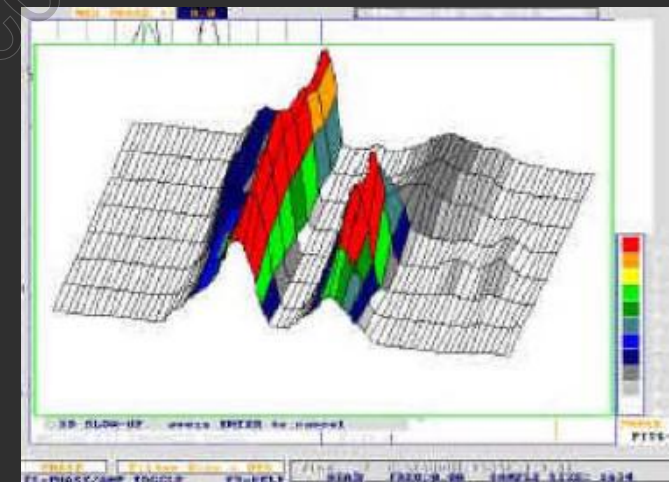


Typical Defects Examples 典型缺陷案例

- LFET技术可以检测腐蚀性和磷酸性雀斑、氢蚀、氧化点蚀、裂纹（包括不锈钢上的应力腐蚀性裂纹）、流动气体/高/低NO_x 和SO_x 侵蚀、虫孔和制造过程缺陷。



▲ 锅炉钢管氢蚀的剖面图



▲ 严重氢蚀的波形图

LFET Water Wall Inspecting System



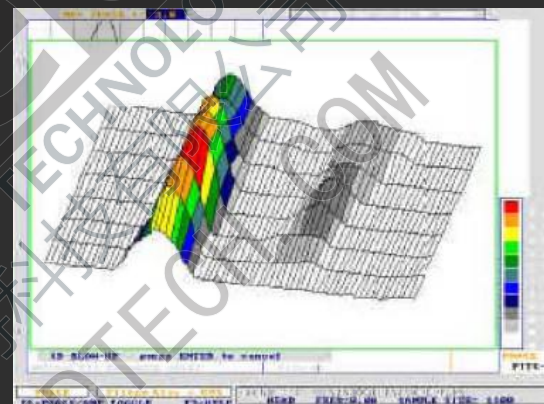
LFET 水冷壁检查系统

Typical Defects Examples 典型缺陷案例

1



Two pits on the boiler threaded steel pipe
螺纹锅炉钢管上的两个点蚀

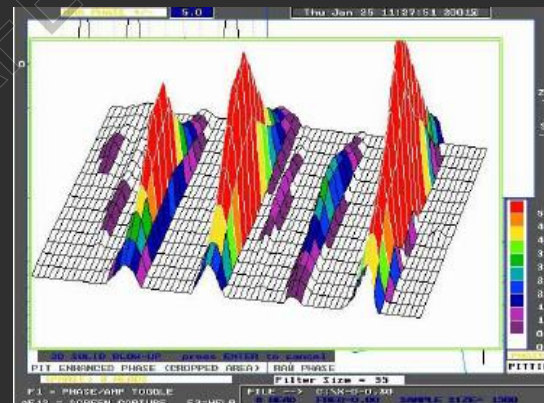


The waveform of the two pits
两个点蚀的波形图

2



Corrosive gouges in the inner wall of boiler steel tube
锅炉钢管内壁的腐蚀性凿坑



The waveform of the corrosive gouges
内壁腐蚀性凿坑的波形图



RFET – Tube Inspection

Remote Field Electromagnet Technology
适用于管道内部检测的电磁检测技术

03

Theory of the RFET probes

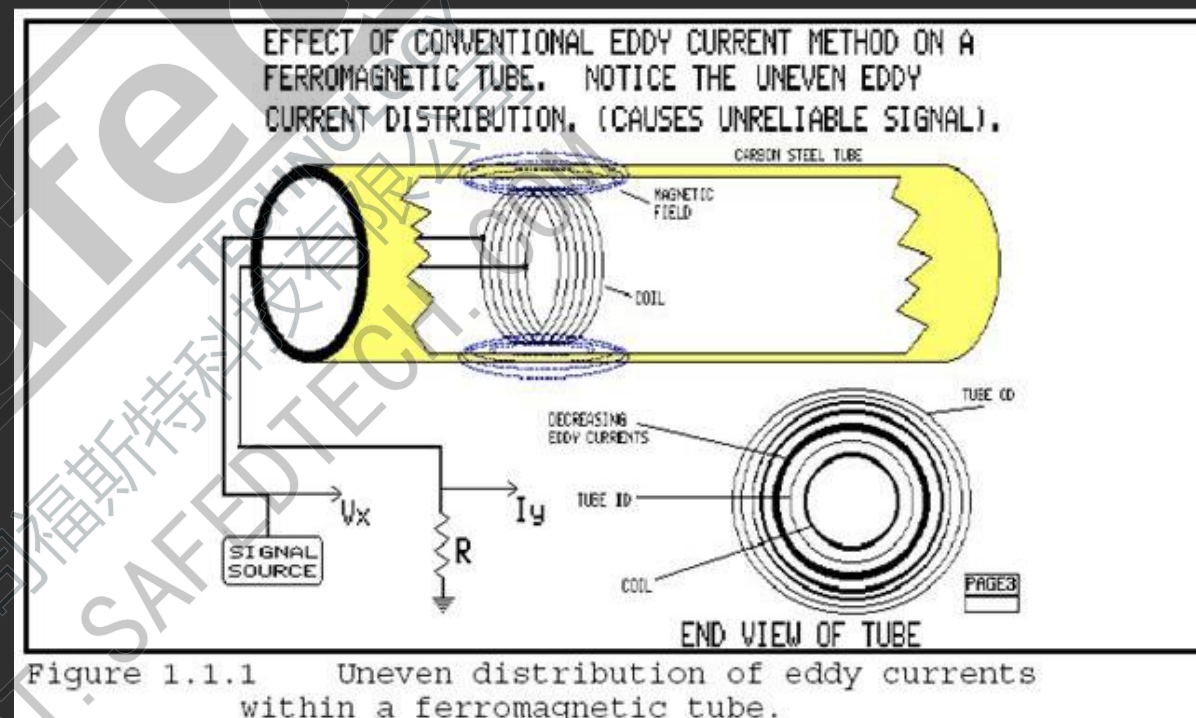
RFET 扫查头技术原理

Two cylindrical coils are placed in a conductive cylindrical tube as shown in Figure. One of the coils, known as the driver-coil or transmit-coil, is excited with a low frequency AC signal. The other coil, known as the pickup-coil, will then receive a signal that is the vector sum of:

- (a) A direct-coupled signal from the driver-coil.
- (b) A very weak remote-field (RFET) signal from the tube wall.

两个圆柱形线圈放置在导电圆柱形管中，如图所示。其中一个线圈（称为驱动线圈或发射线圈）由低频交流信号激励。另一个线圈（称为拾波线圈）将接收一个信号，该信号是以下矢量和：

- (a) 来自驱动器线圈的直接耦合信号。
- (b) 来自管壁的非常弱的远场 (RFET) 信号。



RFET probes

RFET 扫查头



RFET 优势

- ✓ Minimal tube preparation, requires no couplant, 最少的表面准备处理, 无需耦合剂
- ✓ Uses no magnets 不使用磁铁
- ✓ I.D. or O.D. scale have no signal impact 内径或外径尺寸对信号没有影响
- ✓ Standard probe sizes from 0.320" (8mm) to 6" (150mm) 标准探头尺寸为 0.320" (8mm) 至 6" (150mm)
- ✓ Tests approximately 300 tubes per shift 每轮班可检测约 300 支管
- ✓ Fill factor is not critical (can be as low as 40%) 填充系数可以低至 40%
- ✓ Full circumferential coverage over entire length 整个长度上的全周向覆盖
- ✓ Wide frequency range allows ferrous or non-ferrous testing 宽频率范围允许检测黑色金属或有色金属
- ✓ 高分辨率3D彩色图形 High Resolution 3-D color graphics



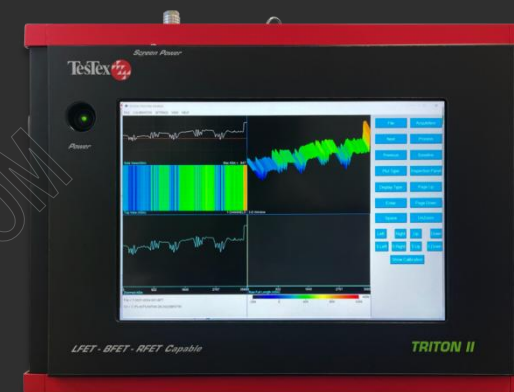
RFET probes

RFET 扫查头



■ 显示控制一体机 Triton II

重量 Weight	4.9 kg
尺寸 Size mm	353 mm × 274 mm × 122
通道数 Channels	1~8 通道
供电电源 Power	110/220VAC (可调节)
50/60Hz	
操作系统 OS	Windows 10



■ 扫描器 Scanner

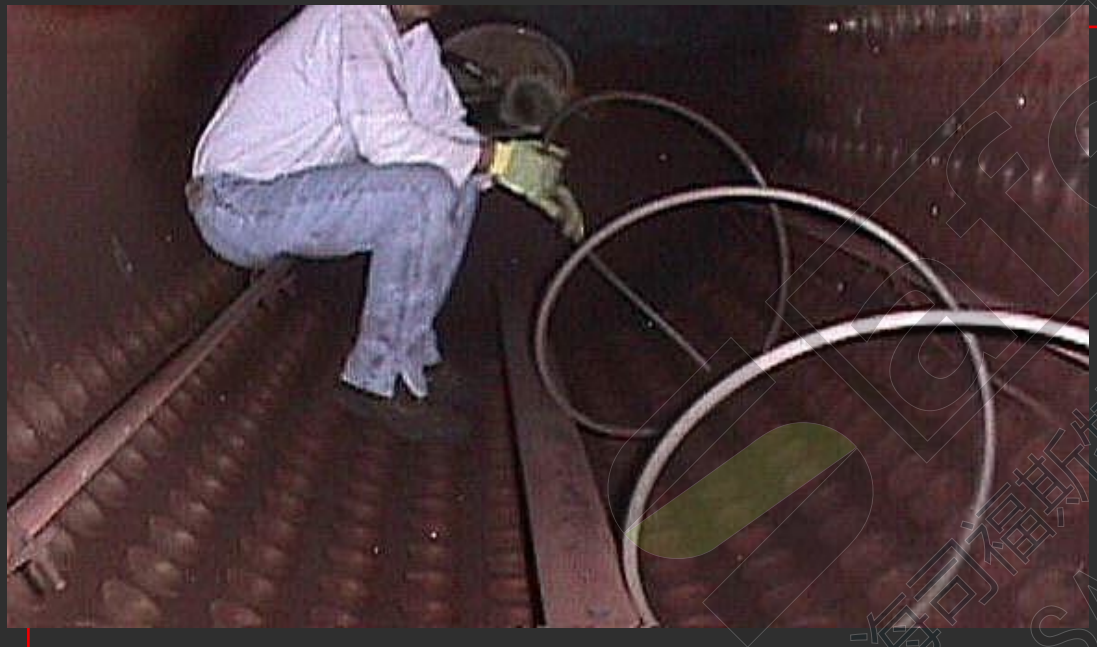
重量 Weight	0.14 - 0.7 kg (根据应用变化)
尺寸 Size	$\phi \geq 6 \text{ mm}$
填充率 Fill Factor	$\geq 40\%$
长度 Length	U to 30 m
探头/通道数 Channels Sensors	由 1-16 个探头提供 1-8 通道



Full Length Boiler Tube Inspection



锅炉管道全长检测



▲ Probe insertion/retraction from a boiler steam drum
探头从锅炉汽包插入/缩回

Boiler inspections are performed on drum to drum type boilers as well as straight tube boilers. These tests are full length examinations from the tube I.D. giving a quantitative evaluation of each tube. Applications include power boilers, recovery boilers, waste heat boilers, fire tube boilers, dowtherm boilers, and related boiler components such as tubular air heaters, etc. With the flaw characterization process, defects such as areas of wall thinning, pitting, cracking, erosion/corrosion, soot blower thinning, flue gas thinning, etc. are exposed and evaluated.

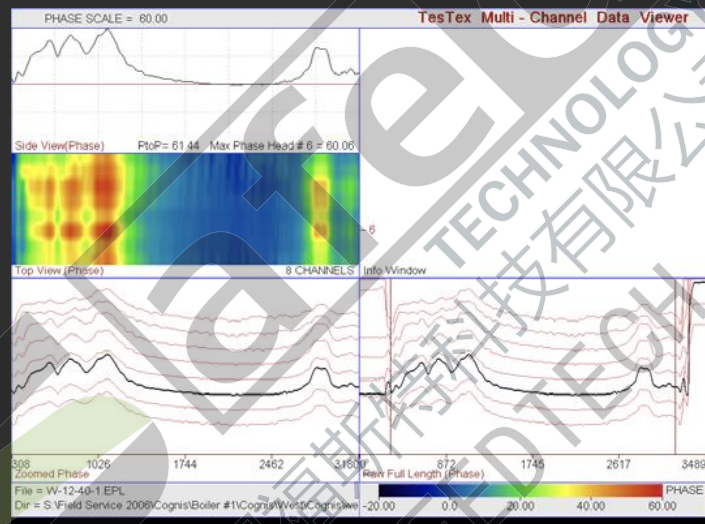
锅炉检查针对锅筒到锅筒式锅炉以及直管式锅炉进行。这些测试是从管内径开始的全长检查。对每个管子进行定量评估。应用范围包括动力锅炉、回收锅炉、余热锅炉、火管锅炉、道热锅炉以及相关锅炉组件（例如管式空气加热器等）。通过缺陷表征过程，可以识别壁薄化、点蚀、裂纹、侵蚀等区域的缺陷 / 腐蚀、吹灰器细化、烟气细化等进行暴露和评价。

Full Length Boiler Tube Inspection

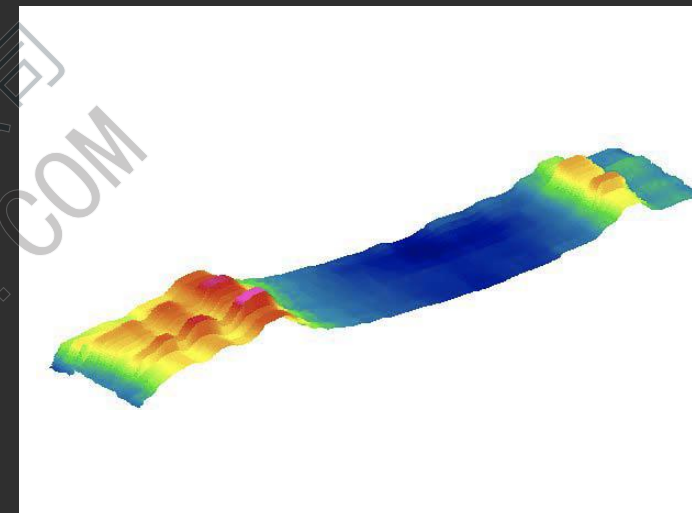
锅炉管道全长检测



Single channel drum to drum boiler data showing 35% to 40% wall loss
单通道汽包到汽包锅炉数据显示壁损为 35% 至 40%



Multichannel drum to drum boiler data showing 65% to 70% wall loss near the mud drum bend
多通道汽包到汽包锅炉数据显示，泥浆汽包弯曲部附近的壁损失为 65% 至 70%



3D representation of the above waveform showing the 65% to 70% wall loss near the mud drum bend
上述波形的 3D 表示显示泥浆汽包弯曲处附近有 65% 至 70% 的壁损

Heat Exchanger Tube Inspection



换热器管道检测



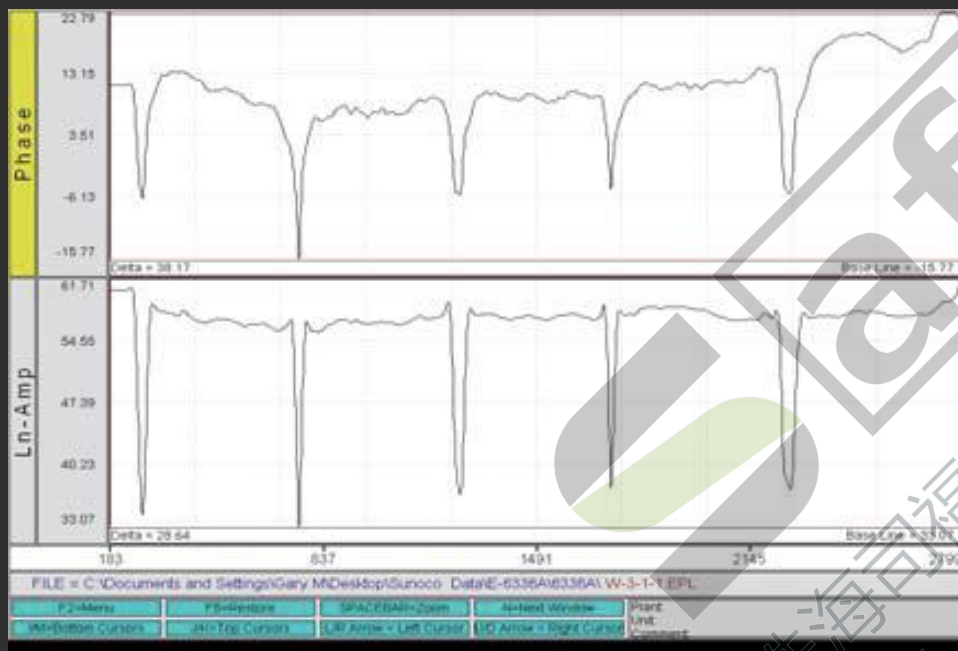
Heat Exchanger inspections are performed on straight shell and tube exchangers, U-bend bundles, and finned tube exchangers. Applications include feedwater heaters, air coolers/fin fans, chillers/coolers, air heaters/ pre heaters, MSR's, reformers/ultraformers, condensers, reactors, reboilers, etc. Types of defects located in these units are wall thinning, pitting, cracking, vibration/fret wear, erosion/corrosion, steam cutting, etc.

热交换器检查是在直壳管式换热器、U 形弯管束和翅片管换热器上进行的。应用包括给水加热器、空气冷却器/翅片风机、冷却器/冷却器、空气加热器/预热器、MSR、重整器/超成型器、冷凝器、反应器、再沸器等。这些装置中的缺陷类型包括壁薄化、点蚀、裂纹、振动/磨损、侵蚀/腐蚀、蒸汽切割等。

Heat Exchanger Tube Inspection

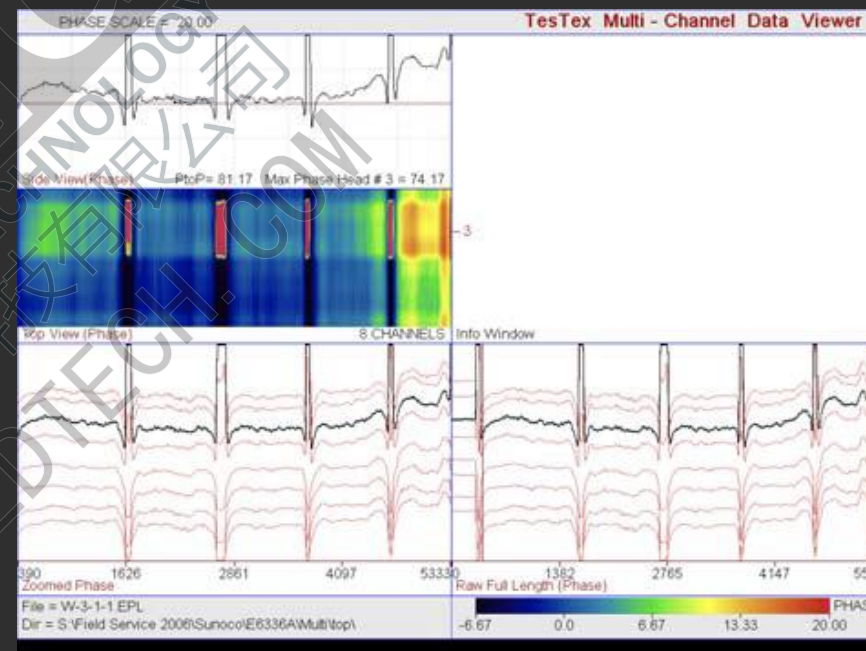


换热器管道检测



Single channel heat exchanger data showing wall thinning near the tube sheet

单通道换热器数据显示管板附近的壁变薄



Multichannel view of the same waveform showing wall thinning near the tube sheet

同一波形的多通道视图显示管板附近的壁变薄



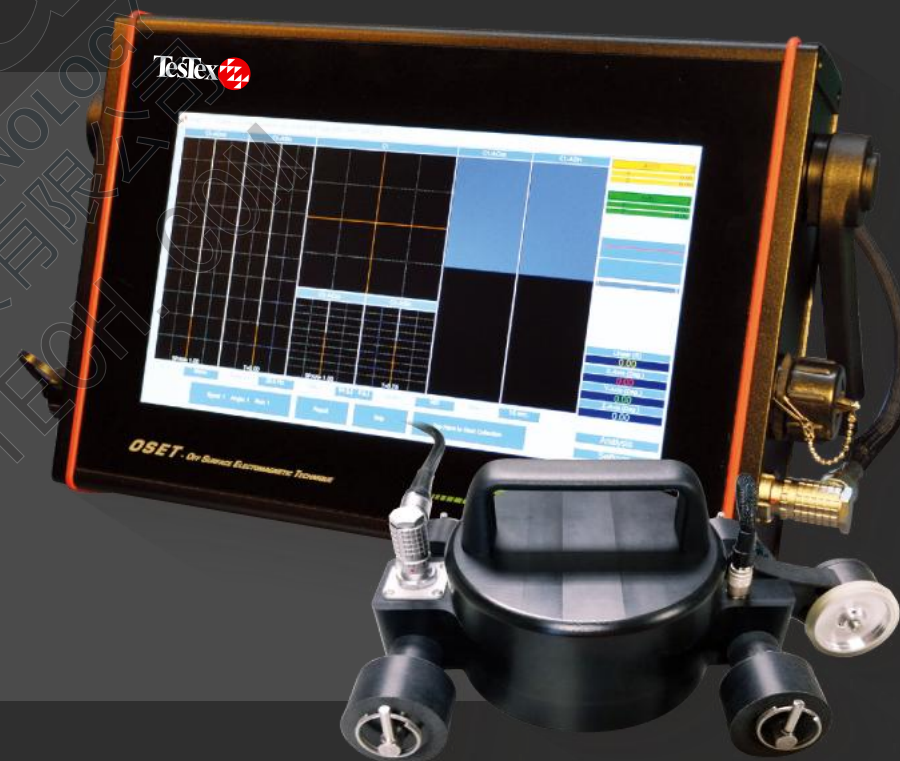
OSET – CUI Detection

Off Surface Electromagnet Technology
离面电磁检测技术 - 保温层下腐蚀检测

SCOUT

Corrosion Under Insulation Detection System

保温层下的
管道腐蚀检测系统



OSET 技术原理



Each excitation coil is used to excite low-frequency electromagnetic fields. The magnetic field will penetrate the insulation layer and outer jacket and directly enter the pipe wall. Defects in the tube wall will cause the magnetic field to deform, and this signal can be detected by the receiving coil. The signals acquired by the system are divided into two channels. The differential signal is used to detect "defects" such as welds and pitting corrosion, while the absolute channel is used to detect large-area corrosion.

Inspection Capabilities of OSET

产品检测能力



Inspection Sensitivity 检测灵敏度

Pits with a diameter of 5 mm, or 10% of wall-loss
5毫米直径的点蚀、10%壁厚减薄



Applicable Defect Types 可检测缺陷类型

- Large Corrosion on internal Surface
内壁较大区域腐蚀
- Surface & Sub-surface Corrosion (wall-loss, pits)
检测表面及内表面腐蚀 (管壁腐蚀、点蚀)
- Wall perforation
检测表面穿透孔
- Weld location detection
检测出焊缝位置



Inspection Efficiency 检测效率

Could change by other variables, i.e. accessibility and pipe's geometric shape
根据容器、管道直径和其他变量而定，如：易接近性和管道形状等



Sub-surface penetration 穿透能力

- Penetration of with thickness of max. 200mm
可穿透保温层最大厚度为200mm
- 可穿透容器、管道最大壁厚为40mm

Inspection Capabilities

检查能力



▼ 目前检测能力 Current Capabilities

护套材质 Jacket material		不锈钢 Stainless	铝 Aluminum	镀锌 Galvanized
护套厚度 Jacket Thickness		2.5 mm	2.5 mm	2.5 mm
绝缘层 厚度 Insulation thickness	焊缝检测 Weld detection	≤ 100 mm	≤ 75 mm	≤ 50 mm
	壁损检测 Wall loss detection	≤ 100 mm	≤ 100 mm	≤ 50 mm
	点蚀检测 Pit detection	≤ 100 mm	≤ 100 mm	不适用 N/A

▼ 检测效率 Productivity

根据管道直径和其他变量，如：易接近性和管道几何形状，目前OSET技术能达到每轮至少1000管的检测效率。

Productivity of up to 1000 linear ft./shift can be achieved, depending on the pipe diameter and other variables such as accessibility and pipe geometry.



Testing Scenarios

检查场景

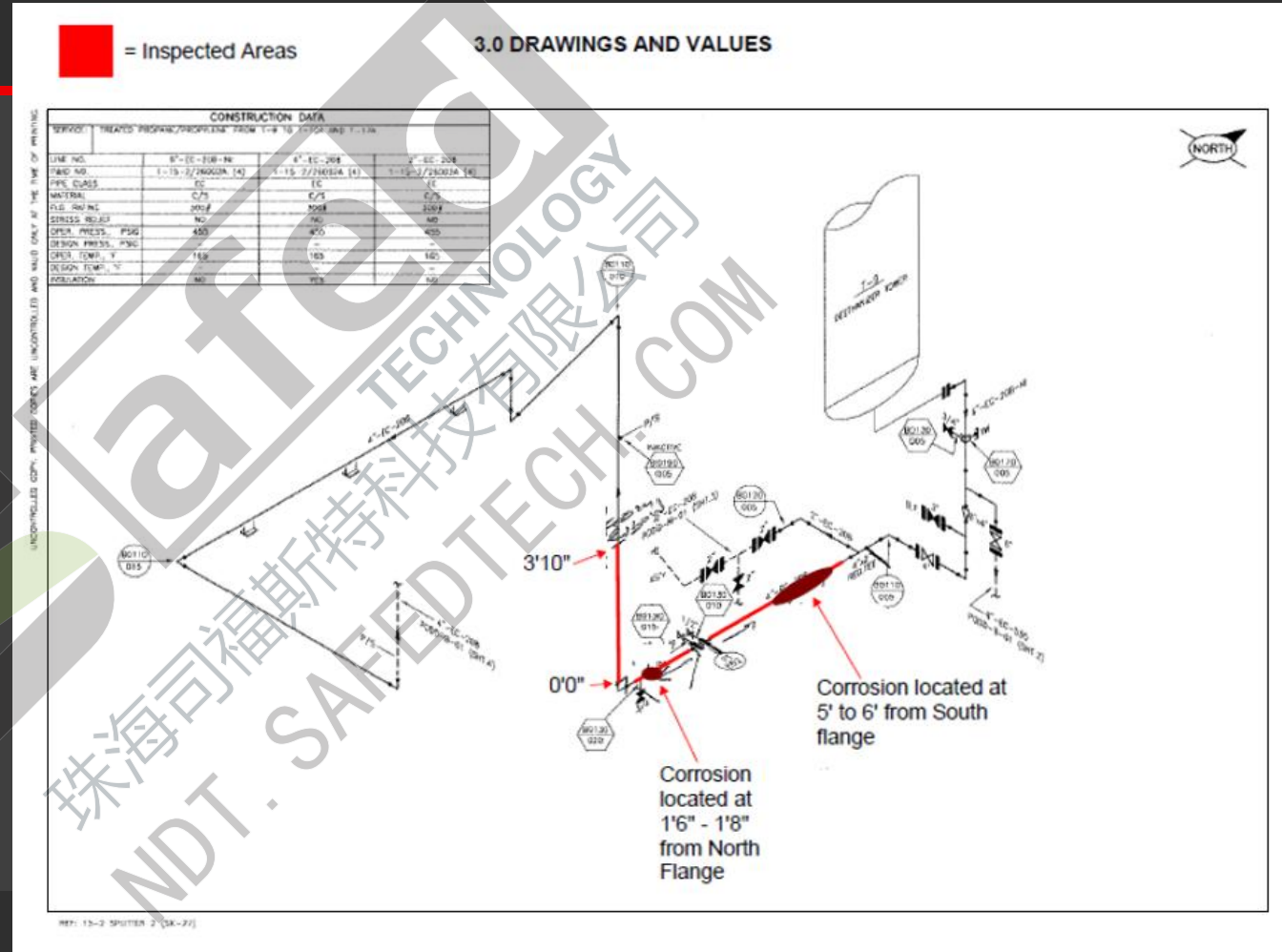


Report Samples

报告示例

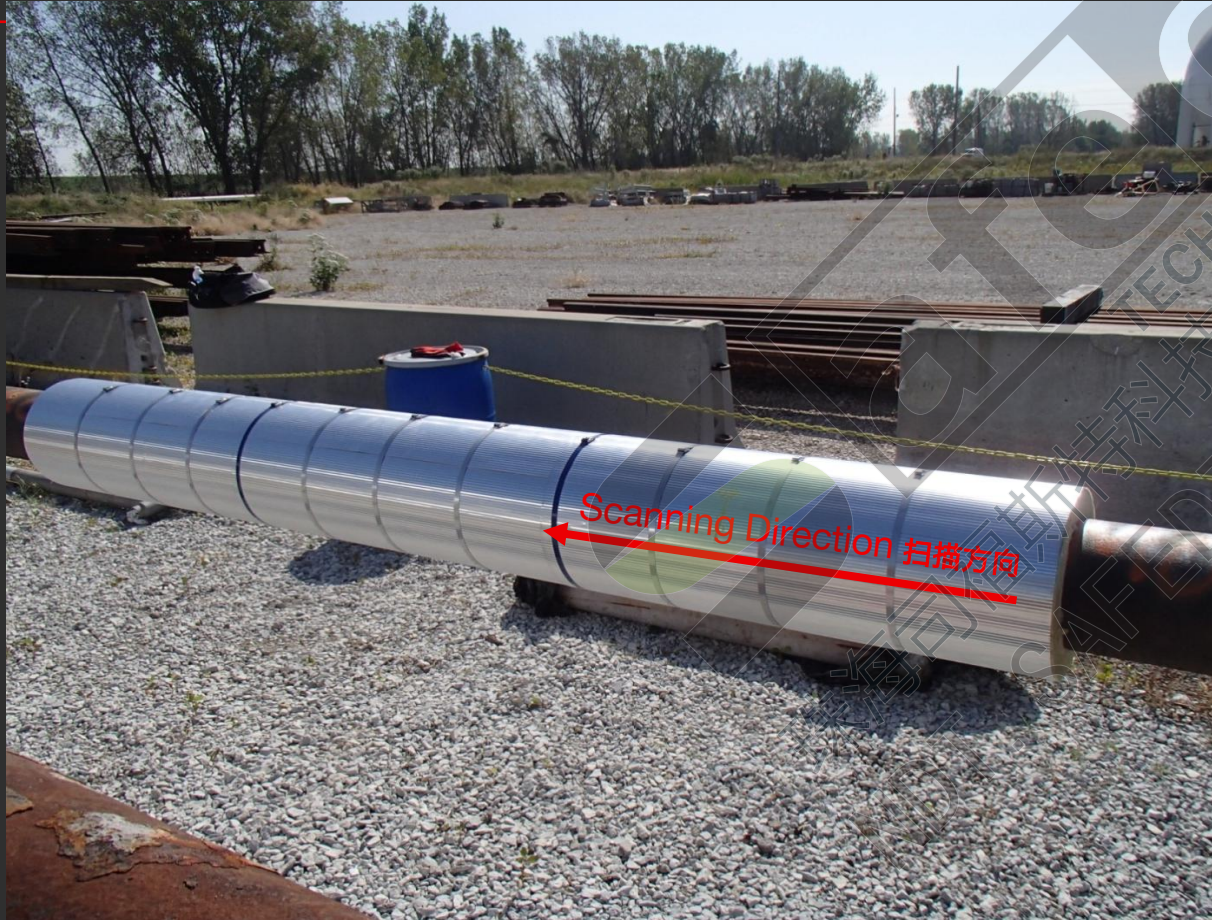
案例中包含被受测管道的图像，被扫描的部分及所有操作者指示的位置。放置在实际管道上的物质也能被标示。

Reports can include drawings of the pipes that were inspected, sections that were scanned, and locations of any indications. Physical markers can also be placed on the actual piping.



Report Samples

报告示例



此照片展示了进行OSET技术测试，扫描部份管道之情形。受测物体为从生产在线移除之管道，管道上有自然腐蚀。

Picture of a pipe scanned as part of a test of the OSET technology. This was a pipe with natural corrosion that was removed from a process line.



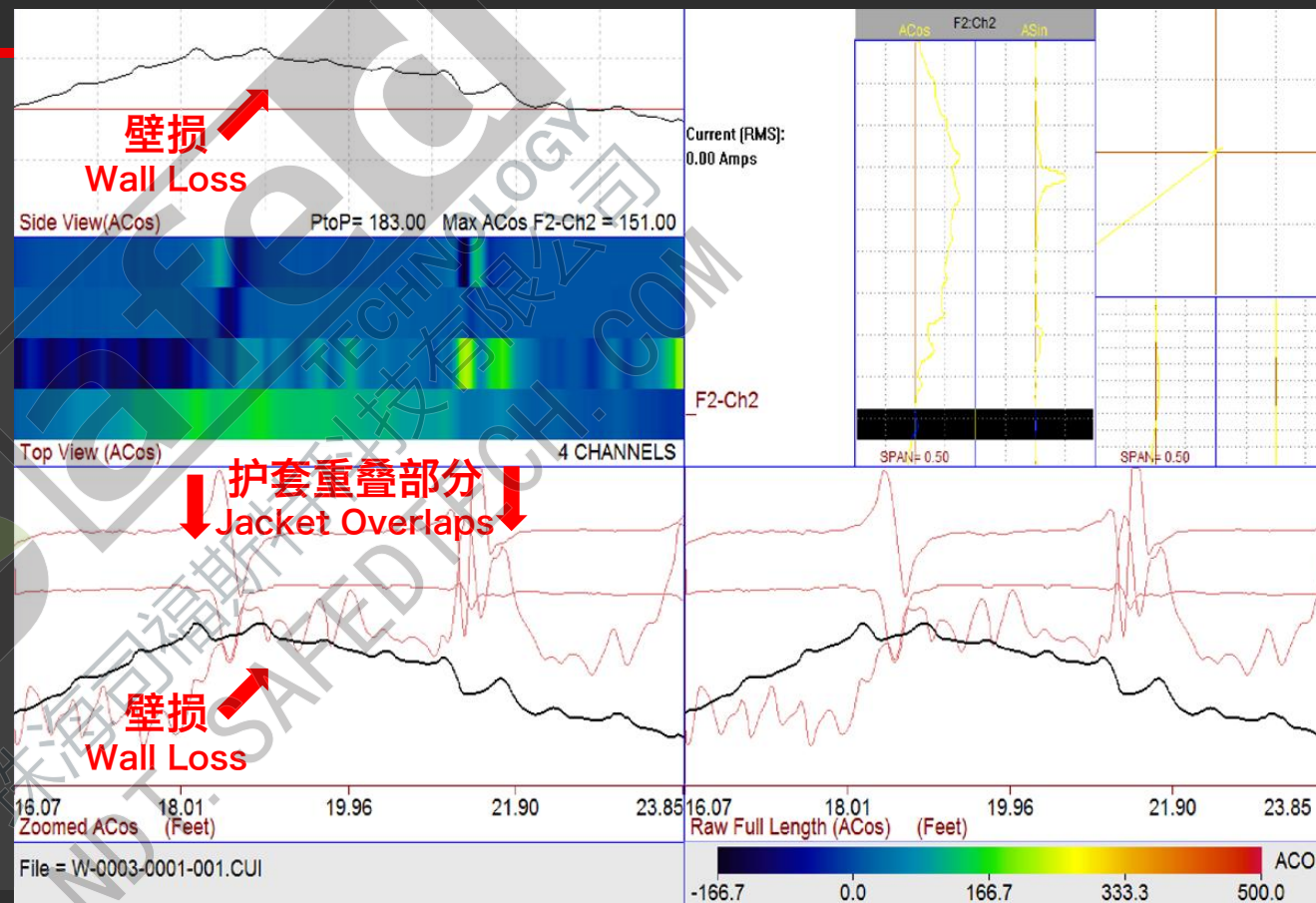
Report Samples

报告示例



Wave form from the scan of the “3:00 O'clock” position of the pipe pictured in the previous slide. Note the fairly large deviation from the base line in the upper left section of the wave form, indicating the corrosion at the 3:00 O'clock position.

此图展示了上一张图中管道「三点钟方向」位置的扫描波形图。注意，在波形图基线的左上方有大幅度的波形偏差，代表该管道三点钟方向的位置有腐蚀。



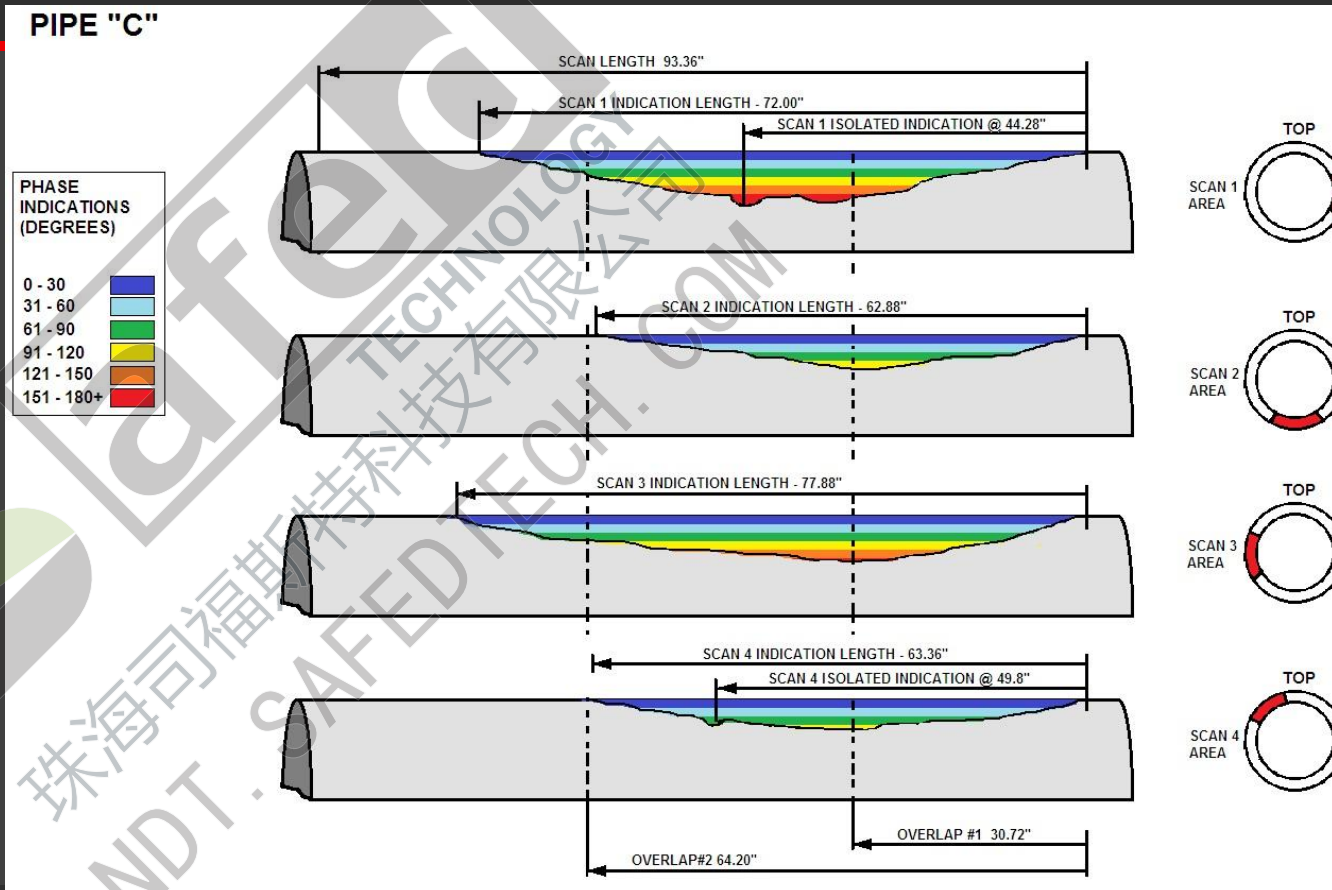
Report Samples

报告示例



This is a representation of the scanned pipe showing wall loss at various scanned clock positions. Note that the corrosion is most extensive at the 3:00 O'clock and 9:00 O'clock positions.

此图展示了在管道上各种位置扫描的壁损示意图。注意，在三点钟及九点钟位置的腐蚀面积最大。



First Tests

验证检测



High Pressure Vessels 高压容器平板

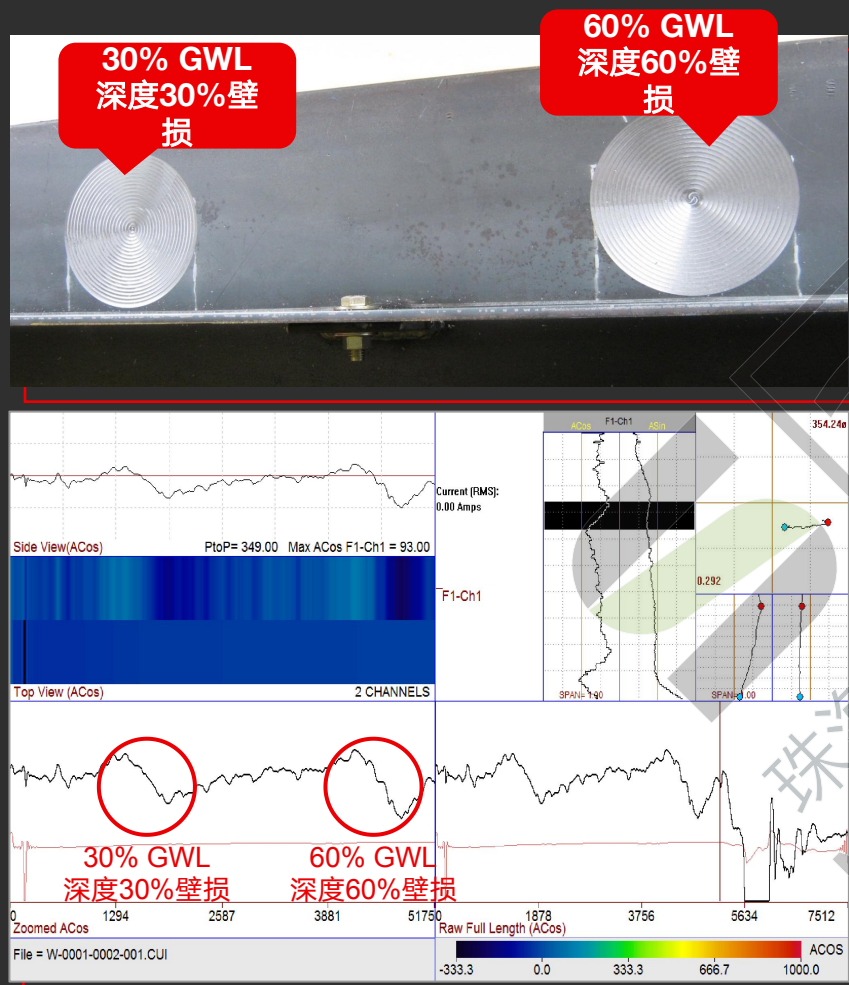
Tests to detect CUI on insulated vessels and tanks. These first tests were designed to find areas of isolated wall loss as shown in the

picture
检测隔热容器与储罐上的CUI。验证测试的目的为扫描到独立的壁损区域，如图片所示。



First Tests

验证检测



- A 38" long x 12" wide by 1/2" thick plate with a 2-1/2" wide support ring to simulate a vessel wall. We had two tapered flaws machined into the surface, one 30% deep and the other 60% deep. The plate was then scanned under 3" of insulation and an aluminum jacket.

一个965mm长、305mm宽、13mm厚的样板，侧边有2-13mm宽的支撑板以模拟容器壁。在板面上加工了两个锥形缺陷，一个深度30%、另一个深度60%；接着将板面在附有3英寸厚的绝缘层与铝套下进行扫描。

- This waveform shows the response of the OSET system to the two tapered circular flaws. As noted, the indication on the left shows the 30% GWL tapered flaw and the one on the right is the 60% GWL flaw.

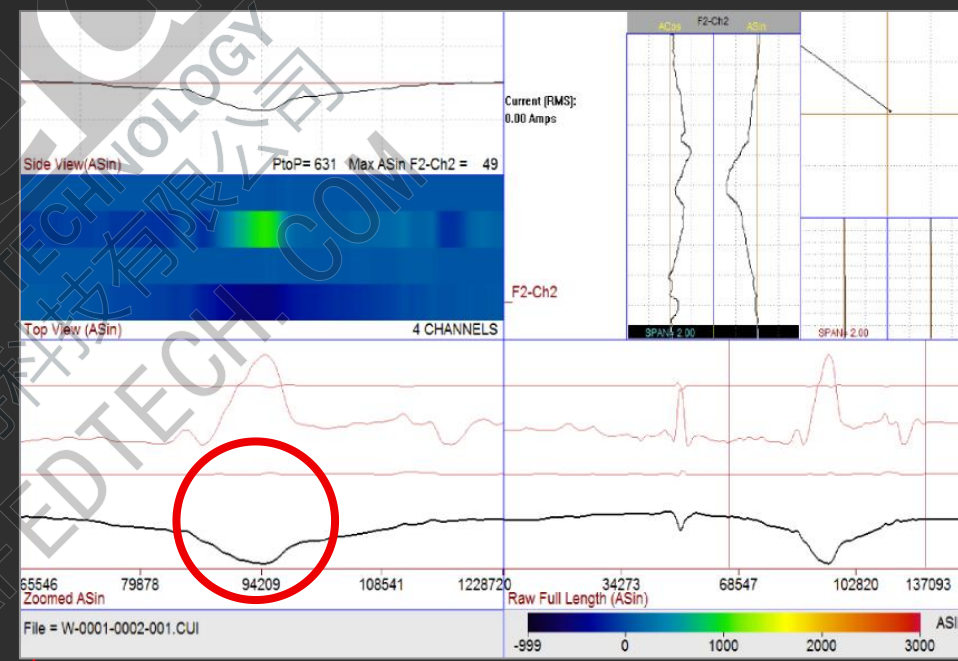
此图展示了OSET系统扫描两个圆锥形缺陷的波形图。如图上所示，左侧为深度30%的壁损圆锥形缺陷，右侧为深度60%的壁损圆锥形缺陷。

OSET Case Studies

OSET 实例研究



Case 1: Braskem – Marcus Hook

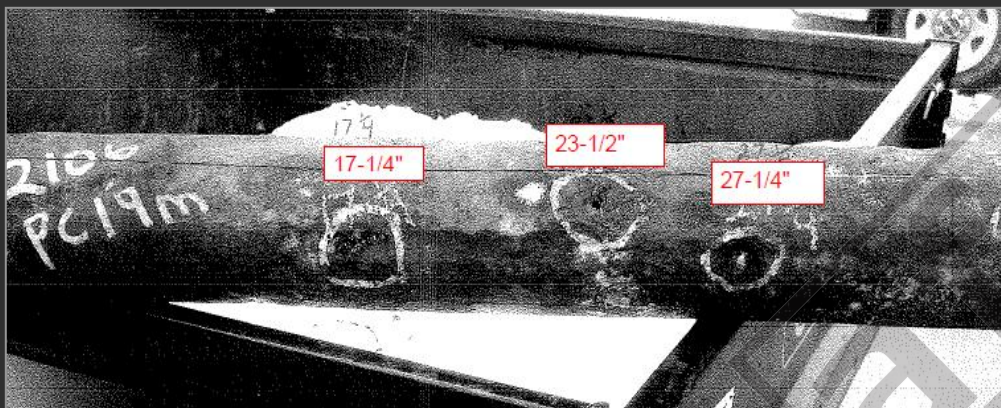


- Pictures of a 4" pipe with suspected corrosion before & after the jacketing was removed.
图片展示了一条炼油厂4 英寸管道，左边为移除护套前，右边为移除护套后。

- Wave form from the scan of the pipe above, with the low frequency absolute trace indicating wall loss (red circle).
此图展示了扫描管道后所呈现之波形图，低频波形的绝对值轨迹中红圈区域显示出了壁损。

OSET Case Studies

OSET 实例研究



Case 2: Marathon – Catlettsburg

- Picture of 4" naturally corroded test pipe that was removed from a process line at the refinery. In a blind test after new insulation and jacketing were installed, the OSET system detected the pitted areas that are circled, along with other flaws and general wall loss.

此图展示了从炼油厂的生产在线所移除之4英寸管道，管道表面有自然腐蚀的现象。在表面套上新的绝缘层与护套后，进行OSET系统检测，扫描出如照片中所圈示的缺陷区域，以及其他缺陷与一般壁损。

- Wave form from the scan of the pipe above, with the low frequency differential trace indicating the three closely spaced pits (red circle) that are shown in the picture. 此图展示了扫描管道后所呈现之波形图，圆圈所标示之连续三个低频波形，即为壁损区域。

