

# Duct Inspection



GENERATING SUCCESS --- FOR 100 YEARS

Kinectrics

Feb 3, 2016

# Agenda



- Background
- Tooling Overview
- NDE Inspection Overview
- Summary

# Background

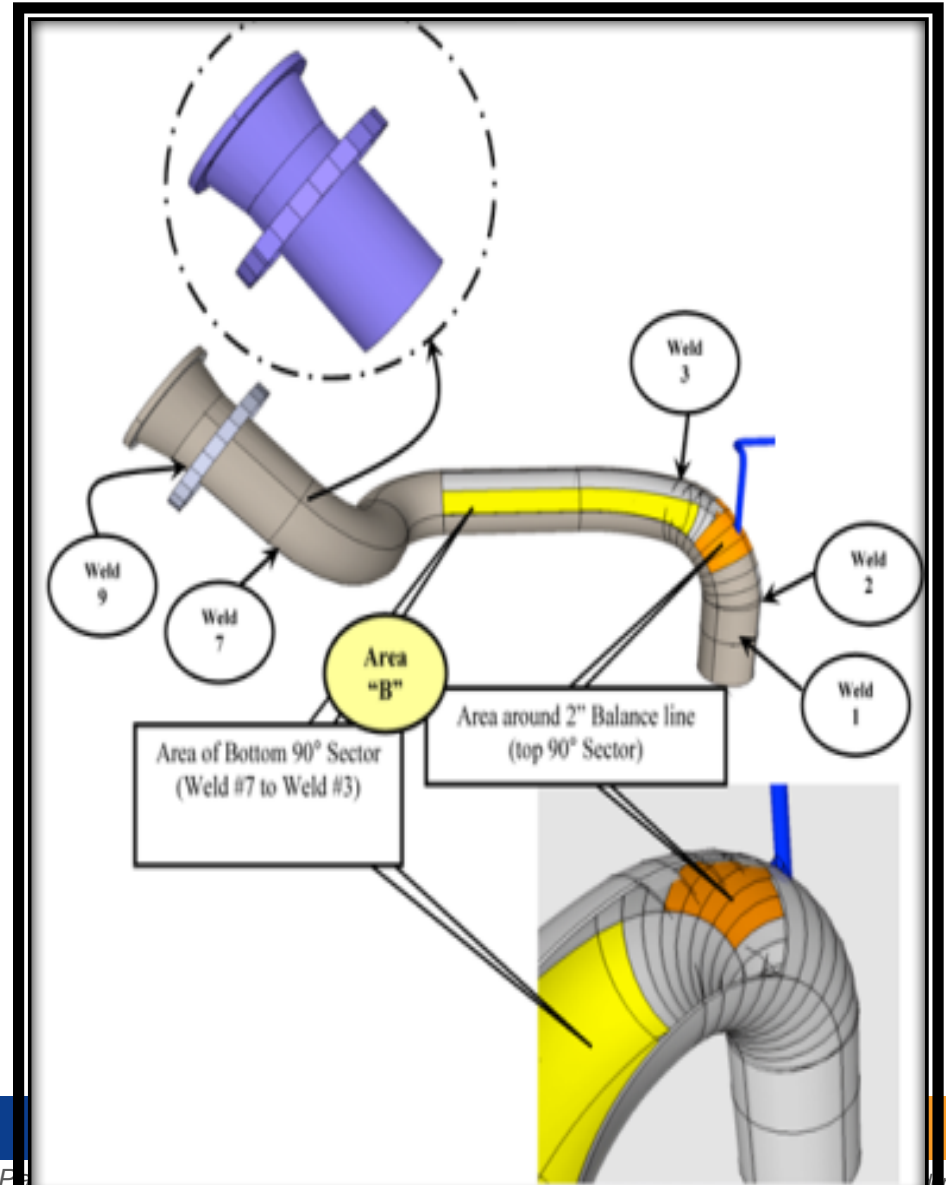
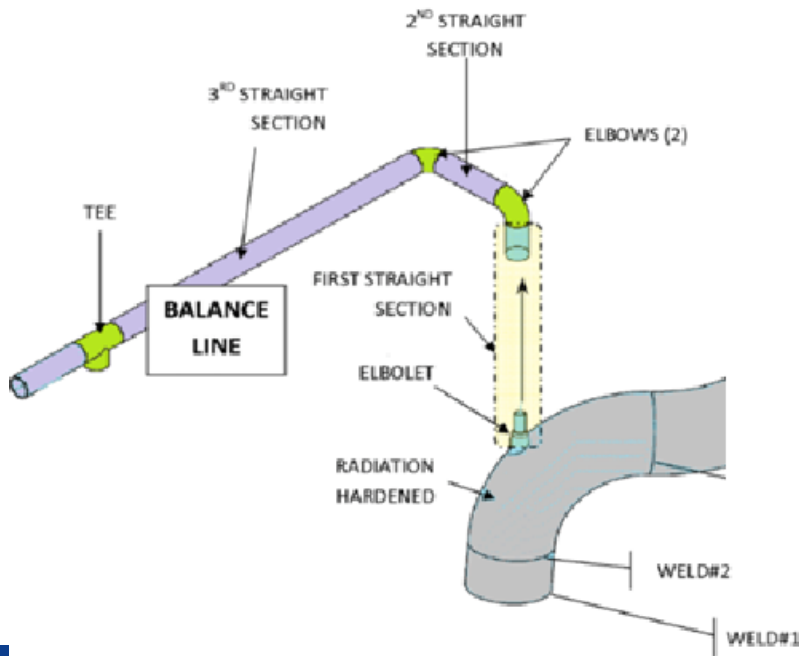


- Ducts require routine inspection
- Not a reactor safety issue
- Tool being tested & operated since 2014
- First deployment is Fall 2016 and routinely thereafter



# Project Scope

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

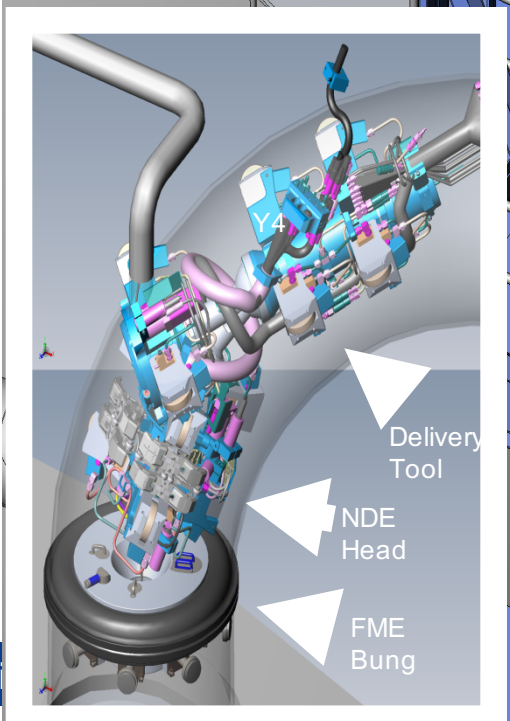
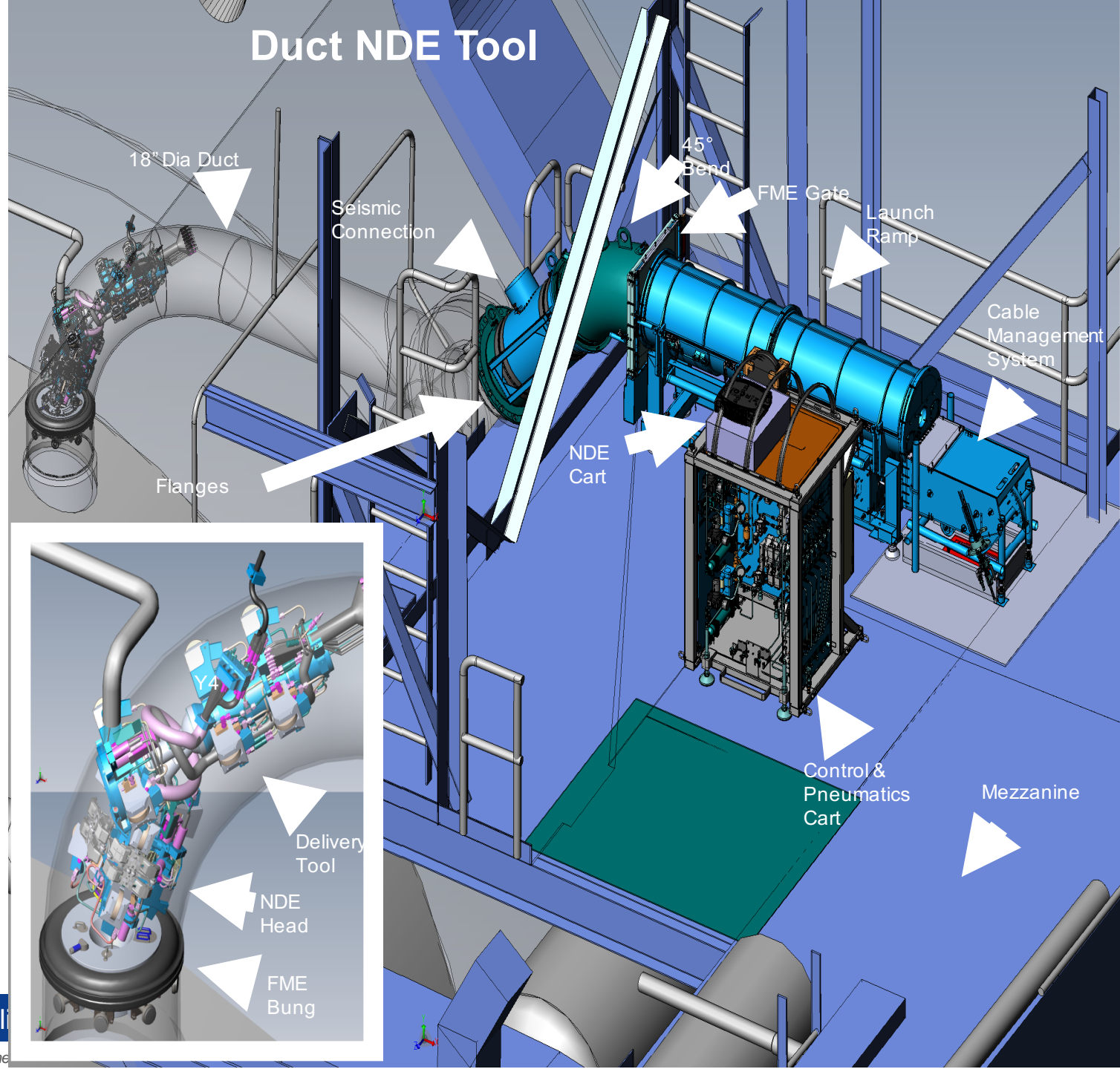


# Tooling Overview



- 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



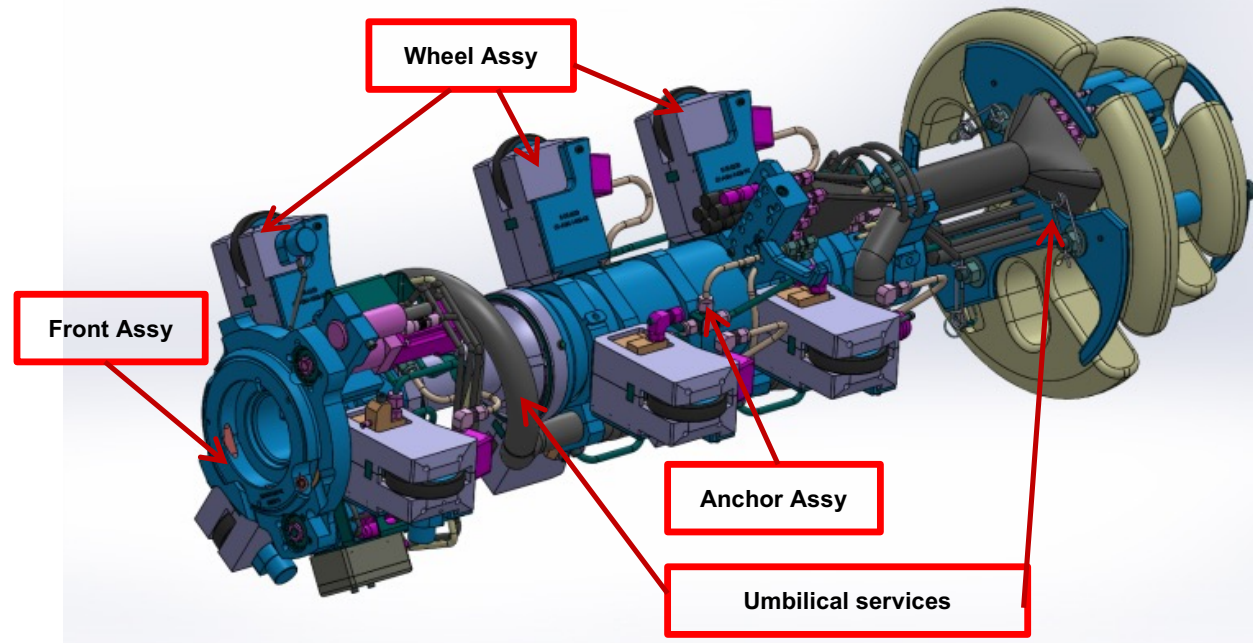
- All tooling verified on a variety of mock-ups:
  - Epoxy coated Mock-up (representative IDs)
  - NDE Mock-up (flaw detection)
  - Ovality Mock-up
  - Mini Mock-up
  - Airlock 5



# 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

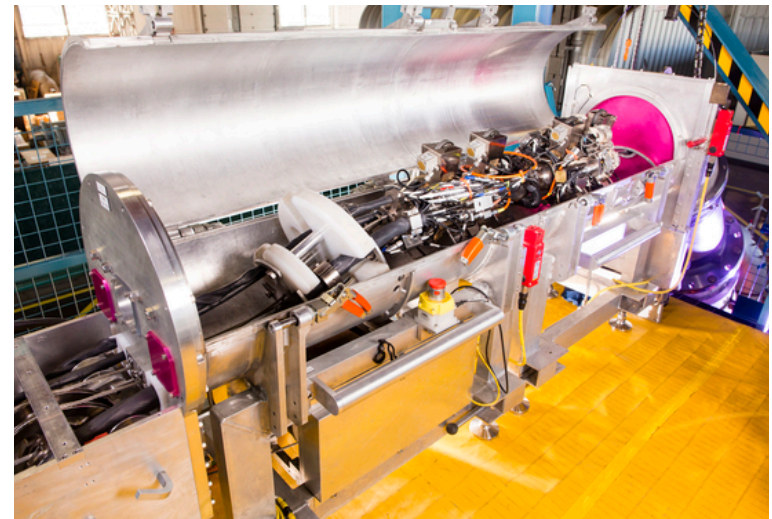
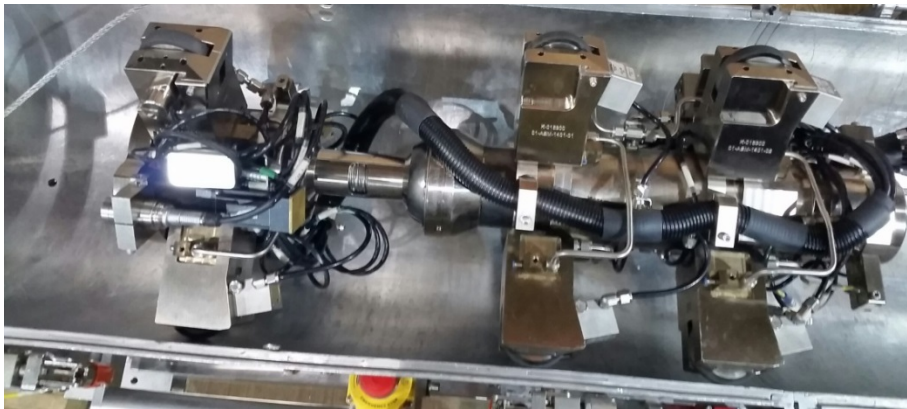




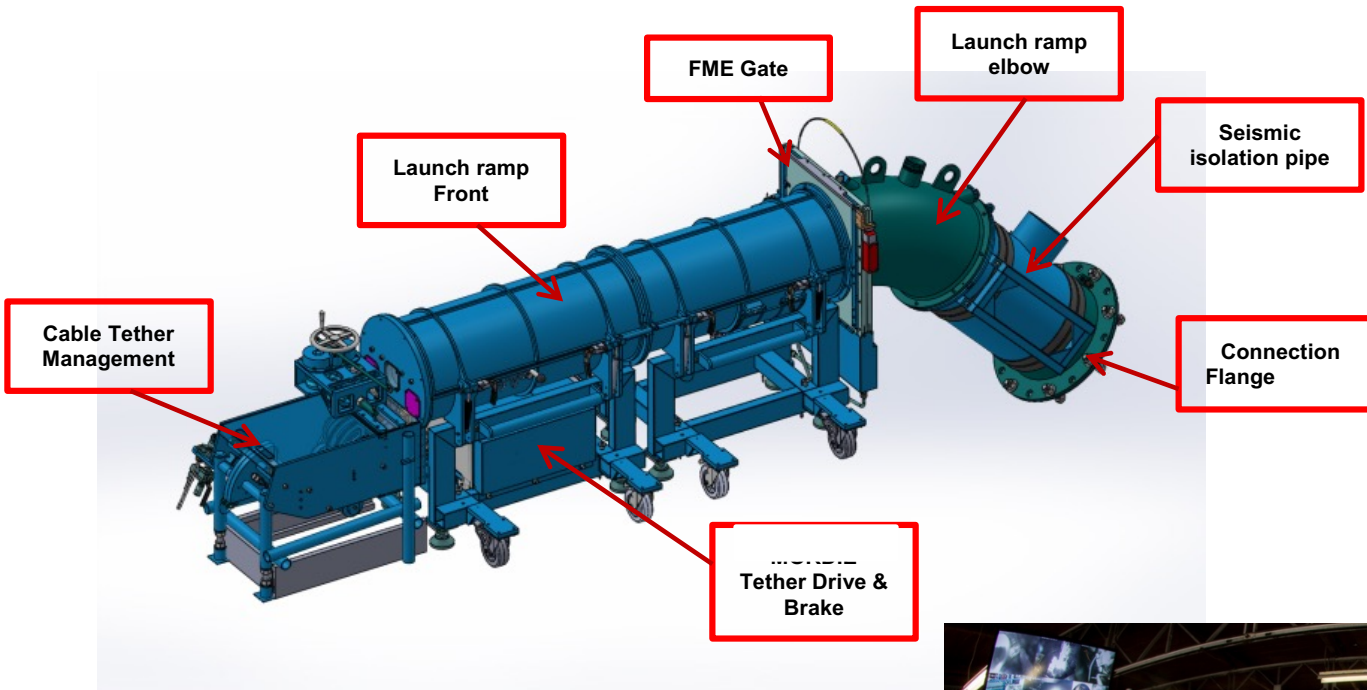
# Delivery System



- 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

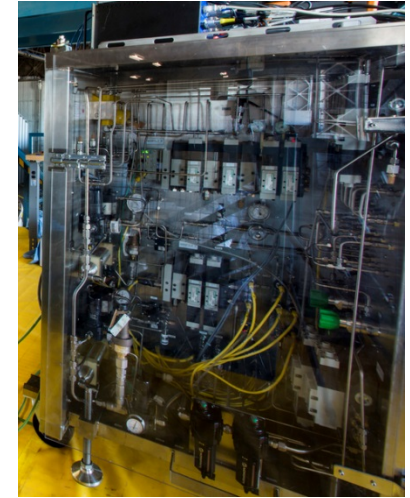


life cycle management solutions

# Delivery System – Support Systems



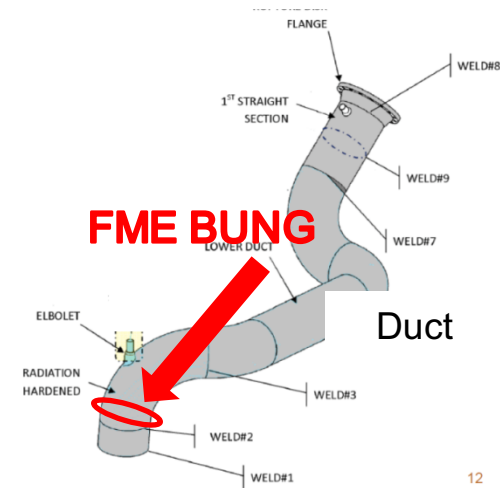
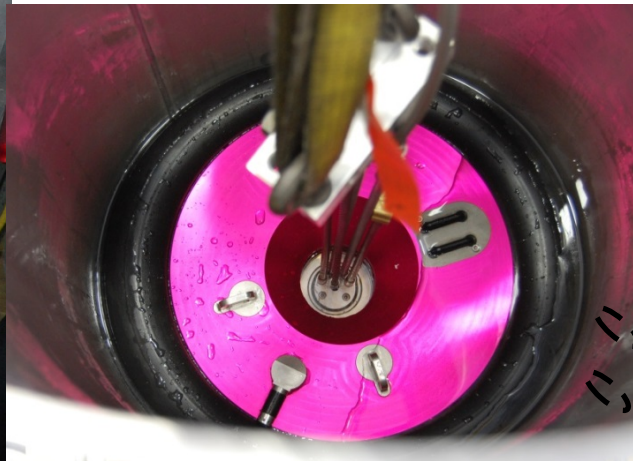
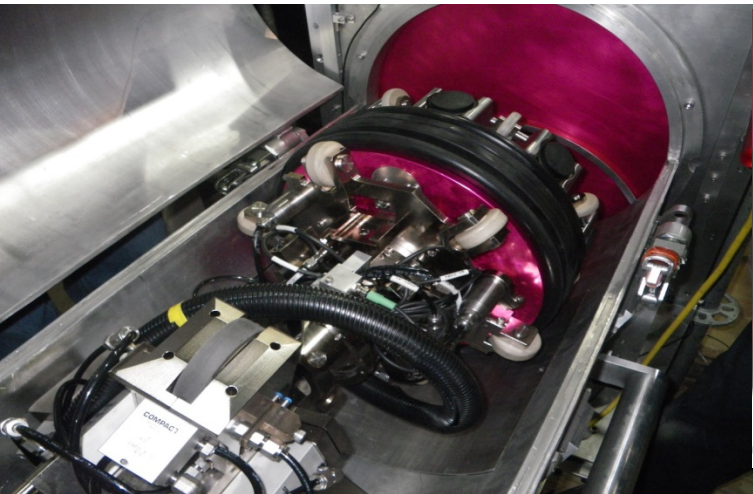
- Power Carts
- Control Cart
- Pneumatics Cart
- Heavy Water (D20 Cart)
- Master Control Station
- Cable & Tether Management



# FME Bung Deployment Tool

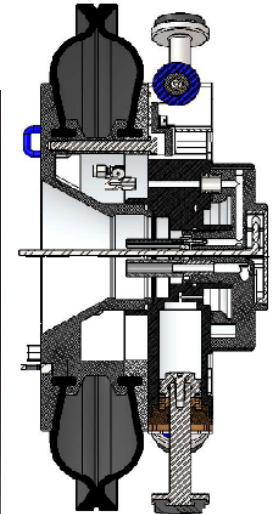
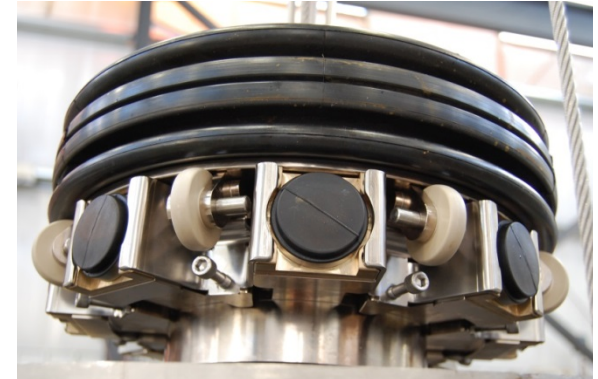


- Establish the FME Barrier to prevent foreign material
- FME Bung Deployment tool is capable of installing the FME Bung horizontally or vertically anywhere in the duct
- FME bung is planned to be installed above Weld #2



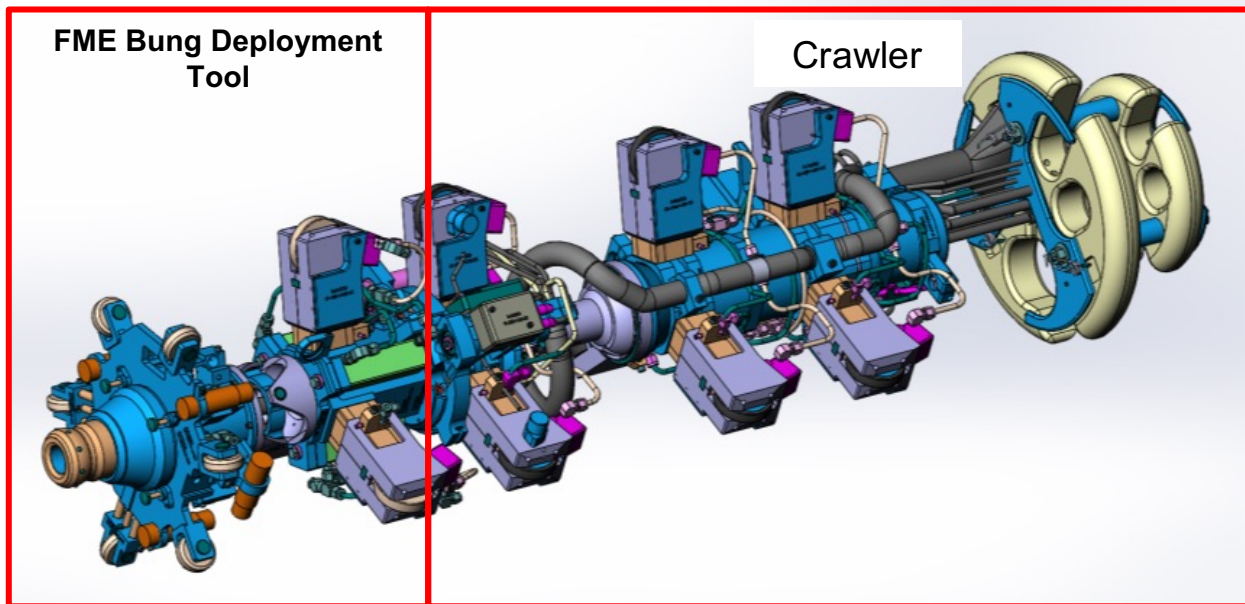
# FME Bung

- 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

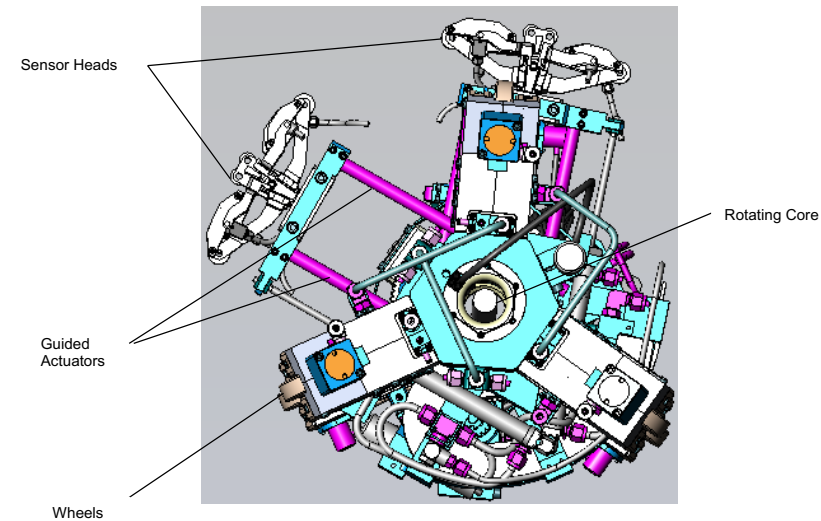
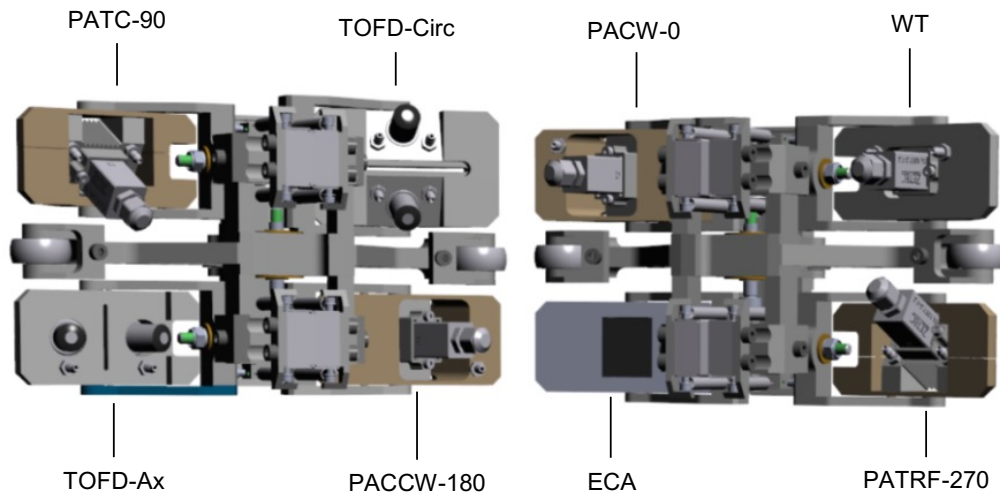
- Interface device connected to front head of the crawler used to place and retrieve the FME
- Able to install & retrieve the FME Bung
- Tool head has a contingency tube knife to deflate the bung in failure condition



# 18" NDE Inspection Tool

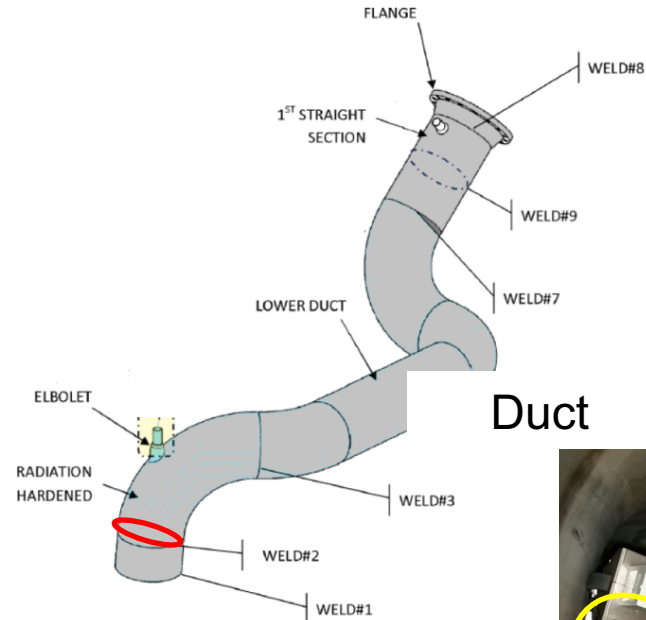


- Two sensor heads with total of 8 various NDE probes
- Sensor heads are mounted on guided pneumatic actuators
- Rotate to cover 370° of the duct using the Delivery System rotary joint
- Sensor heads designed to accommodate openings (i.e an Elbolet and a Weldolet)
- Target Flaw Size (TFS) is 2.5mm



# 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

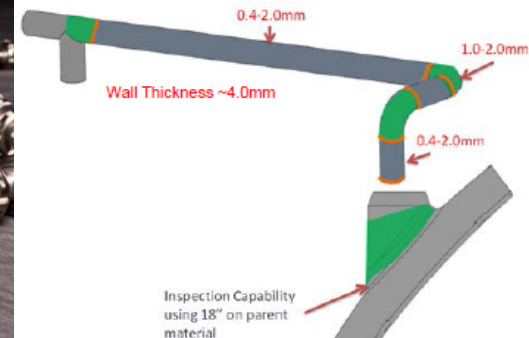
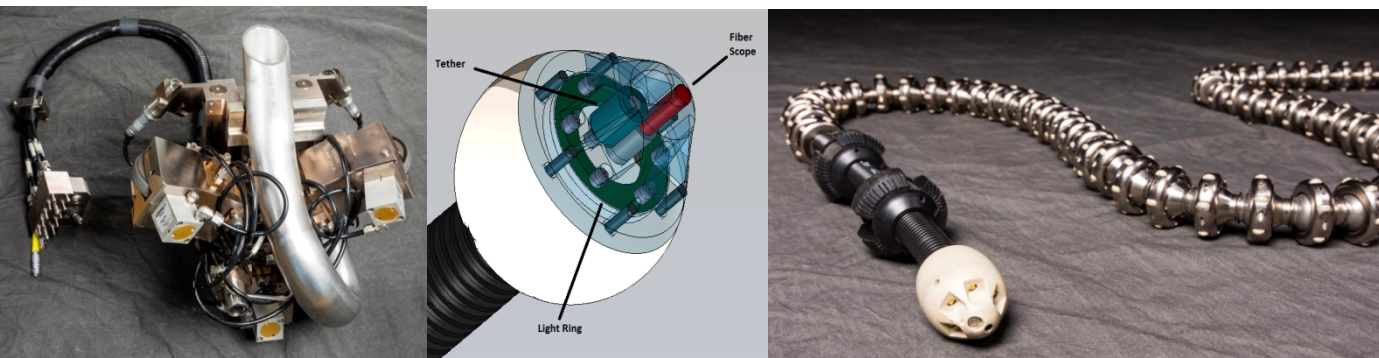




# 2" Inspection System



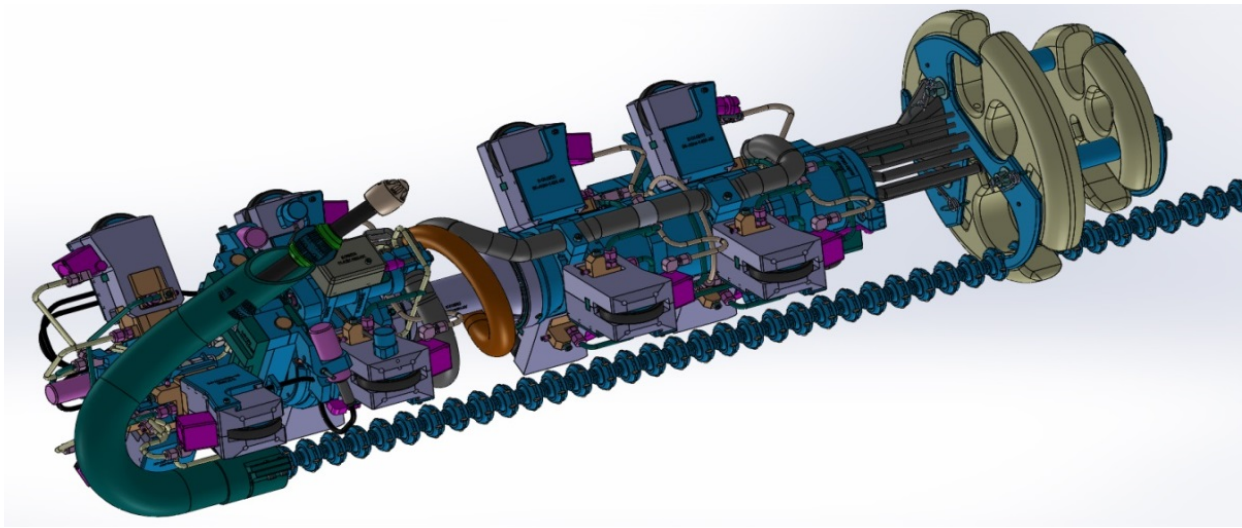
- 2" Inspection System consists of:
  - 2" Snake - Snake completes Eddy Current (ET) inspection
  - 2" Balance Line Deployment Tool - enables alignment with 2" Balance Line in order to deploy the snake
  - Snake Poly Pusher on the LR – enables the snake to be manually deployed from the LR
- TFS for 2"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

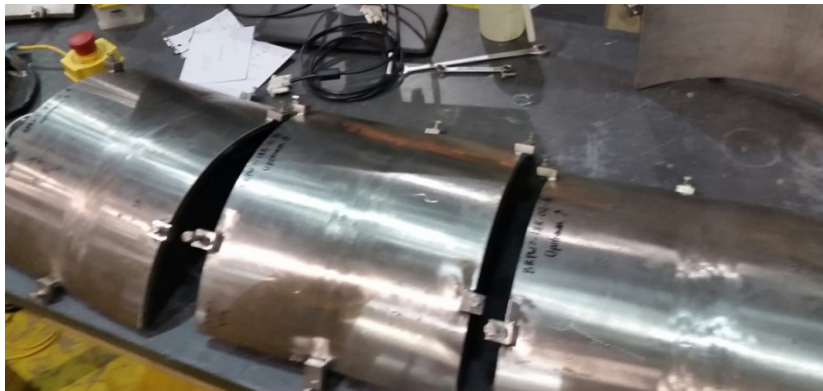


# NDE Inspection Overview



- 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
<b>Total</b>	<b>19</b>	<b>38</b>	<b>9</b>	<b>66</b>



# 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