

Magnetic Thickness Tool (MTT)



The Magnetic Thickness Tool surveys variations in pipe metal thickness. Twelve sensors are mounted on the inside of a set of bow springs, allowing the tool to pass through tubing and log pipe sizes up to 7-inch casing.

Description

An alternating magnetic wave is emitted from the tool; this permeates through the casing wall and then travels a short distance along the outside before passing back through the wall and being detected by the sensors. The velocity and amplitude of the emitted wave are affected by the metal thickness; thinner walls resulting in faster wave propagation and less attenuation. These differences are used to detect and quantify variations such as pitting and metal loss. Reference to the Multi-finger Imaging Tool data determines whether the metal loss found with the MTT is internal or external.

By combining information from the MIT and MTT in WIVA software, images can be created on a computer screen in three dimensions. Color schemes, meshes, arrows and numerical data can be added to help an engineer understand the structure and condition of their well.

Data from the MIT and MTT can be automatically processed with WIPER software to identify certain features in the well; most obviously the collars. After setting certain parameters, the software carries out a joint by joint statistical analysis and builds a report summarising the condition of pipe in the well.

Features

- Pipe inspection for internal and external metal loss
- Surveys wall thickness
- Optimised results using MIT data for internal diameter
- Logs casing below tubing due to bow spring design
- Simultaneous operation with other Sondex Ultrawire* tools
- Surface read out or memory logging
- Visualisation using WIVA 3D imaging software
- Processing, Evaluation and Reporting with WIPER software

Magnetic Thickness Tool (MTT)

Specifications	
Temperature rating	300°F (150°C)
Pressure rating	15,000 psi (103.4 MPa)
Tool diameter	1 ¹¹ / ₁₆ in. (43 mm)
Tool length	82.3 in. (2.090 m)
Tool weight	30 lb (13.6 kg)
Toolbus	Ultrawire*
Current consumption	360 mA
Number of sensors	12
Sensor measure point	36.22 in. (0.92 m)
Pipe range	2 in. tubing to 7 in. casing
Coverage	100% with 12 sensors up to 5 in. ID pipe
Relative bearing accuracy	5°
Relative bearing deviation	5° to 175°
Defect resolution (internal or external)	³ / ₈ in. (9 mm) defect: 50% wall thickness, 35% metal loss ³ / ₄ in. (18 mm) defect: 30% wall thickness, 20% metal loss
Materials	Corrosion resistant throughout



Specifications

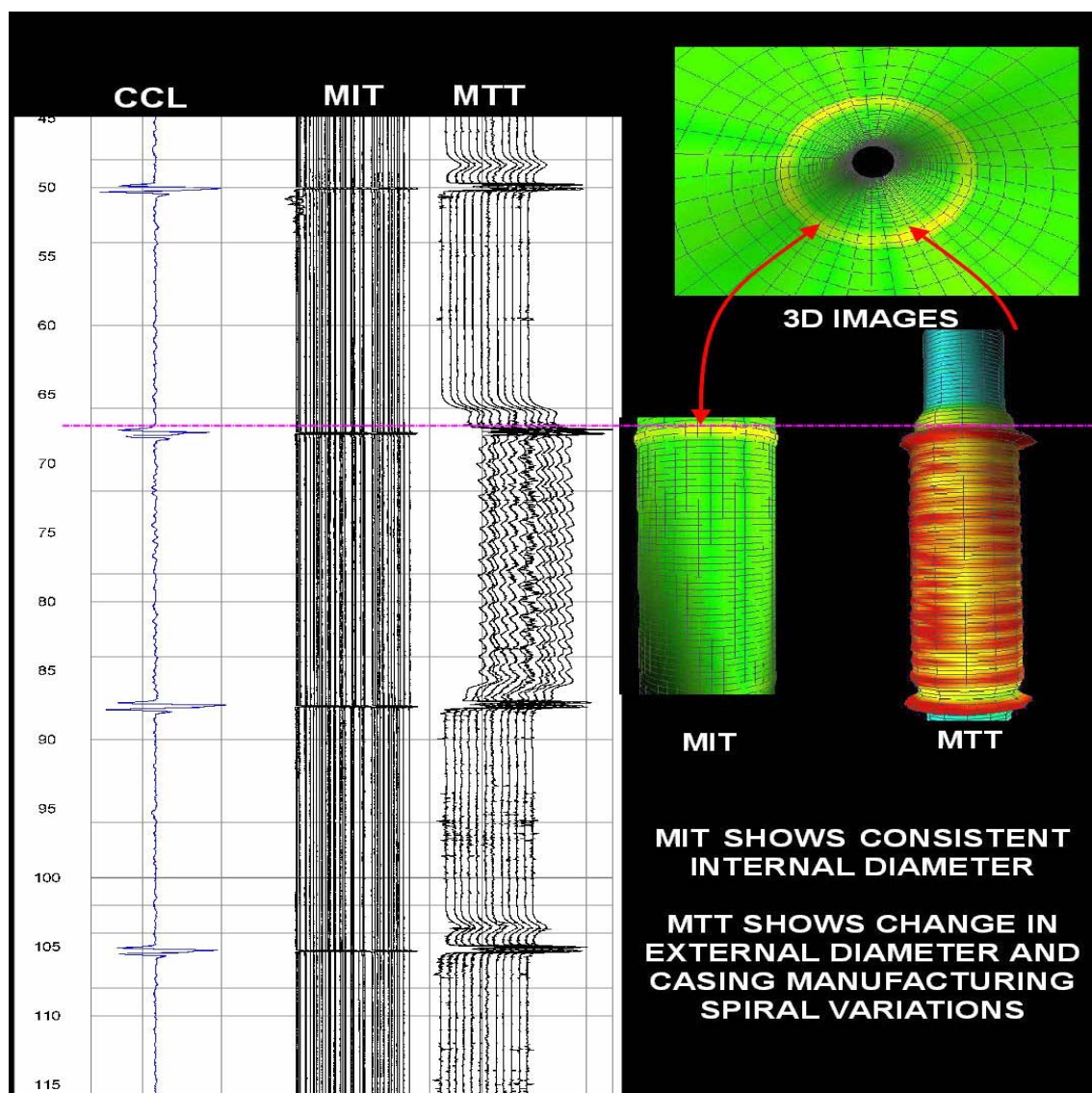
Measurement (the following specifications are subject to change)

Sensors:	12 radially deployed sensors.
Range:	Up to 7" casing.
Thickness Accuracy:	The accuracy of the tool depends on the size of the defect. In undamaged pipe accuracy is better than 15% of wall thickness.
Defect Resolution	The ability to detect a defect depends on the size of the defect. Ø 3/8" diameter defect: 50% wall thickness, 35% metal loss. Ø 3/4" diameter defect: 30% wall thickness, 20% metal loss. Large extent defects better than 10% of wall thickness.
Pressure:	15,000 psi.
Temperature:	150 deg C (177 deg C tool in design).

Tool Dimensions

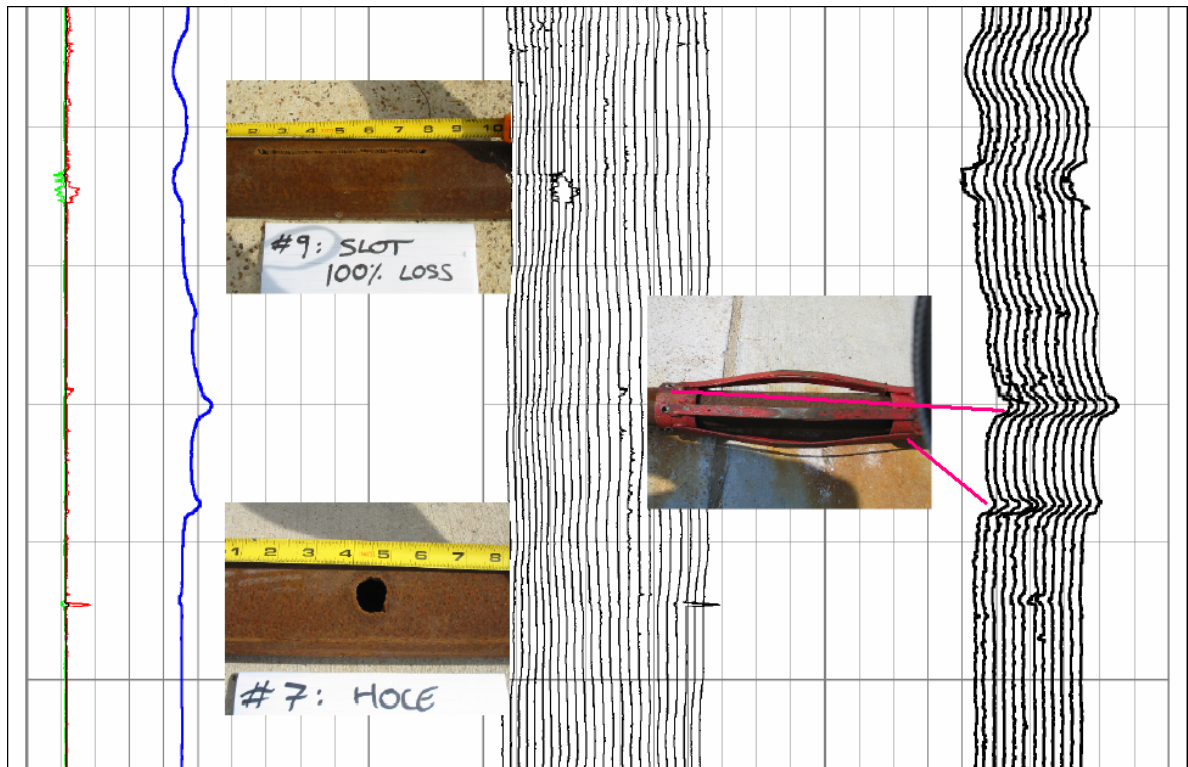
OD 1 11/16", Length 85.8" without centralisers. Weight:30 lbs.

Example MTT Logs



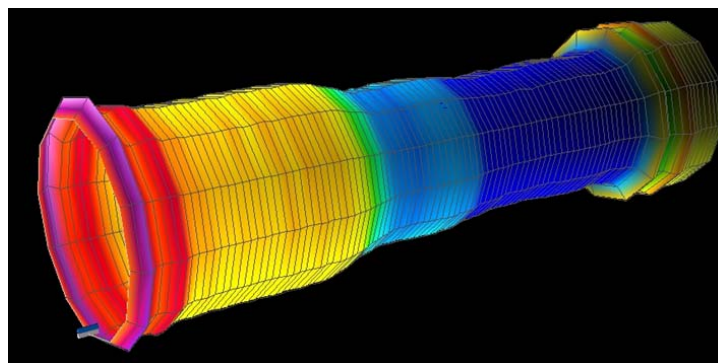
Example 1

Example 1 shows a log of a well logged with both an MIT tool and an MTT tool. The MIT tool shows no changes in internal diameter across the top 3 joints; however the MTT log shows a change in casing type of the joint at 67m. It is thought that this is due to the construction method of the joint which has been spun during manufacture. Note that a collar shadow can be seen on the MTT log. Please refer to the theory section for an explanation of why this occurs.



Example 2

Example 2 shows the comparative responses of the MIT and MTT tools to machined defects in a test well. Note that both tools can see the defects but the MTT is more qualitative. Where damage exists through to the ID of the tubing the MIT data is best, but of course the MIT cannot detect the presence of the centraliser (or anything) on the external wall of the pipe.



Example 3

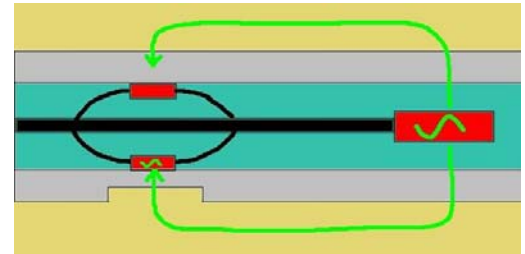
Example 3 shows a gradual tapering of 20% of wall thickness through the length of a joint of 7" casing. Conventional magnetic flux leakage tools would not be able to detect this gradual thinning. This was logged through 2 7/8" tubing, no other magnetic flux tool could go through 2 7/8" tubing to log 7" casing.

Theory

The **Magnetic Thickness Tool** (MTT) consists of two basic elements: a single centrally located transmitter coil and 12 small coil sensors deployed radially on bowsprings.

The transmitter generates an AC magnetic field. This leaves the transmitter, permeates through the casing wall and travels along the outside of the casing. The field then re-enters the casing adjacent to the sensor coils to complete its loop. The travel time of the signal from the transmitter to the sensor is dependent upon the magnetic properties and **thickness** of the metal. In the example on the right, because of the localized reduction in wall thickness, the lower coil will detect the signal before the upper coil. This is measured as a phase change. The amplitude of the signal is also dependent upon the thickness with a region of reduced wall thickness having a higher amplitude than a thicker section of casing. The tool has an on-board rotation sensor so that as the tool rotates when logging the well the data can be re-orientated to show the high side of the well.

Using 12 sensors makes it possible to identify and locate small damage items. It is also possible to image the thickness variations. The tool is run supported by centralisers each end.



Principle of MTT



Hermetically sealed sensor

Transmitter Shadow

During acquisition we can see at the collars that there is 'shadow' at a distance equal to the transmitter / receiver spacing. This is because of the two wall transit of the magnetic wave; first it passes through the casing and later re-enters through the casing. When the sensor passes the collar there is a short high resolution response; when the transmitter passes the collar there is a broader lower resolution response. The transmitter response is only seen at large features, such as collars, which are comparable in length to the transmitter. When features adjacent to the transmitter are small they have negligible contribution to the overall effect and are not detected by the sensors. Software is being developed to remove transmitter shadows during post processing.

Telemetry

The tool runs on Sondex Ultrawire telemetry and thus can be combined with other Sondex Ultrawire tools.

Operations

The tool is run centralized between 2 roller centralisers in combination with other Ultrawire tools. A typical logging speed is 30 ft/min.

Calibration

The tool is calibrated at surface or downhole in clean pipe of known wall thickness. To correct for differences in metal properties from one type of casing to another, a 3 frequency calibration is made to derive correction coefficients particular to the metal. During the logging job, joints with different magnetic properties (eg a change in pipe size) are identified and additional calibrations made for those joints

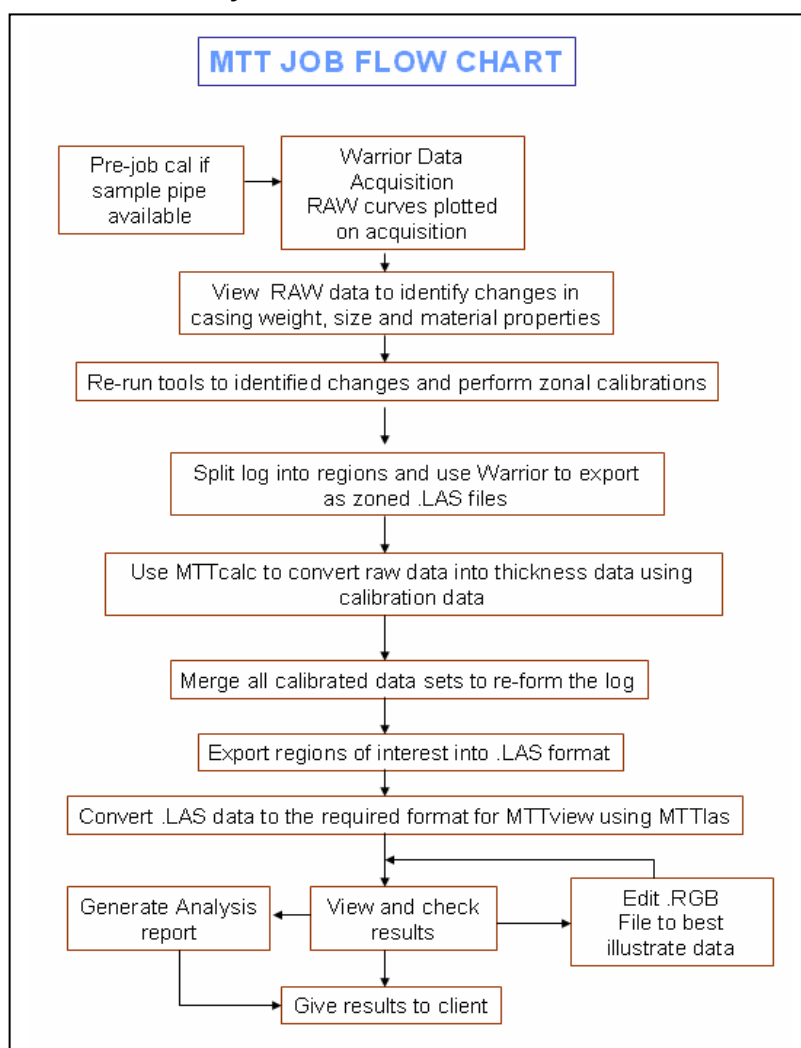
Using the Data

Visualization is an excellent way to convey information. The 3 D imaging allows the client to view the wall thickness and how it changes. This allows the client to build up a hypothesis of the root cause of the damage and how to avoid it.

MTTcal software is used to output wall thickness in engineering units.

Software / Acquisition

The generic software flowchart of an MTT job is illustrated below.



Warrior Surface Readout Acquisition

The MTT can be run either alone or in combination with additional Sondex Ultrawire tools. At the top of the string is an Ultralink telemetry controller to transmit the data to surface. At surface a power supply / telemetry panel decodes the data which is then relayed to the logging computer via a USB or parallel connection. A modified version of the Windows based Warrior acquisition software is used to acquire the data.

During acquisition the engineer has a choice of log formats, which can also include other PL sensor data, and has the option to plot a 2 dimensional colour VDL sensor response map. The Warrior system does not calculate thickness, therefore on-depth MTT data is exported as a .LAS file for post processing and for 3D thickness imaging.

For the thickness calculation MTTcal is run on the exported .LAS data. The output .LAS thickness file can then be read back into Warrior for plotting.

MTTcal: This utility is used to generate correction coefficients and to convert from raw readings into thickness in engineering units.

MTTlas: This utility is used to convert output .LAS files into a format which is compatible with MTTview.

MTTview: At present MITview software is used to image the thickness data. This will later be modified for MTT purposes. The colour mapping is controlled by an .RGB file. The user inputs nominal thickness as ID and sets a range for thickness in the OD box. Multiple MITview windows can be opened. A good view of the well can be generated by displaying MIT data in one window and MTT data in another window. It is important to remember that MTT data is thickness, not ID.

Example MIT / MTT views

Fig 1: This view is of perforations. The MIT data is on the left and the MTT data is on the right. Notice that though both tools detect the perforations, the MIT data has better definition of the perforation holes. Perforations are seen as reductions in thickness by the MTT but by multiple sensors. This in can be an advantage in cases where there may be a small hole which by coincidence is located between the fingers of a multi-finger caliper.

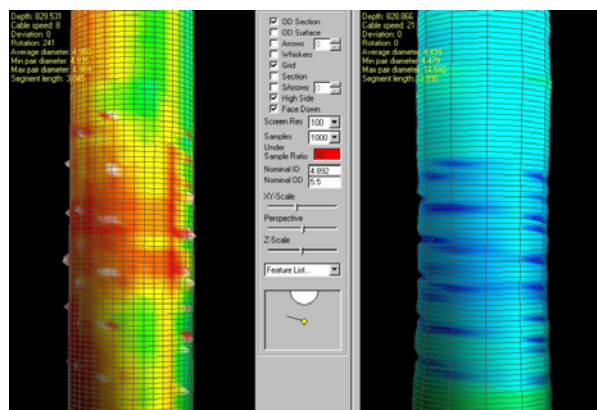
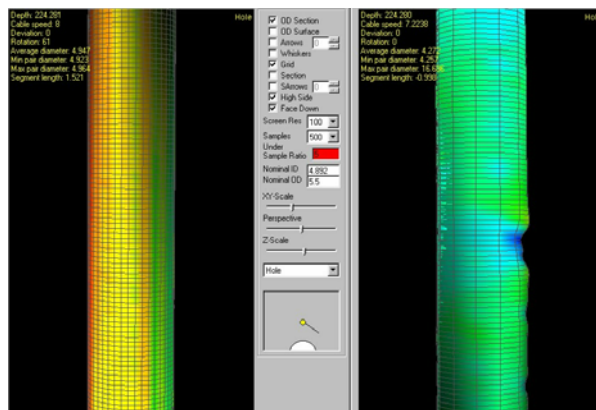


Fig 2: This view is of damage on the outside of the tubing. The MIT data is on the left and the MTT data is on the right. The MIT tool shows undamaged tubing, the MTT shows a localized reduction in wall thickness which must be on the outside of the tubing.



Maintenance of the Tool

The tool should be carefully cleaned after the job using diesel or a similar solvent. Do not use a pressure hose. Examine the sensor housings carefully for any signs of damage. The following items should be changed as required. Refer to the maintenance manual before attempting to strip down the tool.

- 'O' rings of the tool connections and inside the housings.
- Bowsprings – inspect the tool after each job for worn or damaged bowsprings. The bowsprings are not strong enough to support the tool so the tool needs to be well centralised. They are designed to be flexible.
- The sensors and sensor leads are a sealed assembly. Though the sensor assembly is strong the tool should be treated with care – it is a highly complex instrument. The sensors should not be hit or subjected to shock. It is easy to recognize if a sensor is not working or damaged either by physical examination or by looking at the tool response. The sensors can be changed by following the procedures outlined in the manual.



Job History

To our knowledge, as of November 2003 the tool has performed 15 'real well' jobs:

Location	Wells	Depth
Hampshire, UK	1	200m
Texas, USA	1	1000m
Alberta, Canada	13	1200m

The tool has been accepted by the Alberta Energy and Utilities Board as an approved Casing Inspection Tool.