



ASSESSMENT OF AUTOMATION, DIGITALIZATION IN OPERATIONS & SAFETY OF CGD SECTOR





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FOREWORD

The City Gas Distribution (CGD) sector has emerged as an important pillar of India's transition towards a cleaner, reliable & efficient energy system. As the CGD network continues to expand across the country, the question before the sector is no longer how fast the network can be created, but how efficiently, safely and intelligently it can be operated. Managing India's large and growing natural gas network through increasing dependence on manual interventions has its limitations. The present report on "**Assessment of Automation, Digitalization in Operations & Safety of CGD Sector**" provides an assessment of the prevailing level of automation and digitalization across CGD segment as well as the technology-led opportunities that can shape the future of CGD operations.

2. The report takes a sector-wide view of how technology can be deployed across the CGD value chain right from the Natural Gas Pipeline tapping point to CNG stations, Steel and MDPE distribution networks, DRS, GIS and consumer services. Through structured information gathering, stakeholder interactions and field-level assessments, the report benchmarks the automation maturity of CGD entities, identifies critical gaps and highlights opportunities where technology can deliver tangible operational and safety benefits. The outcome is a set of priority-based recommendations intended to provide a roadmap for progressive automation, better operational control, enhanced safety and improved efficiency across the CGD sector.

3. The recommendations brought out in this report may serve as a roadmap for progressive digitalization and automation of the sector. CGD entities are encouraged to examine and adopt these recommendations based on operational criticality, risk, technology readiness and investment priorities after due deliberation within CGD Technical Committee for phased implementation. ***The objective should be to progressively establish an appropriate level of automation across the sector, balancing safety, operational benefits, technical feasibility and economic viability.***

4. I appreciate the efforts undertaken in carrying out this assessment through structured information gathering, stakeholder interactions and field-level observations. I am confident that the report and its recommendations will contribute towards building a safer, more productive, digitally enabled, resilient and efficiently monitored CGD sector.


(Dr. Anil Kumar Jain)
28-8-2026

Preface

The City Gas Distribution (CGD) sector in India is passing through a significant phase of expansion and transformation. From a sector that was initially developed around a relatively limited number of large and established entities, CGD has now evolved into a nationwide network covering Geographical Areas across urban, semi-urban and emerging markets. With 309 Geographical Areas authorised so far, the sector is witnessing rapid growth in PNG connections, CNG infrastructure, industrial and commercial consumers and associated distribution assets.

As this expansion continues, the scale and complexity of managing CGD networks will increase considerably. The sector is envisaged to serve a very large consumer base, potentially reaching about 12 crore users in the years ahead. Managing such a large and geographically dispersed network safely, reliably and efficiently will require a fundamental shift from predominantly conventional and manual modes of operation towards integrated Operational Technology (OT), Automation, Digitalization, SCADA implementation, GIS based network management and data-driven management systems. Digitalization, therefore, is not merely an enhancement to existing systems; it will increasingly become an essential enabler for managing the scale of future CGD operations.

The importance of this transformation extends across the entire energy delivery chain. The objective of the CGD is ultimately not only to transport gas through pipelines, but to ensure that energy reaches the point of use safely, reliably and efficiently—whether at the burner tip of a domestic consumer, the dispenser of a CNG station, an industrial facility, a restaurant, hotel, hospital, other commercial establishments or a large institution. At each of these interfaces, timely availability of reliable operational information, accurate and transparent metering, effective monitoring, automated controls and a reliable responsive emergency system can add significant value to improve safety, continuity, accountability, consumer service and operational decision-making.

It was in this context, and pursuant to the guidance and advice of **Dr. Anil Kumar Jain, Chairperson, PNGRB**, that the present focused exercise on “**Automation, Digitalization in Operations & Safety of CGD Sector**” was undertaken. The exercise was further pursued under the mentoring and guidance of **Sh. Anjan Kumar Mishra, Secretary, PNGRB**. We express our sincere gratitude to both the Chairperson and the Secretary for their guidance, encouragement and support, which provided direction and purpose to this study.

A key feature of this exercise has been its field-based approach. This is not a desktop study based merely on secondary information or responses received on the subject paper. The assessment was undertaken through a combination of structured questionnaires, detailed technical interactions/focused interviews, visits to Control Rooms and Command Centres. These visits to operational installations, demonstrations of deployed systems, discussions with operations, maintenance and automation personnel, field observations and comparative assessment were the foundation of this study. The assessment covered critical elements of the CGD value chain, including CGS, steel pipeline networks, CNG stations, DRS, MDPE networks, consumer metering, GIS, SCADA, centralized monitoring, Third-Party Damage prevention, CCTV, Digital consumer-connect systems and integration of relevant information with PNGRB's NHIMS platform.

The exercise has also demonstrated that the CGD sector is at different stages of automation maturity vis a vis to authorized Geographical Areas. Several entities have established advanced centralized control environments integrating SCADA, GIS, telemetry and enterprise systems, while others are progressing through phased implementation. Such diversity is understandable given differences in the timeline of authorization, age of networks, geographical spread, operating philosophy, investment cycles and stage of development. At the same time, the entry of recent players makes it increasingly important that a common and clearly defined baseline for automation and digitalization is established providing minimum functional capabilities, interoperability, visibility and safety requirements as a consistent foundation for the sector.

An important principle followed during preparation of the report has been transparency and deliberation. The observations and recommendations were not intended to be developed in isolation. The report has been shared with the entities covered under the assessment as well as other stakeholders/peers for their review and comments. Their in-

puts have been examined and appropriately considered in finalising the report. The resulting document is therefore intended to represent a well-reviewed and well-deliberated assessment, while retaining the independent regulatory perspective and objectives of the study.

We also recognise that the future growth of CGD will place substantial demands on the ability of entities to manage increasingly large numbers of assets, consumers and transactions. The challenge will therefore move progressively from network creation to intelligent management of the network. Centralized monitoring, remote operation, digital asset records, smart metering, GIS-based decision support, automated gas accounting, predictive maintenance, digital emergency response and integrated enterprise systems will become increasingly important in managing this growth.

Finally, this report is envisaged not as an end, but as a basis for the next stage of regulatory and sectoral deliberation. The recommendations brought out herein are proposed to be placed before the CGD Technical Committee members and considered through the due regulatory deliberation process of PNGRB. Based on such deliberations, examination of technical feasibility, stakeholder inputs and regulatory considerations, appropriate recommendations may be taken forward for incorporation through amendments to the PNGRB Technical Standards and Specifications including Safety Standards for City or Local Natural Gas Distribution Networks (T4S) Regulations, 2008 and allied regulatory provisions.

It is our sincere hope that this report will contribute to the evolution of safer, smarter, more integrated and future ready CGD networks in India. As the sector moves towards a much larger consumer base and a truly nationwide gas distribution ecosystem, the ability to combine physical infrastructure with digital intelligence will be central to ensuring that gas—and the energy it represents—reaches every intended consumer safely, reliably and efficiently.

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Executive Summary

The City Gas Distribution (CGD) sector in India has witnessed phenomenal expansion over the last decade wherein multiple CGD bidding rounds were conducted. A total of 309 GAs have been authorised so far leading to an increasing development of infrastructure, domestic PNG connections, CNG networks and operational assets. With the growing scale and complexity of operations, the need for enhanced operational visibility, integrity management, Third-Party Damage (TPD) prevention and real-time monitoring has become increasingly important. Consequently, adoption of Operational Technology (OT), Automation, Digitalization and centralized monitoring systems is emerging as a critical requirement for safe and efficient CGD operations.

In this context, PNGRB initiated a focused assessment exercise under to evaluate the extent of automation, digitalization across selected CGD entities. The study was undertaken with the objective of benchmarking prevailing industry practices, identifying technology gaps, assessing operational maturity levels and developing a framework for minimum automation and standardization across the CGD sector.

The assessment involved visits to Control Rooms/Command Centres, structured technical interactions and detailed discussions with operations and automation teams of selected CGD entities. A comprehensive questionnaire-based assessment framework (Annexure-I) was developed and used as the basis for evaluating the following critical operational and monitoring areas:

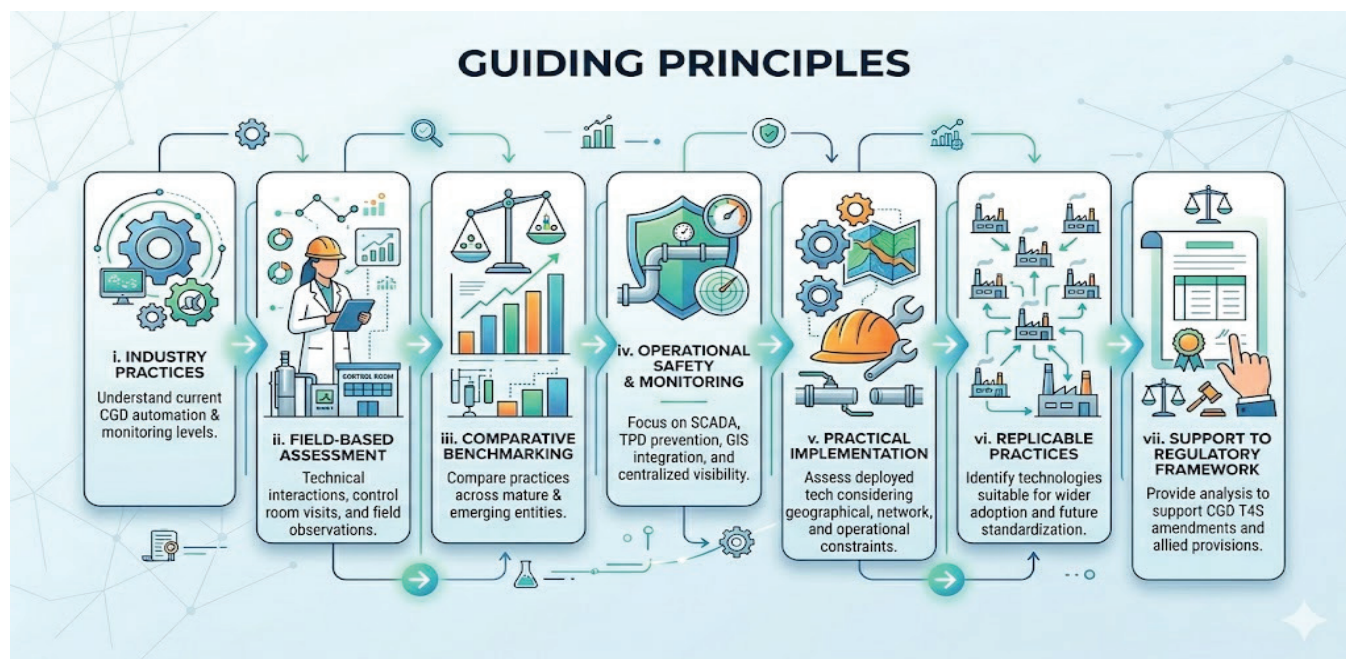
- Control Room / Command Centre infrastructure
- Supervisory Control & Data Acquisition System (SCADA) implementation
- Automation in City Gate Station (CGS), District Regulating Station (DRS), CNG Stations and Sectionalizing Valves & Metering
- GIS integration and digital asset management
- Third-Party Damage (TPD) prevention systems
- CCTV surveillance and centralized monitoring
- Consumer-connect applications
- Accessibility and integration of information with PNGRB's NHIMS platform

The assessment indicated substantial variation across the visited entities in operational maturity, automation adoption and centralized monitoring capability, with several existing Technical Standards & Specifications including Safety Standards (T4S) provisions met only at a baseline level and notable inter-entity gaps in remote operability of valves, geo-fencing for TPD prevention, smart metering, and SCADA–Enterprise Resource Planning (ERP) integration. The guiding principles adopted for the study, key observations emerging from the assessment, recommended regulatory, technical and operational interventions, and chapter-wise analysis of each major CGD infrastructure assets are presented in the subsequent chapters. The report culminates in a phased, risk-based framework for sectoral transition, aligned with possible future amendments to PNGRB T4S and allied regulatory provisions.

A. Guiding Principles

- Understanding Existing Industry Practices:** The study has been carried out with the objective of understanding the prevailing levels of automation, digitalization and operational monitoring practices being adopted across different categories of CGD entities.
- Field-Based Assessment and Validation:** The assessment approach has been based on detailed technical interactions, Control Room visits, demonstrations and field-level observations to understand actual implementation status of automation and monitoring systems.
- Comparative Benchmarking Across Entities:** The exercise aims to benchmark practices across mature and emerging CGD entities to identify variations in operational systems, technology adoption and safety management approaches.
- Focus on Operational Safety and Monitoring:** Special emphasis has been given to systems and practices related to operational safety, SCADA integration, Third-Party Damage (TPD) prevention, GIS integration and centralized operational visibility.
- Assessment of Practical Implementation:** The study has considered practical operational challenges, geographical conditions, network maturity and field-level constraints while evaluating deployed technologies and automation practices.

- vi. **Identification of Replicable Practices:** The assessment has focused on identifying technologies and operational practices that may be suitable for wider adoption and future standardization across the CGD sector.
- vii. **Support to Regulatory Framework:** The observations generated through the study relating to automation, operational monitoring with possible amendments to PNGRB T4S for CGD Network Regulations, 2008 and allied regulatory provisions.



B. Key Observations

i. Variation in Automation Maturity across CGD entities

The assessment revealed substantial variation across entities in terms of operational maturity, automation adoption and centralized monitoring capability. While certain entities have established advanced integrated command centres with SCADA, telemetry, GIS integration and centralized alarm management systems, others continue to rely substantially on decentralized operations and manual field-based practices. A significant variance has also been observed in field-level automation across CGS, DRS, sectionalizing valves (SVs), CNG stations and metering systems.

ii. Need for Benchmarking and Standardization in Phased manner

The assessment revealed considerable disparity across entities in terms of automation adoption, operational monitoring capability and compliance with existing PNGRB CGD regulatory requirements. While certain entities are meeting only the minimum requirements, particularly with respect to automated odorization and GIS mapping, others are significantly advanced across multiple automation parameters.

The observations indicate lack of uniformity in SCADA coverage, telemetry systems, GIS integration and centralized monitoring practices across the CGD sector, highlighting the need for defining minimum standardization levels to ensure baseline digital and operational capability across all CGD entities.

Such benchmarking would enable formulation of more realistic and risk-based recommendations, particularly for future strengthening of PNGRB T4S for CGD Network Regulations, 2008 and ERDMP related regulatory provisions.

iii. Positive Impact of Automation on Operations & Safety

Entities have indicated that implementation of automation systems has led to reduction in manual efforts, improved monitoring and faster response during abnormal operational conditions, thereby contributing positively towards better operational efficiency.

Entities with higher levels of automation demonstrated better operational visibility, quicker response mechanisms, better consumer connect and improved centralized control over geographically distributed assets.

iv. **Integration with PNGRB-NHIMS**

PNGRB's communication during interactions with entities emphasized the need to align their automation systems integration of key asset details and GIS mapping with NHIMS.

C. Key Recommendations

The report outlines a phased and implementation-oriented roadmap for progressive adoption of automation, SCADA, digital monitoring, and integrated operational technologies across the CGD sector. The recommendations brought out in the report are intended to guide CGD entities towards strengthening operational safety, pipeline integrity, emergency preparedness, regulatory compliance, consumer service quality, and long-term business sustainability. While several recommendations may already be covered under existing PNGRB regulations, their structured implementation assumes significant importance from the perspective of safe operations, efficient asset management, improved reliability, and overall business continuity. The recommendations summarized hereby in the Executive Summary represent only the major actionable areas, while detailed technical, operational recommendations have been elaborated in the subsequent chapters of the report each asset wise.

1. Centralized SCADA and ERP Integration for Multi-GA Operations

CGD entities operating multiple Geographical Areas (GAs) should establish centralized Control Rooms integrated with SCADA and ERP/SAP platforms along with GA-level monitoring systems for centralized operational visibility, improved emergency response, and efficient management of geographically distributed assets.

2. Field Automation for Gas Accounting and Lost and Unaccounted Gas (LUAG) Reduction

Field-level automation through pressure, flow, and telemetry monitoring at critical pressure points, DRSs, sectionalizing valves, industrial metering stations, and downstream networks should be implemented to improve gas accounting, enable reconciliation, and reduce LUAG.

3. Automated Odorization and Flow Measurement Integration

Automated odorization systems integrated with real-time flow measurement signals should be mandatorily implemented in line with PNGRB T4S Regulations. Automated flowmeter readings at CGS facilities are essential for proportional odorant dosing under varying gas flow conditions.

4. Comprehensive GIS and Digital Asset Management

Comprehensive GIS implementation should be ensured for all CGD assets, including legacy and newly developed infrastructure through DGPS-based digitization. GIS platforms should support utility coordination, excavation management, integrity monitoring, and reduction of third-party damages.

5. Remote Operability of Isolation and Emergency Valves

Isolation valves, sectionalizing valves, and Emergency Shut-Off Valves (ESDVs) across steel pipeline networks, CGS facilities, and DRS stations should be integrated with SCADA for rapid remote isolation during emergencies, leakages, fire incidents, or third-party damages.

6. Consumer Connectivity Mapping through GIS

GIS platforms should capture detailed consumer connectivity mapping including risers, runners, and service lines to improve operational traceability, emergency management, network planning, and public awareness of CGD infrastructure.

7. Integrated Consumer Digital Platforms

All CGD entities should deploy integrated consumer applications covering registration, billing, prepaid recharge, self-meter reading, consumption monitoring, grievance handling, payment systems, and emergency reporting for improved consumer services and operational efficiency.

8. Vehicle Tracking and Journey Management Systems

GPS-based vehicle tracking and journey management systems should be implemented for Mobile Cascade Vehicles, emergency response teams, patrolling, and surveillance operations to prevent DBS dry-out conditions, improve logistics, and strengthen emergency preparedness. AI-based cabin camera systems may also be deployed for driver fatigue detection.

9. GIS-Based Geofencing and Excavation Monitoring

Considering that approximately 55% of third-party damages during the last three years were associated with excavation and construction activities, GIS-integrated geo-fencing and excavation monitoring systems should be progressively implemented using RFID/GPS-based tracking of construction equipment for proactive infrastructure protection and enhanced public safety.

Introduction

Since the establishment of Petroleum and Natural Gas Regulatory Board under the PNGRB Act, 2006, the Board has played a pivotal role in authorizing Geographical Areas (GAs), framing technical and safety regulations, promoting fair competition, and facilitating expansion of PNG and CNG infrastructure across the country. During this period, the CGD network has expanded rapidly in terms of pipeline infrastructure, domestic PNG connections, industrial and commercial consumers, and CNG stations, including penetration into Tier-II and Tier-III cities.

However, while substantial emphasis has been placed on physical infrastructure creation and market expansion, adoption of automation, digitalization, SCADA integration, GIS-based asset management and data-driven operational systems has largely remained a secondary priority across many entities, resulting in varying levels of technological maturity within the sector. With increasing network size, operational complexity, lost & unaccounted gas & energy security, the importance of Operational Technology (OT), automation, digitalization and centralized monitoring systems in ensuring operational safety, integrity management and continuity of gas supply has increased substantially.

In this context, PNGRB initiated a focused assessment exercise for evaluating automation, digitalization across selected CGD entities. The study has been undertaken with the objective of understanding existing practices, benchmarking technology adoption levels, identifying operational and safety gaps with respect to current regulations and examining the suitability of various automation systems for wider sectoral implementation.

The assessment exercise included structured technical discussions with concerned operations and automation teams, visits to Control Rooms/Command Centres and field installations, review of deployed technologies and comparative analysis of operational practices adopted by different CGD entities. The exercise also focused on evaluating systems related to SCADA integration, field-level automation, Third-Party Damage (TPD) prevention, GIS mapping, telemetry systems, CCTV coverage and consumer-connect platforms.

At present, the level of automation and digital integration varies significantly across CGD entities depending upon network maturity, geographical spread, operational philosophy and investment priorities. While certain entities have implemented advanced integrated control systems with centralized monitoring capabilities, several entities continue to operate with limited automation and field-level manual operations.

The findings and observations from the present study are intended to support development of a risk-based and implementation-oriented framework for strengthening operational safety, monitoring capability, integrity management and digital standardization across the CGD sector. The report further aims to provide inputs for future policy formulation, standardization efforts and strengthening of relevant provisions under PNGRB T4S and allied regulations.

Objectives

The study has been undertaken with the following objectives:

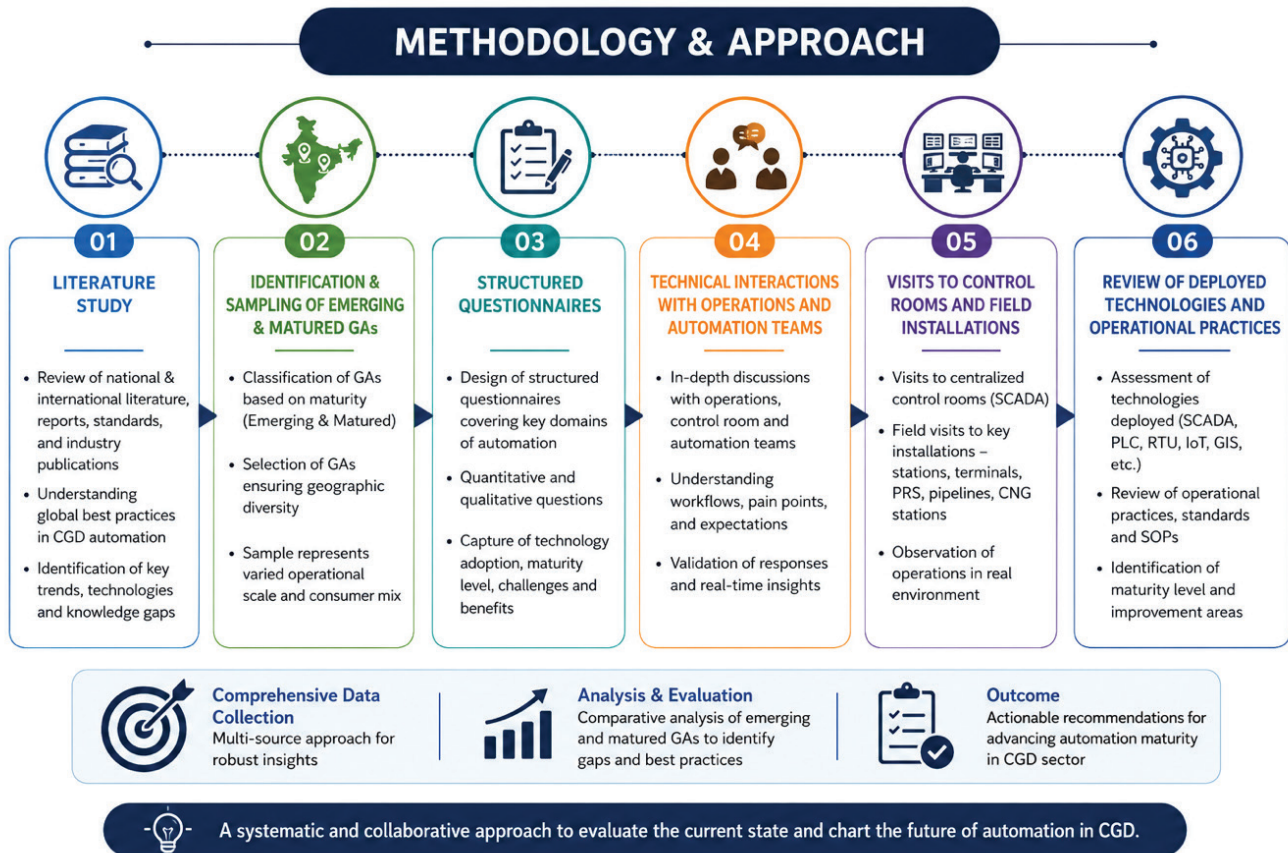
- i. Establish a benchmark for automation levels across CGD networks
- ii. Enhance Operational Safety and Pipeline Integrity
- iii. Strengthening Real-Time Monitoring and Centralized Control
- iv. Promote Comprehensive GIS and Digital Asset Management
- v. Develop a Phased Roadmap for Smart CGD Networks

Scope

The assessment broadly covered the following areas:

- ✓ Control System architecture
- ✓ Control Room / Command Centre setup
- ✓ Automation of CGS, DRS, CNG Stations and Sectionalizing Valves
- ✓ Third Party Damage (TPD) prevention systems
- ✓ GIS mapping and digital asset management
- ✓ Consumers connect systems and Applications
- ✓ CCTV surveillance and monitoring systems

- ✓ Digital project monitoring practices
- ✓ Cybersecurity practices in operational systems



Entities Covered through visits

The following CGD entities were covered during the assessment exercise:

- Indraprastha Gas Limited-**New Delhi**
- Haryana City Gas- **Gurugram**
- Think Gas- **New Delhi**
- Indian Oil Adani Gas Private Limited- **Noida**
- Adani Total Gas Ltd- **Ahmedabad**
- Torrent Gas Ltd- **Ahmedabad**
- Gujarat Gas Limited- **Surat**
- Mahanagar Gas Limited-**Mumbai**
- Maharashtra Natural Gas Limited-**Pune**

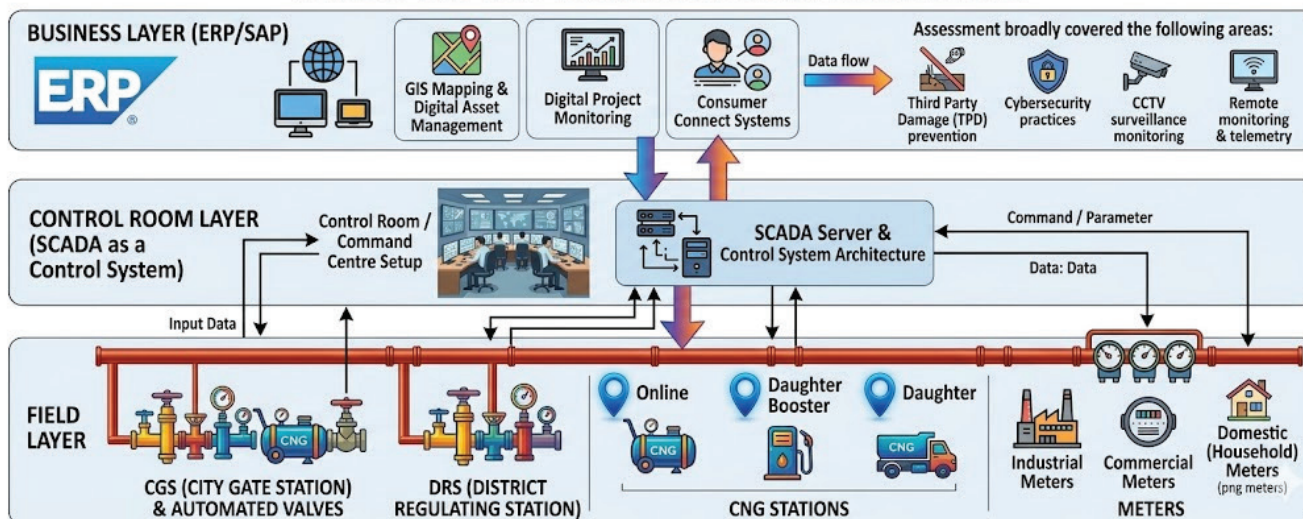
Role of Automation in CGD Operations

Automation plays a vital role in improving the safety, reliability, and efficiency of City Gas Distribution (CGD) operations. With rapid expansion of PNG networks, CNG stations, and pipeline infrastructure, manual monitoring alone is no longer sufficient for managing widespread and complex assets. Automation enables real-time monitoring of parameters such as pressure, flow, gas quality, and equipment performance, thereby reducing human intervention, improving operational control, and supporting predictive maintenance and leak detection.

Automation also strengthens safety and regulatory compliance in CGD systems through automated alarms, remote shutdown systems, intelligent sensors, and centralized monitoring. These technologies help in early detection of

abnormal conditions and reduce risks related to gas leakage, equipment failure, and third-party damage. As CGD networks continue to expand, automation is becoming essential for efficient, scalable, and future-ready operations.

INTEGRATED CGD CONTROL SYSTEM ARCHITECTURE



Supervisory Control and Data Acquisition (SCADA) system form the backbone of operational monitoring and control architecture in modern City Gas Distribution (CGD) networks. With increasing expansion of CGD infrastructure across Geographical Areas (GAs), centralized monitoring and real-time operational visibility have become essential for ensuring operational safety, integrity management, continuity of gas supply and efficient network operations.

SCADA system enable centralized monitoring and operational control of geographically distributed CGD assets through integration of field instrumentation, telemetry systems, communication networks and centralized control rooms and are generally utilized for:

- Real-time monitoring of critical parameters
- Monitoring of operational status of field assets
- Alarm generation and abnormal condition monitoring
- Event logging and operational trend analysis
- Remote monitoring and Emergency response

In view of the expanding scale and complexity of CGD networks, automation and SCADA systems are gradually becoming essential components for ensuring safe, reliable, and efficient operations. The level of integration across CGS, DRS, CNG stations, Industrial consumers, and Enterprise management platforms reflects the technological maturity of a CGD entity and its preparedness for future operational challenges. Adoption of integrated monitoring, remote operation, predictive maintenance, and centralized data management systems not only enhances operational efficiency and safety but also supports regulatory compliance, faster decision-making, and improved consumer services. As the CGD sector continues to evolve, greater emphasis on automation, digitalization, and integrated operational technologies will be critical for developing resilient, scalable, and future-ready gas distribution infrastructure.

In the subsequent chapters, each major CGD infrastructure segment shall be examined individually with respect to minimum recommended automation requirements, operational challenges, and recommended technological interventions. The assessment shall focus on identifying essential automation points for various installations including CGS, DRS, CNG stations, pipeline networks, industrial interfaces, and control room operations, along with recommendations aimed at enhancing safety, operational efficiency, monitoring capability, and overall system reliability.

Chapter - 1 City Gate Station (CGS)

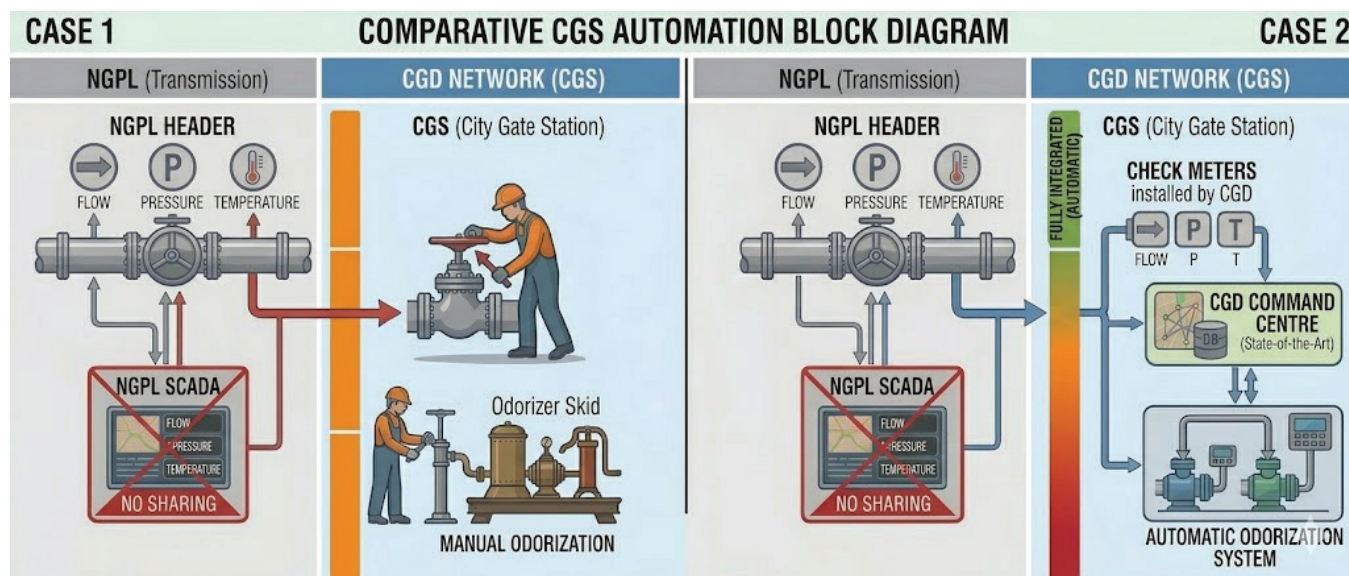
City Gate Station (CGS) is the primary interface facility between the Natural Gas transmission pipeline network and the City Gas Distribution (CGD) network, serving as the starting point for gas distribution within an authorised Geographical Area (GA). CGS facilities can broadly be categorized into two types.

First type comprises CGS installations located within the Sectionalising Valve (SV) station premises of the natural gas transmission entity, wherein gas is tapped off directly from the transmission pipeline. Due to space limitations and operational constraints within such SV stations, dedicated check metering facilities for the CGD entity may or may not be available.

Second type comprises standalone CGS facilities owned and constructed by CGD entity, away from the transmission entity's SV station tap-off point. In such cases, the custody transfer meter installed by the transmission entity may be integrated within the pressure reduction skid and generally remains under the operational control and purview of the transmission company. In addition the CGD entity also installs a check meter of similar make and type of custody meter to avoid any ambiguity in custody transfer of natural gas.

A typical CGS facility consists of pressure reduction and regulation systems, filtration arrangements, metering systems, odorization systems, isolation arrangements, cathodic protection interfaces, and associated instrumentation and electrical systems. In many CGS facilities, check meters are installed downstream of the pressure reduction skid. **Availability of such flow measurement data is extremely important for CGD entities, particularly for automated operation of odorization systems.** Continuous and accurate gas flow data enables proportional dosing of odorant into the gas stream, thereby ensuring proper odorant concentration under varying demand conditions. In the absence of flowmeter data, automation of odorization becomes operationally difficult and, in many cases, practically unviable.

This assumes significance considering that the Petroleum and Natural Gas Regulatory Board (PNGRB) Technical Standards and Specifications (T4S) Regulations for CGD networks mandate automation of odorization systems.

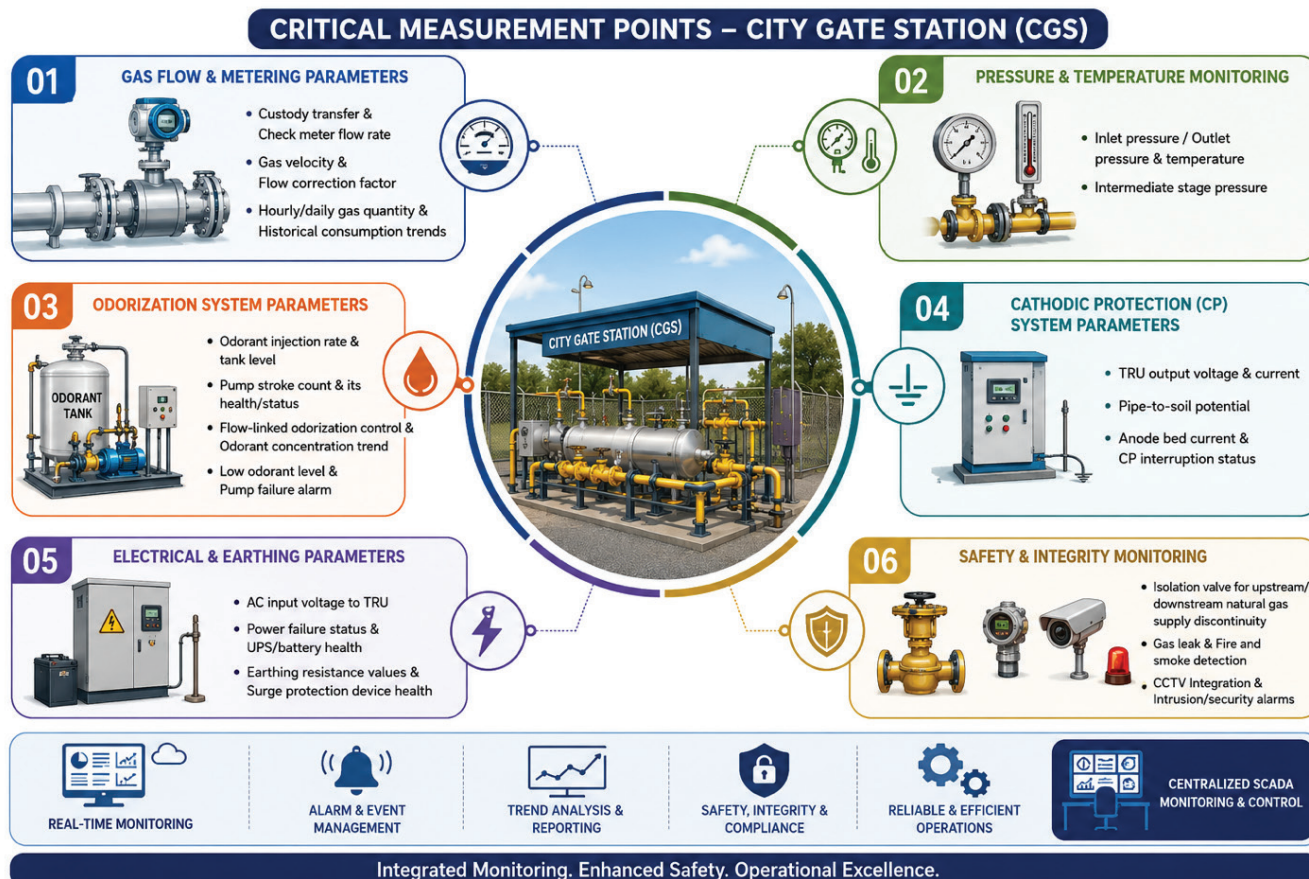


The CGS generally acts as the origin point of the steel pipeline network (primary steel mains) for downstream gas distribution within the authorised GA. Above ground isolation valve to isolate the entire downstream steel mains as well as an additional isolation valve to isolation the tap off SV station of transmission lines are installed. Since buried steel pipelines are susceptible to external corrosion, implementation of Cathodic Protection (CP) systems is essential for maintaining pipeline integrity. During initial construction and commissioning phases, temporary CP arrangements are often provided; however, these are subsequently replaced by permanent CP systems involving installation of dedicated anode beds. As CGS locations are generally selected considering availability of reliable electrical power supply, Transformer Rectifier Units (TRUs) are commonly installed either within the CGS premises or in close proximity.

Electrical grounding and safety systems also form integral components of CGS facilities. Typically, copper earthing systems are provided for instrumentation and electronic systems, while galvanised iron (GI) earthing arrangements are used for fencing, lighting poles, and structural components. Since CGS installations involve interfaces between above-ground and buried metallic pipelines, installation of Insulating Joints (IJs) is mandatory to electrically isolate different pipeline sections and preserve cathodic protection effectiveness.

In addition to the above systems, CGS facilities involve routine operational monitoring wherein critical parameters associated with odorization systems, pressure regulation systems, and gas quality (ensured by installation of gas chromatograph) are periodically recorded.

Critical Measurement Points in CGS



Recommendations for Automation of CGS Facilities

1. Sharing of Flowmeter Data by Natural Gas Transmission Entities

In cases where CGS facilities are located within the SV station premises of transmission entities, the transmission company should provide real-time flowmeter data/signals to the concerned CGD entity through suitable communication interfaces. Availability of such flow data is essential for enabling automated odorization systems as mandated under PNGRB CGD T4S Regulations.

2. Provision for Installation of Clamp-on Ultrasonic Flow Meters

Where sharing of custody meter signals is operationally or commercially constrained, transmission entities should permit installation of independent clamp-on ultrasonic flow meters by the CGD entity. These non-invasive meters can be installed externally on pipelines without shutdown, pipe cutting, or pressure loss and can provide continuous flow signals necessary for automated odorization control.

3. Remote Operability of Isolation and Emergency Shut-Off Valves

Isolation valves and Emergency Shut-Off Valves (ESDVs) installed at CGS facilities, whether intended for isolation of gas supply from the transmission pipeline or for isolation of downstream steel distribution mains, should be equipped with remote operability through SCADA system. Remote actuation capability would enable faster response during emergency situations such as gas leakage, fire incidents, pressure excursions, or pipeline failures, thereby enhancing safety and minimizing response time.

4. **Integration of Complete CGS with SCADA System & Field Instrumentation**

All critical CGS parameters, including pressure, temperature, flow, odorization, cathodic protection, alarms and safety systems, with smart transmitters capable of transmitting continuous digital data should be integrated with centralized SCADA platforms to enable real-time monitoring & remote operation management.

5. **Remote Monitoring of Cathodic Protection Systems**

Remote monitoring units should be installed for continuous monitoring of TRU performance, pipe-to-soil potentials, and anode bed health to ensure pipeline integrity and enable predictive maintenance.

6. **Automated Odorization System**

Odorization skids should be equipped with automated proportional dosing systems integrated with flow measurement signals, along with remote monitoring of odorant tank levels, pump performance, and alarm generation.



Chapter - 2 Steel Pipeline Network

A Steel Pipeline Network or steel mains network constitutes the primary high-pressure gas distribution backbone within a City Gas Distribution (CGD) network. These pipelines generally originate from the City Gate Station (CGS) and transport natural gas across the authorised Geographical Area (GA) to various downstream facilities such as District Regulating Stations (DRS), CNG stations, industrial consumers, and other distribution networks.

The steel pipeline network generally comprises buried carbon steel pipelines along with associated facilities such as sectionalizing valves, isolation valves, insulating joints, cathodic protection systems, test lead points (TLPs), marker posts, warning systems, and pipeline crossings. Since these pipelines remain continuously exposed to external soil conditions, moisture, stray currents, and environmental factors, corrosion protection assumes critical importance. Accordingly, steel pipelines are protected through external coating systems supplemented by cathodic protection systems, generally based on Impressed Current Cathodic Protection (ICCP) methodology.

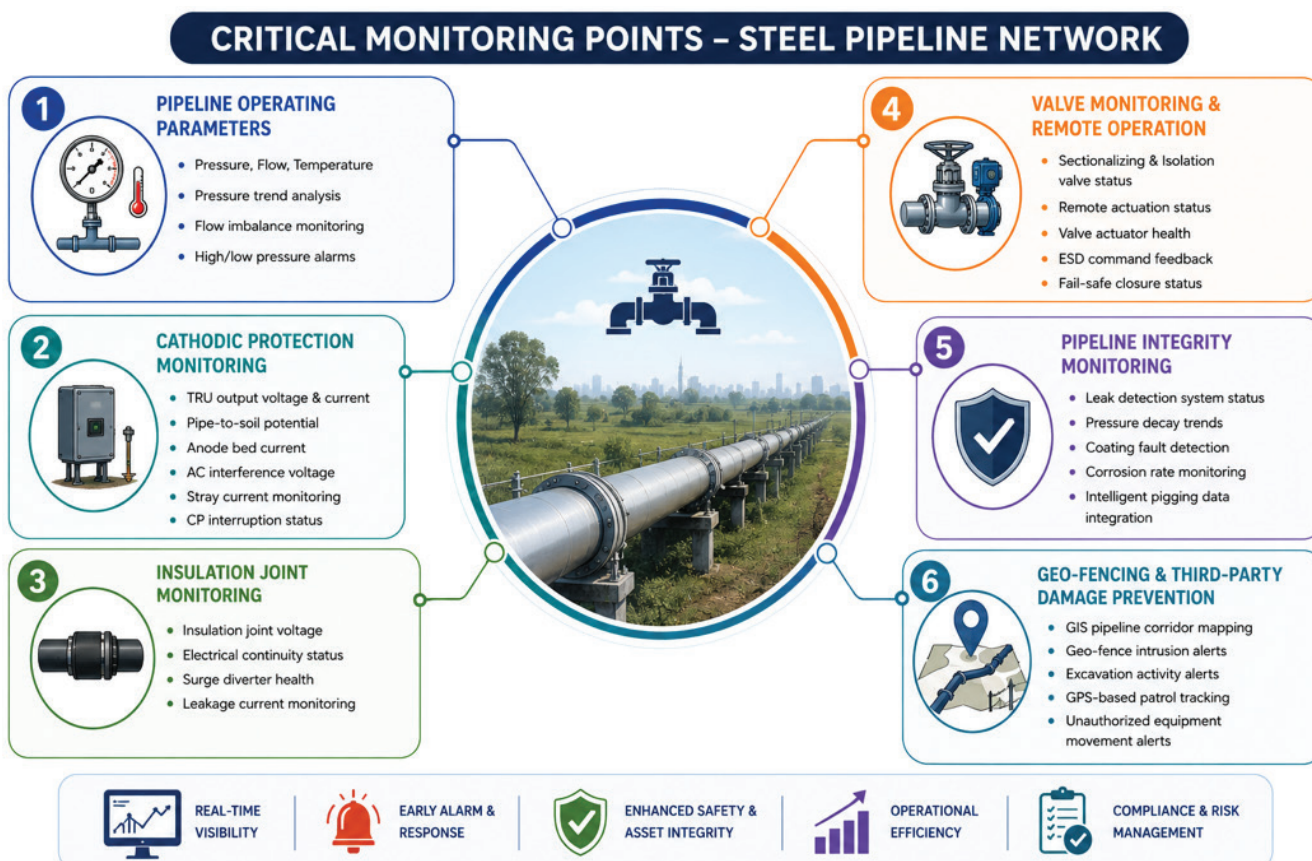
Cathodic protection systems consist of Transformer Rectifier Units (TRUs), anode beds, test stations, Test Lead Points (TLPs), and electrical continuity arrangements and are installed at regular intervals and at critical locations such as road crossings, railway crossings, valve locations.

Insulating Joints (IJs) are another critical component of the steel pipeline network and are installed to maintain electrical discontinuity between different pipeline sections or between cathodically protected sections and above-ground facilities.

Sectionalizing valves and isolation valves are installed at an interval of 3 kilometres throughout the steel pipeline network for operational flexibility, maintenance activities, emergency response, and pipeline isolation during abnormal conditions.

Third-party damage remains one of the major threats to underground steel pipelines within urban environments due to excavation activities, road construction, utility works, and infrastructure development projects. To mitigate such risks, Geo-fencing and GIS-integrated monitoring systems are increasingly being implemented. **Geo-fencing** enables creation of virtual protection corridors around buried pipeline alignments and can be integrated with excavation monitoring systems, GPS-based tracking, and municipal utility coordination platforms for generation of alerts whenever unauthorized excavation or heavy equipment movement is detected near pipeline corridors.

Critical Measurement Points in Steel Pipeline Network



Recommendations for Automation of Steel Pipeline Network

1. Comprehensive SCADA Integration for Steel Network

The complete steel pipeline network including sectionalizing valves, District Regulating Stations (DRS), cathodic protection systems, and monitoring stations should be integrated with centralized SCADA system for real-time monitoring and operational control.

2. Remote Operability of Isolation and Sectionalizing Valves

Isolation valves and sectionalizing valves installed throughout the steel pipeline network should be equipped with remote operability through SCADA systems. Remote operation capability would enable rapid isolation of affected pipeline sections during emergencies

3. Remote Monitoring of Cathodic Protection Systems Insulation Joints and TLPs

Transformer Rectifier Units (TRUs), anode beds, and Test Lead Points (TLPs) should be integrated with SCADA system for continuous monitoring of cathodic protection performance. Insulation joints installed within the steel pipeline network should be digitally monitored to ensure proper electrical discontinuity between pipeline sections and adjacent anode beds.

4. Implementation of Geo-fencing for Third-Party Damage Prevention

GIS-integrated geo-fencing systems should be implemented along steel pipeline corridors to generate alerts in case of unauthorized excavation, construction activity, or heavy equipment movement near the pipeline alignment. Such systems may also be integrated with municipal utility databases and excavation permit systems for proactive prevention of third-party damages.

5. Digital Pipeline Integrity Management System

A centralized digital integrity management platform should be implemented for integrating cathodic protection data, leak survey records, patrolling data, intelligent pigging records, coating assessment reports, and maintenance history for improved asset integrity management.

6. Leak Detection and Real-Time Alarm Systems

Real-time leak detection systems integrated with pressure monitoring and flow analysis should be deployed for early identification of pipeline leakages and abnormal operating conditions.

7. GPS-Based Digital Patrolling Systems

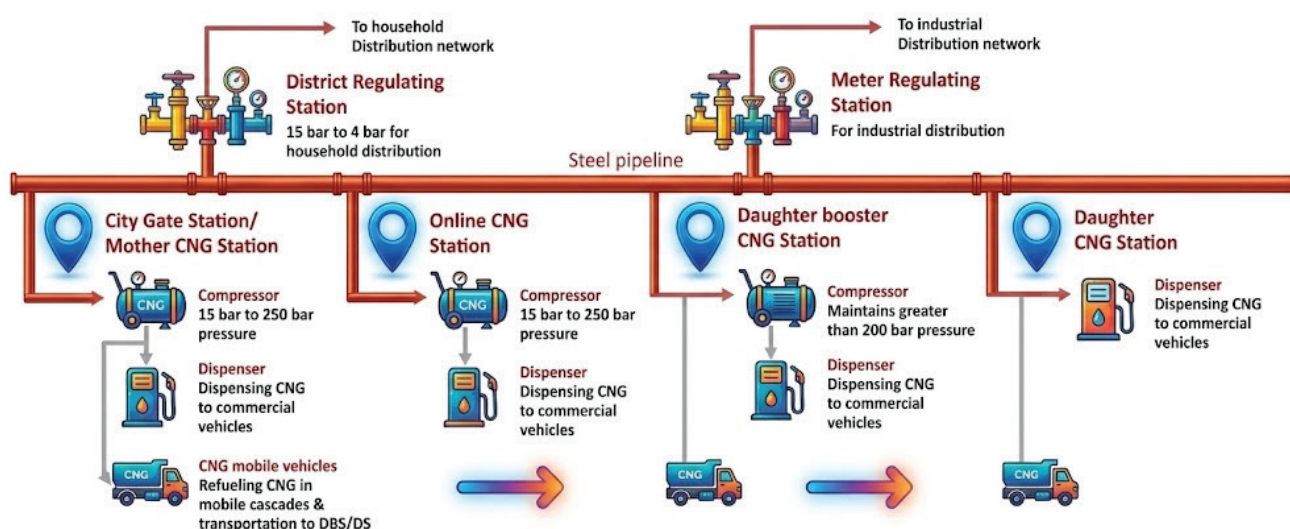
Mobile-based GPS-enabled patrolling applications should be implemented for pipeline surveillance activities, enabling real-time tracking of patrol personnel, digital inspection records, and geo-tagged incident reporting.



Chapter - 3 CNG Stations

A Compressed Natural Gas (CNG) Station is a critical component of the City Gas Distribution (CGD) network developed for dispensing natural gas as automotive fuel to vehicles in compressed form. CNG stations form an important downstream infrastructure within an authorised Geographical Area (GA) and are designed to ensure safe, continuous, and reliable supply of compressed natural gas to transport sector consumers. Depending upon the source of gas supply and operational configuration, CNG stations are broadly categorized into Online/Mother Stations and Daughter Booster Stations.

An **Online CNG Station**, is directly connected to the CGD steel or MDPE pipeline network and receives continuous natural gas supply through pipeline infrastructure. Such stations generally consist of gas filtration systems, inlet isolation valves, pressure regulating systems (wherever required), compressors, priority panels, cascade storage banks, dispensers, electrical systems, firefighting systems, and associated instrumentation. Gas received through the CGD network is compressed to high pressures, generally around 250 barg, and stored in cascade banks before being dispensed to vehicles through CNG dispensers. Mother stations may also serve as cascade filling stations for transportation of CNG through Mobile Cascade Vehicles to Daughter Booster Stations located away from the pipeline network.



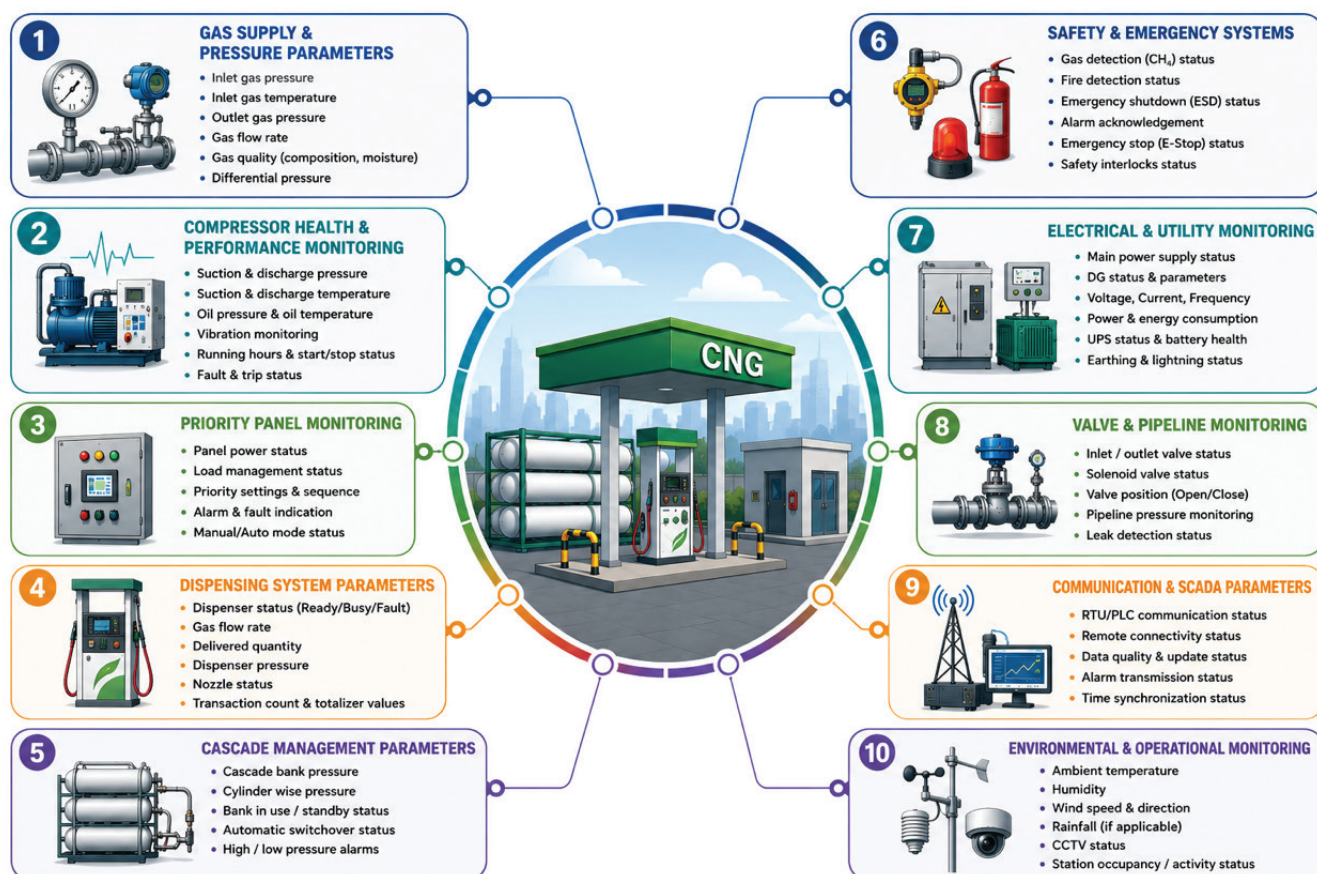
Daughter Booster Stations are established in areas where pipeline connectivity is not presently available or is commercially unviable during initial phases of network expansion. These stations receive CNG through transportable cascades mounted on Mobile Cascade Vehicles from Mother Stations. At Daughter Booster Stations, gas from mobile cascades is further boosted using hydraulic or compressor-based booster systems to maintain dispensing pressure and ensure uninterrupted fueling operations. Such stations generally comprise unloading manifolds, cascade storage systems, booster compressors, dispensers, pressure regulating systems, isolation valves, safety systems, and associated control instrumentation. Daughter Booster Stations play an important role in rapid expansion of CNG infrastructure in developing GAs prior to extension of pipeline connectivity.

Electrical and grounding systems are extremely critical in CNG stations due to the hazardous area classification associated with natural gas handling. Copper earthing systems are generally provided for instrumentation and electronic equipment, while GI earthing is used for structures, canopies, lighting poles, and fencing. Lightning protection systems and surge protection devices are also installed to safeguard electrical and electronic systems against transient voltage surges.

Emergency Shutdown Valves (ESDVs) and isolation valves are installed at strategic locations such as station inlet, compressor suction and discharge headers, cascade manifolds, and dispensing lines. These valves are designed to immediately isolate gas flow during emergencies including gas leakage, fire incidents, overpressure conditions, or compressor malfunction. Gas leak detectors and flame detectors are integrated with automatic shutdown logic to enhance operational safety.

Priority Panels installed in CNG stations constitute one of the most critical operational components for efficient cascade management and uninterrupted dispensing operations. These panels automatically regulate and sequence gas flow between compressor discharge lines, storage cascade banks (low, medium, and high-pressure banks), and dispensers to optimize compressor loading and maximize gas utilization efficiency.

Critical Measurement Points in CNG Stations



Recommendations for Automation of CNG Stations

1. Comprehensive SCADA Integration

All Online/Mother Stations and Daughter Booster Stations should be integrated with centralized SCADA system for real-time monitoring and control of compressors, cascades, dispensers, safety systems, and utility infrastructure.

2. Remote Monitoring of Compressors

Compressors should be integrated with predictive maintenance and condition monitoring systems for tracking vibration, temperature, lubrication parameters, motor performance

3. Automated Cascade and Priority Panel Management

Priority panels and cascade management systems should be fully integrated with PLC/SCADA systems for automated sequencing of low, medium, and high-pressure cascade banks. Critical parameters such as bank-wise pressure, cascade switching operations, valve position status, pressure equalization trends, compressor loading patterns, and abnormal operating conditions should be monitored digitally in real time.

4. Remote Operability of Isolation and Emergency Shutdown Valves

Isolation valves and Emergency Shutdown Valves (ESDVs) installed at station inlet headers, compressor suction and discharge headers, priority panels, cascade manifolds, and dispensing sections should be remotely operable through SCADA system during emergencies.

5. Remote Monitoring of Daughter Booster Stations

Daughter Booster Stations, particularly those located in remote areas, should be equipped with SCADA system for continuous monitoring of cascade pressure, booster compressor health, dispenser operations, priority panel performance, valve status, gas inventory for improved operational reliability and enable faster emergency response

6. Automated Cascade Management

Cascade sequencing and priority panel operations should be automated for efficient gas utilization, optimized compressor loading, and reduction in manual intervention.

7. Automated Safety Interlock Systems

Gas leak detectors, flame detectors, fire alarm systems, and emergency shutdown logic should be fully integrated for automatic station shutdown during hazardous conditions.

8. Digitization of Dispensing Operations

CNG dispensers should be integrated with centralized transaction management systems for real-time monitoring of sales, reconciliation, inventory management, and customer analytics.

9. Integration of Mobile Cascade Vehicle Tracking

GPS-based tracking and digital monitoring systems should be implemented for Mobile Cascade Vehicles to monitor cascade movement, unloading operations, gas inventory, and route optimization. Additionally, AI-based cabin camera systems may be deployed for detection of driver fatigue and alert generation.

10. Implementation of Energy Monitoring Systems

Energy monitoring and analytics systems should be deployed for compressors and utility equipment to improve energy efficiency and optimize operational costs.

11. Digital Maintenance Management Systems

All critical equipment including compressors, dispensers, cascades, valves, and safety systems should be integrated with digital asset management platforms for maintenance scheduling, calibration tracking, equipment history, and compliance management.



Chapter - 4 District Regulating Station (DRS)

A District Regulating Station (DRS) is a critical pressure reduction and distribution facility within a City Gas Distribution (CGD) network that receives natural gas from the upstream steel pipeline network and regulates the gas pressure for downstream distribution through Medium Density Polyethylene (MDPE) networks and service lines supplying domestic, commercial, and small industrial consumers. DRS facilities serve as intermediate pressure regulating nodes strategically installed across the authorised Geographical Area (GA) to ensure safe, reliable, and uninterrupted gas supply at controlled operating pressures suitable for downstream distribution systems.

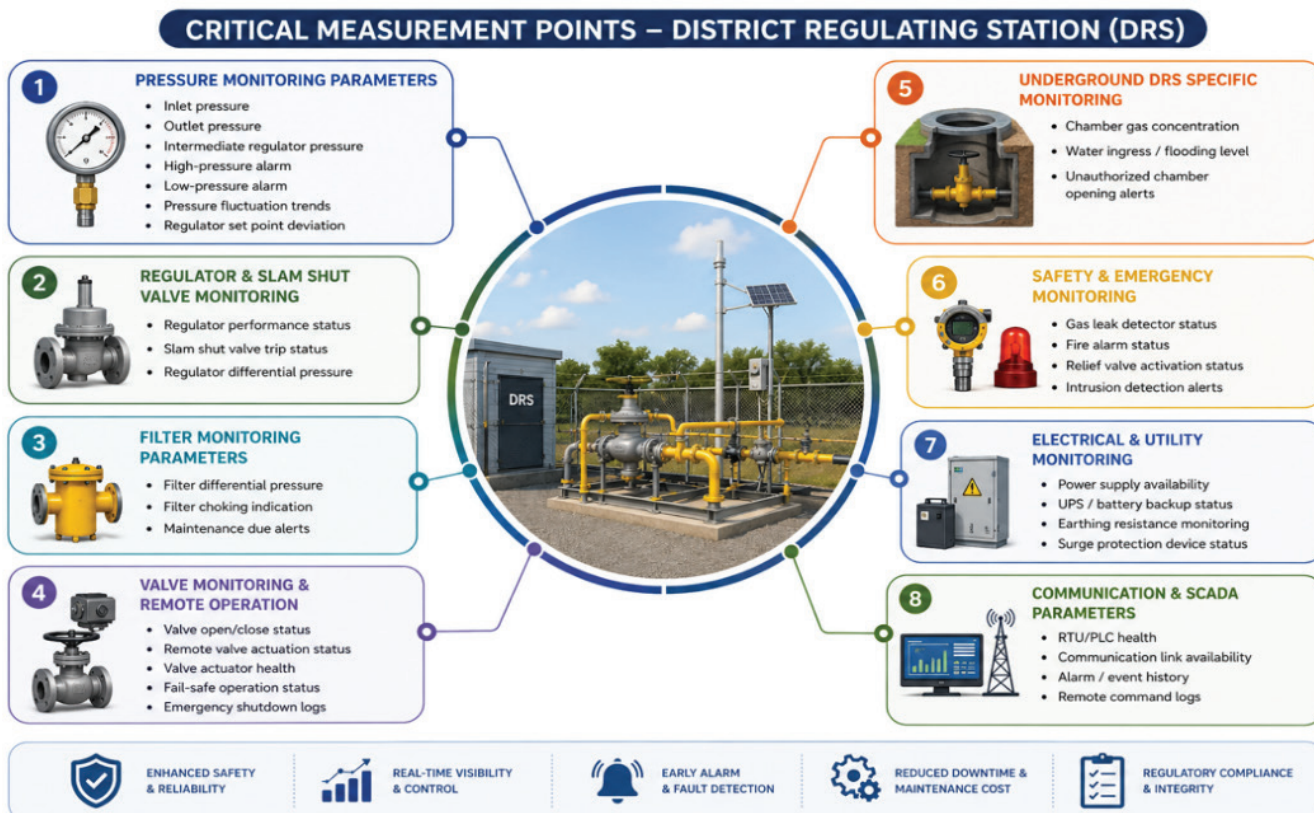
District Regulating Stations are generally categorized into two types based on installation configuration, namely **Above Ground DRS** and **Underground DRS**. Above Ground DRS installations are typically housed within fenced enclosures or prefabricated cabinets installed on concrete foundations and are commonly used in areas where adequate land availability and accessibility exist. Underground DRS installations, on the other hand, are generally deployed in densely populated urban locations, congested city areas, or locations with severe space constraints.

A typical DRS facility comprises inlet isolation valves, filters, pressure regulators, slam shut valves, relief valves, pressure monitoring instruments, outlet isolation valves, and associated piping systems. The primary function of the DRS is to reduce gas pressure from the upstream steel network pressure to downstream MDPE network operating pressure while maintaining stable outlet pressure under varying consumer demand conditions.

Isolation valves are installed upstream and downstream of DRS facilities to facilitate maintenance activities and emergency isolation of gas supply. Increasingly, remotely operable valves integrated with SCADA system are being considered for critical DRS locations to enable rapid isolation during emergencies. Instrumentation systems within DRS facilities generally include pressure gauges, pressure transmitters, temperature indicators, differential pressure indicators across filters, and telemetry systems.

Since DRS facilities interface between steel pipelines and MDPE distribution networks, proper electrical isolation arrangements and corrosion protection considerations are also important. Where applicable, insulating joints may be installed to maintain electrical isolation between metallic pipeline sections and associated above-ground facilities.

Critical Measurement Points in DRS



Recommendations for Automation of DRS Facilities

1. SCADA Integration of DRS Network

All Above Ground and Underground DRS facilities should be integrated with centralized SCADA system for real-time monitoring of pressure parameters, regulator performance, slam shut valve status, alarms, and emergency events.

2. Remote Operability of Isolation Valves

Isolation valves installed upstream and downstream of DRS facilities should be equipped with remote operability through SCADA/RTU systems. Remote isolation capability would enable rapid shutdown of gas supply during emergencies such as gas leakage, regulator malfunction, downstream pipeline damage, fire incidents, or abnormal pressure conditions, thereby improving operational safety and minimizing response time.

3. Automation of Underground DRS Safety Monitoring

Underground DRS facilities should mandatorily be equipped with continuous gas detection systems, ventilation monitoring systems, water ingress sensors, and chamber access monitoring integrated with centralized alarm systems to address confined-space operational risks.

4. Integration with GIS and Emergency Response Platforms

DRS locations should be integrated with GIS-based network mapping and emergency response systems to facilitate rapid identification, remote isolation, and incident management during emergency conditions.

Chapter - 5 MDPE Distribution Network and Service Regulator

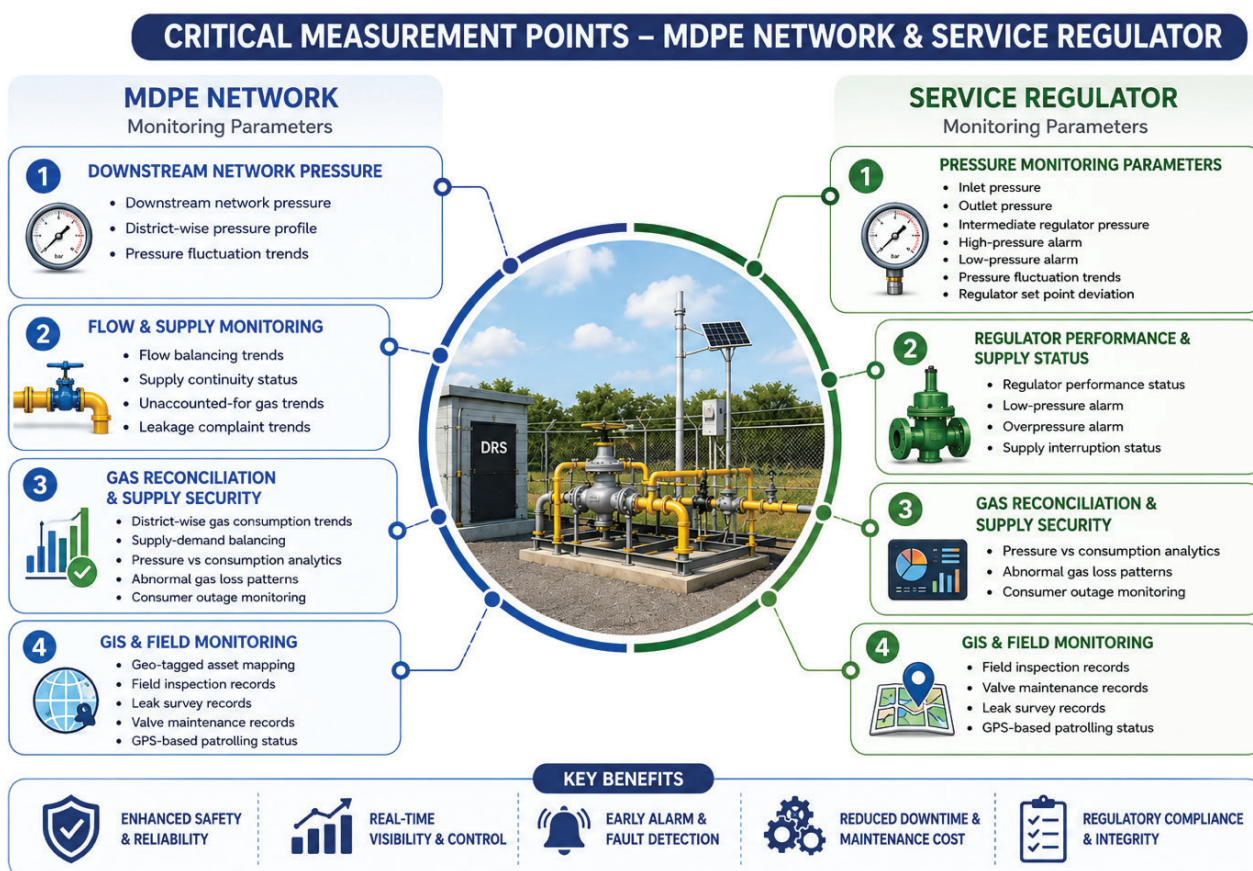
MDPE Distribution Network constitutes the downstream low-pressure gas distribution system within a City Gas Distribution (CGD) network and is primarily used for supplying natural gas to domestic, commercial, and small consumer categories. Medium Density Polyethylene (MDPE) pipelines are generally laid downstream of District Regulating Stations (DRS) and operate at comparatively lower pressures suitable for urban gas distribution. MDPE networks are extensively utilized due to their corrosion resistance, operational flexibility, ease of installation, and suitability for densely populated urban environments.

The MDPE network typically comprises underground polyethylene pipelines, service lines, service regulators, valve chambers, transition fittings, isolation valves, and associated fittings. These networks distribute natural gas from DRS facilities to end consumers through a combination of main distribution lines and individual service connections. Due to the distributed and highly branched nature of MDPE systems spread across urban areas, maintaining supply reliability, pressure stability, leakage control, and consumer safety becomes operationally significant.

Service Regulator is one of the most critical downstream components within the MDPE distribution system and is generally installed near consumer premises or at strategic downstream supply locations. The primary function of the service regulator is to reduce and regulate gas pressure from the MDPE distribution pressure to appliance operating pressure suitable for domestic or commercial usage. Service regulators additionally provide overpressure protection and ensure stable gas supply under varying demand conditions.

Although the scope of automation and digitization within MDPE networks is comparatively limited when compared to steel pipeline systems, CGS facilities, or CNG stations, service regulators can serve as important monitoring points for assessing gas supply continuity, downstream network health, consumer supply reliability, and gas reconciliation within the CGD network.

Critical Measurement Points in MDPE Network and Service Regulators



Limitations in Automation of MDPE Networks

- A. Space Constraints in Valve Chambers
 - o MDPE valve chambers and service regulator enclosures are generally compact and designed primarily for manual operation, thereby limiting installation of telemetry devices, actuators, communication hardware, and power systems.
- B. Public Accessibility and Exposure
 - o Most MDPE network assets are installed within public areas such as footpaths, roadside utility corridors, and residential zones, making automation hardware vulnerable to accidental damage, tampering, vandalism, and unauthorized interference.
- C. Communication Infrastructure Challenges
 - o Underground installations and dense urban environments may adversely affect communication reliability for telemetry and remote monitoring systems.
- D. Large Number of Distributed Assets
 - o MDPE networks consist of extensive distributed assets spread over large urban areas, making complete automation economically and operationally challenging.

Recommendations for Automation of MDPE Networks and Service Regulators

1. Automation of Critical Service Regulators

Critical service regulators and strategically important downstream supply nodes should be equipped with pressure monitoring and telemetry systems for monitoring supply continuity, pressure stability, and network performance.

2. Service Regulators as Monitoring Points for Gas Reconciliation

Service regulators may be utilized as important monitoring points for district-level gas reconciliation, supply-demand balancing, and identification of abnormal gas losses within the MDPE distribution network.

3. GIS-Based Asset Mapping and Monitoring

Complete MDPE network infrastructure including pipelines, valves, service regulators, and consumer connections should be integrated with GIS-based mapping systems for improved asset visibility, maintenance planning, and emergency response.

Chapter - 6 Industrial, Commercial, and Domestic Consumers Metering

Metering systems constitute one of the most critical components of a City Gas Distribution (CGD) Network as they directly govern measurement of gas consumption, billing accuracy, operational monitoring, revenue assurance, customer safety, and demand analytics. With increasing scale and complexity of CGD operations, conventional manual meter reading practices are progressively being replaced with automated and smart metering systems integrated with centralized digital platforms. Automation and digitization of metering infrastructure enable real-time consumption monitoring, reduction in billing disputes, operational transparency, remote safety management, and efficient customer service delivery across industrial, commercial, and domestic consumer categories.

The metering philosophy within CGD networks generally varies depending upon the consumer category, gas consumption pattern, operating pressure, and criticality of supply. Industrial consumers generally require dedicated industrial metering skids with high-capacity and high-accuracy metering systems, whereas commercial and domestic consumers increasingly utilize smart gas meters integrated with Automated Meter Reading (AMR) systems.

Industrial Consumer Metering Systems

Industrial consumers within CGD networks generally operate at relatively higher gas consumption levels and may receive gas supply either directly from the steel pipeline network or through dedicated industrial service lines. Due to higher flow rates, operational criticality, and billing implications, industrial consumers are typically provided with dedicated Industrial Metering Skids consisting of filtration systems, pressure regulation systems, custody transfer meters, flow computers, pressure and temperature transmitters, isolation valves, slam shut valves, and associated instrumentation.

Industrial metering skids generally employ turbine meters, rotary meters, ultrasonic flow meters, or other approved custody transfer metering technologies integrated with flow computers for accurate gas quantity measurement under varying operating conditions. These metering systems continuously capture parameters such as gas flow rate, operating pressure, gas temperature, corrected volume, uncorrected volume, calorific value (where applicable), and cumulative consumption.

Automation of industrial metering systems assumes significant importance due to the large billing volumes and continuous consumption profile of industrial consumers. Automated Meter Reading (AMR) systems integrated with SCADA/telemetry infrastructure enable real-time acquisition of consumption data without manual intervention. Such metering data should preferably be integrated directly with Enterprise Resource Planning (ERP) or SAP-based billing systems for automatic bill generation as per predefined billing schedules.

Additionally, industrial metering automation enables remote monitoring of abnormal consumption patterns, unauthorized gas usage, sudden load variations, pressure deviations, and equipment malfunction. Remote operability of isolation valves associated with industrial metering skids may also be considered for emergency isolation during gas leakage incidents, overconsumption scenarios, or downstream operational emergencies.

Commercial Consumer Smart Metering Systems

Commercial consumers such as hotels, restaurants, malls, hospitals, institutions, and commercial establishments generally operate at comparatively moderate gas consumption levels. Increasingly, smart gas meters are being deployed within the commercial segment for automated billing, consumption monitoring, operational analytics, and customer convenience.

Commercial smart meters are generally equipped with digital communication modules enabling two-way communication between the meter and the central meter data management system. Such smart metering systems facilitate automated meter reading, remote billing, remote diagnostics, tamper detection, and consumption analytics without requiring physical site visits. Smart meters also support interval-based consumption recording which helps in demand profiling and operational planning.

Prepaid smart metering functionality may also be implemented for commercial consumers to improve payment discipline and reduce revenue recovery issues. Such prepaid systems enable consumers to recharge gas credit balances digitally while allowing CGD entities to remotely monitor account balance, consumption trends, and low-balance alerts.

Domestic Household Smart Metering Systems

Domestic consumers constitute the largest consumer base within CGD networks and are increasingly being considered for large-scale deployment of smart gas meters in line with modernization and digitization objectives. Smart meters in the domestic segment significantly improve billing efficiency, reduce manual meter reading dependency, enhance operational transparency, and improve consumer safety.

Under the applicable PNGRB authorization framework for CGD entities, domestic smart meters should preferably incorporate:

- a) Prepaid metering functionality,
- b) Two-way communication capability,
- c) Remote meter reading,
- d) Remote safety valve operation capability,
- e) Tamper detection systems,
- f) Real-time consumption monitoring features.

Two-way communication capability enables continuous interaction between the smart meter and centralized Meter Data Management Systems (MDMS), thereby facilitating automated billing, remote diagnostics, firmware updates, alarm generation, and operational control. Prepaid smart metering systems allow consumers to digitally recharge gas credit balances and improve payment collection efficiency for CGD entities.

One of the most critical safety features recommended for domestic smart meters is remote safety valve operation capability. Such remotely operable safety valves integrated within smart meters enable remote isolation of gas supply during emergencies such as gas leakage incidents, prolonged non-payment, abnormal consumption patterns, fire incidents, or maintenance activities. Integration of such features with centralized control systems can significantly improve consumer safety and emergency response capability.

Smart domestic meters can additionally support advanced functionalities such as leak detection, excess flow detection, reverse flow detection, low battery alerts, communication failure alarms, and tamper alerts. Integration of domestic smart meters with mobile applications and consumer portals also enables consumers to monitor their own consumption patterns, recharge balances, receive alerts, and access billing history digitally.

Critical Measurement Points in Metering

CRITICAL MEASUREMENT POINTS – METER MONITORING SYSTEMS



Recommendations for Automation of Metering Infrastructure

1. Deployment of Metering Skids for Industrial Consumers

All industrial consumers should be provided with dedicated industrial metering skids comprising approved custody transfer metering systems, flow computers, pressure and temperature transmitters, filtration systems, and safety devices for accurate gas measurement and operational monitoring.

2. Integration of Industrial Metering with ERP/SAP Systems

Automated Meter Reading (AMR) systems deployed for industrial consumers should be integrated directly with ERP/SAP platforms for automatic billing generation as per predefined billing schedules. Such integration would improve billing accuracy, reduce manual intervention, enhance revenue assurance, and streamline commercial operations.

3. Implementation of Smart Metering in Commercial and Domestic Segments

Smart gas meters with automated communication capability should progressively be deployed across commercial and domestic consumer categories for automated billing, consumption monitoring, operational analytics, and reduction in manual meter reading dependency with mandatory Prepaid & Two-Way Communication Capability Functionality in Smart Meters

4. Remote Safety Valve Operation in Domestic Smart Meters

Domestic smart meters should incorporate remotely operable safety shut-off valves in line with PNGRB authorization requirements for CGD networks. Such remote safety valve capability would enable rapid isolation of gas supply during emergencies such as gas leakage, fire incidents, tampering, abnormal consumption, or maintenance activities.

5. Centralized Meter Data Management System (MDMS)

A centralized MDMS platform should be implemented for real-time acquisition, storage, analytics, billing integration, and operational management of smart meter data across all consumer categories.

6. Advanced Tamper and Leak Detection Systems

Smart metering infrastructure should incorporate advanced tamper detection, leak detection, excess flow monitoring, reverse flow detection, and communication failure alarms to improve safety and revenue protection.

7. Consumer Mobile Applications and Digital Portals

Integrated digital platforms should be provided to consumers for monitoring gas consumption, recharge balances, billing history, payment status, and safety alerts.



Chapter - 7 GIS in CGD Networks

A Geographic Information System (GIS) is one of the most critical digital infrastructure components within a modern City Gas Distribution (CGD) network and serves as the foundational platform for geospatial mapping, asset management, integrity monitoring, planning, emergency response, and utility coordination. Implementation of GIS in CGD networks assumes significant importance due to the extensive underground infrastructure spread across urban, semi-urban, and industrial areas involving steel pipelines, MDPE pipelines, service lines, valves, regulating stations, and consumer connections.

Implementation and maintenance of GIS for CGD networks is mandatory under the applicable Petroleum and Natural Gas Regulatory Board (PNGRB) Technical Standards and Specifications (T4S) Regulations for CGD networks. The GIS platform is required to maintain accurate geospatial records of the complete gas distribution infrastructure for ensuring operational safety, integrity management, emergency response capability, and coordination with other underground utility agencies.

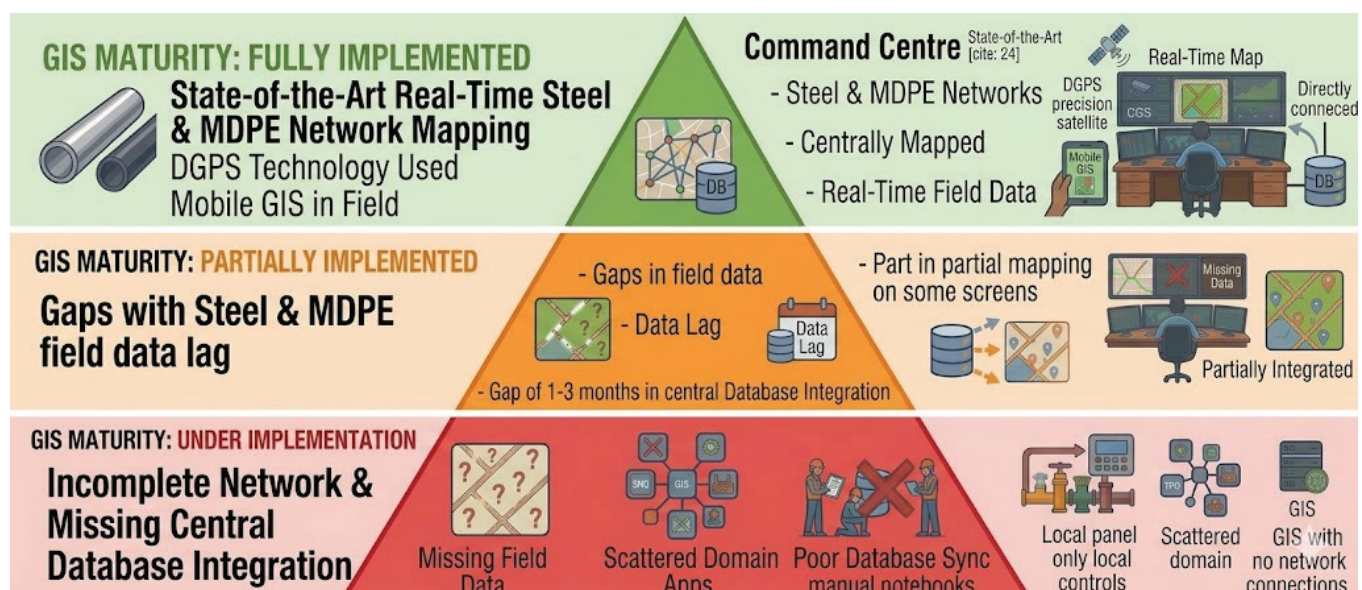
A comprehensive GIS platform within a CGD network should capture detailed spatial and asset-level information associated with all major infrastructure components including City Gate Stations (CGS), CNG stations, steel pipeline networks, MDPE distribution networks, District Regulating Stations (DRS), isolation valves, sectionalizing valves, service regulators, cathodic protection systems, test lead points (TLPs), insulating joints, consumer service lines, and metering infrastructure. GIS systems should additionally capture consumer connectivity details such as the number of households connected through individual risers in high-rise residential buildings or through common runners installed for row housing or clustered residential developments.

GIS implementation within CGD networks also plays a major role in prevention of third-party damages to underground utilities. Underground pipeline damages arising from excavation activities, road construction, sewer laying, water pipeline works, telecom cable installation, and other civic infrastructure projects remain one of the most significant threats to pipeline integrity and public safety. Sharing of GIS viewing access rights with statutory authorities such as municipal bodies, urban local bodies, road development agencies, water utility departments, sewerage authorities, electricity distribution companies, and telecom infrastructure agencies can significantly improve utility coordination during excavation and maintenance activities.

However, such shared GIS access should preferably remain restricted to view-only permissions without allowing modification rights to external agencies in order to maintain data integrity, security, and centralized asset control under the CGD entity.

Accuracy of GIS data assumes paramount importance in CGD networks, particularly considering the safety implications associated with underground gas pipeline infrastructure. Accordingly, Differential Global Positioning System (DGPS) technology should mandatorily be utilized during laying of new pipelines and associated CGD infrastructure.

Use of DGPS during construction activities ensures precise recording of pipeline alignment, depth, crossings, fittings, valve locations, and utility interfaces, thereby improving future traceability and reducing operational uncertainties during maintenance or emergency response activities.



For older or mature Geographical Areas (GAs), particularly where legacy pipeline infrastructure was developed prior to implementation of robust GIS systems or where historical records lack adequate positional accuracy, phased dig surveys should additionally be undertaken for accurate asset verification and GIS update. Such dig surveys involve physical exposure and verification of buried pipelines, fittings, valves, and utility crossings at selected intervals for confirming actual field alignment and depth. Data obtained through dig surveys should subsequently be integrated into GIS platforms to improve positional accuracy and reliability of legacy underground infrastructure records.

Integration of GIS platforms with SCADA systems, cathodic protection monitoring systems, smart metering infrastructure, mobile field inspection systems, and emergency response platforms can further enhance operational visibility and centralized management capability within CGD networks. Modern GIS platforms may additionally support predictive analytics, risk-based integrity assessment, utility conflict analysis, excavation permit management, and mobile workforce management.

Critical Data Points Recommended for GIS Digitization

CRITICAL DATA POINTS FOR GIS DIGITIZATION IN CITY GAS DISTRIBUTION (CGD) NETWORKS



Recommendations for GIS Implementation in CGD Networks

1. Mandatory GIS Implementation and Asset Digitization as per PNGRB T4S Regulations

All CGD entities should implement and maintain comprehensive GIS platforms in compliance with applicable PNGRB T4S Regulations for accurate geospatial mapping and lifecycle management of CGD infrastructure.

GIS platforms should mandatorily capture all critical CGD assets including CGS, CNG stations, steel pipelines, MDPE networks, DRS facilities, isolation valves, sectionalizing valves, service regulators, cathodic protection infrastructure, consumer service lines, and metering systems.

2. Consumer Connectivity Mapping

GIS systems should capture detailed consumer connectivity information including riser-wise household mapping in high-rise buildings and runner-wise household connectivity in row housing developments for improved operational traceability and emergency management. It also enables customers to locate or identify availability of distribution network in close vicinity.

3. **Use of DGPS for New Pipeline Construction**

Differential GPS (DGPS) technology should mandatorily be utilized during laying of new pipelines and CGD infrastructure to ensure high-precision geospatial mapping accuracy.

4. **Phased Dig Surveys for Legacy/Mature GAs**

In older or mature GAs where historical asset records lack sufficient positional accuracy, phased dig surveys should be undertaken for physical verification and accurate GIS updation of buried pipeline infrastructure.

5. **GIS Access Sharing with Statutory Authorities for Excavation Management**

Controlled GIS viewing access rights may be shared with statutory authorities such as municipal bodies and utility agencies for coordination of excavation, utility laying, and maintenance activities in order to minimize third-party damage to underground utilities.

6. **Mobile GIS and Field Inspection Integration**

Mobile GIS applications should be deployed for field inspection, leak surveys, patrolling activities, emergency response, and asset verification with geo-tagged digital records.

7. **Periodic GIS Data Validation and Updating**

GIS databases should be periodically validated and updated through field verification, DGPS surveys, and integrity assessment activities to ensure long-term reliability and operational accuracy of underground asset records.



Chapter - 8 Benchmarking of CGD Entities Based on Automation Maturity

The benchmarking framework was developed based on a comprehensive methodology involving detailed questionnaires, stakeholder interactions, field visits, operational assessment, and analysis of automation practices adopted by various CGD entities. A structured questionnaire covering major operational and technical areas was the basis for collection of information related to SCADA implementation, automation systems, control room operations, CNG station monitoring, DRS/CGS automation, pipeline integrity systems, emergency shutdown systems, communication infrastructure, GIS and asset management systems, cybersecurity practices, consumer digitization, and enterprise-level integration. The questionnaire was broadly categorized into infrastructure details, operational monitoring systems, safety and emergency systems, integrity management practices, digital systems, and future automation plans to enable uniform assessment across entities.

In addition to data collection through questionnaires and document review, selected CGD entities were visited for field-level assessment and verification of operational practices. Site observations included review of control room facilities, SCADA architecture, remote monitoring capability, alarm handling systems, communication redundancy, field instrumentation, emergency preparedness, and integration of operational assets. Interactions were also held with operational and maintenance personnel to understand implementation challenges, operational dependency on manual systems, and future digitalization plans. Based on the information collected, field observations, infrastructure criticality, and overall level of automation maturity, entities were benchmarked into three broad categories representing advanced digitalized networks, partially automated networks, and conventional or minimally automated systems.

Benchmarking Framework for Automation in CGD Sector



To facilitate comparative assessment and benchmarking of CGD entities, the following broad classification framework based on level of automation and digitization may be considered:

Group-I : CGD Entities with SCADA and associated connected subsystems

Entities having:

- SCADA Implementation with fully integrated enterprise-wide automation architecture,
- All GAs monitored from central Control Room
- Real-time SCADA integration across all facilities/assets,

- d) DGPS-based GIS integrated with integrity management systems,
- e) Automated gas reconciliation systems, (High Pressure & High Consumption locations)
- f) Geo-fencing and third-party damage prevention systems,
- g) Integration of limited applications with NHIMS

Such entities may be considered benchmark “**Smart CGD Networks**” demonstrating advanced digital maturity and integrated infrastructure management.

Group–II : Advanced Automation-Level Entities

Entities having:

- a) Selective GAs monitored from SCADA/ central Control Room
- b) SCADA implementation for other GAs is under execution or at various stages of procurement
- c) GIS based asset mapping with lag in real time capturing
- d) Automated metering deployment across Industrial consumer categories,
- e) Automated odorization systems
- f) Selective integration of ERP/SAP applications

Such entities possess advanced operational visibility and centralized control capability.

Group–III : Basic Compliance-Level Automation

Entities having:

- a) **No Central Control Room or SCADA**
- b) Basic Field Level implementation limited to CGS and select CNG stations,
- c) Partial GIS implementation,
- d) Manual cathodic protection monitoring,
- e) Conventional metering systems,
- f) Limited telemetry integration,
- g) Predominantly manual field operations.

Such entities generally meet minimum regulatory requirements but possess limited centralized monitoring capability.

CGD AUTOMATION MATURITY GROUPS

Indicative classification of City Gas Distribution entities based on digital maturity, centralized control, and automation deployment

MATURITY LEGEND



Group-I
Benchmark Smart
CGD Networks



Group-II
Advanced Automation-
Level Entities



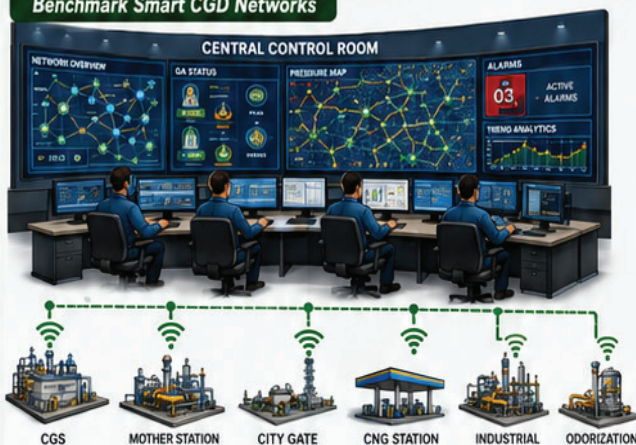
Group-III
Basic Compliance-
Level Automation

MATURITY PROGRESSION

BASIC ADVANCED BENCHMARK

1 / GROUP-I CGD Entities with SCADA and associated connected subsystems

Benchmark Smart CGD Networks



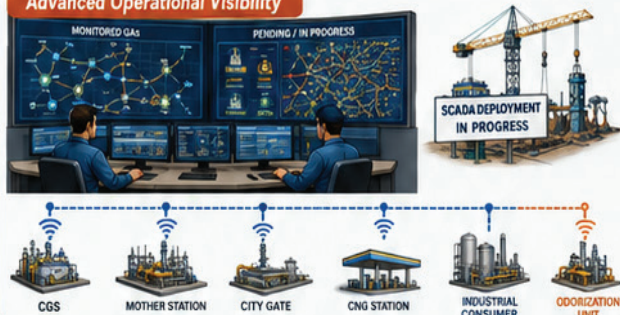
Such entities may be considered benchmark smart CGD networks demonstrating advanced digital maturity and integrated infrastructure management.

- a SCADA implementation with fully integrated enterprise-wide automation architecture
- b All GAs monitored from central Control Room
- c Real-time SCADA integration across all facilities/assets
- d DGPS-based GIS integrated with integrity management systems
- e Automated gas reconciliation systems (high-pressure and high-consumption locations)
- f Geo-fencing and third-party damage prevention systems
- g Ready to integrate with NHIMS



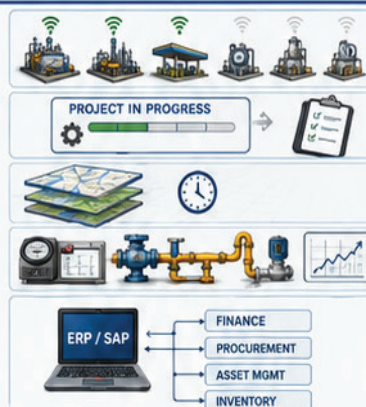
2 / GROUP-II Advanced Automation-Level Entities

Advanced Operational Visibility



Such entities possess advanced operational visibility and centralized control capability.

- a Selective GAs monitored from SCADA / central Control Room
- b SCADA implementation for other GAs is under execution or at various stages of procurement
- c GIS-based asset mapping with lag in real-time capturing
- d Automated metering deployment across industrial consumer categories
- e Automated odorization systems
- f Selective integration of ERP / SAP applications



3 / GROUP-III Basic Compliance-Level Automation

Minimum Regulatory Automation



Such entities generally meet minimum regulatory requirements but possess limited centralized monitoring capability.

- a No central Control Room or SCADA
- b Basic field-level implementation limited to CGS and select CNG stations
- c Partial GIS implementation
- d Manual cathodic protection monitoring
- e Conventional metering systems
- f Limited telemetry integration
- g Predominantly manual field operations



Conclusion

Automation and digitalization of City Gas Distribution (CGD) Network infrastructure has emerged as a critical operational requirement for ensuring safety, integrity, efficiency, reliability, regulatory compliance, and long-term sustainability of CGD operations. The observations across various CGD facilities including City Gate Stations (CGS), steel pipeline networks, CNG stations, District Regulating Stations (DRS), Industrial metering systems, Smart consumer metering infrastructure, MDPE networks, service regulators, and GIS platforms indicate that substantial opportunities exist for improving operational visibility and asset management through phased implementation of automation and digital technologies.

The applicable PNGRB T4S Regulations for CGD networks already mandate implementation of several critical operational and safety requirements such as Automated Odorization Systems, GIS implementation, Integrity Management practices, emergency response mechanisms, and monitoring systems. However, the level of automation presently varies significantly across CGD entities.

Implementation of automation and digitization systems across CGD infrastructure can result in substantial operational and financial savings for CGD entities. These savings may arise through:

- a) Reduction in gas losses and unaccounted-for gas (LUAG),
- b) Faster detection and isolation of leakages,
- c) Reduction in Third-party damages through GIS integration and geo-fencing,
- d) Improved cathodic protection monitoring and corrosion prevention,
- e) Reduction in manual patrolling and inspection dependency,
- f) Automated billing and improved revenue realization,
- g) Reduction in manpower-intensive field operations,
- h) Improved compressor and equipment efficiency,
- i) Predictive maintenance and reduction in unplanned shutdowns,
- j) Improved emergency response capability,
- k) Optimization of energy consumption in compressors and utility systems,
- l) Reduction in billing disputes and reconciliation errors,
- m) Improved lifecycle management of assets.

Automation of industrial metering integrated with ERP/SAP platforms improves billing accuracy, consumption reconciliation, and revenue monitoring. Deployment of smart meters in domestic and commercial segments reduces manual intervention, enhances billing efficiency, and strengthens consumer-side safety through remote monitoring and control.

Implementation of GIS integrated with DGPS-based asset mapping can considerably reduce risks associated with underground utility damages and improve coordination with municipal and statutory authorities.

Future amendments to PNGRB T4S Regulations and allied regulatory provisions for the CGD sector may accordingly consider and deliberate upon the recommendations brought out in the present report through appropriate Technical Committee discussions for phased incorporation.

STRATEGIC PHASED APPROACH FOR AUTOMATION AND DIGITALIZATION OF CGD INFRASTRUCTURE



ENHANCED SAFETY
Reduce risk and prevent incidents



OPERATIONAL EFFICIENCY
Optimize operations and resource utilization



REVENUE ASSURANCE
Improve accuracy, reduce losses



CONSUMER SATISFACTION
Ensure reliable and transparent services



DIGITAL TRANSFORMATION
Build future-ready, smart utility networks

I

PHASE-I : HIGH-PRESSURE AND HIGH-RISK INFRASTRUCTURE

This phase would address maximum safety-critical and high-consequence infrastructure.

PRIORITY INFRASTRUCTURE

- CGS facilities
- Steel pipeline networks
- Major sectionalizing valves
- Cathodic protection systems
- CNG Mother Stations
- Industrial metering skids
- High-capacity DRS installations



AUTOMATION FOCUS AREAS

- SCADA integration**
Real-time monitoring and centralized control
- Pressure and flow monitoring**
Continuous monitoring of pressure and flow parameters
- Automated odorization**
Automated dosing for accurate odorization
- Remote valve operation**
Remote control of critical isolation valves
- CP telemetry**
Real-time monitoring of CP parameters and alerts
- Leak detection systems**
Early leak detection using sensors and analytics
- GIS implementation**
Asset mapping, spatial analysis and network visualization

KEY OUTCOMES

- Maximum safety and risk mitigation
- Real-time visibility of critical assets
- Reduced downtime and faster response
- Improved asset integrity and life
- Regulatory compliance and audit readiness

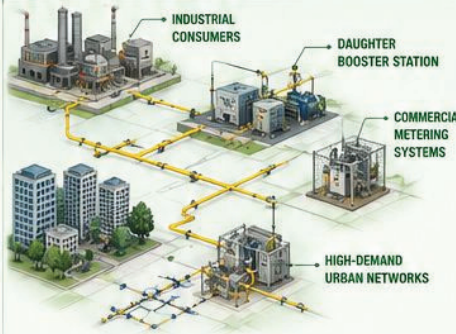
II

PHASE-II : HIGH CONSUMPTION AND REVENUE-CRITICAL INFRASTRUCTURE

This phase would improve commercial efficiency and revenue assurance.

FOCUS INFRASTRUCTURE

- Industrial consumers
- Commercial metering systems
- Daughter Booster Stations
- Major consumer clusters
- High-demand urban networks



AUTOMATION FOCUS AREAS

- ERP/SAP-integrated AMR systems**
Automated Meter Reading integrated with ERP/SAP
- Smart commercial metering**
Advanced metering for accurate billing and monitoring
- Cascade monitoring**
Monitoring of pressure cascade along networks
- Compressor analytics**
Performance analytics for compressor optimization
- Gas reconciliation systems**
Automated reconciliation to minimize losses
- Energy monitoring systems**
Monitoring energy consumption and efficiency

KEY OUTCOMES

- Improved billing accuracy
- Reduced commercial losses
- Better demand management
- Optimized compressor performance
- Stronger revenue assurance

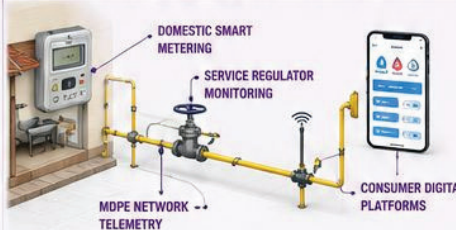
III

PHASE-III : DOWNSTREAM DISTRIBUTION AND CONSUMER DIGITIZATION

This phase would strengthen consumer safety and operational transparency.

FOCUS INFRASTRUCTURE

- Domestic smart metering
- Service regulator monitoring
- Select MDPE network telemetry
- Consumer-facing digital systems



AUTOMATION FOCUS AREAS

- Prepaid smart metering**
Prepaid and postpaid smart metering solutions
- Remote safety valve operation**
Remote operation of consumer safety valves
- Consumer mobile platforms**
Self-service apps for consumers (billing, payments, alerts)
- Leak detection analytics**
Analytics for leak detection and risk prediction
- Supply continuity monitoring**
Real-time monitoring of supply continuity and interruptions

KEY OUTCOMES

- Enhanced consumer safety
- Greater transparency and trust
- Reduced manual interventions
- Faster fault detection
- Higher consumer satisfaction

IV

PHASE-IV : INTEGRATED ENTERPRISE-LEVEL DIGITALIZATION

This phase would transform conventional CGD systems into integrated digitally managed utility networks.

FOCUS AREAS

- Enterprise GIS integration
- AI-enabled predictive analytics
- Digital integrity management systems
- Geo-fencing and excavation monitoring
- Integrated emergency response systems
- Cybersecurity enhancement
- Enterprise asset management integration



AUTOMATION FOCUS AREAS

- Enterprise GIS integration**
Unified geospatial view of all assets and operations
- AI-enabled predictive analytics**
Predictive maintenance, demand forecasting, risk prediction
- Digital integrity management systems**
Pipeline integrity monitoring and risk-based inspection
- Geo-fencing and excavation monitoring**
Real-time monitoring of excavation activities near assets
- Integrated emergency response systems**
Coordinated emergency response and communication
- Cybersecurity enhancement**
Secure networks, threat detection, and compliance
- Enterprise asset management integration**
Unified asset lifecycle management and optimized utilization

KEY OUTCOMES

- End-to-end visibility and control
- Data-driven decision making
- Predictive and proactive operations
- Resilient and secure infrastructure
- Future-ready, digitally managed utility network

IMPLEMENTATION PRINCIPLES



Risk-Based Prioritization



Scalability & Interoperability



Standards & Compliance



Change Management & Capability Building



Continuous Improvement & Innovation

This phased approach ensures systematic investment, maximum risk reduction, operational efficiency, revenue assurance, and a seamless transition towards a built-in digital and intelligent CGD ecosystem.

Way Forward

The future growth and sustainability of CGD infrastructure will increasingly depend upon adoption of intelligent automation, digital asset management, remote monitoring systems, and integrated operational platforms. While the level and pace of implementation may vary across entities, adoption of phased automation aligned with PNGRB T4S requirements can significantly improve:

- a) Operational safety,
- b) Pipeline integrity,
- c) Emergency preparedness,
- d) Commercial efficiency,
- e) Consumer service quality,
- f) Regulatory compliance,
- g) Long-term operational sustainability.

Accordingly, CGD entities should progressively transition from conventional manually operated infrastructure toward integrated digitally managed gas distribution networks through a structured, risk-based, and phased implementation approach. Considering the varying scale and maturity of CGD entities, a phased implementation strategy for automation and SCADA deployment is recommended.

A phased, risk-based, and implementation-oriented framework aligned with network maturity and operational criticality may help strengthen operational safety, integrity management, and consumer supply reliability across the CGD sector, as depicted in the pictorial below.

Note:

The phased implementation framework proposed in the report is indicative in nature and has been suggested primarily to facilitate structured and risk-based adoption of automation and digitalization across CGD networks. However, considering the diversity in operational practices, network maturity, geographical spread, consumer profile, infrastructure availability, and business priorities across CGD entities, the proposed phases may be suitably merged, modified, reprioritized, or implemented in parallel based on operational criticality, commercial viability, and entity-specific requirements.

Accordingly, CGD entities may adopt the implementation sequence most appropriate to their business model, infrastructure readiness, risk perception, and operational strategy while ensuring alignment with applicable PNGRB regulations and safety requirements.



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SAFE & RELIABLE



SUSTAINABLE
DISTRIBUTION

ANNEXURE-I

QUESTIONNAIRE-BASED
OBSERVATIONS OF CGD ENTITIES
COVERED UNDER FIELD VISITS



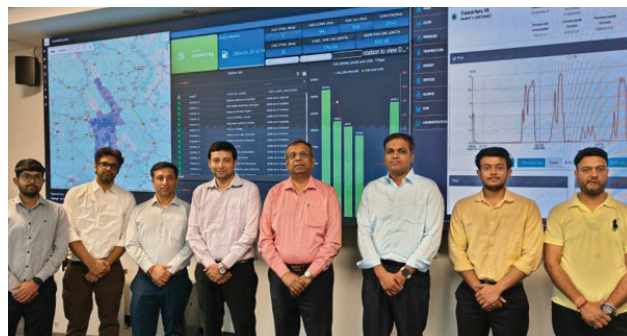
Field Visit Photographs



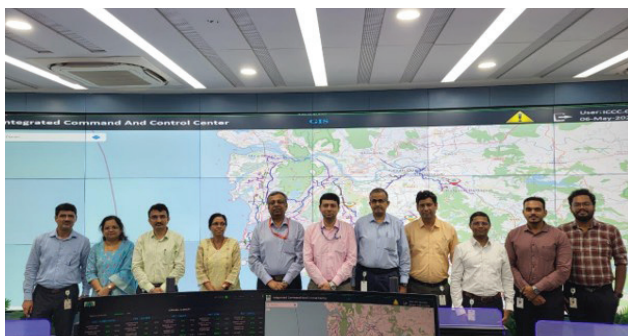
Indian Oil Adani Gas Private Limited (IOAGPL) — PNGRB field visit



Control Room and Command Centre — SCADA and GIS-based network dashboards



Central Control Room — station-wise monitoring and operational dashboards



Integrated Command and Control Centre — centralised network monitoring



Control Room — SCADA schematic and network overview

Section	Sub-Section	Parameter	Think Gas	IGL	IOAGPL	HCG
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	Both	GA-wise	Both	No Control room available
		SCADA platform/vendor	ABB	TAS	TAS	
	Large Video Screen	Video wall dashboards available	Yes	Yes	Yes	
	SCADA	Implemented	Yes	Yes	YES	
	Communication	Information Storage	Cloud	Server	Cloud	
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Available	Available	Available	
		ERP platform used	SAP	SAP	SAP	
	Reporting	SCADA reports generated	Yes	Yes	Yes	
		Operational dashboards available	Yes	Yes	Yes	
Field Level Automation	CGS	Odorization Unit automation	Yes	Partial	Partial	Not available
		Check Meter Installed & Automated	Yes	Partial	Partial	Not available
		Remote control or monitoring only	Both	Monitoring	Monitoring & Remote WIP	Manual Monitoring
		Valves automated	Yes	No	WIP	No
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Yes	Yes	Partial	No
		Sectionalising Valves (SVs) Automated	Yes	Partial	No	No
	CNG Station	CNG SCADA integration	Yes	Yes	Yes	No
		Emergency Stop availability from Remote	Yes	Yes	Yes	No
		Compressor monitoring availability from Remote	Yes	Yes	Yes	No
		DBS Dryout Monitoring	Yes	Yes	Yes	Reactive
	DRS	DRS automation	Yes	Yes	Partial	No
		Gas Detector installed	Yes	Yes	Yes	No
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Yes	Yes	Yes	No
		Camera detection (IRIS for fatigue)	Yes	No	No	No
	Industrial Connections	AMR meters installed	Yes	Yes	Yes	Partial
		Connected with SCADA	Yes	No	FACILITY AVAILABLE	No
	Commercial Connections	AMR meters installed	Partial	Partial	Partial	No
		Connected with SCADA	Yes	No	FACILITY AVAILABLE	No
	Domestic Connections	Smart Meters	Partial	Partial	No	Partial
		Activated Safety Valve in Smart Meters	Yes	Yes	NA	No
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	Yes	No	No	No
CCTV	Monitoring	CGS	Yes	No	Yes	No
	Monitoring	CNG Station	Yes	Yes	Partial	Yes
	Integration with SCADA	View from Central Control Room	Yes	No	No	No
GIS & Mapping	Platform	GIS platform used	GE Small World	In house	NEOGEO	Yes
	Accuracy	Pipeline mapping	Yes	Yes	Yes	No
	Data Capture, Real Time	DGPS used	Yes	No	Yes	No
	Data	As-Laid digitization status	Yes	Yes	Yes	No
	Mobility	Mobile GIS available	Yes	Yes	Yes	No
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Yes	Yes	Yes	Telecalling

Section	Sub-Section	Parameter	ATGL	Torrent	GEL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	Both	GA Level Manual control	3 out of 32 GAs controlled centrally
		SCADA platform/vendor	Honeywell	Vendor selection in progress	Conceptual Study in progress
	Large Video Screen	Video wall dashboards available	Yes	No	No
	SCADA	Implemented	Yes	Planning Pilot for 2 GAs in current FY	Conceptual Study in progress
	Communication	Information Storage	Cloud	Under Implementation	Server
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Available	No	ERP
		ERP platform used	SAP	No	SAP
	Reporting	SCADA reports generated	Yes	No	No
		SCADA Operational dashboards available	Yes	No	No
Field Level Automation	CGS	Odorization Unit automation	Yes	Automated, Local Control	Automated, Local Control
		Check Meter Installed & Automated	Yes	Yes	Yes
		Remote control or monitoring only	Remote Monitoring	Monitoring Manually	Monitoring Manually
		Valves automated	Yes	No	Partial 3 out of 32 GAs
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Yes	No	
		Sectionalising Valves (SVs) Automated	No	No	
	CNG Station	CNG SCADA integration	Yes	No	No
		Emergency Stop availability from Remote	Yes	No	No
		Compressor monitoring availability from Remote	Yes	No	No
		DBS Dryout Monitoring	Yes	Reactive	Reactive
	DRS	DRS automation	Yes	No	No
		Gas Detector installed	Yes	Yes	Partial
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Yes	No	Yes
		Camera detection (IRIS for fatigue)	Yes, (NA)	No	No
	Industrial Connections	AMR meters installed	Yes	Partial	Yes
		Connected with SCADA	Yes	NA	NA
	Commercial Connections	AMR meters installed	Partial	No	Manual
		Connected with SCADA	Yes	NA	NA
	Domestic Connections	Smart Meters	No	No	Partial
		Activated Safety Valve in Smart Meters	NA	NA	Yes
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	No	No	No
CCTV	Monitoring	CGS	Yes	Local	Local
	Monitoring	CNG Station	Yes		
	Integration with SCADA	View from Central Control Room	Yes	No	No
GIS & Mapping	Platform	GIS platform used	ESRI	ESRI, under implementation	ESRI
	Accuracy	Pipeline mapping	Yes	No	Yes
	Data Capture, Real Time	DGPS used	Yes	No	No
	Data	As-Laid digitization status	Yes	No	3 months lag
	Mobility	Mobile GIS available	Yes	No	Yes
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Yes	Yes	Yes

Section	Sub-Section	Parameter	MGL	MNGL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	Centralized	Local Control (2 out of 6 GAs)
		SCADA platform/vendor	ABB	Vendor finalized- ABB
	Large Video Screen	Video wall dashboards available	Yes	No, 12 LED screens
	SCADA Availability	Implemented	Yes	Under Implementation
	Communication	Information Storage	Cloud	
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Available	Standalone
		ERP platform used	SAP	SAP
	Reporting	SCADA reports generated	Yes	No
		Operational dashboards available	Yes	No
Field Level Automation	CGS	Odorization Unit automation	Yes	Automated, Local Control
		Check Meter Installed & Automated	Yes	Yes
		Remote control or monitoring only	Both	Monitoring
		Valves automated	Yes	No
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Yes	Yes
		Sectionalising Valves (SVs) Automated	No	No
	CNG Station	CNG SCADA integration	Yes	No
		Emergency Stop availability from Remote	Yes	Partial (70/300)
		Compressor monitoring available	Yes	Partial
		DBS Dryout Monitoring	Yes	Reactive
	DRS	DRS automation	Yes	No
		Gas Detector installed	Yes	Yes
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Yes	Yes
		Camera detection (IRIS for fatigue)	Yes	No
	Industrial Connections	AMR meters installed	Yes	Yes
		Connected with SCADA	Yes	Yes
	Commercial Connections	AMR meters installed	No	No
		Connected with SCADA	NA	NA
	Domestic Connections	Smart Meters	No	No
		Activated Safety Valve in Smart Meters	NA	NA
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	No	Yes
CCTV	Monitoring	CGS	Yes	Local
	Monitoring	CNG Station	Yes	
	Integration with SCADA	View from Central Control Room	Yes	No
GIS & Mapping	Platform	GIS platform used	GeoNetwork	ESRI
	Accuracy	Pipeline mapping	Yes	Yes
	Data Capture, Real Time	DGPS used	Yes	Yes
	Data	As-Laid digitization status	Yes	Yes
	Mobility	Mobile GIS available	Yes	Yes
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Yes Sales Force	Yes



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ANNEXURE-II

QUESTIONNAIRE-BASED
INPUTS FROM ENTITIES
NOT COVERED UNDER
FIELD VISITS



Section	Sub-Section	Parameter	HPOIL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	GA Wise
		SCADA platform/vendor	NA
	Large Video Screen	Video wall dashboards available	(Video Screen and Conference room available in GA offices and HQ)
	SCADA Availability	Implemented	NA
	Communication	Communication media used	M/s Green Ads Global Pvt Ltd – Whatsapp M/s IT Bizcom Pvt Ltd – Text Messaging
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	ERP
		ERP platform used	ERP – M/s Concept Information Systems Pvt. Ltd., Indore
	Reporting	SCADA reports generated	NA
		Operational dashboards available	NA
Field Level Automation	CGS	Odorization Unit automation	M/s Varicon Pumps & Systems Pvt Ltd
		Check Meter Installed & Automated	M/s Nirmal Industrial Controls Pvt. Ltd.
		Remote control or monitoring only	Monitoring Only
		Valves automated	NA
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Manually by O&M Team (Ambala-Kurukshetra GA - M/s Perfect Pipelines Kolhapur GA - M/s R V Movaliya Construction Co.)
		Sectionalising Valves (SVs) Automated	NA
	CNG Station	CNG SCADA integration	NA
		Emergency Stop availability from Remote	NA (Physical Switch at CNG station)
		Compressor monitoring available	Manually by CAMC vendors
		DBS Dryout Monitoring	NA
	DRS	DRS automation	NA
		Gas Detector installed	M/s Respo Safety Solutions Private Limited
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	
		Camera detection (IRIS for fatigue)	NA
	Industrial Connections	AMR meters installed	Inel Gas - Romet
		Connected with SCADA	NA
	Commercial Connections	AMR meters installed	NA
		Connected with SCADA	NA
	Domestic Connections	Smart Meters	NA
		Activated Safety Valve in Smart Meters	NA
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	NA
CCTV	Monitoring	CGS	Yes, by local vendor
	Monitoring	CNG Station	Yes, by OMCs
	Integration with SCADA	View from Central Control Room	NA
GIS & Mapping	Platform	GIS platform used	M/s Unistal System Pvt Ltd
	Accuracy	Pipeline mapping	
	Data Capture	DGPS used	
	Data	As-built digitization status	
	Mobility	Mobile GIS available	
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	ERP – M/s Concept Information Systems Pvt. Ltd., Indore

Section	Sub-Section	Parameter	GAIL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	Centralized & GA wise both
		SCADA platform/vendor	TAS India
	Large Video Screen	Video wall dashboards available	Yes
	SCADA Availability	Implemented	Yes, under testing for full scale implementation
	Communication	Communication media used	Modem / Lease line
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Yes, under implementation
		ERP platform used	ERP SAP HANA
	Reporting	SCADA reports generated	Yes
		Operational dashboards available	Yes
Field Level Automation	CGS	Odorization Unit automation	Field level Automation available, connectivity with SCADA under implementation after upgrading of Odorization software.
		Check Meter Installed & Automated	No
		Remote control or monitoring only	Monitoring
		Valves automated	Manual valves available
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Yes
		Sectionalising Valves (SVs) Automated	Manual valve
	CNG Station	CNG SCADA integration	Yes
		Emergency Stop availability from Remote	Yes, Available for compressor ESD
		Compressor monitoring available	Yes
		DBS Dryout Monitoring	Yes, Under testing
	DRS	DRS automation	Connected to SCADA
		Gas Detector installed	Yes
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Yes
		Camera detection (IRIS for fatigue)	No, to be implemented in new tender
	Industrial Connections	AMR meters installed	No
		Connected with SCADA	No
	Commercial Connections	AMR meters installed	No
		Connected with SCADA	No
	Domestic Connections	Smart Meters	Yet to be rolled out
		Activated Safety Valve in Smart Meters	Yet to be rolled out
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	To be implemented
CCTV	Monitoring	CGS	Yes
	Monitoring	CNG Station	Yes, at COCO
	Integration with SCADA	View from Central Control Room	View from GA Control Room Available
GIS & Mapping	Platform	GIS platform used	Arc GIS
	Accuracy	Pipeline mapping	Yes
	Data Capture	DGPS used	Yes
	Data	As-built digitization status	done
	Mobility	Mobile GIS available	Yes
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	SAP & SAHAJ Platform for billing of various customers segment wise

Section	Sub-Section	Parameter	BPCL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	IoT devices will be deployed across all critical equipment at CNG stations, including compressors, dispensers, MFMs, energy panels, and other operationally essential assets, enabling real-time control and high-frequency monitoring. The solution will provide equipment-level monitoring and control, along with performance tracking at both station and GA levels. Additionally, the system will support centralized billing operations and remote RSP change management.
		IoT/ SCADA platform/ vendor	The centralized IoT-based automation solution implementation is done through two vendor streams: - Software Vendor (M/s Digital Petro Pvt. Ltd.): Development and maintenance of the Gas Application for centralized monitoring, control, billing, and reporting. - Hardware Vendor (M/s Eviden India Pvt. Ltd. (ATOS) & M/s Digital Petro Pvt. Ltd.): Supply, installation, commissioning, and maintenance of IoT devices along with integration of field equipment with the Gas Application platform.
	Large Video Screen	Video wall dashboards available	Centralized video wall dashboards development is under implementation shall be available for monitoring PAN-India and region-wise operational performance, CNG station status, IoT device health, alarms, transactions, and critical business insights in real time.
	IoT/ SCADA Availability	Implemented	SCADA platform has already been implemented across 3 GAs at CNG station, while IoT-based automation for CNG, CGS, LCNG, and CBG operations is currently under implementation across 20 GAs and will be scaled for all the GAs.
	Communication	Communication media used	IoT devices transmit telemetry data to Azure IoT Hub, which is routed through Azure Event Hub for reliable ingestion. Azure Functions perform lightweight real-time processing, after which processed data and alerts are stored in Cosmos DB and, where required, forwarded to Service Fabric APIs. Azure Kubernetes Service (AKS) hosts microservices supporting advanced analytics, data aggregation, and REST APIs for user interfaces. The Mobile App and Web UI securely access data through APIs protected using OAuth2/JWT authentication.
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Integration with SAP is under progress for key functionalities including RSP updates, gas purchase data integration, sales location transfer data, dealer outstation billing, and auto-allocation of LCVs are under development /exploration.
		ERP platform used	SAP IS-Oil and SAP IS-U
	Reporting	IoT/ SCADA reports generated	- Nozzle wise Transitional - Sales - Nil Sales - RSP Mismatch - IoT Health - Alerts
		Operational dashboards available	Role-based operational dashboards are available to users, providing real-time visibility of KPIs, transactions, IoT device status, sales, gas loss, HSSE alerts, and performance analytics as per the assigned persona and access rights. (Partially roll-out)
Field Level Automation	CGS	Odorization Unit automation	IoT-based implementation for the odorization unit is currently in progress. The solution shall enable automated dosing along with real-time monitoring and control of key odorizer parameters. Additionally, alarms such as over-dosing, under-dosing, and system abnormalities shall also be monitored and managed through the platform.
		Check Meter Installed & Automated	The scope for automation of the check meter is currently under exploration. Post automation, online odorant dosing based on real-time flow rate data from the check meter can be implemented.
		Remote control or monitoring only	Functionality for remote monitoring and control is currently under development. The proposed solution shall enable centralized monitoring of critical CGS equipment such as Odorizer Units, ESD systems, and Gas Detectors. Real-time odorant dosing parameters and alarms shall be monitored through the platform. Additionally, remote actuation of ESD can be facilitated during emergency situations, subject to operational and safety interlocks.
		Valves automated	Automation of valves is currently under exploration and feasibility evaluation.

Section	Sub-Section	Parameter	BPCL
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Automation of Pipeline Network under exploration and feasibility evaluation.
		Sectionalising Valves (SVs) Automated	Automation of SVs under exploration and feasibility evaluation.
	CNG Station	CNG IoT/ SCADA integration	SCADA platform has already been implemented across 3 GAs for CNG station operations. In addition, IoT-based automation for CNG, CGS, LCNG, and CBG operations is currently under implementation across 20 GAs and shall subsequently be scaled across all GAs in a phased manner.
		Emergency Stop availability from Remote	Remote Emergency Stop (ESD) functionality is available and can be utilized for centralized emergency intervention during critical situations. The system enables remote shutdown of compressors, dispensers, and CNG operations, subject to defined safety interlocks and operational protocols.
		Compressor monitoring available	Real-time compressor monitoring functionality is available for tracking critical operational parameters, equipment running status, alarms, and performance analytics through the automation platform. The system shall also support predictive maintenance initiatives through alarm trends, equipment behaviour analysis, and early fault identification..
		DBS Dryout Monitoring	DBS dry out monitoring functionality is currently under development for real-time tracking of dry out events. The proposed solution shall enable identification of the root cause of dry out conditions, such as product unavailability, manpower shortage, power outage, or other operational reasons. Additionally, dry out duration shall also be recorded once development is completed. Alert and notification mechanisms are also planned to ensure timely intervention and improved operational efficiency.
		DRS automation	Tendering is under process for supply, installation, testing, commissioning, and integration of RTU/Modem devices for DRS/DCU with the automation platform. The solution will enable real-time monitoring of operational parameters and alert generation through integrated gas leak detection systems for enhanced safety and operational visibility.
	Vehicle Tracking System (for Mobile Cascade Vans)	Gas Detector installed	Yes
		GPS monitoring	Yes
	Industrial Connections	Camera detection (IRIS for fatigue)	Conducted Vehicle Tracking System (Pilot) project for AI-based real-time camera analytics for proactive incident detection, driver behaviour monitoring, and HSSE risk reduction through driver scoring and counselling. Full scale roll-out is under consideration.
		AMR meters installed	Tendering is under process for supply, installation, testing, commissioning, and integration of AMR/MIU devices for Industries connection with MRS/ RPD/Diaphragm meters, along with integration of existing EVCs.
	Commercial Connections	Connected with SCADA/ IoT	No
		AMR meters installed	Tendering is under process for supply, installation, testing, commissioning, and integration of AMR/MIU devices for commercial RPD/Diaphragm meters, along with integration of existing EVCs.
	Domestic Connections	Connected with SCADA/ IoT	No
		Smart Meters	Smart Meter integration with the PNG Application and EPR (SAP IS-U) is currently under development to enable a fully digital prepaid gas management system. Real-time gas consumption readings will be captured directly from smart meters and integrated with the PNG Application and SAP IS-U platform.
		Activated Safety Valve in Smart Meters	Work in progress
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	GAs are using the "Call Before You Dig (CBUD)" Application with geofencing-based excavation detection to prevent damage to underground gas pipelines and utilities. Further, Asset Management and O&M application development is in progress, which will be integrated with the CBUD Application for centralized monitoring, excavation risk management, and field operation coordination.

Section	Sub-Section	Parameter	BPCL
CCTV	Monitoring	CGS	Currently, CCTV monitoring at CGS and CNG stations is largely dependent on manual surveillance, with no centralized AI-based automation implemented for real-time monitoring and analytics. BPCL GAS BU is exploring implementation of AI-enabled video analytics solutions for automated incident detection, unauthorized access monitoring, safety compliance tracking, fire/smoke detection, and real-time alert generation to improve operational safety, security monitoring, and emergency response effectiveness across locations.
	Monitoring	CNG Station	
	Integration with SCADA	View from Central Control Room	
GIS & Mapping	Platform	GIS platform used	ESRI (ARC GIS)
	Accuracy	Pipeline mapping	5 cm
	Data Capture	DGPS used	Arrow Series GNSS Receivers (manufactured by Eos Positioning Systems) is being used.
	Data	As-built digitization status	Steel Network: 1889 Km. out of 2571 Km. is mapped (73%) MDPE Network: 5547 Km. out of 12712 Km. is mapped (44%)
	Mobility	Mobile GIS available	No
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	The PNG Customer Mobile Application is a comprehensive digital self-service platform. Through the application, customers can apply for new PNG connections, complete KYC formalities, track application status, view and pay bills, submit meter readings, and register complaints related to billing, gas supply, leakage, and meter issues. In addition, customers can also register service requests and complaints through the Toll-Free Smartline Number and Urja Chatbot both of which are integrated with the CRM system.

Section	Sub-Section	Parameter	Purba Bharati Gas Ltd
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	X
		SCADA platform/vendor	X
	Large Video Screen	Video wall dashboards available	X
	SCADA Availability	Implemented	X
	Communication	Communication media used	X
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	X
		ERP platform used	X
	Reporting	SCADA reports generated	X
		Operational dashboards available	X
Field Level Automation	CGS	Odorization Unit automation	X
		Check Meter Installed & Automated	X
		Remote control or monitoring only	X
		Valves automated	X
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	X
		Sectionalising Valves (SVs) Automated	X
	CNG Station	CNG SCADA integration	X
		Emergency Stop availability from Remote	✓
		Compressor monitoring available	X
		DBS Dryout Monitoring	X
	DRS	DRS automation	X
		Gas Detector installed	X
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	✓
		Camera detection (IRIS for fatigue)	X
	Industrial Connections	AMR meters installed	X
		Connected with SCADA	X
	Commercial Connections	AMR meters installed	X
		Connected with SCADA	X
	Domestic Connections	Smart Meters	X
		Activated Safety Valve in Smart Meters	X
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	X
CCTV	Monitoring	CGS	✓
	Monitoring	CNG Station	✓ (Only in COCO)
	Integration with SCADA	View from Central Control Room	X
GIS & Mapping	Platform	GIS platform used	✓ (SmartGasNet)
	Accuracy	Pipeline mapping	X
	Data Capture	DGPS used	X
	Data	As-built digitization status	✓
	Mobility	Mobile GIS available	X
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	✓

Section	Sub-Section	Parameter	Bengal Gas
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	
		SCADA platform/vendor	SCADA to be implemented soon. Under tendering process (Integration)
	Large Video Screen	Video wall dashboards available	Mobile Cascade Movement, CNG Station monitoring
	SCADA Availability	Implemented	SCADA to be implemented soon. Under tendering process (Integration)
	Communication	Communication media used	Communication with consumer through SMS, Email Gateway. Customer Care (office hour) and Emergency no is available 24*7
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	ERP & MIS implemented (CNG since June,2024 and Maintenance since Dec,2024)
		ERP platform used	ERP platform used for billing and maintenance from June 2024.
	Reporting	SCADA reports generated	Not integrated
		Operational dashboards available	ERP MIS is present.
Field Level Automation	CGS	Odorization Unit automation	Not yet implemented
		Check Meter Installed & Automated	Not yet implemented
		Remote control or monitoring only	Not yet implemented
		Valves automated	Not yet implemented
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Not yet implemented
		Sectionalising Valves (SVs) Automated	Not yet implemented
	CNG Station	CNG SCADA integration	Not yet integrated
		Emergency Stop availability from Remote	Not yet integrated
		Compressor monitoring available	Not yet integrated
		DBS Dryout Monitoring	Not yet integrated
	DRS	DRS automation	Not yet implemented
		Gas Detector installed	Not yet implemented
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Yes. Implemented since March 2021
		Camera detection (IRIS for fatigue)	Not yet implemented
	Industrial Connections	AMR meters installed	No consumer yet.
		Connected with SCADA	No consumer yet.
	Commercial Connections	AMR meters installed	No consumer yet.
		Connected with SCADA	No consumer yet.
	Domestic Connections	Smart Meters	Yes. Integration with ERP going on.
		Activated Safety Valve in Smart Meters	Not yet implemented
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	Not yet implemented
CCTV	Monitoring	CGS	Not yet implemented
	Monitoring	CNG Station	Yes. Implemented since March 2021
	Integration with SCADA	View from Central Control Room	Not yet implemented
GIS & Mapping	Platform	GIS platform used	Hexagon from 2021 to December 2023, Arc GIS Enterprise (ESRI) since then.
	Accuracy	Pipeline mapping	95% accuracy
	Data Capture	DGPS used	Arrow 100+(2nos) since May 2024
	Data	As-built digitization status	Approximately 500 km
	Mobility	Mobile GIS available	Yes (Arc field Map) since December 2023
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Self-Billing App-Swang (available in Play store) since January 2025 and Spot Billing App since March 2024

Section	Sub-Section	Parameter	HPCL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	SCADA implemented in Jind-Sonipat GA. Further in all other GA's SCADA works commenced and expected to be completed by Mar'27.
		SCADA platform/vendor	Jind-Sonipat GA-Yokogawa, Other GA's- TAS Systems
	Large Video Screen	Video wall dashboards available	Available in Jind-Sonipat GA. Planned in other GA's as part of SCADA and to be completed by Mar'27.
	SCADA Availability	Implemented	SCADA implemented in Jind-Sonipat GA. Further in all other GA's SCADA works commenced and expected to be completed by Mar'27
	Communication	Communication media used	GPRS
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	ERP Integration WIP and expected to be completed by Mar'27
		ERP platform used	SAP
	Reporting	SCADA reports generated	Yes (Refer Attached PPT Slide - 1)
		Operational dashboards available	Yes (Refer Attached PPT Slide - 2)
Field Level Automation	CGS	Odorization Unit automation	Yes (Refer Attached PPT Slide - 3)
		Check Meter Installed & Automated	
		Remote control or monitoring only	Monitoring Only
		Valves automated	No, taking up during SCADA implementation
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	No
		Sectionalising Valves (SVs) Automated	No
	CNG Station	CNG SCADA integration	Available in Jind-Sonipat GA. Planned in other GA's SCADA implementation and to be completed by Mar'27. (Refer Attached PPT Slide – 4,5)
		Emergency Stop availability from Remote	
		Compressor monitoring available	
		DBS Dryout Monitoring	
	DRS	DRS automation	Available in Jind-Sonipat GA. Planned in other GA's and to be completed by Mar'27. (Refer Attached PPT Slide – 6)
		Gas Detector installed	
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Available (Refer Attached PPT Slide – 7)
		Camera detection (IRIS for fatigue)	Tender will be floated shortly
	Industrial Connections	AMR meters installed	Yes
		Connected with SCADA	Integration WIP and expected to be completed Mar'27
	Commercial Connections	AMR meters installed	No
		Connected with SCADA	No
	Domestic Connections	Smart Meters	No
		Activated Safety Valve in Smart Meters	No
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	No
CCTV	Monitoring	CGS	Yes
	Monitoring	CNG Station	Yes
	Integration with SCADA	View from Central Control Room	CCTV data available in Web and can accessed from Central Control Room (Refer Attached PPT Slide – 8)
GIS & Mapping	Platform	GIS platform used	Work in progress.
	Accuracy	Pipeline mapping	
	Data Capture	DGPS used	
	Data	As-built digitization status	
	Mobility	Mobile GIS available	
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Available (Refer Attached PPT Slide No.- 9)

Section	Sub-Section	Parameter	Megha City Gas
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	SCADA architecture implemented
		SCADA platform/vendor	ABB SCADA Platform implemented
	Large Video Screen	Video wall dashboards available	Operator Work Stations available at field locations with 24" display Monitor units and Head Office 1 Nos EWS and 1 Nos OWS with 24" display Monitor is available, HO Control Room and video wall under implementation
	SCADA Availability	Implemented	SCADA System available 24x7
	Communication	Communication media used	Wireless communication through GPRS network
	ERP/MIS Integration	ERP/MIS/Data layer above SCADA	Under implementation
		ERP platform used	Megha Gas Pulse / Intranet Portal/SAP
	Reporting	SCADA reports generated	Partial Reports are Generating
		Operational dashboards available	Under implementation
Field Level Automation	CGS	Odorization Unit automation	Implemented
		Check Meter Installed & Automated	Implemented
		Remote control or monitoring only	Implemented
		Valves automated	Partially implemented and Testing under process
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	CGS/PRS skid outlet pressure monitoring available at all steel network starting points. DRS section automation under implementation.
		Sectionalising Valves (SVs) Automated	Not implemented
	CNG Station	CNG SCADA integration	Implemented
		Emergency Stop availability from Remote	Available
		Compressor monitoring available	Available
		DBS Dryout Monitoring	Available
	DRS	DRS automation	Under implementation
		Gas Detector installed	Available
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Implemented
		Camera detection (IRIS for fatigue)	Proof of Concept under Process
	Industrial Connections	AMR meters installed	Pilot project testing is under progress
		Connected with SCADA	
	Commercial Connections	AMR meters installed	108+ No's Smart Prepaid Meters installed till date.
		Connected with SCADA	
	Domestic Connections	Smart Meters	2,214+ No's Smart Prepaid Meters installed till date and safety Valves Available
		Activated Safety Valve in Smart Meters	
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	Implemented
CCTV	Monitoring	CGS	Available
	Monitoring	CNG Station	Available
	Integration with SCADA	View from Central Control Room	Not integrated with SCADA
GIS & Mapping	Platform	GIS platform used	ArcGIS – ESRI
	Accuracy	Pipeline mapping	DGPS Device Accuracy less Than 30 HRMS
	Data Capture	DGPS used	Yes, we are using DGPS devices for data capture
	Data	As-built digitization status	Available
	Mobility	Mobile GIS available	Field Maps Mobile Application
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	Megha Gas Pulse Portal and Megha Gas Connect App are being used for consumer applications.

Section	Sub-Section	Parameter	AGCL
Control System Overview	Architecture	Centralized / GA-wise distributed / Both	Centralised Master Control Station for monitoring and control of gas flow to industrial consumers. Gas flow parameter monitoring facility available at major/bulk consumer gas meters and offtake point meters.
		SCADA platform/vendor	SCADA Platform: ABB SCADA Vantage 5.6.5
	Large Video Screen	Video wall dashboards available	3 large display screens for GUI available in the SCADA Master Control Room.
	SCADA Availability	Implemented	Yes
	Communication	Communication media used	GSM communication between field-level instruments and the SCADA system (DNP3 Protocol / Modbus TCP/ IP Protocol).
		ERP/MIS/Data layer above SCADA	ERP is implemented
	Reporting	ERP platform used	SAP HANA Database 2.00.07000
		SCADA reports generated	Industrial consumer consumption reports generated on a daily and monthly basis.
		Operational dashboards available	Dashboards available for alarm management, monitoring, and control.
Field Level Automation	CGS	Odorization Unit automation	Not Available
		Check Meter Installed & Automated	Not Available
		Remote control or monitoring only	Not Available
		Valves automated	Not Available
	Steel Network	Pipeline Network (Pressure and flow Monitoring)	Pressure monitoring available at select critical locations via the SCADA system; integration of new locations is underway using an IoT gateway.
		Sectionalising Valves (SVs) Automated	Not Available
	CNG Station	CNG SCADA integration	Not Available
		Emergency Stop availability from Remote	Not Available
		Compressor monitoring available	Not Available
		DBS Dryout Monitoring	Not Available
	DRS	DRS automation	Not Available
		Gas Detector installed	Gas detector installed in PRS
	Vehicle Tracking System (for Mobile Cascade Vans)	GPS monitoring	Not Available
		Camera detection (IRIS for fatigue)	Not Available
	Industrial Connections	AMR meters installed	
		Connected with SCADA	Connected with SCADA.
	Commercial Connections	AMR meters installed	NA
		Connected with SCADA	
	Domestic Connections	Smart Meters	Yes
		Activated Safety Valve in Smart Meters	
Third Party Damage Prevention	Network	Geofencing for Excavation detection system	Not Available
CCTV	Monitoring	CGS	Not Available
	Monitoring	CNG Station	Available.
	Integration with SCADA	View from Central Control Room	No
GIS & Mapping	Platform	GIS platform used	
	Accuracy	Pipeline mapping	
	Data Capture	DGPS used	
	Data	As-built digitization status	
	Mobility	Mobile GIS available	
Consumer Applications	App	Mobile App (Booking, Billing & complaints)	

ANNEXURE-III

SUMMARY OF RECOMMENDATIONS



Recommendations

A. Recommendations for Automation of CGS Facilities

1. Sharing of Flowmeter Data by Natural Gas Transmission Entities

In cases where CGS facilities are located within the SV station premises of transmission entities, the transmission company should provide real-time flowmeter data/signals to the concerned CGD entity through suitable communication interfaces. Availability of such flow data is essential for enabling automated odorization systems as mandated under PNGRB CGD T4S Regulations.

2. Provision for Installation of Clamp-on Ultrasonic Flow Meters

Where sharing of custody meter signals is operationally or commercially constrained, transmission entities should permit installation of independent clamp-on ultrasonic flow meters by the CGD entity. These non-invasive meters can be installed externally on pipelines without shutdown, pipe cutting, or pressure loss and can provide continuous flow signals necessary for automated odorization control.

3. Remote Operability of Isolation and Emergency Shut-Off Valves

Isolation valves and Emergency Shut-Off Valves (ESDVs) installed at CGS facilities, whether intended for isolation of gas supply from the transmission pipeline or for isolation of downstream steel distribution mains, should be equipped with remote operability through SCADA system. Remote actuation capability would enable faster response during emergency situations such as gas leakage, fire incidents, pressure excursions, or pipeline failures, thereby enhancing safety and minimizing response time.

4. Integration of Complete CGS with SCADA System & Field Instrumentation

All critical CGS parameters, including pressure, temperature, flow, odorization, cathodic protection, alarms and safety systems, with smart transmitters capable of transmitting continuous digital data should be integrated with centralized SCADA platforms to enable real-time monitoring & remote operation management.

5. Remote Monitoring of Cathodic Protection Systems

Remote monitoring units should be installed for continuous monitoring of TRU performance, pipe-to-soil potentials, and anode bed health to ensure pipeline integrity and enable predictive maintenance.

6. Automated Odorization System

Odorization skids should be equipped with automated proportional dosing systems integrated with flow measurement signals, along with remote monitoring of odorant tank levels, pump performance, and alarm generation.

B. Recommendations for Automation and Digitization of CNG Stations

1. Comprehensive SCADA Integration

All Online/Mother Stations and Daughter Booster Stations should be integrated with centralized SCADA system for real-time monitoring and control of compressors, cascades, dispensers, safety systems, and utility infrastructure.

2. Remote Monitoring of Compressors

Compressors should be integrated with predictive maintenance and condition monitoring systems for tracking vibration, temperature, lubrication parameters, motor performance

3. Automated Cascade and Priority Panel Management

Priority panels and cascade management systems should be fully integrated with PLC/SCADA systems for automated sequencing of low, medium, and high-pressure cascade banks. Critical parameters such as bank-wise pressure, cascade switching operations, valve position status, pressure equalization trends, compressor loading patterns, and abnormal operating conditions should be monitored digitally in real time.

4. Remote Operability of Isolation and Emergency Shutdown Valves

Isolation valves and Emergency Shutdown Valves (ESDVs) installed at station inlet headers, compressor suction and discharge headers, priority panels, cascade manifolds, and dispensing sections should be remotely operable through SCADA system during emergencies.

Recommendations

5. Remote Monitoring of Daughter Booster Stations

Daughter Booster Stations, particularly those located in remote areas, should be equipped with SCADA system for continuous monitoring of cascade pressure, booster compressor health, dispenser operations, priority panel performance, valve status, gas inventory for improved operational reliability and enable faster emergency response

6. Automated Cascade Management

Cascade sequencing and priority panel operations should be automated for efficient gas utilization, optimized compressor loading, and reduction in manual intervention.

7. Automated Safety Interlock Systems

Gas leak detectors, flame detectors, fire alarm systems, and emergency shutdown logic should be fully integrated for automatic station shutdown during hazardous conditions.

8. Digitization of Dispensing Operations

CNG dispensers should be integrated with centralized transaction management systems for real-time monitoring of sales, reconciliation, inventory management, and customer analytics.

9. Integration of Mobile Cascade Vehicle Tracking

GPS-based tracking and digital monitoring systems should be implemented for Mobile Cascade Vehicles to monitor cascade movement, unloading operations, gas inventory, and route optimization. Additionally, AI-based cabin camera systems may be deployed for detection of driver fatigue and alert generation.

10. Implementation of Energy Monitoring Systems

Energy monitoring and analytics systems should be deployed for compressors and utility equipment to improve energy efficiency and optimize operational costs.

11. Digital Maintenance Management Systems

All critical equipment including compressors, dispensers, cascades, valves, and safety systems should be integrated with digital asset management platforms for maintenance scheduling, calibration tracking, equipment history, and compliance management.

C. Recommendations for Automation of Steel Pipeline Network

1. Comprehensive SCADA Integration for Steel Network

The complete steel pipeline network including sectionalizing valves, District Regulating Stations (DRS), cathodic protection systems, and monitoring stations should be integrated with centralized SCADA system for real-time monitoring and operational control.

2. Remote Operability of Isolation and Sectionalizing Valves

Isolation valves and sectionalizing valves installed throughout the steel pipeline network should be equipped with remote operability through SCADA systems. Remote operation capability would enable rapid isolation of affected pipeline sections during emergencies

3. Remote Monitoring of Cathodic Protection Systems Insulation Joints and TLPs

Transformer Rectifier Units (TRUs), anode beds, and Test Lead Points (TLPs) should be integrated with SCADA system for continuous monitoring of cathodic protection performance. Insulation joints installed within the steel pipeline network should be digitally monitored to ensure proper electrical discontinuity between pipeline sections and adjacent anode beds.

4. Implementation of Geo-fencing for Third-Party Damage Prevention

GIS-integrated geo-fencing systems should be implemented along steel pipeline corridors to generate alerts in case of unauthorized excavation, construction activity, or heavy equipment movement near the pipeline alignment. Such systems may also be integrated with municipal utility databases and excavation permit systems for proactive prevention of third-party damages.

Recommendations

5. Digital Pipeline Integrity Management System

A centralized digital integrity management platform should be implemented for integrating cathodic protection data, leak survey records, patrolling data, intelligent pigging records, coating assessment reports, and maintenance history for improved asset integrity management.

6. Leak Detection and Real-Time Alarm Systems

Real-time leak detection systems integrated with pressure monitoring and flow analysis should be deployed for early identification of pipeline leakages and abnormal operating conditions.

7. GPS-Based Digital Patrolling Systems

Mobile-based GPS-enabled patrolling applications should be implemented for pipeline surveillance activities, enabling real-time tracking of patrol personnel, digital inspection records, and geo-tagged incident reporting.

D. Recommendations for Automation of DRS Facilities

1. SCADA Integration of DRS Network

All Above Ground and Underground DRS facilities should be integrated with centralized SCADA system for real-time monitoring of pressure parameters, regulator performance, slam shut valve status, alarms, and emergency events.

2. Remote Operability of Isolation Valves

Isolation valves installed upstream and downstream of DRS facilities should be equipped with remote operability through SCADA/RTU systems. Remote isolation capability would enable rapid shutdown of gas supply during emergencies such as gas leakage, regulator malfunction, downstream pipeline damage, fire incidents, or abnormal pressure conditions, thereby improving operational safety and minimizing response time.

3. Automation of Underground DRS Safety Monitoring

Underground DRS facilities should mandatorily be equipped with continuous gas detection systems, ventilation monitoring systems, water ingress sensors, and chamber access monitoring integrated with centralized alarm systems to address confined-space operational risks.

4. Integration with GIS and Emergency Response Platforms

DRS locations should be integrated with GIS-based network mapping and emergency response systems to facilitate rapid identification, remote isolation, and incident management during emergency conditions.

E. Recommendations for Automation of MDPE Networks and Service Regulators

1. Automation of Critical Service Regulators

Critical service regulators and strategically important downstream supply nodes should be equipped with pressure monitoring and telemetry systems for monitoring supply continuity, pressure stability, and network performance.

2. Service Regulators as Monitoring Points for Gas Reconciliation

Service regulators may be utilized as important monitoring points for district-level gas reconciliation, supply-demand balancing, and identification of abnormal gas losses within the MDPE distribution network.

3. GIS-Based Asset Mapping and Monitoring

Complete MDPE network infrastructure including pipelines, valves, service regulators, and consumer connections should be integrated with GIS-based mapping systems for improved asset visibility, maintenance planning, and emergency response.

Recommendations

F. Recommendations for Automation and Digitization of Metering Infrastructure

1. Deployment of Metering Skids for Industrial Consumers

All industrial consumers should be provided with dedicated industrial metering skids comprising approved custody transfer metering systems, flow computers, pressure and temperature transmitters, filtration systems, and safety devices for accurate gas measurement and operational monitoring.

2. Integration of Industrial Metering with ERP/SAP Systems

Automated Meter Reading (AMR) systems deployed for industrial consumers should be integrated directly with ERP/SAP platforms for automatic billing generation as per predefined billing schedules. Such integration would improve billing accuracy, reduce manual intervention, enhance revenue assurance, and streamline commercial operations.

3. Implementation of Smart Metering in Commercial and Domestic Segments

Smart gas meters with automated communication capability should progressively be deployed across commercial and domestic consumer categories for automated billing, consumption monitoring, operational analytics, and reduction in manual meter reading dependency with mandatory Prepaid & Two-Way Communication Capability Functionality in Smart Meters

4. Remote Safety Valve Operation in Domestic Smart Meters

Domestic smart meters should incorporate remotely operable safety shut-off valves in line with PNGRB authorization requirements for CGD networks. Such remote safety valve capability would enable rapid isolation of gas supply during emergencies such as gas leakage, fire incidents, tampering, abnormal consumption, or maintenance activities.

5. Centralized Meter Data Management System (MDMS)

A centralized MDMS platform should be implemented for real-time acquisition, storage, analytics, billing integration, and operational management of smart meter data across all consumer categories.

6. Advanced Tamper and Leak Detection Systems

Smart metering infrastructure should incorporate advanced tamper detection, leak detection, excess flow monitoring, reverse flow detection, and communication failure alarms to improve safety and revenue protection.

7. Consumer Mobile Applications and Digital Portals

Integrated digital platforms should be provided to consumers for monitoring gas consumption, recharge balances, billing history, payment status, and safety alerts.

G. Recommendations for GIS Implementation in CGD Networks

1. Mandatory GIS Implementation and Asset Digitization as per PNGRB T4S Regulations

All CGD entities should implement and maintain comprehensive GIS platforms in compliance with applicable PNGRB T4S Regulations for accurate geospatial mapping and lifecycle management of CGD infrastructure. GIS platforms should mandatorily capture all critical CGD assets including CGS, CNG stations, steel pipelines, MDPE networks, DRS facilities, isolation valves, sectionalizing valves, service regulators, cathodic protection infrastructure, consumer service lines, and metering systems.

2. Consumer Connectivity Mapping

GIS systems should capture detailed consumer connectivity information including riser-wise household mapping in high-rise buildings and runner-wise household connectivity in row housing developments for improved operational traceability and emergency management. It also enables customers to locate or identify availability of distribution network in close vicinity.

Recommendations

3. Use of DGPS for New Pipeline Construction

Differential GPS (DGPS) technology should mandatorily be utilized during laying of new pipelines and CGD infrastructure to ensure high-precision geospatial mapping accuracy.

4. Phased Dig Surveys for Legacy/Mature GAs

In older or mature GAs where historical asset records lack sufficient positional accuracy, phased dig surveys should be undertaken for physical verification and accurate GIS updation of buried pipeline infrastructure.

5. GIS Access Sharing with Statutory Authorities for Excavation Management

Controlled GIS viewing access rights may be shared with statutory authorities such as municipal bodies and utility agencies for coordination of excavation, utility laying, and maintenance activities in order to minimize third-party damage to underground utilities.

6. Mobile GIS and Field Inspection Integration

Mobile GIS applications should be deployed for field inspection, leak surveys, patrolling activities, emergency response, and asset verification with geo-tagged digital records.

7. Periodic GIS Data Validation and Updating

GIS databases should be periodically validated and updated through field verification, DGPS surveys, and integrity assessment activities to ensure long-term reliability and operational accuracy of underground asset records.



STAKEHOLDER
FEEDBACK



DIVERSE
PERSPECTIVES



CONSTRUCTIVE
INPUT



COLLABORATIVE
IMPROVEMENT



ANNEXURE-IV

COMMENTS ON THE REPORT BY
ENTITIES AND PEERS



INPUTS FROM
INDUSTRY ENTITIES



PEER REVIEWS
AND INSIGHTS



COMMENTS AND
SUGGESTIONS



REVIEW AND
RESPONSE



Recommendations	IGL COMMENTS
Recommendations for Automation of CGS Facilities	
1. Sharing of Flowmeter Data by Natural Gas Transmission Entities	
In cases where CGS facilities are located within the SV station premises of transmission entities, the transmission company should provide real-time flowmeter data/signals to the concerned CGD entity through suitable communication interfaces. Availability of such flow data is essential for enabling automated odorization systems as mandated under PNGRB CGD T4S Regulations.	Agreed with recommendations
2. Provision for Installation of Clamp-on Ultrasonic Flow Meters	
Where sharing of custody meter signals is operationally or commercially constrained, transmission entities should permit installation of independent clamp-on ultrasonic flow meters by the CGD entity. These non-invasive meters can be installed externally on pipelines without shutdown, pipe cutting, or pressure loss and can provide continuous flow signals necessary for automated odorization control.	Agreed with recommendations
3. Remote Operability of Isolation and Emergency Shut-Off Valves	
Isolation valves and Emergency Shut-Off Valves (ESDVs) installed at CGS facilities, whether intended for isolation of gas supply from the transmission pipeline or for isolation of downstream steel distribution mains, should be equipped with remote operability through SCADA system. Remote actuation capability would enable faster response during emergency situations such as gas leakage, fire incidents, pressure excursions, or pipeline failures, thereby enhancing safety and minimizing response time.	CGS facilities are under jurisdiction of transmission entity, hence same shall be in the scope of the transmission entity
4. Integration of Complete CGS with SCADA System & Field Instrumentation	
All critical CGS parameters, including pressure, temperature, flow, odorization, cathodic protection, alarms and safety systems, with smart transmitters capable of transmitting continuous digital data should be integrated with centralized SCADA platforms to enable real-time monitoring & remote operation management.	Parameters related to odorization & cathodic protection can be integrated with the SCADA system & integration of rest CGS parameters & field instrument are not feasible and they are with the transmission entities.
5. Remote Monitoring of Cathodic Protection Systems	
Remote monitoring units should be installed for continuous monitoring of TRU performance, pipe-to-soil potentials, and anode bed health to ensure pipeline integrity and enable predictive maintenance.	Remote monitoring of CP Transformer Rectifier Units (TRUs) can only be feasible, rest are not feasible.
6. Automated Odorization System	
Odorization skids should be equipped with automated proportional dosing systems integrated with flow measurement signals, along with remote monitoring of odorant tank levels, pump performance, and alarm generation.	CGD entities should remotely monitor the odorant tank levels however, alarm generation & remote monitoring of pump performance is not feasible.
Recommendations for Automation and Digitization of CNG Stations	
1. Comprehensive SCADA Integration	
All Online/Mother Stations and Daughter Booster Stations should be integrated with centralized SCADA system for real-time monitoring and control of compressors, cascades, dispensers, safety systems, and utility infrastructure.	Agreed with recommendations
2. Remote Monitoring of Compressors	

Recommendations	IGL COMMENTS
Compressors should be integrated with predictive maintenance and condition monitoring systems for tracking vibration, temperature, lubrication parameters, motor performance	Agreed with recommendations
3. Automated Cascade and Priority Panel Management	
Priority panels and cascade management systems should be fully integrated with PLC/SCADA systems for automated sequencing of low, medium, and high-pressure cascade banks. Critical parameters such as bank-wise pressure, cascade switching operations, valve position status, pressure equalization trends, compressor loading patterns, and abnormal operating conditions should be monitored digitally in real time.	Priority panels and cascade management systems should be fully integrated with PLC of compressors. Critical Pressure of priority panel shall be monitored digitally in real time.
4. Remote Operability of Isolation and Emergency Shutdown Valves	
Isolation valves and Emergency Shutdown Valves (ESDVs) installed at station inlet headers, compressor suction and discharge headers, priority panels, cascade manifolds, and dispensing sections should be remotely operable through SCADA system during emergencies.	Isolation valve at station inlet can be consider for remotely operable through SCADA systems. Emergency shutdown command for compressor from SCADA system can stop complete operation compressor and dispensing line pressure.
5. Remote Monitoring of Daughter Booster Stations	
Daughter Booster Stations, particularly those located in remote areas, should be equipped with SCADA system for continuous monitoring of cascade pressure, booster compressor health, dispenser operations, priority panel performance, valve status, gas inventory for improved operational reliability and enable faster emergency response	Agreed with recommendations
6. Automated Cascade Management	
Cascade sequencing and priority panel operations should be automated for efficient gas utilization, optimized compressor loading, and reduction in manual intervention.	Cascade sequencing and priority panel operations already automated through PLC of compressors and can be monitored through SCADA system.
7. Automated Safety Interlock Systems	
Gas leak detectors, flame detectors, fire alarm systems, and emergency shutdown logic should be fully integrated for automatic station shutdown during hazardous conditions.	Already automated through PLC of compressors.
8. Digitization of Dispensing Operations	
CNG dispensers should be integrated with centralized transaction management systems for real-time monitoring of sales, reconciliation, inventory management, and customer analytics.	Agreed with recommendations
9. Integration of Mobile Cascade Vehicle Tracking	
GPS-based tracking and digital monitoring systems should be implemented for Mobile Cascade Vehicles to monitor cascade movement, unloading operations, gas inventory, and route optimization. Additionally, AI-based cabin camera systems may be deployed for detection of driver fatigue and alert generation.	GPS based tacking already implemented. AI based cabin camera can be consider in future tenders.
10. Implementation of Energy Monitoring Systems	
Energy monitoring and analytics systems should be deployed for compressors and utility equipment to improve energy efficiency and optimize operational costs.	Agreed with recommendations
11. Digital Maintenance Management Systems	
All critical equipment including compressors, dispensers, cascades, valves, and safety systems should be integrated with digital asset management platforms for maintenance scheduling, calibration tracking, equipment history, and compliance management.	Maintenance management systems implemented in ERP systems.

Recommendations	IGL COMMENTS
Recommendations for Automation of Steel Pipeline Network	
1. Comprehensive SCADA Integration for Steel Network	
The complete steel pipeline network including sectionalizing valves, District Regulating Stations (DRS), cathodic protection systems, and monitoring stations should be integrated with centralized SCADA system for real-time monitoring and operational control.	Real-time monitoring and operational control is possible for the SVs, however in case of DRS and CP (TRU) only monitoring is feasible.
2. Remote Operability of Isolation and Sectionalizing Valves	
Isolation valves and sectionalizing valves installed throughout the steel pipeline network should be equipped with remote operability through SCADA systems. Remote operation capability would enable rapid isolation of affected pipeline sections during emergencies	Only SVs can be remotely operated, and isolation valves are inside the valve chamber where there is lot of constraints hence remote operation is not feasible.
3. Remote Monitoring of Cathodic Protection Systems Insulation Joints and TLPs	
Transformer Rectifier Units (TRUs), anode beds, and Test Lead Points (TLPs) should be integrated with SCADA system for continuous monitoring of cathodic protection performance. Insulation joints installed within the steel pipeline network should be digitally monitored to ensure proper electrical discontinuity between pipeline sections and adjacent anode beds.	Remote monitoring of CP (TRUs) can only be feasible however, rest are not feasible.
4. Implementation of Geo-fencing for Third-Party Damage Prevention	
GIS-integrated geo-fencing systems should be implemented along steel pipeline corridors to generate alerts in case of unauthorized excavation, construction activity, or heavy equipment movement near the pipeline alignment. Such systems may also be integrated with municipal utility databases and excavation permit systems for proactive prevention of third-party damages.	The said implementation is still at nascent stage so require lot of deliberations before implementation as in area such as Delhi due to non-availability of utility corridors and congested spaces multiple agencies has to lay network on same road and Geo-fencing may not be feasible
5. Digital Pipeline Integrity Management System	
A centralized digital integrity management platform should be implemented for integrating cathodic protection data, leak survey records, patrolling data, intelligent pigging records, coating assessment reports, and maintenance history for improved asset integrity management.	Digital integrity management platform may be explored.
6. Leak Detection and Real-Time Alarm Systems	
Real-time leak detection systems integrated with pressure monitoring and flow analysis should be deployed for early identification of pipeline leakages and abnormal operating conditions.	Not feasible
7. GPS-Based Digital Patrolling Systems	
Mobile-based GPS-enabled patrolling applications should be implemented for pipeline surveillance activities, enabling real-time tracking of patrol personnel, digital inspection records, and geo-tagged incident reporting.	Mobile-based GPS-enabled patrolling applications may be done.
Recommendations for Automation of DRS Facilities	
1. SCADA Integration of DRS Network	
All Above Ground and Underground DRS facilities should be integrated with centralized SCADA system for real-time monitoring of pressure parameters, regulator performance, slam shut valve status, alarms, and emergency events.	Agreed with recommendation

Recommendations	IGL COMMENTS
2. Remote Operability of Isolation Valves	
Isolation valves installed upstream and downstream of DRS facilities should be equipped with remote operability through SCADA/RTU systems. Remote isolation capability would enable rapid shutdown of gas supply during emergencies such as gas leakage, regulator malfunction, downstream pipeline damage, fire incidents, or abnormal pressure conditions, thereby improving operational safety and minimizing response time.	Not feasible
3. Automation of Underground DRS Safety Monitoring	
Underground DRS facilities should mandatorily be equipped with continuous gas detection systems, ventilation monitoring systems, water ingress sensors, and chamber access monitoring integrated with centralized alarm systems to address confined-space operational risks.	May be explored
4. Integration with GIS and Emergency Response Platforms	
DRS locations should be integrated with GIS-based network mapping and emergency response systems to facilitate rapid identification, remote isolation, and incident management during emergency conditions.	Auto-trip or cut-off system are already installed in form of SSV (Slam shut off valve). Hence it is not required.
Recommendations for Automation of MDPE Networks and Service Regulators	
1. Automation of Critical Service Regulators	
Critical service regulators and strategically important downstream supply nodes should be equipped with pressure monitoring and telemetry systems for monitoring supply continuity, pressure stability, and network performance.	Not feasible
2. Service Regulators as Monitoring Points for Gas Reconciliation	
Service regulators may be utilized as important monitoring points for district-level gas reconciliation, supply-demand balancing, and identification of abnormal gas losses within the MDPE distribution network.	Not feasible
3. GIS-Based Asset Mapping and Monitoring	
Complete MDPE network infrastructure including pipelines, valves, service regulators, and consumer connections should be integrated with GIS-based mapping systems for improved asset visibility, maintenance planning, and emergency response.	Agreed with the recommendation of asset mapping however maintenance planning is to be explored
Recommendations for Automation and Digitization of Metering Infrastructure	
1. Deployment of Metering Skids for Industrial Consumers	
All industrial consumers should be provided with dedicated industrial metering skids comprising approved custody transfer metering systems, flow computers, pressure and temperature transmitters, filtration systems, and safety devices for accurate gas measurement and operational monitoring.	Flow computers are not economically viable rest recommendations are agreed upon.
2. Integration of Industrial Metering with ERP/SAP Systems	
Automated Meter Reading (AMR) systems deployed for industrial consumers should be integrated directly with ERP/SAP platforms for automatic billing generation as per predefined billing schedules. Such integration would improve billing accuracy, reduce manual intervention, enhance revenue assurance, and streamline commercial operations.	AMR system is viable for high consumption customers

Recommendations	IGL COMMENTS
3. Implementation of Smart Metering in Commercial and Domestic Segments	
Smart gas meters with automated communication capability should progressively be deployed across commercial and domestic consumer categories for automated billing, consumption monitoring, operational analytics, and reduction in manual meter reading dependency with mandatory Prepaid & Two-Way Communication Capability Functionality in Smart Meters	The recommended capabilities are feasible for high billing customers only.
4. Remote Safety Valve Operation in Domestic Smart Meters	
Domestic smart meters should incorporate remotely operable safety shut-off valves in line with PNGRB authorization requirements for CGD networks. Such remote safety valve capability would enable rapid isolation of gas supply during emergencies such as gas leakage, fire incidents, tampering, abnormal consumption, or maintenance activities.	Not feasible
5. Centralized Meter Data Management System (MDMS)	
A centralized MDMS platform should be implemented for real-time acquisition, storage, analytics, billing integration, and operational management of smart meter data across all consumer categories.	May be explored
6. Advanced Tamper and Leak Detection Systems	
Smart metering infrastructure should incorporate advanced tamper detection, leak detection, excess flow monitoring, reverse flow detection, and communication failure alarms to improve safety and revenue protection.	Not feasible
7. Consumer Mobile Applications and Digital Portals	
Integrated digital platforms should be provided to consumers for monitoring gas consumption, recharge balances, billing history, payment status, and safety alerts.	Agreed with recommendations
Recommendations for GIS Implementation in CGD Networks	H.
1. Mandatory GIS Implementation and Asset Digitization as per PNGRB T4S Regulations	
All CGD entities should implement and maintain comprehensive GIS platforms in compliance with applicable PNGRB T4S Regulations for accurate geospatial mapping and lifecycle management of CGD infrastructure. GIS platforms should mandatorily capture all critical CGD assets including CGS, CNG stations, steel pipelines, MDPE networks, DRS facilities, isolation valves, sectionalizing valves, service regulators, cathodic protection infrastructure, consumer service lines, and metering systems.	• Agreed with recommendation • Reason: Real-time DGPS data collection is a highly capital-intensive activity requiring specialized technical expertise currently beyond the scope of standard site construction teams. Implementing this would necessitate on boarding external specialized survey agencies, significantly affecting project costs as the projects are not continuous but on discreet manner.
	• Recommendation: It is requested to permit a phased compliance window, allowing pipelines to be fully mapped and updated in the GIS database within 6 months of post-commissioning.
2. Consumer Connectivity Mapping	
GIS systems should capture detailed consumer connectivity information including riser-wise household mapping in high-rise buildings and runner-wise household connectivity in row housing developments for improved operational traceability and emergency management. It also enables customers to locate or identify availability of distribution network in close vicinity.	• Agreed with Recommendation • Reason: Mapping the entire consumer network down to individual house-risers and runners introduces extreme data complexity and maintenance challenges.

Recommendations	IGL COMMENTS
	• Recommendation: It is advisable to restrict consumer connectivity mapping to the service line level, which provides sufficient operational visibility while ensuring the data model remains manageable and accurate.
3. Use of DGPS for New Pipeline Construction	
Differential GPS (DGPS) technology should mandatorily be utilized during laying of new pipelines and CGD infrastructure to ensure high-precision geospatial mapping accuracy.	• Agreed with recommendation • Reason: Real-time DGPS data collection is a highly capital-intensive activity requiring specialized technical expertise currently beyond the scope of standard site construction teams. Implementing this would necessitate on boarding external specialized survey agencies, significantly affecting project costs as the projects are not continuous but on discreet manner. • Recommendation: It is requested to permit a phased compliance window, allowing pipelines to be fully mapped and updated in the GIS database within 6 months of post-commissioning
4. Phased Dig Surveys for Legacy/Mature GAs	
In older or mature GAs where historical asset records lack sufficient positional accuracy, phased dig surveys should be undertaken for physical verification and accurate GIS updation of buried pipeline infrastructure.	• Not Feasible • Reason: - Executing physical dig surveys for legacy assets poses significant practical challenges, as ground and road levels change frequently over time—especially within residential societies where a major portion of the CGD network is laid
5. GIS Access Sharing with Statutory Authorities for Excavation Management	
Controlled GIS viewing access rights may be shared with statutory authorities such as municipal bodies and utility agencies for coordination of excavation, utility laying, and maintenance activities in order to minimize third-party damage to underground utilities.	• Agreed with recommendation • Recommendation – CGD to share view only access to utility entities through their official website and actual data can be shared with government only.
6. Mobile GIS and Field Inspection Integration	
Mobile GIS applications should be deployed for field inspection, leak surveys, patrolling activities, emergency response, and asset verification with geo-tagged digital records.	Agreed
7. Periodic GIS Data Validation and Updating	
GIS databases should be periodically validated and updated through field verification, DGPS surveys, and integrity assessment activities to ensure long-term reliability and operational accuracy of underground asset records.	• Agreed with recommendation • Recommendation – For the steel pipeline network, the location can be re-surveyed using the Pipeline locator for position and depth, and DGPS to verify the location. However, in case of MDPE network, only above ground features to be validated for position and coordinates.

Sr. No.	Chapter	Existing Draft Provision	Gujarat Energy Ltd. Comments	Justification
1	Chapter 2 – Steel Pipeline Network	Sectionalizing valve spacing	The reference to a fixed installation interval of sectionalizing valves may be reviewed and aligned with the applicable PNGRB Technical Standards or stated more generically.	This would avoid possible inconsistency in case of future revisions to regulatory provisions or project-specific design considerations.
2	Chapter 2 – Steel Pipeline Network	Leak Detection System	It may be appropriate to clarify that leak detection can be achieved through different suitable technologies depending upon pipeline size, operating conditions and network configuration, without limiting the recommendation to any specific approach.	This would maintain technology neutrality while providing flexibility to CGD entities to adopt suitable solutions.
3	Chapter 4 – District Regulating Station (DRS)	Remote operation of isolation valves	The recommendation may also indicate that remote operation of isolation valves should be considered based on operational criticality and emergency response philosophy of the respective CGD entity.	Not all DRS installations have identical operating conditions. A risk-based approach would provide implementation flexibility while ensuring automation of critical installations.
4	Chapter 5 – MDPE Distribution Network & Service Regulator	Digital monitoring of MDPE network	It may be appropriate to indicate that monitoring points within the MDPE network should be selected based on operational requirements and network criticality rather than adopting a uniform approach across all locations.	The extent of monitoring required may vary depending upon network size, consumer density and operating philosophy adopted by individual CGD entities.
5	Chapter 6 – Industrial, Commercial & Domestic Consumers Metering	Commercial & Domestic Smart Metering	The recommendation may also encourage phased deployment of smart metering based on consumer category, operational priorities and techno-commercial feasibility, considering the varying scale and maturity of CGD entities.	A phased implementation approach would provide flexibility while supporting gradual adoption of smart metering technologies.
6	Chapter 6 – Industrial, Commercial & Domestic Consumers Metering	Prepaid functionality in domestic smart meters	The recommendation on prepaid functionality may be reviewed and retained as an optional capability rather than a general expectation for all domestic smart metering deployments. The choice between prepaid and postpaid metering may be left to the respective CGD entity based on commercial policy, consumer profile and business requirements.	Different CGD entities follow different consumer engagement and billing models. Providing flexibility would encourage wider adoption of smart metering while allowing entities to adopt an approach best suited to their operational and commercial requirements.
7	Chapter 7 – GIS in CGD Networks	Use of DGPS for new pipeline construction	The recommendation on use of DGPS may be reviewed to permit adoption of other suitable survey methodologies capable of achieving the required positional accuracy, wherever DGPS observations are not practicable due to site conditions.	This would provide implementation flexibility while continuing to achieve the objective of maintaining accurate geospatial records.
8	Benchmarking Framework	Classification of CGD entities based on automation maturity	In addition to availability of automation systems, consideration may also be given to evaluating operational utilization and effectiveness of deployed systems while benchmarking CGD entities.	Automation maturity is better reflected by effective utilization of digital systems rather than deployment alone. Parameters such as system availability, data quality and operational adoption may provide a more balanced assessment.

Sr No	Section	Key Point / Observation	Classification	ATGL Recommendation
1	Overall	Centralized SCADA + ERP Integration	Mandatory	- Implement unified cloud-based digital platform for multi-GA entities. - Provide live data access to relevant staff across all GAs. - Enable Virtual Control Room functionality on individual laptops. - Establish single 24×7 centralized control room for all GAs. - Eliminate duplication of control room infrastructure. - Ensure real-time monitoring and action capability.
2	Overall	Collaborative Development of Automation and Digital Infrastructure	Good to Have	- Enable data sharing among CGD, transmission, and LNG entities. - Create seamless interface between different SCADA systems. - Avoid infrastructure duplication (CGS check meters, CTM, etc.). - Develop shared platforms for consumer registration, nomination and scheduling. Enable real-time gas trading between entities. - Allow mature entities to provide services to smaller entities. - Mandate open protocols and APIs for all vendors. - Require cyber security compliance (similar to banking/telecom sectors).
3	Overall	Consumer Mobile Application	Good to Have	- Develop single digital platform for consumers. - Mandate minimum provisions in consumer apps. - Align with LPG customer platforms. - Follow PNGRB/MoPNG initiatives.
4	Overall	Vehicle Tracking System	Good to Have	- Implement GPS-based vehicle tracking. - Enable AI-powered fatigue monitoring. - Include pressure monitoring capabilities.
5	Overall	Consumer GIS Mapping	Good to Have	- Complete riser mapping for all consumers. - Complete runner mapping for all consumers.
6	Overall	GIS Excavation Monitoring	Good to Have	- Implement RFID-based contractor monitoring. - Enable GPS tracking for excavation activities.
7	CGS	Flow Meter Data Sharing from Transmission Entity	Mandatory	- Integrate custody meter data with SCADA. - Integrate check meter data with SCADA. - Implement on priority basis.
8	CGS	Clamp-on Ultrasonic Flow Meter (Where Signals Unavailable)	To Be Reviewed	- Allow CGD entities flexibility in flow meter selection. - Restrict maximum error range as per AGA standards. - Avoid specific product recommendations. - Require verification and acceptability by CGD entities.
9	CGS	Remote ESDV/Isolation Valves	To Be Reviewed	- Assess practicality of full implementation. - May not be feasible for complete network. - Mandate installation at critical locations (CGS, DRS).

Sr No	Section	Key Point / Observation	Classification	ATGL Recommendation
10	Steel Network	Geo-fencing for TPD Prevention	To Be Reviewed	- Assess practicality of implementation. - Require verification by CGD entities. - Obtain acceptability before recommendation.
11	Steel Network	Digital Integrity Management System	Mandatory	- Implement single integrity dashboard. - Refer to Point No. 2 for integration approach.
12	CNG	SCADA for All CNG Stations	Mandatory	- Implement SCADA integration for all CNG stations. - Install inlet and outlet meters. - Use SCADA-compatible instruments. - Include compatible odorisers and dispensers.
13	CNG	Energy Monitoring	Good to Have	- Track energy efficiency using kWh/kg KPI. - Monitor and report energy consumption.
14	DRS	SCADA Integration for DRS	Mandatory	- Install RTU at all critical DRS locations. - Ensure SCADA integration for monitoring.
15	MDPE	Telemetry at Critical Regulators	Good to Have	- Implement telemetry at critical regulators. - Enable pilot district pressure monitoring.
16	Metering	Industrial AMR with ERP Integration	Mandatory	- Achieve 100% SAP integration. - Apply to all industrial meters.
17	Metering	Domestic Smart Meters with Remote Valve	To Be Reviewed	- Assess practicality of implementation. - Require verification by CGD entities. - Obtain acceptability before recommendation.
18	GIS	DGPS and Complete GIS Implementation	Mandatory	- Achieve 100% asset digitization. - Implement complete DGPS coverage.
19	GIS	Dig Survey for Legacy Assets	To Be Reviewed	- Assess practicality of implementation. - Require verification by CGD entities. - Obtain acceptability before recommendation.
20	Overall	Automation for LUAG Reduction	Mandatory	- Implement gas accounting KPI. - Track and monitor LUAG reduction.
21	Not Recommended	Full Automation of Every MDPE Asset	To Be Reviewed	- Assess practicality of implementation. - Require verification by CGD entities. - Obtain acceptability before recommendation.
22	Odorisers	Mandatory Automation of Odorisers	To Be Included	- Mandate automation of all odorisers. - Apply to all applicable installations.

• ATGL PROVEN OUTCOMES (FY 2021–22 to FY 2025–26)

✓ 31% reduction in LUAG from 2.44% to 1.68%, improving revenue assurance - expected LUAG saving during FY 2025–32 of ~₹400 Cr
✓ One centralized control room replacing 34 GA-wise control rooms.
✓ In excess of ₹100 Crore estimated savings from centralized operations.
✓ Enterprise-wide visibility of assets, alarms, operational KPIs, billing, and price management.
✓ Standardized operations, faster decision-making, improved compliance, safety, and reliability.

• **Think Gas: Cost Savings and Operational Benefits Achieved Through SCADA Implementation**

Sr. No.	Benefit Area	Automation / Digital Intervention	Key Benefits / Impact
1	Reduction in Manpower Requirement	Centralised monitoring of CNG stations, DRSSs, CGSSs, compressors and PNG networks through SCADA.	Reduced requirement for dedicated manpower at individual sites through centralised monitoring and supervision.
2	In-house SCADA Commissioning & Troubleshooting	Remote diagnosis, monitoring and troubleshooting through SCADA.	Reduced dependency on OEM/vendor visits, resulting in lower OEM service charges and vendor mobilisation/travel expenses.
3	Reduction in Travel & Field Visit Expenses	Real-time monitoring of pressure, flow, temperature, compressor status, ESD status and communication health.	Reduced routine site visits; field teams mobilised primarily for actual faults and maintenance activities. Centralised price change of dispensers further reduces site-level intervention.
4	Reduction in Gas Losses & Leak Detection Time	Continuous monitoring of network parameters and alarm conditions.	Early identification of gas leakage, pressure abnormalities, pipeline issues and compressor inefficiencies. Prompt corrective action minimises gas and revenue losses.
5	Improved Equipment Reliability & Reduced Downtime	Monitoring of equipment run hours, alarm history and trend analysis, with inputs for preventive and predictive maintenance.	Early identification of equipment issues, reducing breakdowns, unplanned shutdowns and downtime.
6	Energy Optimisation	Optimisation of compressor and equipment operation based on demand and network conditions.	Reduction in unnecessary running hours and inefficient operation, resulting in lower electricity consumption.
7	Faster Emergency Response	Centralised real-time monitoring of critical parameters, alarms and ESD status.	Faster identification of abnormal conditions and initiation of corrective/emergency actions, thereby improving emergency preparedness and network safety.
8	Automated Reporting & Data Management	Automated generation of sales and operational reports through SCADA.	Substantial reduction in manual data collection and reconciliation efforts, with improved data availability and accuracy.
9	SCADA–LMS Integration & Standardisation	Integration of SCADA with the Logistics Management System (LMS) for real-time monitoring of station inventory levels, bank pressures and dry-out conditions.	Optimised cascade deployment, route planning and fleet utilisation, resulting in significant reduction in logistics and transportation costs.
10	Reduction in Emergency Dry-out Situations	Continuous visibility of inventory levels, cascade pressures and station dry-out conditions through integrated systems.	Reduced emergency dry-out situations, avoidance of unnecessary tanker movements, optimised route planning and improved utilisation of transportation resources.

• **MGL: Cost Savings and Operational Benefits Achieved Through SCADA Implementation**

- I. **Operational Efficiency:** Centralized monitoring and control of multiple sites from a single control room enables faster decision-making, better resource allocation, and allows a smaller team to efficiently manage a larger operational area.
- II. **Data & Reporting:** Automatically captures process data and event logs, eliminating manual record-keeping, improving reporting accuracy, and ensuring regulatory compliance.
- III. **Early Fault Detection:** Instant alarms for pressure drop, equipment failures, and other abnormalities enable quick response, reducing downtime and preventing major failures. Historical data also supports effective root cause analysis.
- IV. **Predictive Maintenance:** Trend analysis helps identify equipment deterioration before failure, reducing unexpected breakdowns, maintenance costs, and improving asset reliability.

• Comments received from PNGRB Peer Group

HD HIRAK DUTTA <expert.advisor@pngrb.gov.in>
Tue, 14 Jul 2026 12:25:45 PM +0530 • CGD AUTOMATION
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Security TLS [Learn more](#)

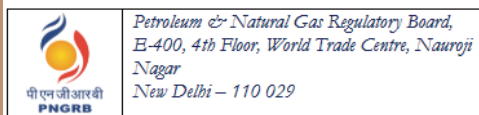
Persued the technical paper on CGD automation.
It has come up well - looks like an educative article.

To my mind, you may include some technical data to substantiate the benefits / gains as suggested in the paper.
Without any data, it seems like a suggestive paper; incorporation of data will ensure high acceptability of the recommendations.

Overall looks good.

Regards,

Hirak Dutta
Expert Advisor - PNGRB



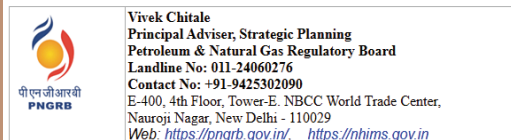
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Dear Shri Gupta,

GIS data of CGD network of steel & MDPE should be in .SHP file format. It may cover STPL, Steel, MDPE, CNG Stations, CGS & DRS stations. All these attributes must have GA-ID, GA-Name, Entity Name. The network of STPL, Steel & MDPE must have length & Diameter.

Regards,



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Dear Ravi ji,

I have gone through the draft report. It is a comprehensive and very useful report.

A few suggestions for further strengthening the report, primarily from the IT/OT governance and implementation perspective, are given below:

1. Cybersecurity

Since the proposed framework envisages extensive connectivity among SCADA, telemetry systems, GIS, smart meters, cloud platforms, enterprise applications and NHIMS, cybersecurity may be treated as a fundamental and cross-cutting requirement from the first phase itself. Remote valves, field telemetry, smart meters and SCADA connectivity create cyber exposure from the initial stages themselves. Therefore, cybersecurity should come out as one of the key recommendations and the section may cover IT-OT network segregation, secure remote access, role-based access control, vendor access, security monitoring, patch and vulnerability management, backup and disaster recovery, communication redundancy and cyber-incident response. Cyber risks in the case of IT-OT integrated environments need to be addressed much more aggressively than in isolated setups and any integration between SCADA and enterprise systems should preferably be through a secure intermediary layer rather than through direct connectivity.

2. Safeguards for critical remote operations

Recommendations relating to remote operation of isolation valves, ESDVs and smart-meter shut-off valves may also specify the associated prerequisites, such as local safety interlocks, fail-safe behaviour upon loss of communication, role-based and two-step command authorisation, local override, command/event audit trails, periodic proof testing and manual fallback procedures. Local safety and shutdown functions should remain capable of operating independently of the central SCADA system.

3. GIS, smart-meter and surveillance data controls

Access to detailed pipeline, consumer-connectivity, CCTV, smart-meter and vehicle-tracking data may be role-based and subject to suitable data-retention, privacy and audit requirements.

Overall, the report is very well written.

Regards,

Vikas Sharma
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Abbreviations	
AI	Artificial Intelligence
AMR	Automated Meter Reading
CCTV	Closed-Circuit Television
CGD	City Gas Distribution
CGS	City Gate Station
CNG	Compressed Natural Gas
CP	Cathodic Protection
DBS	Daughter Booster Station
DGPS	Differential Global Positioning System
DRS	District Regulating Station
ERP	Enterprise Resource Planning
ESDV	Emergency Shut-Off Valve
GA	Geographical Area
GIS	Geographic Information System
GPS	Global Positioning System
ICCP	Impressed Current Cathodic Protection
IJ	Insulating Joint
LUAG	Lost and Unaccounted Gas
MDMS	Meter Data Management System
MDPE	Medium Density Polyethylene
MIS	Management Information System
NHIMS	National Hydrocarbon Infrastructure Monitoring System
OT	Operational Technology
PLC	Programmable Logic Controller
PNG	Piped Natural Gas
PNGRB	Petroleum and Natural Gas Regulatory Board
RFID	Radio Frequency Identification
RTU	Remote Terminal Unit
SAP	Systems, Applications and Products
SCADA	Supervisory Control and Data Acquisition
SV	Sectionalizing Valve
T4S	Technical Standards and Specifications including Safety Standards
TLP	Test Lead Point
TPD	Third-Party Damage

ABOUT THE AUTHORS

RAVI GUPTA

LEAD CONSULTANT – COORDINATION DIVISION & HYDROGEN CELL

Ravi Gupta is an accomplished Oil & Gas professional with over **28 years of experience** spanning regulatory and policy support, Refinery projects, Natural gas pipelines, City Gas Distribution (CGD) and downstream segment. He currently serves as Lead Consultant at the Petroleum and Natural Gas Regulatory Board (PNGRB) where he contributes to regulatory initiatives, technical evaluations, standardisation, safety frameworks, and policy formulation in downstream and emerging energy sectors.

He possesses extensive technical and project management experience in Instrumentation & Control, DCS/ESD/SCADA, automation, telecom, pipeline systems and digital operational technologies. He has also undergone specialised training on SCADA systems in the UK and has international exposure across several countries. Prior to PNGRB, he was associated with HMEL, L&T, GS E&C And Punj Lloyd Ltd.

As an author of the report, he has contributed to the assessment of automation maturity, SCADA deployment, digital asset management, operational safety and technology adoption across CGD entities.

Qualifications

PGDM – Marketing, AIMA, New Delhi

B.E. – Instrumentation & Control Engineering, NSIT, University of Delhi

Chartered Engineer | TUV Certified Functional Safety Engineer (CFSE)



VIJAY KUMAR

DEPUTY DIRECTOR (TECHNICAL)

Vijay Kumar is a seasoned oil and gas professional with over 18 years of experience in natural gas infrastructure and distribution. He currently serves as Deputy Director (Technical) at the Petroleum and Natural Gas Regulatory Board (PNGRB) on deputation from Gujarat Energy Limited. At PNGRB, he contributes to technical evaluations, standardisation initiatives, and policy formulation inputs aimed at strengthening safety, efficiency, and reliability across India's natural gas infrastructure.

He possesses significant expertise in Natural Gas Pipelines (NGPL), Petroleum & Petroleum Products Pipelines (PPPL) and City Gas Distribution (CGD), with a focus on technical compliance, regulatory frameworks, and infrastructure development. Prior to joining PNGRB, he was actively involved in project execution and operations management within Gujarat Energy Limited's NGPL and mature CGD network, gaining extensive practical experience in pipeline integrity, supply reliability, and customer-oriented gas distribution systems. He brings a strong blend of field and regulatory experience to his present role.

Qualifications

Master's in Business Administration - IIM, Amritsar

B.Tech – Oil & Gas Engineering - UPES, Dehradun





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