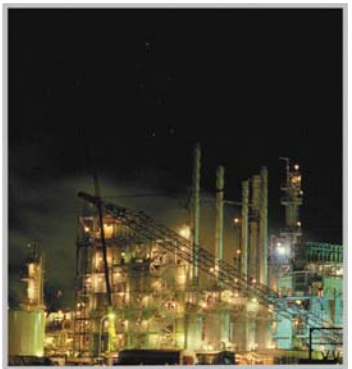
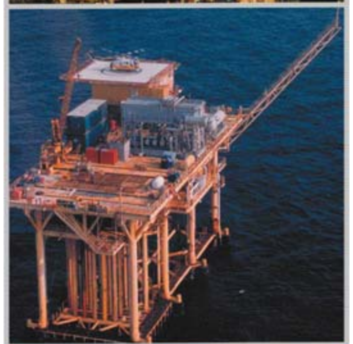
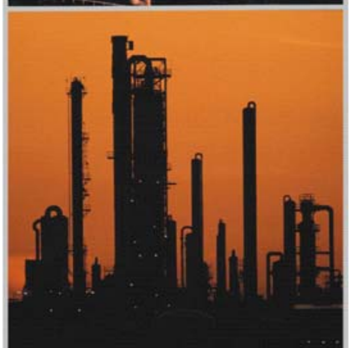
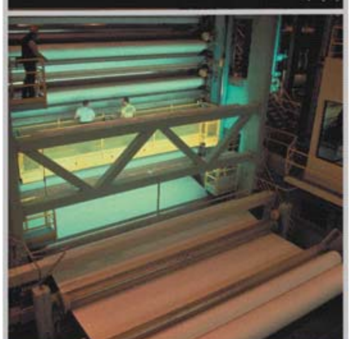
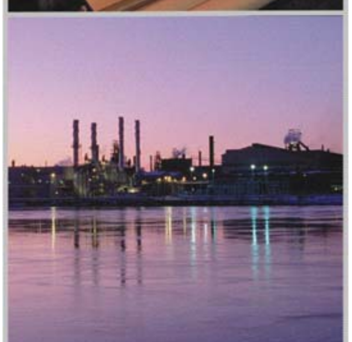







APTECH Engineering Services, Inc.
Petrochemical Group

NDE Capabilities
For Advanced and Non-Intrusive
Inspection Techniques

APTECH Qualifications

Nondestructive examination (NDE) technology has evolved to a point where the technology represents a viable alternative to the traditional "open for inspection" approach to assessment of vessels, valves, and flanges. Many NDE inspections can be performed while the facility is on line without significant disruption to service and deliveries. This increased confidence in NDE results and reporting often leads to longer inspection intervals, consequential cost savings, and reduced facility downtime. APTECH is leading the industry in the design and implementation of NDE programs and methodologies that are specifically designed for individual facility operating conditions and requirements.

Advanced Technology

APTECH's systems have the capability to image discontinuities or flaws in components providing comprehensive insight into flaw and defect resolution.

These advanced systems have the ability to detect relevant defects and measure the position, size, and location. Our systems reveal the data in such a manner that it is possible to use the data in accordance with relevant codes and directly relate to fitness for service, engineering assessment, or risk based inspection strategies.

These advanced systems store and report data in a manner that allows remaining life assessment and realistic inspection interval monitoring.

Available Techniques

- Automated Ultrasonic
  - Mechanized Angle Beam
  - Corrosion Mapping
  - Time of Flight Diffraction (TOFD)
  - Phased Array
- Pulsed Eddy Current
- Video Probe
- Flange Leak Detection

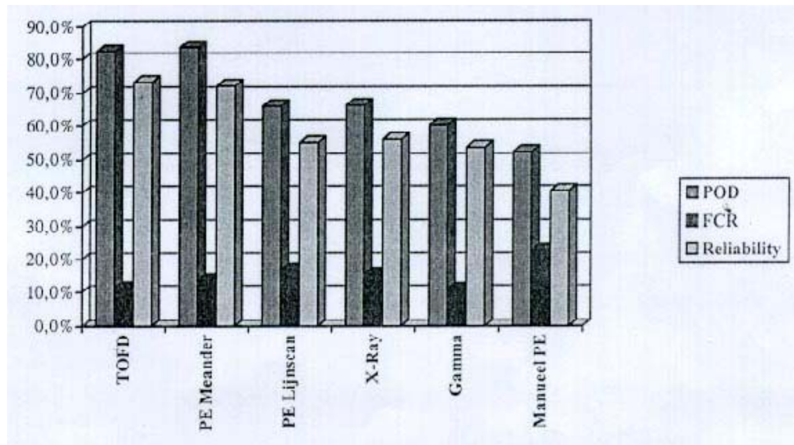
Automated UT

Mechanized Angle Beam

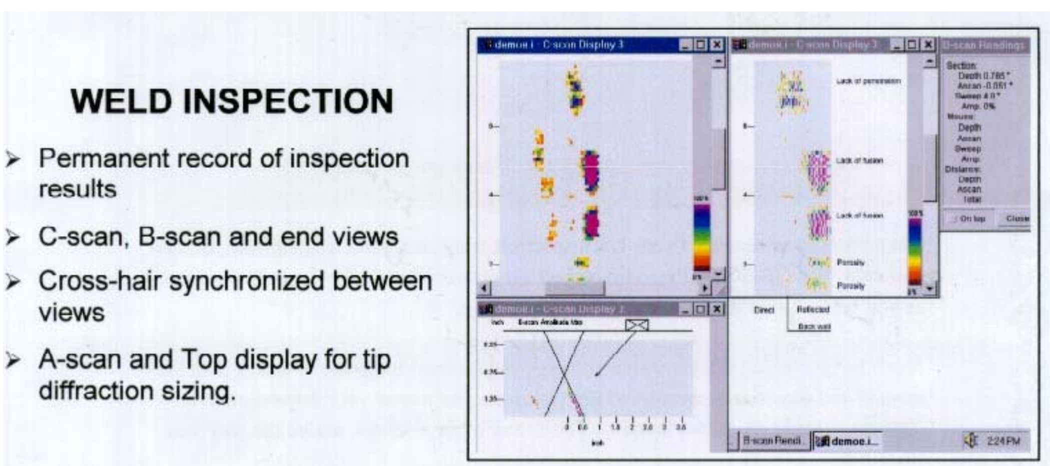
The mechanized pulse echo unit has the ability to clearly display and report inspection results as well as perform computerized evaluations per code acceptance limits. We can record all A-Scan data and report it on CD-ROM. It encompasses pre-recorded set-ups for common pipe sizes and weld preps.

Reliability

This graph indicates through previous studies, PE meander (Automated Raster Scanning) has an 85% probability of detection rating (POD) and only a 15% false call rating (FCR).



Automated Pulse Echo has the highest POD rating over all the methods available, while Time of Flight Diffraction (TOFD) has the lowest FCR. APTECH believes combining the two techniques is the ultimate inspection. Our system has the ability to provide this inspection by the automated ultrasonic line scanning technique.

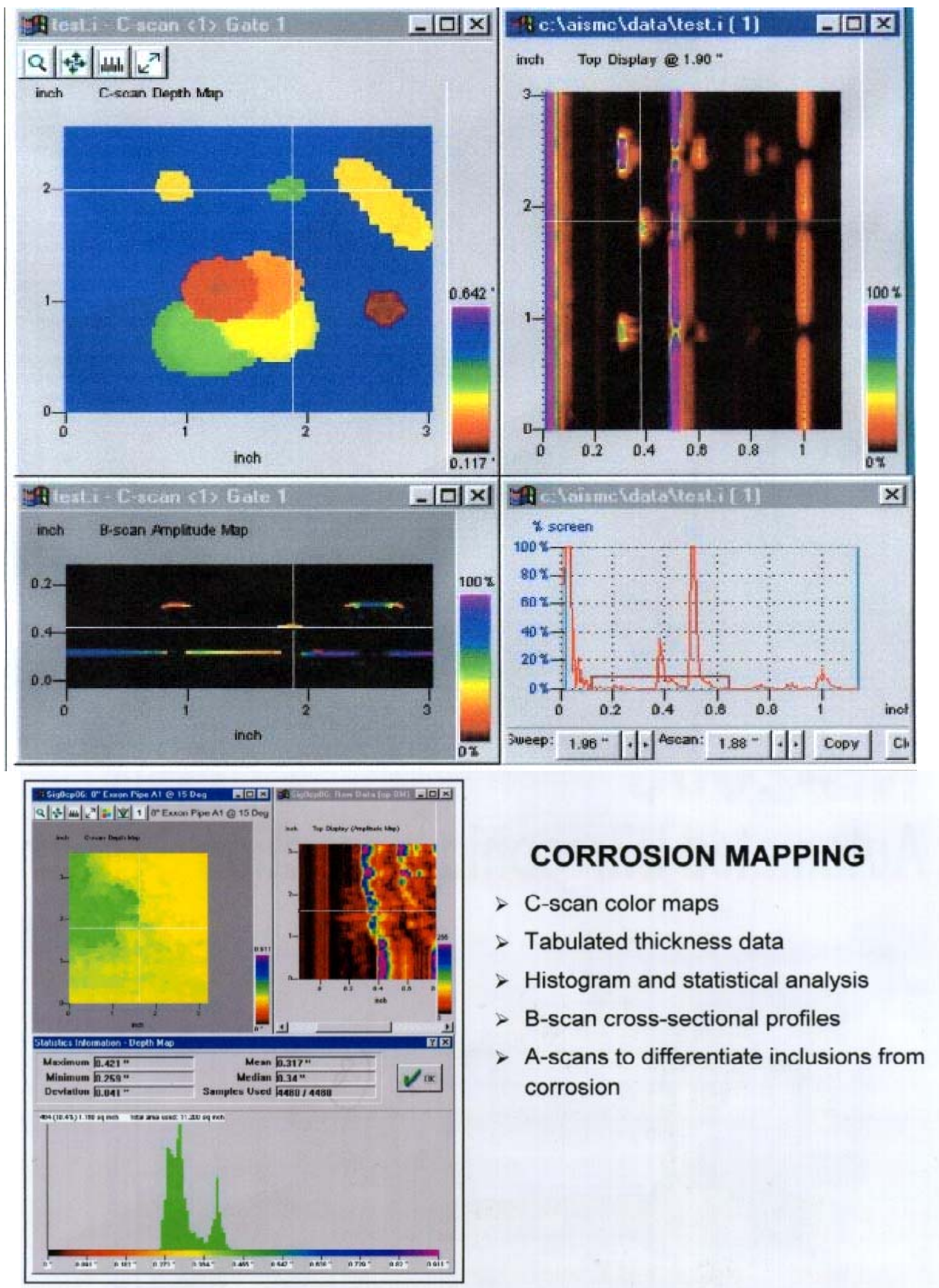


System

Our automated system is equipped with eight separate channels. This allows us to perform techniques that require additional TOFD probes or an assortment of A-Scan shearwave probes, of different angles, for thicker materials. This can be performed by multiple channel Raster scanning, along with X-Y encoding or an encoded line scan.

Corrosion Mapping

As explained previously, our automated system can provide data by utilizing one single channel or eight independent channels. Grid mapping can be collected on intervals as small as 1/32 inch or as large as 1.0 inch. The data can be revealed in A, B, or C scans multi-colored form. Copies of the hard numbers can also be provided. The data is collected by utilizing X-Y scanners, encoded line scanning, or by video camera with an infrared target attached to the transducer.



Time of Flight Diffraction

Summary

Since the early 1990s, the Time of Flight Diffraction (TOFD) technique has been applied to many projects, where it replaced radiography as the commonly utilized procedure. The high performance of the TOFD technique with regard to the detection capabilities of weld defects such as slag, lack of fusion, etc. has led to rapidly increasing acceptance of the technique as a pre-service inspection tool. At the same time, the technique establishes a baseline data, which enable monitoring in the future for critical welds. It also provides documented evidence for lifetime and interval extension programs. TOFD has the ability to detect and simultaneously size flaws of any orientation within the weld and heat affected zone. TOFD is recognized as a reliable, proven technique for detection and sizing of defects and has been proven to be a time-saver, resulting in shorter shutdown periods and construction project times. When the inspection price of TOFD per weld is higher, in the end, it will result in significantly lower overall cost and improve quality.

TOFD Advantages

- Because no ionizing radiation is used, the inspection does not interfere with the production process. TOFD can therefore be executed during any shift.
- There is no need to transfer components to the designated x-ray area. Associated logistic problems and cost do not exist.
- Thickness variations do not greatly affect the inspection speed. Also, very thick materials can be examined in the same efficient manner.
- The TOFD data are very accurate and are presented in an easily understood format. All data are stored for future reference, so that any differences between the situation after a period in service and the production situation can be easily established. The data can be utilized to form the basis for lifetime and inspection interval extension.
- Improved inspection sensitivity is possible without regard to defect orientation.
- Proof of coverage is possible by means of encoded positioning.

On both sides of the weld, an ultrasonic probe is positioned. One acts as an emitter of ultrasound, the other as a receiver. The longitudinal sound beam can encounter obstacles on its path, which cause reflected and diffracted signals (Figures 1 and 2). When the probes are moved parallel along the weld, the resultant waveforms are digitized, stored on hard disk, and displayed on the video screen as a gray scale image (Figure 3). The image build-up is in effect a through sectional view of the weld examined and can be used for accurate sizing and monitoring of indications.

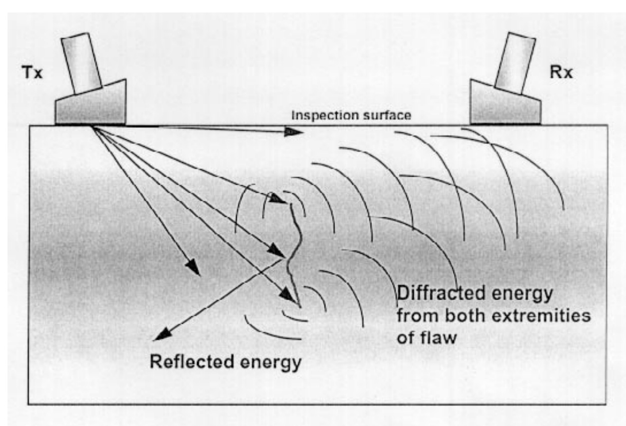


Figure 1 — Diffraction Signals with TOFD[1].

Phased Array

The phased array probe combines the functions of several conventional probes in a single casing. It is no longer necessary to use different wedges to set each of the various angles of incidence, as was the case with conventional probes.

NDE Applications for Phased Array Ultrasonic Probe

If the various conditions that limit nondestructive examination techniquies are considered, use of phased array probes can be seen to offer the following advantages.

Boundary Conditions	⇨	Examination Technique Advantages
Difficult geometry	⇨	Angle of incidence can be adjusted and scanned for the particular component
		Possibility of setting different wave modes
		A single probe for angle beam scanning, contact, and wall thickness measurement
Impaired access to components	⇨	Compact probe system
Inspection requirements demand many test functions	⇨	Considerably fewer probes required thanks to phased array (one probe per scanning direction)
High dose rates in the nuclear or chemical industry	⇨	Fewer or no conversions of probe system reqeuired
Small traversing ranges	⇨	Compact probe system, can be advanced right up to obstruction
Short inspection times	⇨	Only one scan needed
Underwater application	⇨	Watertight casing and plug connector
Reproducibility of inspection date	⇨	One exact probe index for all test functions
Evaluation possibilities	⇨	Possibility of combining data
		Analytical features using contour tracing or tomography

Pulsed Eddy Current

Cross Sections through the Elbow
Viewed with the Flow

Example of a RTD-INCOTEST Probe
Used on an Elbow Intrados

Typical RTD-INCOTEST Screen Display

Flow-accelerated corrosion (FAC) is metal loss through the dissolution of the protective film in piping serving water or wet steam. Many pipe failures caused by FAC have been reported in power plant piping systems. Under certain water chemistry, fluid velocity and operating conditions, FAC can cause internal wall thinning of condensate and feedwater piping, heater drip and drain lines, and other carbon steel piping. In some cases, this thinning has led to catastrophic failures and fatalities.

All personnel are concerned about safety and the consequences of a high energy piping failure. Whether a power plant remains with a utility or is purchased by a new owner, assessment of the potential damage from FAC is a relatively inexpensive and prudent prevention manager.

Approach to FAC Examination

APTECH's FAC experience has led to the development of the following steps for proper evaluation:

- Computer software to identify and rank priority areas
- Online or offline non-intrusive examination of priority areas
- Ultrasonic examination of selected locations
- Engineering analysis

Non-Intrusive Inspection Technology

A unique feature of APTECH's approach is our non-intrusive wall thickness measurement service – RTD INCOTEST – which uses a patented pulsed eddy current technology. Some of our clients have already developed a program to select critical areas for evaluation and are ready to proceed with examinatinon. The RTD-INCOTEST system is especially attractive to many industrial and power plant clients because it can be used:

- While the plant is online or offline – no outage required
- Without removing insulation and lagging
- Substantial cost savings, particularly when asbestos is present
- The field performance is excellent
- Wall thickness accuracy: better than ±5%
- Pipe temperature: -150°F to 950°F
- Insulation thickness: 0 to 4 inches
- Pipe wall thickness: 0.15 to 2.6 inche

Video Probe

For video imaging, the BTX-QL (QUICK LOOK) AC/DC system is used. The system has a 1.25-inch diameter, 98 foot long cable. It has a 4-inch built-in color monitor and a color 9-inch slave monitor. It has recording capabilities and utilizes centering devices for diameter raages (4 inches to 6 inches, 8 inches to 12 inches). The system also has various light heads available, including a 34 bulb, 2-inch head for larger diameter pipe or spaces.

This system has been used successfully for the inspections verification after hydro-blast of power pressure piping. It has also been used for small item retrieval in oil lube lines of steam turbines.

Typical Components Inspected with Video Probe

- Heat Exchanger Inspections
- Tank and Vessel Inspections
- Header Inspections
- Pipe/Weld Inspections
- FCC Reactor/Regenerator Inspections
- Turbine Generator Inspections
- Boiler Tube Inspections
- Loose Part Retrieval

Flange Seal Inspection

Finally a reliable method to quantify degradation of flange connections prior to leakage and without opening the flanged conneciton has been obtained.

Incursion of process fluid between the flange face and gasket is caused by or accompanied by corrosion of the flange face. The ability to measure the width of the remaining seal face allows plant operators to plan flange maintenance without brekaing the connection. Thus, future leakage can be predicted and only connections requiring rework need be opened.

There are numerous types of pipe flanges available. For process and utilities pipe work, the two commonly used flange standards are the American National Standards Institute ANSI B16.5 and the British Standards, BS 1560. For each style of flange, there are three types of flanges that are most commonly used—ring-type joint, raised face, and flat face.

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