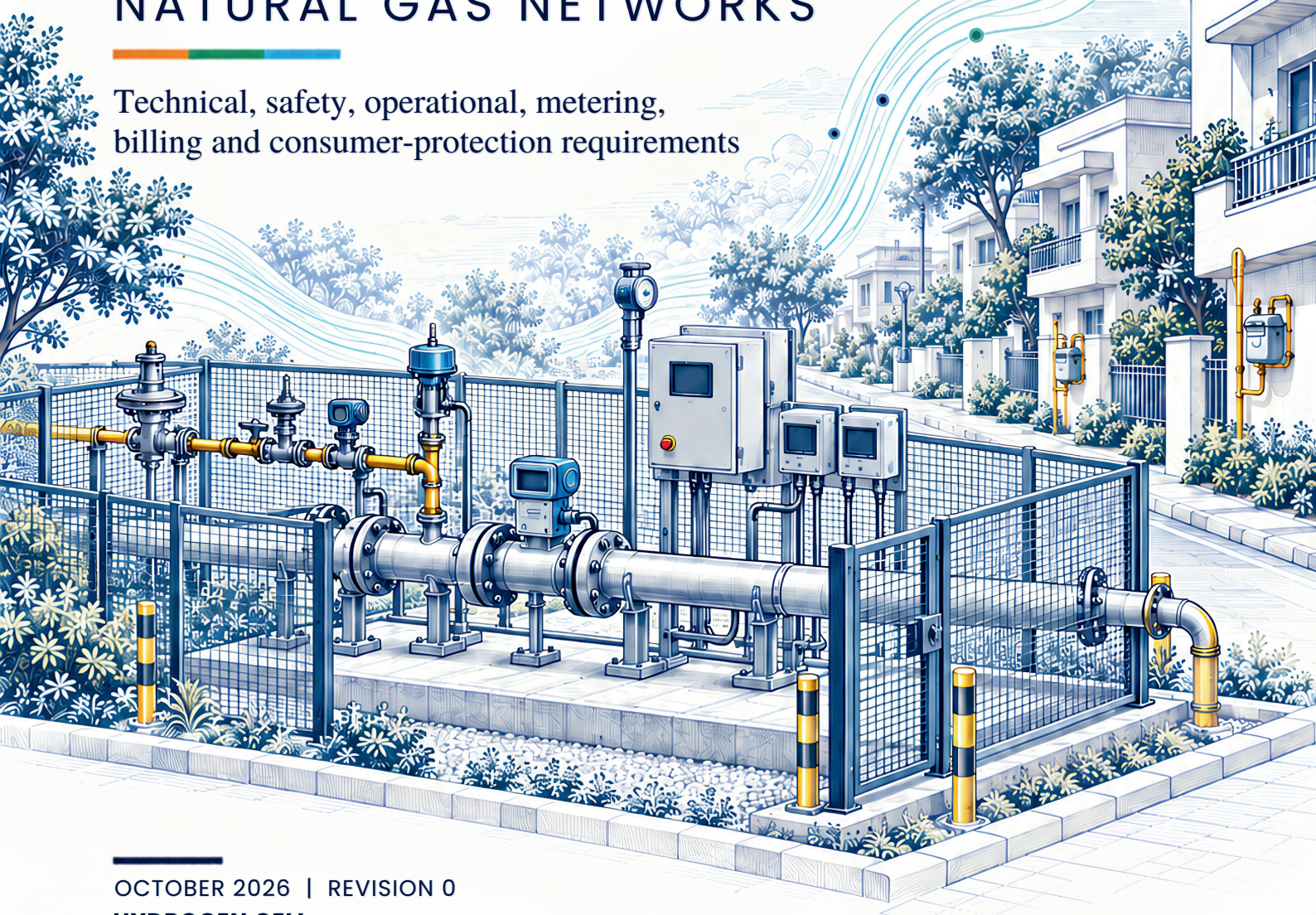


DRAFT TYPICAL GUIDELINES
FOR BLENDING OF

Hydrogen with Natural Gas

IN DOMESTIC PIPED
NATURAL GAS NETWORKS

Technical, safety, operational, metering,
billing and consumer-protection requirements



OCTOBER 2026 | REVISION 0

HYDROGEN CELL

PETROLEUM AND NATURAL GAS REGULATORY BOARD



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This draft does not by itself authorize commercial hydrogen blending. Applicability is subject to statutory enablement, PNGRB approval and all other competent-authority permissions.

Document purpose: To prescribe the minimum conditions for commercial supply of HNG containing not more than 5.0% hydrogen by volume to DPNG consumers, after legal and policy enablement and specific PNGRB approval. Higher-concentration pilot projects are governed separately by Annexure P.

Evidence limitation: AGL/Indore and ATGL/Shantigram provide relevant Indian field evidence at 5% for the assessed assets, conditions and exposure periods. Their findings are not a universal declaration of compatibility. Each entity must qualify its own network, equipment, meters, regulators, appliances, control system and consumer arrangements.

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Glossary and abbreviations

Term	Meaning
ALARP	As Low As Reasonably Practicable.
CGD	City or local natural gas distribution network.
DPNG	Domestic Piped Natural Gas.
DRS/DPRS	District/Distribution Pressure Regulating Station.
ESD	Emergency Shutdown System.
GCV / LHV	Gross Calorific Value / Lower Heating Value.
HAC	Hazardous Area Classification.
HAZID / HAZOP	Hazard Identification / Hazard and Operability Study.
HNG	Hydrogen-blended natural gas.
IMS	Integrity Management System.
LOTO	Lock-out/Tag-out.
MOC	Management of Change.
NDT	Non-Destructive Testing.
OEM	Original Equipment Manufacturer.
P&ID / PFD	Piping and Instrumentation Diagram / Process Flow Diagram.
PAUT	Phased Array Ultrasonic Testing.
PSSR	Pre-Startup Safety Review.
QRA	Quantitative Risk Assessment.
SCADA	Supervisory Control and Data Acquisition.
SCBA	Self-Contained Breathing Apparatus.
TPIA	Third-Party Inspection Agency or another independent competent agency accepted by PNGRB.
Wobbe Index	A gas-interchangeability parameter relating calorific value to relative density.
HFW	High-Frequency Welded (pipe)
IOGP	International Association of Oil & Gas Producers
RWA	Resident Welfare Association
FFS	Fitness-for-Service

Term	Meaning
HE	Hydrogen Embrittlement
PMC	Project Management Consultant
HSE	Health and Safety Executive (United Kingdom)
SME	Subject matter expert (SME): a qualified individual who possesses expertise and experience in the subject matter.
ECA	Engineering critical Assessment

1. DEFINITIONS

1.1 “Act” means the Petroleum and Natural Gas Regulatory Board Act, 2006.

1.2 “Authorized Entity” means an entity authorized by PNGRB to lay, build, operate or expand a city or local natural gas distribution network and which proposes to undertake, or undertakes, hydrogen blending within its authorized geographical area under these Guidelines.

1.3 “Board” or “PNGRB” means the Petroleum and Natural Gas Regulatory Board.

1.4 “DPNG” means gas supplied through a CGD network to domestic households.

1.5 “Blending Facility” means the equipment and control system used to receive hydrogen, regulate, measure, inject, mix, analyse and safely isolate hydrogen at the approved injection point. Hydrogen generation and storage upstream of the hydrogen receipt point are excluded from the Blending Facility.

1.6 “Commercial Deployment” means regular supply of HNG to DPNG consumers under an enabling statutory and regulatory framework and a specific PNGRB approval.

1.7 “Commercial Deployment Area” means the hydraulically defined, operationally controllable and approved portion of a CGD network receiving HNG, including service lines, meters, regulators and domestic end-use installations. The Area may rely on existing or additional isolation and network-control arrangements and need not constitute a newly constructed or permanently segregated network loop.

1.8 “Hydrogen Receipt and Interface Point” means the defined physical point at which hydrogen is received from the upstream hydrogen supply system into the Blending Facility, together with the associated isolation, pressure, flow, quality and emergency-interface requirements.

1.9 “Maximum Commercial Blend Limit” means 5.0% hydrogen by volume as demonstrated in accordance with the measurement and verification arrangements in the approved area, unless a lower limit applies under law, gas-quality requirements, equipment or appliance limitations, or the PNGRB approval.

1.10 “Normal Operating Setpoint” means the target hydrogen concentration selected below the Maximum Commercial Blend Limit by a validated dynamic-control study, allowing for measurement uncertainty, process response, flow variation and credible transients. It is distinct from the upper boundary of the Approved Concentration Control Band and the high-high trip setting.

1.11 “Approved Operating Envelope” means approved limits for concentration, flow, pressure, temperature, gas quality, network boundary, equipment, monitoring, staffing, billing and emergency response.

1.12 “Integrated Safety and Readiness Dossier” means the coordinated and maintained body of technical, safety, operational, integrity, gas-quality, metering, emergency, consumer-protection and independent-assurance evidence necessary to demonstrate that the proposed Commercial Deployment can operate within the Approved Operating Envelope.

1.13 “Independent Competent Agency” means a technically competent third-party organization appointed by the Authorized Entity for independent review or verification, having no conflict of interest that may impair the objectivity of its assessment.

1.14 “Material Change” means a change to concentration, setpoint, injection point, boundary, pressure/flow, hydrogen source or quality, storage/decanting, equipment, control logic, material/appliance population, billing, public communication or emergency arrangements that may affect the approved basis; boundary expansion of the Commercial Deployment Area requires prior PNGRB approval.

1.15 “Hydrogen-Related Complaint” means a complaint concerning safety, smell, flame, appliance performance, pressure or supply, metering, billing, information or another matter reasonably alleged to arise from HNG supply.

1.16 “LEL” and “UEL” mean the lower and upper concentrations of a flammable gas in air between which flame propagation can occur under specified test conditions.

1.17 “Hydrogen-Ready Infrastructure” means that portion of a CGD network, together with its associated equipment, meters, regulators and validated appliance classes, established as suitable for HNG service up to the approved commercial concentration, not exceeding 5.0% hydrogen by volume.

1.18 “Online Hydrogen Analyser” means an instrument providing continuous measurement of hydrogen concentration in the gas stream. No particular analyser technology is prescribed, provided the performance, response, calibration and uncertainty requirements of these Guidelines and the approval are met.

1.19 “Hydrogen Quality” means conformity of hydrogen at the hydrogen receipt and interface point of the Blending Facility to Type I, Grade A of IS 16061 (equivalent to ISO 14687), including the applicable sampling and quality-verification requirements.

1.20 “HNG” means a homogeneous mixture of hydrogen and natural gas supplied within the Approved Operating Envelope. Hydrogen concentration shall be expressed as volume percent on a dry basis at the standard reference conditions prescribed under the applicable regulation or approval. HNG may additionally be characterised, where relevant, on an operating-pressure or hydrogen partial-pressure basis.

1.21 “Pre-Startup Safety Review / PSSR” means a documented multidisciplinary review conducted after mechanical completion and before the first introduction of hydrogen, to verify that the installation has been completed in accordance with the approved design, all applicable permissions and safety requirements have been complied with, safety-critical systems have been tested, relevant recommendations have been closed, and the technical, operational, emergency, metering, consumer-protection and natural-gas-restoration arrangements are ready for safe operation.

1.22 Words and expressions not defined in these Guidelines shall have the meanings assigned in the Act, applicable rules and PNGRB regulations.

1.23 Equipment. Nonmetallic pipes and equipment, such as gaskets, O-rings, valves, and seals, shall be evaluated for suitability for the intended hydrogen service. Potential degradation mechanisms and failure modes include, but are not limited to, rapid gas decompression, compression set/relaxation, stiffening, swelling, and warping in elastomers, and slow crack growth and changes in crystallinity in thermoplastics.

1.24 “Trial Operation Period” means the period of monitored commercial supply commencing in accordance with Clause 10.12 and continuing until PNGRB confirms completion under Clause 10.20, including any continued trial operation expressly authorized under Clause 10.21.**1.25** “Approved Concentration Control Band” means the range of hydrogen concentrations permitted during stable HNG operation around the Normal Operating Setpoint. Its upper boundary shall be below the high-high trip setting, with the separation and margins established by the dynamic-control study under Clause 6.2.3.

2. SCOPE, LEGAL ENABLEMENT, APPLICABILITY AND HIERARCHY

2.1 These Guidelines prescribe minimum requirements for commercial supply of HNG containing not more than 5.0% hydrogen by volume to DPNG consumers. They address single-point injection into small, hydraulically defined Commercial Deployment Areas confined to domestic consumers. Injection at District Regulating Station level, which cannot ordinarily be confined to domestic consumers alone, is not covered at this stage.

2.2 Commercial Deployment shall commence with a Trial Operation Period in accordance with Section 10 and only after the required legal and policy enablement, specific PNGRB approval and all applicable statutory permissions. These Guidelines do not by themselves create a right to blend or commercially supply hydrogen.

2.3 No commercial supply under these Guidelines shall exceed 5.0%. Supply above 5.0% shall be undertaken only as a PNGRB-approved Pilot Project under **Annexure P**, unless a higher commercial limit is subsequently notified or approved by PNGRB.

2.4 These Guidelines apply from the Hydrogen Receipt and Interface Point, through the Blending Facility, to the downstream Commercial Deployment Area and domestic installations. The scope includes hydrogen-side receipt, regulation, measurement, isolation and injection equipment downstream of that interface point and upstream of the mixing point. Hydrogen production, transportation, compression and storage upstream of the interface point, including upstream mobile-cascade systems, remain outside this scope and shall independently comply with applicable laws and competent-authority approvals. The receipt and decanting interface requirements in Clause 6.5 shall apply where relevant.

2.5 These Guidelines exclude CNG/HCNG, automotive use, transmission pipelines, pure-hydrogen supply, refuelling, deblandening and non-domestic PNG unless separately approved by PNGRB.

2.6 Where an injection point could expose excluded consumers or assets, hydraulic segregation, isolation and monitoring shall prevent such exposure.

2.7 These Guidelines shall be read with applicable PNGRB CGD T4S, IMS, ERDMP, Access Code, quality-of-service requirements and all competent-authority approvals, as amended.

2.8 Order of precedence: applicable law and statutory direction; PNGRB regulations; specific approval conditions; these Guidelines; referenced standards or practices.

2.9 A deviation requires prior written PNGRB approval and evidence of equal or higher safety, integrity, gas quality, consumer protection, billing fairness and data quality.

2.10 PNGRB may revise annexures, frequencies or service conditions in light of Indian evidence, incidents, operating experience, standards or statutory direction.

2.11 Technical basis: these Guidelines draw upon the outcomes of the completed hydrogen-blending pilot projects, well-established international references and technical research from reputed organisations, as cited in the References section.

2.12 Hydrogen production, transportation, compression and storage upstream of the hydrogen receipt and interface point are outside the scope of these Guidelines and shall independently comply with all applicable laws, rules, standards, licences and competent-authority approvals. These Guidelines prescribe only those requirements at the Hydrogen Receipt and Interface Point necessary for safe receipt, isolation, pressure and flow control, quality assurance, communication and injection at the Blending Facility.

2.13 Unless otherwise specified, the latest edition of each referenced standard, including applicable amendments and revisions, shall apply. All pressures referred to in these Guidelines are gauge pressures unless expressly stated otherwise. Referenced standards shall apply only to the equipment, service conditions and activities within their scope and to the extent invoked by these Guidelines or the applicable approval. Publications identified as informative references do not impose additional mandatory requirements merely by being listed. Where hydrogen partial pressure is used, it shall be determined using absolute total pressure and the applicable hydrogen mole fraction.

3. GOVERNING PRINCIPLES AND ACCOUNTABILITIES

3.1 Approval shall be evidence-led and asset-specific. Evidence from another site may support but shall not replace assessment of the actual network, materials, equipment, appliances and local context. Where such evidence is relied upon, the Integrated Safety and Readiness Dossier shall state, for each source, the hydrogen concentration, exposure period, operating pressure, network configuration, materials and appliance population to which it relates, its limitations, and its applicability to the proposed Commercial Deployment Area, in accordance with item A16 of Annexure A.

3.2 Five per cent is the maximum commercial concentration, not the routine control target. The Normal Operating Setpoint shall be lower by a validated margin sufficient to prevent exceedance during peak/minimum demand, start-up, shutdown and disturbances.

3.3 Loss of natural-gas flow, valid concentration measurement, essential power, control integrity or a safety-critical protection shall isolate hydrogen. Restoration to natural-gas-only supply shall remain practicable.

3.4 HNG approval shall not relax existing CGD safety, integrity, gas-quality, metering, billing, quality-of-service, emergency or complaint-handling obligations.

3.5 Consumer billing shall account for the reduction in heat content attributable to hydrogen blending so that consumers are not charged for energy not delivered.

3.6 Consumers, local authorities and emergency services shall receive advance information on concentration, billing, appliance/emergency guidance and rollout.

3.7 PNGRB may reduce the setpoint, impose controls, suspend HNG or require return to natural gas where evidence, incidents, complaints, billing errors or uncertainty undermine the approved basis.

3.8 The authorized entity's governing body remains accountable. Outsourcing does not transfer regulatory responsibility.

4. APPLICATION, APPROVAL AND COMMERCIAL GOVERNANCE

4.1 No hydrogen shall be introduced commercially without PNGRB approval and all statutory permissions.

4.2 The Authorized Entity shall submit an Integrated Safety and Readiness Dossier structured in accordance with Annexure A as part of its application for commercial deployment and demonstrate suitability from natural-gas-only operation up to the proposed maximum commercial concentration, which shall not exceed 5.0%, including credible transients and any lower component-, appliance- or area-specific limit. Annexure A specifies the minimum technical evidence to be demonstrated before approval. Performance in service at the approved concentration shall be demonstrated during the Trial Operation Period against the completion criteria in Table B-2 of Annexure B.

4.3 The application shall identify the injection point, Commercial Deployment Area and its boundary, consumers, asset inventory, hydrogen source, pressure and flow envelope, setpoint, high and high-high limits, trips, monitoring arrangements, billing adjustment and natural-gas-restoration arrangements. The intending entity shall identify the network and its boundary, carry out an integrity assessment of the identified network and submit the integrity-assessment report to PNGRB prior to commencement of blending operations.

4.4 The authorized entity shall nominate accountable leads for programme, hydrogen competence, operations, emergency, integrity, metrology/billing, consumer protection, public communication and data governance.

4.5 The authorized Entity shall appoint, at its own cost, an Independent Competent Agency having appropriate technical competence and independence to review the design, compatibility assessment, Integrated Safety and Readiness Dossier, metrology and commercial-readiness arrangements, PSSR and initial go-live, and shall report material adverse findings to PNGRB.

4.6 The authorized Entity shall provide the agency access to all relevant records, data, personnel and facilities and shall submit the agency's complete reports, observations, limitations and recommendations to PNGRB along with its response and action-closure status.

4.7 The Authorized Entity shall constitute an internal multidisciplinary review committee, which shall examine safety, integrity, gas quality, billing, complaints, communication and actions monthly in the first year and quarterly thereafter.

4.8 The authorized entity shall maintain insurance, claims and compensation arrangements proportionate to credible risks.

4.9 Approval may be suspended, modified or withdrawn for non-compliance or an invalidated evidence basis.

5. COMMERCIAL DEPLOYMENT AREA AND NETWORK QUALIFICATION

5.1 Rollout shall be limited to a defined Commercial Deployment Area for which existing or additional isolation and network-control arrangements are demonstrated to be sufficient to confine HNG supply to the approved domestic consumers, enable

emergency isolation and permit restoration of natural-gas-only supply. PNGRB may limit the extent, consumer count or duration of an initial Commercial Deployment Area.

5.2 The boundary of the Commercial Deployment Area shall be hydraulically identifiable and operationally controllable. Cross-connections and excluded off-takes shall be identified and controlled. Physical modification of the network shall be required only where the existing arrangements cannot achieve these functions. The Area may rely on existing or additional isolation and network-control arrangements and need not constitute a newly constructed or permanently segregated network loop.

5.3 Mains, services, risers, joints, valves, meters, regulators and appliance classes shall be inventoried. Unknowns shall be resolved, isolated or specifically assessed.

5.4 Before commencement of hydrogen blending, the authorized Entity shall establish the natural-gas-only leakage and integrity baseline of the proposed Commercial Deployment Area and confirm compliance with the applicable Integrity Management System requirements including PNGRB IMS regulations. All identified defects or unacceptable integrity conditions shall be rectified before introduction of hydrogen. Hydrogen blending shall not be used to justify continued operation of assets having known or unresolved defects.

5.5 Sensitive or high-occupancy premises shall receive specific appliance, evacuation, continuity and emergency assessment.

5.6 The area shall have reliable emergency access, communication and competent staffing. Seclusion shall not weaken response.

5.7 Expansion shall require satisfactory performance of the previously approved Commercial Deployment Area and qualification of the proposed additional area subject to prior PNGRB approval.

6. HYDROGEN SOURCE, INTERFACE, BLENDING FACILITY AND CONTROL PHILOSOPHY

6.1 Hydrogen quality and source assurance

6.1.1 Hydrogen received at the hydrogen receipt and interface point of the Blending Facility shall conform to Type I, Grade A of IS 16061 (equivalent to ISO 14687). The fuel-quality specification in Table 5 of IS 16061 is reproduced in Annexure F for ready reference; the published standard shall prevail in case of any inconsistency. Where practicable, hydrogen supplied for commercial HNG deployment should be green hydrogen produced and certified under the National Green Hydrogen Mission framework and emerging certification mechanisms. Entities are encouraged to report the production pathway and, where available, certification/carbon-intensity status in the Integrated Safety and Readiness Dossier and periodic reports

6.1.2 Moisture, oxygen and impurities shall be controlled so that HNG remains within the material, appliance and gas-quality envelope.

6.1.3 The authorized entity shall clearly define the hydrogen receipt and interface point between the upstream hydrogen supply system and the Blending Facility, including the interface pressure, flow, temperature, quality, isolation, venting and communication requirements. Hydrogen generation, compression and storage design remain outside the scope of these Guidelines; project-specific interface risk assessment shall nevertheless demonstrate that an upstream event cannot defeat the safety functions of the Blending Facility.

6.1.4 Any pure-hydrogen piping or equipment upstream of the mixing point shall comply with the applicable hydrogen-service requirements under the relevant national or international standards. The applicability of ASME B31.8 and ASME B31.12 shall be determined on the basis of hydrogen concentration, operating pressure, hydrogen partial pressure and the service boundary. This clause does not extend hydrogen-service design requirements indiscriminately to the downstream low-pressure HNG network.

6.1.5 Hydrogen quality verification at the Hydrogen Receipt and Interface Point:

(a) The Authorized Entity shall be responsible for the conformity of hydrogen entering the Blending Facility with Clause 6.1.1, irrespective of the supply or contractual arrangement. A supplier's certificate shall support but not replace this responsibility.

(b) The water limit in Annexure F shall be applied on the basis of the maximum operating pressure at the Hydrogen Receipt and Interface Point. Oxygen shall not exceed 0.2 mol%, or such lower value as the Gas Quality and Monitoring Plan establishes as necessary for HNG to remain within the notified gas-quality specification and the material and odorant assessments.

(c) For transportable or batch supply, each consignment shall be accompanied by a certificate of analysis demonstrating conformity with Annexure F and sub-clause (b). A consignment without a valid certificate, or not conforming, shall not be connected or decanted.

(d) For continuous supply from a fixed production or pipeline source, moisture and oxygen shall be monitored continuously at or immediately upstream of the Hydrogen Receipt and Interface Point, with an alarm and automatic isolation of hydrogen injection at the approved limits. Upstream instruments may be credited where their signals are available at the Blending Facility and they are calibrated and maintained under the approved plan.

(e) The full Annexure F parameter set shall be verified by a laboratory accredited for the relevant parameters and acceptable to PNGRB: at commissioning; after any change of source, production or purification process, or supplier; at least quarterly during the Trial Operation Period; and at least half-yearly thereafter. Samples shall be collected in containers demonstrated not to alter the sample composition.

(f) Non-conforming hydrogen shall not be injected. Where non-conforming hydrogen may have been injected, the Authorized Entity shall cease injection; verify HNG quality at the outlet and at representative downstream locations; assess the effect on odorization, materials and appliances; and notify PNGRB under Clause 14.3 where HNG may have departed from the notified gas-quality specification. Injection shall resume only after the cause is corrected and conformity re-established.

6.2 Blending and concentration control

6.2.1 The facility shall provide homogeneous mixing over the full natural-gas flow range using a validated injection/mixing arrangement.

6.2.2 Hydrogen injection shall use measured natural-gas and hydrogen flows for ratio control, with an online hydrogen analyser located downstream of the validated mixing length providing concentration feedback or supervisory trim. A second measurement at a representative user-end or network-end point shall verify delivered concentration and homogeneity and shall not ordinarily be used as the rapid control-loop signal because of network transport delay.

6.2.3 A dynamic-control study shall cover minimum and peak demand, rapid load changes, start-up and shutdown, loss or reduction of natural-gas flow, analyser response and delay, valve response, communication delay and credible disturbances. It shall establish the Normal Operating Setpoint, Approved Concentration Control Band, ramping philosophy, control margins and trip settings, taking account of measurement uncertainty, drift and process response.

6.2.4 Hydrogen concentration in the Commercial Deployment Area shall not exceed the Maximum Commercial Blend Limit and shall in no case exceed 5.0% by volume. The Normal Operating Setpoint, upper boundary of the Approved Concentration Control Band and high-high trip setting shall be established with validated margins sufficient to prevent exceedance of the applicable limit, accounting for analyser uncertainty, calibration tolerance, response time, flow variation and credible transients. Stable HNG operation shall remain within the Approved Concentration Control Band.

6.2.5 Where measured hydrogen concentration is used to initiate automatic shutdown, a separate online protective measurement channel shall be provided in addition to the measurement used for normal blending control. Periodic laboratory analysis or another validated reference method shall be used to verify the accuracy of the online analysers but shall not replace continuous protective measurement. Loss, invalidity or material disagreement of a safety-critical concentration signal beyond the approved measurement tolerance shall automatically stop hydrogen injection.

6.2.6 Hydrogen injection shall be prevented when natural-gas flow is absent or below the validated minimum for mixing/control.

6.2.7 The high-high trip shall prevent downstream exceedance of the Maximum Commercial Blend Limit, accounting for the uncertainty and response established by the dynamic-control study. Setpoints and control logic shall be access-controlled, change-logged and protected from unauthorized alteration.

6.3 MECHANICAL AND PROCESS SAFEGUARDS

6.3.1 Provide pressure regulation, excess-flow/flow-limiting protection, non-return protection, emergency isolation and reverse-flow prevention.

6.3.2 At least two emergency shutdown activation points shall be provided, including one at the operating position and one at a readily accessible safe location outside the hazardous area. Local and remote activation shall place the hydrogen-injection system in a defined safe state. The location and separation of the activation points shall be established through the hazardous-area classification and project-specific QRA.

6.3.3 Vents/reliefs shall terminate at safe locations based on dispersion/radiation assessment. Hydrogen, oxygen and hydrocarbon vents shall not be combined unless demonstrated safe. Hydrogen vent systems shall adhere to CGA G-5.5 (Hydrogen Vent Systems); vent lines shall terminate at a minimum height of 3 m above the nearby working platform and the ground level, whichever is higher.

6.3.4 Flame arresters shall be provided only where hazard analysis requires. Where provided, they shall comply with the applicable adopted Indian Standard, including IS 16485 and IS 11006 to the extent applicable to the device type. Where permitted by applicable law and expressly accepted in the PNGRB approval, ISO/IEC 80079-49 may be used as the successor international standard to ISO 16852. In every case, the arrester shall be qualified for the applicable gas or equipment group, flame transmission mode, operating pressure, temperature and other service conditions for hydrogen or HNG at the approved concentration. The applicable standard and certification basis shall be recorded in the design dossier.

6.3.5 Provide safe inert-gas purging for commissioning, maintenance and isolation, avoiding uncontrolled hydrogen-air mixtures and pressure shocks.

6.3.6 Protect equipment from impact, flooding, water logging and unauthorized access. Current P&IDs, cause-and-effect diagrams, isolation plans and piping-identification/colour-coding schedules shall be available at the facility. The site drawings shall identify, as applicable, pressure ranges, nominal pipe sizes and the location and function of isolation, shut-off, relief and emergency devices. Suitable fire extinguishers and other fire-protection arrangements shall be provided on the basis of the fire-risk assessment and applicable standards.

6.3.7 Safety Data Sheets for hydrogen, natural gas, HNG, odorants and other hazardous materials used at the facility shall be readily available and displayed or accessible to operating and emergency personnel.

6.3.8 Personnel shall be provided with and shall use appropriate PPE based on the task-specific risk assessment. Self-Contained Breathing Apparatus (SCBA) shall be available where a hydrogen-rich or oxygen-deficient atmosphere is credible under the emergency plan.

6.3.9 Underground metallic pipelines and components forming part of the Commercial Deployment Area or the Blending Facility shall be provided with and maintained under the applicable corrosion-control and cathodic-protection requirements of the PNGRB CGD T4S and IMS Regulations.

6.3.10 Enclosed or containerized portions of the Blending Facility shall have adequate natural or mechanical ventilation established through the dispersion and ventilation assessment. They shall be provided with hydrogen-suitable gas and fire detection, automatic isolation, and such fire-suppression arrangements as are established by the fire-risk assessment and applicable standards.

6.4 ELECTRICAL, DETECTION, INSTRUMENTATION AND CONTROL-SYSTEM INTEGRITY

6.4.1 Hazardous-area classification shall be carried out in accordance with the applicable Indian Standard, including IS 5572 where applicable, and shall account for the release and dispersion characteristics of hydrogen and HNG. Electrical installation design, equipment selection, installation and initial inspection in explosive atmospheres shall comply with IS 16724 (aligned to IEC 60079-14). Earthing shall comply with IS 3043; bonding, lightning and static-electricity control shall meet applicable Indian requirements. Existing equipment shall be assessed for the intended service; new or replacement equipment in classified areas shall have the required recognized certification.

6.4.2 Fixed hydrogen detectors shall be placed at credible leak/accumulation points, including high points in enclosed or partly enclosed spaces, based on coverage and dispersion. Within buildings, enclosures and covered (shed) areas, detectors shall ordinarily be ceiling-mounted or located near potential leak-accumulation zones, since hydrogen rises. In-household detectors for DPNG consumers are not mandated under these Guidelines; fixed-detection requirements apply to the blending/injection facility and associated confined areas.

6.4.3 Fixed gas detection shall initiate an audio-visual alarm at a concentration not exceeding 10% LEL and shall initiate executive action, including automatic isolation of hydrogen injection, at 25% LEL, consistent with HSE guidance recorded in IGEM/H/3 Appendix 8. Within the Blending Facility, detectors monitoring pure-hydrogen zones (upstream of the mixing point) shall be referenced to the lower explosive limit of hydrogen; detectors monitoring blended-gas zones shall be referenced to the relevant gas at that location. More conservative setpoints shall be adopted where required by the project-specific QRA, hazardous-area assessment or applicable statutory requirements.

6.4.4 Where the project-specific fire-risk assessment identifies a reasonably foreseeable ignited release of hydrogen or HNG, hydrogen-suitable flame detection shall be provided at the relevant location. Suitable technologies may include UV/IR, multi-spectrum infrared, thermal imaging or another validated technology capable of detecting hydrogen flames under the expected operating and environmental conditions.

6.4.5 Control and data systems shall provide controlled access to setpoints and configuration, change logs, synchronized time, alarm and event records, data backup and recovery, and protection against unauthorized alteration. Appropriate cybersecurity measures proportionate to the system architecture, remote connectivity and assessed risk shall be implemented without creating a separate hydrogen-specific cybersecurity regime.

6.4.6 CCTV coverage of the critical areas of the Blending Facility shall be ensured in accordance with the authorized entity's security requirements and the site-specific risk assessment. Incident-related recordings shall be preserved for investigation in accordance with the authorized entity's approved procedure.

6.4.7 Portable gas detectors suitable for hydrogen, natural gas and the expected HNG mixtures shall be available for commissioning, maintenance, leak investigation and emergency response. Before being placed in service, the Authorized Entity shall establish and document, through manufacturer's data, valid calibration certificates, functional testing or other technically accepted evidence, that the detector provides an adequate response to hydrogen, natural gas and the approved HNG concentration range. Calibration, bump-test and maintenance records shall be retained at the facility and made available to PNGRB or the Independent Competent Agency upon request.

6.4.8 Emergency power or fail-safe energy arrangements shall maintain or safely terminate safety-critical control, detection, communication, isolation and data-recording functions. Emergency lighting shall be provided at critical operating and escape locations.

6.4.9 The facility shall maintain suitable operating instructions, emergency contacts, safety signage and the applicable requirements of IS 15201, Hydrogen Code of Safety, insofar as they are relevant to the Blending Facility and do not conflict with these Guidelines or a specific approval.

6.4.10 Safety-critical electrical, instrumentation and control systems shall be provided with appropriate overvoltage, surge and lightning-transient protection, coordinated with the earthing and bonding system and suitable for the classified-area installation.

6.5 MOBILE-CASCADE OR TRANSPORTABLE-STORAGE INTERFACE

6.5.1 This subsection applies only where a transportable hydrogen source or mobile cascade is connected directly to the Blending Facility. It governs the receipt and decanting interface to the extent necessary to protect safe injection; it does not regulate the design of the upstream transport, storage or production system. Decanting shall be performed only by trained, certified and authorized personnel under an approved procedure.

6.5.2 Address designated parking, wheel restraint, traffic exclusion, verified earthing and bonding, breakaway coupling, depressurization, controlled pressure ramp-up, temperature, leaks, remote isolation and trapped-gas venting. Transfer hoses and assemblies shall be electrically conductive or otherwise demonstrably capable of safely dissipating electrostatic charge; electrical continuity of hoses, couplings and transfer assemblies shall be verified before commencement of decanting. For mobile cascades, all conductive components of the cascade, including the cylinder framework and manifold, shall be maintained at substantially the same electrical potential. Where continuity through the cascade structure cannot be demonstrated, additional bonding shall be provided.

6.5.3 Do not decant during lightning, thunderstorms or unsafe weather; do not move the vehicle until disconnected and safe.

6.5.4 The upstream transportable storage system shall comply with the applicable legal and statutory regime. At the Hydrogen Receipt and Interface Point, the Authorized Entity shall verify valid statutory approvals, pressure and quality compatibility, isolation, earthing and bonding, emergency shutdown and safe depressurization. Where cylinders or cascades are connected, cylinder and valve material compatibility shall be established with reference to IS/ISO 11114 Parts 1 to 4, to the extent applicable.

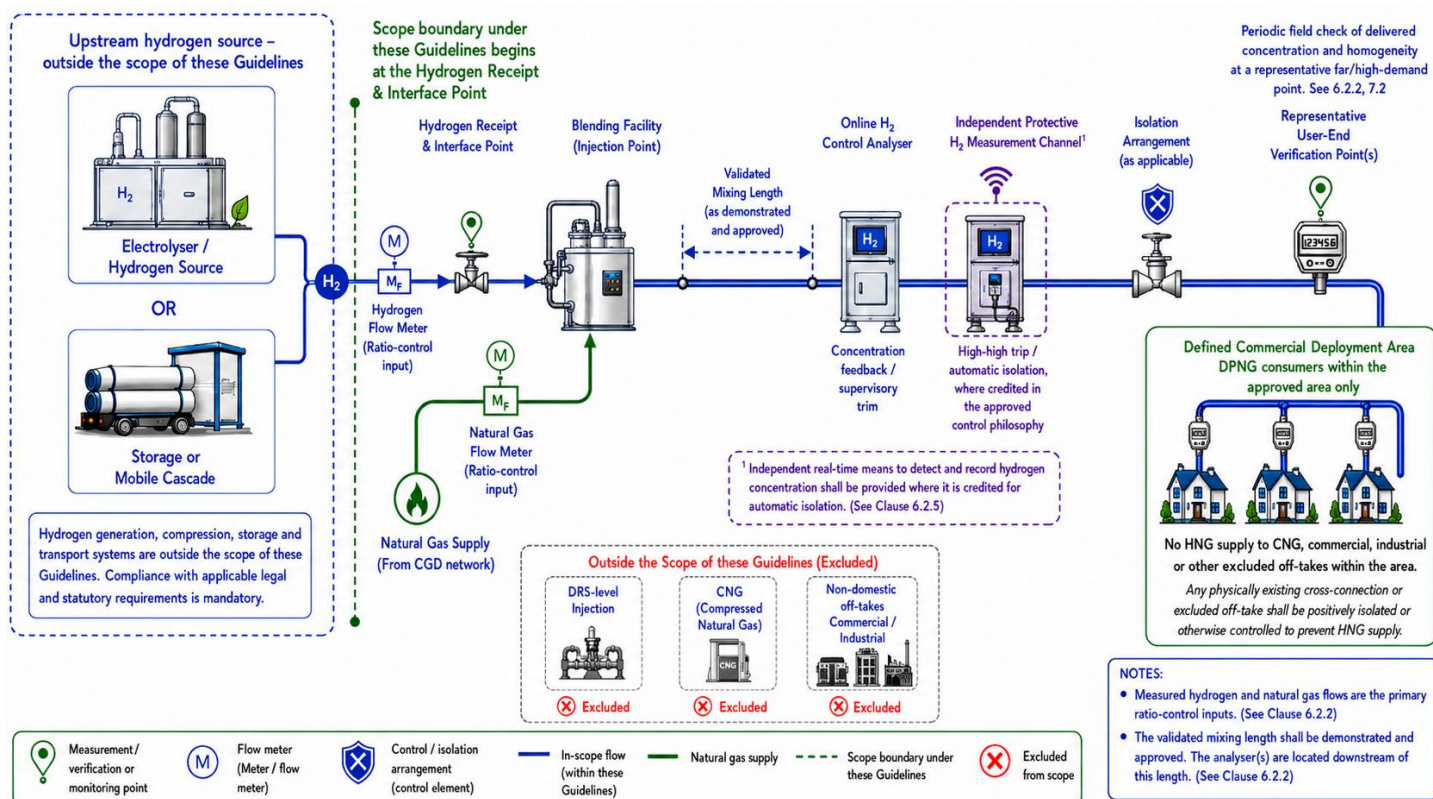


Figure 1 – Schematic of Regulatory Boundary and HNG Supply to DPNG Consumers

7. GAS QUALITY, CONCENTRATION, HOMOGENEITY, INTERCHANGEABILITY AND ODORIZATION

7.1 HNG shall comply with the notified gas-quality specification and Approved Operating Envelope; permitted hydrogen does not excuse other deviations.

7.2 The hydrogen concentration at the Blending Facility outlet, measured after the validated mixing length, shall be continuously monitored and recorded. During commissioning, initial commercial operation and thereafter at frequencies specified in the Gas Quality and Monitoring Plan accepted by PNGRB, the Authorized Entity shall verify hydrogen concentration at hydraulically critical, high-demand, farthest and representative consumer-end locations under peak- and minimum-demand conditions. Additional verification shall be undertaken following any material change, abnormal trend or suspected loss of blend uniformity.

7.3 Demonstrate homogeneity during validation, go-live, material changes and abnormal flows; investigate persistent gradients.

7.4 The Authorized Entity shall monitor the calorific value, relative density and Wobbe Index of HNG, or such other approved interchangeability parameters as may be prescribed, to demonstrate compliance with gas-quality, appliance-performance and heat-content billing-adjustment requirements. HNG shall remain within the applicable notified gas-quality and interchangeability limits.

Note: Until a specific Indian method for determining the calorific value of HNG is prescribed or validated, the Authorized Entity shall use a technically justified and traceable method, supported by calibrated instruments and documented calculations. The method, measurement uncertainty and known limitations shall be included in the approval dossier and monitoring reports.

7.5 Only adequately odorized HNG shall be supplied. Validate odorant and monitoring effectiveness throughout 0-5% at representative endpoints. Odorants and odorization practice shall follow IS 15319 (equivalent to ISO 13734) and ISO/TS 16922; the long-term stability and effectiveness of odorants in HNG shall be periodically validated.

7.6 Check odorant smell and/or concentration at least fortnightly for the first six months and after source/flow changes; thereafter at least monthly unless PNGRB approves otherwise.

7.7 Inadequate/unusual smell or suspected odor fade shall trigger immediate investigation and endpoint testing.

7.8 Compliance, gas-quality and billing-adjustment data shall be obtained using calibrated, traceable instruments and representative measurements. The Gas Quality and Monitoring Plan shall identify at least three representative downstream sampling locations covering the near, intermediate and distal portions of the network, with additional locations as necessary to represent branches, low-flow or dead-end sections, relevant high-rise installations and the consumer distribution. Existing sampling points may be used where they represent the gas delivered to consumers; routine sampling need not require entry into individual residences.

Sampling shall address peak- and minimum-demand conditions, and comparisons shall account for network transport delay and variation in injection concentration. The Plan shall specify sampling methods, measurement uncertainty and acceptance criteria for concentration and homogeneity consistent with Clause 7.9. Frequencies shall comply with Clause 7.2 and Annexure B row B4. Three samples alone shall not be treated as proof of uniformity throughout the network. A spot sample shall not be used to represent billing-period energy delivery unless its representativeness is demonstrated under the methodology approved in Section 12

7.9 Downstream concentration and homogeneity acceptance:

(a) Each downstream verification under Clauses 7.2 and 7.8 shall be compared with the time-aligned outlet record, being the outlet concentration corresponding to the estimated transport delay to that location or, where the delay cannot be reliably estimated, the outlet range over the plausible delay window. Deviations shall be expressed in percentage points of hydrogen by volume (absolute).

(b) Unless the approval specifies a tighter value, the permissible deviation is ± 0.3 percentage point, inclusive of measurement uncertainty.

(c) Alert level: a deviation beyond (b), or a downstream value above the upper boundary of the Approved Concentration Control Band. The verification shall be repeated within 48 hours after checking sampling, time alignment and instrument validity, and the result recorded in the monthly report.

(d) Action level: an alert confirmed on repeat, recurring at the same location in two consecutive scheduled verifications, or occurring at two or more locations in the same verification. The Authorized Entity shall investigate the cause, inform the Independent Competent Agency, and revert to at least weekly verification under row B4 until three consecutive results are within (b). PNGRB may direct a reduction in the Normal Operating Setpoint.

(e) Stop level: any downstream value exceeding the Maximum Commercial Blend Limit. The setpoint shall be reduced or hydrogen injection ceased immediately pending verification; a confirmed exceedance shall be notified under Clause 14.3 and injection resumed only under Clause 14.4.

(f) Grab samples shall be collected in pressurised metallic sample cylinders or other containers demonstrated not to lose or gain hydrogen; bladder or bag samplers shall not be used for hydrogen determination unless validated. Hydrogen content shall be determined by a method validated for hydrogen, with the measurement uncertainty stated in the Gas Quality and Monitoring Plan.

8. MATERIALS, INTEGRITY, METERS, REGULATORS AND DOMESTIC APPLIANCES

8.1 Asset and material compatibility

8.1.1 Maintain a compatibility matrix covering pipelines, joints, valves, regulators, meters, springs, diaphragms, elastomers, gaskets, sealants, hoses, instruments and appliance classes.

8.1.2 Demonstrate suitability through OEM confirmation, recognized standards, material data, service evidence, representative testing or a combination; no unassessed safety-critical material may remain.

8.1.3 For MDPE, emphasize material and resin batch traceability; joint workmanship, including electrofusion and butt fusion joints and service saddles; squeeze-off and recovery practice; leakage; permeation; and field performance, assessed in accordance with Clause 8.1.2 and the applicable technical standards. Do not impose default destructive testing of in-service assets..

8.1.4 For metallic components, consider strength, stress, welds/defects, cyclic service and hydrogen-assisted degradation; specifically review high-strength springs and stressed components.

8.1.5 Seals, diaphragms, gaskets and other non-metallic components shall be assessed for the intended hydrogen or HNG concentration, pressure, temperature and operating duty in accordance with Clause 8.1.2. The assessment shall identify applicable degradation mechanisms, including leakage or permeation, swelling, shrinkage, stiffening, warping, compression set or relaxation, and rapid gas decompression where credible. Slow crack growth and changes in thermoplastic structure shall be addressed where relevant. Existing material, OEM and service evidence may establish suitability; additional testing shall address identified evidence gaps. Monitoring shall focus on applicable mechanisms and functional performance.

8.1.6 Inspection and testing shall be selected on the basis of the material, operating pressure, stress condition, credible degradation mechanism and consequence of failure. NDT and destructive testing shall not be prescribed indiscriminately and shall be used only where technically applicable. For MDPE networks, assessment shall primarily address material traceability, joint workmanship, leakage, permeation and field performance. For relevant steel pipe segments, including HFW pipe, PAUT may be used for inspection of the seam weld and heat-affected zone and, where justified, for post-blending condition assessment. PAUT equipment, procedures and personnel shall be appropriately qualified and calibrated in accordance with the applicable standards and recognized industry practices, including relevant IOGP recommendations. The integrity assessment under Clause 4.3 and the baseline under Clause 5.4 shall be applied on the same risk-based basis and shall not by themselves require blanket inspection or testing of existing CGD assets.

8.1.7 Where degradation is identified, complete fitness-for-service assessment or replacement before continued HNG operation. For MDPE assets, the assessment shall address acceptance criteria for legacy assets and estimation of remaining life, and shall establish requalification intervals appropriate to the material, duty and findings.

8.2 Meters and regulators

8.2.1 Assess each meter and regulator type or model for accuracy, rangeability, pressure control, lock-up, leakage and material compatibility across the proposed concentration range, using OEM information, representative testing, service evidence and applicable metrology requirements.

8.2.2 Before go-live, complete any required type validation, representative calibration, correction-factor configuration, replacement or enhanced maintenance. Where a meter is calibrated or verified for HNG service, the reference gas or validated correction method shall represent the approved blend composition. These Guidelines do not require removal and individual recalibration of every domestic meter where type-level and representative evidence establish continued suitability.

8.2.3 Trend representative units against the natural-gas baseline; an abnormal type/batch result triggers expanded or 100% inspection.

8.3 Domestic appliances and installations

8.3.1 The Authorized Entity shall assess the type, condition and suitability of domestic gas appliances within the Commercial Deployment Area. Appliance suitability shall be established with reference to the applicable BIS requirements, available manufacturer information, relevant pilot evidence and representative field or laboratory assessment, as necessary. The hydrogen concentration shall not exceed any limit specified for the appliance or imposed by the applicable standard or competent authority. Appliances found unsafe, materially modified or unsuitable for the proposed HNG blend shall be repaired, replaced or excluded from HNG supply before commercial operation.

8.3.2 Assess ignition, flame stability/visibility, blow-off, flashback, noise, heat input, CO/NO_x where relevant and abnormal burner heating/deterioration.

8.3.3 Inspect or exclude known unsafe, modified, legacy or sensitive appliances. Commercial rollout shall not legitimize pre-existing unsafe installations.

8.3.4 No appliance shall be modified solely for HNG unless engineered, documented, tested and accepted by the OEM or a competent testing body.

8.3.5 Flame, ignition, smell, cooking-performance or damage complaints require prompt field inspection and common-cause trending.

9. SAFETY ENGINEERING, MANAGEMENT SYSTEMS AND EMERGENCY PREPAREDNESS

9.1 The Authorized Entity shall prepare, submit and maintain a deployment-specific Integrated Safety and Readiness Dossier covering the Hydrogen Receipt and Interface Point, Blending Facility, Commercial Deployment Area, domestic installations and appliances, public and consumer interface, emergency arrangements and restoration of natural-gas-only supply.

9.2 The Dossier shall include or cross-reference the design basis, asset and material compatibility assessment, integrity baseline, HAZID/HAZOP, QRA, HAC, dispersion and ventilation assessment, fire and explosion assessment including identification of the credible hazards arising from a loss of containment, determination of the potential impact area and assessment of the associated consequences, control and shutdown philosophy, IMS and ERDMP addenda, procedures, competency arrangements, Gas Quality and Monitoring Plan, consumer-protection arrangements, action-closure evidence and independent verification.

9.3 Assess the full concentration range from natural-gas-only operation up to the proposed maximum commercial concentration, not exceeding 5.0%, and credible upset concentrations, including ratio-control, low-flow, analyser, power, ventilation, reverse-flow, enclosure-leak, appliance-leak and delayed-isolation scenarios.

9.4 Safety-critical alarms, interlocks and shutdown functions credited in the risk assessment shall have a documented cause-and-effect, verification and proof-test programme and lifecycle maintenance proportionate to their risk-reduction function. Where a Safety Integrity Level is claimed, the applicable functional-safety standard and assessment basis shall be identified.

9.5 Complete MOC covering network, procedures, controls, maintenance, metering, billing, communication and emergency arrangements.

9.6 Update the CGD IMS through a hydrogen addendum addressing inventory, compatibility, leakage/permeation, joints/seals, meters/regulators, appliances, inspection, trends and thresholds. The threat categorisation under the IMS shall include hydrogen-specific time-dependent threats, including hydrogen embrittlement and hydrogen-assisted fatigue.

9.7 Update the ERDMP for difficult-to-see flame, indoor accumulation, public communication, evacuation, customer-care continuity, natural-gas restoration and investigation.

9.8 IMS/ERDMP addenda shall be approved by the authorized entity, independently certified where required and submitted to PNGRB before go-live.

9.9 No critical/high-risk recommendation from HAZOP, QRA, PSSR, independent or statutory review may remain open before commercial operation.

9.10 Control SOPs for operation, maintenance, calibration, isolation, purging, sampling, LOTO/work permits, ESD, restart, complaints, billing correction and incident reporting.

9.11 Provide role-specific hydrogen competency for operations, maintenance, emergency, customer-care, billing and field personnel, with annual and change/incident-triggered refreshers.

9.12 Conduct a pre-start exercise testing detection, ESD, isolation, customer-care, local-authority coordination, public messaging and restoration; conduct at least one full exercise annually thereafter.

9.13 Approved safe operating and emergency procedures shall be readily available at the Blending Facility. Critical isolation, purge, detector-alarm, ESD and emergency-contact instructions shall be prominently displayed at appropriate operating locations.

10. PRE-STARTUP SAFETY REVIEW (PSSR), CONTROLLED GO-LIVE AND TRIAL OPERATION

10.1 Complete Annexure B baseline/pre-start activities and issue mechanical completion before hydrogen introduction.

10.2 Complete pressure/leak, valve/regulator, earthing/bonding, electrical, loop, analyser, detector, alarm, trip, ESD, ventilation, communication, control-system integrity tests.

10.3 Establish a natural-gas-only baseline for leakage, hydraulic profile, composition, GCV/LHV/Wobbe, odorization, meters and regulators, representative appliance performance, metering data, representative consumer bills and complaints.

10.4 Test the 24-hour customer-service arrangement, ticketing and escalation, field dispatch, emergency messaging, heat-content billing-adjustment configuration and disclosure, and the applicable consumer grievance-redress arrangements.

10.5 Before the first introduction of hydrogen, the Authorized Entity shall conduct and document a multidisciplinary Pre-Startup Safety Review. The review shall confirm that the Integrated Safety and Readiness Dossier is complete, current, consistent with the as-built installation and approved operating arrangements, and that all critical and high-risk findings have been closed. The Independent Competent Agency shall participate in or independently verify the review.

10.6 On completion of the PSSR, the Authorized Entity and the Independent Competent Agency shall sign the Commercial Readiness Declaration at Annexure C, confirming the status of the Integrated Safety and Readiness Dossier and closure of the required actions. The declaration shall support the application for PNGRB go-live clearance. Hydrogen shall not be introduced until prior written PNGRB permission for go-live and entry into the Trial Operation Period, together with all applicable statutory permissions, is in place.

10.7 Commercial commissioning may ramp from zero towards the Normal Operating Setpoint under the approved commissioning procedure to verify control performance and prevent transient overshoot. Stable HNG operation shall remain within the Approved Concentration Control Band. Commissioning is not a pilot concentration step-up and shall not increase the approved operating envelope. The Maximum Commercial Blend Limit shall not be exceeded during ramping, stabilization or subsequent operation.

10.8 The facility shall remain under attended operation for at least the first 24 hours following the first introduction of hydrogen, and thereafter as provided in Clause 10.15. During the first 72 hours, hydrogen concentration, relevant gas-quality parameters and odorization shall be verified at the Blending Facility outlet and at hydraulically critical, high-demand, farthest and representative consumer-end locations under peak- and minimum-demand conditions.

10.9 Continue the leakage survey required under Annexure B row B7, review of operating data and customer-care records, and verification of the heat-content billing adjustment and representative consumer bills for at least 30 days or for a longer period if directed by PNGRB.

10.10 The Authorized Entity shall submit a go-live report covering concentration control, excursions, alarms and trips, leakage, gas quality, odorization, equipment and appliance performance, consumer communication, complaints, metering, calorific-value measurement and implementation of the heat-content billing adjustment. The report shall record the date and time at which stable supply of HNG to consumers is first established within the Approved Concentration Control Band around the Normal Operating Setpoint, together with the supporting operating records.

Trial Operation Period

10.11 Commercial supply following go-live shall commence with a Trial Operation Period having a minimum duration of six months, adjusted in accordance with Clause 10.12 or extended by PNGRB. During stable HNG operation, concentration shall remain within the Approved Concentration Control Band and shall never exceed the Maximum Commercial Blend Limit. Start-up, shutdown and temporary cessation of injection shall follow the approved procedures. All applicable provisions of these Guidelines and Annexure B shall apply throughout the Trial Operation Period. Supply during this period is commercial supply under an approval granted under Section 4. It is not a Pilot Project. Annexure P applies only to projects separately approved as pilots.

10.12 The minimum trial duration shall be measured from the date recorded under Clause 10.10. Periods of suspension under Clause 14.2 shall be excluded. Within seven days of resuming hydrogen injection after such a suspension, the Authorized Entity shall notify PNGRB of the excluded period and revised date for completion of the minimum trial duration.

Routine operational stops falling within Clause 14.4 shall be recorded and reported in the monthly report without requiring a separate revised-date notification for each stop. Such stops may be included in the calendar duration only where they are consistent with the approved operating pattern and do not prevent collection of the required evidence. Actual hydrogen-injection

hours, start-stop cycles and demand conditions shall be reported. PNGRB may require additional operating exposure where interruptions or insufficient coverage of operating conditions limit the evidence.

10.13 Operation under a Pilot Project approved under Annexure P shall not count towards the duration of the Trial Operation Period, save to the extent that PNGRB expressly directs otherwise having regard to the scope, concentration, duration and consumer arrangements of that pilot.

10.14 The boundary of the Commercial Deployment Area shall not be extended during the Trial Operation Period.

10.15 The Blending Facility shall ordinarily remain under attended operation during hydrogen injection for the first thirty days of the Trial Operation Period, or longer where directed by PNGRB. PNGRB may approve a shorter attended period, not less than the first twenty-four hours required under Clause 10.8, on the basis of satisfactory commissioning evidence, independent verification of control and shutdown performance, validated alarm communication and demonstrated emergency response arrangements. Thereafter, operation may proceed under the approved control, alarm and shutdown philosophy, with defined attendance and response times. A reduction in attendance shall not reduce any monitoring, inspection or reporting obligation.

10.16 Throughout the Trial Operation Period, monitoring, data review and leakage surveys shall comply with Annexure B. A reduction to a less frequent monitoring tier shall occur only where permitted by that Annexure and the approved plan, after the specified conditions have been met and the supporting basis recorded in the monthly report. PNGRB may require increased frequency, coverage or duration where warranted by risk, findings or operating experience.

10.17 Reports under Clause 15.4 shall be submitted monthly throughout the Trial Operation Period.

10.18 Within thirty days after completion of the minimum trial duration prescribed under Clause 10.11, adjusted under Clause 10.12, the Authorized Entity shall submit a Trial Operation Report covering the complete period up to that completion date. The Report shall address concentration control and excursions; operating hours and cycles; alarms, trips and ESD activations; leakage and integrity findings; gas quality, calorific value and odorization; meter, regulator and appliance performance; consumer communication, complaints and their resolution; heat-content billing adjustment and representative consumer bills; incidents, deviations and action closure; and performance against the acceptance objectives in Annexure B and the completion criteria in Table B-2 of that Annexure. The Independent Competent Agency shall verify the Report and state its conclusions, evidence limitations and recommendation on completion of the Trial Operation Period.

10.19 Monthly reports under Clause 15.4 shall continue until PNGRB communicates its decision under Clause 10.20. Any matter arising after the Trial Operation Report cut-off date that materially affects its conclusions shall be notified promptly and addressed in a supplementary submission; safety-critical and reportable events remain subject to Clause 14.3. Routine subsequent operating information may be included in the monthly reports without a separate closing return.

10.20 Completion of the minimum trial duration shall not by itself constitute completion of the Trial Operation Period. Transition to routine commercial operation requires written confirmation by PNGRB after review of the Trial Operation Report and relevant subsequent information. Satisfaction of the completion criteria in Table B-2 is a necessary condition for such confirmation but shall not by itself entitle the Authorized Entity to it. PNGRB may confirm completion, impose conditions, require further trial operation and evidence, reduce the approved concentration limits, or direct suspension and safe restoration of natural-gas supply under Section 14.

10.21 The approval under Section 4 shall expressly specify whether, and on what conditions, supply may continue under trial obligations after completion of the minimum trial duration while the Trial Operation Report is prepared and considered. Where expressly authorized, such supply may continue within the Approved Operating Envelope until PNGRB communicates its decision, subject to timely reporting, valid statutory permissions and compliance with Section 14. Continued supply shall not constitute deemed acceptance of the Report or approval for routine commercial operation. Where continuation is not authorized, hydrogen injection shall cease at the approved expiry and natural-gas supply shall be maintained or restored only where safe under Section 14.

11. OPERATION, MAINTENANCE, INSPECTION, TESTING AND MONITORING

11.1 Comply with Annexure B and the approved plan. Risk, OEM advice, adverse trends, incidents or PNGRB may require more stringent frequencies.

11.2 Continuously record hydrogen concentration, H₂/NG flows, pressure, relevant temperatures, analyser health, detector status, ESD/interlock status and critical alarms in a synchronized historian.

11.3 Review critical operating data at the frequencies specified in Annexure B, including daily review throughout the Trial Operation Period. Investigate excursions, adverse trends and invalid data promptly. Scheduled data review shall not delay automatic protection, alarm response or event-triggered action.

11.4 Leak-survey instruments shall be validated and calibrated for the expected HNG mixture; natural-gas-only calibration without demonstrated H₂ response is unacceptable.

11.5 Network leakage surveys shall comply with Annexure B row B7 and the approved plan. Their frequency and coverage shall not be less stringent than the applicable PNGRB T4S and IMS requirements. Additional surveys shall follow relevant alarms, complaints, changes or adverse findings.

11.6 Monitor meters, regulators and appliances through justified representative sampling and complaint-triggered inspection.

11.7 Log, investigate and report all alarms, trips, detector activations, concentration excursions, leaks, complaints, billing corrections, appliance defects, replacements and maintenance.

11.8 Treat complaint rates, repeat complaints, emergency attendance, billing disputes and appliance observations as leading indicators; adverse trends may require suspension.

11.9 Conduct independent technical and consumer-protection audit at least annually, or more frequently as directed.

11.10 Publish accessible aggregate information on the approved concentration range, emergency and customer-service contacts, material safety advisories and such operating or consumer information as PNGRB may direct, while protecting personal and sensitive data.

12. METERING, CALORIFIC-VALUE MEASUREMENT AND HEAT-CONTENT BILLING ADJUSTMENT

12.1 Billing for HNG supplied to domestic consumers shall be adjusted to account for any reduction in heat content arising from hydrogen blending, based on the measured calorific value of the gas supplied, so that consumers are not charged for energy not delivered. The basis and calculation of such adjustment shall be documented and transparently disclosed to consumers.

12.2 The calorific-value data used for the adjustment shall be obtained through calibrated and traceable instruments and representative measurements in accordance with Section 7. The Authorized Entity shall document the natural-gas baseline, HNG calorific value, averaging period, calculation method, measurement uncertainty and records supporting the adjustment.

12.3 The consumer bill or accompanying statement shall clearly disclose that a heat-content adjustment has been applied, the basis of the adjustment and the applicable complaint and correction mechanism. Where valid calorific-value data are unavailable or subsequently found to be inaccurate, the Authorized Entity shall apply a consumer-favourable estimate and undertake the necessary correction or credit after validation.

12.4 No Compressed Biogas (CBG) injection or other gas-composition intervention shall take place within the Commercial Deployment Area unless separately assessed and approved. Any upstream gas-composition intervention shall be accounted for while determining the calorific value used for billing adjustment.

12.5 Where continuous calorific-value measurement is impractical for a particular deployment, the Authorized Entity may, with PNGRB acceptance, apply a compensation factor reflecting the measured energy dilution of the blend relative to reference natural gas, consistent with the energy-dilution basis set out in the PNGRB *Roadmap on Hydrogen Transportation Pipelines and Blending with Natural Gas* (Module 5, "Indian Context," p. 67), provided the factor is set consumer-favourably at the approved maximum blend.

13. CONSUMER PROTECTION, PUBLIC ENGAGEMENT, CUSTOMER SERVICE AND GRIEVANCE REDRESSAL

13.1 Implement a PNGRB-approved Consumer Protection and Engagement Plan before hydrogen introduction. The Authorized Entity shall designate a Consumer Protection Nodal Officer (being the accountable consumer-protection lead nominated under Clause 4.4) responsible for grievance oversight, whose contact shall be displayed under Clause 13.10.

13.2 Provide advance public notice and direct communication ordinarily at least 30 days before first supply. Individual consent applies only where law/approval requires; acknowledgements shall not waive rights or liability.

13.3 Give clear local-language information on concentration, smell, flame, ventilation, appliance use, prohibited modifications, emergency action, billing, complaints and authorized entity responsibilities.

13.4 Consult local authorities, fire services, RWAs/equivalent bodies and publish rollout dates, emergency contacts, grievance channels and billing treatment.

13.5 Conduct community knowledge/awareness sessions before rollout and at least annually, covering safe actions, smell, flame, appliance dos/don'ts, emergency contacts and bill interpretation.

13.6 Place a visible HNG identification/emergency-contact label at the meter or approved location without obscuring statutory markings.

13.7 Maintain 24-hour telephone and at least one digital channel; issue unique complaint references and status updates.

13.8 Classify HNG complaints as emergency/safety, smell/leak, flame/appliance, pressure/interruption, metering/billing, information/notice or service quality.

13.9 Meet the strictest applicable PNGRB service/consumer timeline; safety complaints require immediate triage and emergency dispatch.

13.10 Display the Consumer Protection Nodal Officer, escalation, authorized entity channels and grievance route on bills, notices, website and materials.

13.11 Investigate repeat/clustered complaints as possible common-cause events, not merely individual cases.

13.12 Where HNG, an excursion or an authorized entity-directed modification is shown to cause appliance/property damage or unsafe operation, arrange appropriate inspection, repair, replacement or compensation without prejudice to rights.

13.13 Conduct initial and periodic surveys on flame, cooking, smell, interruptions, billing clarity, complaints and emergency understanding.

13.14 Identify vulnerable consumers requiring additional communication/service support; comply with service standards for interruptions and restoration.

13.15 Collect only necessary personal/household data, protect it and report in aggregate/anonymized form unless individual detail is required for investigation.

14. EMERGENCY ISOLATION, SUSPENSION, NATURAL-GAS RESTORATION AND RESTART

14.1 Hydrogen injection shall be automatically isolated upon invalid safety-critical concentration measurement, concentration reaching or exceeding the high-high setting, loss of the natural-gas-flow permissive, high-high gas detection, fire/flame detection, ESD activation, unsafe pressure or temperature, or loss of essential control or power. The approved cause-and-effect shall also specify isolation of natural gas and affected equipment or network sections wherever required to control the initiating hazard. Continued natural-gas supply following a blending-control upset shall be permitted only where the affected system remains safe and gas quality, pressure and other operating conditions remain compliant.

14.2 Suspend H₂ and restore natural gas where practicable after fire, explosion, injury, uncontrolled release, reportable incident, repeated trip, material failure, significant leak trend, ineffective odorization, abnormal appliance behavior, systemic billing/consumer-safety concern or PNGRB direction. Where loss of containment, fire or equipment damage is involved, the

affected gas supply and equipment or network sections shall be isolated as required by the ERDMP and approved cause-and-effect. Natural-gas supply shall be maintained or restored only after the affected installation and supply conditions have been demonstrated safe. Cessation of hydrogen injection alone shall not be treated as sufficient control of a continuing gas leak or fire.

14.3 Notify incidents to PNGRB under applicable rules/ERDMP; communicate a safety-critical event immediately and submit a preliminary written report within 24 hours unless a shorter timeline applies.

14.4 Restart requires root-cause analysis, action closure, revalidation, independent verification and PNGRB concurrence where directed/reportable.

14.5 Do not extinguish a hydrogen flame until the source is isolated unless necessary to protect life; water spray may cool exposed equipment under competent fire direction.

14.6 Maintain spares, materials, competent personnel and procedures to isolate, purge, repair and restore natural gas safely.

14.7 Give affected consumers timely verified advisories on the issue, required action, status, restoration and contacts.

15. DATA GOVERNANCE, REPORTING AND INDEPENDENT ASSURANCE

15.1 Use synchronized timestamps and retain raw data, calibration, laboratory, inspection, billing, complaints, changes and incident evidence for at least five years or longer if required.

15.2 High-resolution historian data shall be retained for at least five years, or longer where required under Clause 15.1, with synchronized timestamps, trend analysis, event-reconstruction and machine-readable export capability. Compression or archival storage may be used provided that the original recorded resolution, values, timestamps and quality flags remain recoverable.

15.3 Reports shall cover operation, H2 use, concentration/excursions, gas quality, leakage, odorization, meters/regulators, appliances, alarms/trips, incidents, billing, complaints, awareness, maintenance, tests and actions.

15.4 The Authorized Entity shall submit one consolidated monthly report throughout the Trial Operation Period, including any continued trial operation authorized under Clause 10.21. After PNGRB confirms completion under Clause 10.20, reports shall be submitted quarterly for the remainder of the first year measured from the commencement date under Clause 10.12, and thereafter at the frequency specified by PNGRB. Where the Trial Operation Period extends beyond that first year, PNGRB shall specify the subsequent reporting frequency on confirming completion. Material excursions, incidents, abnormal trends and consumer-safety concerns shall be reported promptly under Clause 14.3. Routine submissions may cross-reference supporting records without duplicating them.

15.5 The Independent Competent Agency / SME / Competent person shall have access to the sites, data and personnel necessary for its assigned scope and shall report material limitations, adverse findings and unresolved technical disagreements to the authorized entity and PNGRB.

15.6 Suppression or unjustified omission of adverse operational, billing or complaint data is non-compliance; corrections shall preserve original record, reason, date and authority.

15.7 Anonymized data on hydrogen quantity injected (and production pathway, where available) may also be shared periodically to support national tracking of green hydrogen offtake under NGHMs or under any State subsidy/incentive scheme.

16. MANAGEMENT OF CHANGE, PERIODIC REVIEW, ENFORCEMENT AND WITHDRAWAL

16.1 No Material Change may be implemented without documented MOC and approval at the prescribed level.

16.2 MOC shall identify technical basis, drawings/procedures, risk, compatibility, tests, training, billing, communication, emergency implications, natural-gas-restoration arrangements and approvals.

16.3 Temporary changes require equivalent safety review, a defined expiry and shall not bypass concentration, billing or consumer controls.

16.4 The 5% commercial limit shall not be changed under these Guidelines. A higher limit requires separate statutory/PNGRB action supported by adequate national evidence.

16.5 Review the Integrated Safety and Readiness Dossier, IMS and ERDMP addenda, calorific-value measurement and billing-adjustment methodology and Consumer Protection and Engagement Plan at least annually and after a Material Change or significant incident.

16.6 PNGRB may inspect, audit, require tests, impose conditions, reduce setpoint, suspend or withdraw approval.

16.7 A withdrawal plan shall ensure controlled H2 cessation, safe purging, NG restoration, consumer communication, billing reconciliation, records and complaint/claim closure.

16.8 Stakeholder Communication and Awareness with all users shall be done by respective operators well before starting the physical blending operations. Records towards this communication shall be retained for further verification by PNGRB. Do's and Don'ts be informed to all consumers.

16.9 The Authorized Entity shall be encouraged to align hydrogen-related training and competence frameworks with emerging skill standards under NGHMM / NSDC as and when notified.

ANNEXURE A - MINIMUM CONTENTS OF THE INTEGRATED SAFETY AND READINESS DOSSIER

Item	Submission element	Minimum content
A1	Legal and approval basis	Enabling instrument, PNGRB application and statutory approvals.
A2	Deployment description	Injection point, Commercial Deployment Area and its boundary, consumers, pressure and flow conditions, hydrogen source, rollout and natural-gas-restoration arrangements.
A3	Design basis	PFD/P&ID/layouts, specifications, calculations, mixing/dynamic-control studies and cause-effect.
A4	Hydrogen quality/interface	Hydrogen Receipt and Interface Point specification, Type I Grade A hydrogen quality, certificates, interface isolation, transportable-source interface where applicable and vent arrangements. Receipt limits, certificate-of-analysis and laboratory-verification arrangements under Clause 6.1.5
A5	Asset/compatibility register	Mains, services, joints, valves, meters, regulators, seals, instruments and appliance classes.
A6	Integrity baseline	Leakage, condition, unknown materials, incidents, repairs and IMS status.
A7	Appliance assurance	Population profile, protocol/results, sensitive appliances and field response.
A8	Safety studies and risk demonstration	HAZID/HAZOP, QRA, HAC, dispersion, fire/explosion, safety-critical functions and ALARP demonstration.

Item	Submission element	Minimum content
A9	Management systems	Management of Change, IMS/ERDMP addenda, operating and maintenance procedures, Lockout/Tagout and permit-to-work arrangements, and personnel competency.
A10	Commercial readiness	Mechanical completion, PSSR, drills, staffing, spares and independent certificate.
A11	Gas Quality and Monitoring Plan	Details and locations of online, protective and reference analysers; downstream sampling and verification locations and methods; monitoring of hydrogen concentration, GCV/LHV, relative density, Wobbe Index and odorization; instrument calibration, traceability and measurement uncertainty; monitoring frequencies consistent with Annexure B; The Plan shall cross-reference the network-leakage monitoring, data-governance and heat-content billing-adjustment arrangements contained elsewhere in the approval dossier.
A12	Metering and billing adjustment	Natural-gas calorific-value baseline; HNG calorific-value measurement method; instrument traceability; averaging period; adjustment calculation; uncertainty; bill format and disclosure; data-loss treatment; complaint correction; sample bills and audit arrangements.
A13	Consumer protection	Notice, local-language material, sessions, 24-hour channels, grievances, vulnerable consumers and compensation.
A14	Control-system and data integrity	Access controls, configuration/change logs, time synchronization, backup/recovery, appropriate cybersecurity measures, retention and incident process.
A15	Assurance/reporting	Independent reviews, annual audit, reports, KPIs and public information.
A16	Evidence basis and transferability	For each external evidence source relied upon (Indian pilot, international study, laboratory or OEM test): hydrogen concentration, exposure period, operating pressure, network configuration, materials and appliance population; correspondence to the proposed Commercial Deployment Area; identified evidence gaps and the testing or trial-period monitoring by which each gap will be closed.

The Integrated Safety and Readiness Dossier shall be reviewed and updated after a Material Change, significant incident, modification of the approved operating basis or expansion of the Commercial Deployment Area, and at the periodicity specified by PNGR

ANNEXURE B - MINIMUM COMMERCIAL MONITORING AND ASSURANCE MATRIX

The frequencies below are minimum requirements, subject to more stringent statutory requirements, the approved plan or PNGRB direction. “Trial Operation Period” includes continued trial operation authorized under Clause 10.21. Unless otherwise specified, initial monitoring intervals are measured from first introduction of hydrogen; the trial-duration calculation under Clause 10.12 does not defer commissioning or first-30-day checks. Automatic protection and immediate event response apply continuously, irrespective of scheduled review frequency.

Ref.	Parameter / activity	Minimum frequency	Review	Event-triggered action	Acceptance objective
B1	Outlet H2 concentration	Continuous	Daily exceptions; monthly trend	Isolate on invalidity/ high-high; investigate excursions	Within the Approved Concentration Control Band during stable HNG operation; never exceed the Maximum Commercial Blend Limit; validated control and trip margins.
B2	H2/NG flow, pressure, temperature	Continuous	Daily first 3 months; weekly thereafter	Low NG flow prevents H2; abnormal ratio trips	Within envelope
B3	Independent real-time protection and analyser verification	Continuous protective availability; reference verification at go-live, monthly and after change	Compare online analyser with independent real-time channel and periodic laboratory/reference method	Loss/ conflict in safety-critical measurement isolates H2; metrological discrepancy investigated	Within approved uncertainty
B4	Downstream homogeneity	At commissioning and during the first 72 hours under Clause 10.8; at least weekly for the first 30 days; at least monthly for the remainder of the Trial Operation Period; at least quarterly thereafter where the approved stability criteria are met. More frequent checks shall continue where those criteria are not met.	Compare representative downstream locations selected under Clause 7.8 with the outlet record, covering peak- and minimum-demand conditions and accounting for transport delay, concentration variation and measurement uncertainty	Repeat verification after a relevant flow or boundary change, abnormal trend, complaint or suspected loss of uniformity; investigate and correct unacceptable variation.	Within Clause 7.9; no downstream value above the Maximum Commercial Blend Limit.

B5	GCV/ LHV, relative density and Wobbe Index	Online measurement, where provided, or a technically justified representative sampling and calculation method; review trends at least monthly	Review against applicable gas-quality and appliance-performance limits. Use the measured calorific value for determining the heat-content billing adjustment under Section 12	Where gas quality or interchangeability is outside the Approved Operating Envelope, suspend hydrogen injection and restore compliant supply. Where calorific-value data or the billing adjustment is found incorrect, correct the calculation and provide the necessary consumer adjustment or credit	Gas-quality compliance, appliance compatibility and accurate heat-content billing adjustment
B6	Odorization	Fortnightly first 6 months; at least monthly thereafter	Farthest/ representative endpoints	Immediate after smell complaint/ source/ flow change	Reliable detectability
B7	Network leakage	Full baseline survey before hydrogen introduction. Full Commercial Deployment Area survey within the first 72 hours. Targeted surveys of joints, regulators, meters and enclosures at intervals not exceeding seven days for the first 30 days, and fourteen days thereafter throughout the Trial Operation Period. In addition, carry out a full-area survey at least once between the third and fourth month and once during the final thirty days of the minimum trial duration, as adjusted under Clause 10.12. After PNGRB confirms completion of the Trial Operation Period, apply the risk-based frequency and coverage justified in the approved plan, subject to applicable T4S and IMS requirements.	Target joints/ regulators/ meters/ enclosures	Immediate after alarm/ complaint/ event	No unexplained adverse trend
B8	Detectors, alarms, ESD/ interlocks	Continuous status; proof-test per plan	Monthly readiness	After activation/ maintenance/ change	Available and cause-effect verified

B9	Meters/ regulators	Baseline by type; semi-annual sample first year; risk-based thereafter	Accuracy/lock-up/pressure/leak trend	Expand affected type/batch	Within limits
B10	Domestic appliances	Type qualification; quarterly rotating sample first year; annual/risk-based	Complaint-triggered inspection	Expand model/type; Suspend HNG supply to the affected Commercial Deployment Area, where necessary	Safe ignition/flame/CO/NOx/heat input
B11	Materials/ integrity	Baseline; IMS routine; risk-based NDT	Focus MDPE joints, elastomers, springs, stressed metals	Failure/defect investigation and FFS	No integrity/function loss
B12	Heat-content billing-adjustment verification	Periodic reconciliation of measured calorific value, adjustment calculations and representative consumer bills	Sample records and bills	Data loss or complaint trend	Auditable adjustment; no consumer charged for energy not delivered
B13	Complaints/ field response	Continuous complaint recording; monthly trend review; governance review monthly during the first year from go-live and at least quarterly thereafter.	HNG categories/repeat complaints	Immediate common-cause review	Immediate safety triage; systemic closure
B14	Awareness/drills	Pre-go-live; annual full drill/session; change-triggered tabletop	Customer care, fire/local authority, restoration	After incident/change	Public understands safety/billing
B15	Control-system/historian integrity	Continuous logs; monthly access/configuration review; periodic backup and cybersecurity review	High-resolution data retained for at least five years under Clauses 15.1–15.2.	After cyber/data event	No unauthorized change; recoverable
B16	Independent audit	Pre-start and at least annually	Technical, safety, billing and consumers	After significant event/direction	Objective assurance
B17	Hydrogen quality at receipt	Certificate per consignment, or continuous O ₂ /moisture monitoring; lab verification per 6.1.5(e).	Each consignment; daily exceptions; monthly trend	Reject the consignment; isolate on high-high; apply 6.1.5(f).	Annexure F and 6.1.5(b) limits; no non-conforming hydrogen injected.

Table B-2

Each criterion shall be demonstrated in the Trial Operation Report under Clause 10.18 and verified by the Independent Competent Agency. Where a criterion refers to a project-specific value, the Authorized Entity shall propose it in its application under Section 4 and confirm it in item C17 of Annexure C; PNGRB shall fix the value in the go-live permission under Clause 10.6.

Ref.	Criterion	Minimum condition at report cut-off
TC1	Exposure and data	Minimum duration met (10.11–10.12); valid critical-data completeness $\geq 95\%$ of injection time; peak and minimum demand covered
TC2	Concentration control	Zero confirmed exceedances of the Maximum Commercial Blend Limit; no open investigations into control-band excursions or high-high trips
TC3	Homogeneity	No unresolved stop-level event under 7.9(e); final-three-month verifications within 7.9(b), or alerts closed with cause identified
TC4	Hydrogen quality	No non-conforming hydrogen injected, or any event closed under 6.1.5(f); lab verifications done at the required frequency
TC5	Gas quality and odour	100% of validated CV, relative-density and Wobbe results within notified limits; odour detectability confirmed at 100% of B6 checks
TC6	Leakage	All B7 surveys done; 100% of leaks repaired within T4S/IMS timelines; leak frequency not above the 10.3 baseline by more than the approved margin
TC7	Meters and regulators	Sample within the applicable metrology requirements under Clause 8.2.1 and OEM lock-up/pressure limits; no open type or batch anomaly
TC8	Appliances	No unresolved HNG-attributable unsafe condition; sample within the approved appliance test protocol
TC9	Safety events	No unresolved incident attributable to HNG; all ESD and trip activations root-caused; no open critical or high-risk actions
TC10	Billing	Adjustment applied to 100% of bills; errors credited within the next billing cycle; B12 shows no consumer charged for energy not delivered
TC11	Complaints	100% closed within PNGRB timelines; no open common-cause cluster; rate not above the 10.3 baseline by more than the approved margin
TC12	Independent verification	Independent Competent Agency recommendation under 10.18; no unresolved material adverse finding

ANNEXURE C - COMMERCIAL READINESS DECLARATION

Instructions: Complete by the Authorized Entity and countersign by the Independent Competent Agency after PSSR and before PNGRB go-live clearance. This declaration records readiness and supports the request for permission; it does not itself authorize hydrogen introduction.

Ref.	Readiness item	Entity evidence	Status	Independent remarks
C1	Entity/GA			
C2	Commercial Deployment Area, boundary and consumers			
C3	Injection point/ source			
C4	5% maximum and proposed setpoint/margin			
C5	Statutory approvals			
C6	Integrated Safety and Readiness Dossier / HAZOP / QRA / HAC			
C7	IMS/ERDMP approvals			
C8	Compatibility status			
C9	Control/ analyser/ detector/ ESD tests			
C10	Gas quality/odorization/sampling			
C11	Metering, calorific-value measurement and heat-content billing-adjustment readiness			
C12	Consumer/customer-service readiness			
C13	Drill/local-authority coordination			
C14	Control-system, historian and cybersecurity readiness			
C15	Open actions			
C16	Natural-gas-only restoration readiness			
C17	Proposed trial commencement, monitoring and attended-operation arrangements, and the requested approval conditions for any continued trial supply under Clause 10.21			

Entity declaration: the information is complete and operation will remain within the approved envelope.

Name: _____ Designation: _____ Signature: _____ Date: _____

Independent verification: the deployment is / is not recommended for PNGRB go-live clearance and for entry into the Trial Operation Period, Hydrogen introduction remains subject to prior written PNGRB permission and all applicable statutory permissions.

Name: _____ Designation: _____ Signature: _____ Date: _____

ANNEXURE D - MINIMUM CONSUMER NOTICE AND BILL-DISCLOSURE REQUIREMENTS

Part	Minimum information
Advance notice	Concentration range $\leq 5\%$; commencement, purpose, area and emergency/customer contacts.
Safety/appliances	Smell, flame visibility, ventilation, appliance use, prohibited modifications and leak/abnormal-flame action.
Billing	Basis of the heat-content adjustment, calorific-value measurement, information displayed on the bill, and complaint and correction process.
Rights	Complaint reference/escalation, PNGRB grievance route, inspection/repair and non-waiver.
Engagement	Local-language sessions, FAQs, drills and digital channels.
Bill/statement	Metered quantity, applicable calorific-value or heat-content adjustment, adjustment or credit applied, applicable rate and complaint contacts.

Annexure E - Indicative properties and implications of hydrogen vis-à-vis natural gas

Parameter	Natural gas / methane - indicative	Hydrogen - indicative	Implication for HNG
Molecular size and relative density	Predominantly methane; lighter than air but substantially denser than hydrogen.	Smallest molecule; approximately eight times lighter than methane on a molecular-mass basis and strongly buoyant.	Assess leakage, permeation, high-level accumulation, ventilation, detector location and sealing.
Volumetric energy content	High relative to hydrogen.	Approximately one-third of natural gas per standard volume.	Control calorific value/interchangeability and apply an appropriate billing adjustment for the reduction in volumetric heat content.
Mass energy content	Approximately 50 MJ/ kg for methane.	Approximately 120 MJ/kg (LHV).	Do not infer volumetric billing equivalence from mass energy content.
Flammability range in air	Approximately 5-15% by volume for methane.	Approximately 4-75% by volume.	Wider flammable range requires ignition control, HAC, detection, ventilation and isolation.
Minimum ignition energy	Approximately 0.28 mJ for methane under reference conditions.	Approximately 0.02 mJ.	Stricter control of ignition sources, static electricity, earthing and bonding.
Autoignition temperature	Approximately 537 C for methane; depends on test conditions.	Approximately 560 C; depends on test conditions.	Use recognized data and project conditions in fire/explosion assessment.

Parameter	Natural gas / methane - indicative	Hydrogen - indicative	Implication for HNG
Laminar flame speed	Approximately 0.4 m/s for methane.	Approximately 2.9 m/s.	Assess ignition, flame stability, flashback, burner temperature and flame detection.
Flame visibility	Generally visible blue flame.	Pale and difficult to see, particularly in daylight.	Provide hydrogen-suitable flame detection, training and emergency procedure.
Combustion emissions	Produces CO ₂ ; CO and NO _x depend on appliance and combustion conditions.	No carbon in the fuel, but thermal NO _x can form; HNG CO/NO _x response is appliance-dependent.	Representative appliance testing and emissions observation; avoid unsupported universal claims.
Material interaction	Generally compatible with established CGD materials when correctly selected and maintained.	Not corrosive in the ordinary sense, but can cause hydrogen-assisted degradation in susceptible metals and permeation/functional effects in some non-metals.	Asset-specific compatibility, focus on stressed/high-strength components, seals, diaphragms, joints and field leakage.
Wobbe Index and interchangeability	Existing appliances are designed for the notified natural-gas range.	Hydrogen addition generally lowers volumetric calorific value and changes relative density/Wobbe Index.	Maintain the notified interchangeability envelope and validate representative appliance classes.

ANNEXURE F - HYDROGEN QUALITY SPECIFICATION (IS 16061, TABLE 5)

The fuel-quality specification in Table 5 of IS 16061 (equivalent to ISO 14687), “Fuel quality specification for applications other than PEM fuel cell road vehicle and stationary applications”, is reproduced below for ready reference. Type I, Grade A is the applicable quality grade for hydrogen supplied at the hydrogen receipt and interface point for DPNG blending under these Guidelines. The standard is cited without edition year so that the latest edition and amendments apply; the published standard prevails in case of any inconsistency.

Table 5 — Fuel quality specification for applications other than PEM fuel cell road vehicle and stationary applications

Constituents ^a (assay)	Type I			Type II	Type III
	Grade A	Grade B	Grade C	Grade C	
Hydrogen fuel index ^b (minimum mole fraction)	98,0 %	99,90 %	99,995 %	99,995 %	99,995 %
<i>Para</i> -hydrogen (minimum mole fraction)	—	—	—	95,0 %	95,0 %
Impurities (maximum content)					
Total non-hydrogen gases	2 % (mole fraction)	1 000 µmol/mol	50 µmol/mol	50 µmol/mol	—
Water (H ₂ O)	250 µmol/mol ^c 60 µmol/mol ^c	250 µmol/mol ^c 60 µmol/mol ^c	d	d	—
Hydrocarbons except methane ^e (C1 equivalent)	100 µmol/mol	Non-condensing at all ambient conditions	d	d	—
Oxygen (O ₂)	f	100 µmol/mol	g	g	—
Argon (Ar)	f	—	g	g	—
Nitrogen (N ₂)	f	400 µmol/mol	d	d	—
Helium (He)	—	—	39 µmol/mol	39 µmol/mol	—
Carbon dioxide (CO ₂)	f	—	h	h	—
Carbon monoxide (CO)	20 µmol/mol	—	h	h	—
Sulfur compounds (S1 equivalent)	7 µmol/mol ⁱ	10 µmol/mol	—	—	—
Permanent particulates	j	k	k	k	—
^a For the constituents that are grouped, such as hydrocarbons except methane and sulfur compounds, the sum of the constituents shall be less than or equal to the acceptable limit. ^b The hydrogen fuel index is determined by subtracting the "total non-hydrogen gases" in this table, expressed in mole percent, from 100 mole percent. ^c To prevent condensation under expected temperature condition range, the value is 250 µmol/mol at maximum operating pressures ≤1 MPa and 60 µmol/mol at maximum operating pressures > 1 MPa. ^d Combined nitrogen, water and hydrocarbon: maximum 9 µmol/mol. ^e Hydrocarbons except methane include oxygenated organic species and shall be measured on a C1 equivalent basis (µmolC/mol). ^f Combined oxygen, nitrogen, argon and carbon dioxide: maximum mole fraction of 1,9 % (19 000 µmol/mol). ^g Combined oxygen and argon: maximum 1 µmol/mol. ^h Combined CO ₂ and CO: maximum 1 µmol/mol. ⁱ Sulfur compounds excludes any sulfur from odorants and shall be measured on a S1 basis (µmolS/mol). NOTE Odourisation is considered as a safety issue dealt with at the national level. National requirements can permit amount fractions higher than 7 µmol/mol. ^j The hydrogen shall not contain dust, sand, dirt, gums, oils or other substances in an amount sufficient to damage residential/commercial combustion appliances. ^k To be defined as appropriate for each application.					

Reference for the applicable Type I, Grade A values: ISO 14687:2025, Table 5. Governing Indian Standard: IS 16061, applicable edition under Clause 2.13.

TECHNICAL REFERENCES AND EVIDENCE STATUS

Ref.	Document / evidence source	Status	Use in this draft
R1	DNV, GAIL CGS Indore/AGL final report, Report 2230367 Rev.1, 16 July 2024.	Independent assessment	2%/5% site evidence, materials, integrity and end-use; site-specific limitations.
R2	Bureau Veritas, ATGL compliance assessment, IND-A-43-25-0690-ATGL-001, 24 February 2026.	Independent assessment	5% control margin, gas quality, material/safety, training and consumer findings.
R3	GEL (erstwhile GGL) / GERMI analytical and field-test compilation for the Kawas project.	Supporting raw evidence; integrated engineering assessment awaited	Longitudinal concentration, odorant, material and consumer data; not treated as a standalone commercial conclusion.
R4	PNGRB Original Draft Typical Guidelines for Hydrogen Blending with Natural Gas.	Source draft	Safety, mechanical, electrical, instrumentation, odorization, integrity and emergency provisions recast.
R5	SAC comments and presentations, 2026.	Expert input	Definitions, Wobbe Index, continuous monitoring, control-system integrity, detection, Hydrogen Receipt and Interface Point provisions, decanting and odorant provisions.
R6	Applicable PNGRB CGD T4S, IMS, ERDMP, Access Code and service regulations, as amended.	Binding framework	Read in conjunction; existing obligations remain.
R7	IS 16061 (equivalent to ISO 14687), Hydrogen fuel quality — Product specification.	Adopted Indian Standard	Hydrogen quality at receipt; Table 5 reproduced at Annexure F (Grade A relevant for DPNG).
R8	IS 15319 (equivalent to ISO 13734) and ISO/TS 16922 — odorants and odorization of natural gas.	Adopted / international standards	Odorant requirements and odorization technique for HNG (clause 7.5).
R9	IS 16724 (aligned to IEC 60079-14) — Explosive atmospheres: electrical installation design, selection and installation of equipment, including initial inspection.	Adopted Indian Standard (supersedes IS 5571)	Electrical installations in hazardous areas (clause 6.4.1).
R10	CGA G-5.5, Hydrogen Vent Systems.	International practice	Hydrogen vent system design (clause 6.3.3).
R11	ASME B31.8 and ASME B31.12.	International codes	Applicability based on hydrogen concentration, operating pressure and hydrogen partial pressure (clause 6.1.4). Methods for consequence and potential-impact-area evaluation, applied only to the extent relevant under clause 6.1.4.
R12	IS/ISO 11114 (Parts 1 to 4) — compatibility of cylinder and valve materials with gas contents.	Adopted standards; applicability under examination	Cylinder/cascade material compatibility where cylinders are used (clause 6.5.4).
R13	IGEM/TD/3 Edition 5 Supplement 1 - Repurposing of natural-gas distribution pipelines with MOP not exceeding 7 bar for NG/hydrogen blends.	Informative international reference	Low-pressure distribution-pipeline compatibility, repurposing and operational considerations.
R14	IGEM/TD/13 Edition 3 Supplement 2 - Pressure regulating installations for	Informative international reference	Pressure-regulation and installation considerations for blends.

Ref.	Document / evidence source	Status	Use in this draft
	NG/hydrogen blends at pressures not exceeding 7 bar.		
R15	IGEM/SR/25 Hydrogen Supplement 1 and IGEM/H/1 Edition 2.	Informative international references	Hydrogen-specific HAC, detection, material and utilisation principles; applied only where relevant to HNG and Indian conditions.
R16	IS 5572 - Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation; IS 3043 - Code of practice for earthing; IS 15201 - Hydrogen Code of Safety.	Indian Standards	HAC, earthing, operational and emergency safety provisions, as applicable.
R17	IS 1090 - Compressed Hydrogen - Specification.	Indian Standard considered	Legacy compressed-hydrogen specification; not the governing DPNG fuel-quality specification where IS 16061 Type I Grade A applies.
R18	IGEM/H/3 Edition 2— Hydrogen Enabling Standard for Non-Domestic premises / hydrogen (Appendix 8, Detection Systems).	Informative international reference	Hydrogen detection alarm and executive-action setpoints (10% / 25% LEL basis), clause 6.4.3.
R19	PNGRB, <i>Roadmap on Hydrogen Transportation Pipelines and Blending with Natural Gas</i> .	PNGRB roadmap document	Energy-dilution basis and compensation-factor approach for heat-content billing (Module 5, "Indian Context," p. 67); energy-based billing and traceable CV/Wobbe metering alignment (clauses 12.2, 12.5).
R20	IS 17314 - Hydrogen Enriched Compressed Natural Gas (HCNG) for Automotive Purposes - Specification.	Indian Standard outside scope	Automotive HCNG standard considered and expressly excluded from DPNG application.
R21	ISO 19880 series	International reference	Focused on the safety, design, installation, operation and performance of gaseous hydrogen fueling stations
R22	IS/IEC 60079 series	Indian Standard	Flameproof Enclosures
R23	API RP 1173	International Standard	Pipeline Safety Management System framework
R24	IS 16485 / ISO 16852— Flame arresters: performance requirements, test methods and limits for use.	Adopted Indian Standard	Flame-arrester selection and certification under Clause 6.3.4. ISO 16852:2016 has been replaced internationally by ISO/IEC 80079-49:2024. The applicable adopted Indian Standard and any statutory transition requirements govern; use of the successor international standard shall follow Clause 6.3.4. Record the standard, edition and service qualification relied upon.
R25	IS 11006 — Flash Back Arrestor (Flame Arrestor): Specification.	Adopted Indian Standard	Flash-back arrestors under clause 6.3.4 where applicable to the device type.

Some other reference which may be useful for the operators;

- DOT/PHMSA Project #693JK32210013POTA (2024), Review of Integrity Threat Characterization Resulting from Hydrogen Gas Pipeline Service, Engineering Mechanics Corporation of Columbus (Emc²), prepared for U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, November 25, 2024. Publisher: Pipeline and Hazardous Materials Safety Administration, www.phmsa.dot.gov
- PRCI Catalog #PR337-23115-R01 (2024), Consensus Engineering Requirements for Pipelines in Hydrogen and Hydrogen Blend Service
- PRCI Catalog #PR337-231110-R01 Hydrogen Impact on Usage of Existing Integrity Assessment Models, 2026.
- APGA Code of Practice Hydrogen Pipeline Systems, Project RP3.2-10. Publisher: Australian Pipelines and Gas Association, www.apga.org.au.
- Recommended practice — DNV-RP-F123. Edition February 2026 Hydrogen pipeline systems
- Supplementary Specification to API Specification 5L and ISO 3183 Line Pipe

Citation convention: wherever an adopted Indian Standard exists, the IS number is cited followed by its ISO/IEC equivalent; standards are cited without edition year so that the latest edition, including amendments, applies.



PETROLEUM AND NATURAL GAS REGULATORY BOARD

ANNEXURE P - PROCEDURE, TESTING REQUIREMENTS AND REGULATORY FORMS FOR HYDROGEN-BLENDING PILOT PROJECTS AND STAGED INCREASE IN DPNG NETWORKS

**Pilot-only framework for pre-commissioning, commissioning, staged
concentration increase, testing, monitoring and closure**

Companion annexure to the Draft Typical Guidelines for Blending of Hydrogen with Natural Gas in DPNG
Networks

October 2026

Revision 0

This draft does not by itself authorize commercial hydrogen blending. Applicability is subject to statutory enablement, PNGRB approval and all other competent-authority permissions.

Regulatory boundary: This Annexure applies only to PNGRB-approved pilots. It does not permit commercial supply above the applicable commercial limit. A pilot may examine concentrations above 5%, including above 10%, only within a Project-Specific Maximum Approved Pilot Concentration.

Higher-assurance threshold: Ten per cent hydrogen by volume is a higher-assurance review threshold, not an absolute pilot ceiling. Operation above 10% requires full reassessment and specific prior PNGRB approval.

CONTENTS

Section	Title
P1	Purpose, scope and relationship with commercial guidelines
P2	Pilot definitions and approval principles
P3	Pilot application and deployment-area selection
P4	Design, engineering and safety studies
P5	Pre-commissioning, PSSR and permission to introduce hydrogen
P6	Initial injection and commissioning
P7	Project-specific concentration stages and hold points
P8	Step-up review levels and approval thresholds
P9	Gate criteria, suspension, natural-gas-only restoration and restart
P10	Testing, monitoring, reporting and independent verification
P11	Consumer participation, awareness, complaints and billing
P12	Pilot closure and final evidence
Forms P-1 to P-9	Consolidated model regulatory forms and entity-maintained registers
Schedule P-T	Phased testing and monitoring matrix
References	Technical references and evidence status

GLOSSARY AND ABBREVIATIONS

Term	Meaning
ALARP	As Low As Reasonably Practicable.
CGD	City or local natural gas distribution network.
DPNG	Domestic Piped Natural Gas.
DRS/DPRS	District/Distribution Pressure Regulating Station.
ESD	Emergency Shutdown System.
GCV / LHV	Gross Calorific Value / Lower Heating Value, on the basis prescribed by the applicable regulatory framework.
HAC	Hazardous Area Classification.
HAZID / HAZOP	Hazard Identification / Hazard and Operability Study.
HNG	Hydrogen-blended natural gas.
IMS	Integrity Management System.
LOTO	Lock-out/Tag-out.
MOC	Management of Change.
NDT	Non-Destructive Testing.
OEM	Original Equipment Manufacturer.
P&ID / PFD	Piping and Instrumentation Diagram / Process Flow Diagram.
PAUT	Phased Array Ultrasonic Testing.
PSSR	Pre-Start-up Safety Review.
QRA	Quantitative Risk Assessment.
SCADA	Supervisory Control and Data Acquisition.
SCBA	Self-Contained Breathing Apparatus.
Wobbe Index	A gas-interchangeability parameter relating calorific value to relative density.
Hold Point	An approved stage beyond which concentration shall not be increased without completion of the prescribed review and prior written PNGRB permission.
Pilot Stage	An approved concentration setpoint or band operated for a defined evidence period.

P1. PURPOSE, SCOPE AND RELATIONSHIP WITH COMMERCIAL GUIDELINES

P1.1 This Annexure establishes the procedure for design, approval, pre-commissioning, first injection, staged concentration increase, testing, monitoring, suspension and closure of HNG pilots supplying DPNG consumers.

P1.2 It applies to pilot concentrations up to and beyond 5% and, where technically justified and specifically approved, beyond 10% by volume.

P1.3 The commercial limit shall not restrict PNGRB from approving higher pilot concentrations for research, validation and evidence generation. Nothing herein permits commercial supply above the notified/approved commercial limit.

P1.4 Each pilot shall be time-bound, reversible, limited to an approved area and governed by a Project-Specific Maximum Approved Pilot Concentration. Approval of the maximum does not permit direct commencement at that maximum.

P1.5 CNG/HCNG, automotive use, transmission, pure hydrogen and non-domestic consumers are outside scope unless expressly included with an additional technical basis.

P2. PILOT DEFINITIONS AND APPROVAL PRINCIPLES

P2.1 “Pilot Project” means a time-bound, reversible and data-generating activity approved for controlled HNG supply to a limited DPNG area.

P2.2 “Project-Specific Maximum Approved Pilot Concentration” means the highest concentration PNGRB has approved for evaluation; amendment requires fresh or supplemental approval.

P2.3 “Pilot Stage” means an approved concentration setpoint/band operated for a defined stabilization and evidence period.

P2.4 “Hold Point” means a stage beyond which increase is prohibited until evidence, review and authorization are complete.

P2.5 “Routine Gate Review” applies within the fully assessed envelope with no Material Change or significant adverse finding.

P2.6 “Substantial Revalidation” applies at minimum before first operation above 5%, after Material Change, new equipment/consumer classes or adverse trends.

P2.7 “Full Reassessment” applies at minimum before first operation above 10%, exceeding the originally assessed envelope, after a significant incident/material failure or PNGRB direction.

P2.8 Absence of an incident is not evidence of readiness; progression requires representative data, acceptance criteria and independent verification.

P2.9 Other-pilot results may support but not replace assessment of the actual network, materials, pressure, appliances, consumers and local risks.

P3. PILOT APPLICATION AND DEPLOYMENT-AREA SELECTION

P3.1 Submit Form P-1 and supporting dossier before design/procurement commitments that could prejudice approval.

P3.2 A pilot above the applicable commercial limit shall be located within confined premises, meaning a compact and clearly bounded residential colony, institutional campus, staff-housing cluster or similarly controlled area that is hydraulically identifiable and isolatable, has a known and manageable consumer population, has no uncontrolled off-takes, permits rapid hydrogen isolation and natural-gas restoration, and provides dedicated monitoring, emergency access and customer-service arrangements.

P3.3 The boundary shall be hydraulically identifiable and isolatable, with no uncontrolled off-takes and a practical natural-gas restoration route.

P3.4 The site shall have emergency access, communications, competent staffing and customer service; seclusion shall not weaken response.

P3.5 Avoid sensitive/high-occupancy premises in early stages; inclusion requires specific appliance, evacuation and continuity assessment.

P3.6 Every participating household shall give prior written informed consent. A household declining or withdrawing consent shall not be penalized. Before continued pilot operation, the entity shall either exclude that household through an approved physical or operational arrangement, provide an approved alternative supply arrangement, or suspend hydrogen injection to the affected pilot zone where individual exclusion is not practicable.

P3.7 The application and entity-maintained registers shall document and resolve the network, consumer, meter, regulator, appliance and material populations and unknowns. Identifiable household-level records shall ordinarily remain with the entity and shall be produced to PNGRB only for audit, investigation or as specifically directed.

P4. Design, engineering and safety studies

P4.1 The design and Integrated Safety and Readiness Dossier shall assess the full Project-Specific Maximum Approved Pilot Concentration and credible transient/upset concentrations, even though operation proceeds in stages.

P4.2 Include PFD/P&ID, hydraulic/mixing and dynamic-control studies, cause-effect, compatibility, metering/billing, HAZOP, QRA, HAC, dispersion, fire/explosion and emergency arrangements.

P4.3 The Blending Facility shall meet the relevant Commercial Guideline technical requirements, including fail-safe ratio control, concentration feedback, low-natural-gas-flow permissive, independent real-time protection, ESD, non-return protection, venting, detection, control-system integrity and appropriate cybersecurity measures.

P4.4 Each stage setpoint shall include a margin below its approved maximum and a high-high trip preventing exceedance.

P4.5 Compatibility shall identify concentration-dependent limits. Above 10%, explicitly address fracture toughness, fatigue crack growth, HE, stressed/high-strength components, seals/diaphragms/springs, burner temperatures and long-term appliance effects where relevant.

P4.6 Prepare IMS and ERDMP addenda, MOC, SOPs, maintenance and calibration plans, LOTO/work-permit arrangements, training, communication, consumer-protection and the approved pilot metrology/billing methodology before PSSR.

P4.7 No critical/high-risk action may remain open before first H2 or step-up; record closure in Form P-2.

P4.8 For new steel line pipe procured for pilot hydrogen/HNG service, the following additional qualification measures beyond the baseline requirements of ASME B31.12 shall be considered at the design stage: (i) for HFW pipes, seam-weld inspection may preferably be strengthened through Phased Array Ultrasonic Testing (PAUT) covering the weld and heat-affected zone, with weld-inspection equipment qualification, calibration and periodic performance verification per applicable IOGP recommendations; (ii) for pipe grades API 5L X52 and above, fracture-toughness characterisation may include rising-load fracture toughness testing in accordance with ASTM E1820 to evaluate crack initiation and propagation resistance for hydrogen service; and (iii) steelmaking requirements (chemistry control, cleanliness, inclusion control and manufacturing practices) may be aligned with the relevant IOGP recommendations.

P4.9 The compatibility assessment for polyethylene mains and services shall address the grades and components actually present in the pilot area, including PE80 or PE100 where applicable, at the Project-Specific Maximum Approved Pilot Concentration and relevant operating conditions. The assessment shall consider joint integrity,

slow crack growth, permeation, ageing, pressure cycling, residual stress and long-term creep to the extent relevant to the material and duty.

Suitability may be established through applicable standards, traceable material or OEM data, relevant service evidence and adequate existing qualification results. The approved test plan shall identify evidence gaps and any additional tests required, with methods, conditions and acceptance criteria specified under Form P-1 and findings reported under Form P-9. Testing shall comply with Clause P10.2. Laboratory-derived properties, field observations and lifetime predictions shall be distinguished, with the limitations of any extrapolation stated.

P5. PRE-COMMISSIONING, PSSR AND PERMISSION TO INTRODUCE HYDROGEN

P5.1 Complete Schedule P-T baseline and pre-commissioning requirements and the consolidated Pre-Commissioning, PSSR and Permission Form P-3.

P5.2 Establish natural-gas-only baseline for leakage, pressure/flow, gas quality, odorization, meters/regulators, appliances, billing and complaints.

P5.3 For pilots, inspect 100% of domestic connections and identified appliances before commencement unless PNGRB approves a justified alternative for a large pilot.

P5.4 Test pressure and leakage, valves, electrical systems, earthing and bonding, loops, analysers, detectors, alarms, trips, ESD, ventilation, communication, control configuration, data logging, backup/recovery and appropriate cybersecurity measures.

P5.5 A pre-start drill shall include leak, detector alarm, ESD, isolation, customer-care escalation, local-authority interface and restoration; close observations due before start.

P5.6 A multidisciplinary PSSR shall verify design, approvals, studies, actions, procedures, training, spares, emergency, data, consent, billing and natural-gas-only restoration.

P5.7 The Independent Competent Agency shall certify readiness through Form P-3. Hydrogen shall not be introduced until PNGRB gives prior written permission for the initial stage.

P6. INITIAL INJECTION AND COMMISSIONING

P6.1 Commission under an approved procedure with competent personnel and continuous safety-critical monitoring.

P6.2 Safely purge H₂ systems and first demonstrate stable natural-gas operation.

P6.3 A new pilot shall ordinarily start at the lowest approved stage, not exceeding 2%, unless PNGRB accepts equivalent evidence and another initial stage.

P6.4 The ramp rate and intermediate stabilization steps shall be established by the approved dynamic-control study and commissioning procedure, having regard to natural-gas flow, line-pack, mixing length, analyser and valve response, network transport delay, overshoot prevention and abort criteria. No universal numerical ramp rate is prescribed.

P6.5 Prevent overshoot/slugging; concentration above stage high-high or loss of valid measurement shall isolate H₂.

P6.6 At initial injection/each stage, check concentration, homogeneity, GCV/LHV/Wobbe, odorization, pressure, leakage, meters/regulators and representative appliances at outlet, critical/high, farthest and consumer points at peak/min demand.

P6.7 Attend the facility for at least the first 24 hours of each new stage or longer under the test plan.

P6.8 Consolidated Form P-4 shall record commissioning, deviations, alarms and trips, communication, user-end verification and acceptance for stabilized operation.

P7. PROJECT-SPECIFIC CONCENTRATION STAGES AND HOLD POINTS

P7.1 The entity shall propose stages appropriate to the maximum sought; PNGRB may approve, modify or prescribe them based on concentration, materials, pressure, appliances, evidence and public exposure.

P7.2 Illustrative stages may include 2%, 5%, 8% and 10%, but are not mandatory. Smaller or different increments may be required.

P7.3 Complete each Hold Point sequentially unless PNGRB expressly waives a stage based on equivalent evidence.

P7.4 Each stage shall capture peak/minimum demand, weekday/weekend variation, start/stop cycles, representative appliance use, complaints and billing reconciliation.

P7.5 The evidence period at each stage shall be approved on the basis of the pilot objective and risk and shall be sufficient to cover peak and minimum demand, weekday and weekend variation, start-stop and pressure cycles, representative appliance use, consumer feedback and the tests specified for that stage. PNGRB may prescribe a minimum calendar duration, operating hours or number of cycles for any stage. Progression shall not be based solely on a short incident-free period.

P7.6 The approved test plan shall identify the safety-critical data channels and the method for calculating valid-data completeness. Unless PNGRB approves otherwise, valid critical-data completeness shall be at least 95%, excluding only pre-approved non-operating or maintenance periods. Any gap in concentration, flow, pressure or safety-function status during hydrogen operation shall invalidate the affected period unless independently reconstructed and accepted.

P7.7 Before every increase in pilot concentration, the entity shall submit consolidated Form P-5 with the stage evidence and independent recommendation and shall obtain prior written PNGRB permission for the next stage.

P8. STEP-UP REVIEW LEVELS AND APPROVAL THRESHOLDS

P8.1 Routine Gate Review

P8.1.1 A Routine Gate Review may be used only where the next stage is within the fully assessed envelope, no Material Change or adverse trend exists and all gates are met; it does not dispense with prior written PNGRB permission for the next concentration stage.

P8.1.2 Focused confirmation of HAZOP/QRA assumptions, controls, gas quality, appliances, billing and communication may suffice; full study repetition is not automatic.

P8.2 Substantial Revalidation

P8.2.1 Required before first operation above 5%, after Material Change, new consumer/appliance/meter class, changed source/quality, recurring alarm, adverse leak/material/seal trend, gas-quality deviation, billing error or systemic complaints.

P8.2.2 Update the relevant HAZOP/QRA, control and trip settings, compatibility, appliance and metrology assessment, IMS/ERDMP, procedures, consent/information and monitoring. Submit the updated basis with Form P-5 and obtain prior written PNGRB concurrence.

P8.3 Full Reassessment - above 10% or outside the assessed envelope

P8.3.1 Ten per cent is a higher-assurance review threshold, not a concentration ceiling or a material-compatibility threshold. Full Reassessment and specific prior PNGRB approval are required before first operation above 10%. Further Full Reassessment shall be required where a trigger in Clause P8.3.2 applies; an increase within an already fully assessed and approved envelope shall instead undergo the applicable stage review, independent verification and prior written permission under Clauses P7.7 and P8.3.4.

P8.3.2 Also required before exceeding the assessed envelope, after significant incident/material failure, invalidated assumptions or PNGRB direction.

P8.3.3 Submit revised design/Safety Case; full HAZOP/QRA/HAC/dispersion; H2-specific integrity/material assessment; relevant fracture/fatigue/HE tests; seals/diaphragms/springs review; full appliance/interchangeability tests; odorant validation; enhanced emergency/consumer safeguards; longer stabilization and independent expert review.

P8.3.4 Each stage above 10% requires independent expert support and explicit prior written PNGRB permission in accordance with Clause P7.7. Approval of an overall pilot protocol, concentration range or sequence of stages shall not by itself authorize progression to the next stage. Operation remains a time-bound pilot and creates no commercial entitlement.

P9. GATE CRITERIA, SUSPENSION, NATURAL-GAS-ONLY RESTORATION AND RESTART

P9.1 Valid representative data and approved completeness threshold are achieved.

P9.2 Concentration stayed in the control band; excursions are investigated/closed.

P9.3 No unresolved fire, injury, release, reportable incident, safety-critical trip or common-cause complaint exists.

P9.4 No unexplained adverse leakage trend; leaks are repaired/retested.

P9.5 Gas quality, GCV/LHV/Wobbe, odorization, pressure and flow remained acceptable.

P9.6 Meters, regulators, appliances and materials met acceptance criteria.

P9.7 Consent/communication are complete; no unresolved safety or material billing concern remains.

P9.8 Safety studies, IMS/ERDMP, procedures, training, drills, billing and cause-effect are current.

P9.9 Independent agency supports progression and PNGRB approvals are available.

P9.10 If the gate criteria are not met, concentration shall not be increased. PNGRB may direct continued operation at the current safe stage, reduction to another approved stage, or complete suspension. The entity shall investigate, correct and obtain the required written permission before any restart or further increase.

P9.11 Commercial Guideline automatic isolation/suspension/notification criteria apply, plus stricter pilot conditions.

P9.12 Restart after a safety-critical event or suspension requires consolidated Form P-8, root-cause closure, revalidation, independent verification and prior PNGRB concurrence where required.

P10. TESTING, MONITORING, REPORTING AND INDEPENDENT VERIFICATION

P10.1 Schedule P-T is the minimum model matrix; classify activities as baseline, commissioning/each stage, routine, event-triggered or closure.

P10.2 Tests shall be technically applicable. Destructive, HE, fatigue, fracture and advanced NDT shall be limited to relevant materials, coupons, removed components or failure investigation unless approved otherwise.

P10.3 Monitor critical data, downstream concentration/homogeneity, GCV/LHV/Wobbe, odorization, leakage, pressure/flow, meters/regulators, appliances, materials, complaints, billing and awareness.

P10.4 Submit consolidated Form P-6 at the frequency specified in the approval, ordinarily monthly, with machine-readable data where required; report adverse findings and safety-critical events immediately.

P10.5 Independent verification applies to pre-start, required gates, significant events and final dossier.

P11. CONSUMER PARTICIPATION, AWARENESS, COMPLAINTS AND BILLING

P11.1 Written informed consent shall explain purpose, stages, material risks, appliance checks, billing, complaints, emergency action, data use, withdrawal and non-waiver of rights.

P11.2 Provide local-language information before first injection and every material concentration increase. Consent, briefings, awareness activities and drills shall be recorded in the entity's internal consumer register and summarized in consolidated Form P-7.

P11.3 Operate 24-hour complaint and emergency channels, ticketing, escalation and field response before hydrogen introduction. Complaints, appliance observations, alarms, deviations and incidents shall be maintained in entity registers and summarized through Forms P-6 to P-8; identifiable records shall be provided to PNGRB only when directed or required for investigation.

P11.4 Awareness sessions and drills shall cover smell, flame, appliance dos and don'ts, emergency contacts, customer service and the approved billing approach. Experience from ATGL and GEL (erstwhile GGL) supports periodic refresher communication.

P11.5 Pilot billing shall account for any reduction in heat content attributable to hydrogen blending through a project-specific methodology accepted by PNGRB. The methodology shall be transparent and consumer-favourable, and sample bills shall be validated at each material stage. The compensation-factor billing approach in Clause 12.5 of the Commercial Guidelines may be applied to a pilot with PNGRB acceptance, set consumer-favourably at the Project-Specific Maximum Approved Pilot Concentration.

P11.6 Do not step up while a safety complaint, systemic billing error or material appliance concern remains unresolved.

P12. PILOT CLOSURE AND FINAL EVIDENCE

P12.1 Every pilot shall have an approved closure/transition plan; operation beyond the approved period requires written permission.

P12.2 Closure includes complete cessation of hydrogen injection, safe isolation and purging, restoration of natural-gas supply, final leakage and appliance checks, billing reconciliation, consumer communication, complaint closure and preservation of records. Any subsequent pilot or commercial operation requires a separate valid approval.

P12.3 Consolidated Form P-9 shall provide the complete operating history, stages, valid and invalid data, tests and trends, excursions, incidents, complaints, billing, material and appliance findings, deviations, limitations and recommended safe envelope.

P12.4 Distinguish entity and independent conclusions and identify transferability, conditions and site-specific limitations.

P12.5 The final dossier shall include independent validation under Form P-9. PNGRB may require peer review, non-confidential publication or additional testing before relying on the evidence for policy, standards or commercial limits.

MODEL REGULATORY FORMS

Form control: PNGRB may issue electronic versions or revise the forms without amending substantive clauses. Detailed household-level and operational registers shall be maintained securely by the entity; submissions to PNGRB shall ordinarily contain evidence references, summaries and anonymized data unless individual records are required for audit or investigation.

Form P-1 - Pilot application and confined-premises dossier

Ref.	Field / requirement	Entity entry / evidence reference
1	Entity, GA, responsible officers and independent agency	
2	Purpose, research questions and maximum concentration sought	
3	Confined-premises boundary, isolation, consumers and sensitive premises	
4	Injection point, Hydrogen Receipt and Interface Point, source and transportable interface	
5	Proposed stages, hold points and approval schedule	
6	Design, safety, compatibility and evidence-gap summary	
7	Testing/monitoring and data-completeness plan	
8	Consent, customer service, public engagement and billing methodology	
9	Suspension, closure and natural-gas restoration plan	
10	Statutory and PNGRB approvals requested	
11	Information regarding whether the Pilot is linked to, or can contribute evidence towards, any Centrally or State Government supported pilot, Hydrogen Valley Innovation Cluster, or testing/R&D activity	

Form P-2 - Compatibility and safety-action register

Ref.	Field / requirement	Entity entry / evidence reference
1	Asset/component/appliance class and location	
2	Material/model/OEM/age and operating duty	
3	Hydrogen concentration assessed and evidence method	
4	Limitation, mitigation and inspection frequency	
5	HAZID/HAZOP/QRA/HAC action and risk ranking	
6	Responsible person, due date and closure evidence	
7	Independent verification and status before start/step-up	

Form P-3 - Pre-commissioning, PSSR and permission to introduce hydrogen

Ref.	Field / requirement	Entity entry / evidence reference
1	Approved design/as-built and statutory approvals	
2	Pressure/leak, valves, NRV, ESD and purge tests	
3	Electrical, HAC, earthing, bonding, analysers and detectors	
4	Alarms, trips, interlocks, cause-and-effect and data integrity	
5	IMS/ERDMP/MOC/SOP, training, drill and staffing	
6	Consent, customer service and approved billing readiness	
7	Punch-list/open actions and interim controls	
8	Independent readiness recommendation	
9	Entity authorization and PNGRB decision/conditions	

Form P-4 - Initial injection and stage commissioning record

Ref.	Field / requirement	Entity entry / evidence reference
1	Stage, start/end, personnel and approved setpoint	
2	Natural-gas baseline and ramp/concentration profile	
3	Outlet, network-end and consumer-point measurements	
4	GCV/calorific basis, Wobbe, gas quality and odorization	
5	Pressure, flow, mixing and homogeneity	
6	Leak survey, detector and safety-function status	
7	Meter/regulator/appliance observations	
8	Alarms, trips, deviations, communication and actions	
9	Decision for stabilized operation	

Form P-5 - Step-up application and gate certificate

Ref.	Field / requirement	Entity entry / evidence reference
1	Current and proposed stage; maximum approved concentration	
2	Evidence period, operating cycles and valid-data completeness	
3	Concentration control, excursions and analyser verification	
4	Gas quality, odorization, pressure, flow and homogeneity	
5	Leak, material, seal, meter, regulator and appliance findings	
6	Complaints, consent, communication and billing status	
7	Required revalidation level and updated studies/actions	
8	Natural-gas-only restoration/suspension readiness	
9	Independent recommendation	
10	PNGRB written decision/conditions	

Form P-6 - Periodic pilot report

Ref.	Field / requirement	Entity entry / evidence reference
1	Operating hours, hydrogen use and concentration profile	
2	Data completeness and analyser/reference verification	
3	Gas quality, calorific-value basis, Wobbe and odorization	
4	Pressure, flow, homogeneity, leak and integrity findings	
5	Meters, regulators, appliances and materials	
6	Alarms, trips, incidents, maintenance and open actions	
7	Complaints, consumer feedback, awareness and billing reconciliation	
8	Next-stage proposal or continued-stage justification	

Form P-7 - Consumer consent, awareness and complaint summary

Ref.	Field / requirement	Entity entry / evidence reference
1	Number of participating/withdrawing households and operational resolution	
2	Consent version, concentration range and briefing completed	
3	Appliance inspection status and vulnerable-consumer support	
4	Awareness sessions, drills and emergency understanding	
5	Complaint categories, response, common-cause review and closure	
6	Repairs, replacement or compensation actions where applicable	
7	Privacy controls and anonymized summary submitted	

Form P-8 - Alarm, incident, suspension and restart record

Ref.	Field / requirement	Entity entry / evidence reference
1	Date/time, classification, stage and actual concentration	
2	Alarm/trip/detector/ESD sequence and safe state	
3	Isolation, consumer/public action and notifications	
4	Data preserved, cause, consequences and affected systems	
5	Corrective actions and independent verification	
6	Updated studies, procedures, training and monitoring	
7	Proposed restart stage	
8	PNGRB decision/conditions	

Form P-9 - Final technical dossier and independent validation

Ref.	Field / requirement	Entity entry / evidence reference
1	Scope, duration, stages and complete operating history	
2	Tests, trends, valid/invalid data and deviations	
3	Safety, integrity and material conclusions	
4	Meter, regulator and appliance findings	
5	Consumer, complaint and billing findings	
6	Incidents, actions and lessons	
7	Limitations, transferability and recommended safe envelope	
8	Closure, natural-gas restoration and archive	
9	Independent agency competence, scope, limitations and data verification	
10	Independent conclusion and sign-off	
11	Information regarding whether the Pilot is linked to, or can contribute evidence towards, any Centrally or State Government supported pilot, Hydrogen Valley Innovation Cluster, or testing/R&D activity	

SCHEDULE P-T - PHASED TESTING AND MONITORING MATRIX

Ref.	Assessment	Applicability	Baseline/pre-commissioning	Commissioning/ each stage	Routine minimum	Event/closure	Acceptance objective
T1	Asset register	All	Complete/ verify; resolve unknowns	Confirm no boundary/ asset change	Update after maintenance/ change	Revalidate after event; final as-built	Traceability
T2	Material compatibility	All wetted	OEM/ standard/ service/ test evidence	Confirm stage within assessed envelope	Monthly findings/ replacements	Failure investigation/ closure samples	No unassessed critical material
T3	Appliance inspection	All households	100% visual/functional ; baseline tests	Representative checks at each material stage as specified in the approved test plan	Risk-based sample; immediate complaint-triggered inspection	Affected/ closure inspection	Safe ignition/ flame/ CO/ NOx/ heat input
T4	Meter/ regulator	All types	Accuracy/ lock-up/response/ leak baseline	Representative each major stage	Risk-based representative verification and trend review	Expand anomaly; closure comparison	Within limits
T5	Safety Case/studies	All	Complete for maximum; close critical	Review per P8	Formal review at each material step-up and at least annually during extended pilots	After change/ incident; closure	ALARP/ assumptions valid
T6	IMS/ERDMP/ MOC/SOP	All	Approved/ verified	Revalidate each step	Monthly action review	Update event/change	Current/ configuration aligned
T7	Facility pressure/leak	Facility	Complete before PSSR	Check before stage	Daily visual; OEM/ risk plan	After maintenance/ ESD/event	No unacceptable leakage
T8	Analyser/ flow/control	Critical	Calibration /loop/ dynamic test	Validate each stage low/peak flow	Continuous health; periodic calibration	After excursion / conflict	Controlled within stage limit
T9	Detection/ ESD/interlocks	Safety critical	Coverage/proof test	Confirm before stage	Continuous status; proof-test	After activation/ change/event	Cause-effect verified
T 10	Concentration/ homogeneity	Network	Hydraulic baseline	Outlet after mixing length and representative network/user-end points at peak/minimum demand	Continuous outlet; weekly first month then monthly	After flow/boundary/complaint	No gradient/over shoot

Ref.	Assessment	Applicability	Baseline/pre-commissioning	Commissioning/each stage	Routine minimum	Event/closure	Acceptance objective
T 11	GCV/LHV/Wobbe/ gas quality	Network/appliance	NG baseline	Each stage peak/min	Online or weekly/ lab; monthly review	After source/ event	Within envelope
T 12	Odorant	Endpoints	Baseline injection/farthest	Each stage; weekly initial month	At least fortnightly unless the approval requires more stringent checks	After complaint/ source/ flow	Reliable detectability
T 13	Leak survey	Network	Full pre-H2	Enhanced survey after initial injection and each material step-up	Risk-based, not less stringent than T4S/IMS and the approved pilot plan	Immediate alarm/ complaint/ event; final	No adverse trend
T 14	Pressure/ flow/ regulators	Network	NG hydraulic profile	Continuous ramp/ hold	Continuous; monthly review	After change/ complaint	Stable envelope
T 15	Metering/ billing	Consumers	Billing engine validation	Sample bills each major stage	Monthly reconciliation	Data loss /complaint/ final	No disadvantage
T 16	Feedback/ awareness	Households	Briefing, consent and baseline survey; identifiable records retained by entity	Contact after major stage	Approved survey frequency; continuous complaints	Incident/ closure survey	Informed/ no unresolved concern
T 17	MDPE joints/ permeation	Where present	Traceability/leak baseline; test if needed	Review joint/ leak evidence	Quarterly technical review	After joint failure/ leak; closure	No adverse trend
T 18	Metallic/ NDT	Where relevant	Visual/thickness/ corrosion/risk baseline	Target after stage/ modification	Risk-based; not blanket	After indication/ failure	No rejectable defect
T 19	Elastomers / seals/ springs	Where present	Compatibility/ function baseline	Leak/function each stage	Quarterly representative review	After leak/ failure; closure sample	No adverse functional trend
T 20	HE/fatigue/fracture/destructive	Relevant samples	Qualification coupons/ components	Enhanced before/above 10%; not routine otherwise	Risk/ test-plan based	Failure/ closure research	Valid suitability evidence
T 21	Training	Personnel	Initial assessment before PSSR	Rebrief each stage	Quarterly touchpoint; annual refresher	After incident/ change	Current competence

Ref.	Assessment	Applicability	Baseline/pre-commissioning	Commissioning/each stage	Routine minimum	Event/closure	Acceptance objective
T 22	Emergency/public drills	All	Pre-start full drill	Tabletop before material stage	At least annual full	After change/incident/closure	Isolation/communication/restoration
T 23	Control-system, cybersecurity and historian integrity	Automated	Access, configuration, change-log, backup/recovery and risk-based cybersecurity checks	Verify setpoint/configuration	Monthly access/ log; vulnerability tests	After cyber/data event	Auditable/recoverable
T 24	Independent review	All	Design/PSSR	Gate as required	At required gates and at least annually for extended pilots	After significant event/ final	Objective assurance

TECHNICAL REFERENCES AND EVIDENCE STATUS

Ref.	Document	Status	Use in this draft
P-R1	DNV Indore/AGL report, 2024.	Independent	2%/5% integrity findings, material priorities and >10% considerations.
P-R2	Bureau Veritas ATGL report, 2026.	Independent	Testing, 5% control margin, consumers, training, QRA/HAZOP/HAC and documentation.
P-R3	GEL (erstwhile GGL) / GERMI test compilation for the Kawas project.	Supporting raw evidence	5%/~8% sampling, low-flow endpoints, odorant and consumer evidence; final integrated report awaited.
P-R4	Original Guidelines and SAC comments.	Regulatory/expert	Safety, integrity, detection, odorization, interface decanting, control-system integrity, Wobbe Index and monitoring.
P-R5	Commercial HNG Guidelines up to 5%.	Companion	Technical requirements apply unless this Annexure is stricter.
P-R6	IS 16061 (equivalent to ISO 14687), Type I Grade A; IS 15319 (equivalent to ISO 13734); ISO/TS 16922.	Indian/international standards	Hydrogen quality, odorant and odorization provisions.
P-R7	IGEM/TD/3 Edition 5 Supplement 1; IGEM/TD/13 Edition 3 Supplement 2; IGEM/SR/25 Hydrogen Supplement 1; IGEM/H/1 Edition 2.	Informative international references	Low-pressure blends, pressure regulation, HAC, detection, materials and trial principles, applied selectively.
P-R8	IS 16724, IS 5572, IS 3043, IS 15201 and IS/ISO 11114 Parts 1-4, as applicable.	Indian/adopted standards	Electrical installation, HAC, earthing, hydrogen safety and cylinder/valve material compatibility.
P-R9	IS 1090 and IS 17314.	Standards considered	IS 1090 considered for compressed hydrogen context; IS 17314 is automotive HCNG and outside DPNG pilot scope unless separately approved.