Christmas with TAG

EMW-I™ Internal Pipeline Inspection with Electromagnetic Waves

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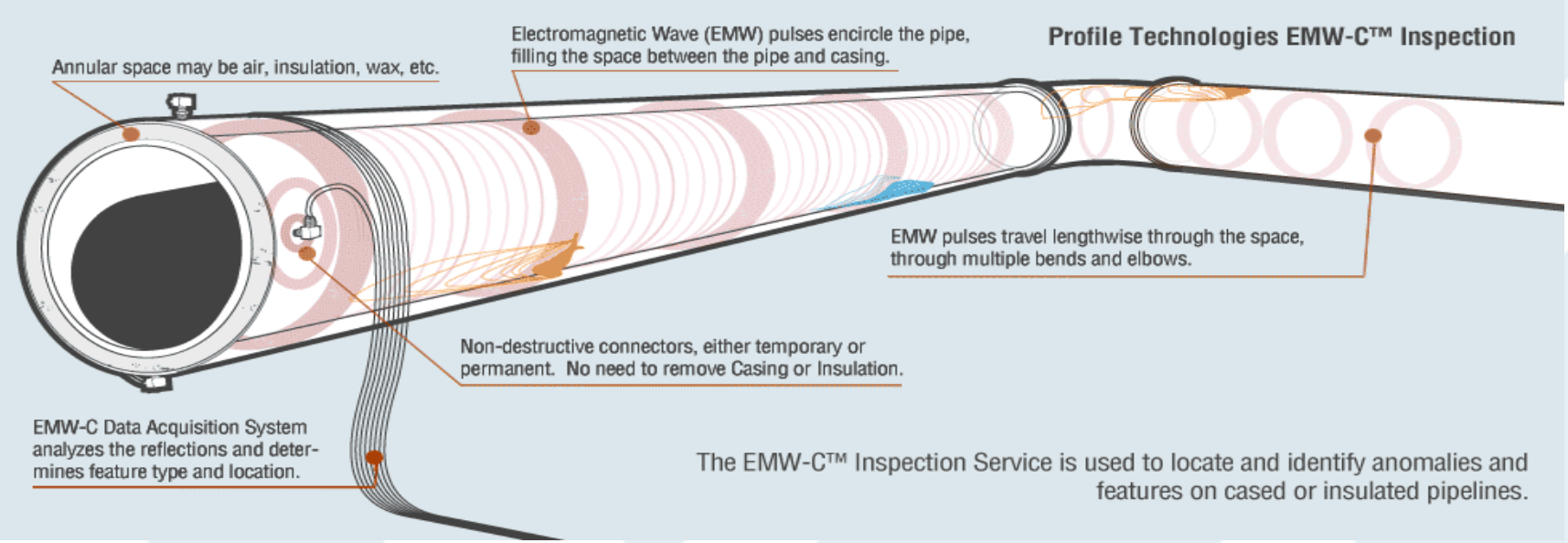
About WaveTrue

WaveTrue inspection tools utilize Electromagnetic Waves to interrogate the pipe system.

EMW-C is used to inspect Cased and Insulated pipe for CUI and other anomalies.

These are long range methods allowing for inspection of long segments in both directions from a single location.



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Wax Filled Casing Monitoring

The EMW-C is being used by gas companies in the lower 48 for inspection of cased pipelines.

A newly developed application of the EMW-C allows us to provide inspection and monitoring of wax filled casings as well.

Capabilities include volumetric monitoring of the annulus for conditions such as wax fill levels, voids, and water in wax. Periodic monitoring can be used to watch for changes in wax and/or corrosion growth versus baseline.

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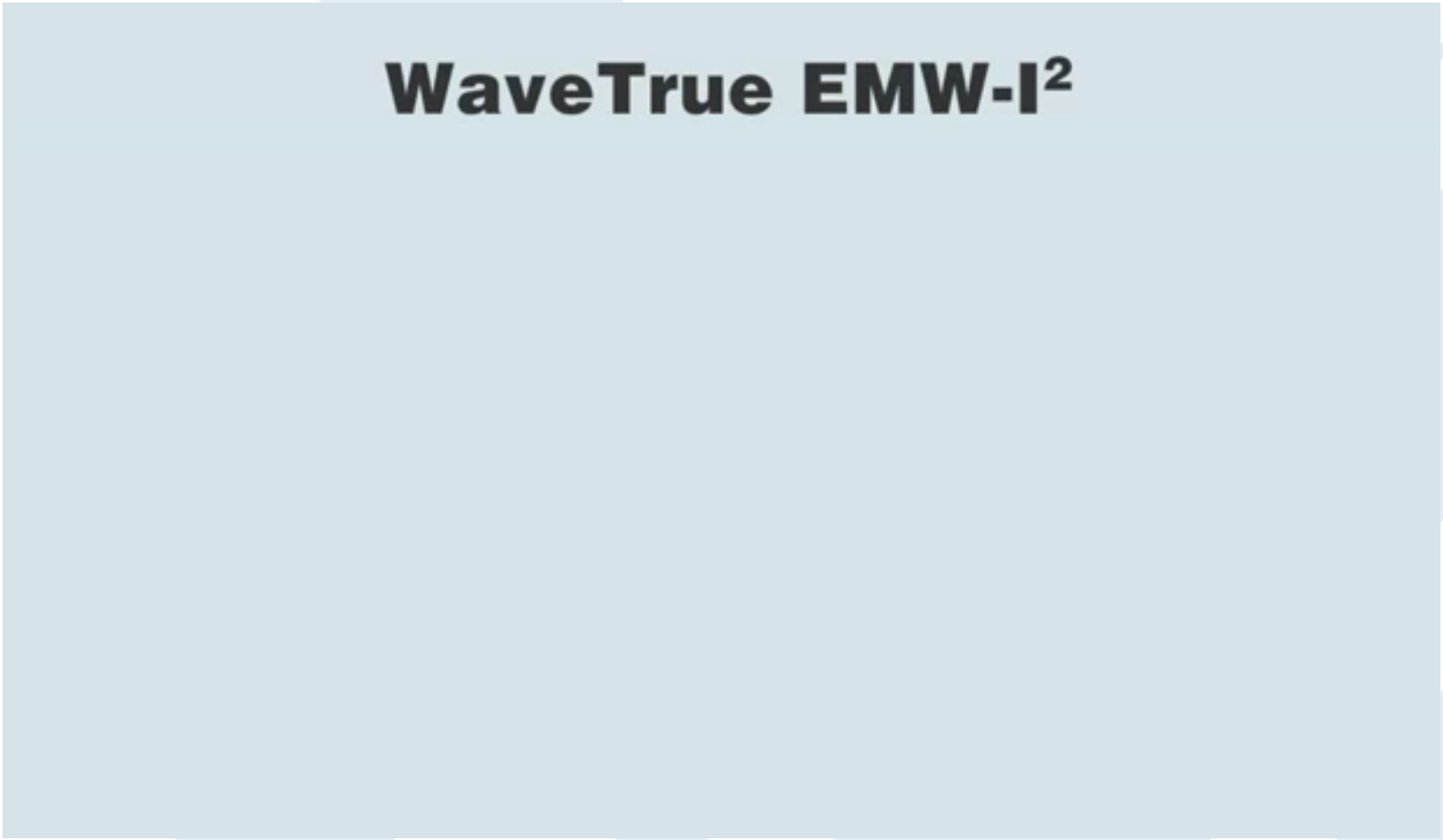
Animation EMW- I



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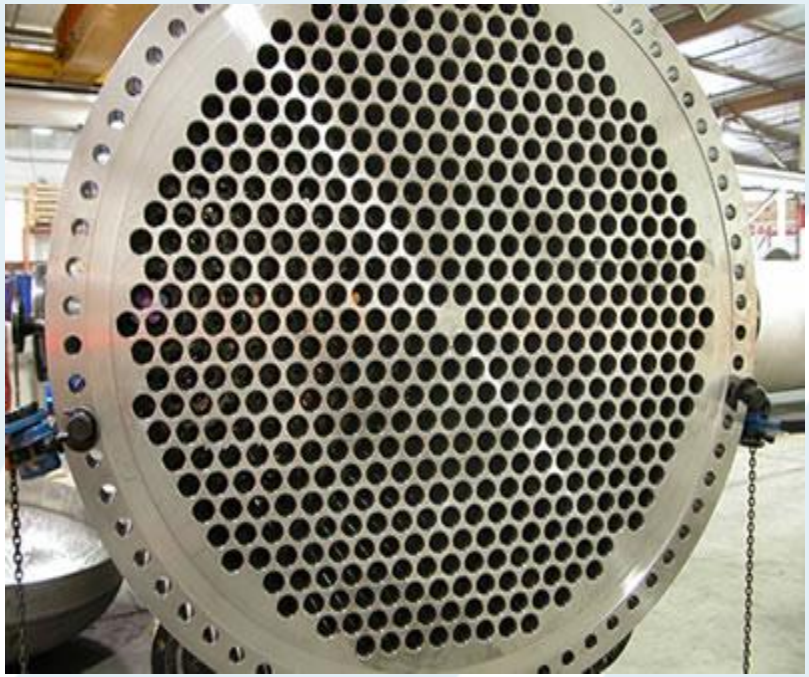
Applying EMW to the Inside

EMW technology now expanded to an Internal inspection method. Electromagnetic Waves (EMW-I) are injected into the pipe or tube and 'fill' the internal space producing an interrogation of the entire volume.

- Waves travel through the materials in the space (gas, oil, water, scale, corrosion product, sludge, etc).
- Materials are considered dielectrics to the waves. Part of the wave continues through and another part is reflected back.
- Each dielectric material has a permittivity associated with it which changes the impedance of the structure as the EMW pass through it.
- Analyzing the impedance changes and reflected waves, and comparing them to a signature, materials and their location within the casing can be identified.



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Applications for EMW-I

- Long range detection of internal anomalies
  - Corrosion Product
  - Location of Cracks
  - Location of Water holdup
  - Scale or Paraffin Build-up
  - Upsets in product flow (ie. Slugs)
- Industry Applications:
  - Pipeline – Oil / Gas / Water / Chemical
  - Refineries and Power – Heat Exchangers / Boilers
  - Food Processing and Paper – Process Piping and Tubes
- Magnitude of the anomaly based on data and equivalency models.
- Continuous /periodic monitoring to detect changes over time.
  - Permanent connectors may be installed.

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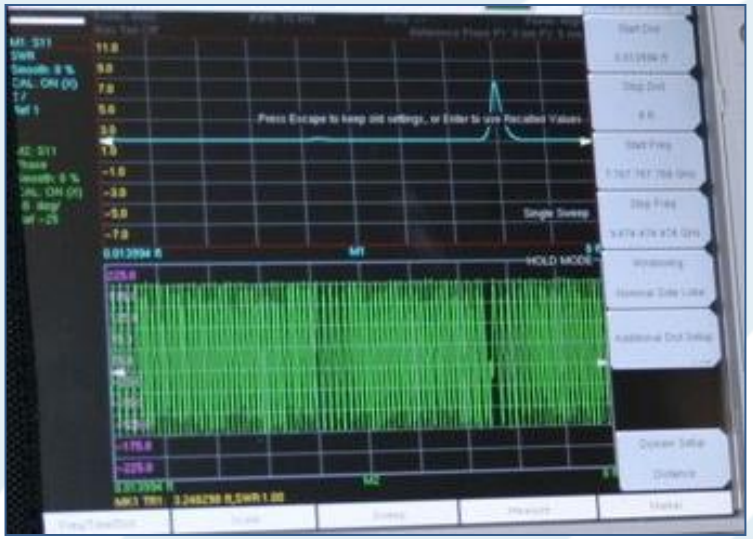
EMW-I Combines Distance, Phase, and Dielectric Analysis

- Rich data provided by EMW reflections interprets characteristics inside the pipe.
- Distance and feature length determined by TDR
- Makeup of the feature can be inferred (differentiate corrosion -water -scale).
- Through Phase interpretation EMW-I is capable of identifying volumetric differences of features - differentiation of voids (e.g. pits vs scale).



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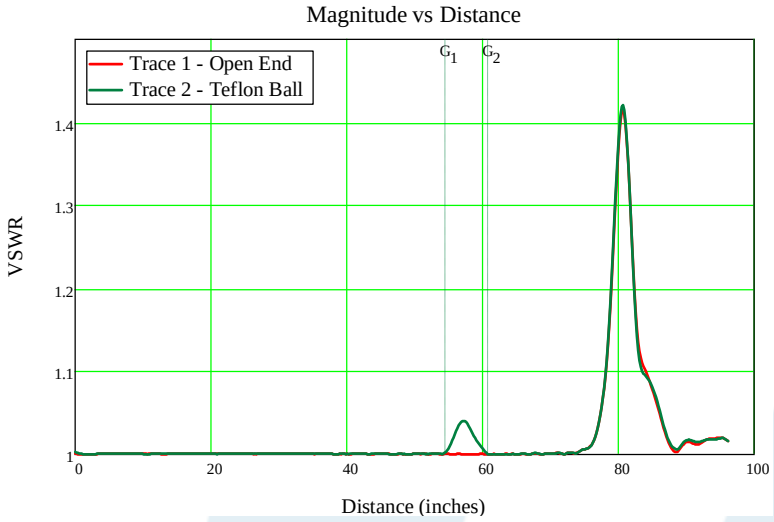
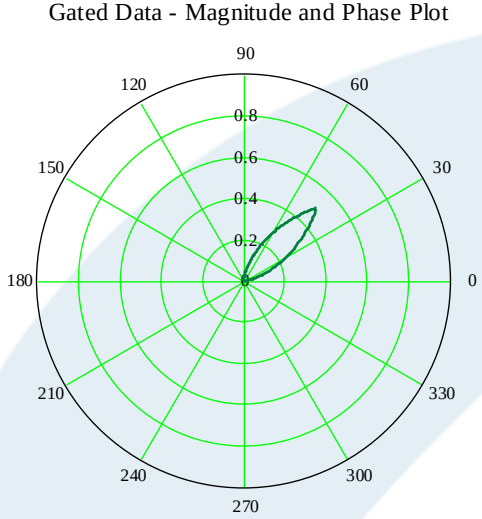
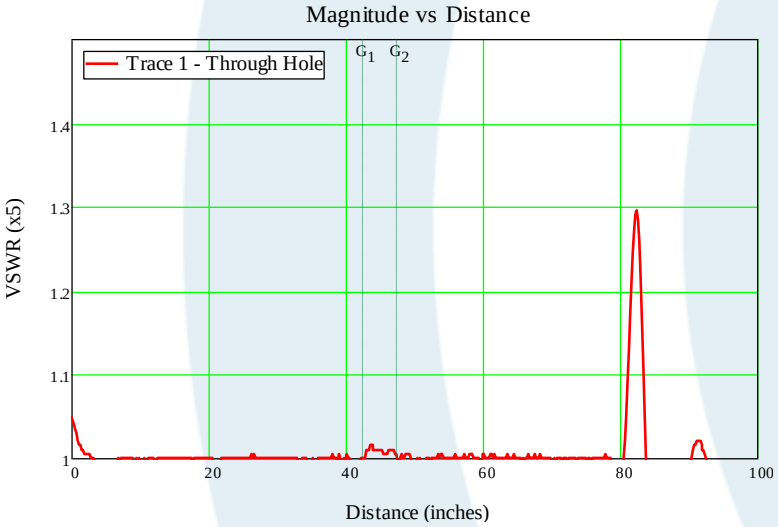
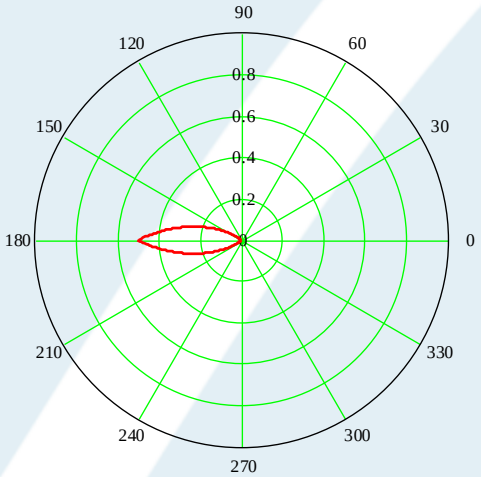
EMW-I Data Comparing Positive / Negative Features





Data for a 1 inch by 0.028 inch wall thickness heat exchanger tube. On left, the traces for the baseline and with a Teflon sphere inserted. On right, the magnitude and phase plot for the gated Trace 2.





Data for a 1 inch by 0.028 inch wall thickness heat exchanger tube. On left, the traces for the baseline for through-wall hole. On right, the magnitude and phase plot for the gated Trace 2.

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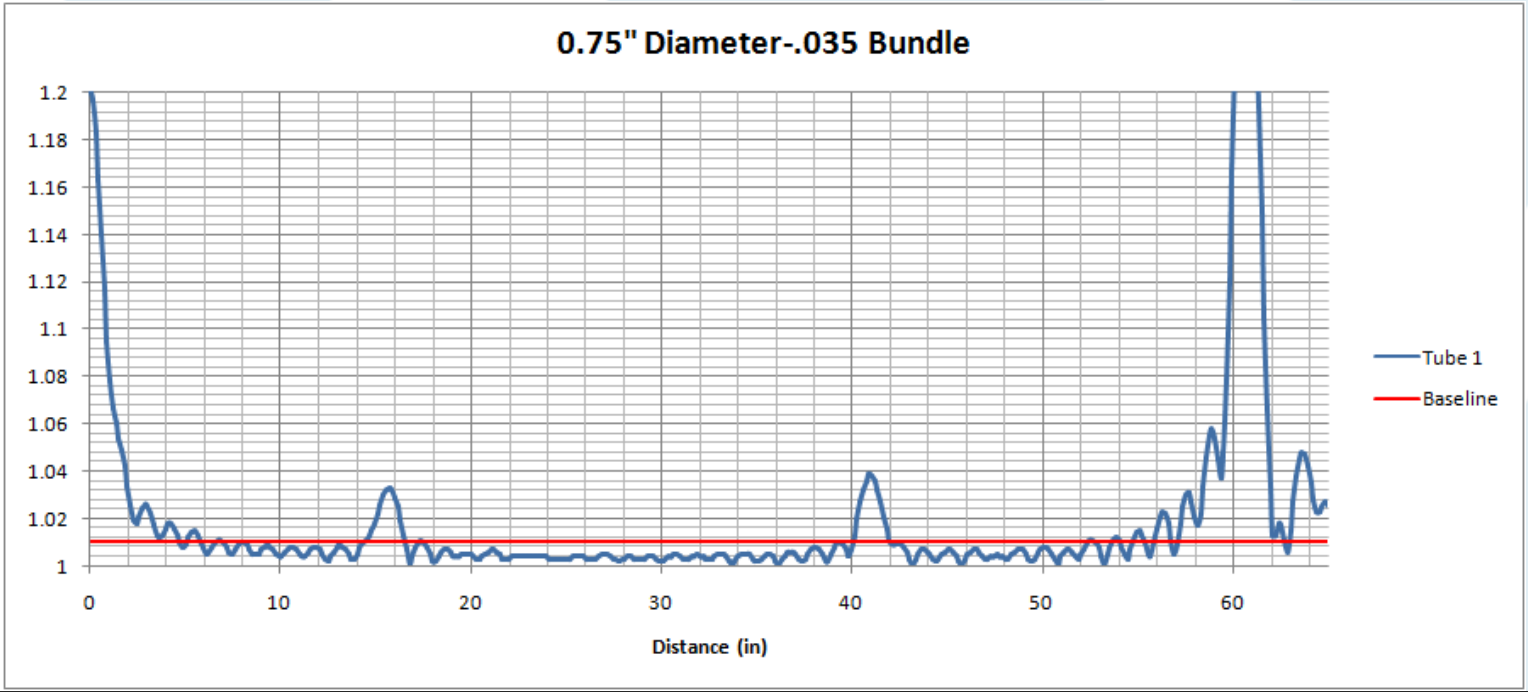
Recent Sample Data

- Recently WaveTrue collected data from tubes used for Eddy Current (EC) calibration.
- These tests showed the EMW-I to be on par with EC for detection of pits sized .0052” as shown below.
- EMW-I also detected surface crack features representing SCC.



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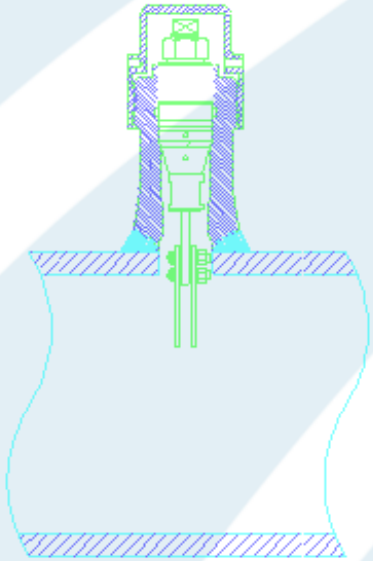
Implementation

- EMW-I launches transverse electric (TE) and/or transverse magnetic (TM) mode waves inside the pipe to be tested.
- For sludge or blockage detection, the TE11 mode is most predominant.
- Mode launchers for this application will typically be of in-line type though end launchers can also be used.
- Launchers are a retractable, dielectric-coated stub antenna inserted through existing coupon test locations.
- For each pipe diameter a calibration standard with machined defects is used, and baseline data is stored in the equipment.
- The parameters for a particular scan are related to the pipe ID, the fluid flowing in the pipe, and the desired range and resolution.



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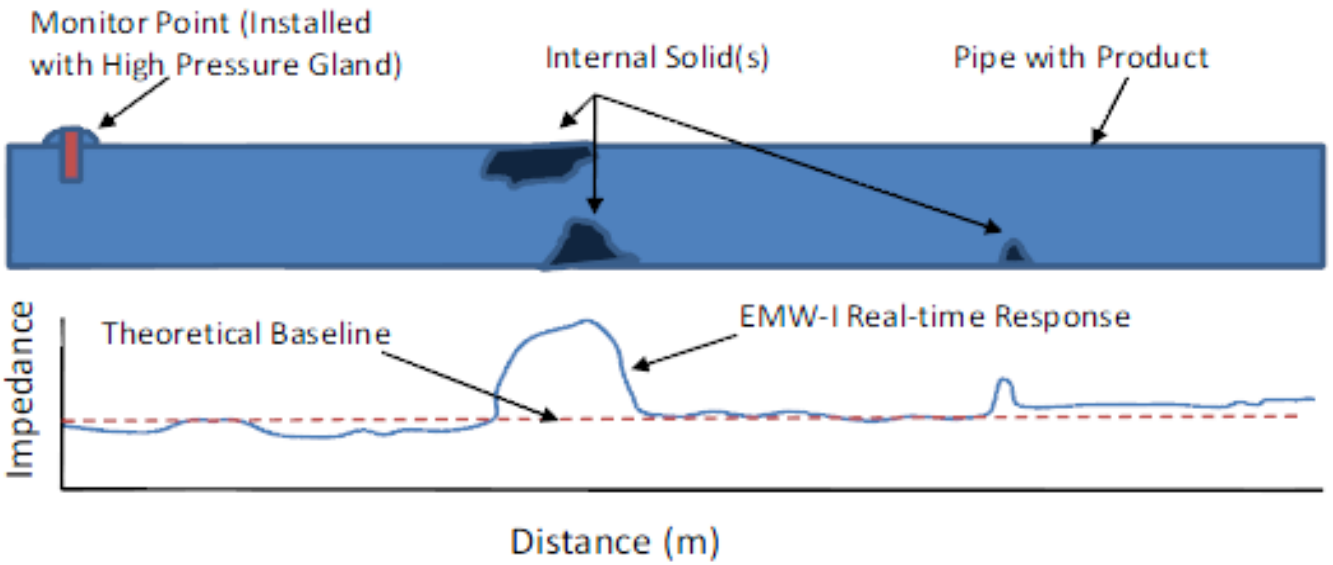
Sludge Detection

- Directionality (currently) requires two access ports.
- Data from both ports is shifted by the known separation distance and overlapped.
- Fluid flowing in the pipe represents a uniform impedance to the instrument.
- Normal fluctuations in fluid density can be averaged out.
- Sludge build up represents a change in density at a fixed location.
- Any non-uniformity inside the pipe will cause energy to be reflected.



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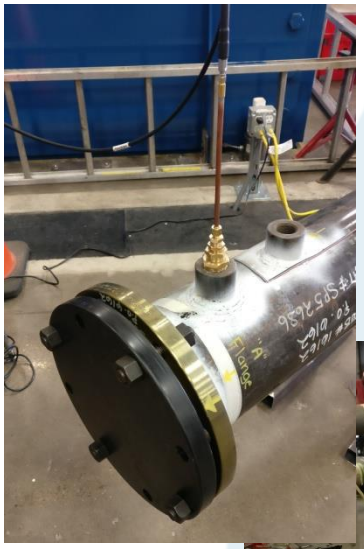
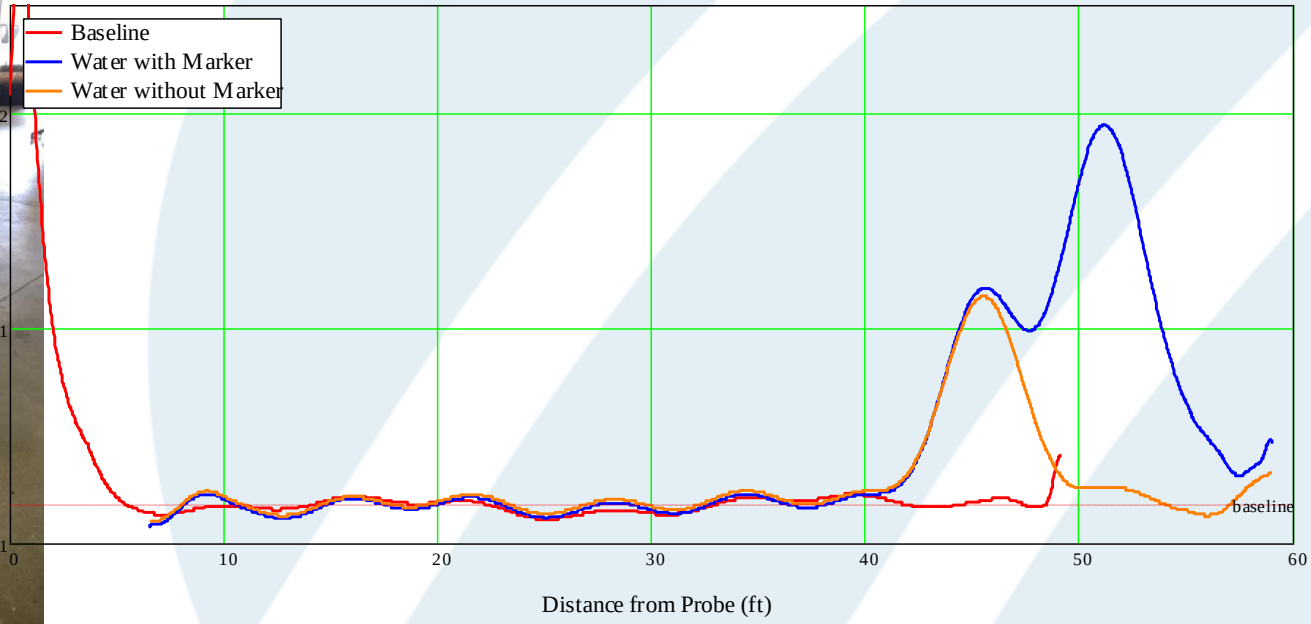
Water Detection

- Recent testing at Stress – Locate one quart of water inside an 8 inch pipe past a flange and a 90° bend.



- Located the water to within ~7 inches of its actual position at ~46 feet from the probe location



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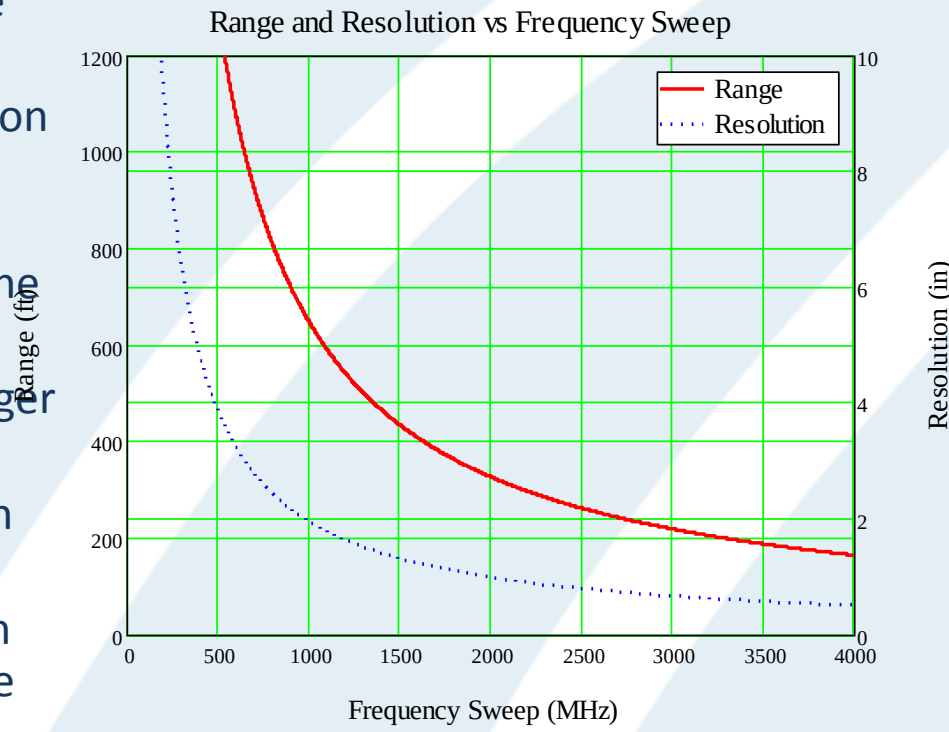
Detection Ranges

The maximum range and minimum resolution for a 4 inch ID pipe are shown below
For pipes with an ID >4 inches, the instrument has a large dynamic range (80 dB)

- In practice, the maximum range achievable will depend on attenuation of the signal.
- The signal can attenuation due to conduction losses which are dependent on the conductivity of the pipe material
- Dielectric losses can occur dependent on the material flowing through the pipe
- In general, for the same pipe materials, larger pipes have lower conduction losses
- Overall attenuation is mainly dependent on the product material.
- We can characterize the material flowing in the pipe to get an accurate estimate for the detection range



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Other Uses

- In addition to detection of sludge build-up, EMW-I can be used to detect and locate anomalies such as wall loss and cracks.

- Cracks significantly disrupt the currents that drive the modes and usually present a large reflection

- EMW-I can also be used as a process monitoring system. In this application, real time monitoring can be used to observe slugs of varying density flowing through the pipeline, e.g. a water slug in a steam pipeline.

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Key Points

- A defect or anomaly can be detected even if it is much smaller than the resolution.
- Bends do not pose a problem unless the bend radius is less than about 1.5x the ID of the pipe.
- The TE or TM modes launched down the pipe can propagate past an insulating flange. Although the insulating flange will give a response, information can be obtained past it.

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Summary of Internal Inspection EMW-I

- Using EMW, the internal surface and area of a pipe or tube can be inspected at long range for various features including.
  - Pits, Corrosion Product, and Cracks
  - Water Holdup, Scale, Sludge, Paraffin, and other Blockages
  - Monitoring of Upsets, Slugs
- The technology can be applied with access to pipe or tube end or via access port such as high pressure gland.
- May be used for spot inspection or online real-time monitoring.

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Next Steps

To implement an EMW-I system:

- Identify pipe candidates where blockage is known to be a problem
- Access via corrosion monitoring ports (i.e. Cosasco Flarweld Fitting).
- Either have portable monitoring or setup permanent monitoring station
- Identify product chemistry (what's typically flowing through the pipe)?
- Identify what you want to find
- With this information, WaveTrue can work to implement internal monitoring stations.

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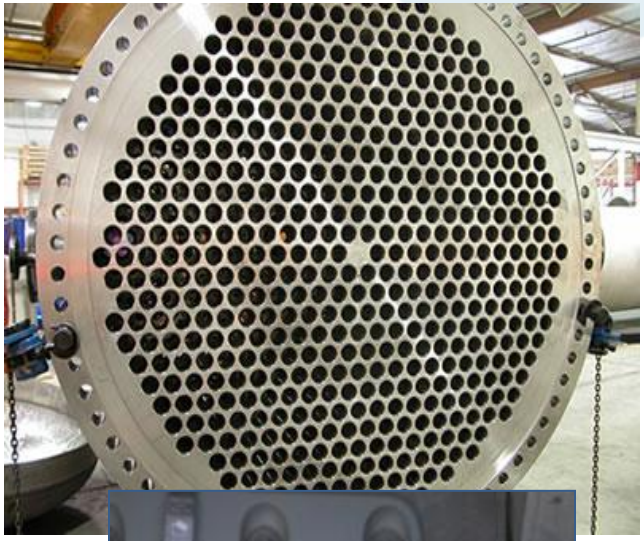
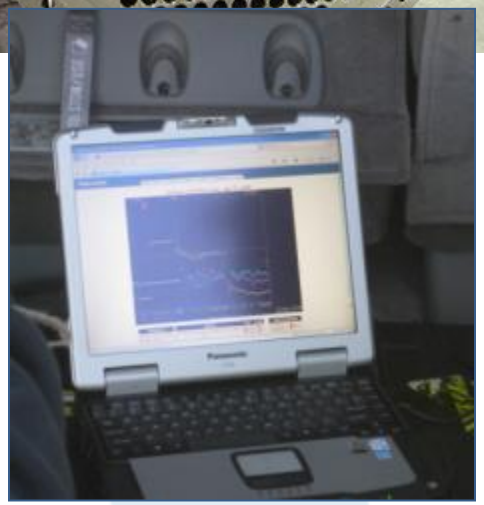
Thank You!





For Answers please contact:

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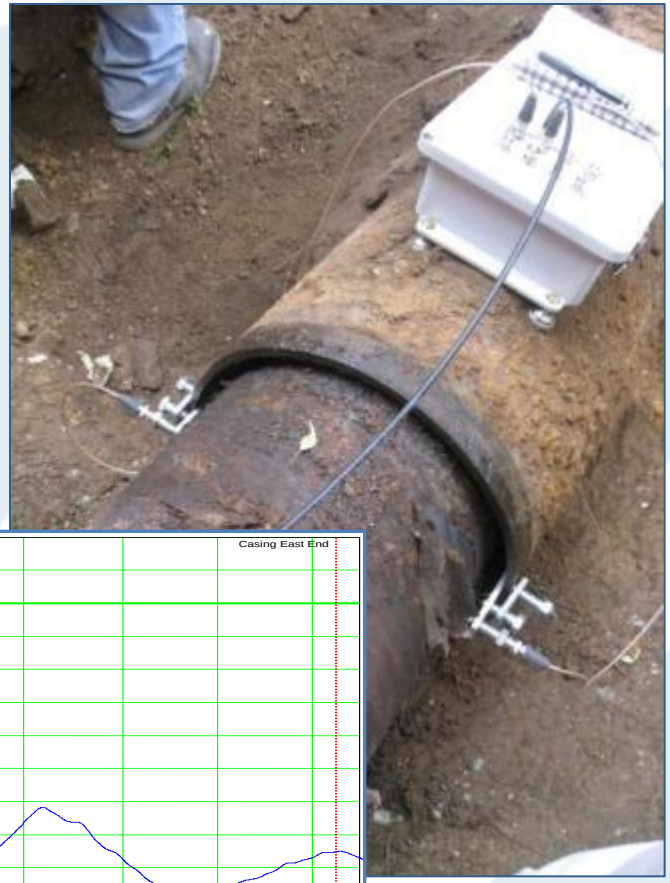

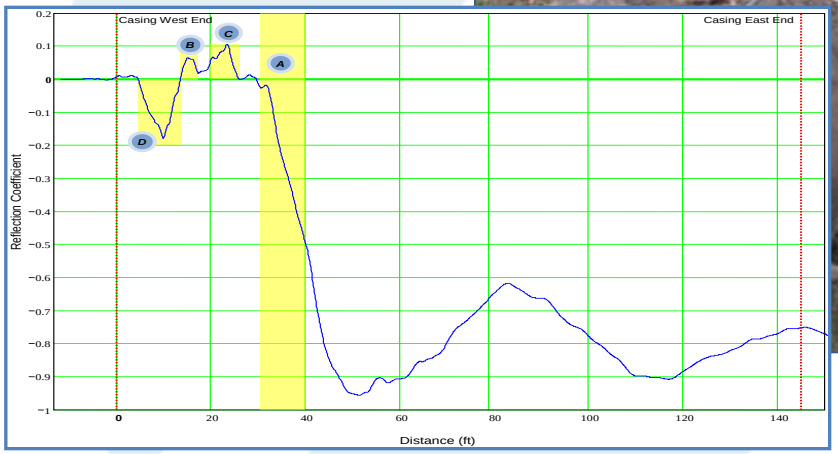

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