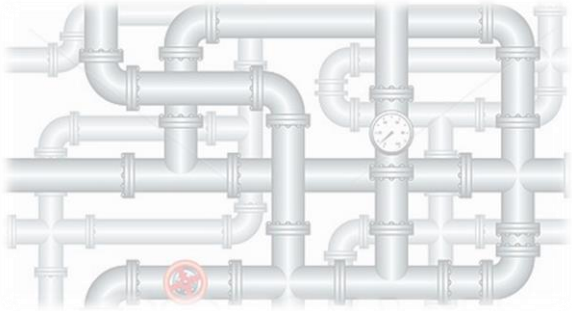


Customization of Integrity Assessment Techniques for CGD Steel Pipelines for the North-Eastern Region: Technologies and Best Practices

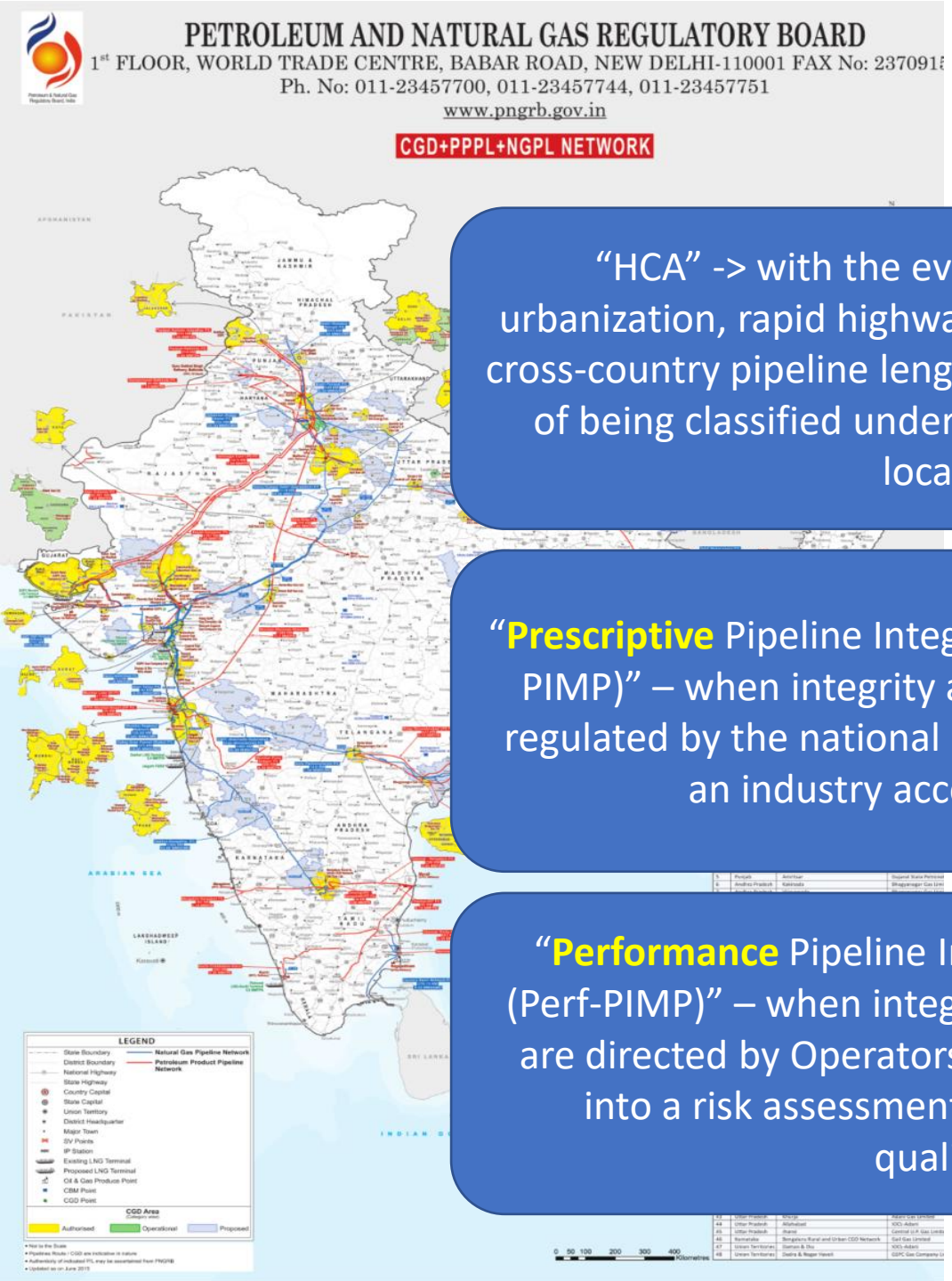
Arnab Saikia, Engineer (Pipeline)

Assam Gas Company Limited

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Global incidents in city gas pipeline scenario

Indian Pipeline Network Map as per PNGRB



"HCA" -> with the ever-growing population, urbanization, rapid highway construction – higher % of cross-country pipeline length are coming into the gamut of being classified under HCA or into the next class location….

"**Prescriptive** Pipeline Integrity Management Plan (Pres-PIMP)" – when integrity assessment of pipelines are regulated by the national legislative authorities within an industry accepted time-frame

"**Performance** Pipeline Integrity Management Plan (Perf-PIMP)" – when integrity assessment of pipelines are directed by Operators' self inspection results fed into a risk assessment tool (quantitative over qualitative)

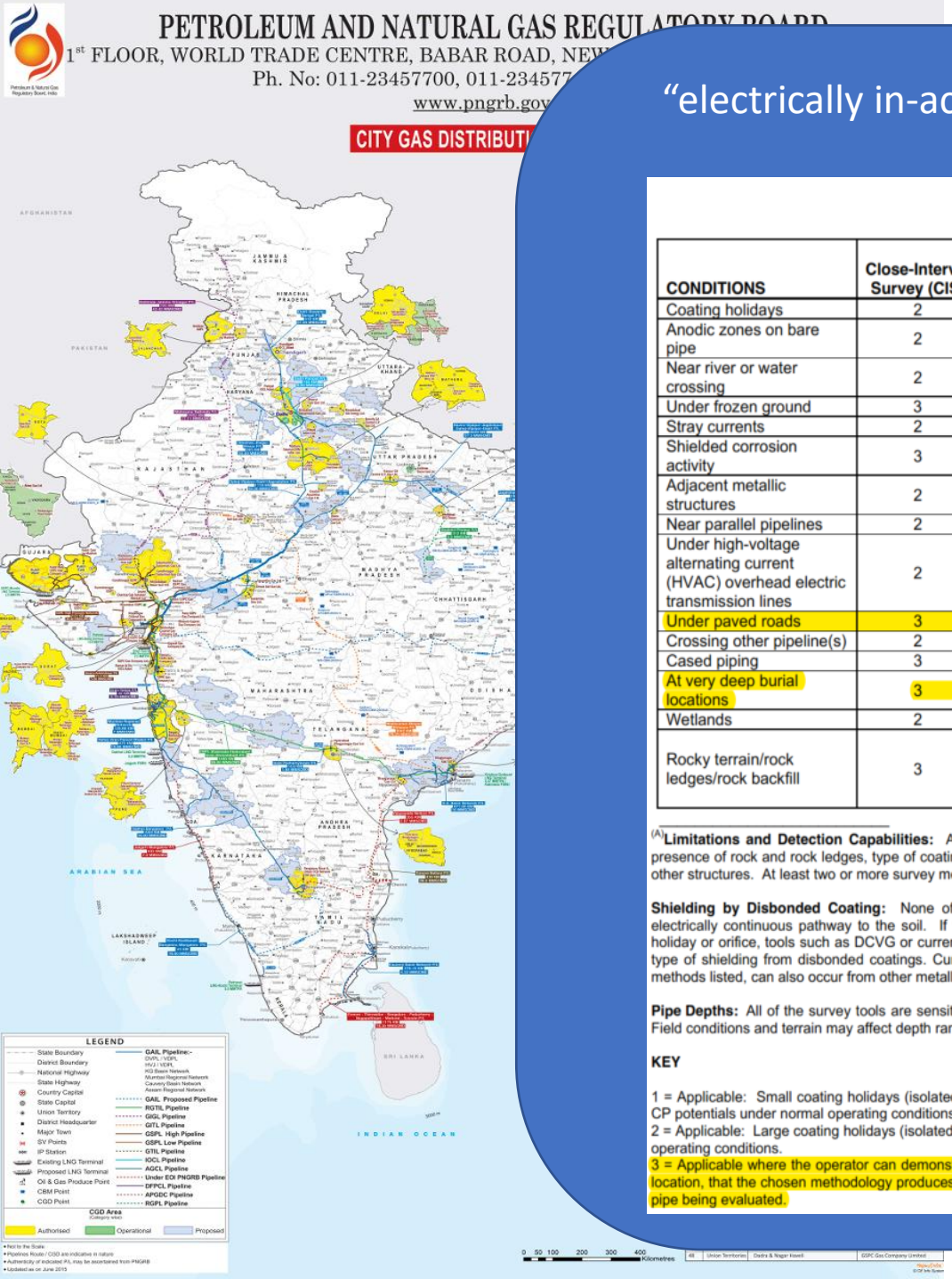
pipeline network >40,000 Km (natural ducts, etc.)

overnment organizations, private

length are designed to be piggable and at a regular interval (regulatorily

in/eng-web/data-bank.html#map-1

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING



"electrically in-accessible for indirect inspection surveys"

Table 2
ECDA Tool Selection Matrix [A]

CONDITIONS	Close-Interval Survey (CIS)	Voltage Gradient Surveys (ACVG and DCVG)	Pearson[8]	Current Attenuation Surveys
Coating holidays	2	1, 2	2	1, 2
Anodic zones on bare pipe	2	3	3	3
Near river or water crossing	2	2	2	2
Under frozen ground	3	3	3	1, 2
Stray currents	2	1, 2	2	1, 2
Shielded corrosion activity	3	3	3	3
Adjacent metallic structures	2	1, 2	3	1, 2
Near parallel pipelines	2	1, 2	3	1, 2
Under high-voltage alternating current (HVAC) overhead electric transmission lines	2	1, 2	2	2
Under paved roads	3	3	3	1, 2
Crossing other pipeline(s)	2	1, 2	2	1, 2
Cased piping	3	3	3	3
At very deep burial locations	3	3	3	3
Wetlands	2	1, 2	2	1, 2
Rocky terrain/rock ledges/rock backfill	3	3	3	2

[A] **Limitations and Detection Capabilities:** All survey methods are limited in sensitivity to the type and makeup of the soil, presence of rock and rock ledges, type of coating such as high dielectric tapes, construction practices, interference currents, and other structures. At least two or more survey methods may be needed to obtain desired results and confidence levels.

Shielding by Disbonded Coating: None of these survey tools is capable of detecting coating conditions that exhibit no electrically continuous pathway to the soil. If there is an electrically continuous pathway to the soil, such as through a small holiday or orifice, tools such as DCVG or current attenuation may detect these defect areas. This comment pertains to only one type of shielding from disbonded coatings. Current shielding, which may or may not be detectable with the indirect inspection methods listed, can also occur from other metallic structures and from geological conditions.

Pipe Depths: All of the survey tools are sensitive in the detection of coating holidays when pipe burials exceed normal depths. Field conditions and terrain may affect depth ranges and detection sensitivity.

KEY

1 = Applicable: Small coating holidays (isolated and typically < 600 mm^2 [1 in^2]) and conditions that do not cause fluctuations in CP potentials under normal operating conditions.
2 = Applicable: Large coating holidays (isolated or continuous) or conditions that cause fluctuations in CP potentials under normal operating conditions.
3 = Applicable where the operator can demonstrate, through sound engineering practice and thorough analysis of the inspection location, that the chosen methodology produces accurate comprehensive results and results in a valid integrity assessment of the pipe being evaluated.

ype of network that n HCA?

- s distribution pipeline networks
- ions, Private conglomerates, es (large, medium and small) OPEX parity by all parties to te budget for regular M&I
- tomers (sales points)
- through heavy population area
- re un-piggable, go under paved DD, non-accessible for indirect y and *'electrically')*

https://pngrb.gov.in/data-.pdf

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Not uncommon to have City Gas Pipelines Buried in such surroundings of HCA’s

We do not need rocket science to imagine the consequence of an event (ASME B31.8S) in such a scenario..

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

The M&I concern is only going to be larger and larger going forward….

2023

Gplus
GUWAHATI'S FOREMOST MEDIA NETWORK

65,000 Consumers To Get Piped Gas Connection From Feb 2024 In Guwahati

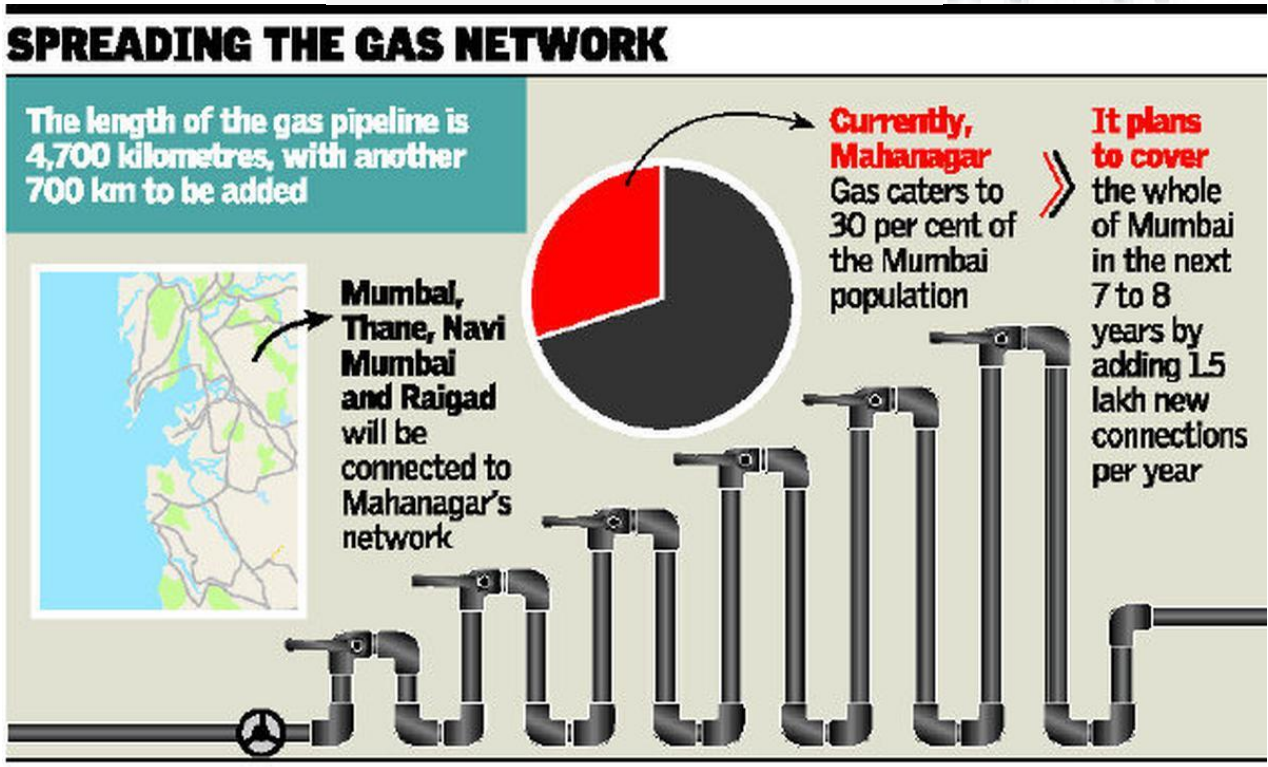
Rahul Chanda (Nov 10, 2023)

The PBGPL is also working in three cities of Barak Valley to supply piped natural gas.

Source: https://guwahatiplus.com/guwahati/65000-consumers-to-get-piped-gas-connection-from-feb-2024-in-guwahati

2016

THE HINDU



Source: https://www.thehindu.com/news/cities/mumbai/news/Mahanagar-Gas-aims-to-cover-entire-Mumbai-region-by-2022/article14422922.ece

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Available Code-Compliant Integrity Assessment Techniques?

Pipeline Anomalies Matrix

Best

		Axial Crack				Circumferential Crack		Metal Loss				Geometry	Mapping
		EVO UC	EVO UCx	EVO Eclipse UCx	PROTON	EVO UCc	EVO UCcx	EVO UMp	EVO UMp+	EVO UMx	ART Scan	EVO Geometry	EVO Mapping (IMU)
Operational	Liquid medium	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔
	Gas medium												
	Natural Gas Liquids (NGLs)	✔	✔	✔	✚	✔	✔					✔	✔
	Multi diameter												
	Dual diameter	✚	✚	✚	✚	✚	✚	✚	✚	✚		✚	✚
	Bidirectional							✚					
	Thick wall pipe > 12,7 mm (> 0.5 in)	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔
	Low flow / low pressure	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔
	CRA clad pipe	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Waxy lines inspection	✚	✚	✚	✚			✚	✚		✔	✚	✚
Cracks	Axial crack	■	◆	◆	◆								
	Circumferential crack												
	Cracks in dents	◆	◆	◆	◆								
	Girth weld crack					■							
	Tilted crack	●	▲	◆	◆								
	Skewed crack	■	▲	◆	◆								
	Hydrogen Induced Cracking (HIC)	■	▲	◆	◆								
	Lack of fusion	▲	◆	◆	◆	■	▲						
	Longitudinal weld crack	■	▲	◆	◆								
	Stress Corrosion Cracking (SCC)	▲	◆	◆	◆	▲	◆						
	Stacked cracks	■	▲	◆	◆	■	▲						
Corrosion and Metal Loss	General corrosion												
	External												
	Internal												
	Pinholes												
	Complex corrosion												
	Highly corroded												
	Narrow axially oriented												
	Circumferentially oriented												
	Wall thinning/erosion												
	Corrosion cluster												
	Girth weld anomaly												
	Gouging												
	Microbacterially Induced Corrosion (MIC)												
	Pilferage												
	Pitting							■	▲	◆			
	Lamination	●	●	●	●			◆	◆	◆		■	
	Seam weld anomaly							■	◆	◆			
	Spiral weld anomaly							■	▲	◆			
	Local wall thickness							◆	◆	◆			
Geometry	Bending												◆
	Buckle											◆	
	Dent							●	●	●	■	◆	
	Dent with metal loss							■ *	▲ *	◆ *	■	◆ ***	
	Pipe expansion							●	●	●	●	◆	
	Roof topping				●			●	●	●			
	Ovality							●	●	●	■	◆	
	Pipe movement												◆
	Wrinkle											◆	

✔ Yes ✚ Consult with NDT Global

Difficulties for carrying out ILI in CGD Pipelines:

1. Low operating pressure and velocity.
2. For launching of certain ILI tools, Liquid propelling medium is required.

Available Code-Compliant Integrity Assessment Techniques?

Hydrotesting of operational / running natural gas pipelines – will anyone do it?

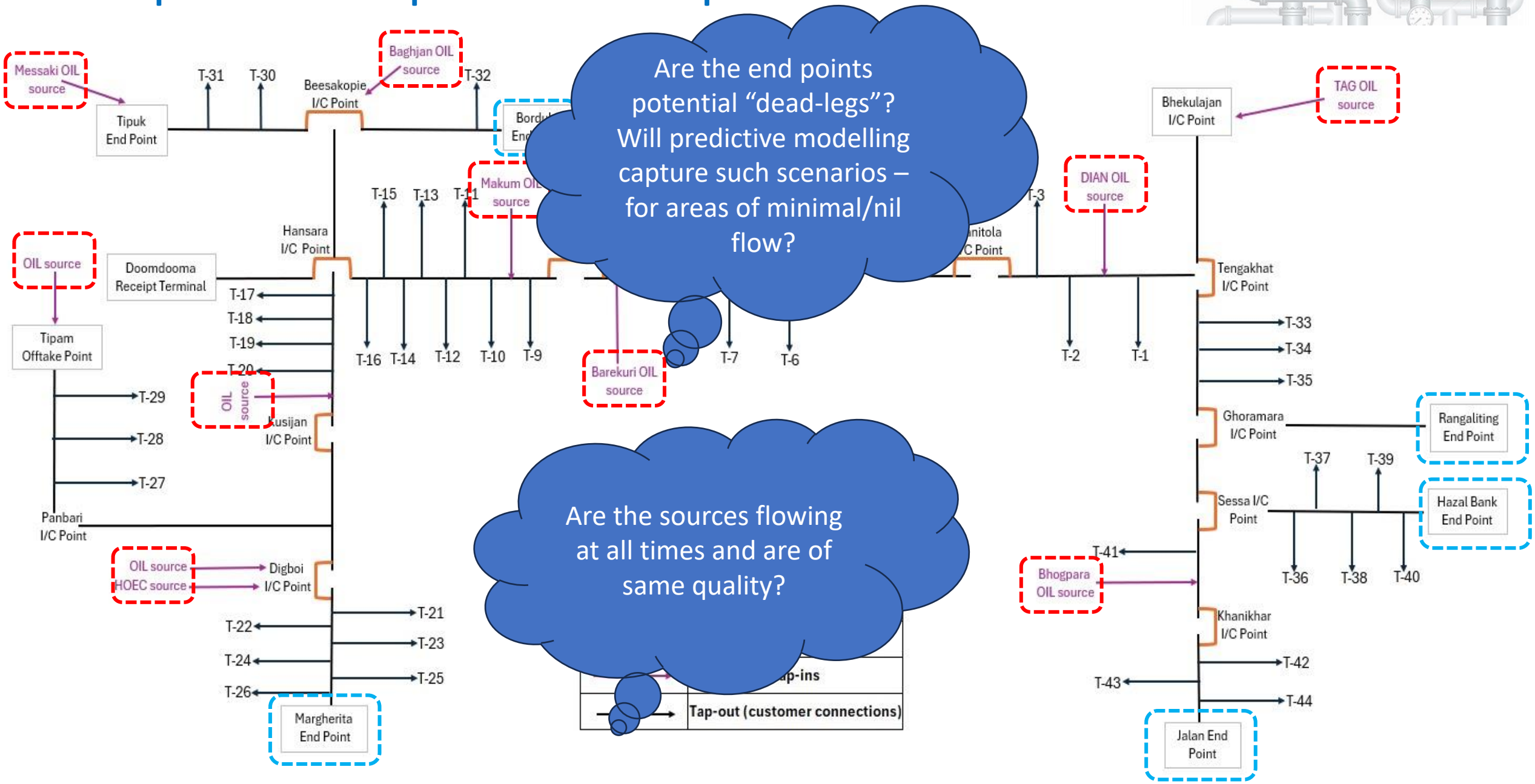
DIRECT ASSESSMENT (ECDA, ICDA and SCCDA)

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

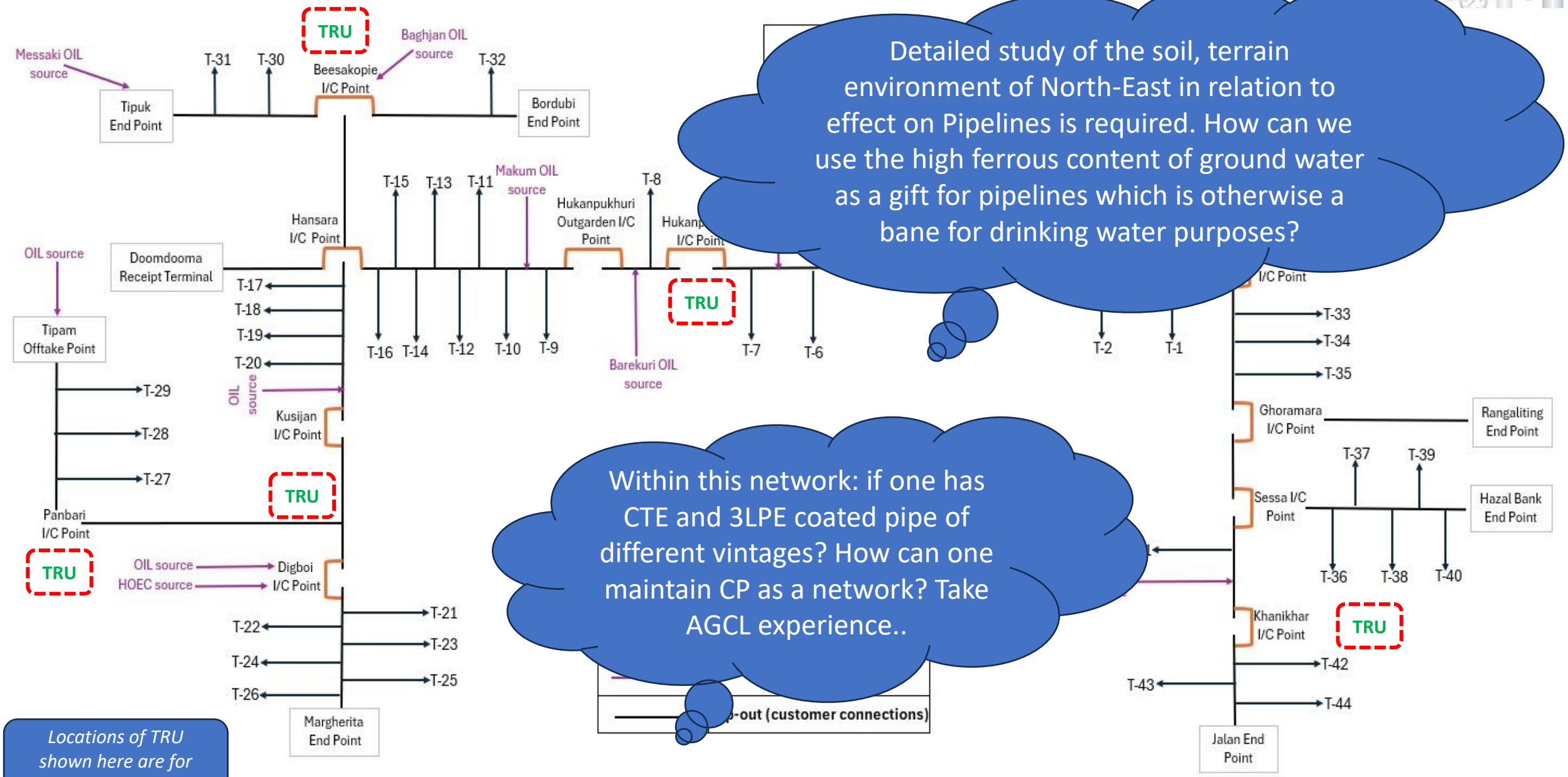
ASSAM GAS COMPANY LTD
A GOVERNMENT OF ASSAM UNDERTAKING

THINGS TO KEEP IN MIND, WHILE INITIATING A DIRECT ASSESSMENT (DA) PROJECT TO ENSURE THE BEST DELIVERABLES ARE RECEIVED BY THE PIPELINE OWNER

Example of Complex AGCL Pipeline Network – Internal Corrosion



Example of Complex AGCL Pipeline Network – External Corrosion

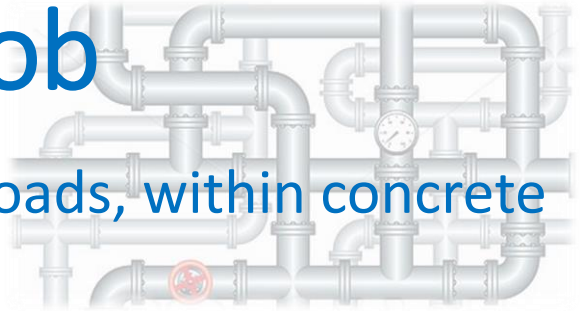


Detailed study of the soil, terrain environment of North-East in relation to effect on Pipelines is required. How can we use the high ferrous content of ground water as a gift for pipelines which is otherwise a bane for drinking water purposes?

Within this network: if one has CTE and 3LPE coated pipe of different vintages? How can one maintain CP as a network? Take AGCL experience..

Locations of TRU shown here are for illustration only

ECDA is not “just” a CP Survey Job



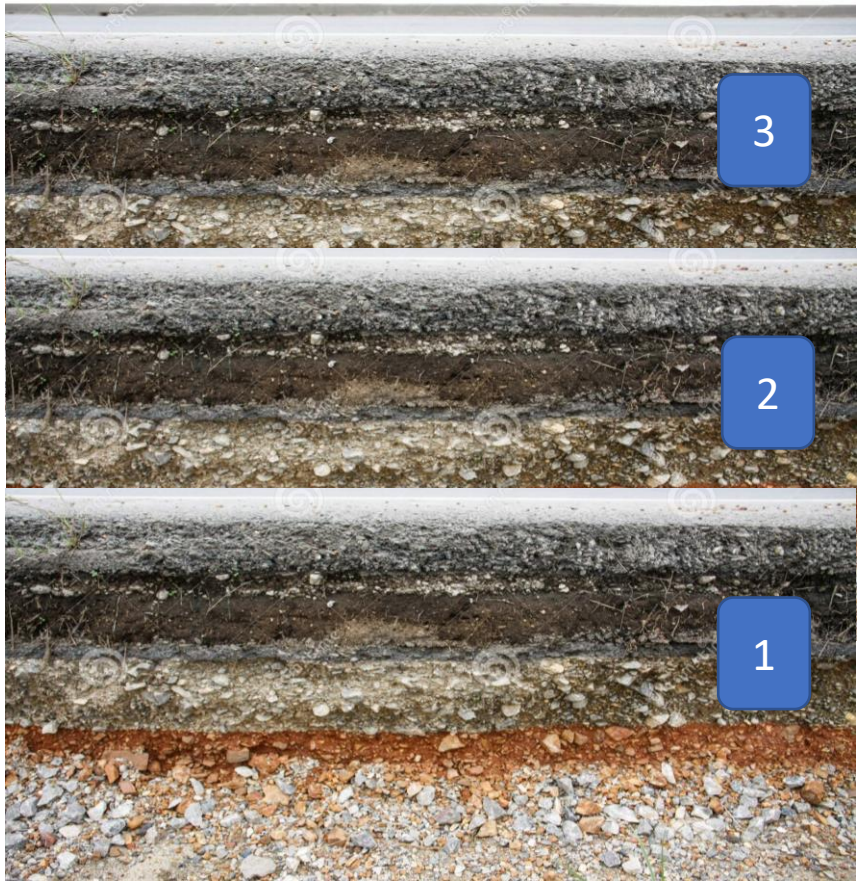
- Especially for city gas pipelines that are underneath concrete / paved roads, within concrete drains, underneath interlock blocks, etc.
- Operator (owner) understanding the fact that various types of indirect inspection technologies apply to various types of coating type (it is not a *‘one-size-fits-all’*).
- Simultaneously, understanding the fact that various types of indirect inspection technologies apply to various types of soil/surface type (it is again not a *‘one-size-fits-all’*).
- Addition of other newer indirect inspection – traditional and non-traditional techniques to increase data resolution [ex: soil terrain & environmental modeling, continuous inductive soil resistivity, soil pH, soil Oxidation Reduction Potential (ORP), soil chlorides, etc.]
- Software for spatial alignment of all data collected & collated.
- Analysts that understand that under a working CP system -> a large %IR DCVG does not necessarily mean it is of a higher integrity concern!

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Indirect Inspection Survey (should be applicable for paved road/surface)

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Other Challenges in City Area – Applicability of Correct Survey Technologies?



Single Layer Construction Method

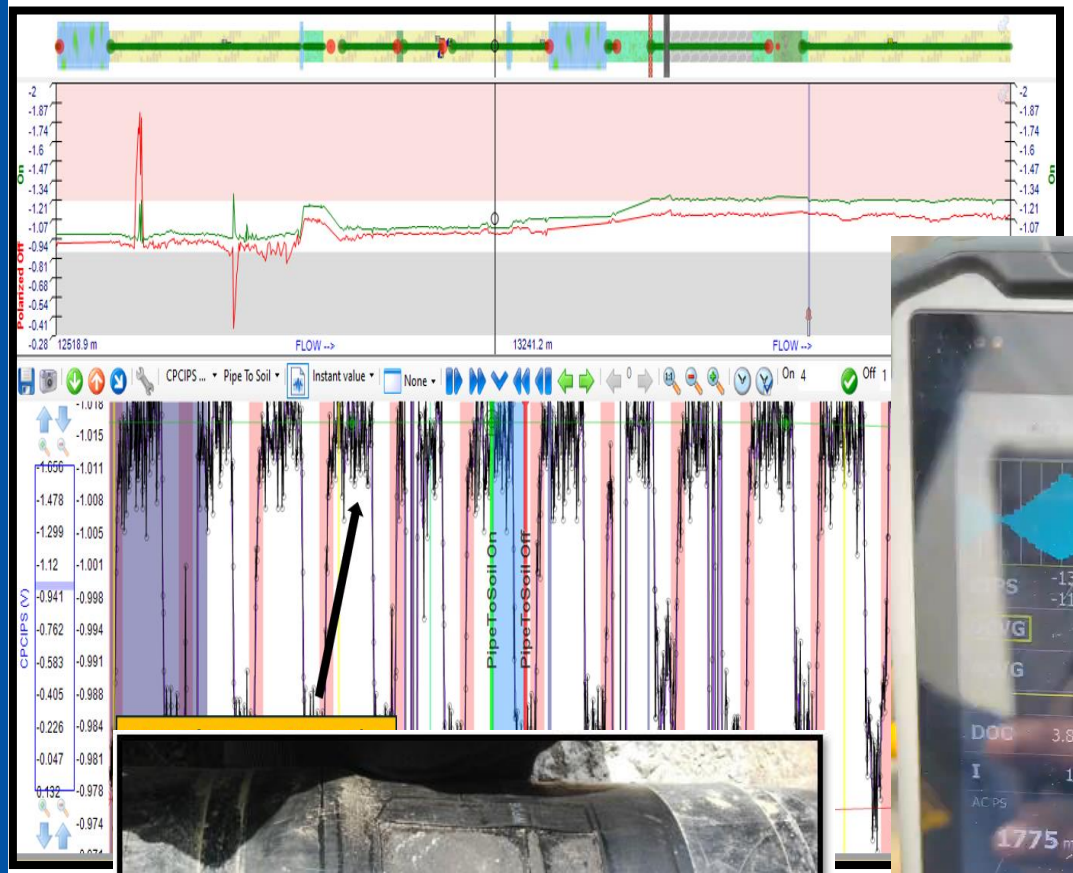
City Roads!

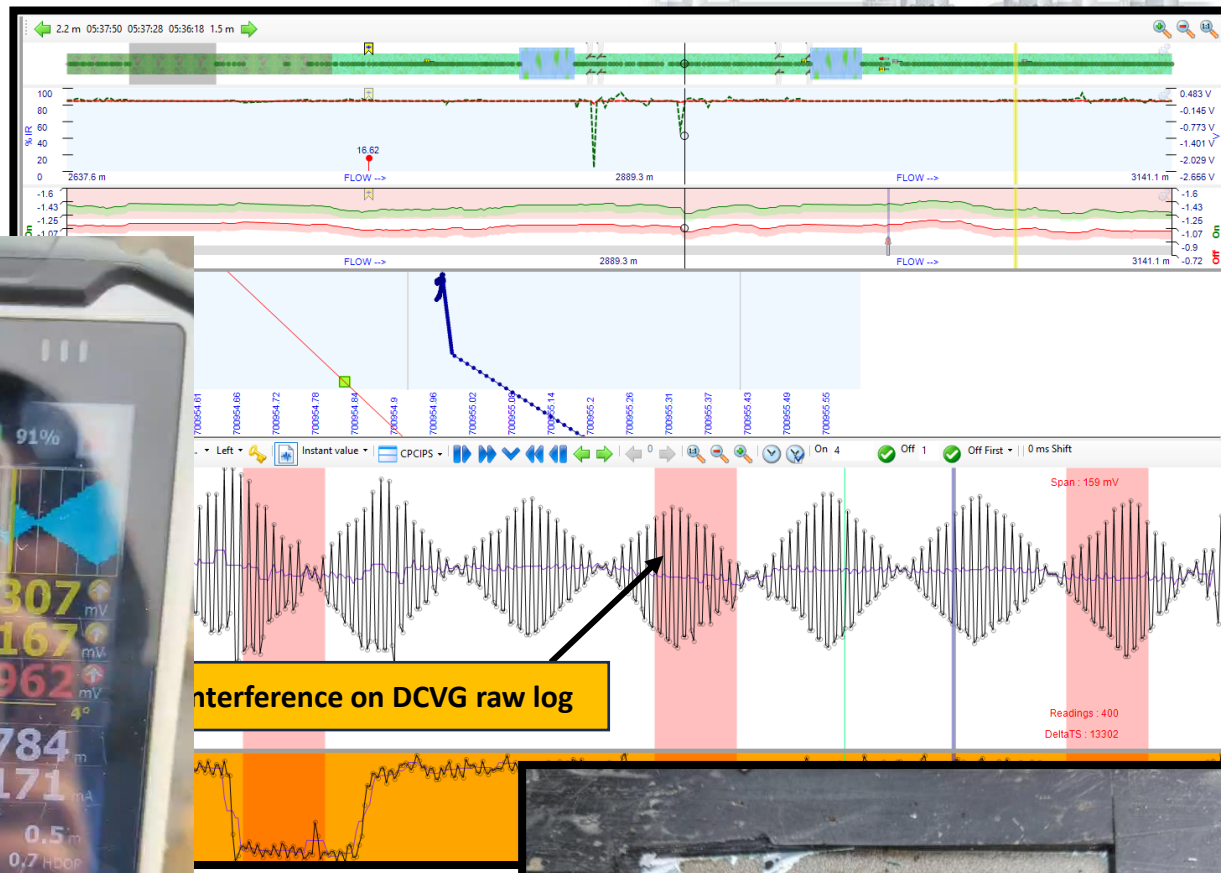
Maybe more layers…?

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

ALLIED ENGINEERS - PIPELINE INTEGRITY

Sample AC Interference seen in the field and verified by raw logs during Indirect Inspection (IDi) Surveys





nterference on DCVG raw log

ASSAM GAS COMPANY
A GOVT. OF ASSAM UNDERTAKING

Challenges of Internal Corrosion inspection in Gas Pipelines

Need for selecting the correct Internal Corrosion Predictive Modelling (ICPM) that has the ability to provide locations of liquid hold-up, solids hold-up and predict corrosion rates…

Understanding of possible internal corrosion pit morphologies during internal corrosion scanning…

1 mm probe placement error from the affected area would mean the inspector calling this pipe free of corrosion!

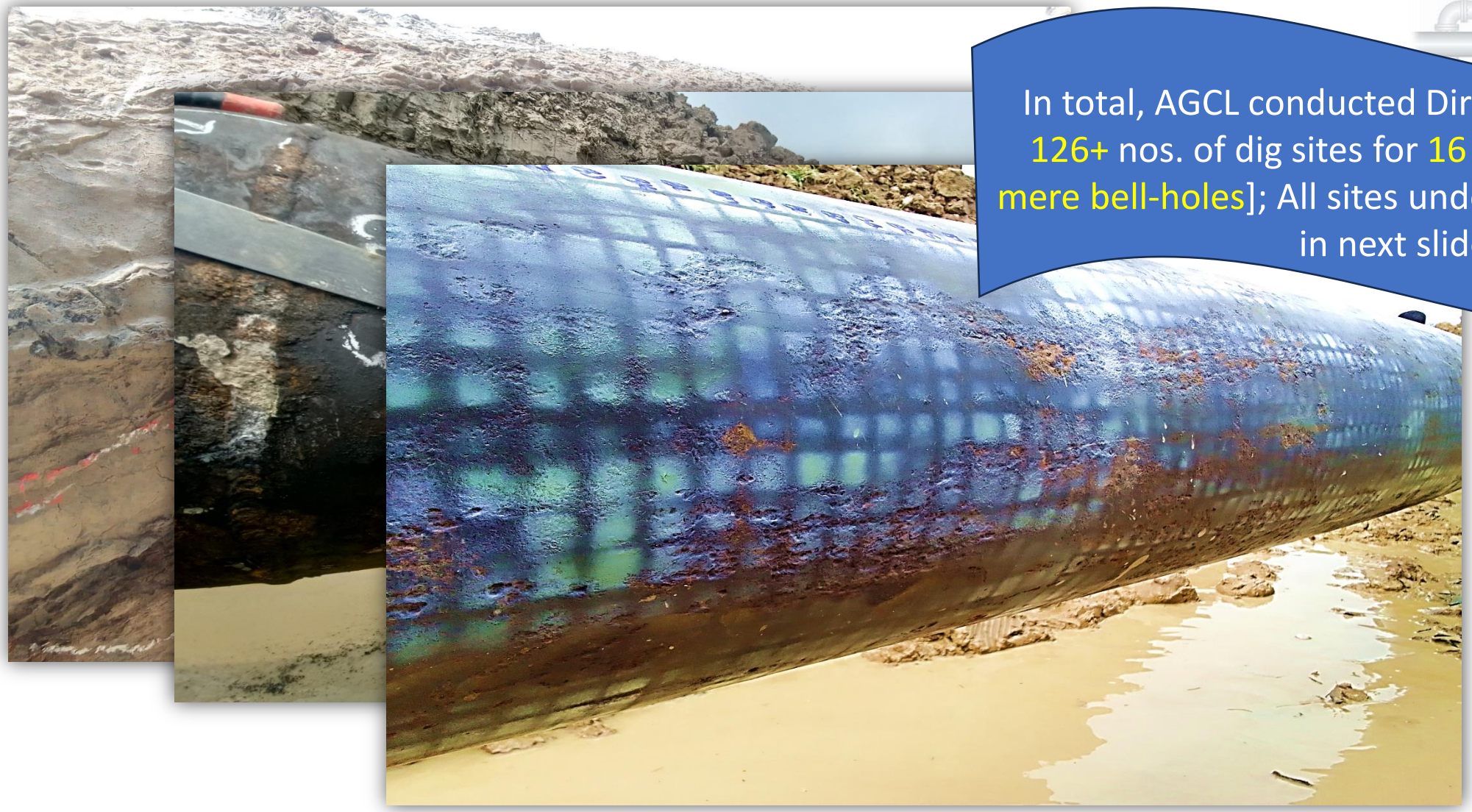
ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Challenges in Dig Verification, Subsequently Repair…

Night excavation, followed by dewatering, inspection, repair, rehabilitation and site back-fill

Excavation adjacent to roads, permissions, HSE concerns..

Detailed Examinations in Dig Sites during the DA process



In total, AGCL conducted Direct Examinations on 126+ nos. of dig sites for 16 CGD pipelines! [not mere bell-holes]; All sites underwent NDE as shown in next slide…

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Types of NDE Conducted

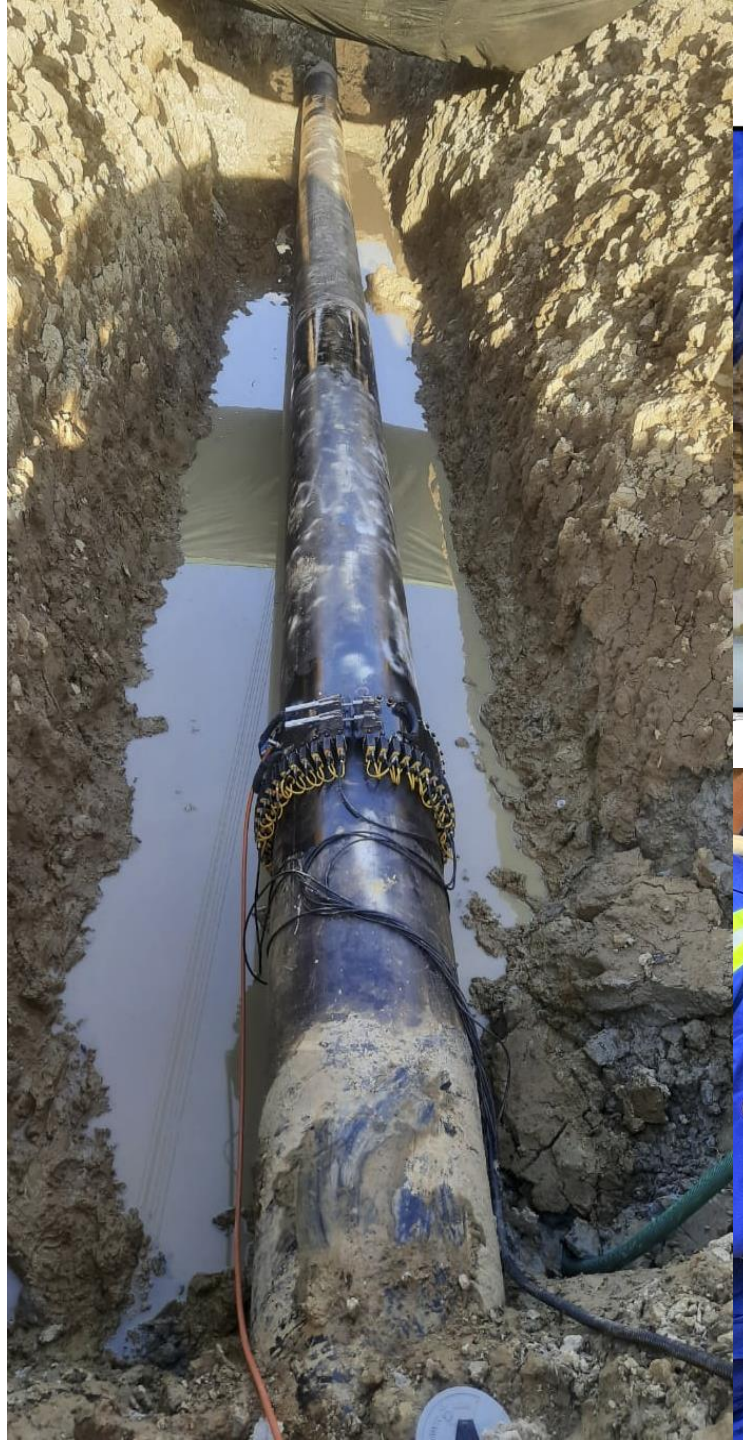


Figure 22: Magnetic Particle Inspection (MPI) for Stress Corrosion Cracking (SCC) for Pipe Body, ERW Seam as well as Girth Welds

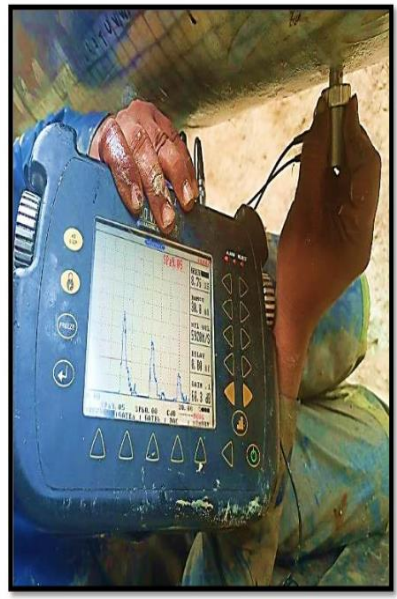
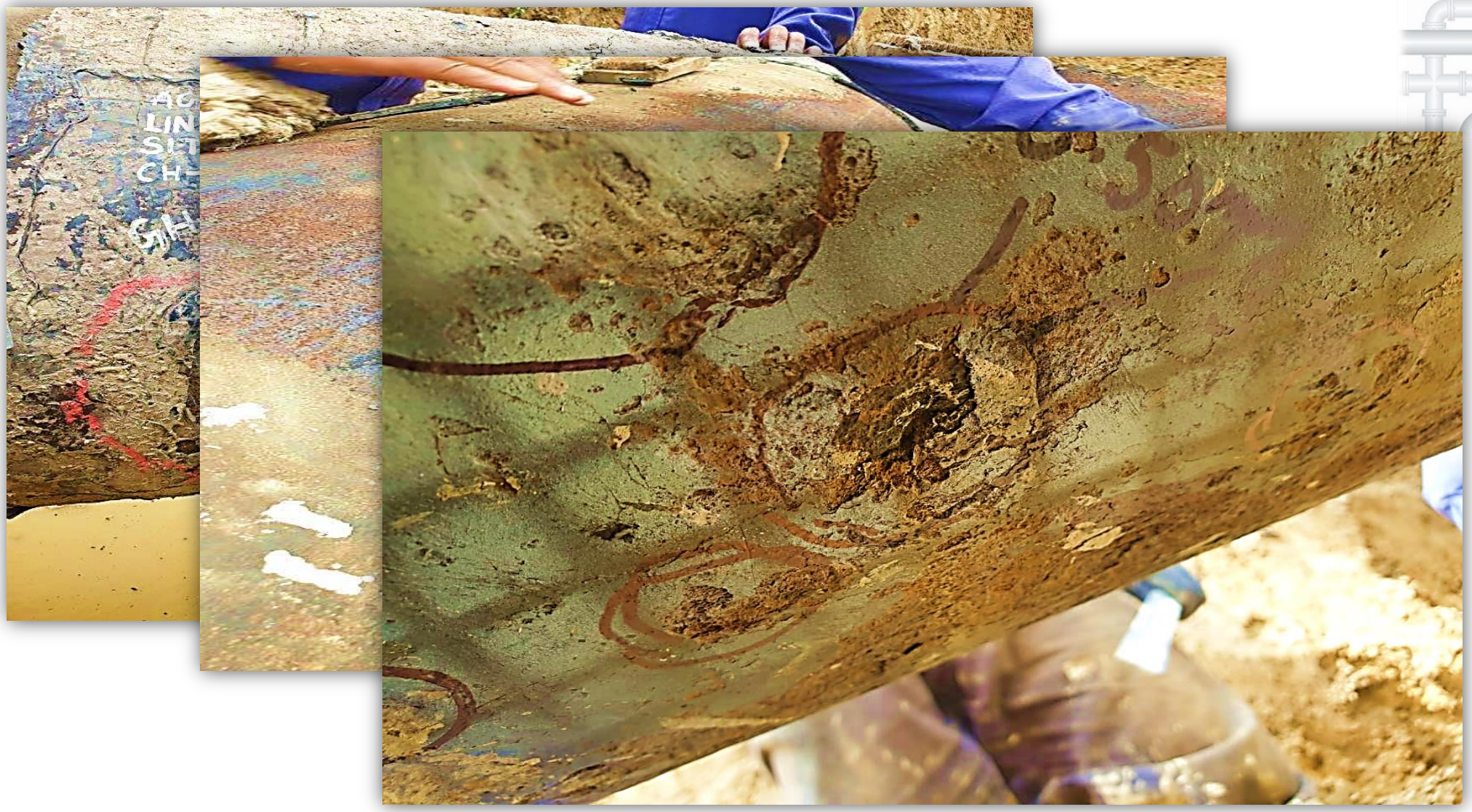


Figure 21: Ultrasonic Flaw Detector (UFD) based Internal Corrosion Mapping (ICM) [Site-1]

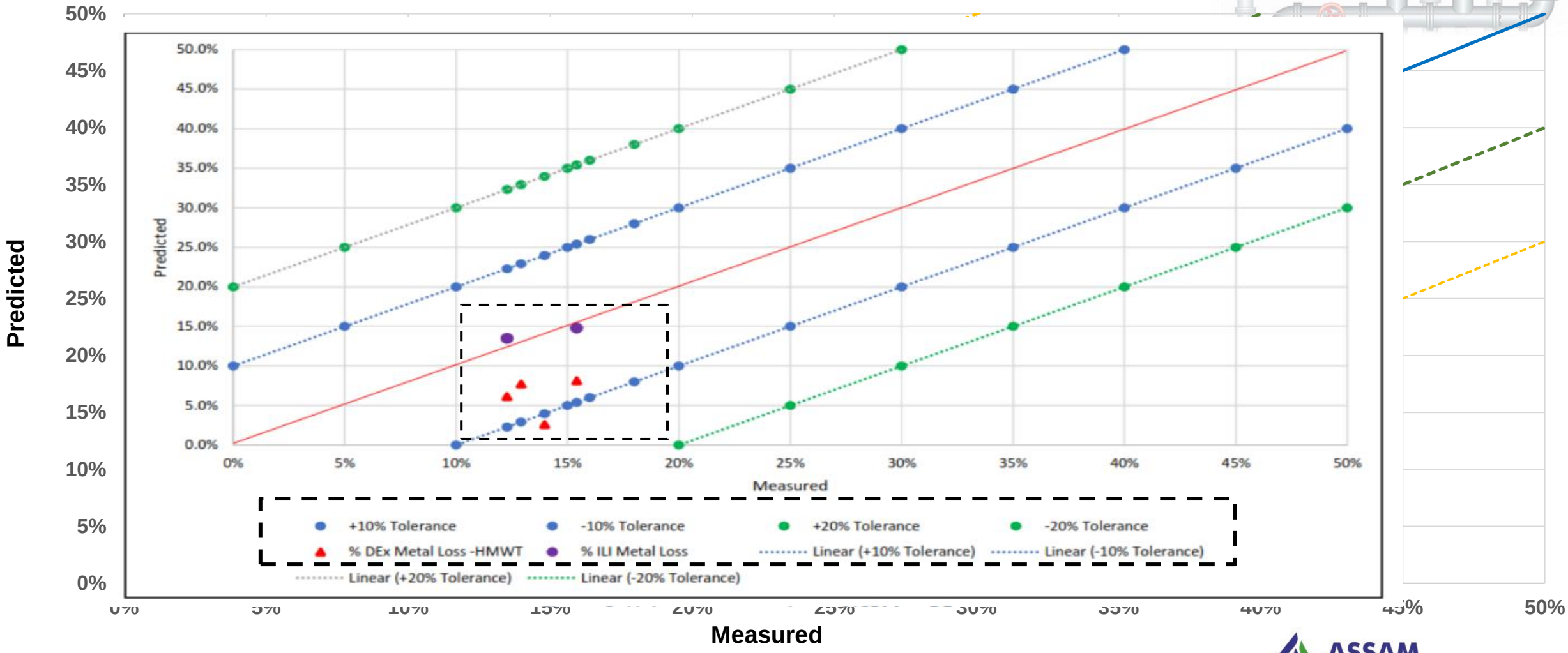
Sample of Defects observed during the DA process



ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Defects Identification & Rectification during the DA process

Unity Plot for ICPM Validation – Palacios Model Validation for AGCL Pipelines



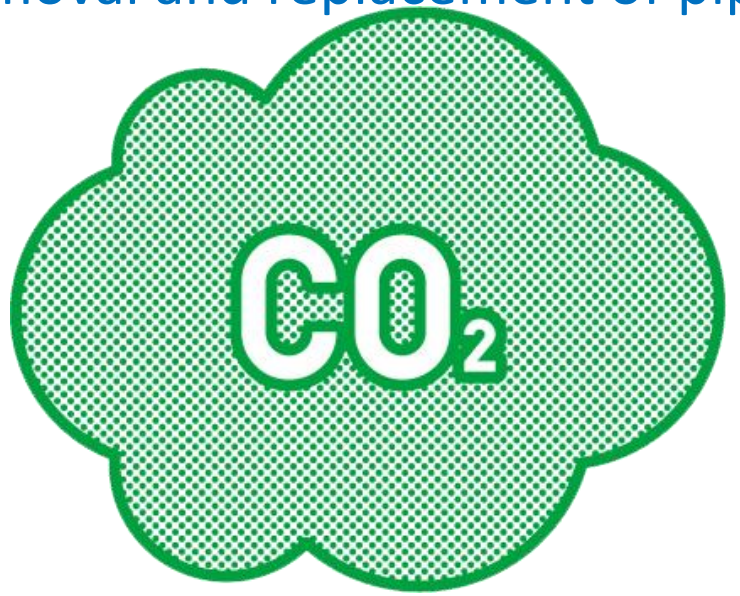
ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Permanent Repair Options an operator has for attaining maximum confidence on pipeline integrity:

Option-1: Removal and replacement of pipe

Cons:

- Throughput loss
- Highly skilled personnel required
- Pre-inspection for tie in points
- Hot work
- Fillet welds resulting in hydrogen cracking
- Annular corrosion exposure
- Masking of future intelligent pig inspection
- Venting of natural gas (evacuation)
- Nitrogen purging
- Gas testing
- Air blowing
- Pipe welding,
- RT, NDT
- Crane / hydra for lifting works
- Numerous HSE checks – pre-job, during job and post job

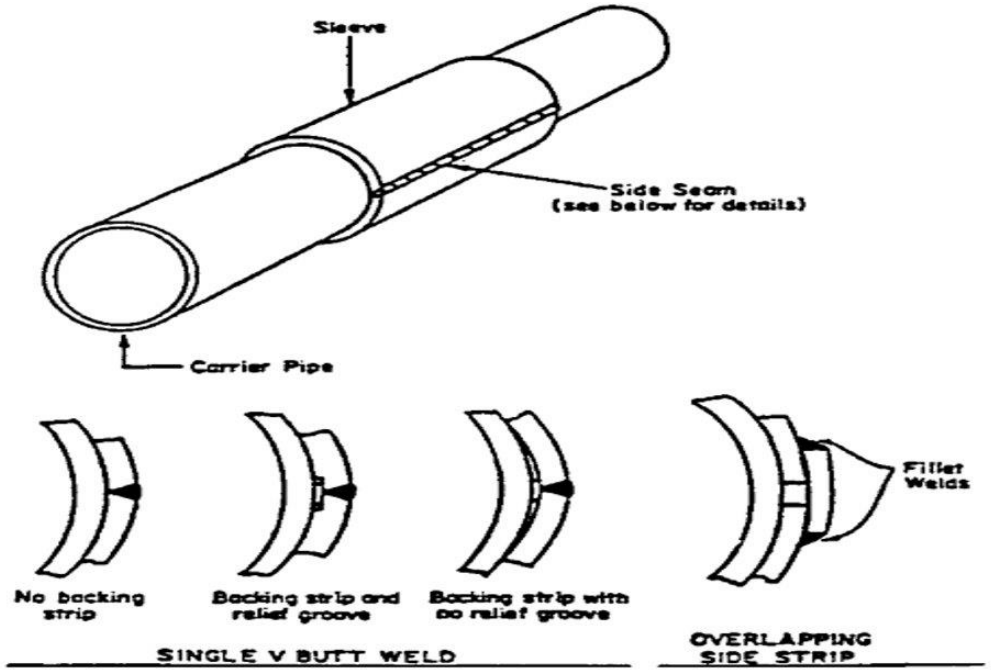


Good luck bringing a heavy lifter crane to remote places!

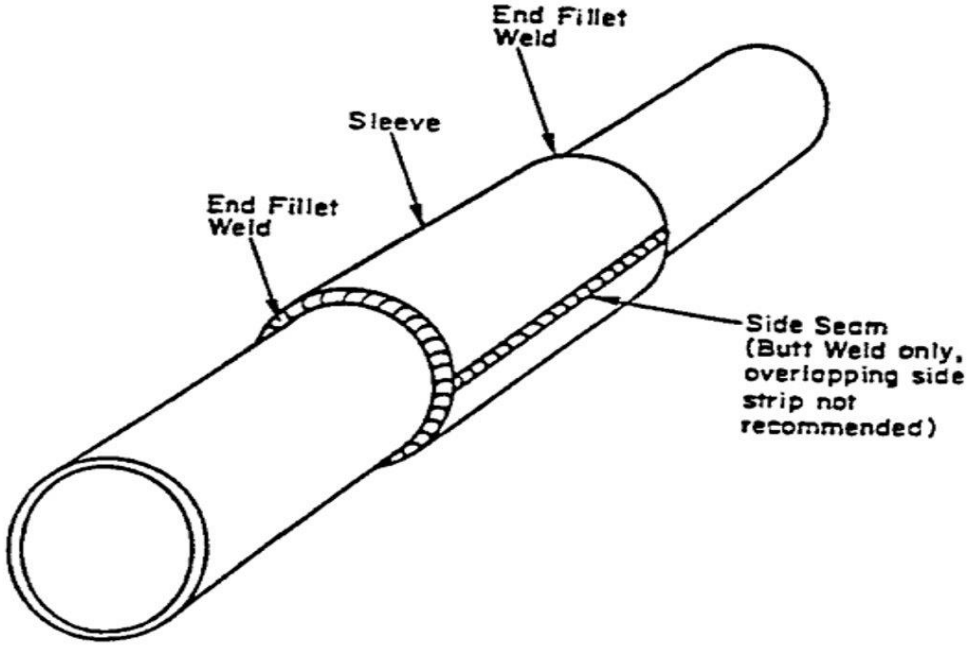
ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

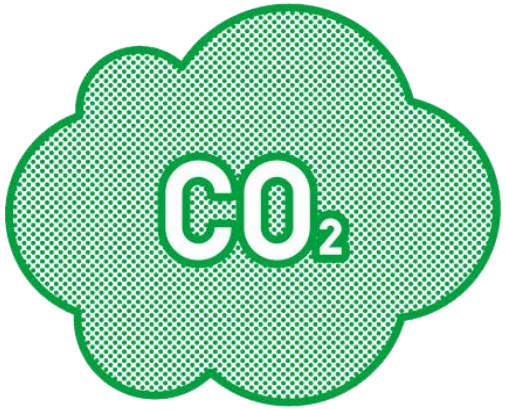
Permanent Repair Options an operator has for attaining maximum confidence on pipeline integrity: Option-2

Type-A steel sleeves (hot)



Type-B steel sleeves (hot)





ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Permanent Repair Options an opera
maximum confidence on pipeline

Table 7.1-1 Acceptable Threat Prevention and Repair Methods (Cont'd)

Prevention, Detection, and Repair Methods	Third-Party Damage			Corrosion Related		Equipment				Incorrect Operation	Weather Related				Manufacture		Construction				O-Force	Environment
	TPD(IF)	PDP	Vand	Ext	Int	Gask/ Oring	Strip/ BP	Cont/ Rel	Seal/ Pack	IO	CW	L	HR/F		Pipe Seam	Pipe	Fab Gweld	Weld	Coup	WB/B	EM	SCC
Repairs (Cont'd)																						
Type B, pressurized sleeve	...	X	X	X	X	...	...	...	...	...	...	...	...		X	X	X	X	X	...	...	X
Type A, reinforcing sleeve	...	X	X	X	...	...	...	...	...	...	...	...	...		X	X	X	A/D	...	...	...	X
Composite sleeve	...	D	D	X	...	...	...	...	...	...	...	...	...		X	X	X	A	...	...	...	...
Epoxy filled sleeve	...	X	X	X	...	...	...	...	...	...	...	...	...		X	X	X	A	X	X	C	...
Annular filled saddle	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...	...	B	...	...	...	...
Mechanical leak clamp	...	...	...	X	...	...	...	...	...	...	...	...	...		...	...	...	A	...	...	...	...

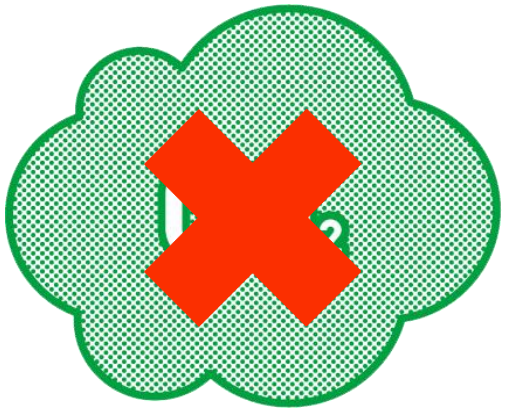
Key
X = acceptable
... = unacceptable
A = these may be used to repair straight pipe but may not be used to repair branch and T joints.
B = these may be used to repair branch and T joints but may not be used to repair straight pipe.
C = the materials, weld procedures, and pass sequences need to be properly designed and correctly applied to ensure cracking is avoided. Particular care must be exercised to ensure the safety of workers when welding on pressurized lines. Guidance can be found in publications by W. A. Bruce, et al., IPC2002-27131, IPC2006-10299, and IPC2008-64353.
D = this repair is not intended to restore axial pipe strength. It can only be used for damaged pipe where all the stress risers have been ground out and the missing wall is filled with uncompressible filler. Transitions at girth welds and fittings and to heavy wall pipe require additional care to ensure the hoop carrying capacity is effectively restored.

GENERAL NOTE: The abbreviations found in Table 7.1-1 relate to the 21 threats discussed in section 5. Explanations of the abbreviations are as follows:

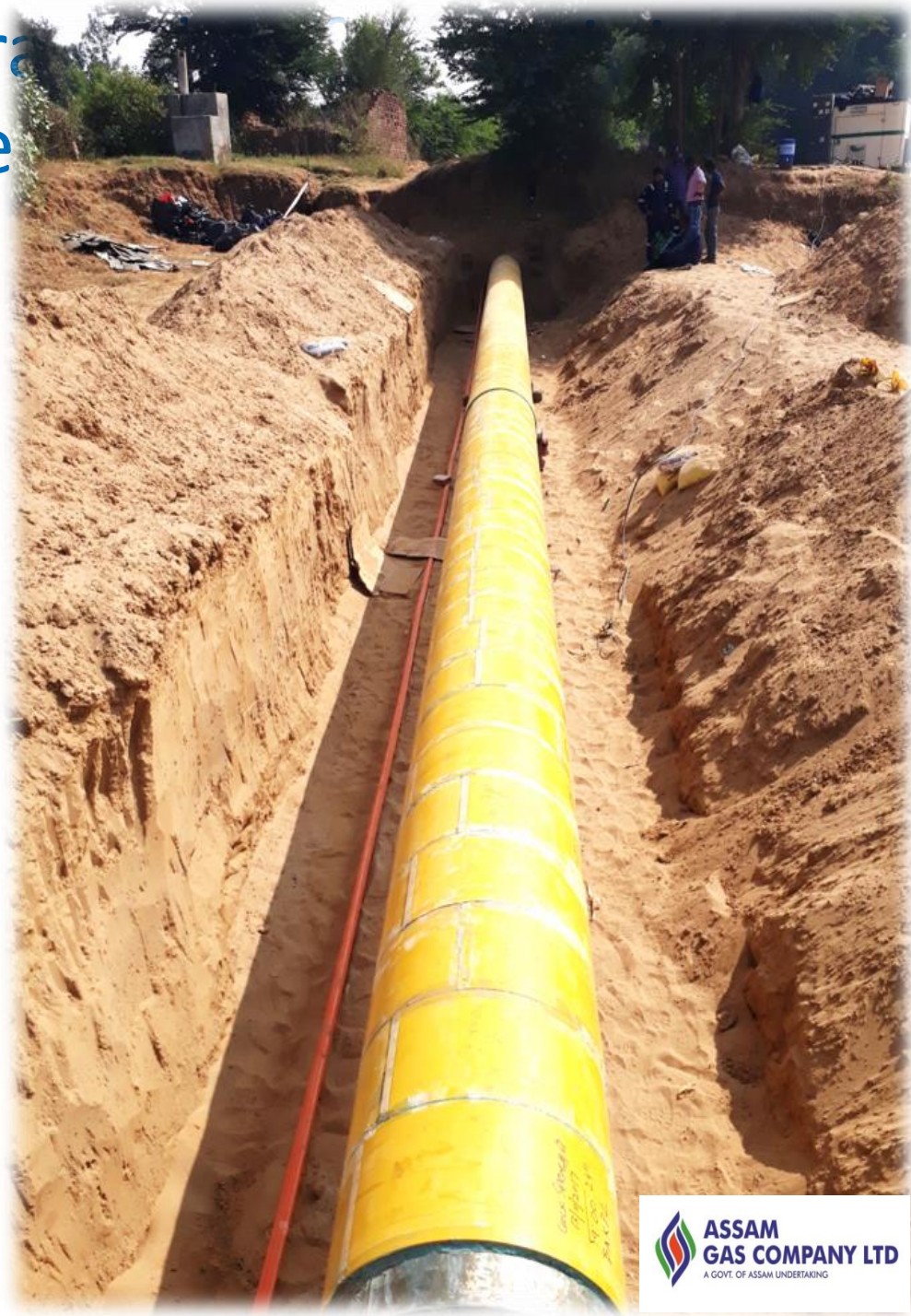
Cont/Rel = control/relief equipment malfunction
Coup = coupling failure
CW = cold weather
Direct deposition weld = a very specialized repair technique that requires detailed materials information and procedure validation to avoid possible cracking on live lines
ECA = engineering critical assessment
EM = earth movement
Ext = external corrosion
Fab Weld = defective fabrication weld, including branch and T joints
Gask/Oring = gasket or O-ring
Gweld = defective pipe girth weld (circumferential)
HR/F = heavy rains or floods
Int = internal corrosion
IO = incorrect operations
L = lightning
PDP = previously damaged pipe (delayed failure mode such as dents and/or gouges); see ASME B31.8, para. 851.4.2 and Nonmandatory Appendix R, para. R-2
Pipe = defective pipe
Pipe Seam = defective pipe seam
SCC = stress corrosion cracking
Seal/Pack = seal/pump packing failure
Strip/BP = stripped thread/broken pipe
TPD(IF) = damage inflicted by first, second, or third parties (instantaneous/immediate failure)
Vand = vandalism
WB/B = wrinkle bend or buckle

APPROVED APPROVED APPROVED

ASME SETTING THE STANDARD

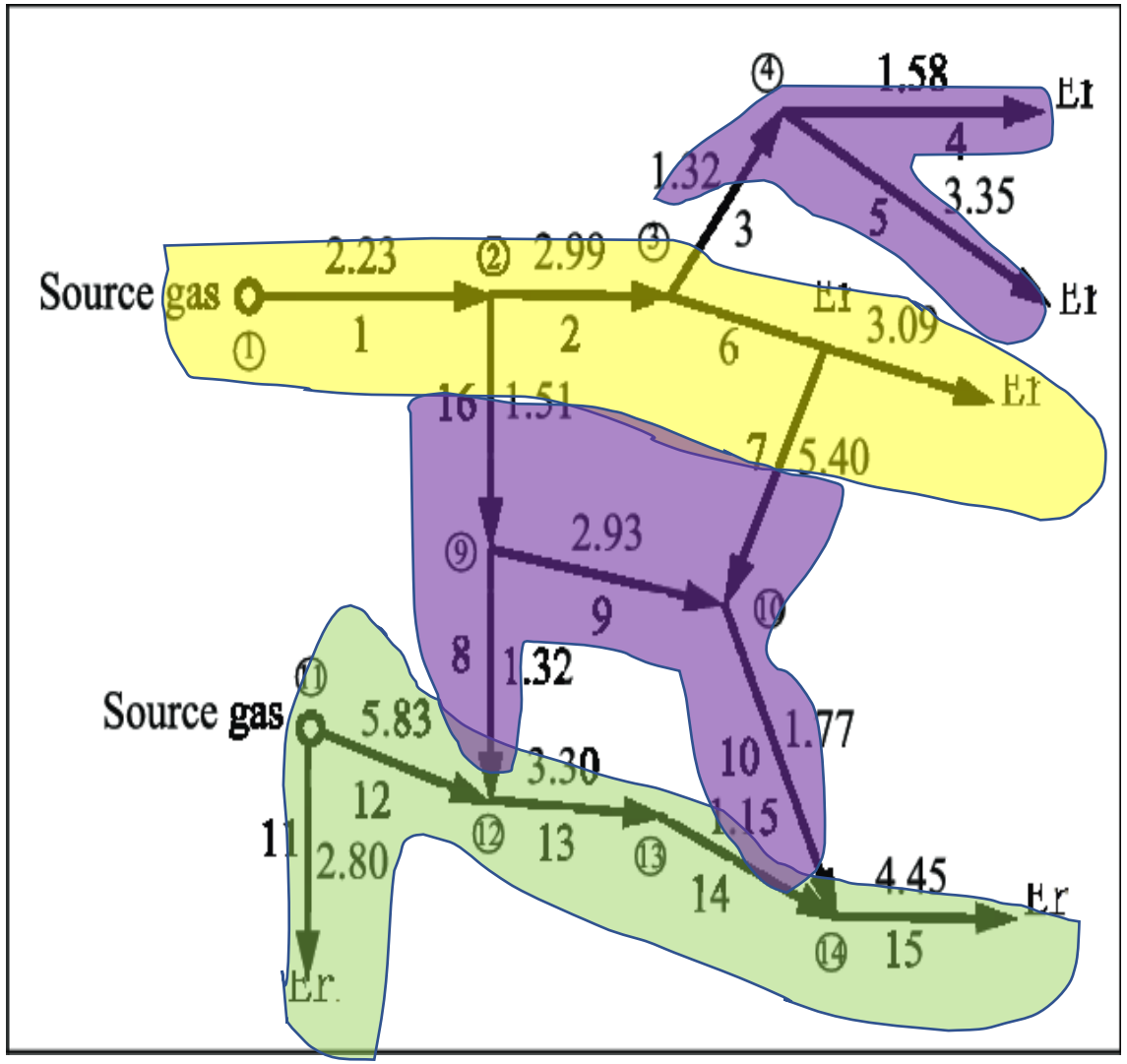


Assam Gas Company Limited selected a minimum CO2 emitting product and fully in-line with ASME B31.8S as well as ASME B31.4 Codes.



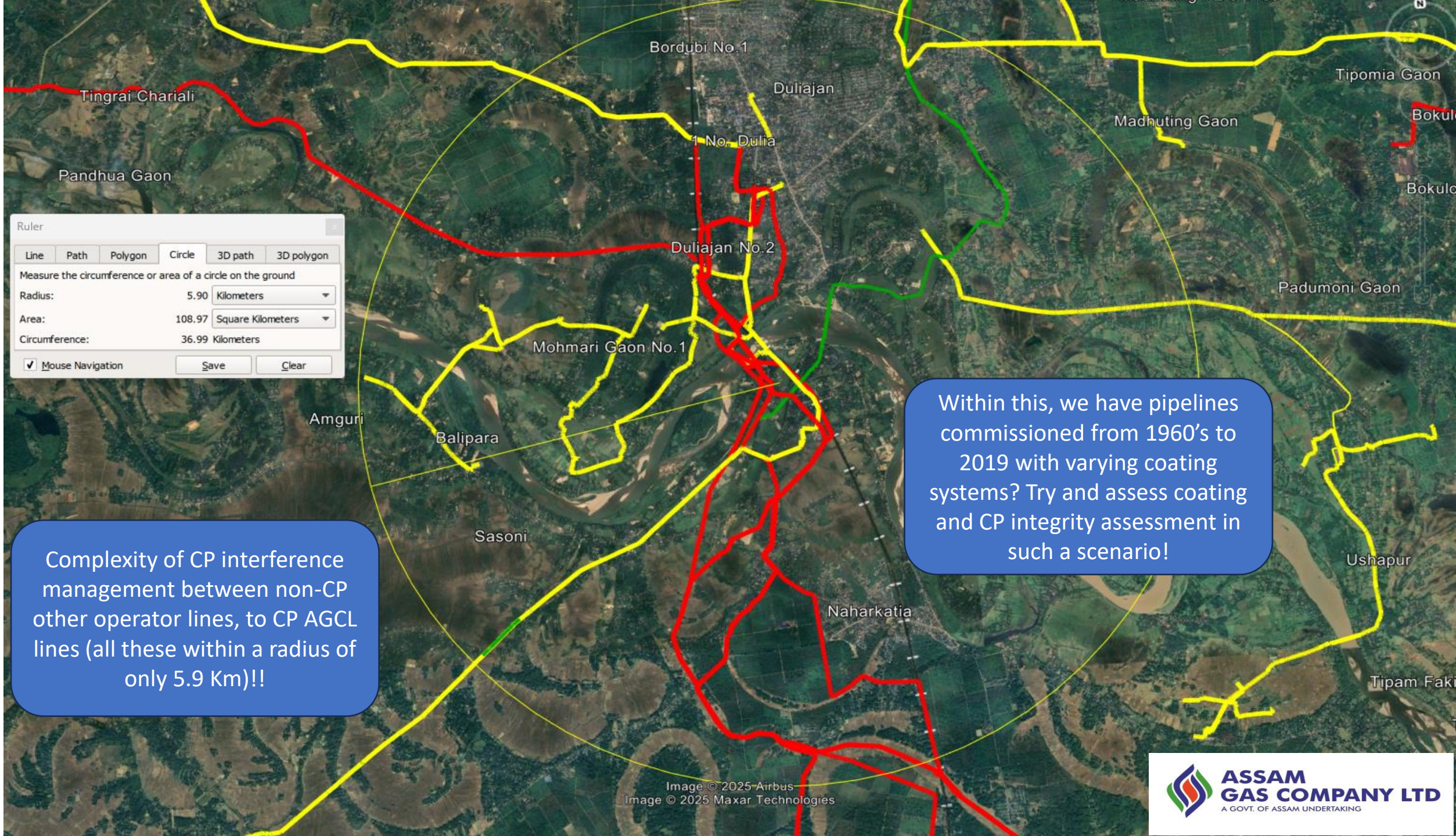
ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Assessing a city gas pipeline network based on eras from commissioning for the purpose of representative ICDA Simulations



- Commissioning of this was in 1986
- Commissioning of this was in 1996
- Commissioning of this was in 2024
- Today it is consolidated network working under one (1) operating pressure. Health assessment of the entire system -> how does one go about assessing integrity threats?
- **Solution:** Carefully crafted technical specifications for DA work, experienced Turnkey DA Team with years of proven experience.

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING



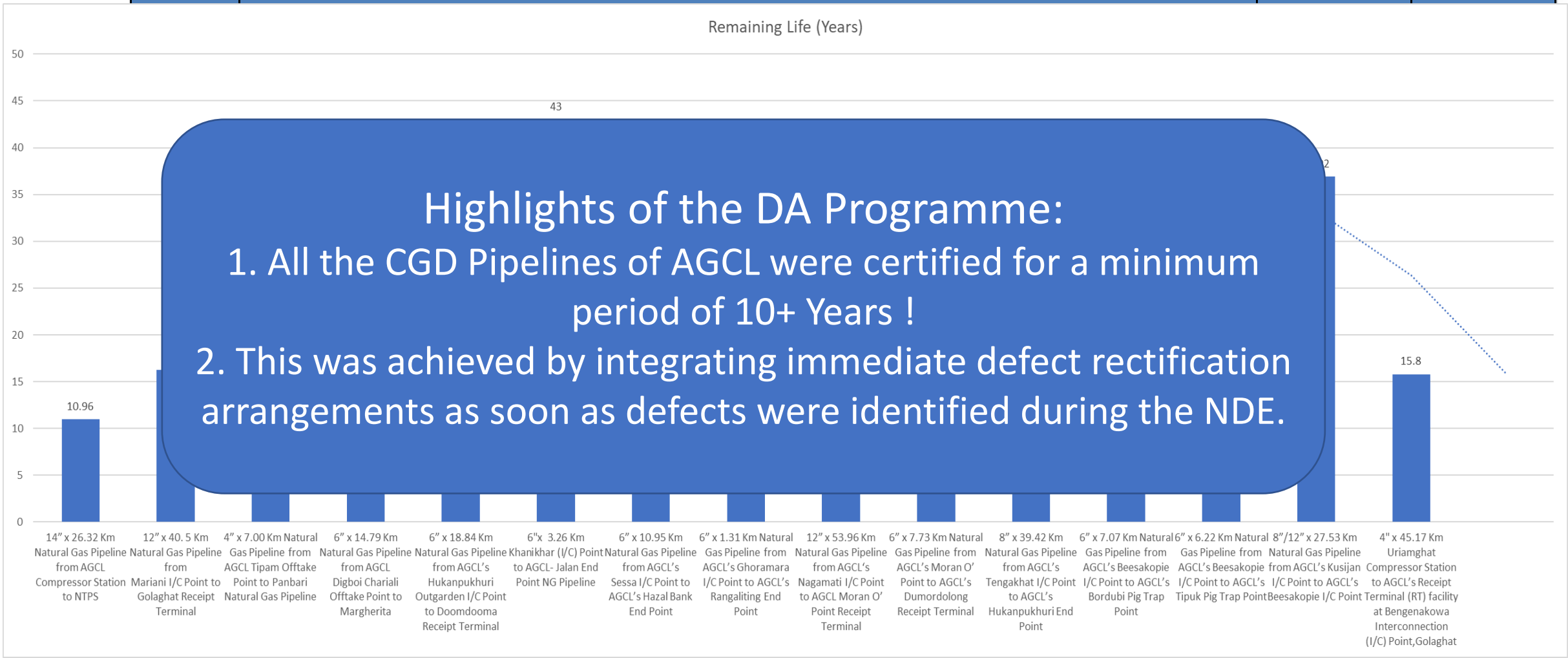
Complexity of CP interference management between non-CP other operator lines, to CP AGCL lines (all these within a radius of only 5.9 Km)!!

Within this, we have pipelines commissioned from 1960's to 2019 with varying coating systems? Try and assess coating and CP integrity assessment in such a scenario!

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

Code Compliant Remaining Life Assessment

Pipeline Code	Pipeline Name / Specification & Length (Km)	Date of Work Carried Out	Remaining Life (Years)
Line-24	8”/12” x 27.53 Km Natural Gas Pipeline from AGCL’s Kusijan I/C Point to AGCL’s Beesakopie I/C Point	16-Mar-24	36.92
Line-27	4" x 45.17 Km Uriamghat Compressor Station to AGCL’s Receipt Terminal (RT) facility at Bengenakowa Interconnection (I/C) Point,Golaghat	12-Nov-24	15.8



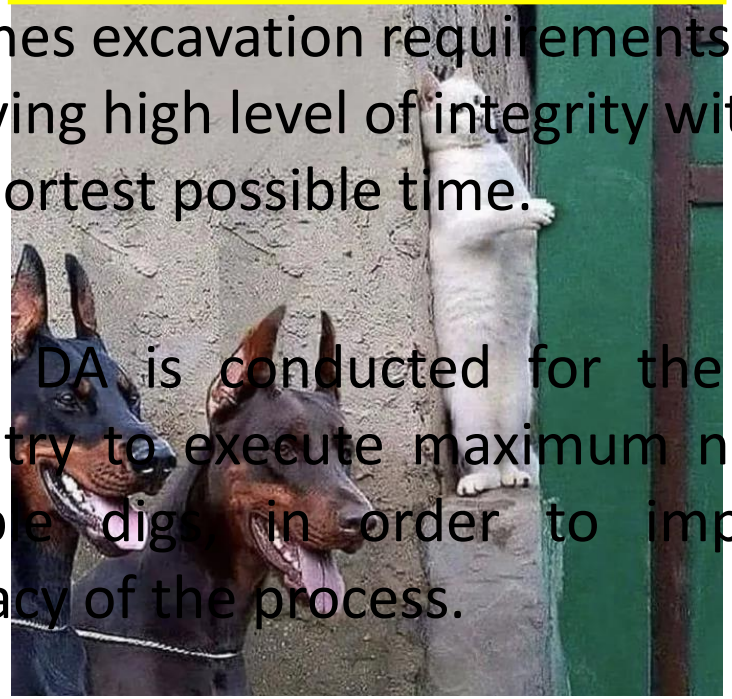
Highlights of the DA Programme:

1. All the CGD Pipelines of AGCL were certified for a minimum period of 10+ Years !
2. This was achieved by integrating immediate defect rectification arrangements as soon as defects were identified during the NDE.

Learnings from AGCL…

And NOT hide behind the “fear” of being audited to take bold decisions to deploy best available technologies….

Simultaneous DA inspection and repair program help in minimization of pipelines excavation requirements and achieving high level of integrity within the shortest possible time.



When DA is conducted for the first time, try to execute maximum no. of possible digs in order to improve accuracy of the process.

ASSAM GAS COMPANY LTD
A GOVT. OF ASSAM UNDERTAKING

ASSAM GAS COMPANY LTD

A GOVT. OF ASSAM UNDERTAKING

When blessed with the right intent: Pipeline Operators are not just "looking after the pipeline"

– they are TRUE "Asset Managers"