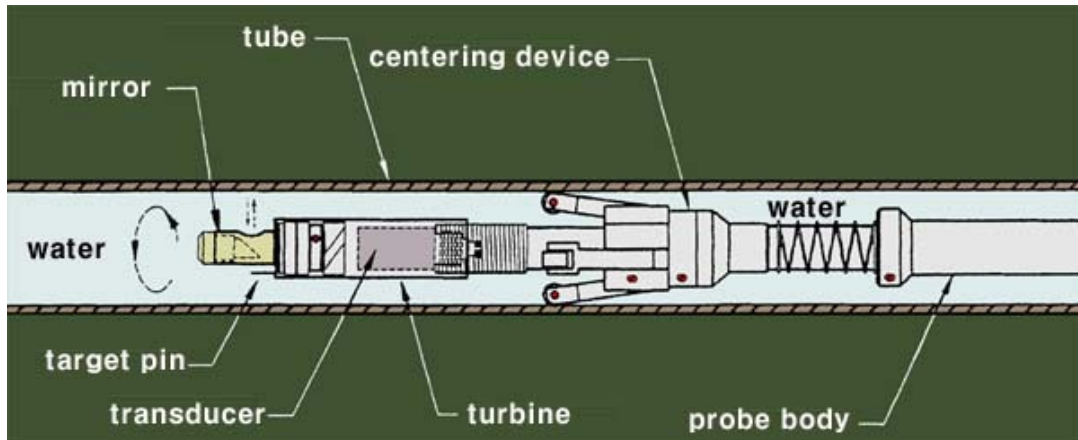




# Internal Rotational Inspection Systems (IRIS)

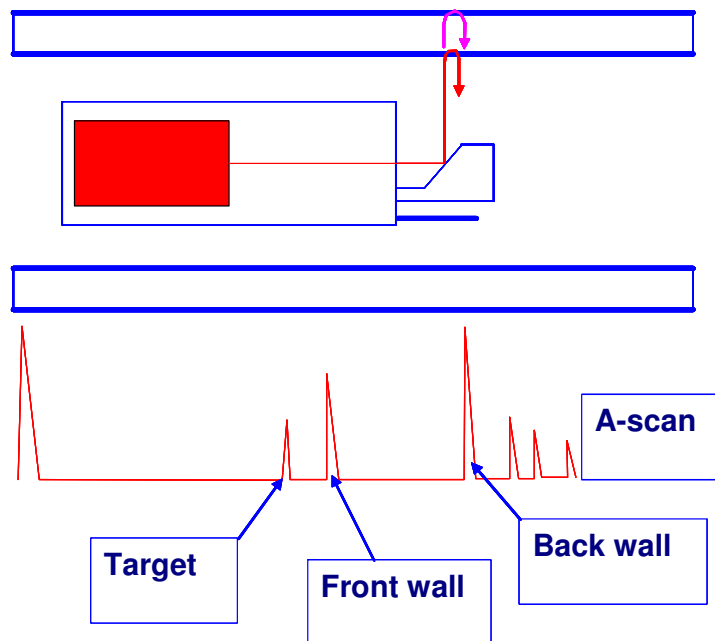


Internal Rotational Inspection System (IRIS) is an ultrasonic immersion pulse echo technique. Unlike the Eddy Current, Remote Field and Magnetic Flux Leakage techniques which are based on electromagnetic principles, the IRIS technique is based on ultrasonics.



**Diagram 1: An IRIS scan within the heat exchanger tube**

Diagram 2 shows a beam from an ultrasonic transducer is reflected from a mirror set at 45 degrees so that the reflected ultrasonic beam impinges on the tube internal diameter at right angles. Part of this beam is then reflected from the tube internal diameter while the remainder is transmitted through the wall thickness and is reflected from the tube outer diameter.



**Diagram 2: How the IRIS technique works**

The time difference between the two reflected signals is then used to measure the tube wall thickness. The mirror is mounted on a water driven turbine that rotates at a speed of about 2 000 rpm. Measurements are then made around the full tube circumference and as the probe head is pulled through the tube the ultrasonic beam maps out a spiral along the tube length.

If the probe pulling speed is sufficiently slow, taking into account the inspection parameters, 100 % coverage of the tube surface is achieved. There are ~ 150 readings per revolution and 2400 revolutions per minute.

Each successive pulse is mapped out as a horizontal scan line on the UT equipment screen. With advanced software, results can be displayed in a number of views as illustrated below in Diagram 3.

The C-scan presentation provides a plan view of the tube when it has been rolled flat. Colour-coding is used to display the wall thickness as illustrated by the rainbow of Colours displayed in the icon in the right hand bottom corner of Diagram 3.

The B-scan display provides a 2 dimensional display of a transverse cut through the tube at any desired position along the tube length, while the D-scan display provides a 2 dimensional display of a longitudinal cut through the tube at any desired circumferential position on the tube.

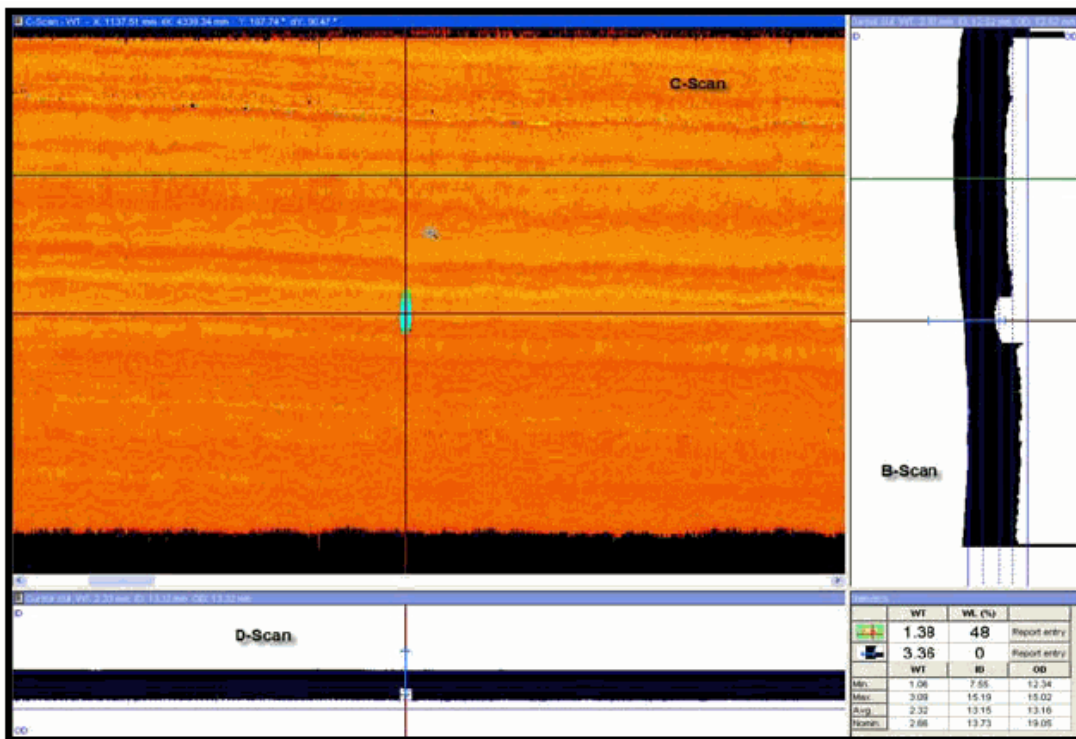


Diagram 3: Scan Presentation

The advantages of the IRIS inspection technique include the following:

1. It is very accurate. Wall thickness measurements can be made, with the use of a 15MHz-focused transducer, to an accuracy of within 0.1mm.
2. It is a fairly sensitive technique. The sensitivity achieved will depend on tube dimensions and tube cleanliness. In general, it can be stated that, it should be possible to detect a 1.5mm defect in tubing up to 1 inch which has been properly cleaned.
3. Both ferromagnetic and non-ferromagnetic tubes can be inspected
4. A three dimensional picture of the defect is obtained, thus the defect profile and its depth is provided.
5. Interpretation of results is easier than in the other techniques assuming that reasonable tube cleanliness has been achieved

On the other hand, the IRIS inspection technique poses the following disadvantages:

1. It is a slow technique. The actual testing speed will depend on a number of factors but will generally be in the order of 0.04m/sec in order to achieve 100% coverage. However it must be noted that the tube has to be filled with water (couplant) every time prior to the actual inspection. This reduces the typical production rates to the order of +/-100 tubes per 12-hour shift, which again depends on the tube length, number of units being inspected, the cleanliness of the tubes and the water pressure supplied at the point of inspection.
2. Tubes must be very clean. While all the other techniques are able to tolerate some degree of scaling, the tubes must be cleaned virtually down to the bare metal for a successful IRIS inspection.
3. Water must be introduced into the tube to act as a couplant. At times this may pose as a problem as no suitable water outlet is available at the point of inspection. In other cases the source of water may not be clean enough or may not be at the ambient temperature required for a successful inspection. In some cases, the introduction of water into the tubes may give rise to corrosion problems.
4. Only volumetric defects can be detected and is therefore insensitive to cracking.
5. A dead zone is present due to the effects of 'probe ringing'.
6. Probe must be centralized in the tube to avoid a loss of signal.

## Internal Rotational Inspection Systems (IRIS)



The pictures below show an inspection carried out on heat exchanger tubes using the IRIS scan technique.



Inspector manipulating the IRIS probe. Tubes are plug at the other end and flooded with the turbine.



Operator in the truck watches the signals in real-time.

The pictures below show an inspection carried out on boiler tubes using the IRIS scan technique.



Inspection of steam drum. Tubes are plugged from the mud drum and filled with water



External corrosion near the lower bend