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Materials, Welding, NDT for Arctic Pipelines
PHMSA R&D Forum – July 24-25, 2009



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Outline

- Arctic Pipelines - Context
- Materials
 - Pipe
 - Fittings – bends, flanges, tees, etc.
 - Valves
 - Coatings – pipe, girth welds, field-applied
- Welding
 - Mainline
 - Tie-in and Repairs
 - Double Joints
- NDT
 - Mainline
 - Tie-in and Repairs
- QMS – Quality Management System
- Alternative Integrity Validation



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Slide 2

Arctic Pipelines

- Low temperatures
 - -10C below ground, -50C above ground
- Remote
 - Logistics and construction efficiencies
- Long distances
 - Prudhoe Bay to Alberta – approx 2000 miles
 - Alberta to Chicago – approx 1500 miles
- High Pressure
 - 2000 to 2500 psi
- Strain-based Loading for part of route



Slide 3

Materials – Pipe

- High Strength
 - Defined σ - ϵ curve
 - High ϵ_u
 - Non - aging
- “Heavy” WT
- High Toughness
 - Initiation/Propagation
 - X100: ~300J available
 - X80: ~250J available

WT	2175 psi		2500 psi	
	DF 0.6	0.8	0.6	0.8
X70	1.243"	0.932"	1.429"	1.071"
X80	1.088"	0.816"	1.250"	0.938"
X100	0.870"	0.653"	1.000"	0.750"



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Materials – Pipe

- Gaps
 - Proven manufacturing capability X100
 - Need multiple 20 mile runs to demonstrate
 - Variability of properties
 - Distributions are basic input to RBDA
 - Understanding hydrotest
 - Benefits versus drawbacks
 - Sensitivities
 - Alternatives



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Materials - Fittings

- Bends
 - Available but limited supply for X80 grade bends (2 in Canada)
- Flanges
 - Lower grade, transition pieces to match higher grade
- Tees etc.
 - ?



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Materials - Fittings

- Gaps
 - Limited supply for bends, flanges
 - Tees – may be issue with equipment to manufacture
 - All – low temperature rating if -50F
 - No industry standards for P, T of concern



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Materials - Valves

- May be available to ANSI 900#, NPS 42
- Gaps
 - No industry standards for P, T
 - Low temperature rating problematic
 - Metallurgy – thru hardening issues
 - No 2500 psi valves to date
 - Much development needed



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Materials - Coatings

- Pipe
 - FBE: field bends only if $>-20^{\circ}\text{C}$
 - HPCC – bendable and provides mechanical protection
 - FBE/Lightweight concrete - ditto
- Girth welds
 - Shrink sleeves
 - ???
- Field-applied
 - ?



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Materials - Coatings

- Gaps
 - Low temp FBE to avoid thermal effects on pipe – does it provide same level of protection?
 - Reputation of shrink sleeves – standards for application and performance testing
 - Performance of CP in permafrost
 - HPCC – limited use to date
 - FBE/Lightweight concrete - ditto
 - Field-applied- ?



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Welding

- Mainline
- Tie-in and Repairs
- Double Joints



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Welding

- Mainline
 - High productivity Systems
 - Tandem, Dual-torch, Dual-tandem GMAW
 - LASER-Hybrid
 - Overmatching strength requirement for SBD
 - Gaps
 - Consumables matched to pipe and process
 - Consistency of properties
 - Acceptable distributions
 - Essential variables and ranges
 - Qualification of procedures, processes, welders
 - Industry Standards
 - Weld Flaw Acceptance Criterion



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Welding

- Tie-in and Repairs
 - Semi-automatic
 - Flaw acceptance to “workmanship”
 - Gaps
 - Consumables matched to pipe and process
 - Consistency of properties
 - Acceptable distributions
 - Essential variables and ranges
 - Delayed hydrogen cracking
 - Susceptibility
 - Delay time
 - Qualification of procedures, processes, welders
 - Industry Standards



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Welding

- Double Joints
 - SMAW or GMAW/SMAW hybrid
 - Gaps
 - Overmatching
 - Consumables and Procedure



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NDT

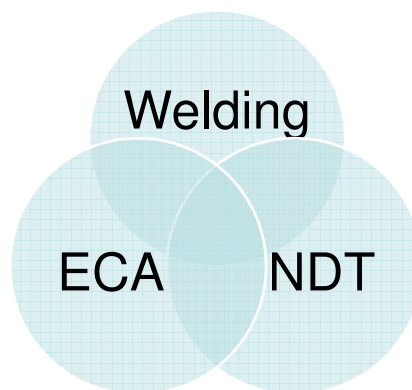
- Mainline - AUT
 - Focused probes or Phased Array
- Tie-in and Repairs
 - Phased Array
 - Radiography too slow at these WT
- Gaps
 - Industry standards
 - System design
 - System qualification
 - POD and Accuracy
 - Operator qualification
 - Operator interpretation wrt acceptance criteria
 - Shortage of qualified personnel



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Welding – NDT - ECA

- These elements are not independent!
 - Need industry guidelines



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Alternative Integrity Validation

- Hydrotest does not address “root cause”
- High toughness materials
 - very tolerant to flaws
 - hydrotest may not detect
 - Girth welds not loaded during hydrotest
- Water issue
 - Source, disposal, freeze protection
- Gap
 - need robust methodology and management system to demonstrate equivalent quality