



Oil & Gas Industry

Oil Country Tubular Goods
and Bar Products



Types of Oil & Gas Products include:

- ☑ Line Pipe-
(Larger diameter, relatively thin wall)
- ☑ Drill Pipe-
(Typically heavy wall seamless tubes)
- ☑ Casing -
(Mainly seamless but may be welded)
- ☑ Sucker Rods- (In Cut lengths)
- ☑ Umbilical Coils-
(Small diameter, long length)
- ☑ Other types of tubes-
(Including coupling stock)

Note: Line pipe, drill pipe, casing, and other types of oil and gas tubes are best inspected using flux leakage & ultrasonic multi test systems. Whereas, sucker rods and umbilicals are best inspected using eddy current & ultrasonic multi test systems.

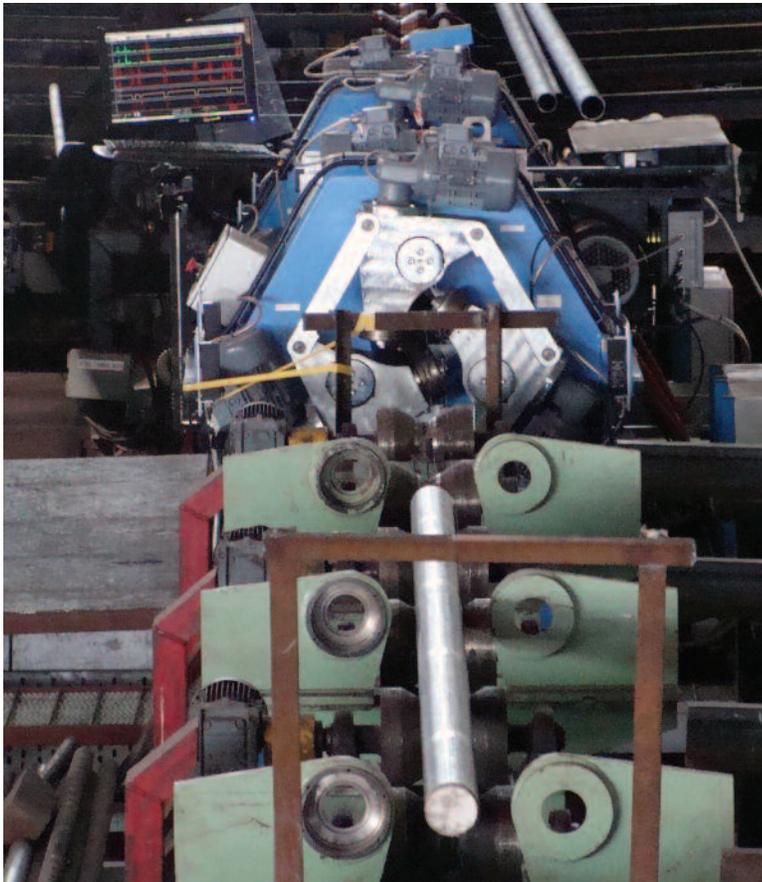
Common applications include:

- ☑ Sour Gas
- ☑ High Pressure
- ☑ Offshore Wells
- ☑ Arctic Wells
- ☑ API grades for other wells

Methods of production Include:

- ☑ Welded-
(Scarfed & Annealed for flux leakage)
- ☑ Seamless

Oil Country Tubular Goods (OCTG)



MAC has a wide variety of custom designed systems for the inspection of oil country tubular goods (OCTG) and other oil and gas products that not only meet individual client specifications, but that of API 5CT and 5L, ASTM, and ISO.

MAC's Rotoflux® flux leakage and Echomac® ultrasonic inspection systems are the best suited for inspecting heavy wall pipe for wall thickness variations, laminations, longitudinal, transverse, ID/OD, and internal defects.

The transverse and longitudinal flux leakage systems are designed to inspect pipe up to 500mm (19.6") and the ultrasonic systems can inspect pipe up to 360mm (8.6") in diameter. MAC eddy current systems such as the Multimac®, and the Minimac® 50 are also available for thinner wall pipe.

Inline ultrasonic rotary test system designed to test carbon steel tubes for longitudinal and transverse defects as well as wall thickness and lamination. The system includes the seal-less designed ultrasonic rotary mechanics developed to minimize maintenance especially due to dirt accumulation from hot rolled product. Coupled with the rotary is the Echomac® electronics which provides all the channels necessary in one computer chassis. The rotary head is mounted on a Triple Guide Roll Test Bench which is highly automated to provide fast changeover times and consistent product throughput, and is extremely durable; thus able to withstand the heavy demands of OCTG plant conditions.

Another system recently installed is comprised of MAC's transverse and longitudinal Rotoflux® flux leakage and Echomac® ultrasonic technologies to detect OD, ID, surface, longitudinal and transverse notches as well as lamination, and measure wall thickness variations in casing pipe, green pipe, and coupling stock after heat treatment and straightening. Oblique defects may be detected if the oblique angle is known within $\pm 5\%$. The specifications for this multi test system are:

Pipe Diameter-	60.3-220mm; 2.37"-8.66"
Wall Thickness-	4-25mm; 0.15"-0.98"
Speed-	35m/min; 114 fpm

This system operates similarly to that in the previously described multi test system with the pipe first passing through the transverse test then the longitudinal test, a demagnetizer, and finally, through the ultrasonic test station.

This system is driven by a heavy duty dual pinch V-roll test bench. Three slide and elevate mechanisms are provided; one for the transverse, the longitudinal, and the ultrasonic rotaries.

This complete system includes a water system, automatic markers, Rotoflux® and Echomac® electronics, and a conductor control system.

Multi Test Methods for Demanding Specifications

To meet individual requirements for more demanding specifications, MAC has custom designed systems that may be comprised of eddy current, flux leakage, and/or ultrasonic technologies. Selection of the most appropriate test technology is based on size and speed specifications, wall thickness, and the discontinuities that must be detected.

A recently installed system for welded and seamless carbon and micro alloy steel included MAC's Rotoflux® transverse and longitudinal flux leakage inspection systems, a demagnetizer, and an Echomac® ultrasonic test system to inspect heavy wall, straight or upset end pipe. The system was designed to inspect pipe diameters from 60mm to 220mm (2.36"-8.6") with wall thickness up to 20mm (0.81") at test speeds ranging up to 60m/min (200 fpm).

The nondestructive test commences when the pipe



Longitudinal & transverse flux leakage rotaries, ultrasonic rotary, and demagnetizer multi test system.

The combination of an ultrasonic and eddy current NDT system allows for the detection of incomplete and mismatch welds, pinholes, leakers, and weepers in small diameter, long length umbilical coils. For sucker rods, which are hot rolled, cut length carbon or alloy steel, complete automated systems including encircling and spinning probe eddy current for surface and near surface defects, and ultrasonic rotary for internal and subsurface defects are available.

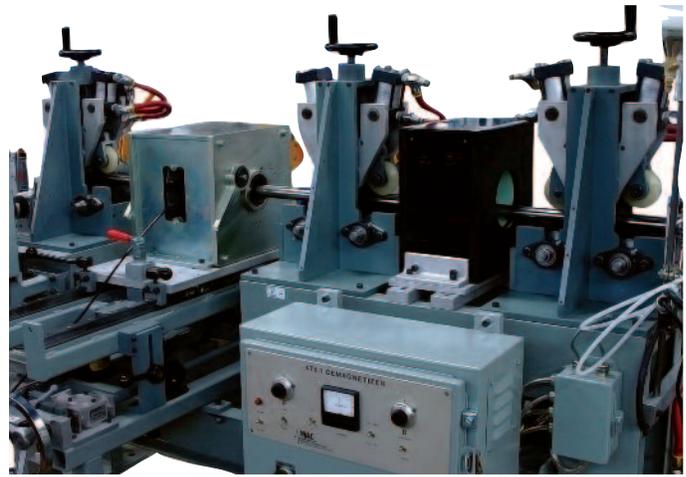
passes through the transverse flux leakage test where it receives a high level of magnetic saturation. Then, the pipe passes through the longitudinal test followed by a demagnetizer to remove any residual magnetization before the pipe enters the ultrasonic test for wall thickness, ovality and lamination inspections.

The total system also includes inlet and outlet conveyors comprised of driven articulated V-rolls. This means that they can be moved up or down allowing the upset ends to pass. The inlet conveyor feeds the pipe through the system which is on a triple guide roll test bench. The bench is designed to open for upset ends and close automatically after the leading or trailing end has passed. The outlet conveyor then transports the pipes from the test and into accept or reject sorting pockets. This system is completed with the Rotoflux® and Echomac® electronics, a water system, automatic markers, a conductor control system, and PLC.

Eddy Current Test Methods

In some cases, surface and subsurface defects in oil and gas welded line pipe or sucker rod can be detected with eddy current technology alone. MAC's Multimac® eddy current tester can be used with encircling coils for full body inspection, or sector coils for weld line applications where only the weld zone must be tested. A drilled through-hole, usually 3-6mm (1/8"-1/4") in diameter to meet API specifications should be used as a point of reference when calibrating. Coils are available with DC saturation for carbon steel and other magnetic tubing.

Eddy current is typically used for the detection of short surface and subsurface, OD/ID cracks, and weld line defects, including short transverse discontinuities in pipe up to 180mm (7.2") in diameter.



Ultrasonic Test Methods

On some grades, the API 5CT acceptance level (L2) for heavy wall pipe calls for establishing a reject level of 5% of the wall thickness for OD/ID defects. In this instance, MAC's standard Echomac® FD-5 multi channel ultrasonic rotary and electronics is one of the preferred inspection systems that can accommodate a four direction shear wave test and meet 100% wall thickness and lamination specifications using transducers optimized for specific line speed and notch length requirements.

The Echomac rotaries are available in sizes that accommodate product ranging from 6.35-500mm (1/4"-19.6") in diameter. Rotational speeds range from 850-4500 rpm and the maximum throughput speed depends on the minimum defect length to be detected. A complete Echomac FD-5 system includes electronics, rotary transducer head, and a water recirculation system.



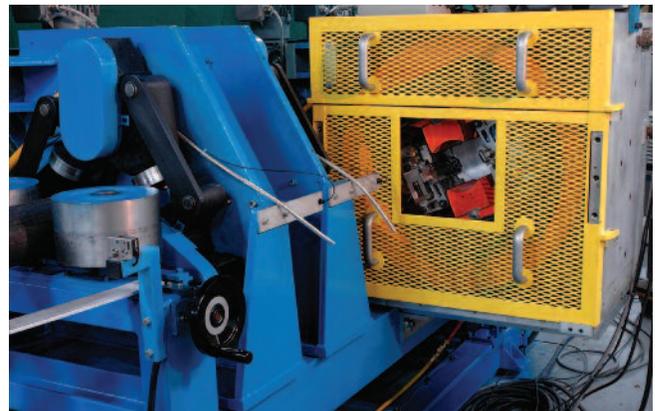
Flux Leakage Test Methods

MAC's Rotoflux® flux leakage technology can be used on all carbon steel tube and pipe with straight or upset ends. The Rotoflux can inspect pipes from 76.2-500mm (3"-19.6") in diameter. The following table conservatively outlines API specifications that can be met with flux leakage:

API Standard	Defect Depth	Wall Thickness as a % of WT
API L2	5%	up to 10mm (3/8")
API L3	10%	up to 12mm (1/2")
API L4	12.5%	up to 19mm (3/4")

Note: Some MAC systems (as described in the examples) are operating to meet API specifications in greater wall thickness.

The Rotoflux detects longitudinal and transverse defects on the OD/ID, such as rolling skins, laps, cracks, laminations, cavities, and internal defects. The pipe first passes through the transverse test to detect transverse defects. Residual magnetization that is introduced during this test is reduced by the subsequent longitudinal test for longitudinal defects. A separate demagnetizer may also be needed for the removal of any residual magnetization.



A separate demagnetizer may also be needed for the removal of any residual magnetization.

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