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**技术推动全球管道业的发展**

Technology drives growth of global pipelines

**墨西哥湾海岸恢复进行中**

Gulf Coast restoration continues

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More gas through subsea compression

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Global industry commentary from Azfar Shaukat

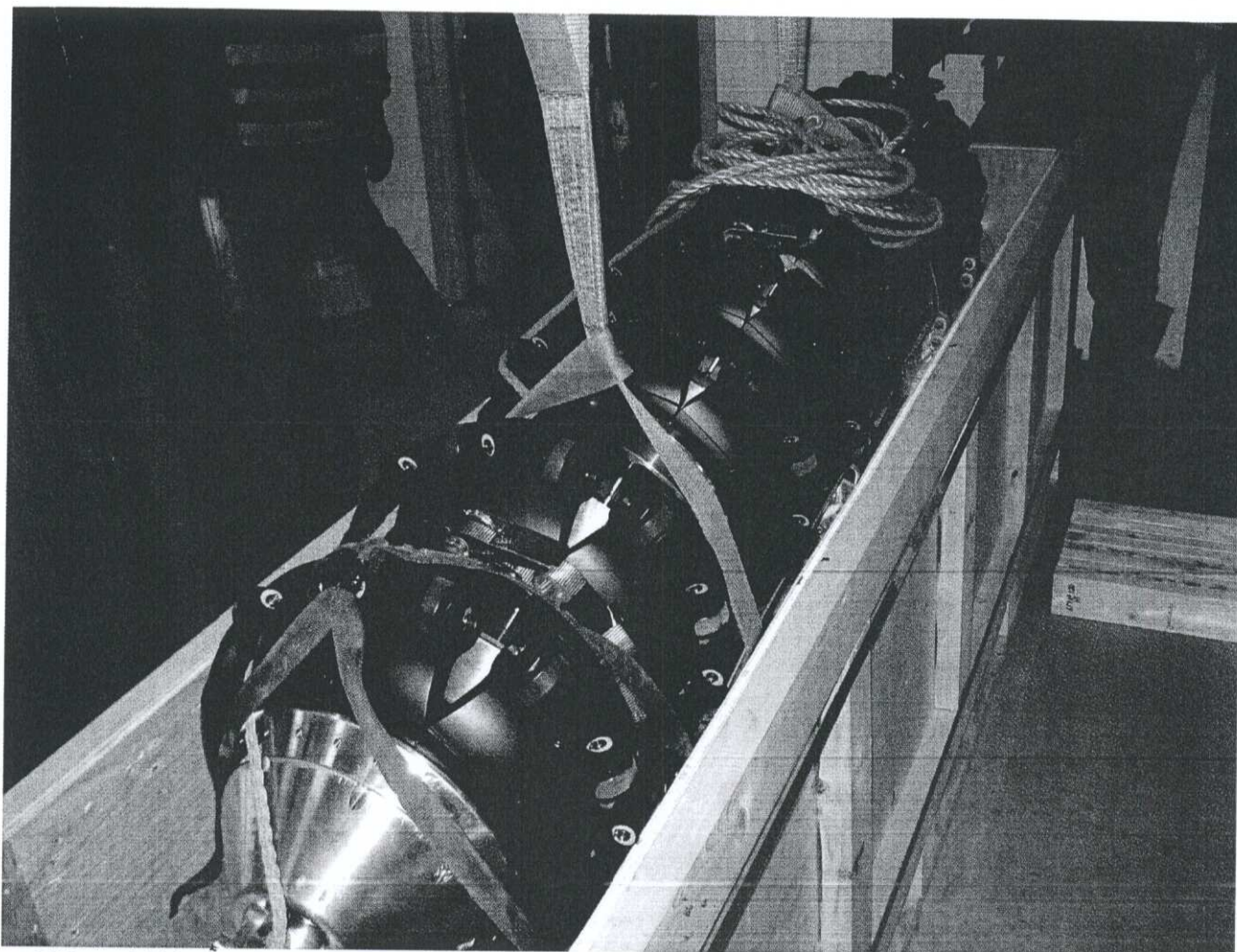
**专题报道：管道技术**

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# 非常规管道的专用检测工具

## Specialised inspection tool for unconventional pipelines

**半**个世纪以来，常规管道的管内检测一直主要采用漏磁检测 (MFL) 工具，漏磁检测工具又称智能清管器。但人们认为有许多非常规管道无法清管，漏磁检测工具无法对这类管道进行检测。这类非常规管道包括：内衬管道、涂层管道或积垢管道、低流量管道、短管道和因桥接或负载造成局部区域应力集中的管道。

在过去的二十年中，远场技术 (RFT) 工具已经越来越多地应用于此类颇具挑战性的环境，并取得了成功。RFT技术的优势在于，它是

The in-line inspection of conventional pipelines has been the domain of magnetic flux leakage (MFL) tools, known as smart pigs, for half a century. However, there are many unconventional pipelines that are deemed to be unpiggable, which cannot be inspected with MFL tools. Such unconventional pipelines include: internally lined pipelines, coated or scaled pipelines, low flow pipelines, short pipelines and pipelines that have local areas of stress concentration due to bridging or loading

一种透射技术，所以它对励磁线圈及传感线圈与管道材料的距离远近并不敏感。因此，该技术探测管壁损失缺陷的(传感器发射)距离可达到1.5英寸。

RFT工具能够从头至尾测量管道的壁厚，还能够检测腐蚀斑、侵蚀及退化机制，如蠕变和应力/张力。RFT工具配有高灵敏度的探测器阵列，适用于所有周长为3英寸至30英寸的管道。RFT工具可使用系绳或自由游动。每次运行的检测距离可达30km。

加拿大路塞尔无损检测系统公司(RNSI)在多种行业的远场技术应用领域处于公认的领先地位。路塞尔公司成立于1972年，许多经验丰富的研发人员已为公司服务了三十年左右。RNSI从事远场技术设备的设计与制造，同时也利用本公司设计制造的远场技术专用工具提供检测服务。

凭借其广泛而丰富的经验，RNSI已成为知名的非常规管道检测专家。公司能够提供管道资产管理，为您做出明智、主动的决策提供最佳资讯和建议，以便在造成惨重损失的泄漏和破裂发生前对管道进行维修、修复或更换。

路塞尔无损检测系统公司的管道检测工具产品线中包括一种柔性工具，这种工具是通过RFT来测量管壁厚度。RFT的工作原理是通

For the past two decades, Remote Field Technology (RFT) tools have been increasingly applied in these challenging conditions with good success. The RFT technique has the advantage that it is a through transmission technique, and therefore is not sensitive to the proximity of the exciting and sensing coils to the pipe material. Hence its ability to detect wall-loss defects at (sensor lift-off) distances of up to 1.5".

RFT tool can measure the wall thickness of a pipeline from start to end, and can detect corrosion pitting, erosion, and degradation mechanisms such as creep and stress/strain. With highly sensitive arrays of detectors, the RFT tools cover the complete circumference of pipelines ranging in size from 3" to 30". The RFT tools can be tethered or free swimming. The inspection distance can be up to 30km in one run.

Russell NDE Systems (RNSI) is well known for its leadership in applying Remote Field Technology (RFT) to many industries. The company was founded in 1972 and many of our experienced research and development personnel have remained with the

## 非常规管线检测



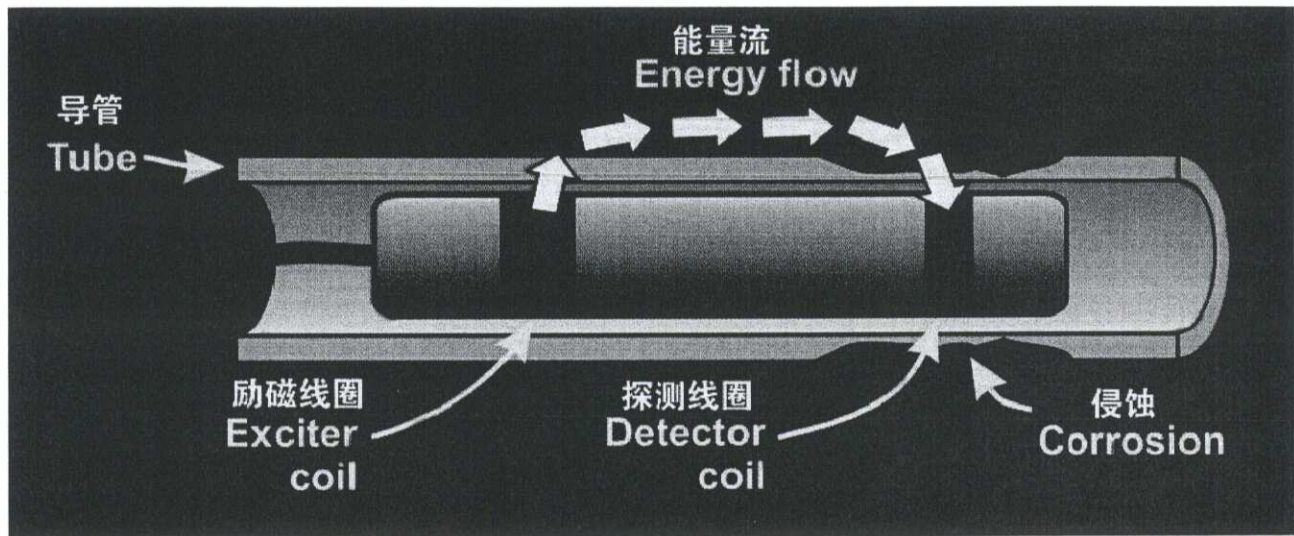
### 用于非常规管线的 专业检测器

专用于：

- 内衬管线
- 带涂层或积垢管线
- 低流量管线
- 短管线

钢管 · HDPE内衬





RFT探头操作的基本原则  
The basic principle of operation of a RFT probe

过探测工具产生的交流电磁场的变化来实现对管道的探测。电磁场与管内的金属进行相互作用，并在存在金属损失的区域得到增强。通过柔性工具上的探测器对磁场的相互作用进行测量，随后该柔性工具采用其交流/直流转换器和数字信号处理器(DSP)来对这种相互作用进行处理。

经过处理的数据可存储在柔性工具上，也可以通过多芯线传输存储在便携式电脑中。获取所有数据后，采用精密分析软件，生成有关管道壁厚情况的精确信息。

RFT技术的优势在于，它是一种非接触式的无损检测方法，而且不需要液体耦合剂。RFT还拥有超越其它对手技术的有利优势，它无需与管道壁紧密接触，即可检测剩余壁厚的变化。因此，管内积垢、沉渣、砂及衬层(如高密度聚乙烯、水泥砂浆或粘土)对工具的操作无明显影响。

RFT的另一优势是：它对于内径或外径壁厚损失同样敏感。换句话说，壁厚损失在土壤一侧或管道的产品一侧都不重要：RFT工具都能很好地探测出来并测定其损失的程度。RFT工具能够以相当快的速度提供全面检测，总体来说，与在某个单一的地点实施挖掘检测和现场测量相比，这种测量方法更加快速和全面，因为前种方法可能无法检测到局部腐蚀。

坚固的机械设计：RFT工具能够穿透短半径弯头和三通。此类工具完全能够通过短半径弯头，并能够在压力高达700psig的条件下工作。新型管道内窥镜也是完全独立的器件，并且可以“自由游动”。也就是说，这些内窥镜都配有所有必要的电子器件、电池、内存及传感器，并能够在无拴系连接的情况下通过较长的管道。

新型管道内窥镜远场工具拥有多种渠道，可有效地划分管道的时钟定位，将管道周长划分为各小段，以提高壁厚损失缺陷检测的分辨率。这种自由游动的工具均配有各自的里程表，能够感知并报告壁厚损失缺陷的时钟定位。

本文由路塞尔无损检测系统公司总裁David Russell和远东区营销经理Vincent Shen共同撰写

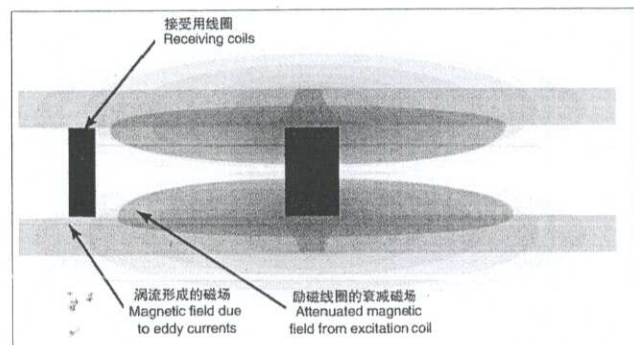


图2图解展示工具励磁部分与探测器之间的磁耦合路径  
Figure 2 schematically shows the magnetic coupling path between the exciter section of the tool and the detectors

company over the past three decades. While RNSI is a designer and manufacturer of RFT instrumentation, the company also offers inspection services using the specialised RFT tools it designs and manufactures.

From its extensive and varied experience, RNSI has become known as the expert to inspect unconventional pipelines. We can provide Pipeline Asset Managers with the best information possible to make informed, proactive decisions to repair, rehabilitate or replace pipelines before costly leaks and breaks occur.

The Russell NDE Systems' line of pipeline inspection tools consist of flexible tools that employ Remote Field Technology (RFT) for measuring pipe wall thickness. RFT technology works by detecting changes in an AC electromagnetic field generated by the tool. The field interacts with the metal in the pipe and becomes stronger in areas of metal loss. The field interactions

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are measured by on board detectors, and subsequently processed on the tool itself using A/D converters and DSPs.

The processed data is either stored on-board, or transmitted over a multi-conductor wire-line for storage on a laptop. Once all the data is acquired, sophisticated analysis software is applied to generate accurate information on the wall thickness profile of the pipeline.

RFT technology has the advantage that it is a non-contact NDT method and liquid couplant is not required. RFT also has the advantage over competing technologies that it does not require intimate contact with the pipe wall to detect changes in remaining wall thickness. Therefore, internal scale, sludge, sand and liners such as HDPE, cement mortar or clay do not interfere significantly with the operation of the Tool.

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## For the past two decades RFT tools have been increasingly applied in these challenging conditions with good success

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RFT also has the advantage that it is equally sensitive to ID or OD wall loss. In other words, it does not matter whether the wall loss is on the soil side, or the product side of the pipe: it will be detected and sized equally well. It can deliver complete coverage at reasonably fast inspection speeds and overall is faster and more complete than isolated excavations and spot measurements, which could miss localized corrosion.

**Rugged mechanical design:** RFT Tools can traverse short radius bends and tees. The Tools are fully able to negotiate short radius elbows, and can operate at pressures up to 700psig. The new See Snakes are also completely self-contained and "free swimming". That is, they have all necessary electronics, batteries, memory and sensors on board, and can travel untethered down long lengths of pipeline.

The new See Snake RFT Tools have multiple channels. Effectively, this segments the pipe into clock positions, small fractions of the pipe circumference, which provides enhanced resolution to defects. The free swimming Tools have their own odometer and can sense and report the clock orientation of wall-loss defects. ■

*This article was written by David Russell, president, and Vincent Shen, marketing manager far east, at Russell NDE Systems Inc*