SUMMER INTERNSHIP PROJECT

ON

PRESSURE REDUCING SKID (PRS) FLOW 1200 SCMH

By Himanshi Mittal

student of

B.tech Mechanical and Automation, IGDTUW Delhi-110006

Problem Statement

Industries and commercial setups depend heavily on reliable natural gas supply, but the gas is often delivered at very high pressures-far above what the end equipment can handle safely. To solve this, there is a constant demand for systems that can reduce gas pressure safely and efficiently, all while making sure the gas stays clean and the entire setup runs smoothly.

During my internship, I worked on a Pressure Reducing Station (PRS) skid-a compact, ready-to-install unit designed for this exact purpose. The PRS skid is responsible for bringing down high gas pressures to safer, usable levels and ensuring all safety and quality standards are met.

My project focused on understanding and contributing to the design of a PRS skid capable of handling flows up to 1,200SCMH. The process involved tackling practical challenges: keeping the flow consistent, preventing pressure fluctuations, guaranteeing system safety and following ASME and industry standards. The ultimate aim was to help develop a system that's not only technically solid and safe, but also easy to deploy and cost-effective; meeting the performance needs of real-world industrial clients.

Introduction to PRS Skid

A PRS Skid or Pressure Reducing Station Skid, is a compact, pre-engineered system designed to reduce and regulate the pressure of natural gas or other industrial gases before it is delivered to downstream systems. The entire unit is assembled on a metal base frame (called a skid), which allows for easy transportation, installation and maintenance.

It acts as an interface between high-pressure supply pipelines and low-pressure distribution networks or industrial consumers. These systems are commonly used in city gas distribution, power generation and industrial fuel supply setups.

Pressure Reduction Skid

Functions of a PRS Skid

The main purpose of a PRS Skid is to:

- Reduce incoming gas pressure from transmission levels (like 19–50 bar) to a safer, usable level (like 0.5–4 bar).
- Maintain consistent downstream pressure, regardless of fluctuations in input pressure or demand.
- Ensure safety by using automatic shut-off valves, safety relief valves, and flame arrestors.
- Monitor flow and pressure using instruments like pressure gauges, temperature indicators and flow meters.

Types of Skids

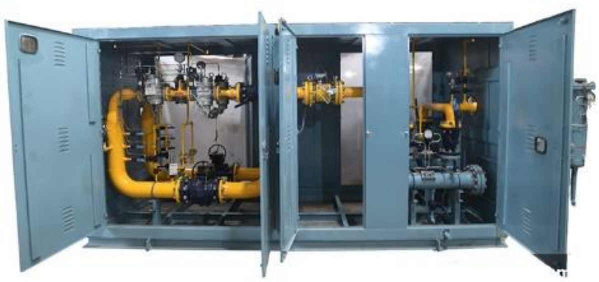
In industrial and city gas applications, skids are modular, pre-assembled systems mounted on steel frames for ease of transportation and installation. Each skid type serves a different role based on system needs. Common types include:

1. PRS Skid (Pressure Reducing Station Skid)

- Reduces and regulates high-pressure natural gas (19–50 bar) down to medium pressure (around 4 bar).
- Acts as the first pressure control stage in city gas or industrial systems.
- Equipped with regulators, safety valves, filters and flow meters.

2. DRS (District Regulating Station)

- Further reduces gas pressure from medium (~4 bar) to low pressure (0.1–1 bar), suitable for household and commercial distribution.
- Strategically located in urban zones near points of consumption.
- Maintains safe, stable pressure zones within city distribution networks.



District Regulating System

3. Filtration Skid

- Removes dust, liquids and other impurities from gas or fluid.
- Protects downstream equipment from damage and improves gas quality.
- Often used before pressure regulation or metering systems.

4. Metering Skid

- Measures the flow rate, pressure and temperature of gas or liquids.
- Crucial in custody transfer, billing and performance monitoring.
- Includes flow meters, transmitters and data logging systems.

Understanding Flow Rate: 1200 SCMH

In industrial and fluid systems, flow refers to the movement of a fluid (liquid or gas) through a pipeline or equipment over time. It is a critical parameter that helps engineers understand how much gas or liquid is being transported, processed or consumed in a system.

SCMH stands for ***Standard Cubic Meters per Hour***. It is a unit to measure volumetric flow rate of gases or fluids at standard conditions (usually 1 atm and 0°C or 25°C). In this project, the PRS skid is designed to handle 1200 SCMH of flow, meaning it can regulate 1200 cubic meters of gas per hour reliably.

ASME Standards for PRS Skid Flow 1200 SCMH

ASME standards are engineering guidelines that ensure safe and reliable design, fabrication and testing of mechanical systems.

ASME Section VIII Division 1 – Pressure Vessel Design

- This section provides rules for the design, fabrication, inspection, testing and certification of pressure vessels operating under internal or external pressure.
- Covers aspects like wall thickness calculations, material selection, stress analysis and safety factors.
- Ensures that pressure vessels can safely handle the maximum operating pressure without risk of rupture or failure.

Materials Used in a PRS Skid

The selection of materials in a PRS Skid depends on the operating pressure, temperature, gas composition and safety requirements. Below is a breakdown of commonly used materials in different components of a PRS Skid:

1. Pipes

- **Seamless Pipes**
  - No welded seam; ideal for high-pressure gas applications.
  - Standard: ASTM A106 Gr. B
- **ERW (Electric Resistance Welded) Pipes**
  - Welded along the length; used in medium or low-pressure zones.
  - Standard: IS 1239 / IS 3589
- **Laser Welded Pipes**
  - Used in instrumentation tubing and control signal lines.
  - Standard: ASTM A249 / ASTM A554

2. Valves

- **Ball Valve**
  - On/off isolation valve
  - Standard: API 6D / IS 9890
- **Slam Shut Valve (SSV)**
  - Closes gas flow in emergency high/low pressure.
  - Standard: PNGRB CGD Guidelines / OISD 226
- **Pressure Relief Valve (PRV / SRV)**
  - Automatically vents excess pressure
  - Standard: ASME Sec VIII / API 520, 521
- **Pressure Regulating Valve**
  - Maintains outlet pressure at set levels
  - Essential for pressure control in the PRS
- **Instrument Valves (Needle / Globe)**
  - For precise regulation in impulse and instrument lines
  - Standard: ASTM A479 (SS 316)

3. Pressure Vessels (Filter/Separator, Knockout Drum)

- **Material:** Carbon Steel (ASTM A516 Gr. 70)
- **Standard:** ASME Section VIII Division 1
- **Application:** For holding and filtering gas under pressure.

4. Instrumentation (Pressure Gauges, Temperature Indicators, Transmitters)

- **Material:** Stainless Steel 304 / 316
- **Standard:** ASTM / IEC
- **Application:** For monitoring gas flow, pressure and temperature.

5. Skid Frame and Support Structure

- **Material:** Mild Steel – IS 2062 Grade B
- **Coating:** Hot-Dip Galvanized or Epoxy Painted
- **Application:** Base frame for mounting all components.

6. Flanges

- **Material:** ASTM A105 (Carbon Steel), SS 304 / SS 316 (for corrosion resistance)
- **Standard:** ASME B16.5 (Weld Neck, Slip-On, Blind Flanges), IS 6392 (Indian flange standard)
- **Application:** Used to join pipes, valves, and vessels through bolted joints with gaskets.

7. Gaskets & Seals

- **Material:** Spiral Wound Gaskets (SS with Graphite) or PTFE
- **Standard:** ASME B16.20
- **Application:** Sealing flanged joints and valve connections.

8. Fittings

- **Material:**
  - CS: ASTM A234 WPB (Butt-weld)
  - SS: SS 304 / 316 (for corrosive areas)
  - Forged: ASTM A105 (Socket/Threaded)
- **Standard:** ASME B16.9 (Elbows, Tees, Reducers), ASME B16.11 (Forged fittings)
- **Application:** Used for changing direction, branching, and reducing pipe size in PRS pipelines.

System Design Calculations

The following outlines the standard design parameters and calculation methodologies for Pressure Reducing Skid:

Parameter	Value
Inlet Pressure	19-21 bar
Outlet Pressure	4-5 bar
Maximum Flow Rate	1200 SCMH
Gas Type	Natural Gas (PNG)
Temperature Range	10-45 C
Pipe Diameter	As per ASME Standard

Pressure Drop Calculation:

Pressure drop across the PRS system is estimated using the Darcy-Weisbach equation:

$$\Delta P = f \cdot \left(\frac{L}{D}\right) \cdot \left(\frac{\rho v^2}{2}\right)$$

Where:

- ΔP: Pressure drop across the pipeline
- *f:* Friction factor, determined from Moody's chart
- L: Length of pipe
- D: Pipe diameter
- ρ: Gas density
- v: Average gas velocity

This calculation helps assess the adequacy of the piping system and verifies that the outlet pressure remains within the required range.

Flow Rate Sizing:

The system is sized for peak gas demand using the standard flow equation:

$$Q = A \times v$$

Where:

- Q: Volumetric flow rate (SCMH)
- A: Pipe cross-sectional area (m2*m*2)

- v: Gas velocity (m/s)

Industry practice targets a velocity limit below 20 m/s to minimize risk of noise and erosion.

Valve Sizing:

Safety Relief Valve (SRV) sizing is based on maximum system pressure and design codes. A typical sizing approach is:

$$Q_{SRV}=K(\Delta P/\rho)^{1/2}$$

Where:

- Q_{SRV}: Required valve discharge capacity
- K: Valve coefficient
- ΔP: Pressure difference
- ρ: Gas density

All design calculations are performed in accordance with ASME and project specifications to ensure safe operation and reliability throughout the skid's lifecycle.

Assembly of PRS Skid (1200 SCMH)

The assembly of a PRS skid involves the integration of mechanical instrumentation and safety components on a compact steel structure, ensuring proper flow sequence and accessibility for operation and maintenance.

Step-by-Step Assembly Process:

1. **Skid Frame Fabrication**
   - A base frame is fabricated using Mild Steel (IS 2062 Gr. B) channels and plates for structural strength.
   - It is hot-dip galvanized or epoxy painted to prevent corrosion.

2. **Mounting of Pressure Vessels**

   - The filter separator or knockout drum is placed first, aligned to the inlet side.
   - It is welded or bolted on anti-vibration mounts.
   - Orientation is maintained for drainage and filter replacement access.

3. **Pipework & Headers Installation**

   - Main inlet and outlet headers are assembled with ASTM A106 Gr. B carbon steel seamless pipes, chosen for strength and pressure rating.

- All pipe routing follows approved layout drawings, maintaining alignment for ease of inspection.

4. Valve Integration

Valves are installed at strategic locations:

- Ball Valves for isolation (API 6D)
- Slam Shut Valve (SSV) after the filter
- Pressure Regulating Valve for pressure control
- Relief Valve (SRV/PRV) at outlet

5. Tubing & Instrumentation Assembly

SS 316 seamless tubing (ASTM A269) is used to connect:

- Pressure gauges
- Temperature indicators
- Transmitters
- Pilot sensing lines of regulators

6. Electrical / Control Panel Mounting

In auto-operated PRS skids, a local control panel is fixed with:

- Pressure switches
- Solenoid valves
- Emergency shutdown system

7. Leak Testing & Hydrotest

After mechanical assembly, the entire skid undergoes:

- Hydrostatic pressure testing (as per ASME B31.3)
- Pneumatic leak test using nitrogen/air
- All flanges, joints, and welds are inspected with NDT techniques (ASME Sec V)

8. Painting & Nameplates

- Final painting is done with polyurethane or epoxy finish.
- Nameplates for each valve, line tag, and instrument are attached as per P&ID.

Assembly Tools Used:

- Welding sets (GTAW/SMAW)
- Torque wrenches for flanges
- Pressure testing pumps
- NDT instruments (DPT, RT, UT)
- Tubing benders and cutters

Process Flow of a PRS Skid (1200 SCMH)

A PRS Skid is used to reduce the pressure of natural gas from a high-pressure pipeline to a controlled, safe level suitable for downstream consumption (like in domestic, industrial, or commercial use).

Step-by-Step Process Flow

1. Inlet Filter Separator

- First stage where incoming gas passes through a filter-separator that removes dust, solid particles and moisture.
- Protects downstream equipment like regulators and valves from damage or clogging.

2. Slam Shut Valve (SSV)

- A safety device that automatically shuts off gas flow if outlet pressure goes too high or too low beyond set limits.
- Prevents unsafe conditions and protects downstream users.

3. Pressure Regulating Unit (PRV or Pilot Operated Regulator)

- Accurately reduces the inlet high pressure to a desired outlet pressure.

4. Relief Valve (SRV/PRV)

- Releases excess gas if outlet pressure builds up beyond safe limits (due to regulator failure or backpressure).
- Protects the system from over-pressurization and potential explosion.

5. Bypass Line

- Provides an alternate flow path when the main line is under maintenance or regulator is being serviced.
- Ensures uninterrupted gas supply during servicing.

6. Outlet Isolation Valves & Pressure Gauges

- Gauges monitor inlet and outlet pressures in real-time.
- Allows safe shutdown, inspection, and continuous pressure monitoring.

7. Outlet to Consumer / Pipeline

- The reduced-pressure clean gas is supplied to the downstream network (commercial and domestic users).
- Final delivery point after full regulation and safety checks.

Process Flowchart of a Pressure Reduction Skid

High-Pressure Gas Inlet

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Filter Separator

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Slam Shut Valve (SSV)

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Pressure Regulating Valve

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Safety Relief Valve (SRV)

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Isolation Valves & Gauges

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Outlet to Consumer (Low Pressure)

Inspection

Inspection ensures that the PRS Skid is assembled, welded and tested as per required design standards and safe for handling pressurized natural gas. All inspections are conducted as per ASME, IS and PNGRB guidelines.

Inspection/Quality Standards Used:

- **ASME Section IX – Welding Qualifications**
  Ensures welders and welding methods meet strength and safety requirements.
- **ASME Section V – Non-Destructive Testing (NDT)**
  Ensures that materials and welds are defect-free through testing without damage.
- **ASME Section II (Part C) – Welding Consumables Specifications**
  Ensures welding rods/fillers are suitable and safe for use in pressure systems.

Types of Inspection Performed

1. Raw Material Inspection

- Verifies Mill Test Certificates for all pipes and plates (ASTM A106, A105).
- Checks material grade stamping and visual condition for rust, cracks, and dents.

2. Dimensional Inspection

- Verifies that all pipes, flanges, fittings and assemblies are as per design drawings.
- Verifies alignment of pipes and face-to-face valve distances.

3. Welding Inspection

- Checks the quality of welded joints as per approved WPS/PQR.
- Conducts visual inspection and dye penetrant testing (DPT) for surface cracks.

4. Hydrostatic Pressure Test

- Ensure mechanical integrity and strength of the piping and skid under pressure.
- Monitor for pressure drop or leaks during the test duration.

5. Pneumatic Leak Test

- Ensure there are no gas leaks under operating pressure.
- Soap solution or calibrated leak detector is used.

6. Valve Operation & Set Pressure Verification

- Set pressure checked and validated using calibrated gauges
- Confirm auto shut-off and relief operation

7. Instrument Calibration & Tagging

- Instruments Checked: Pressure Gauges, Temperature Indicators, Pressure Transmitters
- Verified using master calibration kits
- Instruments tagged as per P&ID.

8. Coating & Painting Inspection

- Checks corrosion protection of structural parts.
- DFT (Dry Film Thickness) measurement using paint thickness gauge.

9. Final Inspection & Third-Party Certification

- Carried out by QA/QC team and/or third-party inspection agency (TPIA).
- Final checklists include:
  - Material traceability
  - Test certificates
  - Dimensional report
  - Weld & NDT reports
  - Functional test reports
  - Documented in an Inspection Test Plan (ITP)

Pre-Use Clearance (PUC) and Dispatch of PRS Skid

Once assembly and inspection of the PRS skid are complete, the unit goes through final validation, documentation and preparation for safe dispatch to the client site.

1. Pre-Use Clearance (PUC)

Objective:

To certify that the skid is fully inspected, tested, safe and ready for operation before it is dispatched.

Steps in PUC:

- **Review of Inspection Test Plan (ITP):**
  - Cross-check all inspection reports: hydrotest, NDT, dimensional, calibration.
  - Ensure compliance with design codes (ASME, PNGRB).
- **Functional Validation:**
  - Operate all valves (manual + control)
  - Confirm regulator settings
  - Slam shut valve tested for triggering at set limits
  - Instruments tested for response and display
- **Electrical & Control Panel Check:**
  - All relays, switches and indicators verified for continuity and proper wiring.
  - Earthing and IP protection confirmed.
- **Documentation Pack preparation includes:**
  - Final drawings (GA, P\&ID)
  - MTCs
  - Pressure test reports
  - Calibration certificates

- ➢ Valve test reports
  - ➢ Bill of materials (BoM)
  - ➢ Warranty and compliance documents
- **Client/TPI Approval (if applicable):**
  - ➢ Final PUC may require client or third-party inspection sign-off.
  - ➢ Any comments or hold points must be cleared.

PUC confirms the unit is ready for operation upon installation - only utility connections are needed at site.

2. Dispatch

Objective:

To ensure safe and damage-free transportation of the assembled PRS skid to the site.

Steps in Dispatch:

- **Surface Preparation:**
  - ➢ All inlet/outlet pipe end scaped and sealed with plastic or metal caps.
  - ➢ Exposed tubing and instruments covered with bubble wrap or foam.
- **Tagging & Labeling:**
  - ➢ Tag numbers as per P\&ID attached to each component.
  - ➢ Skid nameplate attached (includes Flow: 1200 SCMH, design pressure, Mfg. date, etc.)
- **Packaging & Securing:**
  - ➢ Skid fixed on a wooden pallet or MS frame for handling.
  - ➢ Shock-absorbing padding used under sensitive components.
- **Dispatch Documents Include:**
  - ➢ Invoice
  - ➢ Packing List
  - ➢ Test Certificates
  - ➢ PUC Certificate
  - ➢ Installation Manual
  - ➢ Delivery Challan

Dispatch is done under controlled conditions to prevent damage or alignment loss during transport.

Logistics:

1. Skid transported via closed truck or trailer depending on size.
2. Route survey is done for large-size skids.
3. Driver briefed for handling instructions.

Challenges faced during the project:

- **Design Integration:** Ensuring seamless integration of different skid components was difficult due to space constraints.
- **Material & Standards Compliance**: Sourcing pipes, valves and fittings according to strict ASME standards and project specs led to minor delays and required close coordination with suppliers.
- **Inspection & Testing**: Achieving defect-free welding joints and passing hydrostatic pressure tests required multiple inspection rounds and careful adherence to quality control.
- **Logistics**: Coordinating timely dispatch and transportation of the assembled skid while maintaining mechanical integrity, presented operational challenges.

Cost-Effective Design Choices

- **ERW Pipes in Non-Critical Areas**: Used IS 1239/3589 ERW pipes where allowable to reduce cost without affecting safety.
- **Manual Valves Instead of Motorized Ones**: For shut-off and bypass functions, manual ball valves were chosen over expensive actuated valves.
- **Skid Modularity**: Skid was designed to be fabricated in modules, allowing quicker on-site assembly and minimal crane handling.

Conclusion

The design and understanding of a PRS Skid with a flow capacity of 1200 SCMH has been successfully executed through this project. Every stage- from material selection and design layout to inspection, assembly and dispatch-was executed aligning with ASME, IS and PNGRB guidelines to ensure operational safety and reliability.

This project provided valuable hands-on experience with mechanical design, P&ID interpretation and quality assurance practices. Familiarity with tools such as AutoCAD further facilitated precise planning and review of system layouts. The skid is designed to be technically sound, field-deployable and cost-effective meeting industry requirements for safe and continuous gas supply.

Through this project, I gained critical insights into the complexities of industrial gas systems, the necessity of rigorous compliance and the collaborative efforts required for successful project execution. The knowledge and professional skills developed during this project will serve as a strong foundation for future endeavours in mechanical engineering and process industries.