



Beyond Conventional External and Internal Tools for External Corrosion Direct Assessment Unpiggable Pipelines

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Corrosion and Cathodic Protection

Specialist

Discussion

- Self propelled and Tethered Tools
 - Remote Eddy Current – Geo Explorer
 - Bristle Tractor with integrated systems
 - Camera and Laser Video
- Pumping/wire line tools
 - Piglet
- Free floater that is used primarily in water and oil lines
 - Smart ball
- New Technologies
 - Extra High Resolution
 - MIC Pig
 - Rope and Riser Inspections
 - Magnetic Tomography
- Advances in Existing Technologies
 - Guided Wave Technology
 - Magnetostrictive
 - Radiographic
- Above Ground Monitoring Tools
 - Electromagnetic Attenuation Coating
- Permanent Monitoring
- Conclusions

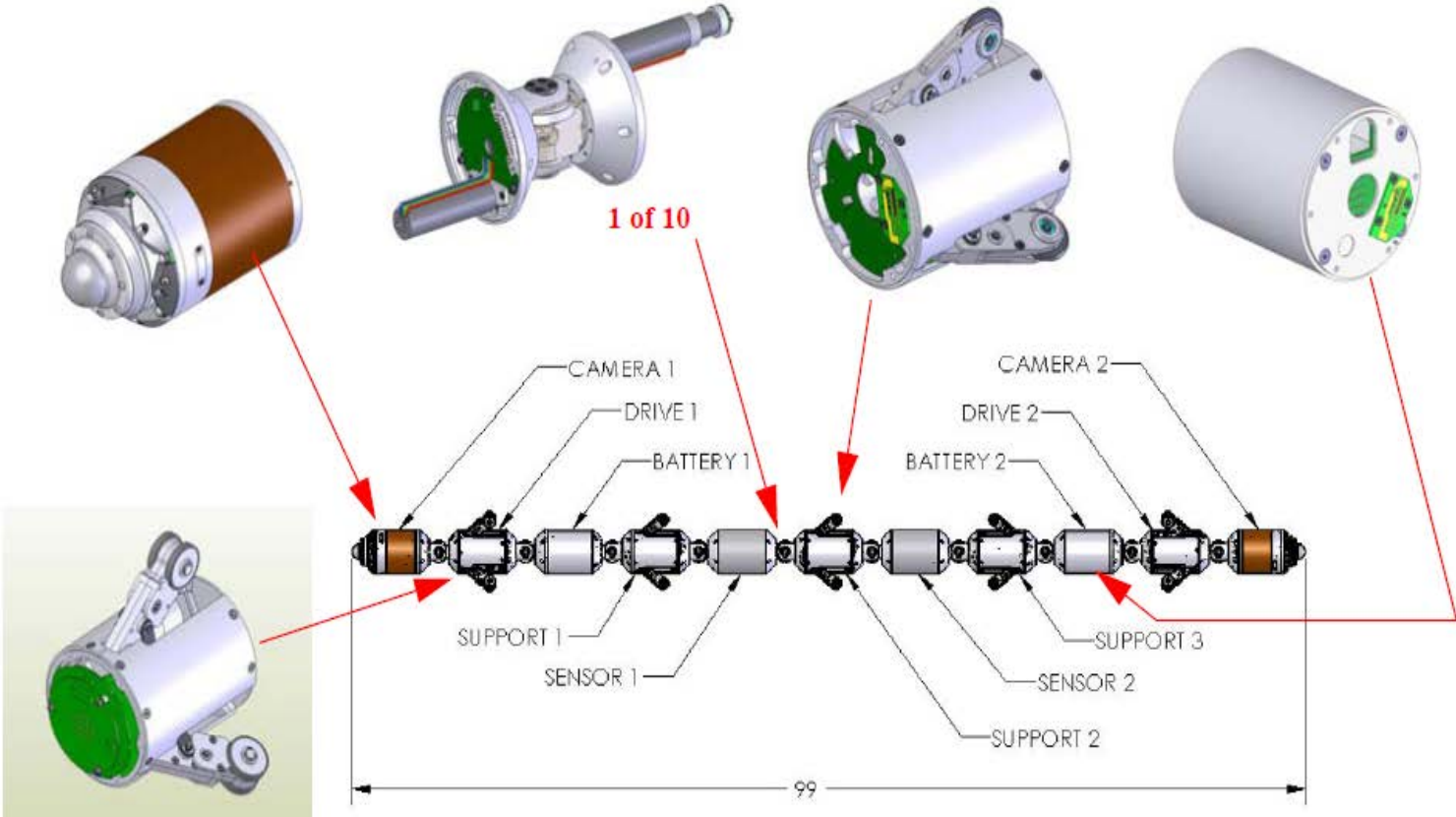
Internal Tools

- Self propelled and Tethered Tools
 - Remote Eddy Current (DOE) 6" to 8"
 - Uses eddy currents to detect metal indications
 - Can collapse down to 4"
 - Bristle Tractor with integrated systems
 - Uses brushes to push pull itself
 - Consists of an integrated package using guided wave, ultrasonic testing, phased array, magnetic flux leakage
 - Camera and Laser Video
 - Light Emitting Diode (LED) technology that allows brighter lighting with less power along with high definition; these tools have improved video capability.
 - Next down the road is 3-D resolution

Geo Explorer



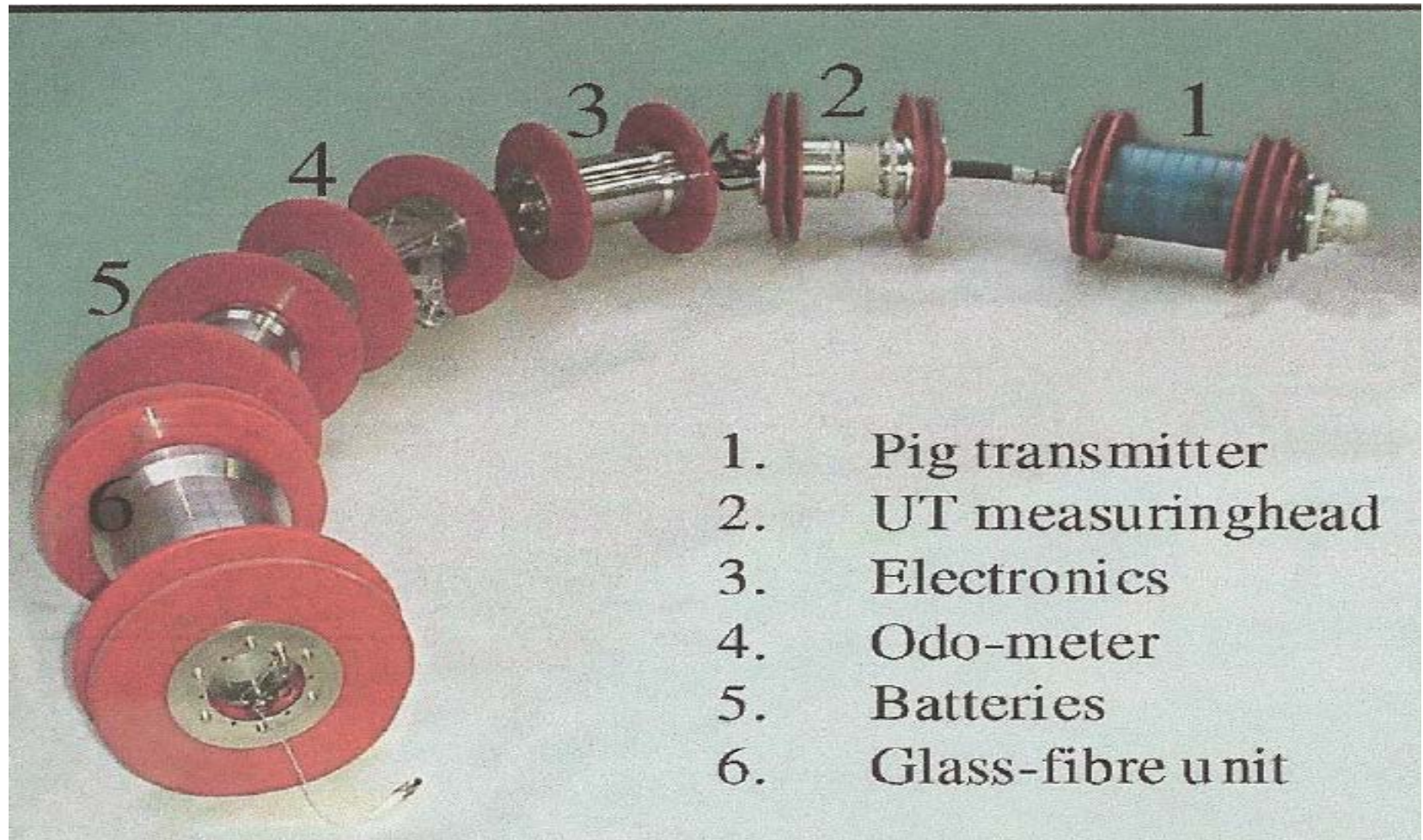
Components of Geo Explorer



Pumping/Wire Line Tools

- Tool is designed for short sections of piping where the system has been determined unpiggable.
- Runs in loading lines, tank farm connection lines and limited short sections of pipe or piping.
- Uses tight seals and injecting water into the pipe to push the pig to a predetermined end point.
- Configured with ultrasonic test equipment and special electronics these tools can conduct A-scan, inner and outer wall reflection, distance, o'clock position

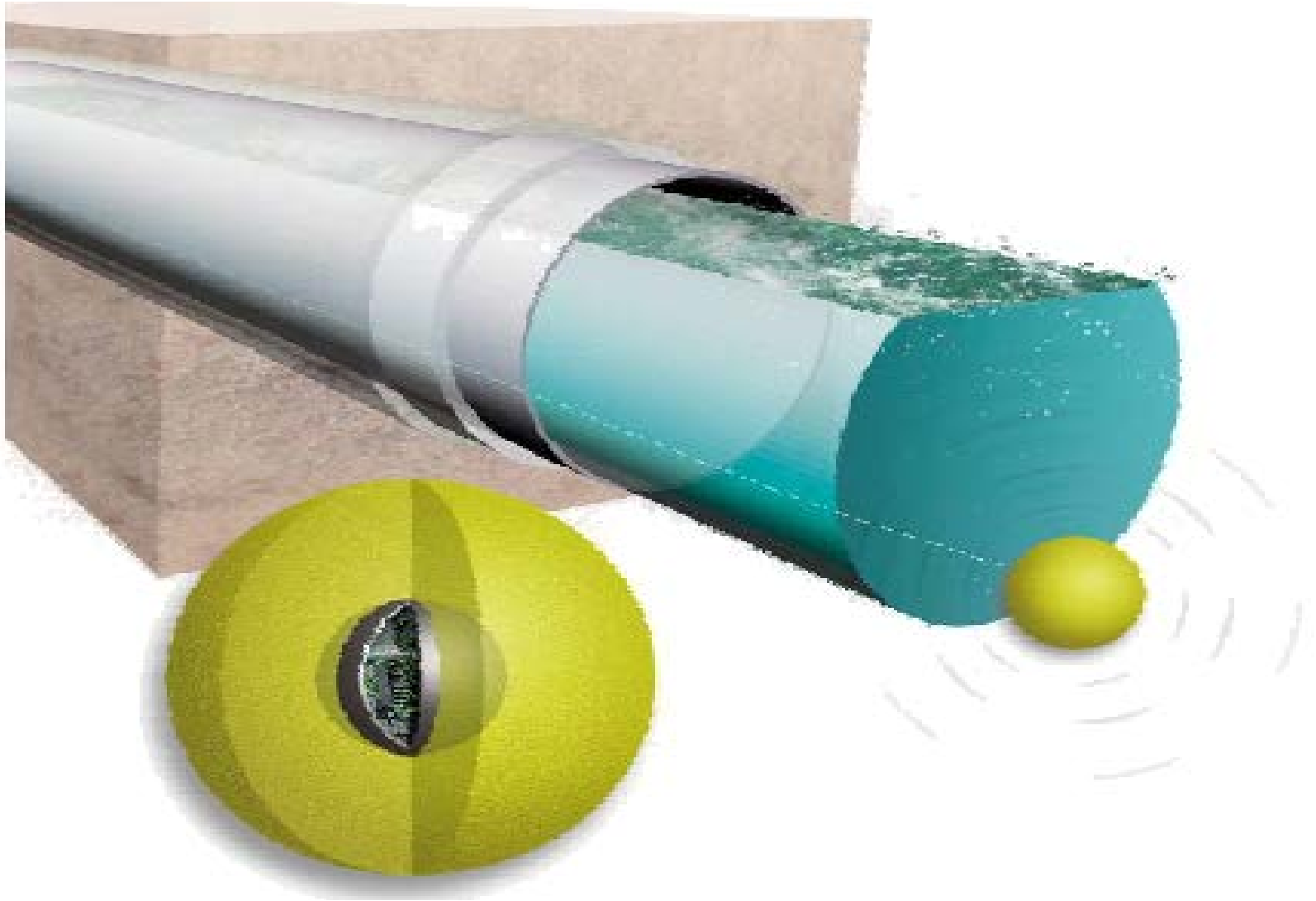
Pumping/Wire Line Tool



Free Floater

- Instrument detects primarily leaks and appurtenances.
- Tracked within the pipeline using external receivers and an internal tri-axial accelerometer.
- Used primarily in water lines but versions have been used both in oil and gas pipelines

Free Floater



NEW TECHNOLOGY

- Extra High Resolution Magnetic Flux Leakage data represents a truly generational step in intelligent pipeline inspection
- Consists of both hardware and software developed through cutting edge technology,
- Data correlation and defect location are coordinated through a series of above ground markers.
- Onboard signal processing to distinguish between the pig's transmitter and other noise in the 20 Hz range and also to distinguish between the pig's magnets and stray magnetic fields.
- Response to other 20 Hz noise is greatly diminished and false triggering on magnetic fields other than the pig's is reduced at least two orders of magnitude compared to commercial tracking equipment.

Ultra High Resolution Tool



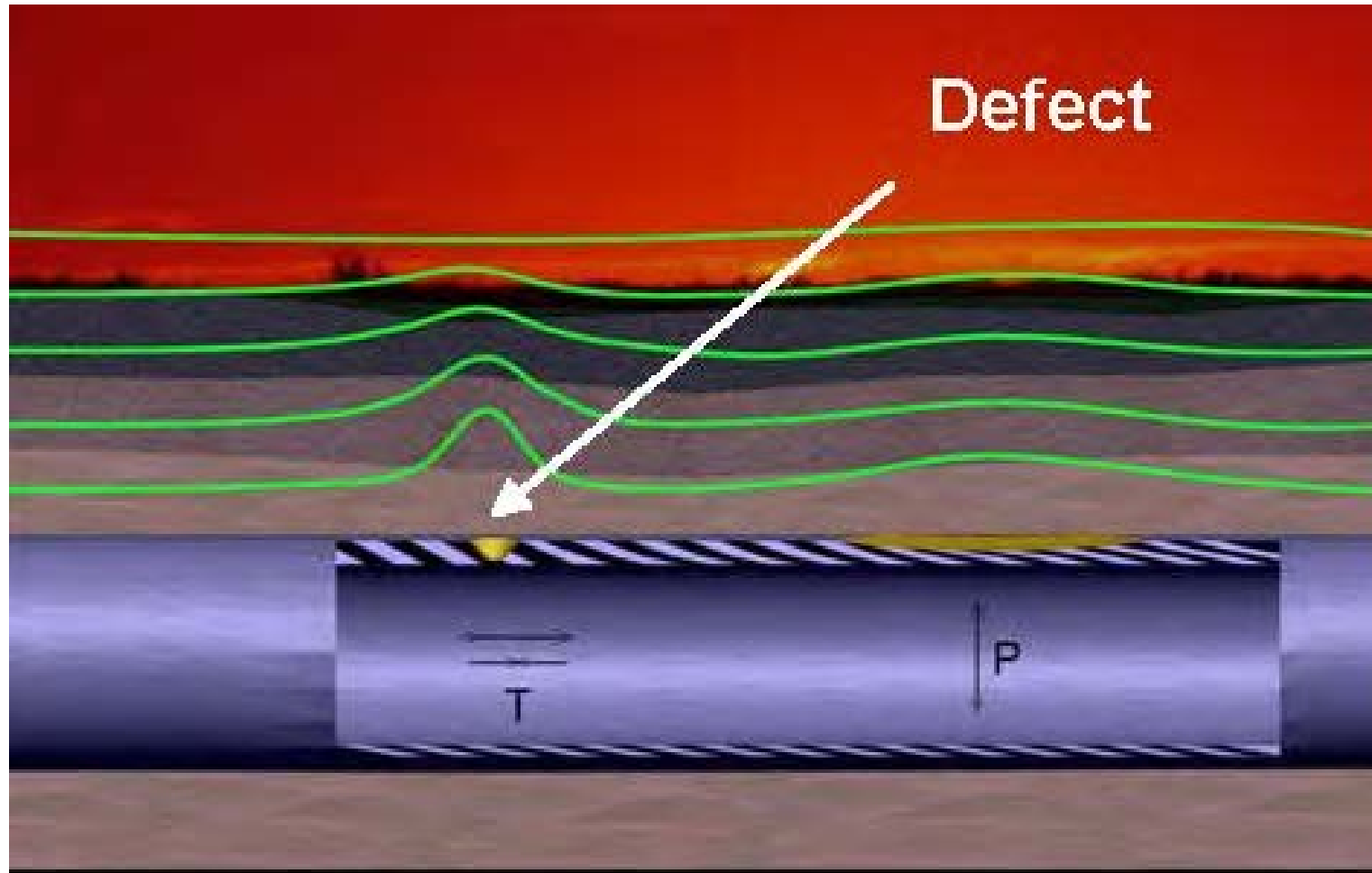
New Technology

- MIC Pig samples pipeline's in-situ gas, oil, water and black powder components.
 - MIC corrosion is a local event which may be missed with single-point sampling
- Rope and Riser Inspections allows for the delivery of various non-destructive testing devices, high-tolerance gauging of rope thickness and diameter, and full-coverage, using acoustic-optic-radiographic imaging sensors.
 - Inexpensive robots monitoring floating production platforms' risers and mooring ropes, structural integrity can quickly be identified before the fault becomes a threat to safety

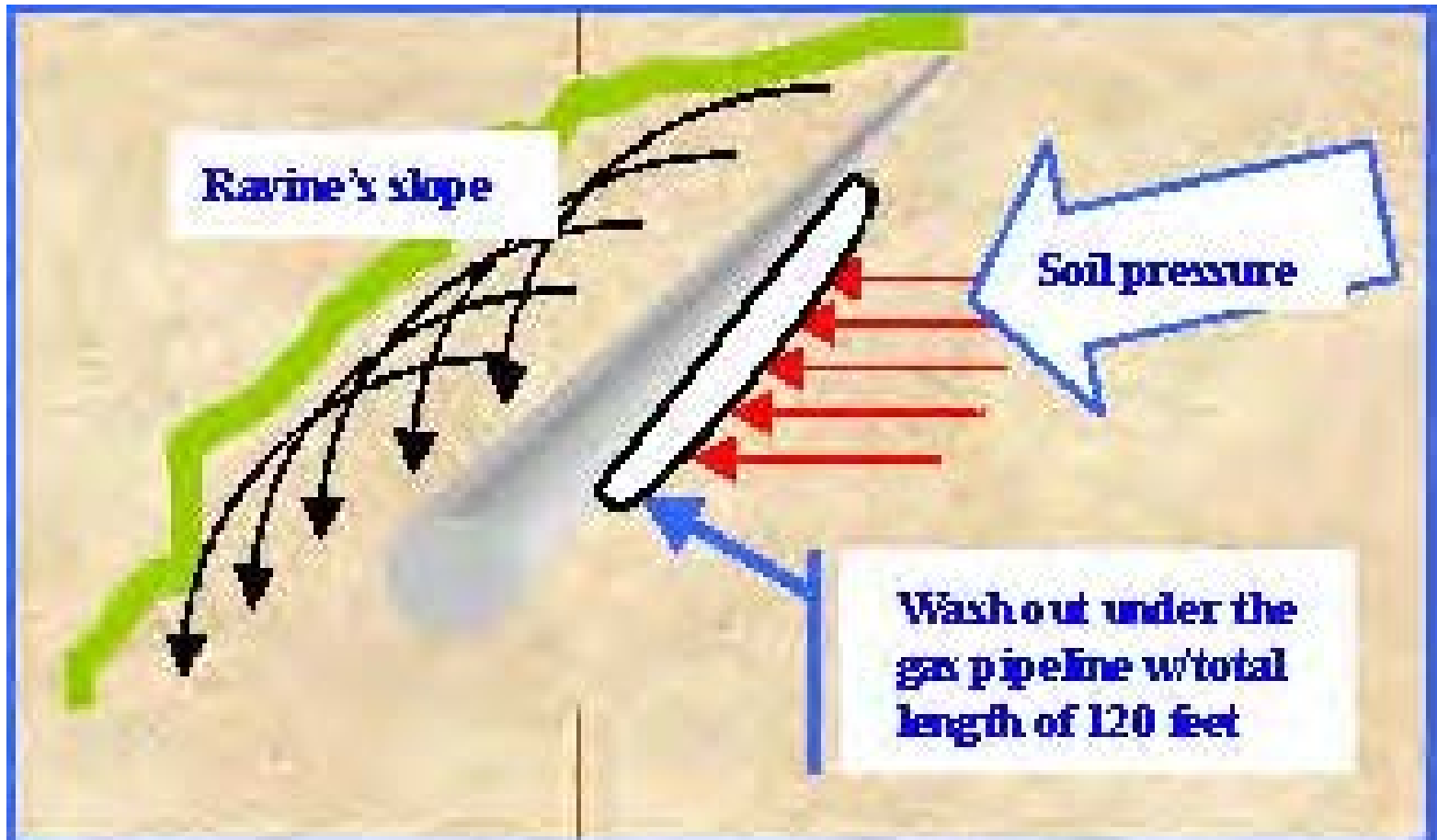
Magnetic Tomography Method

- MTM passively records magnetic measurements along a pipeline (electric signals are not conducted through the pipe). This technology detects mechanically stressed areas due to excessive mechanical loading, changes in structural condition of the steel or a combination of such factors.
- Steel structures buried near the pipeline surveyed may also interfere with achieving thorough data. An operating pressure of a pipeline which is less than 30% of SMYS will lower the probability of detection below 80% but never less than 60%.

MTM Detection (Defect in Wall)



MTM Detection (Washout)



Advances in Technology

- Guided wave testing (GWT) is the rapid screening of long lengths of pipe from each test location in order, first, to achieve large area coverage of the pipes in a cost-effective manner and, second, to target suspect areas for closer examination by local non destructive techniques (NDT).
- GWT is used:
 - Cased, buried, or above-ground steel pipe to locate and evaluate areas of metal loss.
 - Buried pipe, inspection distances range from 40 to 150 feet on either side of the transducer collar.
 - Above ground insulated and non-insulated pipe on racks, overhead on supports and dock areas.

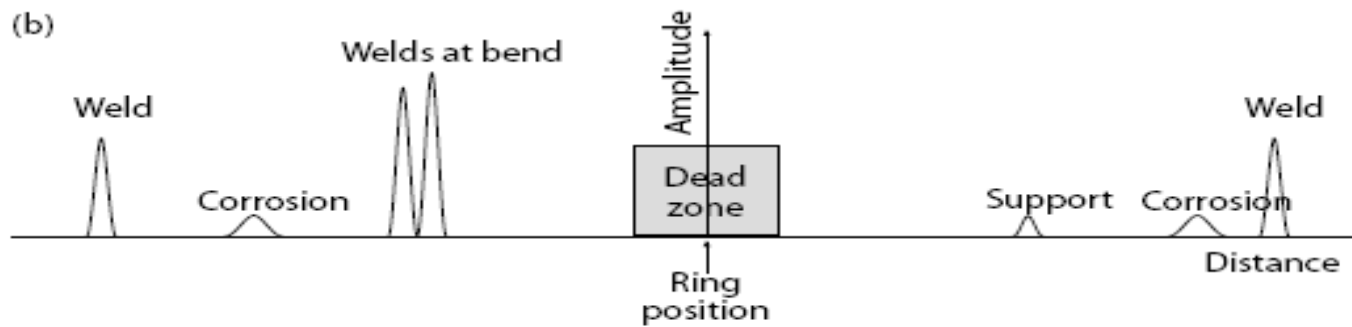
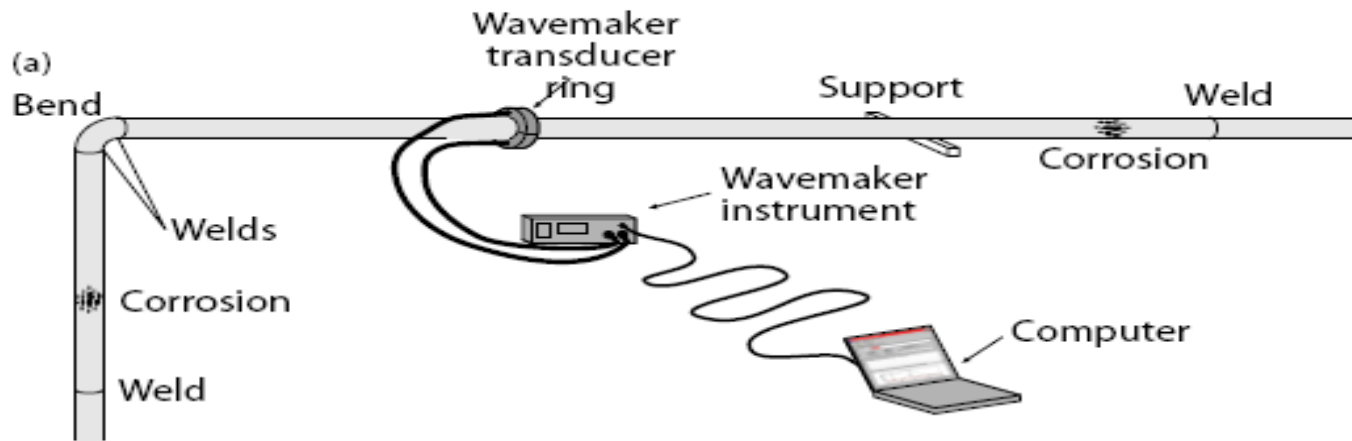
GWT

- GWT is a rapid screening of long lengths of pipe from each test location:
 - to achieve large area coverage of the pipes in a cost-effective manner
 - to target suspect areas for closer examination by local non destructive techniques (NDT).
 - to examine pipe lengths which are inaccessible for more conventional NDT methods

GWT

- Guided wave technology is used on:
 - Cased, buried, or above-ground steel pipe to locate and evaluate areas of metal loss.
 - Buried pipe, inspection distances range from 40 to 150 feet on either side of the transducer collar.
 - Above ground insulated and non-insulated pipe on racks, overhead on supports and dock areas. Typical distances range from 200 to 500 feet on either side of the collar.

GWT Setup



GWT PIMs at Cased X-ings



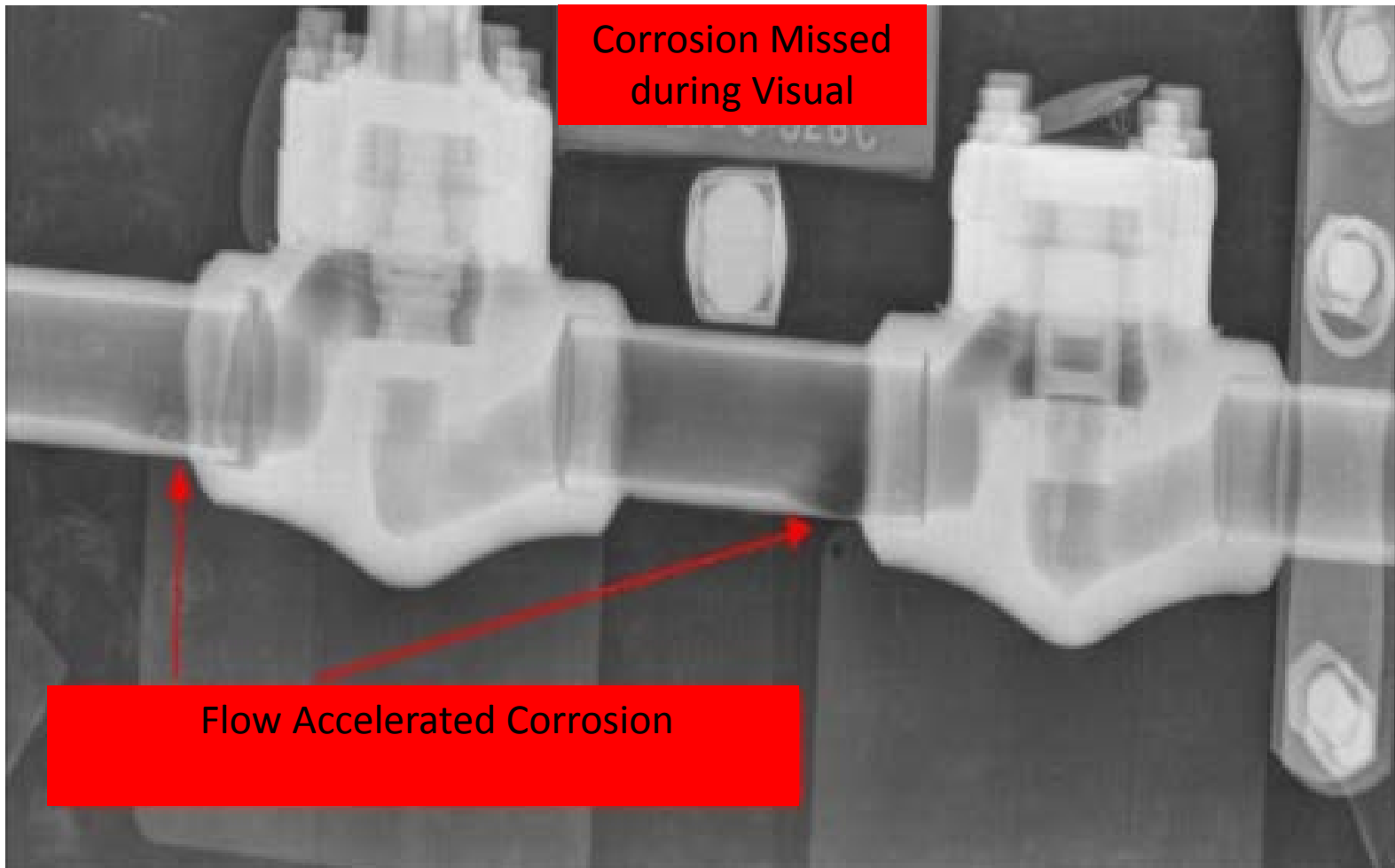
Magnetostrictive (MsS)

- MsS sensor can transmit and detect elastic waves in a steel pipeline and thus perform the functions of a piezoelectric-type ultrasonic transducer. In addition, MsS can perform the functions of a strain gauge, vibration sensor, accelerometer, and piezoelectric acoustic emission sensor. While performing these functions, it does not require direct physical contact with the area or material of concern and does not need the use of a couplant as with most UT.
- Pipeline applications elastic waves are sent and reflected signals from the defects such as corrosion or cracks are detected using MsS.
- Inspecting these structures for defects up to 100 feet in length, particularly those caused by corrosion can be done quickly as shown in the picture below. Whereas conventional NDE techniques such as ultrasonics and eddy current are useful for piping inspections for probe up of specific or localized areas once the problems have been detected.

Digital Radiographic Technologies

- Developments in digital radiographic pipeline inspection equipment to assess corrosion:
 - primarily durable
 - mobile computers
 - digital image capturing devices
- Anomalies that create a change in the amount of radiation that passes through the object can potentially be imaged in radiographs.
 - slag,
 - porosity,
 - cracks
 - weld defects
 - areas of metal wastage caused by corrosion and scale buildup or transported products

Radiographic Image



ADVANCES IN ABOVE GROUND MONITORING

- **Electromagnetic Attenuation Coating Tools**
 - AC current is transmitted directly to the pipe by the signal generator, a self-contained computerized unit powered by rechargeable batteries, which is attached to the pipeline at a convenient point.
 - Receiver component detects the radiated electromagnetic field and guides the operator directly over the pipeline, where it computes the depth of the line and the strength of the remaining signal.

ADVANCES IN ABOVE GROUND MONITORING

- Data, including location, depth (meters or feet) and signal current (mA) are transferred to a computerized database and analyzed on site.
- Mathematical models for multiple field conditions can take into consideration probe spacing, resistivity, depth of cover, and signal level which results in a more accurate coating assessment.

ADVANCES IN ABOVE GROUND MONITORING

- New methodology allows the surveyor to collect the ACVG, DCVG, DOC, and current data from a distance at a perpendicular offset to the pipeline; not standing over the line.
- Profiling the offset CP CIS profile in conjunction with the voltage gradient, DOC, and ACCA allows the condition of the coating to be used to assess the significance of CP undulations.
- CP CIS is confirmed against drilled holes

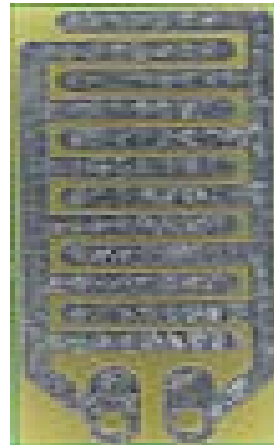
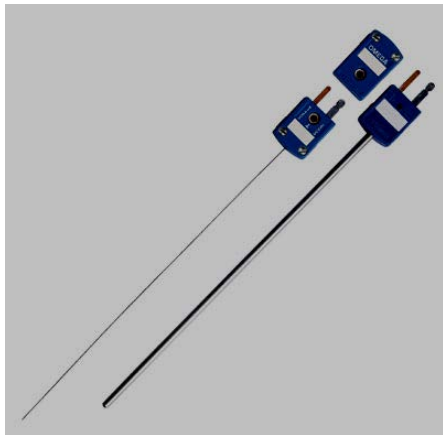
Tool Selection

Permanent Monitoring

- NACE RP 0502-2002 §3.4.1.1, states:
 - *The pipeline operator shall select indirect inspection tools based on their ability to detect corrosion activity and/or coating holidays reliably under the specific pipeline conditions to be encountered.*

PERMENANT MONITORING

- ER Probes
- pH, Temperature,
- Humidity
- Sampling – Gas – Liquid



Conclusions

- New technologies and methods can reduce very costly mistakes.
 - Cost of excavation, collateral damage during excavation, not assessing the defect properly, and not maintaining a useful data base is like doing nothing at all or going back to the old days
- Operators must excavate to conduct prove up, must assess the integrity of the pipe judiciously.
 - Where integrity is of concern, permanent monitors can be used to monitor these areas
- Use technically qualified third party consultants to reduce
 - Unanticipated failures
 - Risk of jury, public and regulators in litigation issues
- Now, Who is Minding Your Assets?