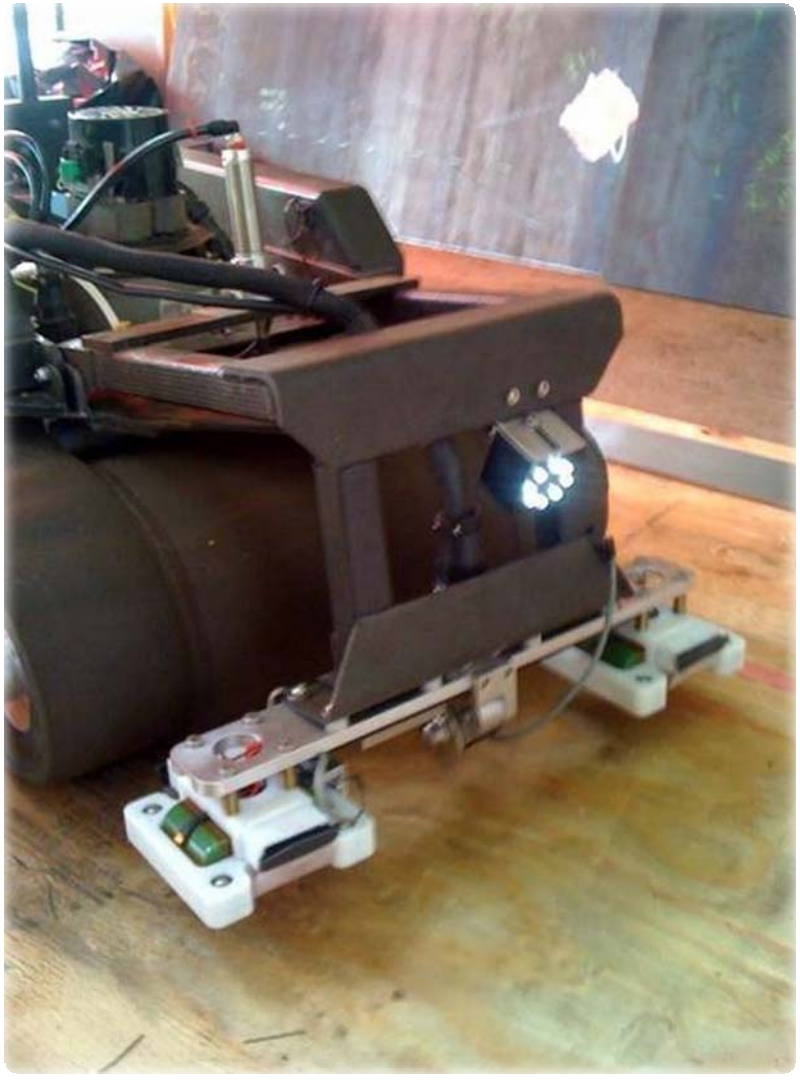
Electromagnetic Acoustic Transducer Demonstration at Hanford



JP Robocker
Technical Integration Program
November 2010

Overview

- Electromagnetic Acoustic Transducer (EMAT)
  - Technology
  - Read out
- New EMAT crawler
  - Onboard EMAT
  - Onboard cleaning system
  - Fall protection
  - Deployment
- Moving forward

DST Volumetric Inspection Criteria

Corrosion Type	BNL-52527 Requirement	DST Guide
General Wall Thinning	20 Percent of Wall Thickness	10 Percent of Wall Thickness
Pitting	50 Percent of Wall Thickness	25 Percent of Wall Thickness
Cracking	< 12 Inches 50 Percent of Wall Thickness ≥ 12 Inches 20 Percent of Wall Thickness	≥ Six Inches 10 Percent of Wall Thickness

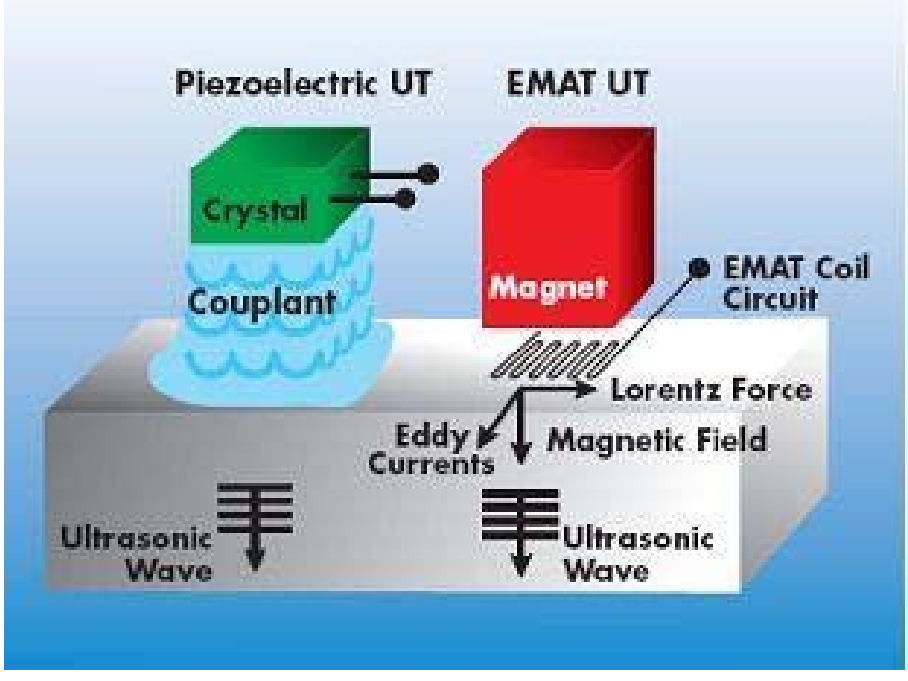
Brookhaven Report BNL-52527, Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks

Current Ultrasonic (UT) Inspection System and Limitations

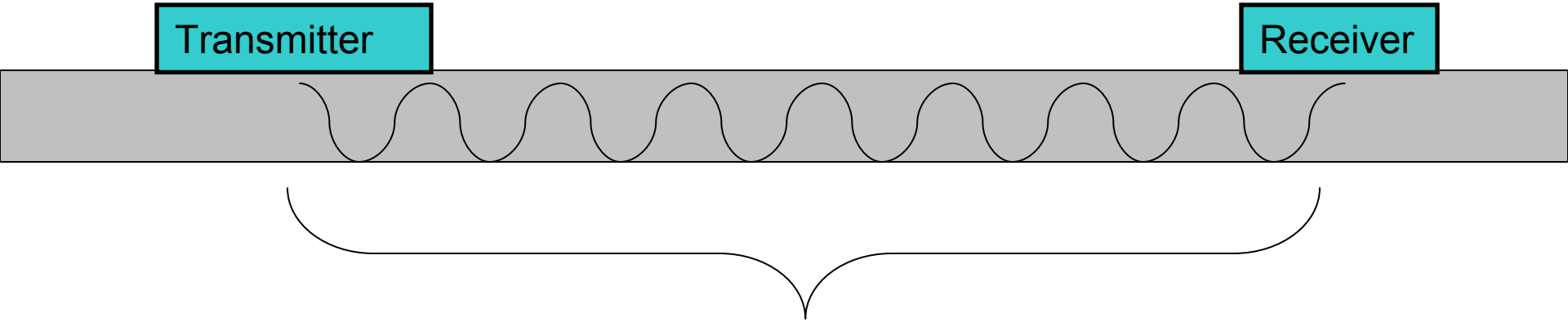
- Only 2% of the surface area of the primary tank wall is inspected in 30 shifts of UT inspections
- The UT system is sensitive to rust on the tank
  - In order to get a reliable reading, rust must be removed from the tank wall without taking off any base metal
- Cleaning rust with the current UT system is time consuming
- Point-by-point scanning system (0.035” X 0.035”)

Electromagnetic Acoustic Transducer (EMAT) Technology

- A wire placed near the surface of an electrically conducting object is driven by an alternating current, eddy currents will be induced in a near surface region of the object.
- The combination of the electric field forces and the magnetic field force create ultrasonic waves that propagate normal to the surface against which the EMAT is applied.
- The coil is driven by a pulsed electrical current of the proper frequency to generate the desired wave.



EMAT

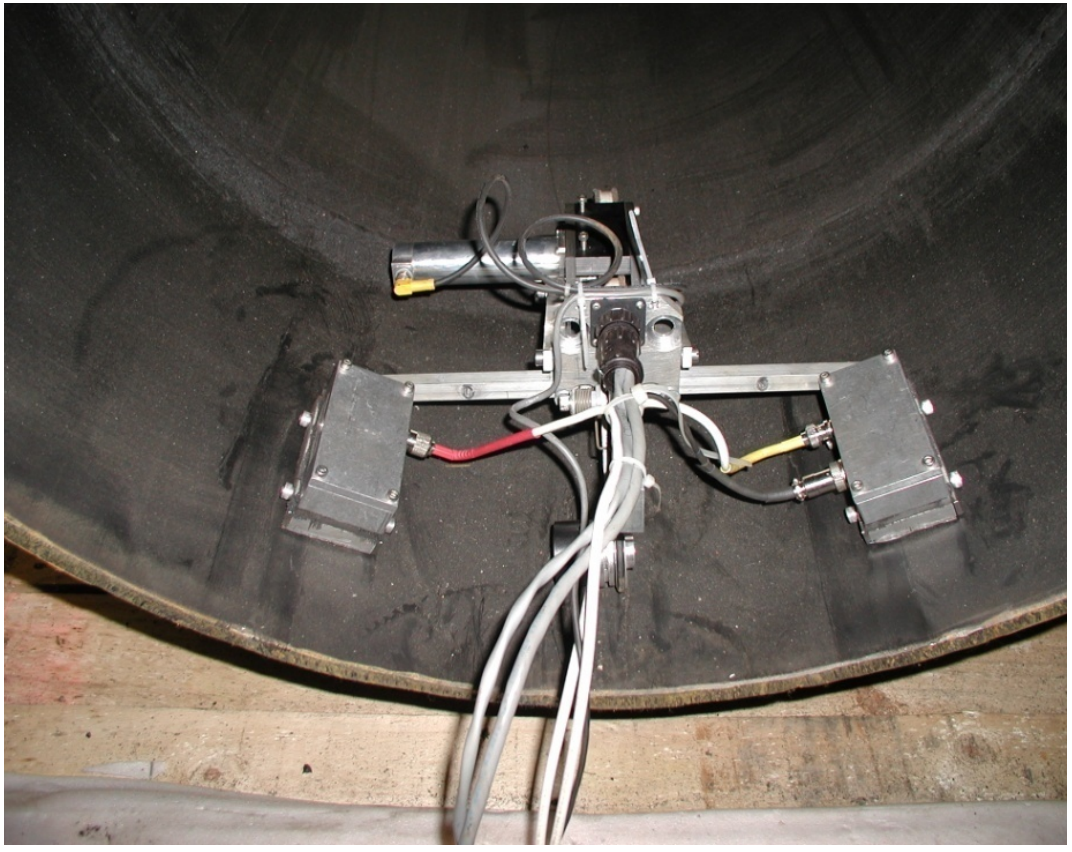


Volume Inspected

- High Speed
- Large Area covered in a single scan

EMAT Generating Lamb Waves in Tank Wall

- Currently used in pipeline industry as shown
- Rectangular boxes are EMAT transducers (transmitter and receiver)
- Capable of detecting thinning or isolated defects depending on mode



Scope of EMAT Onboard Crawler

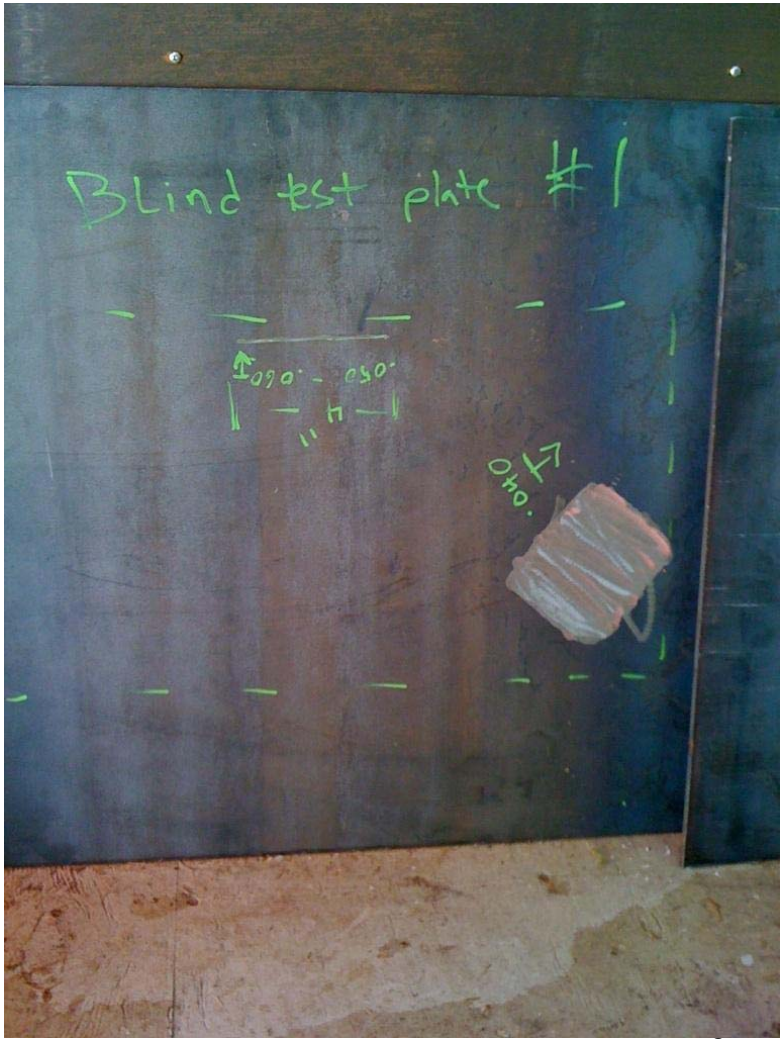
- The EMAT onboard the new crawler must be capable of detecting
  - 10% Thinning
  - 25% Pitting
  - 6” Linear indications of 1/10 wall thickness

EMAT Onboard Crawler

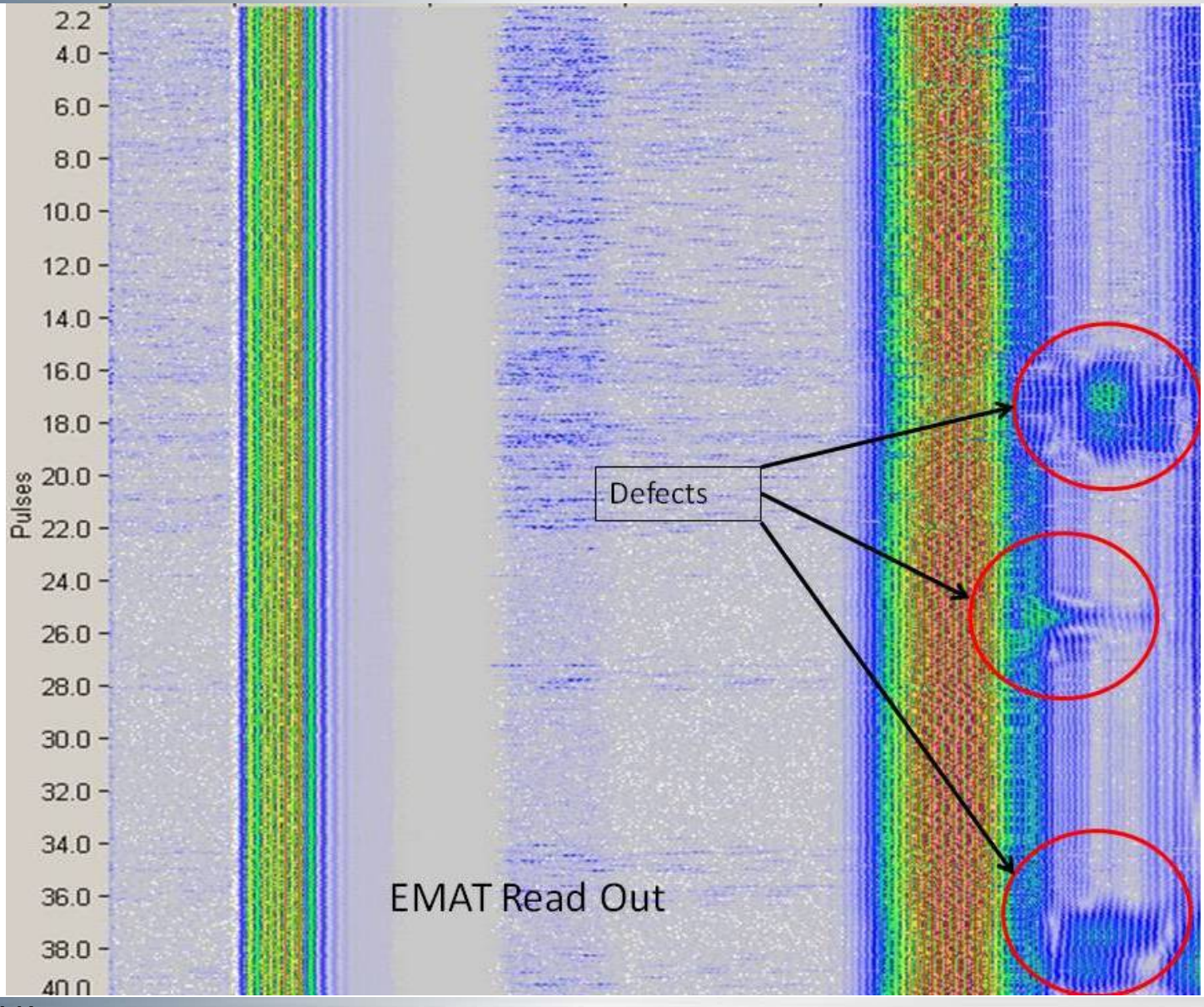
- EMAT on front end of crawler
- Transmitter and receiver spaced 14” apart
- Onboard camera and light for assisting inspections
- Separate EMATs needed for different plate thicknesses

Blind Testing EMAT

- Blind tests at 4 week demonstration in Ithaca, NY and 8 week demo at Hanford's CTF illustrated EMAT's ability to detect all flaws within scope.



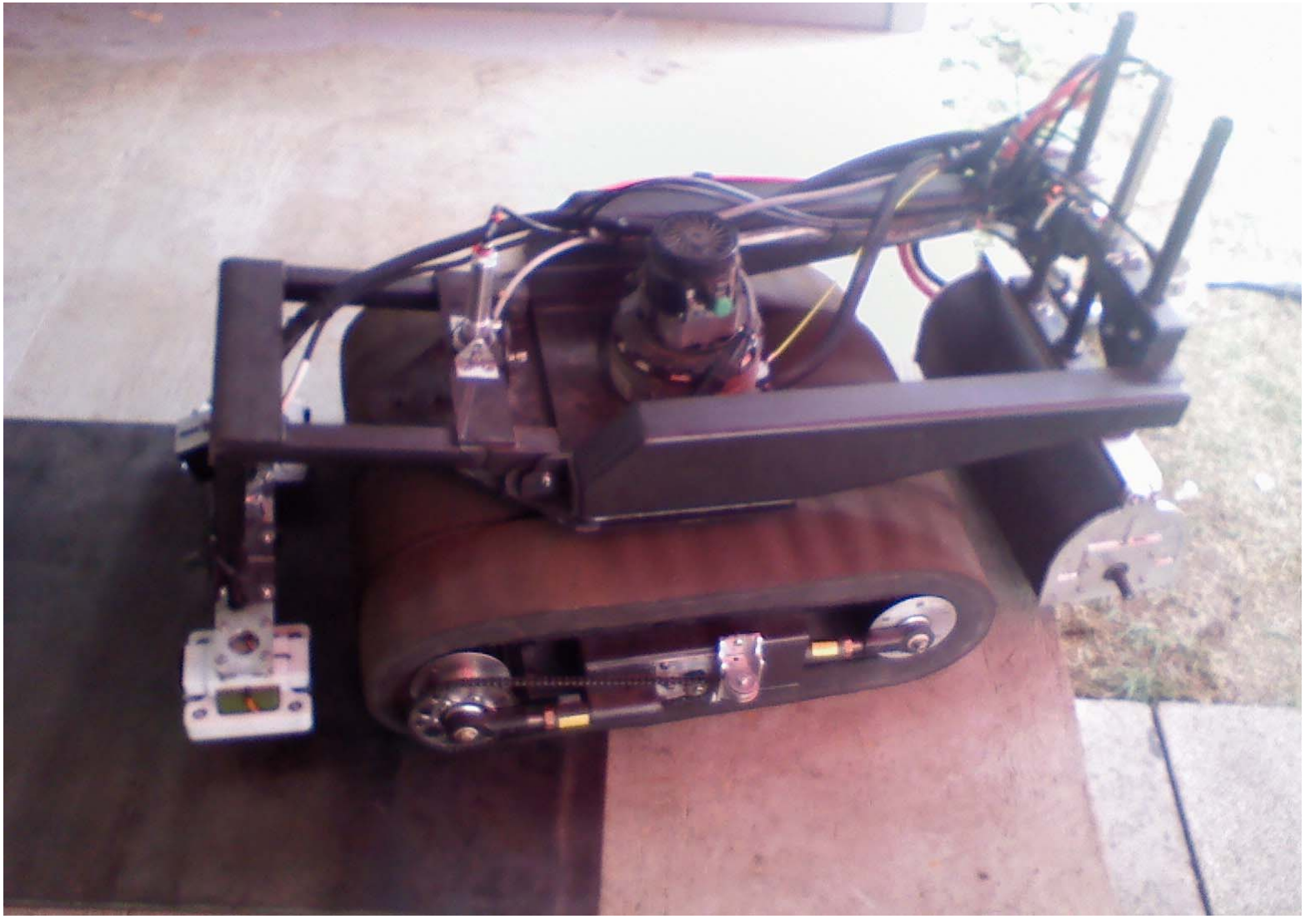
EMAT Read Outs



EMAT Limitations

- EMAT is capable of detecting a defect in the 14” spacing, but cannot tell you exactly where
- Noise is blanked out in 4” of the readout, causing a need for overlap scanning
- Three separate EMATs will be needed for the DSTs because of differences in wall thicknesses

International Climbing Machines (ICM) Vacuum Crawler

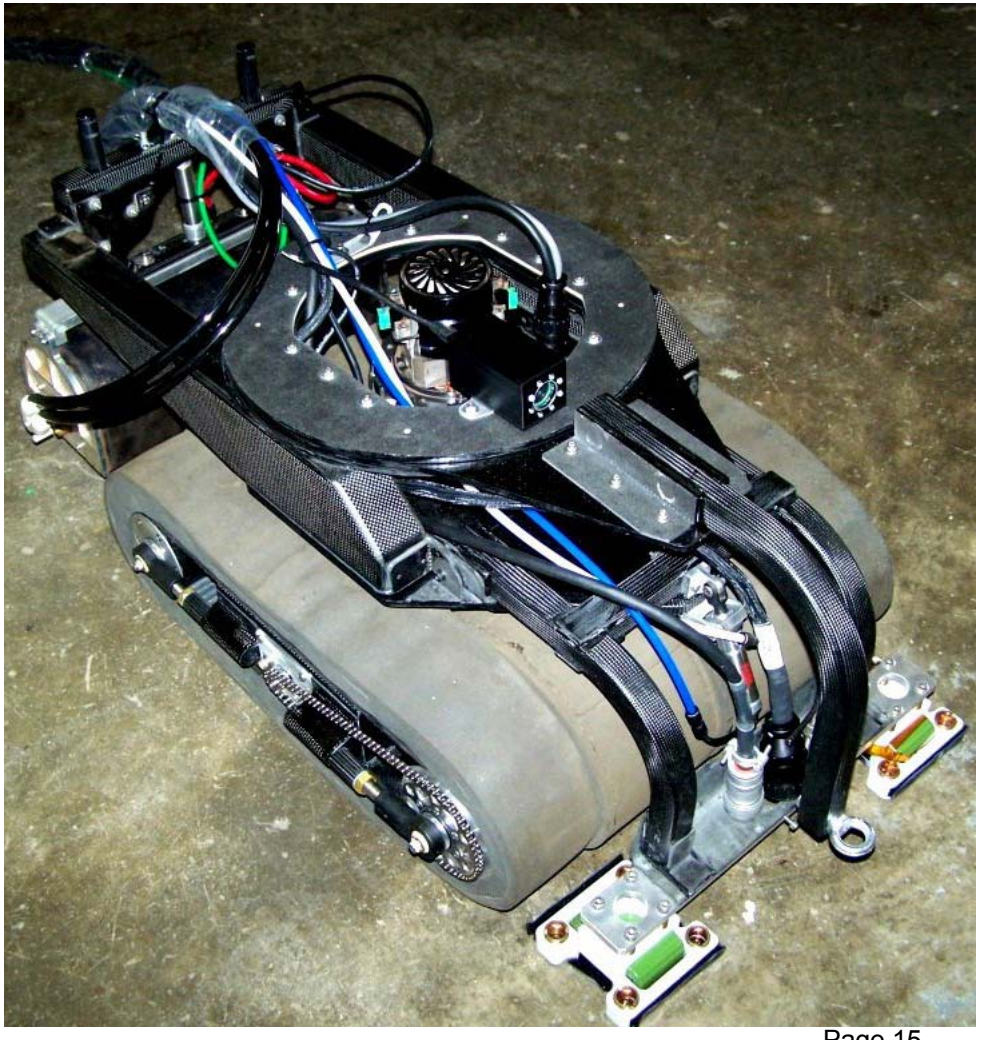


Scope on New Crawler

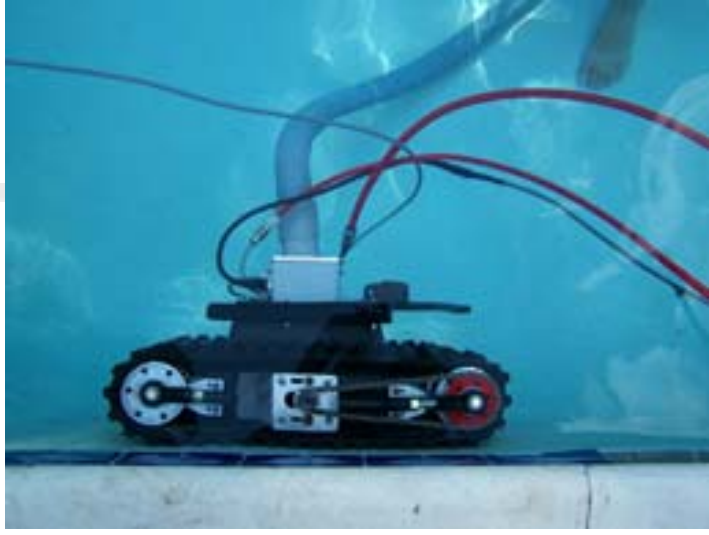
- The EMAT system must scan a wall area of approximately 1300 ft^2.
- The minimum speed of this scan shall be 35 ft^2/hr.
- The cleaning system must remove rust and other contaminants while not removing a measurable amount of the surface metal.
- A surface can be considered “clean” if the currently utilized UT system can achieve sufficient surface contact.

ICM Crawler

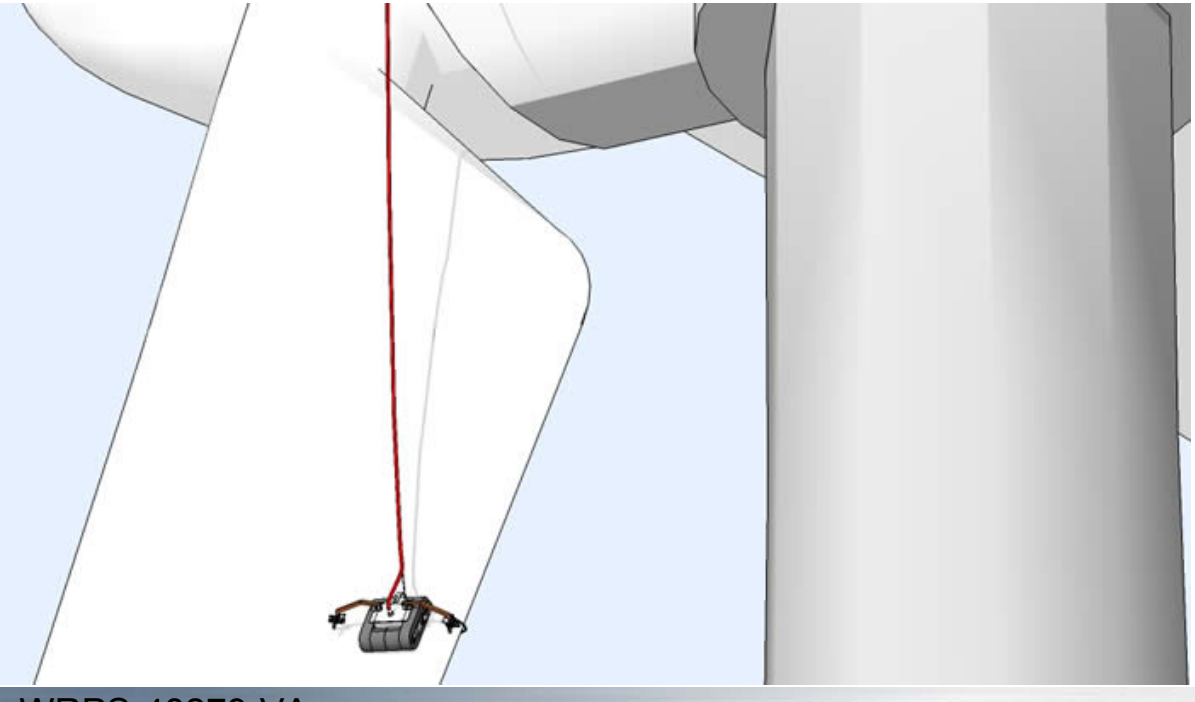
- Vacuums to side of primary tank in annulus
- Supports cleaning and EMAT system onboard
- Relatively simple yet effective design



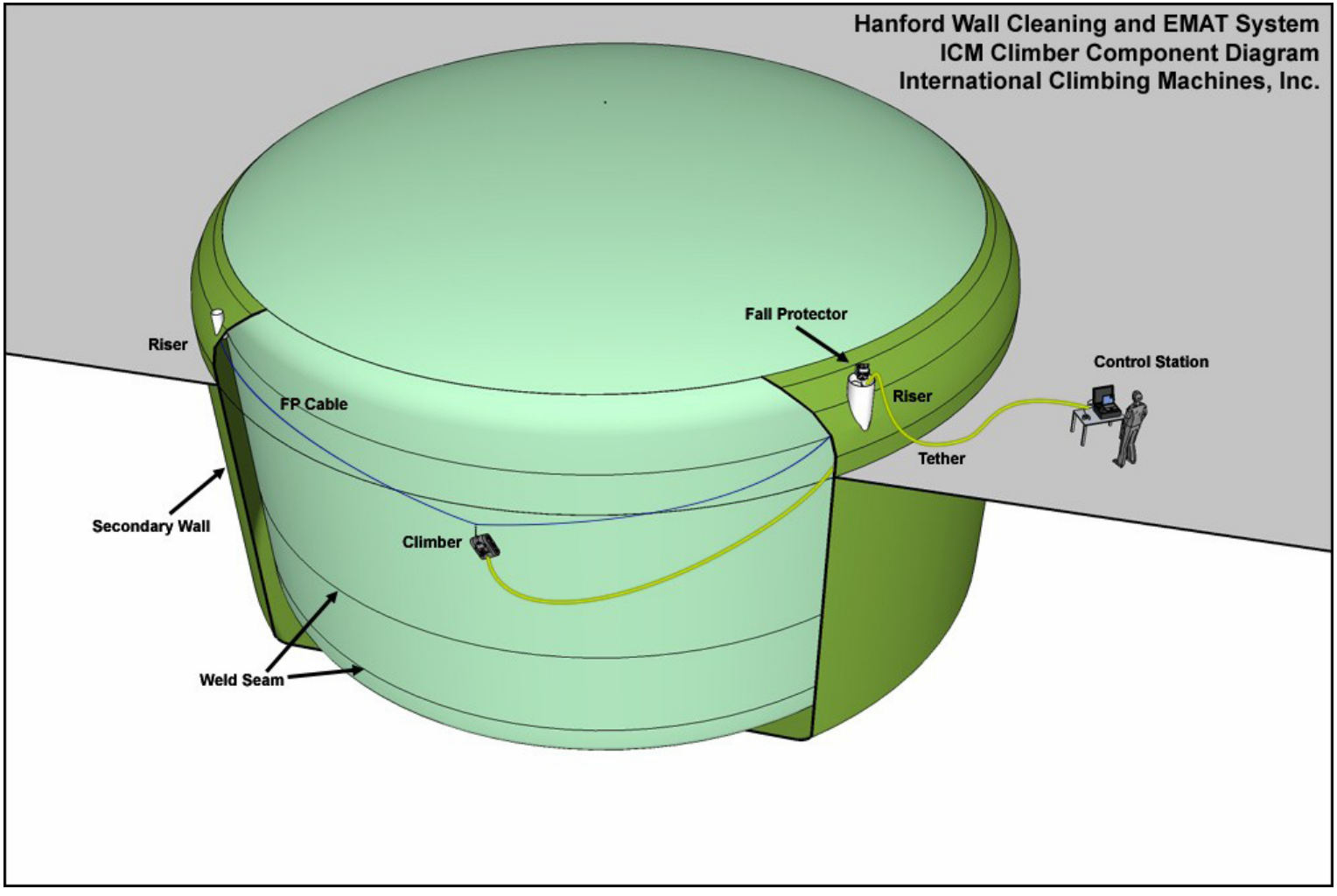
ICM Crawlers



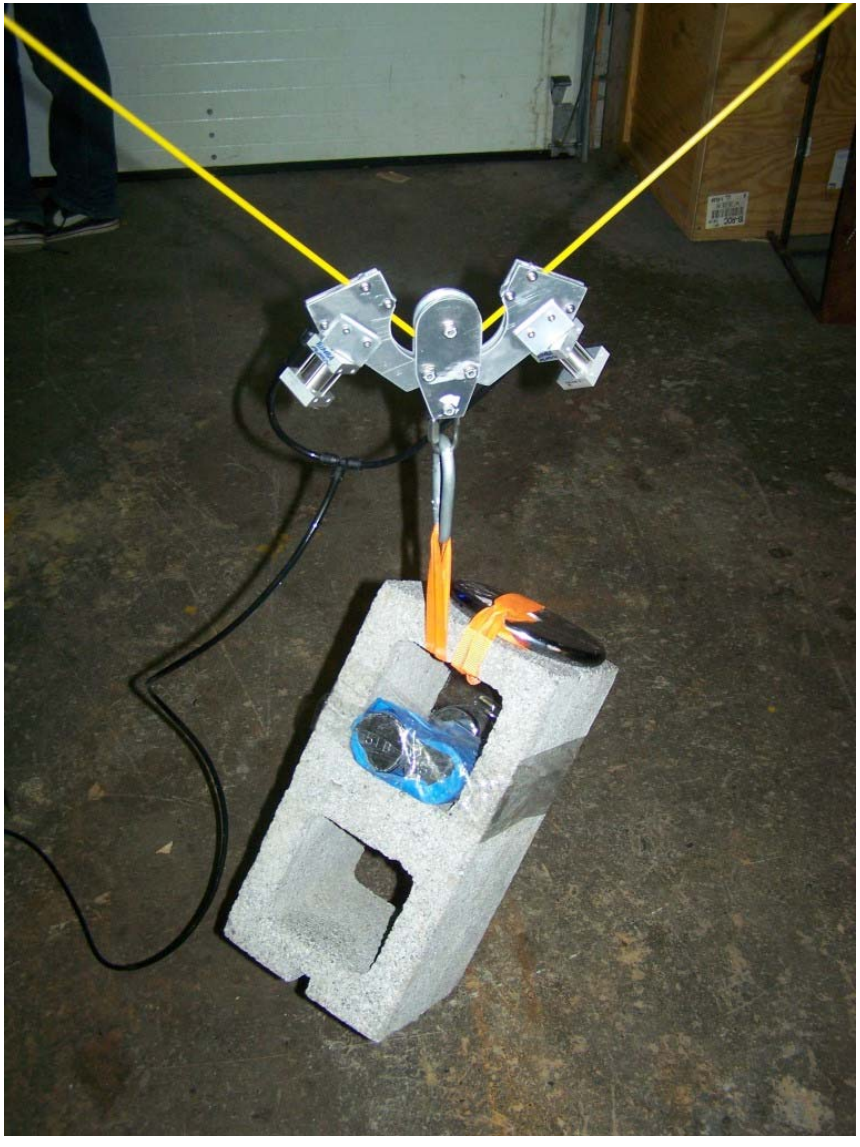
- Diverse vacuum robot used for:
  - Underwater functions
  - Inspection of wind turbine blades
  - Cutting through contaminated materials
  - Painting in limited access areas



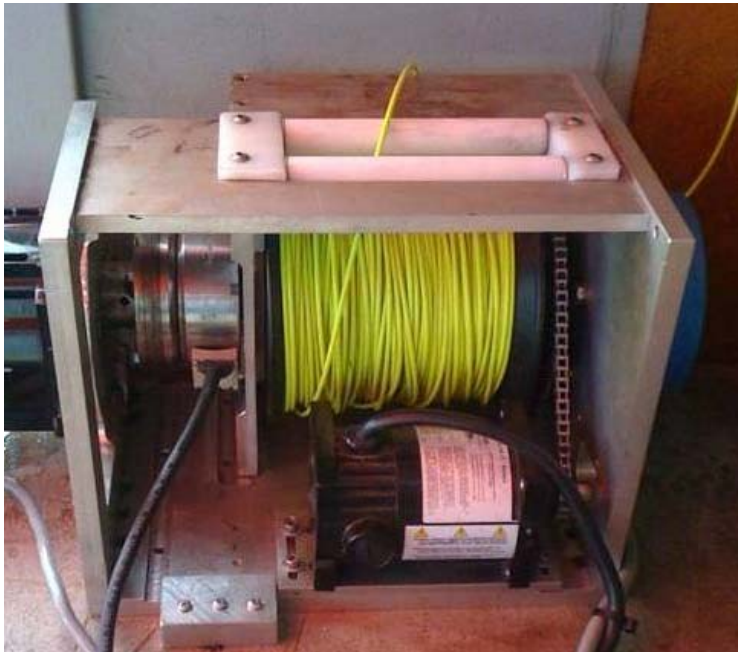
ICM Crawler Fall Protection



ICM Crawler Fall Protection



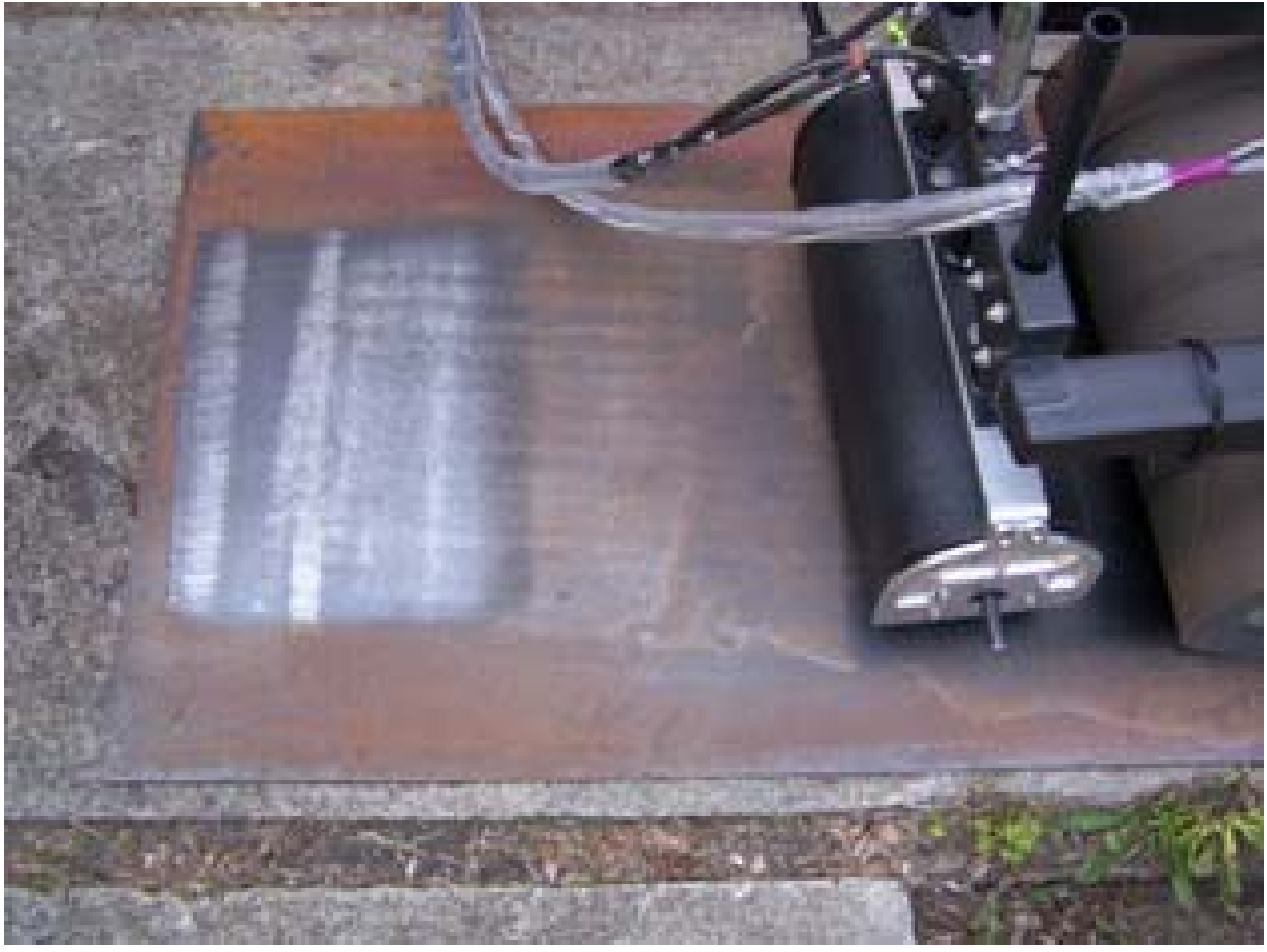
- ICM's crawler has two forms of fall protection
  - Cable with catch clutch
  - Onboard air-powered cable grab



ICM Crawler Brush Cleaning

- Nylon bristle impregnated with a silicon grit
- Motor for brush mounted inside
- Custom made by ICM
- Chosen by trial and error

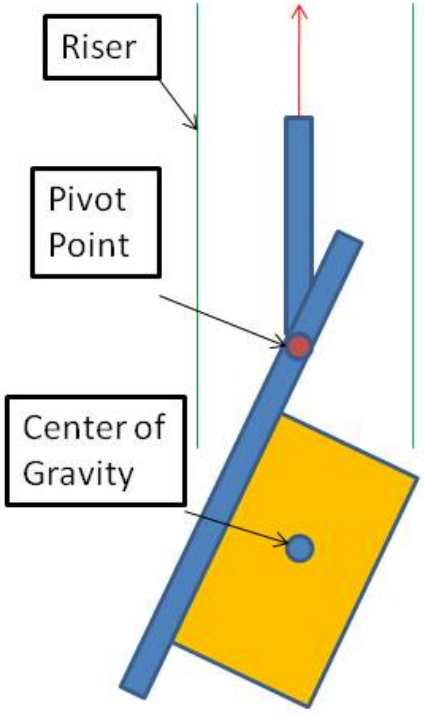
ICM Crawler Brush Cleaning

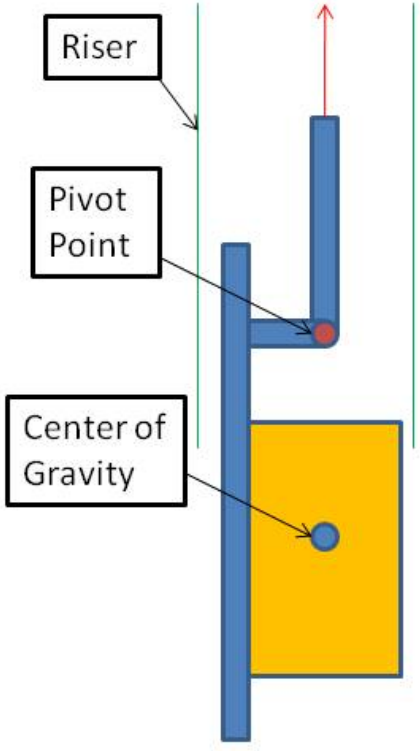


Deployment Issues

Problem

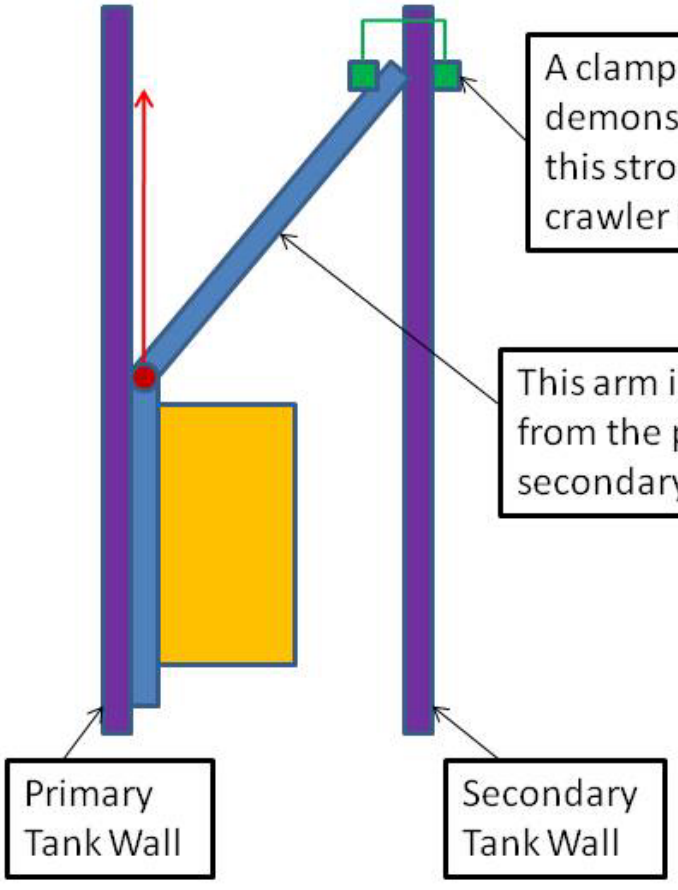
Solution





Deployment Issues

Wedging: the wedge is needed in order for the crawler to not lose vacuum when crawling off the deployment tray.



A clamp was placed here to simulate wedging. We need a demonstration to prove that we will be able to achieve this strong of a wedge manually in a tank before the crawler is deployed.

This arm is too long. When the tray is pulled up on from the primary tank wall, the arm moves up the secondary wall instead of wedging.

Crawler Video

Click on Black Box Above to Play Video

Combination of Technology

- If the EMAT crawler detects a defect within its 14” spacing, the UT crawler will be deployed to find exactly where and what kind of defect it is
- The EMAT crawler will also be able to clean the area for the UT crawler, saving time with the inspections

Moving Forward

- The EMAT crawler has been demonstrated at the CTF successfully
- In early November, the crawler will be deployed and demonstrated in tank 241-AN-107

Questions