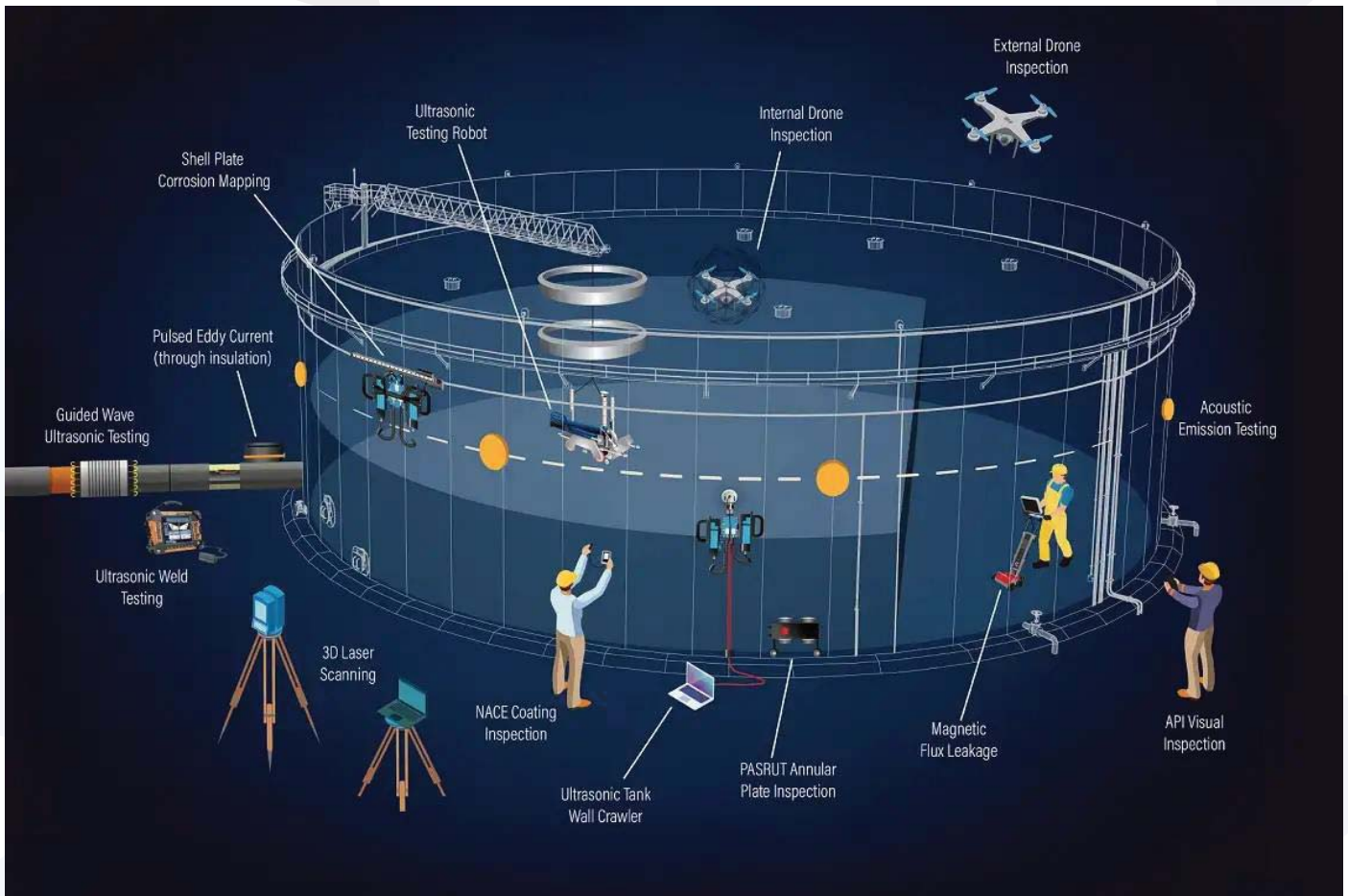# C4i

ROBOTICS

NON-DESTRUCTIVE TESTING SOLUTIONS AND TECHNOLOGIES

C4I-PRO
Pipe Robot and tank options

Examples of activities to consider around above ground storage tanks

Some of the activities in or around Above Ground Storage Tanks

- Test of the in and out flow of products
- Test of the pipes and conduits connected to the tanks
- Visual inspection of the tank hull; using eyeball / photography / manually or through drones
- 3D laser observation of the tank hull
- 3D imaging of the inside of the tank
- Testing of the metal tank hull, through ultra sonics
- Ultra Sonic tank plate inspection
- Tank wall cleaning
- Tank bottom cleaning
- Tank level control and monitoring
- Tank product detections and monitoring
- Weld inspections in pipes and tanks
- Tank management software

Customized Software will assist with any of the above activities and presentation of data
We can identify some readily available software we can use and work on Customization of the same

This is a very important aspect to any of the above

As mentioned I have a layout / concept for the pipe robot
The specifications will be adjusted to the actual requirements and pipe diameters
Variables are:
Temperature / pressures
Product in the pipes
Diameter of the pipe
Length to be covered
In or out of process work
Angles required
Speeds and time frames
Environmental conditions
Inspections, repairs, etc to be done separately or simultaneously

These are some of the questions we would have to address.

Hereby my quick wrote up on the concept
Please consider this confidential.

General

This system is designed form the ground up and will perform the following functions in sequence:
- Visual testing of the inside pipe track
- Paint preparation, through sand blasting
- Cleaning the debris, through vacuuming
- Painting of the required section
- Observation of all operations
- Testing of the painted area

The system is controlled from a distance, from a main controller.
This main controller can be build-in into a control trailer/caravan.

The robot is connected through an umbilical with electrical supplies and hoses to carry the pressure, paint and debris removal

We will need about 3 to 4 weeks to detail the design and document all aspects though computer aided drawings. This is a "one off" overhead cost and includes 3 parties to assist in secure and protected aided design and protection of the intelligent property.

We would provide detailed, web based project management and progress controls.

The Main controller will control each step of the process and be able to document the results in video- and scanner files to present to the Customer.
It controls the speed of the robot, the location (Depth inside the pipe) the grinding and cleaning, the painting and drying and the holiday testing.

Part of this product offerings, to the Customer, is a Customized software based mapping of the pipe, locating anomalies, welds and locating the processed sections.

This, in turn, allows for future reference testing and be part of Pipe management.

Internal Pipe Blasting, Coating & Inspection Task Robot
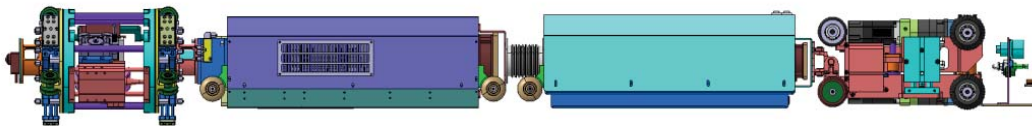
Smart and effective remote controlled.

Features:
- System(s), with adaptation, to cover Pipes with diameters ranging from 150 to 1,600 mm. This needs to be addressed .Additional modules (Small Medium and Large) and/ or adjustments need to be included to achieve any pipe diameter range and required length in the pipe.
- Length's, continuous, standard is 60 meters
- Introduction of the system through handbooks, fault finder procedures and instructional video's.
- One visit to KSA for up to one week is included to introduce the robot and to assist with the first operations and to include training.

•   A set of basic spare parts is included. We recommend to buy a set of more substantial parts.
•   Support from our Houston offices
•   Warrantee is one year on all manufactured parts. Excluded is natural wear and tear and excessive use of the parts.
•   Controls from main controller, with computer and screens.
•   Modular design; allowing for easy adaptation and replacements

Also included:

A cleaning procedure and maintenance program for the robot will be presented.

Supply of paint and other expendables at whole sale prices.
Paint is Engineered for the specific applications.,
Nozzles are also adapted to the Engineered paint and the applications.

Applications:
1. Pumping PipePumping Lines (Gas, Oil, Water etc.)
2. Cooling pipeline Systems
          •Nuclear Power Plants
          •Thermal Power Plants
3. Connections Pipelines in Refineries
4. Pressure Pipelines of Hydroelectric Power Plants
5. Municipal Sewage / Tap Water Pipe Systems

System Layout:
• Front camera (Pathfinder section) guides the robot in the structure.
• Weld camera section, to inspect and align the grinding section
• Grinding section
• Cleaning section
• Inspection section with 360 viewing camera modules
• Paint section
• Dry section and 360 viewing camera modules
• Holiday testing section
• Drive section

Technical Specifications:

Surveillance and tracking
A number of scanners and cameras are used to monitor the process.

• Running speeds of up to 25 meters per minute
• Power supply: 24 Volt DC
• Cameras: 4: Camera's / Laser scanners / Lidar system
• One in the Pathfinder section. To observe the trajectory.
• One in front of the Weld grinder (360 viewer). To observe the Weld.
• One in front of the Paint section. To observe the
• One at the tail end to observe, and document, the work done.

Technical Specifications:

This Robot consists of 9 sections for 4 main functions:

First Function: Sand blasting rotating head.
Second Function: Vacuum of debris and Inspection of the Preparation and cleaning.
Third Function: Paint of the prepared weld, through rotating paint nozzle.
Forth Function: Holiday tester inspection then quality of the work done.

Each section is connected with articulating swivels and runs on ball rollers.
This makes the system capable of manipulating corners and bends.
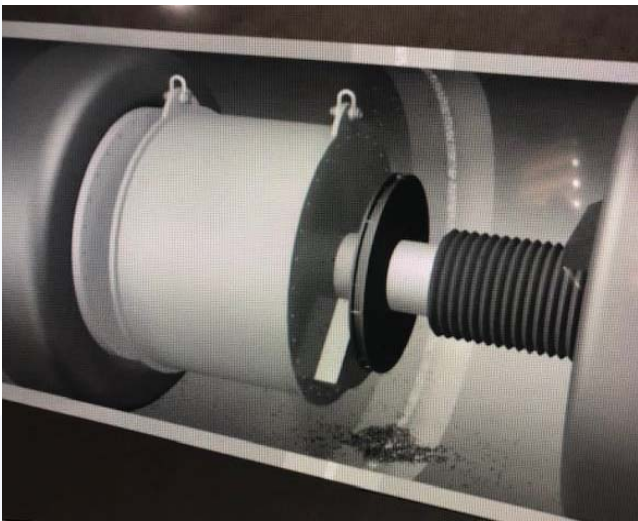
First Function

Comprises of a pressure system and a container with abrasive sand. The sand is pressurized and fed to a rotating swivel, controlled through a slip ring with rotation counter and visual observation.
The visual observation allows for control over the process, monitoring the progress and the quality, and to provide visual documentation.

Specific detailing on the sand, pressure settings and duration of each cycle is included.

Second Function

This section will follow the first section. It contains a Suction unit to remove all debris in the weld area and more.
The debris will be filtered and removed through an abrasion proof hose. An additional storage on the robot will be installed to hold heavier particles.

A camera observation system is part of this section.

Third Function

Paint of the prepared Weld
Airless paint sprayer, high pressure, using a rotating nozzle.
Here too an observation unit will be build-in to monitor and document the progress.

Paint, flow and pressure all controlled to achieve max results.

Fourth Function

Holiday tester

We develop a specific roller brush to cover the weld area in a circular motion.
This is a new development and we need to do a number of calibrations, using different paints and scenarios to obtain relevant test results.
This is a unique application and part of the IP of this system.

Robotic controls
The robot controller consists of a mobile rack, with all converters, and controls.
We can adapt to the specific accommodations of the Customer.

Control center

The control center is modular and split into the same four sections as the robot Functions
It has two main "over ride" buttons that will stop all operations in case of emergency or when a complete halt of the operations is needed.

One of the buttons is located at the robot and one at the controls and are clearly identified.
A separate section is build-in for the observations (Camera-&Scanner- controls and recordings).

First section: Sand flow control, Speed of head rotation. Pressure of the system and levels of stored sand .

Second section: Vacuum pump control, Filter pressure and observation

Third section: Paint flow, paint pressure, paint level at the robot cel.

Forth section: Holiday tester controls (Sparks through' s, dielectric levels)

Fifth section: Camera controls; playback, record, pan and tilt controls, angles and zoom.

Sixth section: Drive control and feed back. (Hall sensors, Encoders, Tacho-Generators and or other applicable technologies)

Spare Parts

Including:
- Paint Nozzles
- Paint
- Filters
- Cleaners
- Spare motor drive
- Module connectors
- Electrical connectors
- Cables

Electronics

Some of our modules need smart functioning and controlling.
We will be using Arduino and/or Raspberry's

The Arduino is a micro-controller, and not in fact a mini-computer. A micro-controller is just a small part of what makes a whole computer. The Arduino only provides a subset of the functionality of the Raspberry Pi.

Although the Arduino can be programmed with small applications written in C++, it cannot run a full scale "operating system" . The Raspberry Pi on the other hand, is a full blown (Micro) computer.

An Arduino is perfect for electronics projects. It contains a set of inputs and outputs that can be connected directly to components and sensors, and is incredibly easy to just jump straight into making something. This makes it ideal for prototyping things, or making small projects that don't require the complexities of a Pi.

The Arduino runs the Arduino firmware – a basic bit of core software which allows it to communicate with a computer over USB and gives access to all the features. You generally wouldn't replace this firmware, but it is possible. Once your code has been loaded, you can just plug it in anywhere and it'll start working immediately – you don't need to reboot, plug in a keyboard, or choose an application to run. It does the one job it's been programmed to do, does it well, and it does it immediately.

The Raspberry Pi on the other hand is a fully functional mini-computer. It requires an operating system (for instance Linux), and takes a small amount of time to boot up before it is operational. Storage is provided from a micro-SD card, while built-in Ethernet allows for networking.