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DG-ICDA "Technical Gaps and Challenges – An Operator's Perspective"

- Andrew Pulsifer

Houston, Texas

Many Gaps and/or Technical Challenges identified…but for today - 9 key issues

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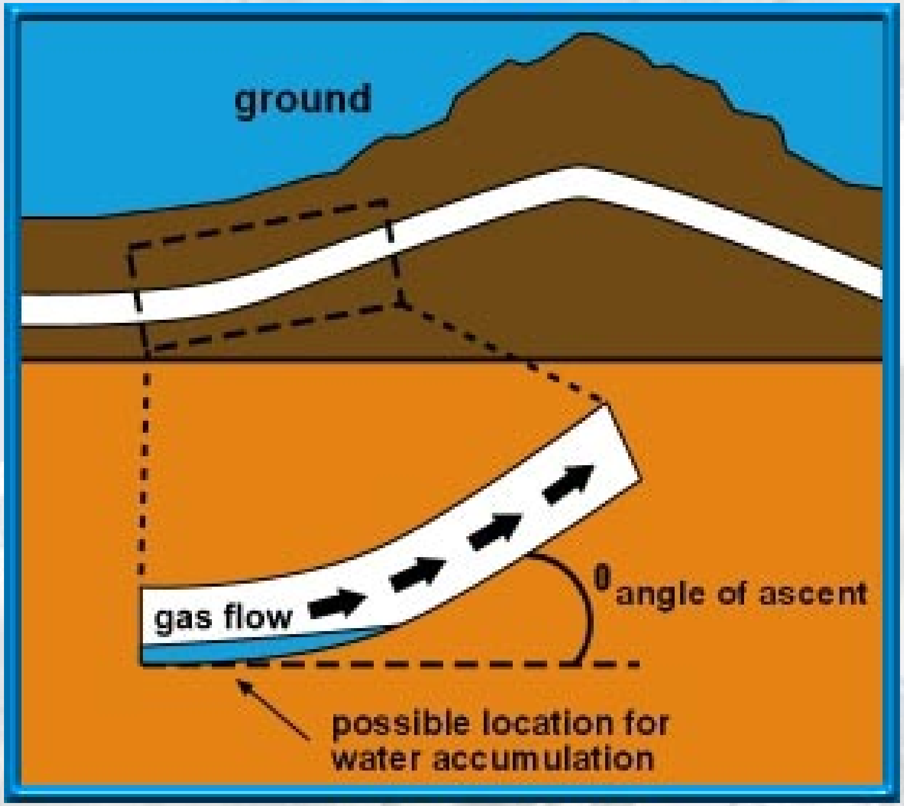
1. DG-ICDA Guidance - Rule or NACE
2. Pre-assessment – Data Collection
3. Pre-assessment – System Analysis
4. Indirect Inspection - Flow modeling data
5. Indirect Inspection - Pipeline Elevation Profile
6. Detailed Examinations – Wall Loss
7. Detailed Examinations – If Corrosion Found
8. Post Assessment – IC Monitoring
9. Post Assessment – Effectiveness of DG-ICDA

"THEORY" of DG-ICDA

- "Dry" Natural Gas
- Force of gravity is greater than force of shear stress provided by gas regime
- Critical Inclination Angle (CIA) = angle of ascent
- Water holdup – no D/S accumulation of water
- <u>Localized</u> internal corrosion

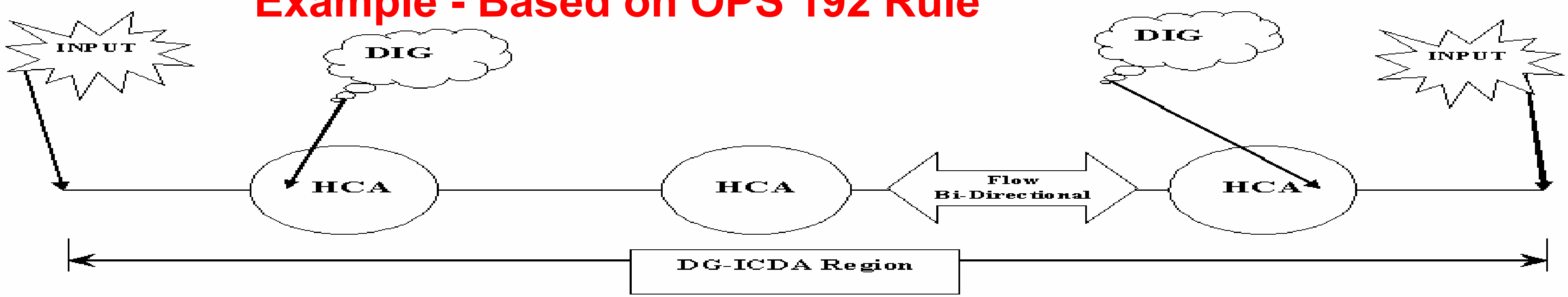


DG-ICDA Issue #1

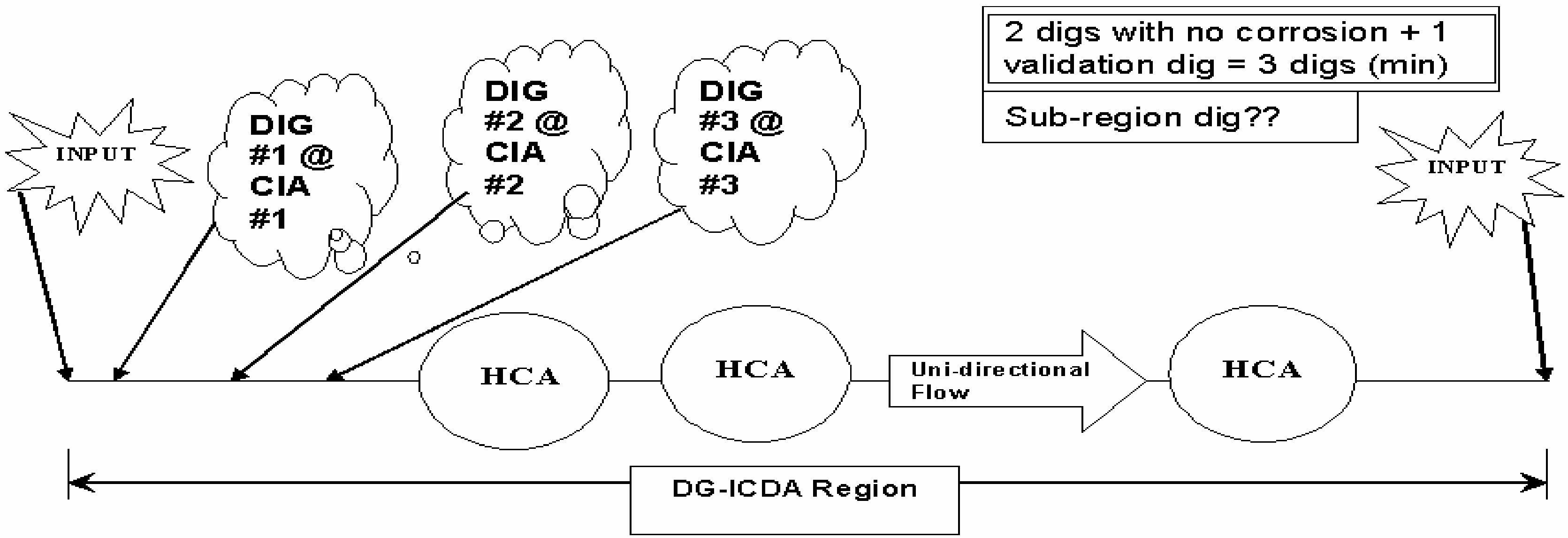
Resolving the Difference: The Rule and NACE Standard

When it comes to dig requirements – significant difference!
Rule focuses on Covered Segments; NACE on entire pipeline

Example - Based on OPS 192 Rule



Example - Based on NACE Standard



DG-ICDA Issue #1

Resolving the Difference: The Rule and NACE Standard

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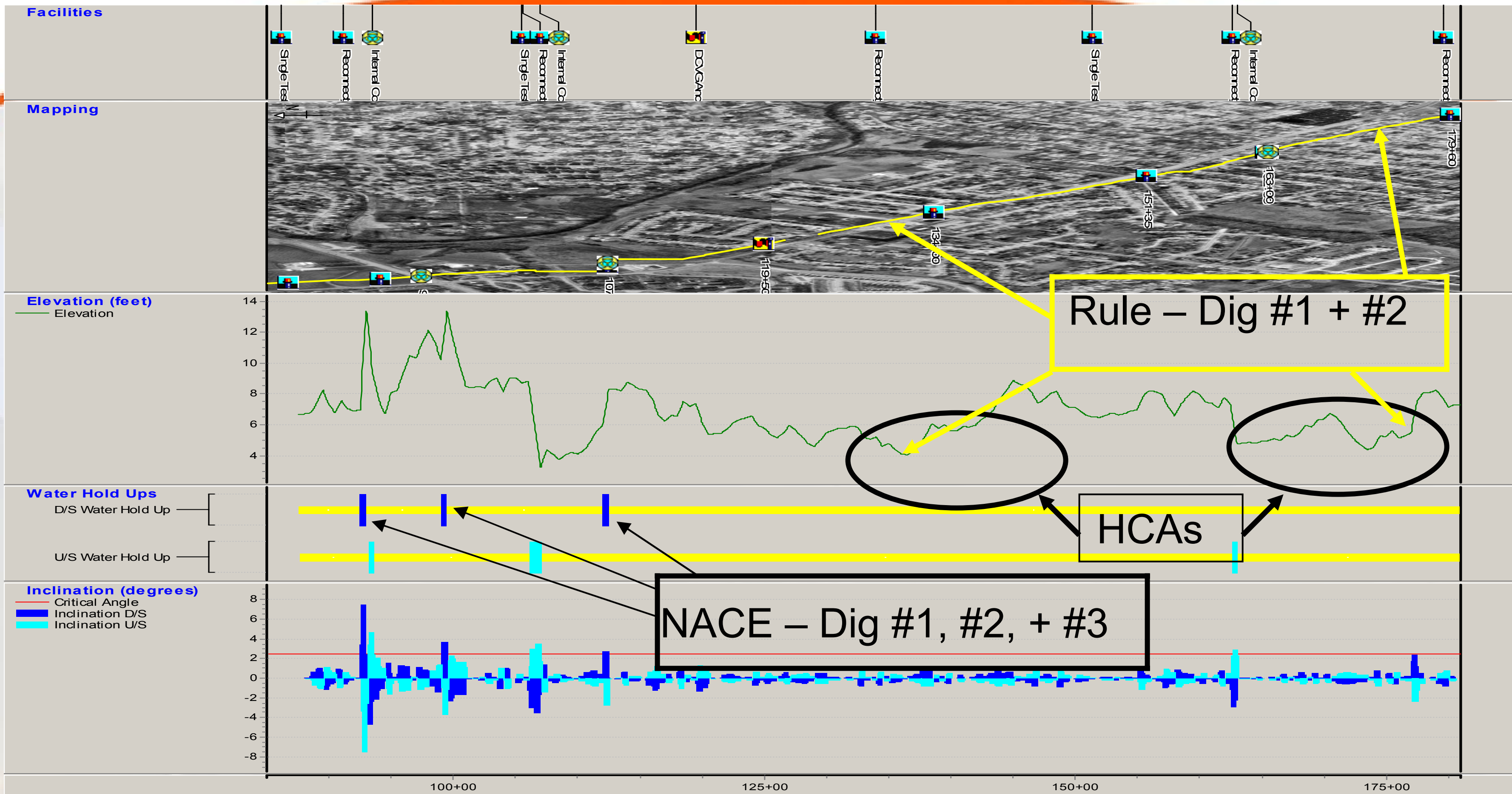

Research? – clearly define industry guidance (Rule, NACE, combination?)

DG-ICDA Issue # 2
Pre-assessment – Data Collection

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Pre-assessment:

- Collection of data
- Feasibility of DG-ICDA
- Region delineation

Data Element Tables (DETs)

- Pipe Information
- Construction
- Historical
- Gas Quality
- Operational

- Data collection is time consuming
- Perform feasibility Analysis FIRST
- Identify pipeline length requiring Detailed Data Collection

Research? – order matters and what data is really necessary?

DG-ICDA Issue # 3
Pre-assessment - System Analysis

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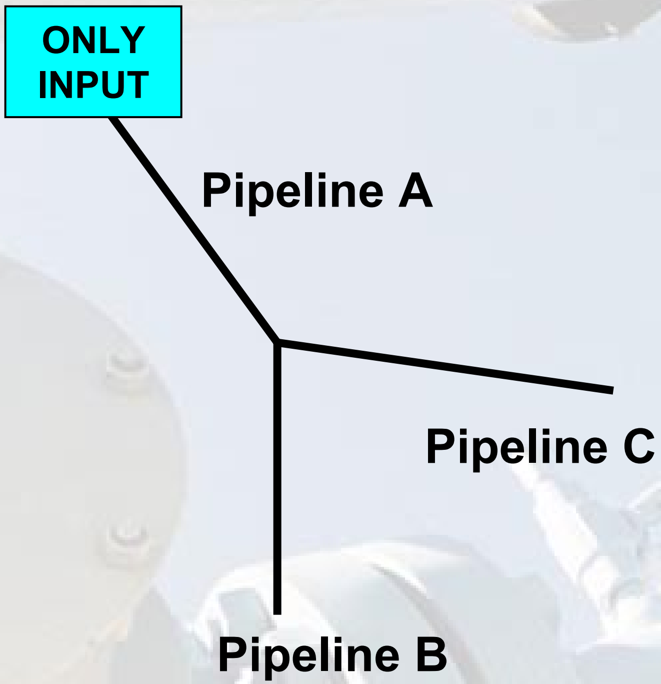

Assuming any water entering Pipeline A is held up at Critical Inclination Angle(s), and assessment by DG-ICDA/ILI indicates that no water/IC exists in Pipeline A, the <u>theory</u> of DG-ICDA indicates that water and/or internal corrosion is extremely unlikely downstream in Lines B or C – therefore, <u>is there a need to physically assess Line B and Line C?</u>

Review impact on Assessment Plan – possibly significant cost/resource savings

<u>Research?</u> – validate "System Analysis" process - document the System Analysis as a formal Pre-assessment step

Indirect Inspection - Flow Modeling

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1. Selection of gas flow data (low/high/average flow?)
2. Difficult to obtain flow data (especially accurate historical)
3. High flow rate value is not the norm – not representative
4. Low flow rate (i.e., zero?) will be captured by assessing first low point in line (sub-region as per NACE and in HCA as per Rule)
5. Use 'average' flow rates

$$\theta = \arcsin \frac{P_g}{P_l - P_g} \times \frac{V_g^2}{g \times d_{id}} \times F$$

P_g = liquid density;

P_l = gas density (determined by total pressure and temperature);

g = acceleration due to gravity;

d_{id} = internal diameter;

V_g^2 = superficial gas velocity, and;

F = critical Froude number
= 0.35 (0.07 standard deviation) at $\theta < 0.5°$
= 0.56 (0.02 standard deviation) at $\theta > 2°$

Research? – what flow data is optimum?

DG-ICDA Issue # 5
Indirect Inspection –
Pipeline Elevation Profile (PEP)

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1. Highly accurate PEP is critical
2. Use Pipeline Current Mapper (PCM) to determine Depth of Cover (DOC) with Global Positioning System (GPS) / Real Time Kenetics (RTK)
3. Optimize survey length based on locations of Critical Inclination Angles

Research? – optimize the PEP procedure

DG-ICDA Issue # 6
Detailed Examination – Wall Loss Measurement

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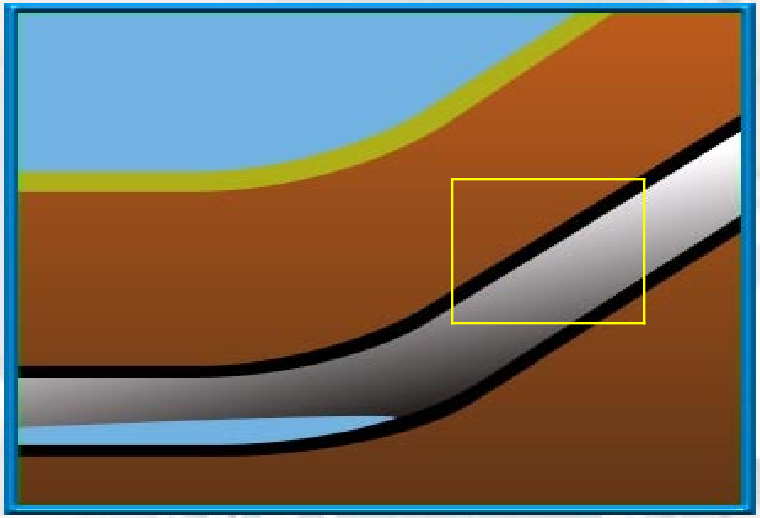

Research shows water may likely accumulate between inclination onset and 1/3rd up slope – angle in pipe may possibly affect signal strength – when using GUL, there is a dead zone – what method of wall loss thickness measurement is ideal (handheld UT grid? - over what length and circumference)?

<u>Research?</u> – develop a procedure to optimize detection of wall loss

DG-ICDA Issue # 7
Detailed Examination – If Corrosion is Found

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WHAT IF YOU FIND INTERNAL CORROSION?

- THE RULE – additional digs required in HCAs and along pipeline(s) with similar characteristics
- NACE – additional digs at D/S critical inclination angles as well as U/S at sub-region
- **Must acquire a good understanding of condition and integrity of pipeline!**
- If many additional digs uncover internal corrosion, is DG-ICDA applicable or suitable?........not based on the theory!

Research? – identify how many digs are necessary before DG-ICDA should no longer be used

DG-ICDA Issue # 8
Post Assessment – IC Monitoring

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- **Once DG-ICDA has been completed, internal corrosion monitoring devices should be installed.**
- **Where is the ideal location to install these devices (in HCAs, immediately downstream from input, low point, Critical Inclination Angle, other)?**
- **Once these devices have been installed to allow monitoring, can the threat of internal corrosion be considered to be stabilized if the coupons show no signs of internal corrosion?**
- **If the threat for internal corrosion remains stabilized, does this mean further future assessments for internal corrosion are necessary, or does continued monitoring become an "Other Technology" assessment method?**

Research? – identify optimum location for IC monitoring devices and identify guidelines for threat stabilization

DG-ICDA Issue # 9
Post Assessment – Effectiveness of DG-ICDA

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Once DG-ICDA has been completed, was it effective?

Research? – identify how to determine if DG-ICDA is considered effective

Questions?

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Thank You!

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