

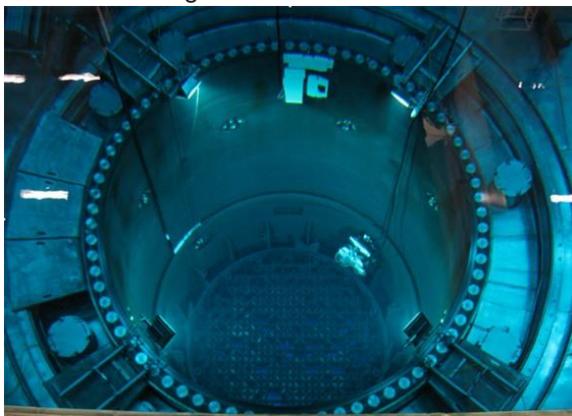
## T-crawler Family

### Background

**Traditionally, inspections inside nuclear reactor vessels were performed using manipulators based on large structures and/or rails. These structures generally made parallel activities impossible and themselves required days to set up and remove, all of which significantly prolonged critical path activities in the reactor vessel.**

In 2006 WesDyne® Sweden introduced the first T-crawler – a thin, compact stand-alone robot that attaches itself strongly to the underwater surfaces of the reactor vessel or core shroud walls using several remotely controlled suction cups that allow it to maneuver freely along the surface, thus leaving room for other activities inside the vessel. That robot got its name from its characteristic form, resembling the letter “T”.

A number of NDE robots have been added to the family since then. They do not always look like a “T”, but they share many other design goals: small size, ability to move and work independently in narrow gaps and around obstacles and modular reuse of key elements across the family to provide flexible and cost saving solutions.



*Two T-crawlers and one Goldfish robot performing three parallel vessel and nozzle inspections. Still, the area over the core is free for other work.*

T-Crawlers at work

### Description

T-crawler robots perform UT and ET inspections of the inside of the reactor pressure vessel and both sides of the core shroud, moving in the narrow annular gap areas between the two. Several manipulator geometries have been produced, optimized for scanning different areas of the vertical and circumferential seam welds. Special end-effectors give coverage of corner welds at the bottom of the vessel and horizontal surfaces of core shroud rings. Similarly extended end-effectors access restricted spaces created by internal components such as jet pumps, risers and instrumentation lines.

T-crawlers are engineered for easy handling, with a high degree of modularity and a thin structure suitable for inspection of all the reactor vessel and core shroud surfaces down to the reactor floor.

Once in the water, insertion and rough positioning near the desired inspection area is done with hand-lines, avoiding use of other lifting devices. Under the control of a specialized WesDyne program called T-Control™, the T-scanner then attaches itself to the chosen vessel wall using combined suction-cup and jet assemblies. Then, with T-control's help, the machine is levelled and “walks” along wall in an exact way to accurately position itself before acquiring data scans using WesDyne's general purpose scanning software, WILMA.

The program and our procedures allow a global positioning accuracy of  $\pm 15$  mm independent of external references under multiple steps. Local scan accuracy is qualified to  $\pm 3$  mm.

The design is adaptable for a large range of vessel dimensions. Current configurations are designed for vessel diameters between four and six meters.

## Benefits

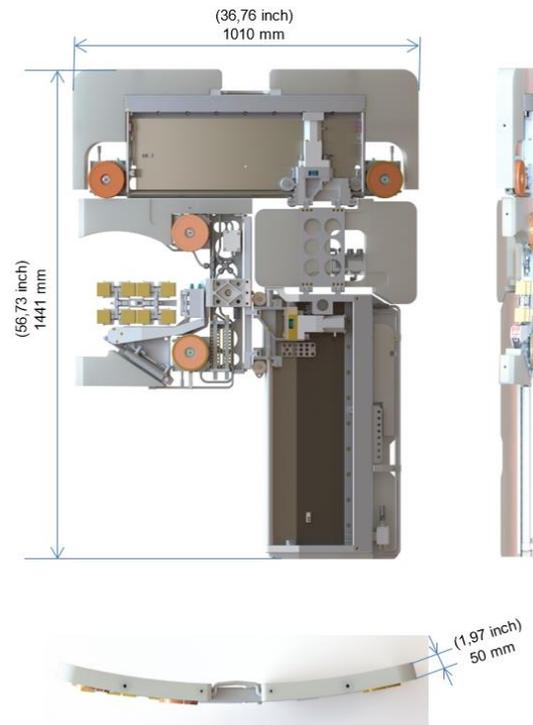
### Compared to other vessel inspection systems, T-crawler manipulators have several advantages

- Allow for parallel activities and/or parallel inspections in the RPV during the inspection
- Lightweight, (10 – 25 kg in air) does not require a crane or lifting device for movements under water or on land
- Quick setup and tear down on the refueling floor (ideal for unexpected inspections or repeat inspection of special interest area )
- Small footprint on the refueling floor (typically 4x4 m )
- Easy to handle, requires only a small crew on-site
- No need for a separate rail system or other installations in the RPV
- Modular design, easily exchangeable end- effectors and probe setups
- Compatible with multiple simultaneous nondestructive inspection data collection systems

## Experience

T-crawlers have been successful in over 25 BWR and PWR reactor examinations in USA and Europe since 2006.

The modular approach and WesDyne's long experience in designing for work in the nuclear industry primary system environment have resulted in a number of first-of-a-kind examinations including record-breaking coverage of previously inaccessible regions of GE BWR's core shroud welds.



A version of the T-crawler robotics

*WesDyne is the nondestructive inspection branch of Westinghouse and a leading supplier of mechanized nondestructive examination (NDE) products for all inspection needs worldwide providing turnkey and one-off-type solutions with a focus on the nuclear market. WesDyne's expertise spans all aspects of remote and mechanized inspections, from problem analysis and solutions generation to development and manufacturing to field deployment of personnel and equipment. Inspection capabilities cover all key NDE areas such as ultrasonic, visual, eddy current, magnetic particle, dye penetrant and X-ray.*

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