

Duct Inspection



GENERATING SUCCESS --- FOR 100 YEARS

Kinectrics

Feb 3, 2016

Agenda



- Background
- Tooling Overview
- NDE Inspection Overview
- Summary

Background

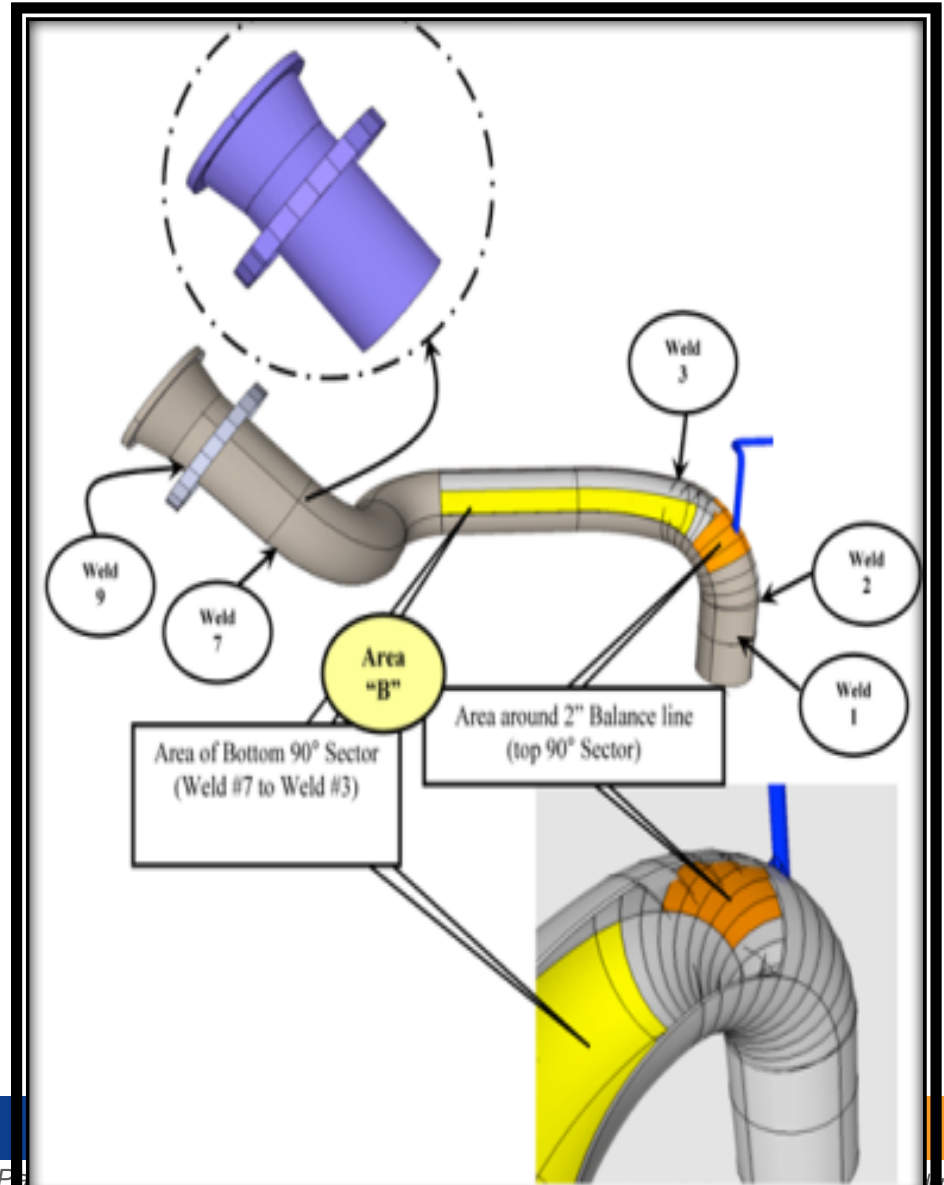
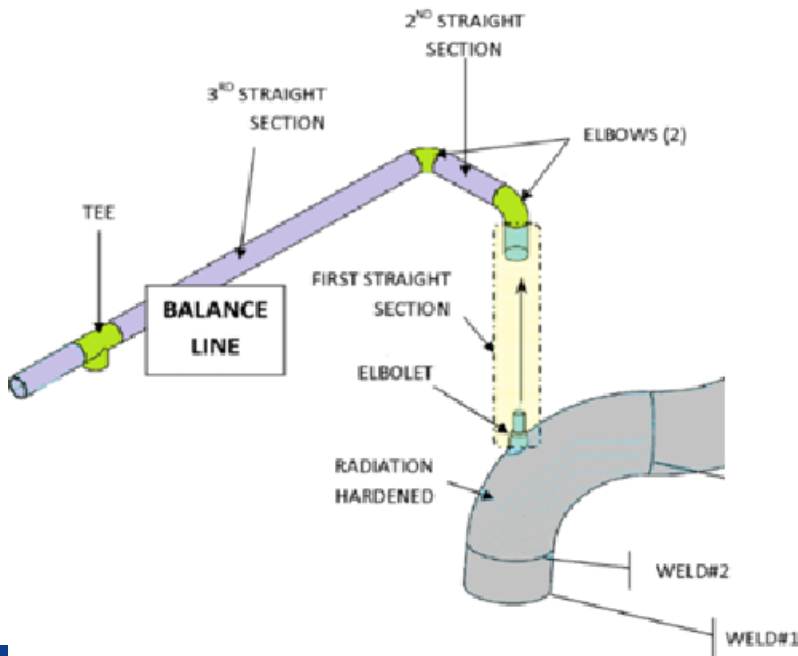


- Ducts require routine inspection
- Not a reactor safety issue
- Tool being tested & operated since 2014
- First deployment is Fall 2016 and routinely thereafter



Project Scope

- Project scope is to develop and build the tooling to:
 - Clean the duct
 - Non-destructive Examination (NDE) inspection

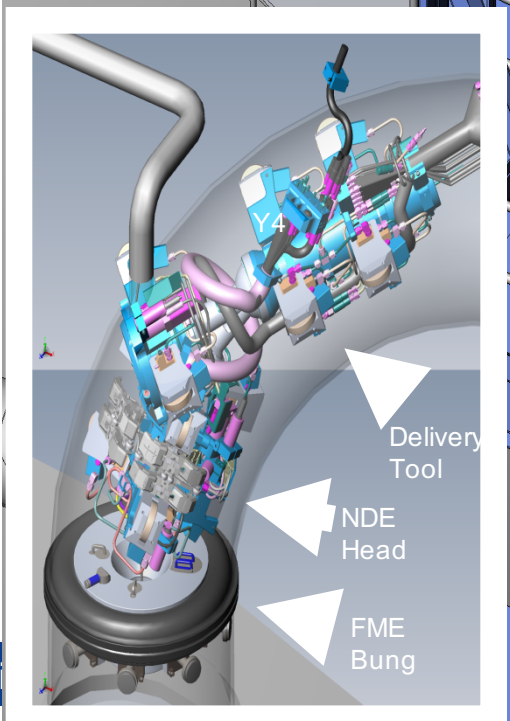
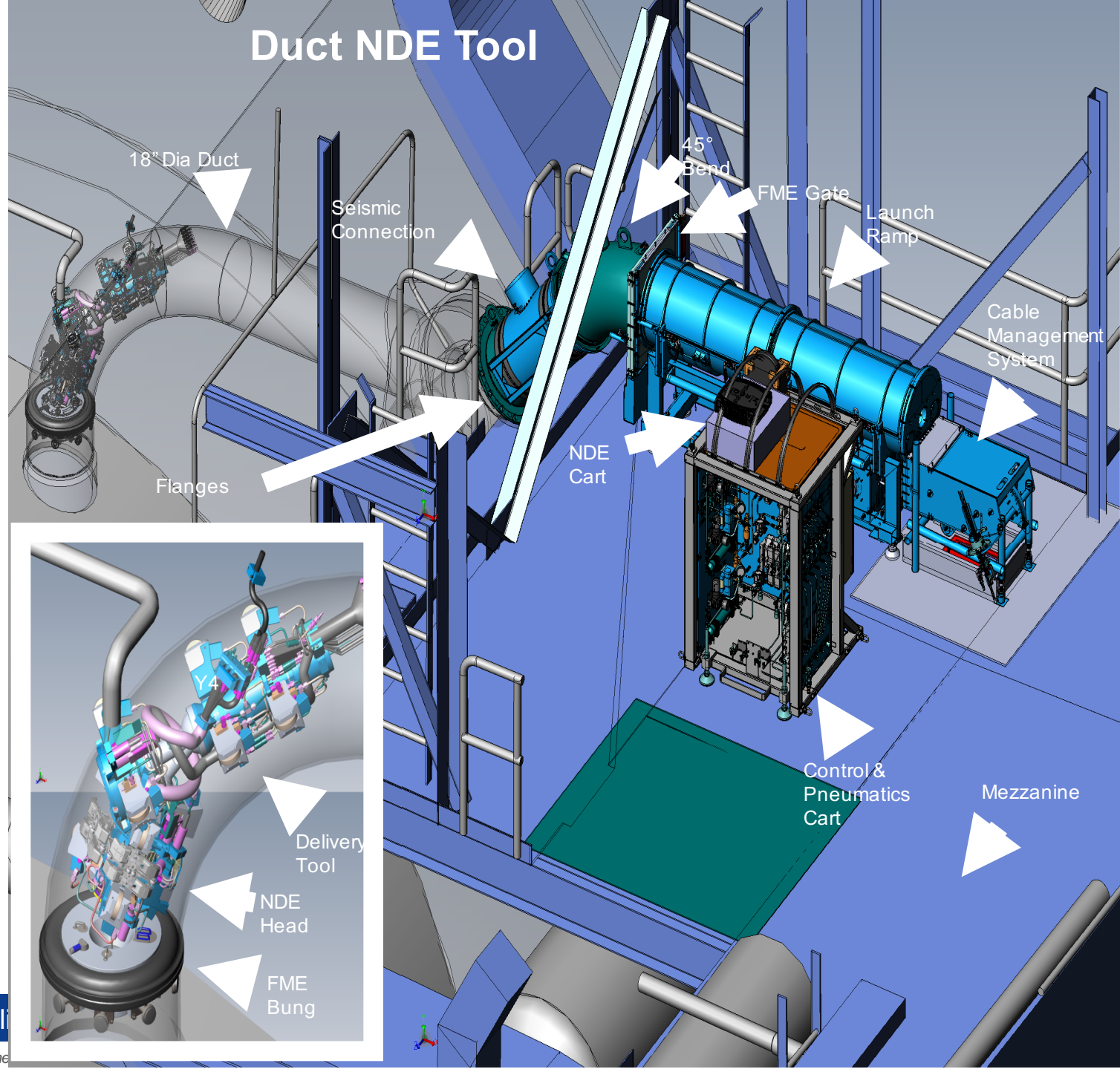


Tooling Overview



- Base project awarded to Kinectrics consists of the following tools:
 - Inch Worm Crawler (aka Delivery System)
 - Interchangeable Tool Heads
 - Foreign Material Exclusion (FME) Bung Deployment Module
 - 2" NDE Snake
 - 18" NDE Inspection Tool
 - Support equipment & carts
- Subsequently, projects released to Kinectrics for:
 - 18" Cleaning Tool (not included in this presentation)

Duct NDE Tool



Mock-ups



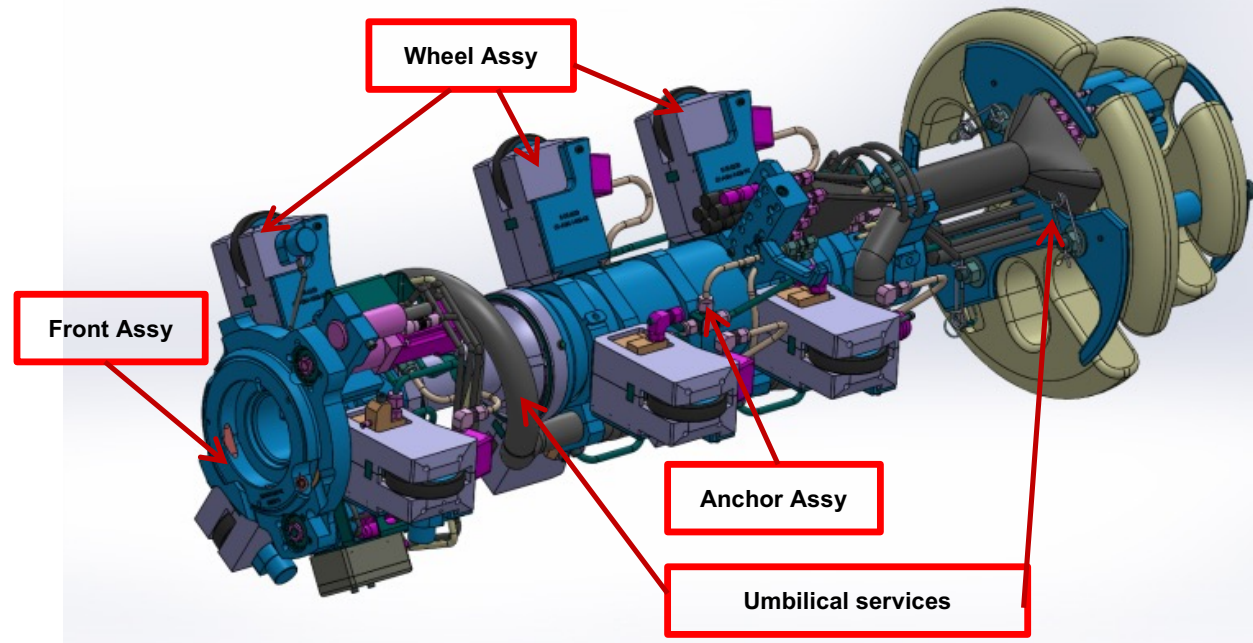
- All tooling verified on a variety of mock-ups:
 - Epoxy coated Mock-up (representative IDs)
 - NDE Mock-up (flaw detection)
 - Ovality Mock-up
 - Mini Mock-up
 - Airlock 5



Delivery System (DS)

- inch-worms through complex geometry 1.5D and 1.0D bends
- DS is tethered to the Launch Ramp (LR)
- Accommodate FME Bung tether and Umbilical through the centre of the tool
- Interchangeable heads connect to the front assembly
- Locally or remotely controlled

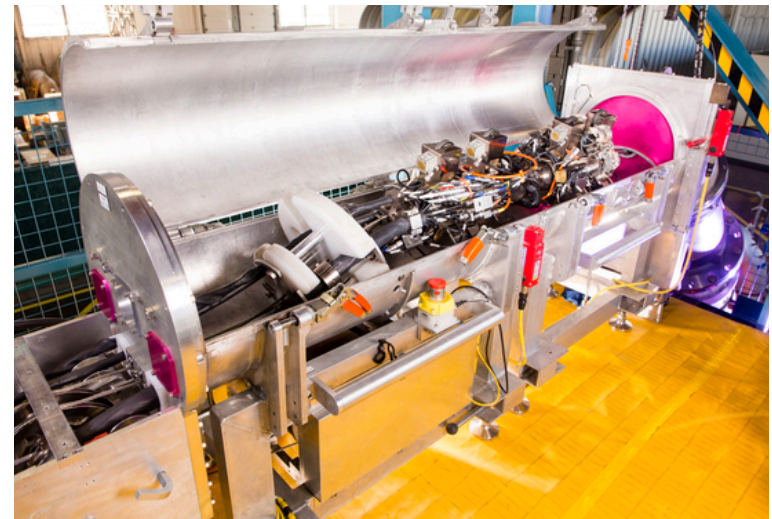
Crawler



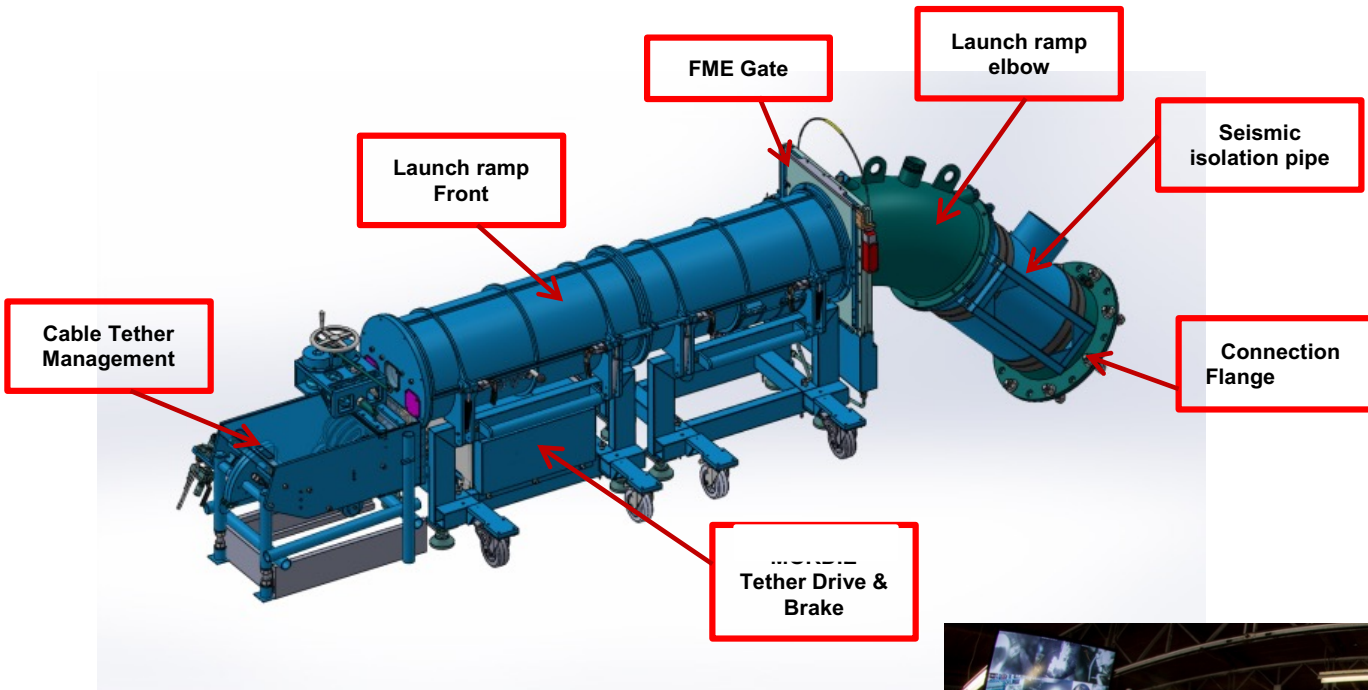
Delivery System



- Once installed in the Launch Ramp (LR), Inch Worm is able to navigate down the duct with varying IDs
- Crawler is used to deploy FME Bung, 18" NDE an 2" Snake
- Time to deploy down the duct ~45 mins, travel up the duct ~5 mins
- Travel speed during NDE inspection is the limiting speed at 1 hr/linear ft



Launch Ramp



- LR provides an effective means for crawler to enter the duct

- Seismic Isolation Pipe
- FME Control & Gate
- Slave E-stop Control
- Safety Interlocks
- Manage the umbilical and tethers

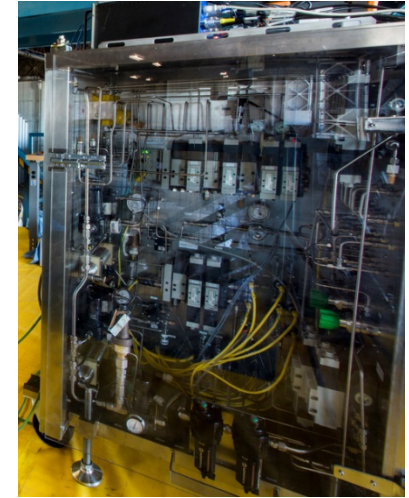


life cycle management solutions

Delivery System – Support Systems



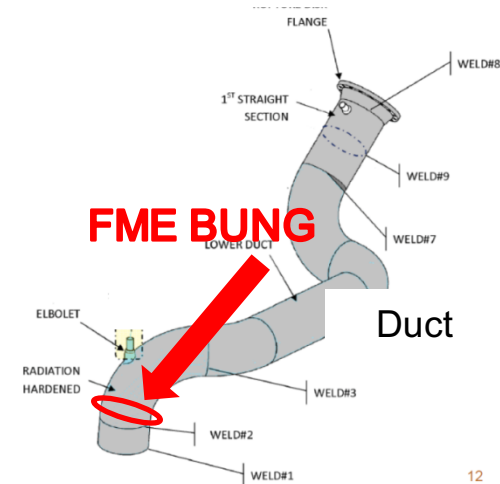
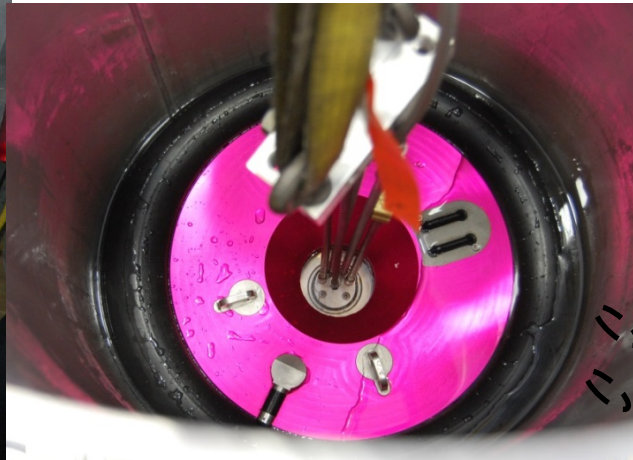
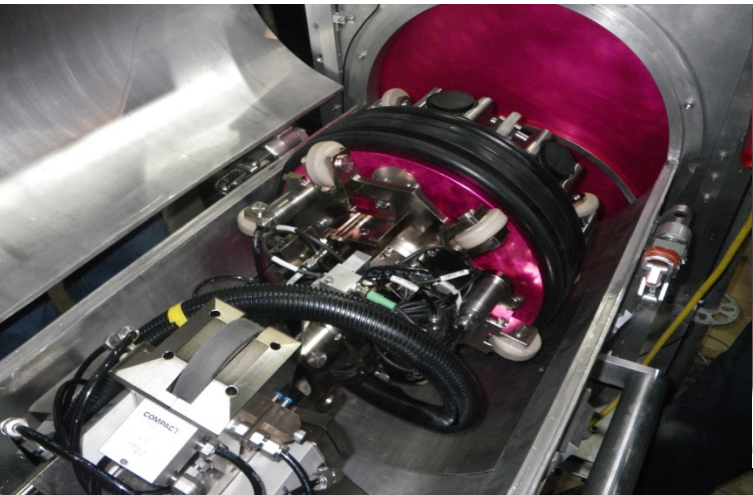
- Power Carts
- Control Cart
- Pneumatics Cart
- Heavy Water (D20 Cart)
- Master Control Station
- Cable & Tether Management



FME Bung Deployment Tool

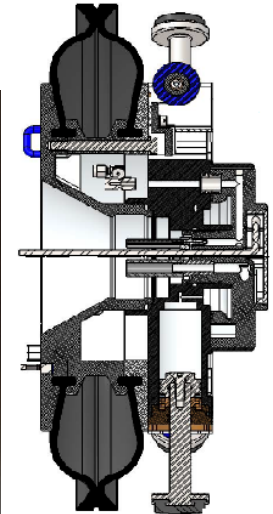
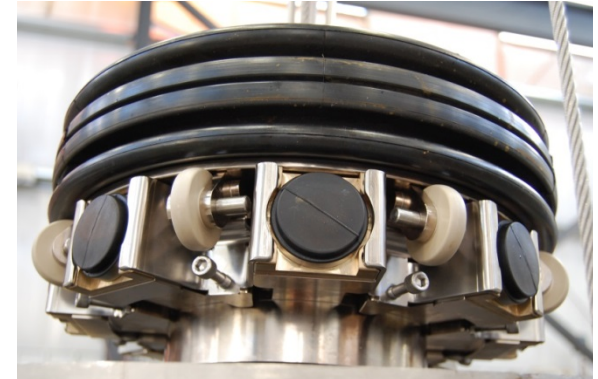


- Establish the FME Barrier to prevent foreign material
- FME Bung Deployment tool is capable of installing the FME Bung horizontally or vertically anywhere in the duct
- FME bung is planned to be installed above Weld #2



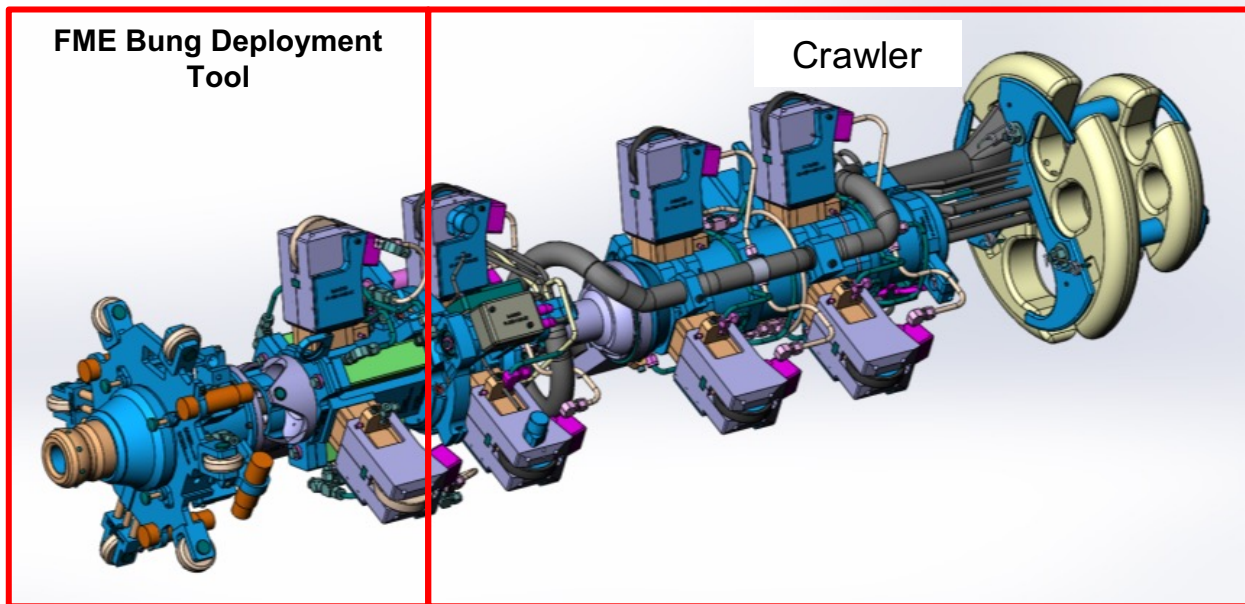
FME Bung

- Pneumatic (inflatable) seal which forms a liquid tight boundary in the duct
- Pneumatic grip clamps center and hold the FME Bung
- FME Bung Umbilical service cable supplies air and vacuum
- Safety tether which anchor the FME Bung to the work platform
- Tested to hold 100L with no leaks
- Leak Detection Groove that is actively monitored by the control system
- Designed with redundancies to mitigate Failure Modes and Effects Analysis (FMEA)



FME Bung Deployment Tool

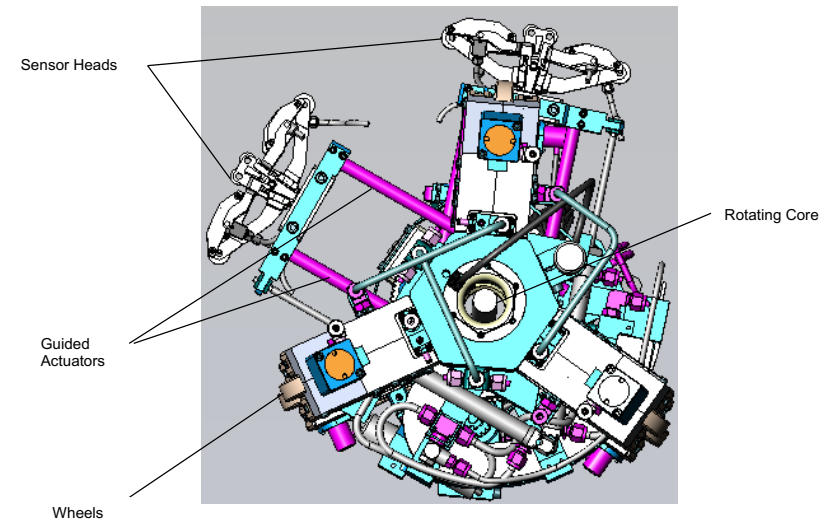
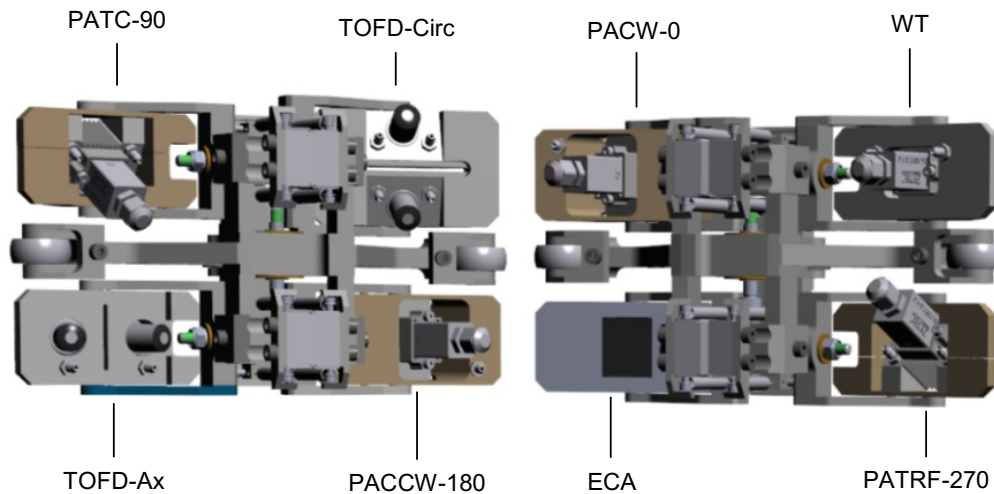
- Interface device connected to front head of the crawler used to place and retrieve the FME
- Able to install & retrieve the FME Bung
- Tool head has a contingency tube knife to deflate the bung in failure condition



18" NDE Inspection Tool

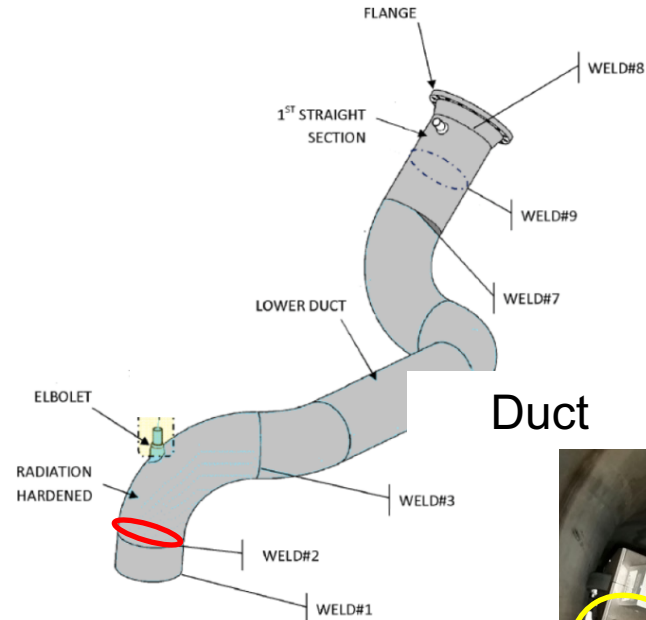


- Two sensor heads with total of 8 various NDE probes
- Sensor heads are mounted on guided pneumatic actuators
- Rotate to cover 370° of the duct using the Delivery System rotary joint
- Sensor heads designed to accommodate openings (i.e an Elbolet and a Weldolet)
- Target Flaw Size (TFS) is 2.5mm



18" NDE Inspection Tool

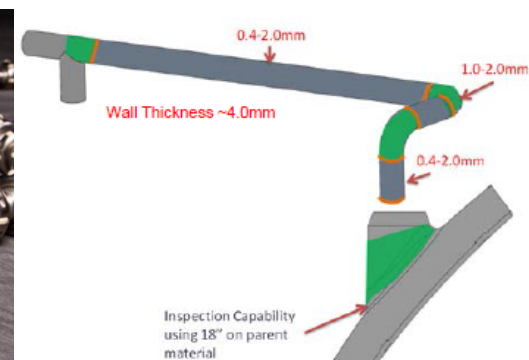
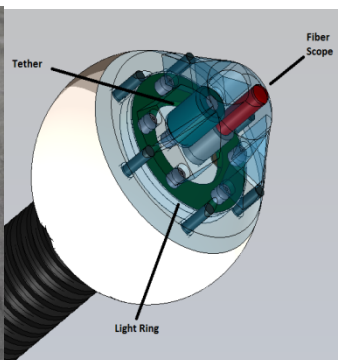
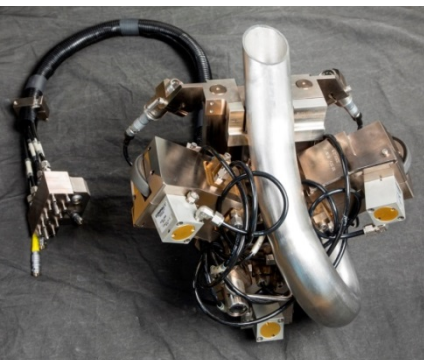
- Complete full circumferential inspection from Weld #8 to top of Bung
- Scan lines will be acquired every 5 mm
- 1 m of scan would be done in about ~3 hours 20 minutes, therefore, travel speed during inspection ~ 1 hour per linear ft
- FME Bung will actively removed NDE couplant from the duct



2" Inspection System



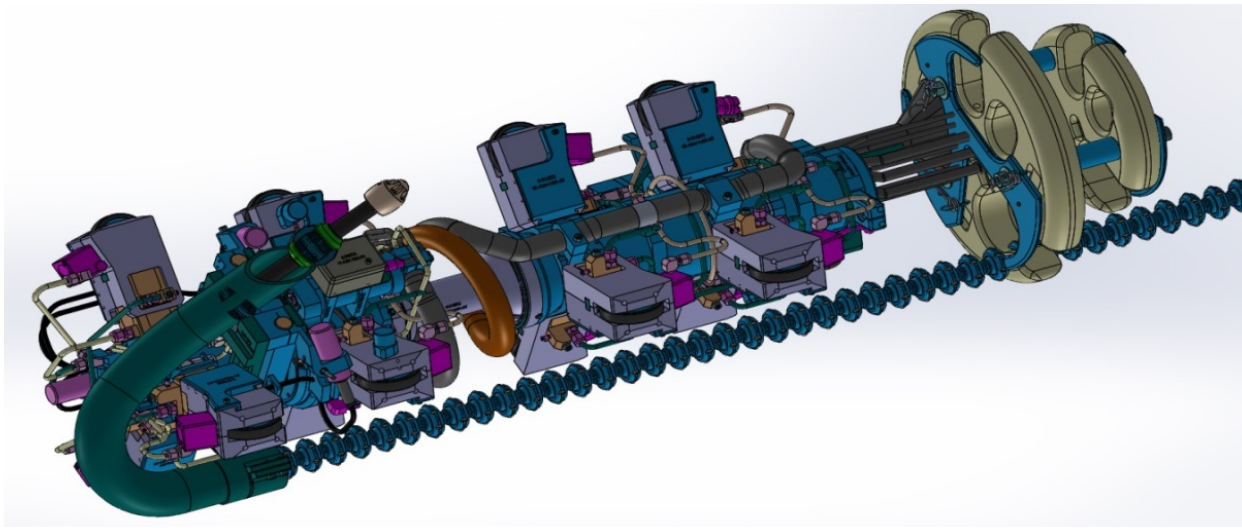
- 2" Inspection System consists of:
 - 2" Snake - Snake completes Eddy Current (ET) inspection
 - 2" Balance Line Deployment Tool - enables alignment with 2" Balance Line in order to deploy the snake
 - Snake Poly Pusher on the LR – enables the snake to be manually deployed from the LR
- TFS for 2" Balance Line is:
 - 0.4 mm in the straight sections
 - 1.0 mm in the welds and elbows



2" Deployment Tool



- Delivery System & video cameras are used to align the deployment module with the Elbolet
- Personnel manually deploy the Snake from the 2" Balance line via the snake poly pusher on the LR
- NDE scan occurs on the pull of snake and take 5" mins each scan, 12 pulls are planned for the outage

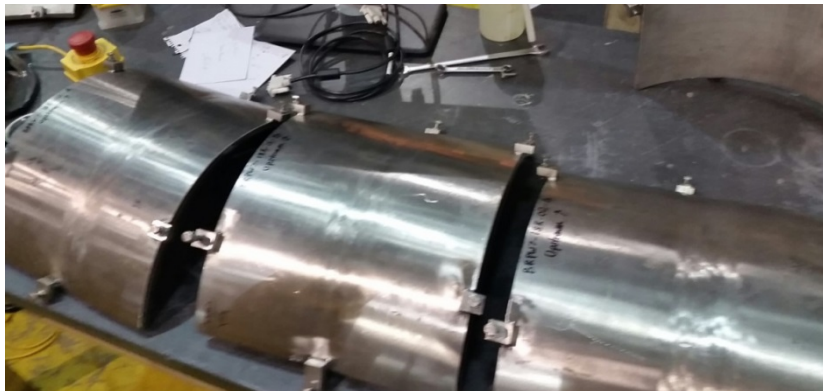


NDE Inspection Overview



- CANDU Inspection Qualification Board (CIQB) based inspection qualification with Technical Justification (TJ) for 18" & 2" Inspections
- Various coupons are required for the TJ with over 220 flaws fabricated in 66 coupons & multiple mock-ups

Geometry	Development	Qualification	Calibration	Total
2"	14	30	2	46
18"	5	8	7	20
Total	19	38	9	66



Summary



- Project is a difficult technically challenging inspection
- The tool set is one of the most complex in CANDU industry
- Teams continues to seek pragmatic solutions where variances to “meet the spec” occur
- Kinectrics is confident the first deployment will be a success