INTRODUCTION

A Comprehensive Approach to Digital Smart Infrastructure and Operational Excellence for Assam Gas Company Limited (AGCL) as per Industry 4.0

1. PRIVATE 5G NETWORK FOR GAS INDUSTRY (CGD)
2. CONTENT DELIVERY NETWORK (CDN) FOR CGD
3. GIS BASED GAS PIPELINE MANAGEMENT
   [Focusing on Reliability-Centered Asset Integrity Management (R-C-AIM)]
1. INTEGRITY MANAGEMENT SYSTEM FOR RISK ANALYSIS IN CGD
   [As input for Reliability-Centered Asset Integrity Management (R-C-AIM)]


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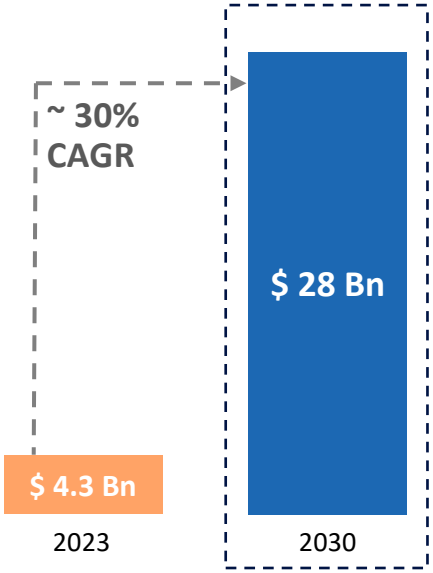
PRIVATE 5G NETWORK FOR GAS INDUSTRY

5G MARKET OUTLOOK FOR OIL & GAS

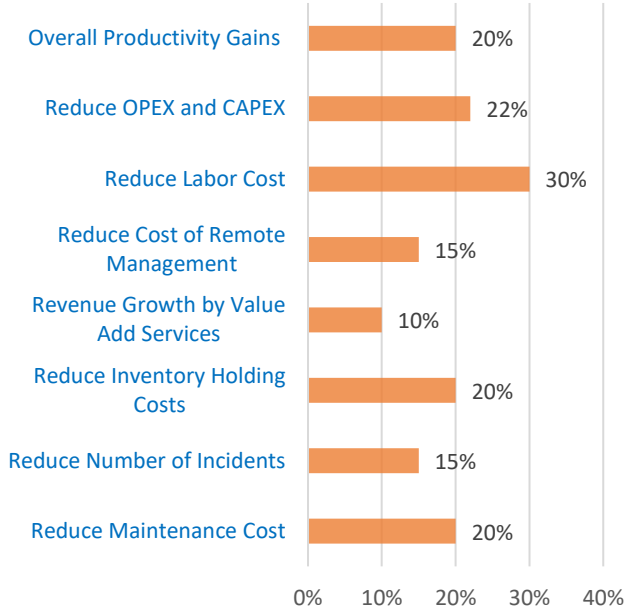
5G technology addresses communication challenges in the oil and gas sector by offering ultra-high speed and low latency in extreme conditions. The adoption of 5G facilitates the integration of drones, robotics, and AI, leading to improved operational efficiency and fostering industry growth.

5G MARKET SIZE IN OIL AND GAS MARKET (IN USD)



Source: Market Research Reports

BENEFITS OF 5G AND DIGITAL TRANSFORMATION



CRITICAL SUCCESS FACTORS

- **High Data Speed** to support Applications
- **Ultra-low latency**, often in the single-digit milliseconds range.
- **Real time Data and Content Delivery** for Critical Tasks
- **Edge Computing** Integration and **AI** based **Analytics**
- **Reliable** connection for critical applications and functionalities

PRIVATE 5G ADVANTAGES

High Speed Connectivity with Mobility

Private 5G's high-speed capabilities efficiently handle massive data streams from sensors, cameras, and IoT devices in refineries, ensuring seamless communication and optimal performance

Ultra Reliable

The reliability and high availability of a private 5G network ensure steadfast connectivity, even in challenging conditions, offering a resilient communication infrastructure

Scalability

Capability to support millions of devices, coupled with its ability to scale up on demand, provides a flexible and scalable network infrastructure

Device & Sensor Integration

Architectural support for sensors, enabling monitoring of health, environmental conditions, and overall operational performance with enhanced precision and efficiency

Edge Computing

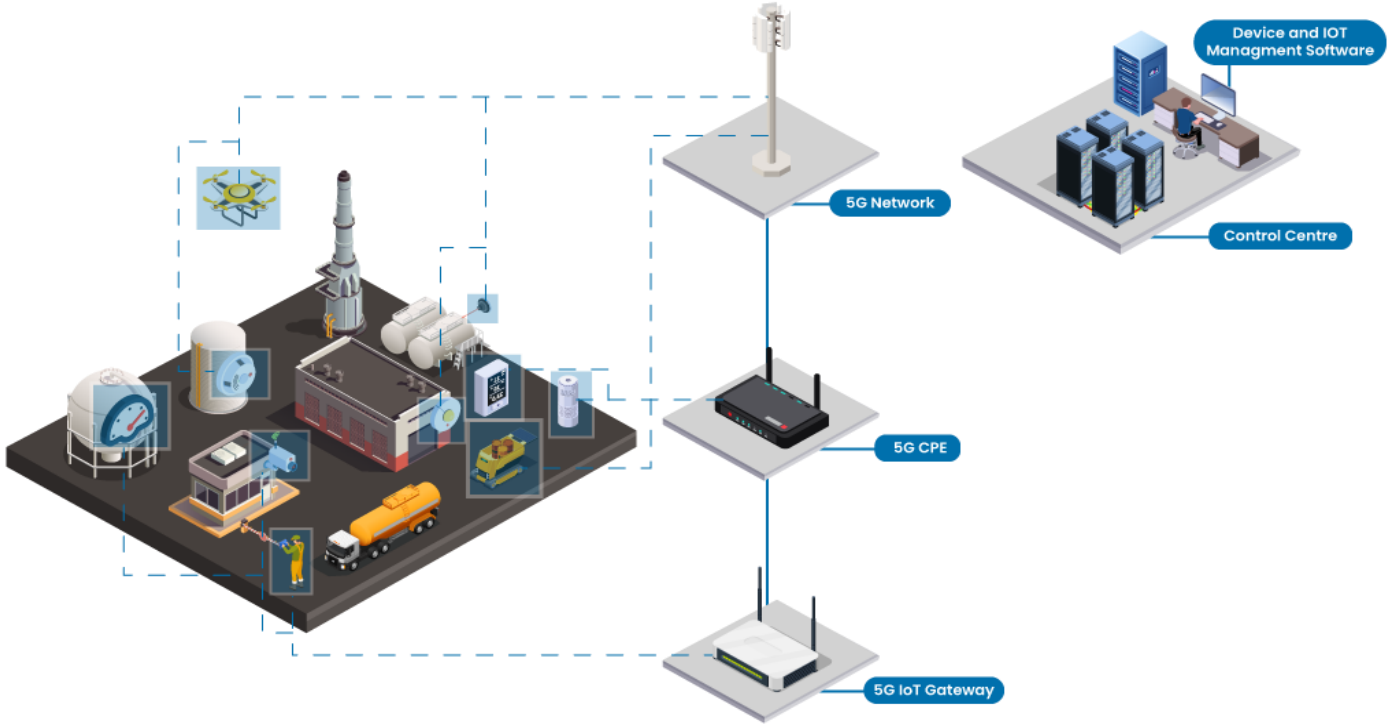
Edge computing support for low-latency applications facilitates the efficient development of analytics and AI/ML applications, ensuring swift and responsive processing

Security

Advanced security features, such as encryption and network slicing, ensuring the isolation and protection of critical refinery communications from potential cyber threats

REMOTE DEVICE AND IOT MANAGEMENT

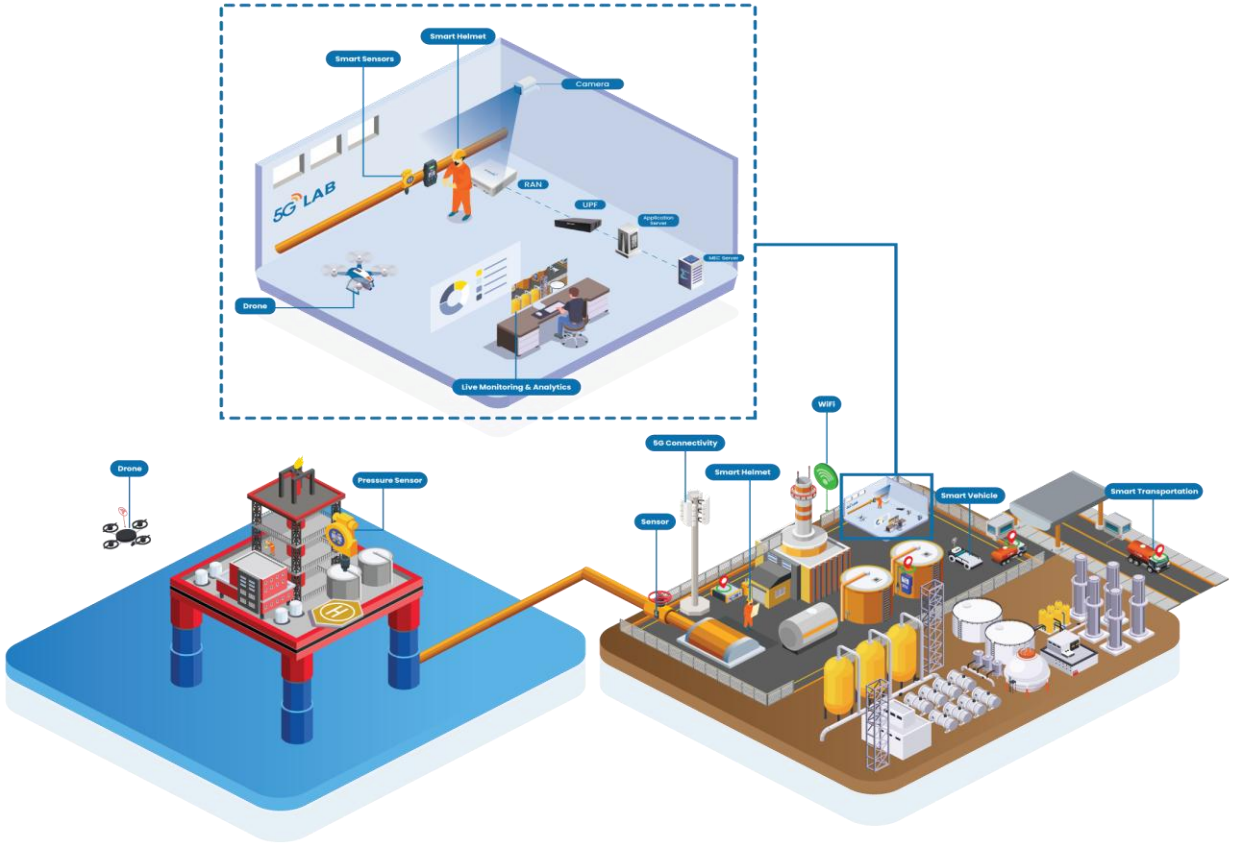
Device Management Applications integrated with 5G network providing Network Slices & QoS as per the services.



Common Applications & Dashboards	Device Provisioning	Configuration Management	Alerts & Notifications	Data Logging & Reporting	Access Control	OTA Updates

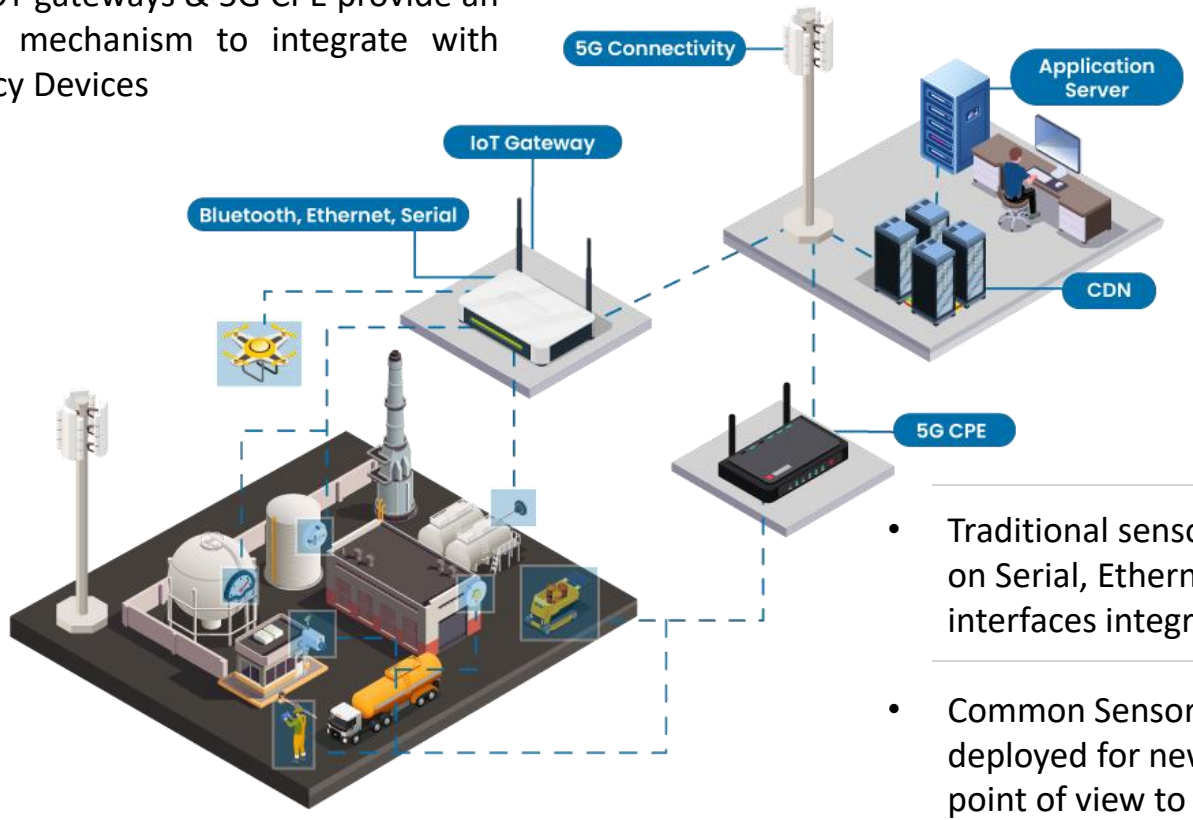
CENTRAL CONTROL AND 5G IOT DASHBOARDS

- Central Console room to monitor all applications
- Urgent notifications and Alarms integration with email/SMS/ other messaging systems
- Report Generation using Big Data Analytics
- Support for Secure Remote logins



LEGACY EQUIPMENT INTEGRATION

5G IOT gateways & 5G CPE provide an ideal mechanism to integrate with Legacy Devices



- Traditional sensors and machines working on Serial, Ethernet, Bluetooth and WIFI interfaces integrated with 5G Gateways
- Common Sensor and Analytics Apps deployed for new and old devices for single point of view to the operators

PRIVATE 5G SOLUTION LAYERS

Smart Applications

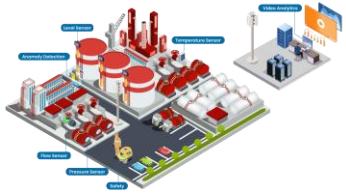
Personal Protective Equipment

Fire & Smoke Detection

Geo Fencing

Visual Inspection

Environmental Monitoring



Content Delivery Network (CDN)

Fleet Management

Smart Connectivity

5G

Bluetooth

LAN

Serial

Smart Sensors

Automated Guided Vehicles

Drones

AI Enabled Cameras

LiDAR

Environmental Sensors - Temp, Pressure, Flow, RFID, Bluetooth Tags Fire, Corrosion, Acoustic etc

PRIVATE 5G – SOLUTION COMPONENTS

5G Core & Radio Network

- 3GGP Compliant SA Core
- Network Slicing
- Private Cloud Deployment
- 40 Gbps support
- Multi Device Support
- Secured Communication

IOT Devices, Gateways & Services

- Environmental, Health and machine sensors
- IOT Platform to ingest and Process received Data
- Analytics and AI based Algorithms to process data

Smart Cameras & Applications

- 5G Integrated Smart Cameras with AI Processors
- Thermal, Digital and IR Cameras for various Apps
- Apps for Video Processing

Mobile Edge Computing

- 5G Mobile Edge computing for low latency Applications
- Integrated with 5G Core for high speed Apps like drones and automation

AI/ML & Analytics

- Worker Safety Apps
- Refinery Safety Apps
- Traffic Management
- IOT Data Processing
- Edge Analytics devices for Local video processing

Content Delivery Network

- Local Content Delivery
- Deliver content in real time
- Integrated with 5G Network
- Increase Delivery Scalability & Reliability

Drones & Robotics

- 5G Drones & Apps
- Safety Applications & live video streams
- 5G Automated Guided Vehicles for remote monitoring

Legacy Infra Integration

- Gateways for integration with legacy devices supporting WIFI, Bluetooth and Serial interfaces
- Common Dashboards for devices & Apps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CONTENT DELIVERY NETWORK (CDN)

WEBSITE/DATA ACCESS FLOW WITHOUT CDN

Sikkim
User

Meghalaya
User

Tripura
User

User
Arunachal Pradesh

User
Assam

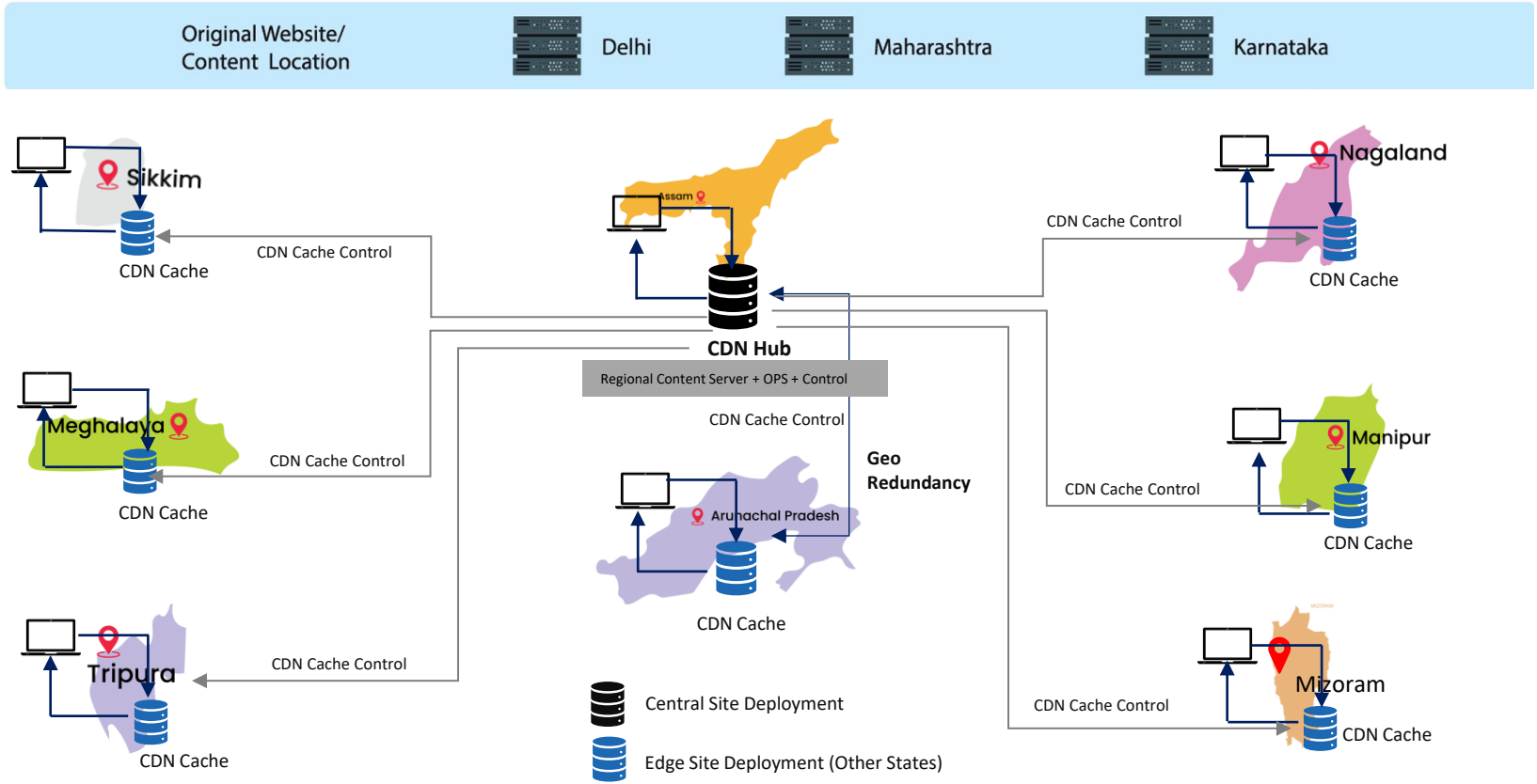
User
Nagaland

User
Manipur

User
Mizoram

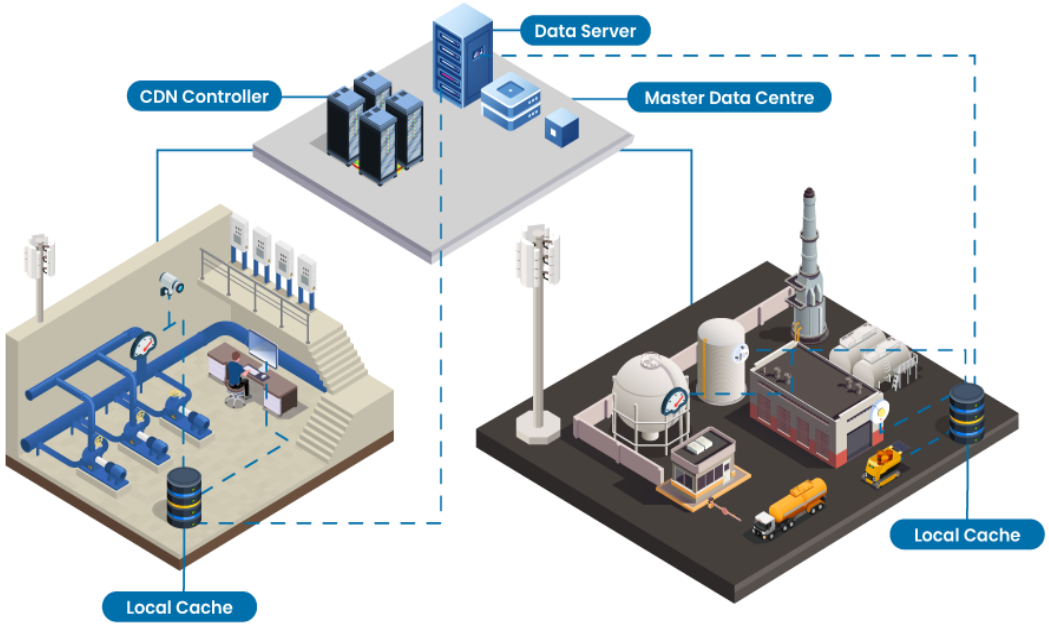
High Latency **Slow Loading** **Less Reliability** **Not Secure** **Bad User Experience**

WEBSITE / DATA ACCESS FLOW WITH CDN DEPLOYMENT



Low Latency | **Faster Loading** | **High Reliability** | **Very Secured** | **Good User Experience**

CDN AND 5G



Edge Computing Integration

- CDNs operate at the edge of the network
- This allows for processing data closer to the source, reducing the need to transfer large volumes of data to centralized data centres and improving overall system efficiency

Faster Data Access

- CDNs cache frequently used content locally
- This ensures that real-time data, such as monitoring information or process control data, can be accessed quickly, improving operational responsiveness.

Security

- Data is fetched Locally avoiding accessing of remote servers making the system secure

Data Distribution & Replication

- Distribute and replicate data across geographically dispersed locations

Scalability

- CDNs provide scalability to handle increased traffic
- In smart refineries it helps to scale solutions as the number of devices grow

GIS BASED GAS PIPELINE MANAGEMENT

[Focusing on Reliability-Centered Asset Integrity Management (R-C-AIM)]

Overcoming Gas Pipeline Challenges with Geographic Information System (GIS)

CHALLENGES

- No centralized record of the location and status of underground assets like pipelines, valves, and meters.
- Reliance on traditional survey methods for inspections, repairs, and emergency response.
- Lacks real-time monitoring systems to track gas flow, pressure, and asset conditions.
- Absence of predictive analytics tools makes it difficult to forecast future gas demand and assess risks.
- Managing consumer connections, billing, and services across diverse geographies.
- Integration with existing systems, including SCADA, ERP, and field management tools.

50% GIS-enabled asset and operations management streamline business processes, boost productivity, and reduce costs by up to 50 percent..

Framework for capturing, analysing, and visualizing spatial and geographical data.

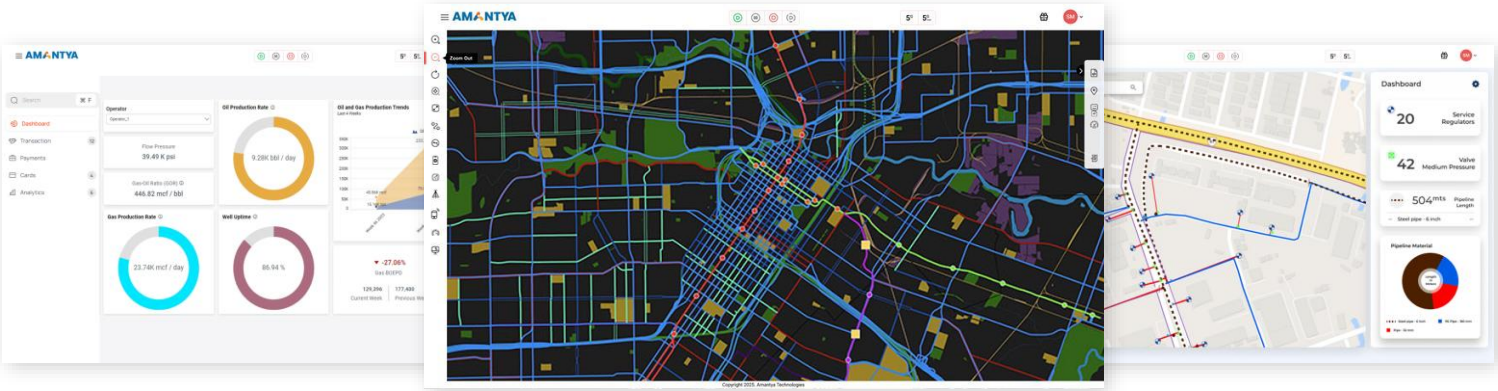
Integrates location-based data with descriptive information, enabling spatial analytics.

Why GIS?

Empowers organizations to make data-driven decisions by uncovering patterns, relationships, and trends.

PROPOSED SOLUTION – GIS BASES PIPELINE MANAGEMENT SYSTEM

GIS-based pipeline management solution system is designed to streamline operations, enhance safety, and improve efficiency.



KEY COMPONENTS

- **Pipeline Mapping and Visualization**
- **Asset Tracking and Management**
- **Real-Time Monitoring and Alerts**
- **Data Management and Integration**
- **Predictive Maintenance**

PIPELINE MANAGEMENT PLATFORM



NB-IoT

IoT Data Collection

- Real time data collection.
- Structured and un-structured data types.


5G /LTE

Video Data Collection

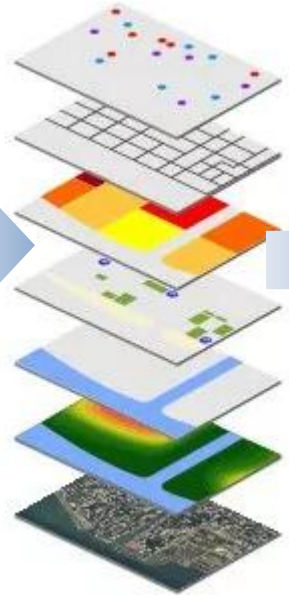
- Real-time video data streaming.
- Video data storage.

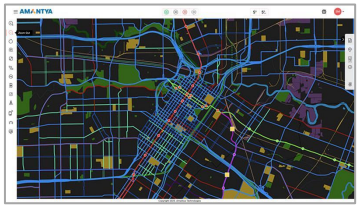
AI, Big Data Collection Service



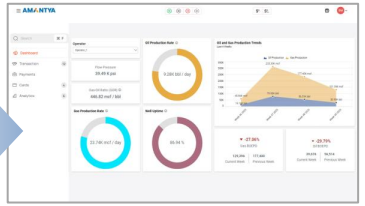

- Big data based AI pipeline model.
- Calculates optimal routes for new pipeline installations
- Identify unusual patterns in pressure, flow, or vibration data.
- Predict pipeline failures, corrosion, or leaks based on historical data.

GIS Data Layers

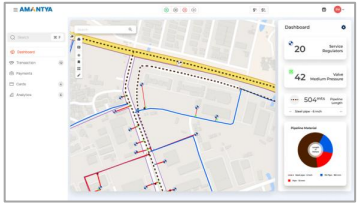




Digital Pipeline Mapping

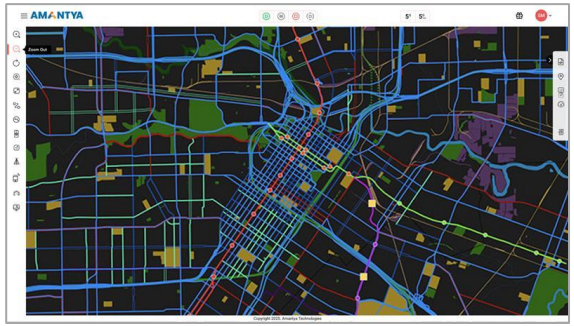


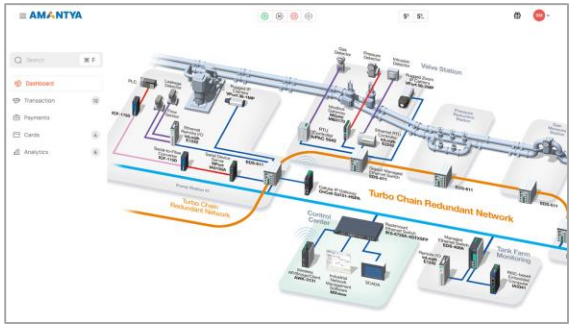
Advance Analytics

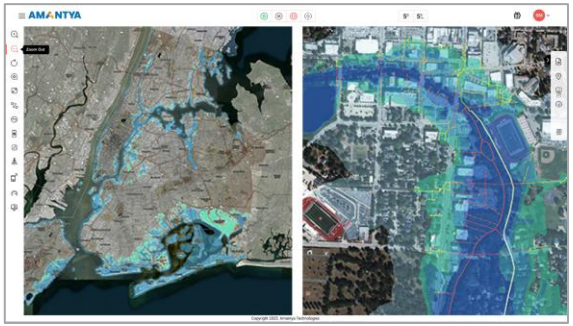


Dashboard and Reporting

KEY FEATURES (1/2)







Digital Mapping

- Layered GIS data displaying pipeline routes, valves, stations, and key infrastructure.
- Show pipeline locations, including depth, diameter, and material type.
- Geographic insights into surrounding terrain, population density, and environmental conditions.

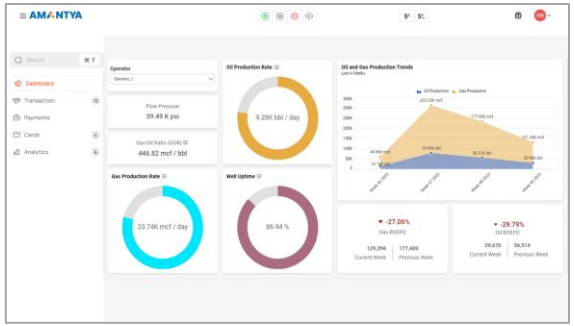
Asset Management

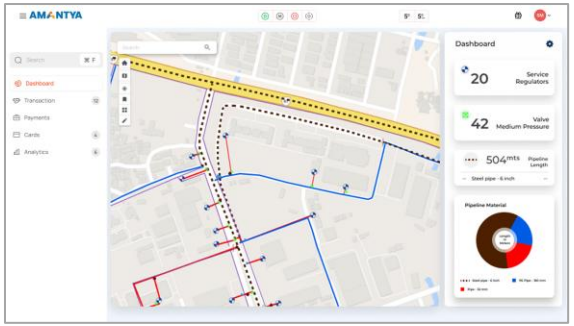
- Central repository for physical and digital details of all pipeline assets.
- Tracking of material specifications, installation dates, repair histories, and ownership records.
- Supports categorization of assets based on function, condition, or location.

Real-Time Monitoring

- Integrates with SCADA, PLC or IoT sensors for live updates on pipeline operations.
- Displays current gas flow rates, pressure levels, and any anomalies.
- Alerts operators to deviations from normal operating conditions, such as leaks or blockages.

KEY FEATURES (2/2)





Advanced Analytics

- Uses historical and real-time data to forecast potential failures, demand surges, or supply bottlenecks.
- Machine learning algorithms predict pipeline wear, corrosion rates, or operational inefficiencies.
- Offers insights into customer usage trends for better capacity planning.

Routing and Network Analysis

- Calculates optimal routes for new pipeline installations to minimize costs and risks.
- Simulates gas flow to identify bottlenecks, over-capacity areas, or pressure drops.
- Provides contingency routes for emergencies or shutdowns.

Dashboards and Reporting

- Intuitive dashboards for viewing pipeline conditions, operational statistics, and KPIs.
- Geographic heat maps, trend charts, and alerts for management, operators, and technicians.
- Mobile app for field workers to access GIS data, monitor pipeline conditions, and log incidents.

BENEFITS OF PIPELINE MANAGEMENT

Comprehensive Asset Mapping

- Provides an accurate, real-time geospatial view of pipelines, valves, stations, and associated assets.

Improved Decision Support

- Facilitates data-driven decision-making by analysing pipeline routes, environmental conditions, and risk factors.

Operational Efficiency

- Optimizes routing and capacity management to ensure seamless pipeline operations and faster responses to operational issues.

Integration with Advanced Systems

- Integrates with SCADA, IoT, and other monitoring systems to provide real-time updates and a unified operational view.

Enhanced Maintenance Planning

- Helps identify high-risk or aging pipeline sections, enabling efficient scheduling of inspections, repairs, and replacements.

Regulatory Compliance

- Streamlines compliance with safety, environmental, and operational regulations by maintaining accurate.

Incident Mgt. and Risk Mitigation

- Accelerates identification of leaks and damages enabling swift action to minimize environmental and financial impacts.

Cost Optimization

Reduces costs through proactive maintenance, efficient resource utilization, and avoidance of pipeline failures or unnecessary inspections.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INTEGRITY MANAGEMENT SYSTEM FOR RISK ANALYSIS IN CGD
[As input for Reliability-Centered Asset Integrity Management (R-C-AIM)]

Integrity Management System with Risk Analysis in City Gas Distribution System

THE CGD SECTOR IN INDIA- THE GROWTH STORY

India's City Gas Distribution (CGD) sector is experiencing rapid growth, driven by the country's push towards cleaner energy and environmental sustainability. With government support through the 'Pradhan Mantri Urja Ganga' and 'One Nation, One Gas Grid' initiatives, the CGD network has expanded significantly to meet rising urban and industrial demand.

This sector supports multiple end-users, including domestic households, commercial establishments, and industries, by providing a reliable and cleaner fuel alternative. With a projected increase in natural gas's share in India's energy mix from 6.3% in 2021 to 15% by 2030, CGD is poised to play a crucial role in India's energy transition goals.

The Petroleum and Natural Gas Regulatory Board (PNGRB) has played a pivotal role in this expansion, sanctioning numerous licenses, safety guidelines to facilitate CGD networks across various regions.

Moreover, technological advancements in pipeline integrity and risk management systems are enhancing operational safety, which further promotes public confidence and investment in CGD networks.

ASSET INTEGRITY – A KEY CHALLENGE IN A CGD NETWORK

- Safety, efficiency, regulatory compliance, and risk management remains a foremost apprehensions.
- Threats are not Limited to only steel pipelines. It also covers PE Pipelines, Compressors, CGS, Cylinders-Cascades, Odorizers etc (Many other equipment & materials cause threats to the CGD network)
- Regular and proactive threat / risk audits (T4S, ERDMP, IMS etc) to be carried out to endorsed the integrity of the CGD network
- How many threats are identified for their risk analysis?

Assessment of Impact of Threats

Threats	Challenges
(a) Time Dependent	
1) External Corrosion	AC/DC Interference, Casings Shorts, Disbonded Coating
2) Internal Corrosion	Quality of fluid, Piggability, Fluid velocity, Fluid Cleanliness
3) SCC	All types of env. induced cracking in future?
(b) Resident (earlier Stable)	
(4) Manufacturing related defects	Design, Manufacturing Process, QA/QC
(5) Welding / Fabrication related	D/t ratio, High grade steel, QA/QC, Steel Grade / Wall Thickness Matching, Bends related
(6) Equipment	Gasket life / Inspection, IJ failure, Valve problems, Pig Barrel doors
(c) Random or Time Independent (earlier Time Independent)	
(7) Third-party/mechanical damage	Unregulated development, development of transport corridors across / along pipelines
(8) Incorrect operational procedure	
(9) Weather-related and outside force	Wash-out, pipeline cover erosion, free-spanning, slope stability, ground movement

Challenges Faced by Traditional IMS

Identifying key limitations in traditional integrity management systems

- Manual Data Collection
- Ageing Infrastructure
- Compliance Complexity
- Difficult to carryout Risk Analysis and Prioritization
- Resource-Intensive Risk Assessment
- Prioritization Challenges
- Document and record keeping
- Reactive Maintenance
- Inability to Leverage Historical Data
- Passive Preventive Maintenance

Addressing these challenges transitioning from manual to automated IMS system is need of time which is data-driven IMS, incorporating real-time monitoring/ batch data processing, predictive analytics, and digital record-keeping to enhance safety, compliance, and operational efficiency.

System shall be preventive in nature & should not be mitigative type—this will save Cost, environment, human, capital loss, reputation.

Benefits of Implementing Cloud-Based IMS

Maximizing Efficiency and Safety in CGD Networks

Scalability and Flexibility

Easily Scalable: Cloud-based IMS can scale up or down to accommodate growing CGD infrastructure without the need for significant hardware investments.

Flexible Access: Authorized personnel can access the IMS from any location, enabling remote monitoring and management across multiple regions.

Real-Time Data Processing and Monitoring

Instant Data Updates: Cloud computing enables real-time data capture from sensors, allowing for immediate anomaly detection, predictive analysis, and prompt responses to potential issues.
Enhanced Visibility: With continuous data streaming, operators gain comprehensive visibility into the network's health, which is critical for proactive risk management.

Advantage of using batch data if real time data acquisition is not possible

(Daily data input

Enhanced Collaboration and Data Sharing

Centralized Data Access: Cloud platforms allow centralized data storage, facilitating easy access and data sharing among different teams and departments.

Collaborative Workflows: Teams in different locations can collaborate effectively in real-time, which enhances communication and speeds up decision-making processes.

Advanced Analytics and Predictive Maintenance based on threat severity index

Predictive Analytics: Cloud-based IMS can leverage AI and machine learning to analyze historical data and predict potential failures, enabling a shift from reactive to predictive maintenance.

Improved Decision-Making:

Advanced analytics help prioritize maintenance tasks based on risk levels, optimizing resource allocation and reducing unnecessary interventions.

Every hour /Every day Integrity

Cloud based system also offers flexibility to check every day integrity by carrying out risk assessment & risk level on hourly & daily basis. This will helps to reports higher management about the status of the system by briefing at what risk level/ integrity level they are operating.

Easy integrity level measurement/ Risk level

All data at One Location and easy access at anywhere.

Automated report generation for the compliances @ click of button as required by regulatory authority i.e. PNGRB.

Designing Cloud-Based IMS

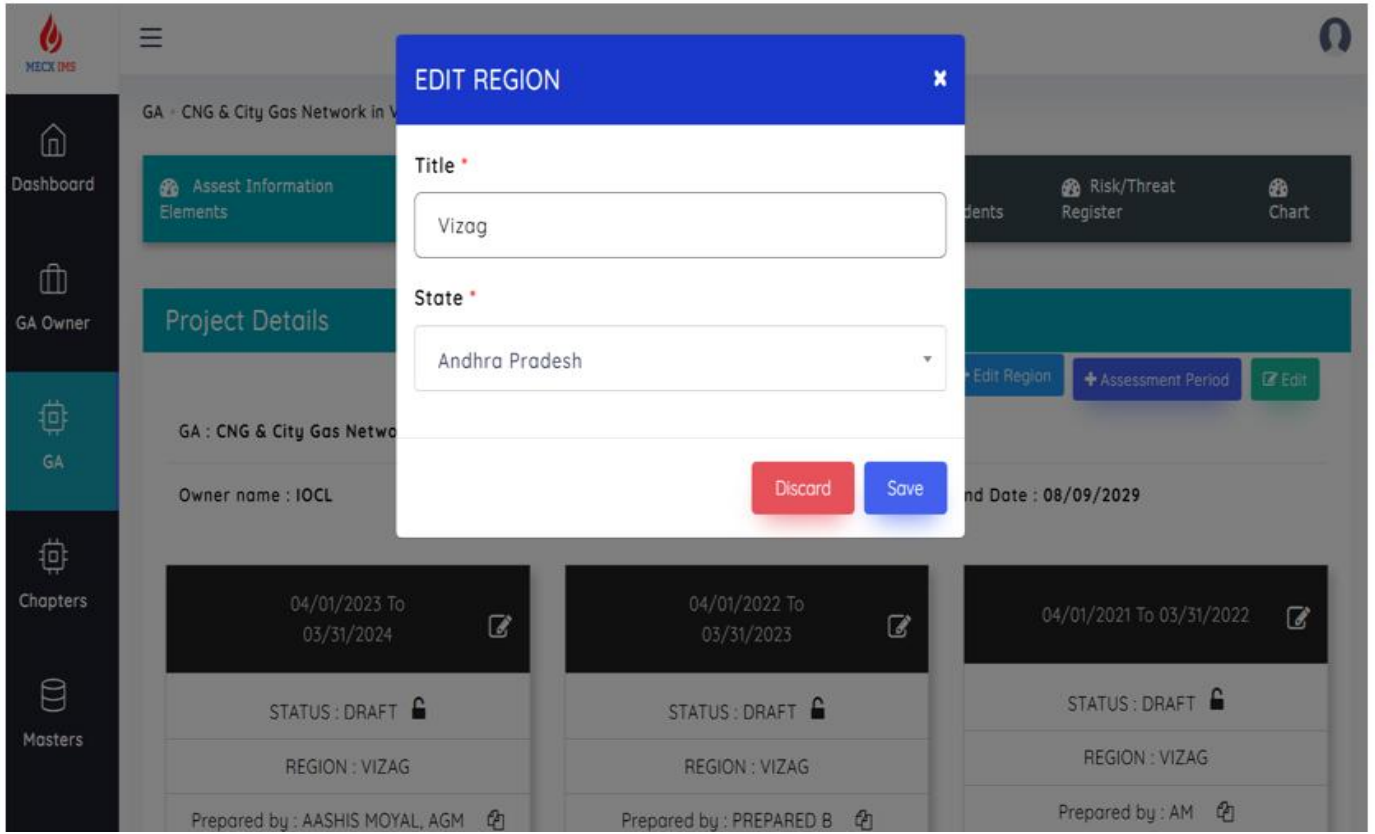
Maximizing Efficiency and Safety in CGD Networks

- The proposed cloud-based IMS for city gas distribution systems operates using a three-layer architecture:
  - **Data Collection Layer:** Various operating parameters from sensors placed throughout the network and data collected from the various integrity surveys are put into the application for analysis of asset integrity.
  - **Cloud Infrastructure Layer**: This layer processes the incoming data, performs risk assessments, and stores historical records. The cloud offers scalability, allowing the system to handle large volumes of data efficiently
  - **Risk Management and Response Layer:** The final layer analyses the compiled data to identify threats, assess risks, and trigger appropriate incident management actions. A user interface provides operators with real-time alerts, visualizations, and decision-making tools.

Such systems are hosted on a cloud server, leveraging the flexibility, scalability, and security of cloud infrastructure. It connects to a cloud-managed database, ensuring real-time data storage, retrieval, and management. The cloud server processes incoming requests, runs the application's business logic, and communicates with the database to fetch or update data. Users benefit from high availability, seamless scaling, and secure data access from anywhere, as the application efficiently handles large volumes of transactions in a dynamic cloud environment.

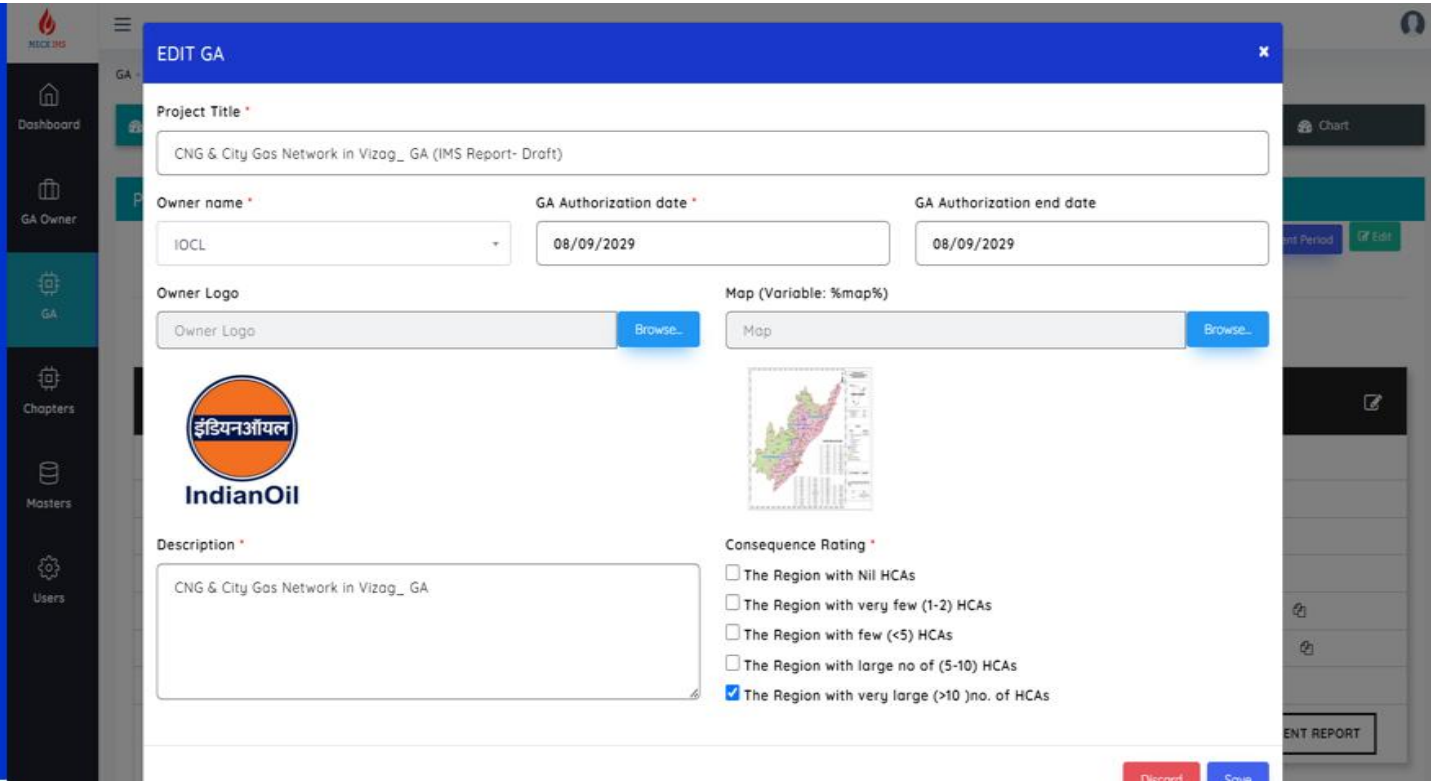
Network Details

Designing Cloud-Based IMS

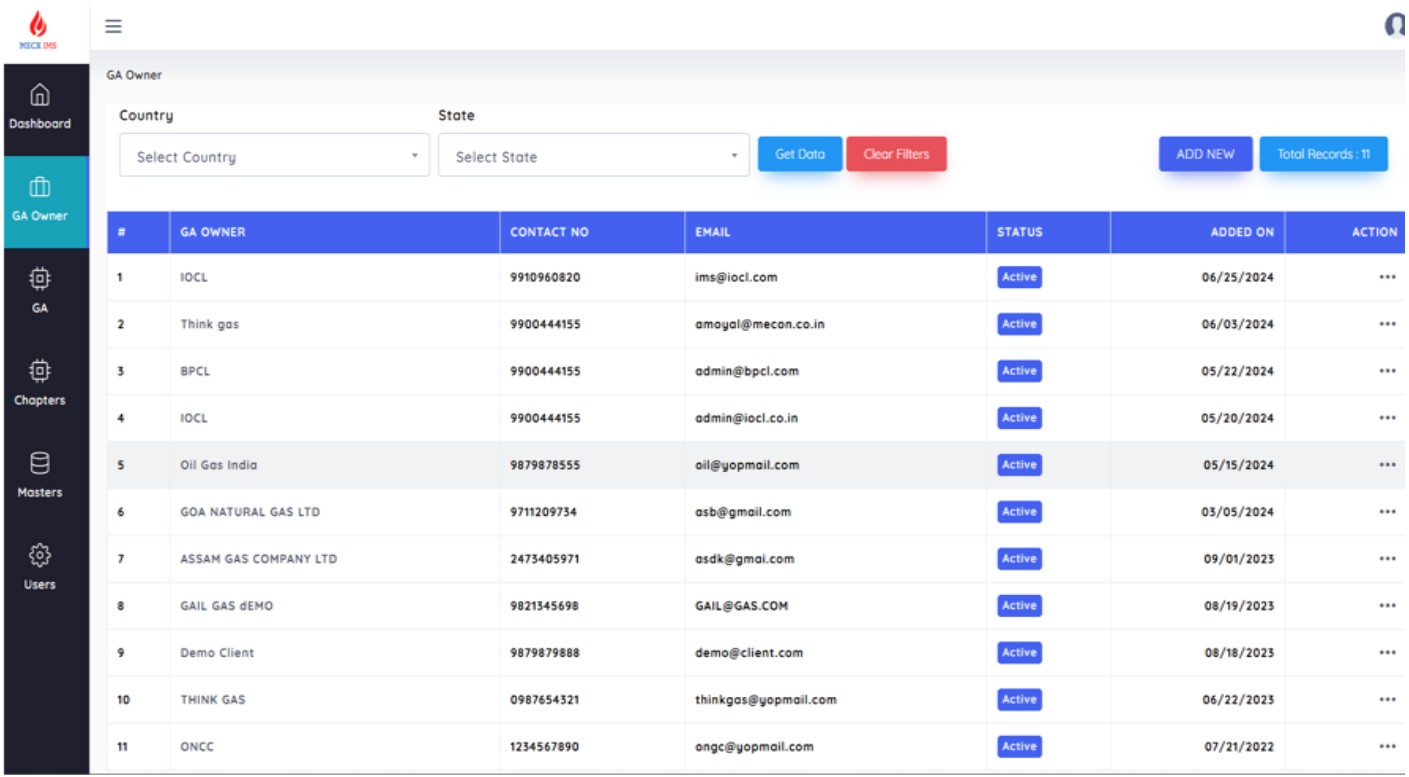


Network/ GA Details

Designing Cloud-Based IMS

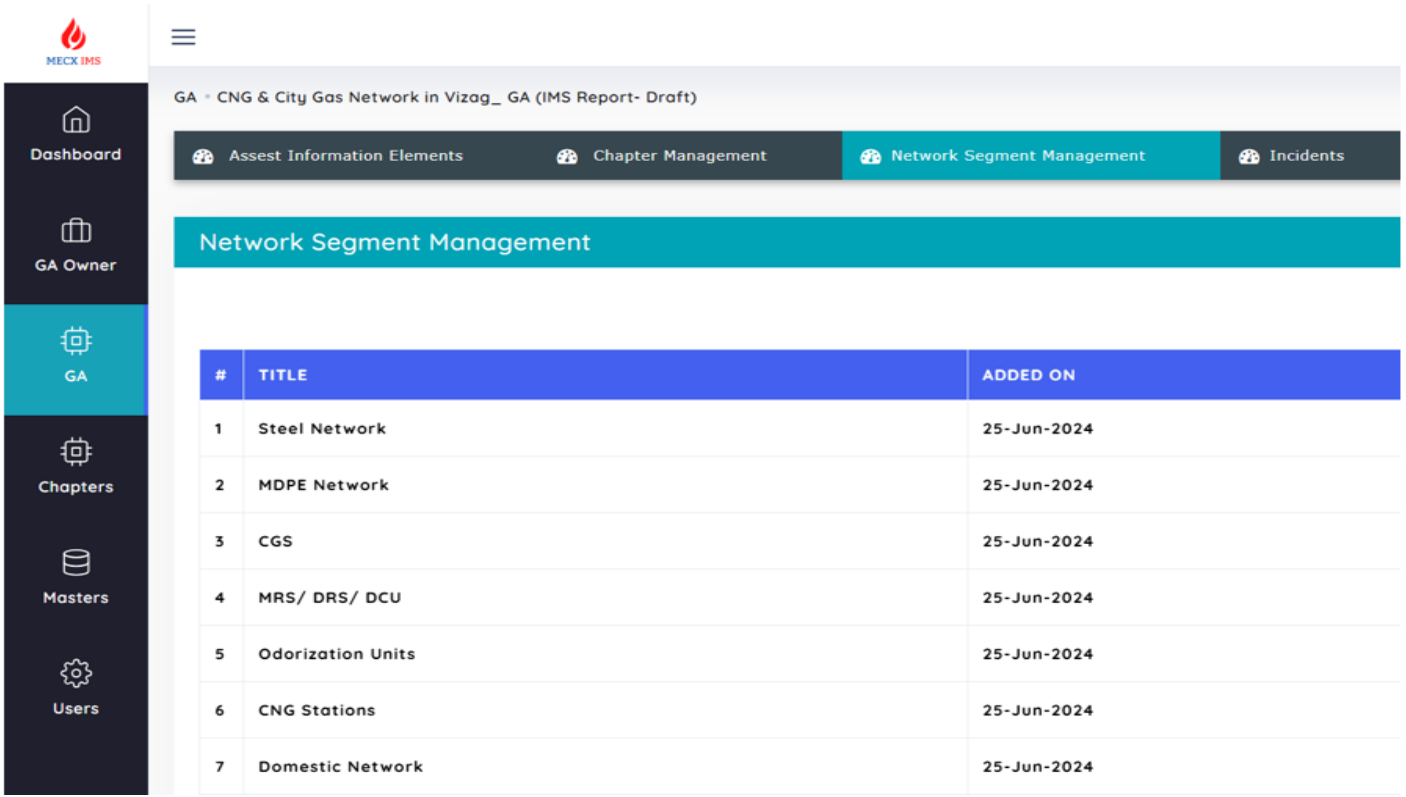


Manage Multiple GA/ Network Details at One Location



Network Segment Management

Designing Cloud-Based IMS



Risk Analysis & Nos of Threats considered for Risk Analysis.

Steel Network

Approx. 80 threats considered

PE Network

Approx. 30 threats considered

MRS/DRS/DCU

Approx. 40 threats considered

CGS

Approx. 45 threats considered

Odorization Units

Approx. 25 threats considered

CNG Stations

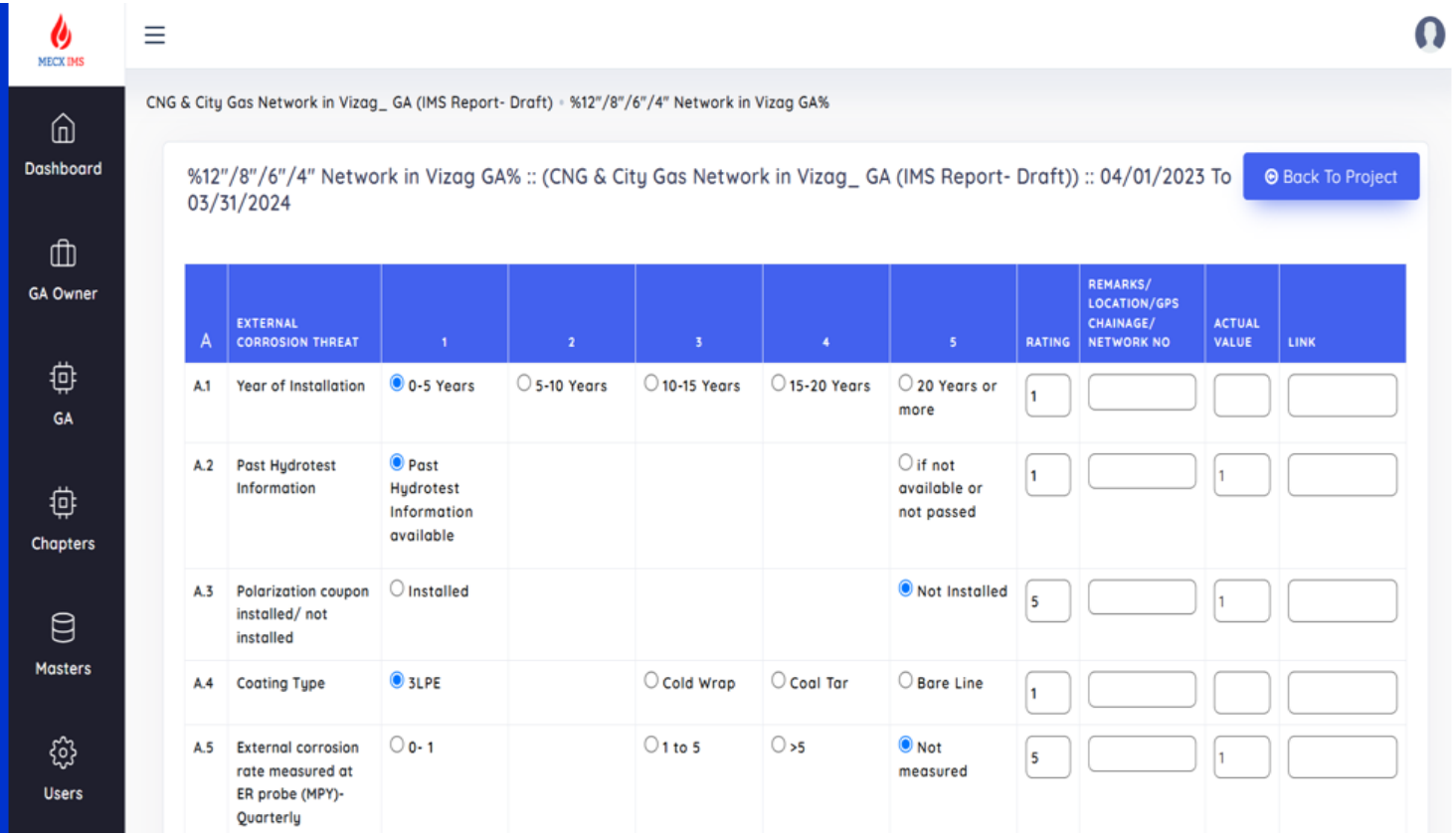
Approx. 80 threats considered

GI-Domestic Network

Approx. 30 threats considered

Risk Analysis & Nos of Threats considered for Risk Analysis.

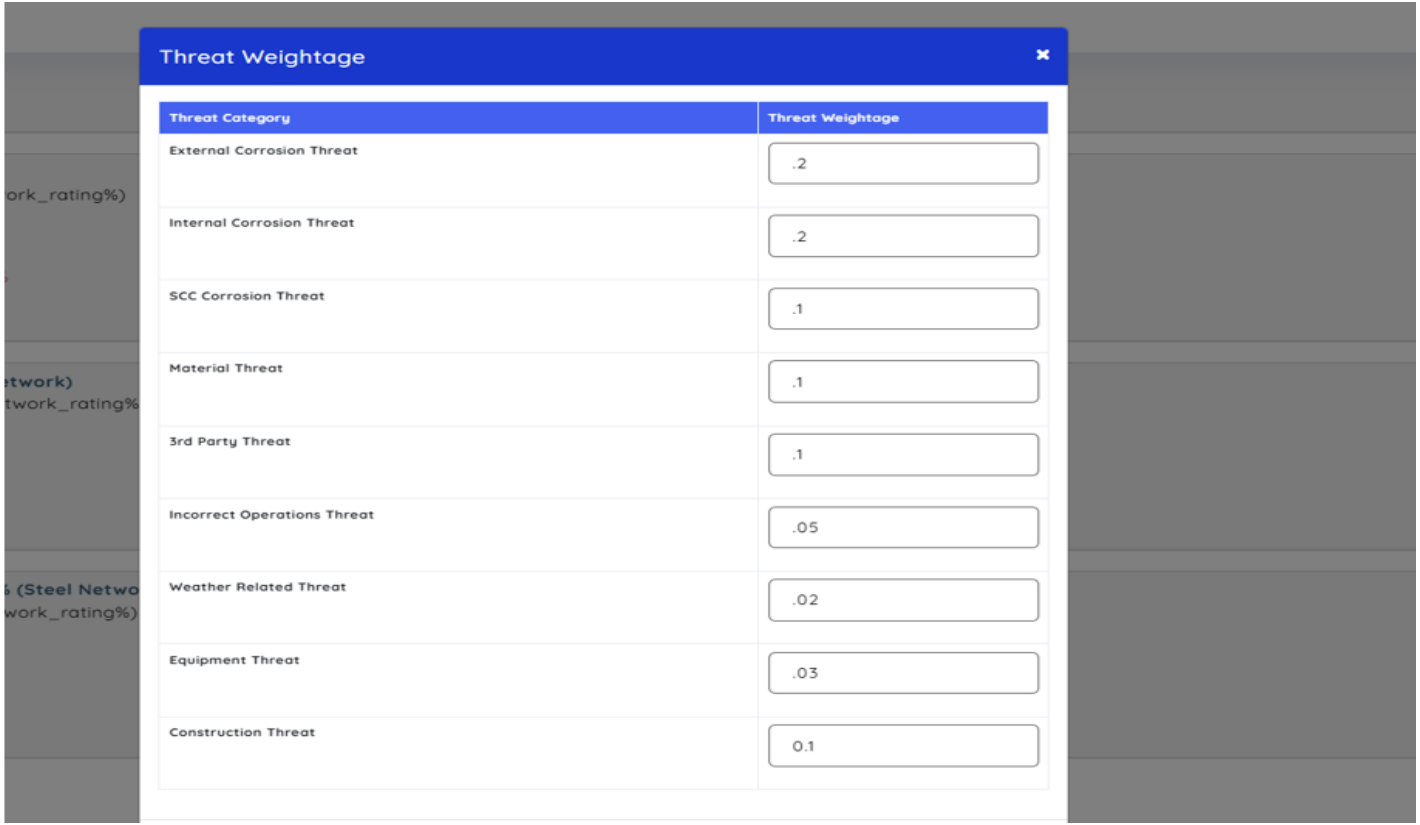
Designing Cloud-Based IMS



A	EXTERNAL CORROSION THREAT	1	2	3	4	5	RATING	REMARKS/ LOCATION/GPS CHAINAGE/ NETWORK NO	ACTUAL VALUE	LINK
A.1	Year of Installation	◉ 0-5 Years	○ 5-10 Years	○ 10-15 Years	○ 15-20 Years	○ 20 Years or more	1			
A.2	Past Hydrotest Information	◉ Past Hydrotest Information available				○ if not available or not passed	1		1	
A.3	Polarization coupon installed/ not installed	○ Installed				◉ Not Installed	5		1	
A.4	Coating Type	◉ 3LPE		○ Cold Wrap	○ Coal Tar	○ Bare Line	1			
A.5	External corrosion rate measured at ER probe (MPY)- Quarterly	○ 0- 1		○ 1 to 5	○ >5	◉ Not measured	5		1	

GA defined threat weightages

Designing Cloud-Based IMS



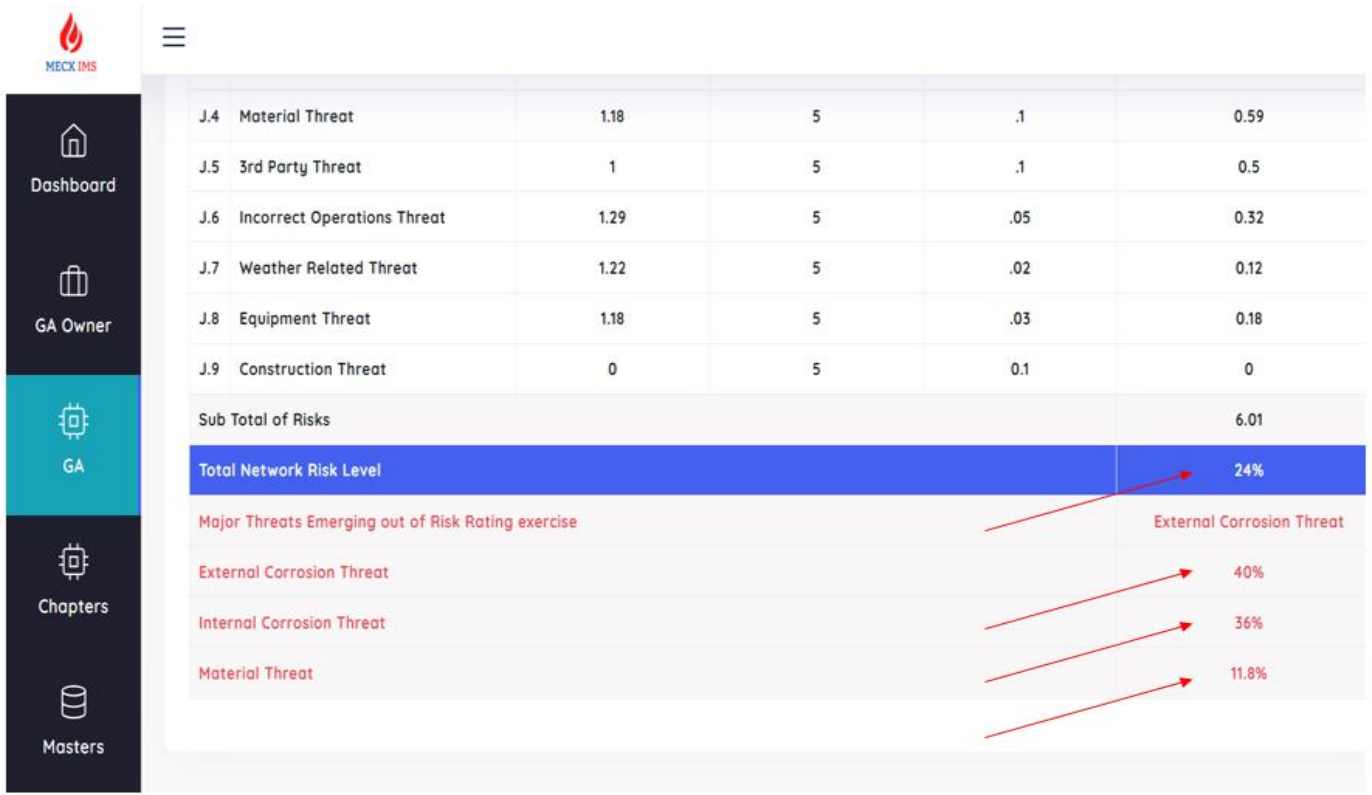
Threat Severity Index and Risk Level of All Segments

Grand Total	10
Mean Score	1
Threat Severity Index %	0

INCORRECT OPERATIONS THREAT

District		VIZAG							Steel Network
Name of the Network									
F	Incorrect Operations Threat	1	2	3	4	5	Total	Actual Value	Remarks/ Loc
F.1	Last Audit Compliance & Punch Points (Internal/ IMS/ ERDMP / T4s audit)	Fully Complied				Not Complied	1		
F.2	Audit records (Internal/ IMS/T4S/ EMDRP)	Available				Not Available	1		
F.3	SOP Review (Procedure review information)	Yearly		in 3 year		in 5 year	3		
F.4	Failures caused by incorrect operation	None	< 3	3 - 5	5 - 10	> 10	1		
F.5	Audit status- Internal/ IMS/ ERDMP / T4s audit	Done				Not done	1		
F.6	Number of Inservice leaks due to incorrect operation	None		< 3		> 3	1		
F.7	Mock Drill	Yearly		in 3 year		Not done	1		
						Grand Total	9		
						Mean Score	1.29		
						Threat Severity Index %	7.14		

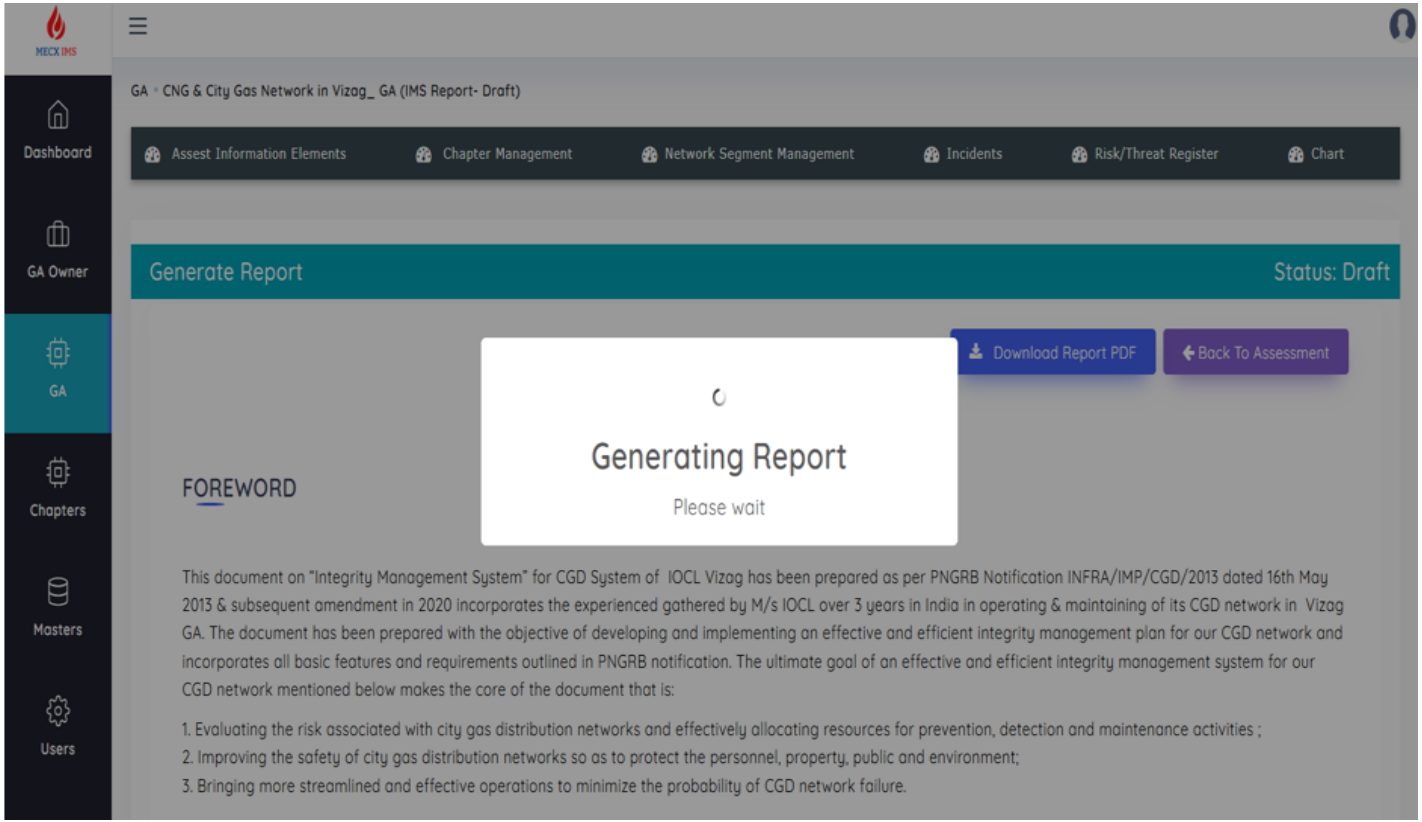
Threat Severity Index and Risk Level of All Segments



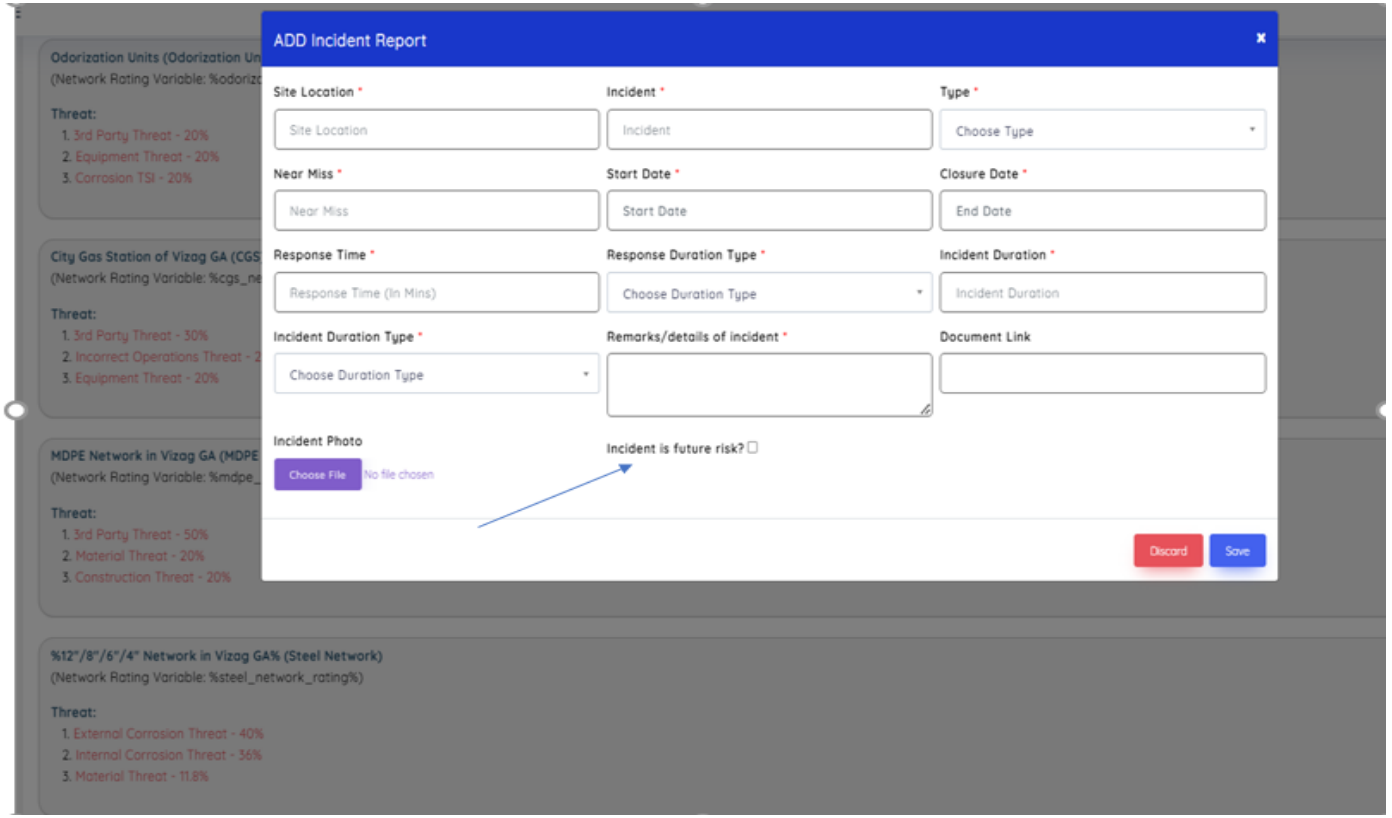
J.4	Material Threat	1.18	5	.1	0.59
J.5	3rd Party Threat	1	5	.1	0.5
J.6	Incorrect Operations Threat	1.29	5	.05	0.32
J.7	Weather Related Threat	1.22	5	.02	0.12
J.8	Equipment Threat	1.18	5	.03	0.18
J.9	Construction Threat	0	5	0.1	0
Sub Total of Risks					6.01
Total Network Risk Level					24%
Major Threats Emerging out of Risk Rating exercise					External Corrosion Threat
External Corrosion Threat					40%
Internal Corrosion Threat					36%
Material Threat					11.8%

Generating IMS report

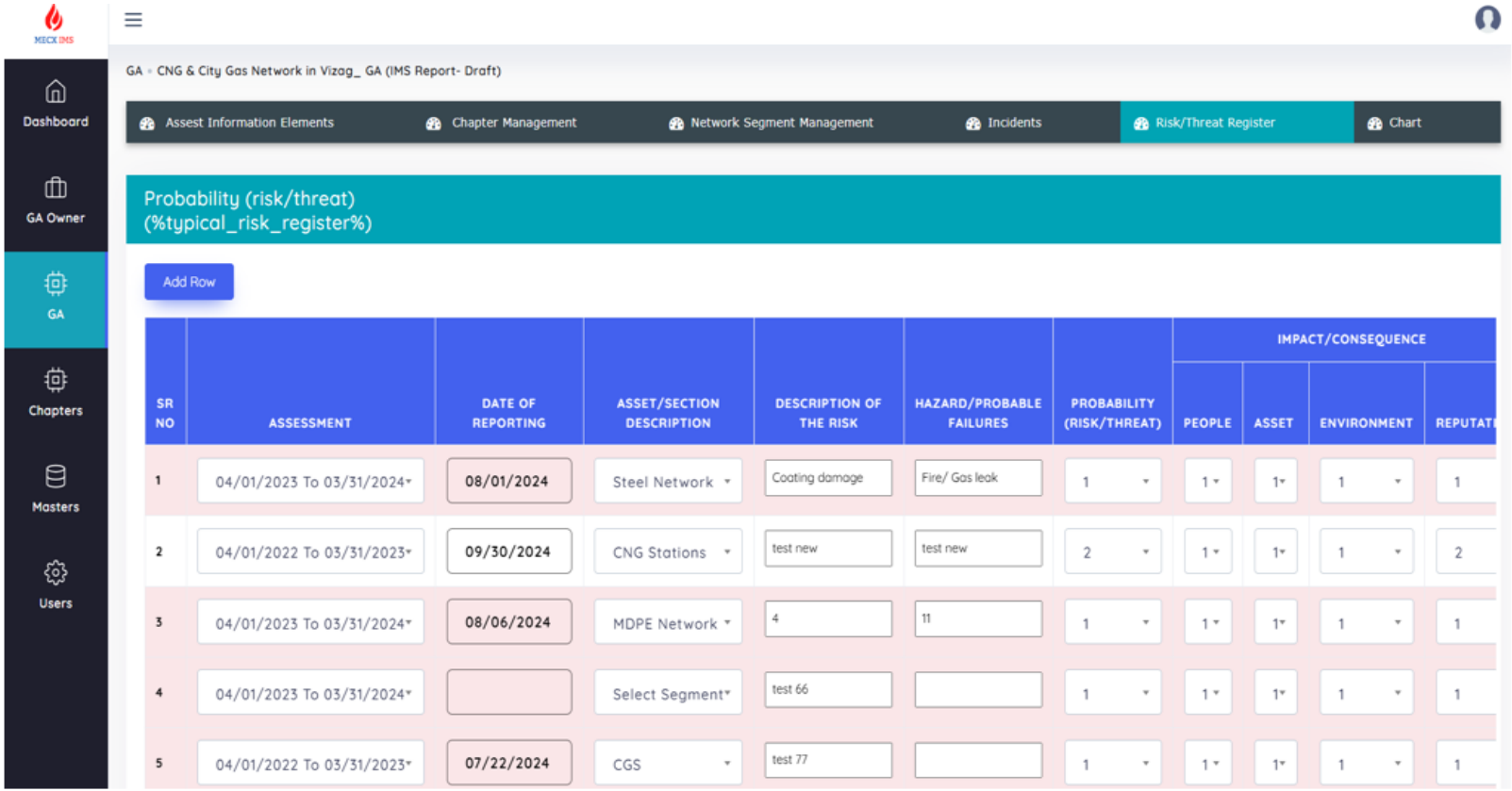
Designing Cloud-Based IMS



Incident report Mechanism with classification of incident as future risk

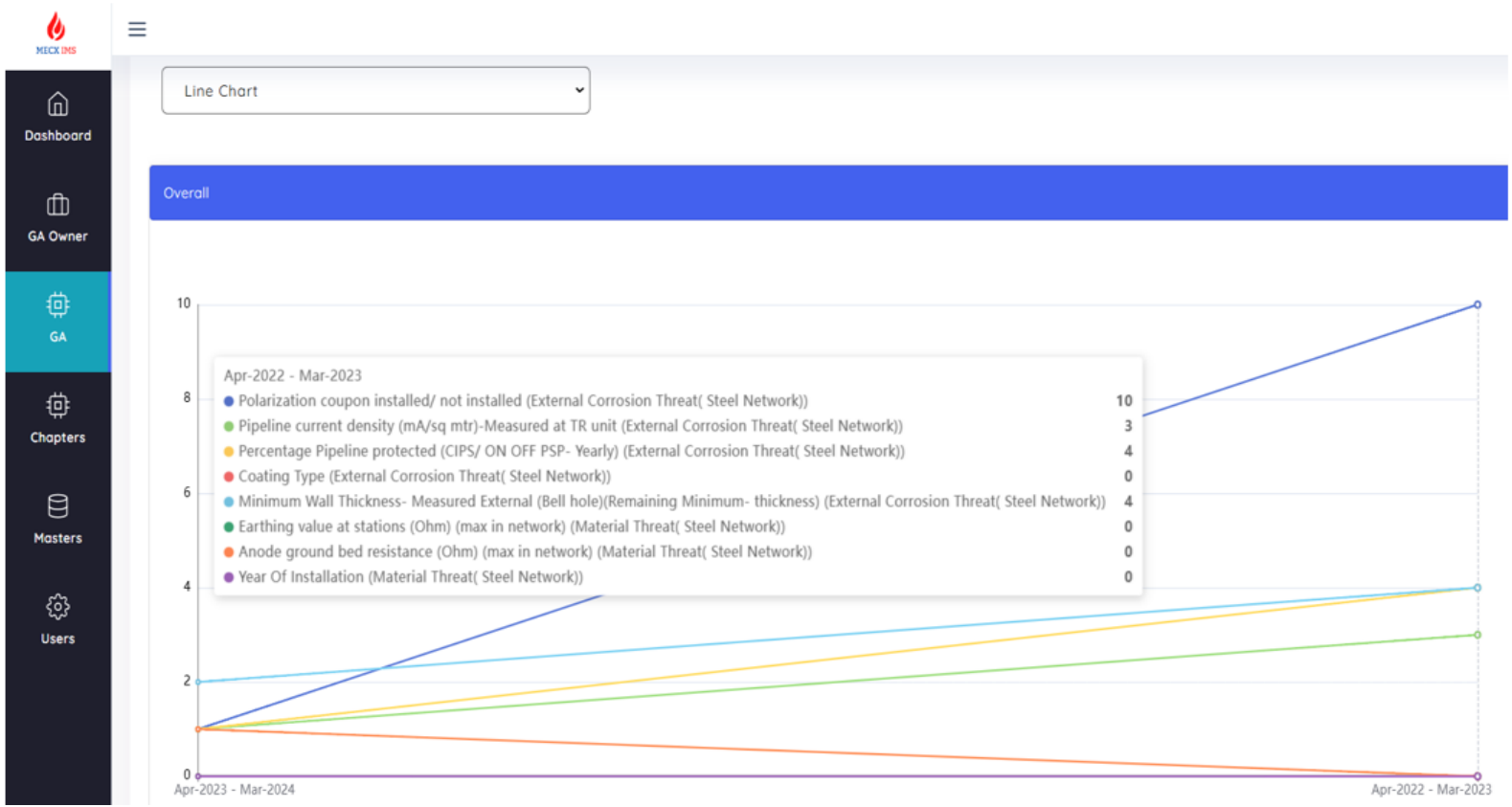


Other features of the System- Online Risk Register

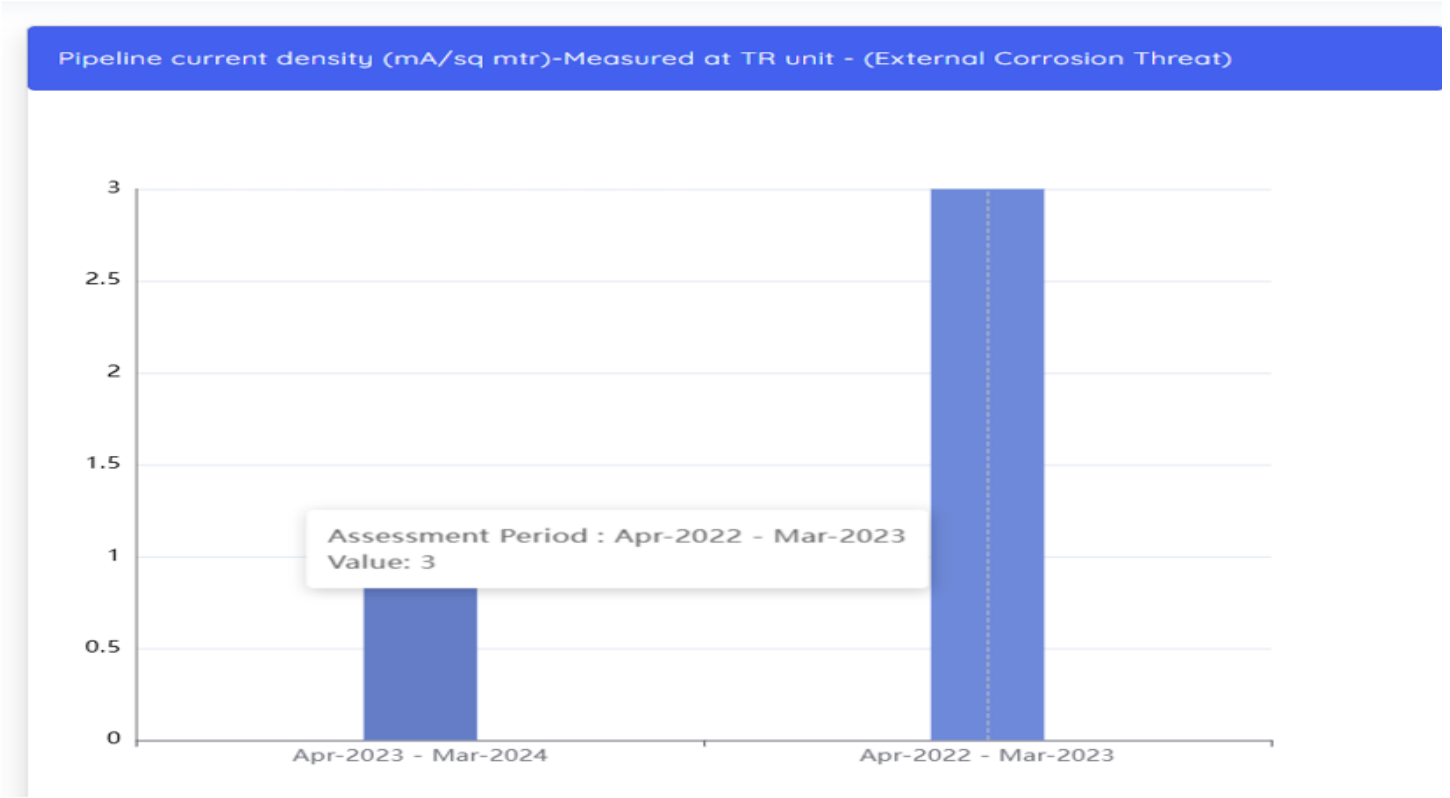


SR NO	ASSESSMENT	DATE OF REPORTING	ASSET/SECTION DESCRIPTION	DESCRIPTION OF THE RISK	HAZARD/PROBABLE FAILURES	PROBABILITY (RISK/THREAT)	IMPACT/CONSEQUENCE			
							PEOPLE	ASSET	ENVIRONMENT	REPUTATI
1	04/01/2023 To 03/31/2024	08/01/2024	Steel Network	Coating damage	Fire/ Gas leak	1	1	1	1	1
2	04/01/2022 To 03/31/2023	09/30/2024	CNG Stations	test new	test new	2	1	1	1	2
3	04/01/2023 To 03/31/2024	08/06/2024	MDPE Network	4	11	1	1	1	1	1
4	04/01/2023 To 03/31/2024		Select Segment	test 66		1	1	1	1	1
5	04/01/2022 To 03/31/2023	07/22/2024	CGS	test 77		1	1	1	1	1

Other features of the System- Trends and Analytics



Other features of the System- Trends and Analytics



How Cloud-Based IMS Overcomes Traditional Challenges

Transforming CGD Network Management with Cloud Solutions

Manual Data Collection Traditional systems rely on manual input, leading to errors and delays.	**Limited Scalability** Growth is constrained by the system's ability to scale with demand.	**Data Silos** Information is often trapped in separate systems, hindering access and analysis.	**Delayed Response** Slow data processing results in delayed decision-making and responsiveness.
Automated, Real-Time Data Collection Cloud-based IMS automates data gathering, ensuring up-to-date information.	**Seamless Scalability** Easily adapts to growing needs without compromising performance.	**Centralized Data Storage** All data is stored in one location, enhancing accessibility and collaboration.	**Instant Alerts and Insights** Real-time notifications help in quickly addressing issues as they arise.

Conclusion

- Ease in data input to check the integrity of the system.
- Optimized solution considering Indian Context- Real time and discreet data input, no need to have IoT sensors at all locations except critical locations.
- Predictive IMS system-Helps in decision making & prioritizing preventive maintenance as per Daily/Weekly/ Monthly integrity checks with risk levels.
- Report generation on one Click as required for Compliance (PNGRB).
- Easy Access to Historical data analysis, all maintenance records, audit reports (T4S, IMS, ERDMP etc) past reports at One location.
- All integrity data at One Location and can be access from anywhere in India and also shared to regulatory body (PNGRB).
- Asset owner can manage Multiple GA & Location at same window for Integrity assessment.
- Simplified process with minimal resource allocation vs complex process which require lot of Human resource.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THANK YOU