PERFORMANCE QUALIFICATION PROTOCOL FOR NITROGEN GAS GENERATION AND DISTRIBUTION SYSTEM CAPACITY: 10 Nm^3/Hr

EQUIPMENT ID. No.	
LOCATION	**UTILITY BLOCK**
DATE OF QUALIFICATION	
SUPERSEDE PROTOCOL No.	**NIL**

PROTOCOL CONTENTS

1.0 PROTOCOL PRE -APPROVAL:

INITIATED BY:

DESIGNATION	NAME	SIGNATURE	DATE
OFFICER/EXECUTIVE (QUALITY ASSURANCE)			

REVIEWED BY:

DESIGNATION	NAME	SIGNATURE	DATE
HEAD (PRODUCTION)			
HEAD (QUALITY CONTROL)			
HEAD (ENGINEERING)			

APPROVED BY:

DESIGNATION	NAME	SIGNATURE	DATE
HEAD (QUALITY ASSURANCE)			

2.0 OBJECTIVE:

- To provide documented evidence that the **Nitrogen Gas Generation & Distribution System** is performing consistently, repeatedly and reproducibly within its established operating range and the results of all the test parameters meet the pre-defined acceptance criteria.
- To confirm the suitability of the Standard Operating Procedures for all routine activities associated with the system.

3.0 SCOPE:

- The Protocol covers all aspects of Performance Qualification for the **Nitrogen Gas Distribution & Generation System (Make- Mass Gas air Systems Pvt. Ltd.**) installed in the Utility Block at …….
- This Protocol will define the methods and documentation used to qualify the **Nitrogen Gas Distribution & Generation System** for PQ.

4.0 RESPONSIBILITY:

The Validation Group, comprising of a representative from each of the following departments, shall be responsible for the overall compliance of this Protocol cum Report:

DEPARTMENTS	RESPONSIBILITIES
Quality Assurance	• Preparation, Authorization, Approval and Compilation of the Performance Qualification. • Co-ordination with Quality Control, Production and Engineering to carryout Performance Qualification Activity. • Monitoring of Performance Qualification.
Production	• Review of Protocol. • To co-ordinate and support Performance Qualification Activity.
Quality Control	• Review of Protocol. • Analytical Support (Microbiological Testing/Analysis)
Engineering	• Reviewing of qualification protocol for correctness, completeness and technical excellence • Responsible for trouble shooting (if occurred during execution). • Maintenance & preventive maintenance as per schedule.

5.0 EQUIPMENT DETAILS:

Equipment Name	**NITROGEN GAS GENERATION & DISTRIBUTION SYSTEM**
Equipment ID No.	
Model	**PSA Based**
Manufacturer's Name	**MASS GASAIR SYSTEMS PVT. LTD.**
Supplier's Name	**MASS GASAIR SYSTEMS PVT. LTD.**
Capacity	**10Nm^3/hr.**
Outlet Pressure	**5.5 Kg/cm^2**
Place of Installation	**UTILITY BLOCK**

6.0 SYSTEM DESCRIPTION:

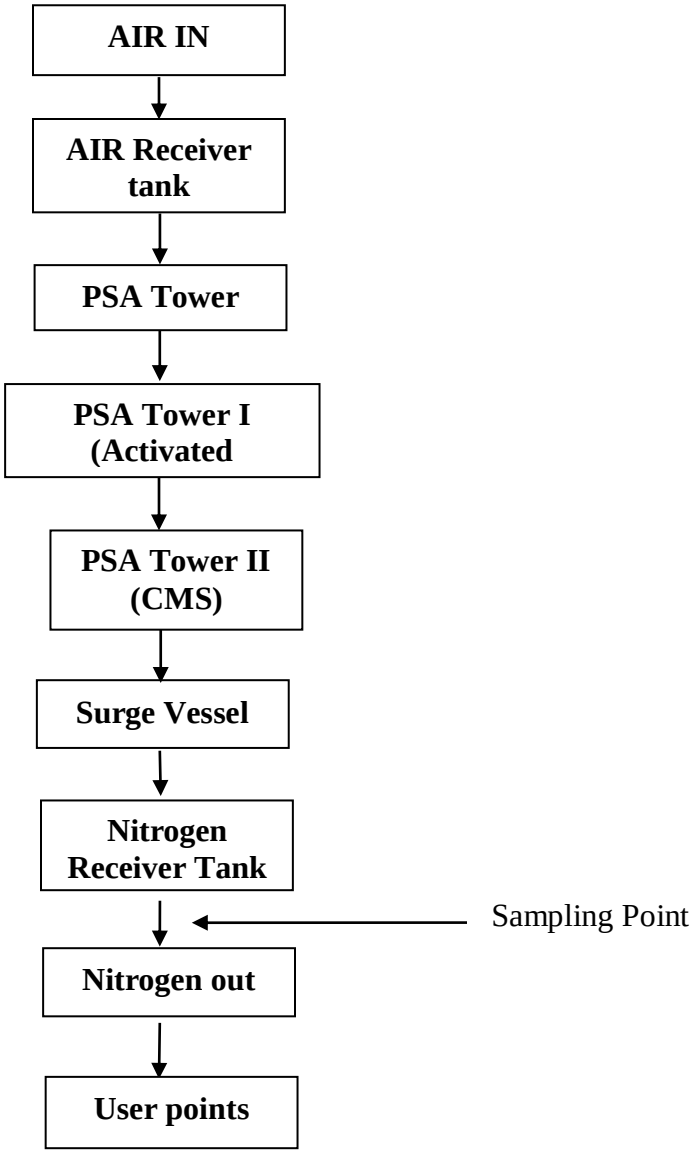
Type	**:**	**PSA BASED NITROGEN PLANT**
Capacity	**:**	**10 Nm^3/hr.**
Purity	**:**	**99.5%**
Outlet Pressure	**:**	**5.5 Kg/cm^2**
Dew Point	**:**	**(-) 40 °C**

- PSA (Pressure Swing Adsorption) Based Nitrogen Plant is to produce Nitrogen gas form Atmospheric compressed air. Air passes through Carbon Molecular Sieves (CMS) at a certain pressure, the moisture, Oxygen and CO_2 are selectively adsorbed, and balance nitrogen comes out and collects in the receiver.
- Compressed air first collects in air receiver at 7.0 kg/cm^2 pressure and then goes to PSA module through air filter module. The air receiver has been providing to avoid air pressure fluctuation so that a constant flow & pressure will available during plant operation. One high efficient air filter has been provided at the outlet of air receiver to arrest dust particles from nitrogen gas before enter in PSA module.
- This is a specially designed composite bed type PSA module having two towers filled with special grade of Activated Alumina and second generation of high efficient Carbon Molecular Sieves (CMS) to produce 99.5% pure Nitrogen. As compressed air passed through PSA module, moisture from

compressed air is adsorbed in Alumina Bed and oxygen & carbon dioxide are selectively adsorbed in CMS bed, balance Nitrogen collected in surge vessel at the outlet of PSA Module.

- Surge Vessel is a vertical, cylindrical type vertical pressure vessel. Surge vessel has been provided to collect outlet nitrogen before send to storage tank / user point.
- One Oxygen analyzer connected with this vessel to measure oxygen impurity in the product nitrogen. Nitrogen from surge vessel now goes to user point through flow meter and backpressure control valve at required flow and pressure. To avoid impure high oxygen content in nitrogen on 3-way vent valve has been provided with an interlock of oxygen analyzer. In case oxygen content high as purity limit nitrogen will vent out in the atmosphere till purity comes with in desired limit.

FLOW DIAGRAM OF GENERATION, STORAGE AND DISTRIBUTION OF NITROGEN GAS SYSTEM:



7.0 REASON FOR QUALIFICATION:

- New equipment in utility block at …….
- After completion of the Operation Qualification of the Equipments, it is imperative to perform the Performance Qualification. The study will establish that the parameters are followed, critical variables are under control and the quality of the output is, as desired.

8.0 SITE OF STUDY:

Utility Block.

9.0 FREQUENCY OF QUALIFICATION:

- Once in every two years time period.
- After any major breakdown or after major modification.
- After Change of Location.

10.0 PRE – QUALIFICATION REQUIREMENTS:

Verification for availability, completeness and approval status of all the required relevant documents shall be done and observations shall be recorded in the performance qualification report.

10.1 Verification of Documents:

Document Name	Document/SOP No.	Completed (Yes/No)	Checked By (Engineering) Sign/Date	Verified By (QA) Sign/Date
Executed and approved Design Qualification document				
Executed and approved Installation Qualification document				
Executed and approved Operational Qualification document				
SOP for operation & Cleaning of Nitrogen gas Distribution & Generation System				
SOP for Preventive Maintenance Nitrogen gas Distribution & Generation System				

10.2 Training Record of Validation Team:

- All the persons involved in the execution of qualification activity must be trained in all aspects of the qualification activity including the test methodology, acceptance criteria and safety precautions to be followed during working.
- Verify the training records and record the details in table mentioned in performance qualification report.

10.3 Calibration of Test Instruments:

- Calibration of all the instruments used for qualification should be mentioned along with Calibration Certificates.

11.0 TESTS AND CHECKS:

A. Document Verification.

B. Verification of Calibration of test instruments.

C. Performance Qualification Testing:

Performance Qualification study shall be carried out using following tests:

- **Determination of Oil Content in Nitrogen gas**
- **Determination of Moisture Content in Nitrogen gas**
- **Determination of Carbon Dioxide (CO_2) Content**
- **Determination of Carbon Monoxide (CO) Content**
- **Assay of nitrogen**
- **Determination of Oxygen Content**
- **Hydrocarbon test:**
- **Determination of Sulphur Dioxide (SO_2) Content**
- **Dew point test**
- **Determination of Nitrogen Oxide Content**
- **Sterility of Nitrogen**
- **Non-viable Particle Count**
- **System Supply Reliability Test**

List critical and non-critical user point all mentioned in the Annexure-I of this protocol. Testing for performance qualification activity shall be performed on the critical & non-critical nitrogen gas supply points which are in use as applicable and all new introduced supply points shall be enclosed as addendum to the PQ report.

Acceptance Criteria:

- DQ, IQ & OQ activity should be completed and executed, approved qualification report should be available prior to commencing the performance qualification activity.
- Calibration of all components of system should be completed prior to commencing the performance qualification activity.

- Nitrogen gas should meet the specifications for Oil content, Moisture content, CO_2, CO, Assay of Nitrogen, Oxygen content, Hydrocarbons, NO_2, Sterility, Non-Viable particle count and System Supply reliability test.

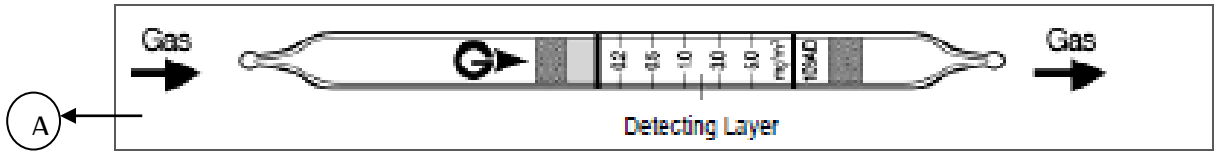
11.1 Determination of Oil Content in Nitrogen Gas:

11.1.1 Objective:

The objective of this test is to ensure that the Nitrogen Gas that is used for various processes is free from oil contaminants or such contaminants is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.1.2 Principle:

The test is performed to determine the oil content in the nitrogen gas. Test is carried out using the Gastec tubes (Oil Mist Airtec Tubes No. 109AD).



Specifications for Oil Mist (Mineral Oils) Airtec Tubes No. 109AD are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	0.2 to 5.0 mg/m^3
2.	Sampling Volume	20000 ml
3.	Sampling Rate	1 Liter per minute
4.	Sampling Time	20 minutes
5.	Colour Change	Pale Red ⟶ Pale Blue
6.	Reaction Principle	**Oil Mist + Cr^{6+} (Pale Red Color) ⟶ Cr^{3+} (Pale Blue Color)**

Measuring Procedure:

- Attach a pressure reducer with gauze and flow meter to a cylinder, or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.

- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 1000 ml per minute.
- Stop supply of nitrogen gas to the test unit.
- Break tips of Gastec tube using tube tip breaker.
- Attach the Gastec Tube to the assembly keeping the arrow showing the flow direction of air towards the flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- Record the time.
- On completion of 20 minutes stop supply of nitrogen gas to test assembly.
- Record the reading for oil content shown on the scale by pale blue color.
- Detach Gastec tube from the test assembly.

11.1.3 Acceptance Criteria:

Oil Content should be below 1 mg/m^3.

11.1.4 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system

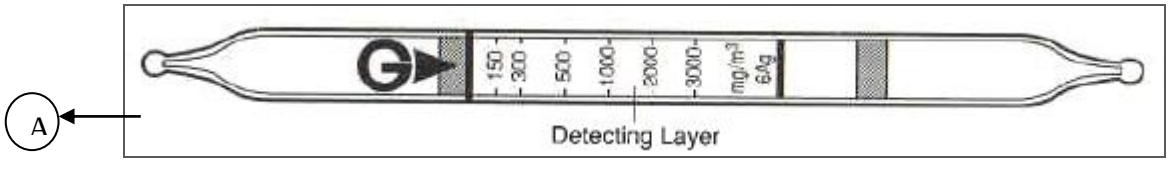
11.2 Determination of Moisture Content in Nitrogen gas:

11.2.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from water vapor or water vapor is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.2.2 Principle:

The test is performed to determine the moisture content in the nitrogen gas. Test is carried out using the Gastec tubes (Water Vapour Airtec Tubes No. 6Ag).



Specifications for Moisture Content Airtec Tubes No. 6Ag are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	20 to 80 mg/m^3
2.	Sampling Volume	500 ml
3.	Sampling Rate	100 ml per minute
4.	Sampling Time	5 minutes
5.	Colour Change	Yellow ⟶ Green
6.	Reaction Principle	**H_2O + $Mg(ClO_4)_2$ (Yellow Color) ⟶ $Mg(ClO_4)_2$ (Green Color)**

11.2.3 Measuring Procedure

- Attach a pressure reducer with gauze and flow meter to a cylinder, compressor or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.
- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 500 ml per minute.
- Stop supply of nitrogen gas to the test unit.
- Break tips of Gastec tube using tube tip breaker.
- Attach the Gastec Tube to the assembly keeping the arrow showing the flow direction of air towards the flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- Record the time.
- On completion of 1 minute stop supply of nitrogen gas to test assembly.
- Record the reading for moisture content shown on the scale by purple color.
- Detach Gastec tube from the test assembly.

11.2.4 Acceptance Criteria:

Water Vapor Content should be below 500 mg/m^3.

11.2.5 Observation

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

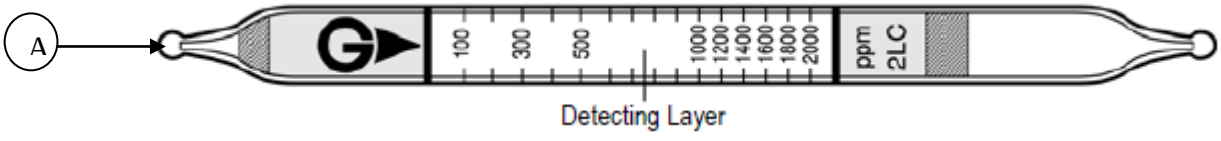
11.3 Determination of Carbon Dioxide (CO_2) Content in Nitrogen gas:

11.3.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from Carbon Dioxide (CO_2) or is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.3.2 Principle:

The test is performed to determine the Carbon Dioxide (CO_2) content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 2LC).



Specifications for Gastec Detector Tubes No. 2LC are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	100-2000 ppm
2.	Sampling Volume	100 ml
3.	Flow Rate	50 ml per minute
4.	Sampling Time	2 minutes
5.	Detecting Limit	20 ppm (n=1)
6.	Colour Change	Pale Red ⟶ Yellow
7.	Reaction Principle	**CO_2 + 2KOH (Pale Red Color) ⟶ K_2CO_3 (Yellow Color) + H_2O**

11.3.3 Measuring Procedure:

- Attach a pressure reducer with gauze and flow meter to a cylinder, compressor or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.
- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 50 ml per minute.
- Stop supply of nitrogen gas to the test unit.
- Break tips of Gastec tube using tube tip breaker.

- Attach the Gastec Tube to the assembly keeping the arrow on flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- Record the time.
- On completion of 2 minute stop supply of nitrogen gas to test assembly.
- Record the reading for Carbon Dioxide content shown on the scale by yellow color.
- Detach Gastec tube from the test assembly.

11.3.4 Acceptance Criteria:

Carbon Dioxide Content should be not more than 500 ppm.

11.3.5 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

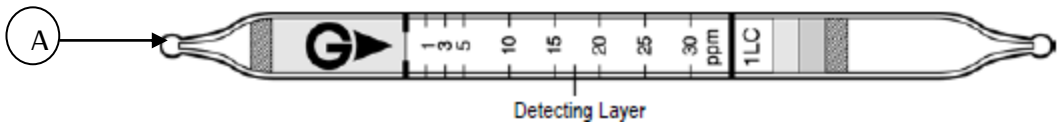
11.4 Determination of Carbon Monoxide (CO) Content in Nitrogen gas:

11.4.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from Carbon Monoxide (CO) or is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.4.2 Principle:

The test is performed to determine the Carbon Monoxide (CO) content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 1LC).



Specifications for Gastec Detector Tubes No. 1LC are as follows:

S. No.	Parameter	Specification

1.	Measuring Range	1 - 30 ppm
2.	Sampling Volume	100 ml
3.	Flow Rate	50 ml per minute
4.	Sampling Time	2 minutes per pump stroke
5.	Detecting Limit	0.5 ppm (n=1)
6.	Colour Change	White ⟶ Pale Pink
7.	Reaction Principle	**CO + Palladium salt (White) ⟶ Reaction product (Pale Pink)**

11.4.3 Measuring Procedure:

- Attach a pressure reducer with gauze and flow meter to a cylinder, compressor or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.
- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 50 ml per minute.
- Stop supply of nitrogen gas to the test unit.
- Break tips of Gastec tube using tube tip breaker.
- Attach the Gastec Tube to the assembly keeping the arrow on flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- Record the time.
- On completion of 2 minute stop supply of nitrogen gas to test assembly and wait for next 2 minutes.
- Record the reading for Carbon Monoxide content shown on the scale by pale pink color.
- Detach Gastec tube from the test assembly.

11.4.4 Acceptance Criteria:

Carbon Dioxide Content should be not more than 5 ppm.

11.4.5 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

11.5 Assay of Nitrogen:

11.5.1 Objective:

The objective of this test is to ensure that, Nitrogen Gas produced by Nitrogen Gas Generation & Distribution System is pure and as per Pharamacopeial limit.

11.5.2 Procedure:

Introduce a specimen of nitrogen into a gas chromatograph by means of a gas sampling valve. Select the operating condition of the gas chromatograph Such that the standard peak signal resulting from the following procedure corresponds to not less than 70% of the full scale reading. Use industrial grade helium (99.99%) as the carrier gas, with a thermal-conductivity detector, and control the column temperature: the peak response produced by an oxygen-helium certified standard, and equivalent to not more than 1.0% of oxygen when compared to the peak response of the oxygen-helium certified standard, indicating not less than 99.5%, by volume, of Nitrogen.

11.5.3 Acceptance Criteria:

Not Less than 99.5 % by volume of Nitrogen.

11.5.4 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

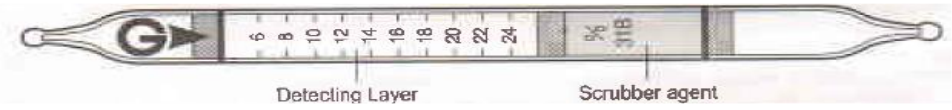
11.6 Determination of Oxygen (O_2) content:

11.6.1 Objective:

The objective of this test is to ensure that, the Nitrogen Gas contains oxygen contents within the specified limit.

11.6.2 Principle:

The test is performed to determine the Oxygen (O_2) content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 31 B).



Specifications for Gastec Detector Tubes No. 31 B are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	6 – 24%
2.	No. of pump strokes	1/2
3.	Stroke correction factor	1
4.	Sampling Time	30 seconds
5.	Detecting Limit	2% (n=1)
6.	Colour Change	Black ⟶ White
7.	Reaction Principle	**O_2 + 4$TiCl_3$ + 6H_2O (Black) ⟶ 4TiO_2 + 12 Hcl (White)**

11.6.3 Measuring Procedure:

- For checking the leakage of the pump, insert a freshly sealed detector tube into the pump. Follow instructions provided with the pump operation manual.
- Break tips off a fresh detector tube with the tube tip breaker in the pump.
- Insert the tube into the pump inlet with the arrow (G➡) on the tube pointing toward the pump.
- Make certain the pump handle is all the way in. Align the guide marks on the pump body with the guide marks on the handle.
- Pull handle out until it locks at the half pump stroke (50 ml). Wait 30 seconds and confirm that the sampling has completed.
- If the discoloration is before the first calibration mark (6%), prepare a fresh tube. Break off both ends of the tube and connect the tube to the pump. Pull the handle all the way out (100 ml) and wait until the staining stops.
- Obtain a true concentration by dividing the tube reading by two.

- Detach Gastec tube from the test assembly.

11.6.4 Acceptance Criteria:

Oxygen Content should be not more than 0.5%.

11.6.5 Observation:

11.6.6 Record the results in Performance Qualification Report for Nitrogen Gas Generation and Distribution system.

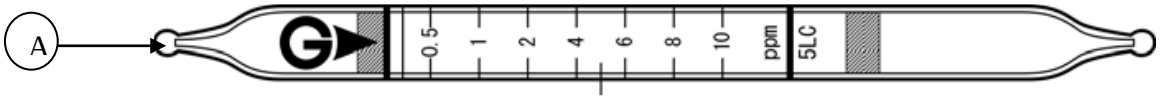
11.7 Determination of Sulphur Dioxide (SO_2) content:

11.7.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from Sulphur Dioxide (SO_2) or is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.7.2 Principle:

The test is performed to determine the Sulphur Dioxide (SO_2) content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 5LC).



Specifications for Gastec Detector Tubes No. 5LC are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	0.25 - 10 ppm
2.	Sampling Volume	200 ml
3.	Flow Rate	50 l per minute
4.	Sampling Time	4 minutes
5.	Detecting Limit	0.02 pm (n=4)
6.	Colour Change	Bluish Purple ⟶ White
7.	Reaction Principle	**$SO_2 + I_2 + H_2O$ (Bluish Purple) ⟶ $2HI + H_2SO_4$ (White)**

11.7.3 Measuring Procedure:

- Attach a pressure reducer with gauze and flow meter to a cylinder, compressor or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.
- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 50 ml per minute.
- Stop supply of nitrogen gas to the test unit & Break tips of Gastec tube using tube tip breaker.
- Attach the Gastec Tube to the assembly keeping the arrow on flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- On completion of 4 minute stop supply of nitrogen gas to test assembly.
- Record the reading for Sulphur Dioxide content shown on the scale by change in color from bluish purple to white.
- Detach Gastec tube from the test assembly.

11.7.4 Acceptance Criteria:

Sulphur Dioxide Content should be not more than 1 ppm.

11.7.5 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

11.8 Hydrocarbon test:

11.8.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from Hydrocarbon content or is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.8.2 Principle:

The test is performed to determine the Hydrocarbon content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 105).

Specifications for Gastec Detector Tubes No. 5LC are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	200 - 3000 ppm
3.	No. of Pump Strokes	1
4.	Sampling Time	1.5 minutes
5.	Detecting Limit	200 ppm (n=2)
6.	Colour Change	White ⟶ Blackish Brown
7.	Reaction Principle	Higher class hydrocarbons reduce iodine pentoxide to liberate iodine to produce blackish brown in color

11.8.3 Methodology:

- Install a reducer pressure with gauge and flow meter to nitrogen gas line and adjust the flow meter to sampling rate 100 ml/min.
- Break tips off a fresh detector tube in the tube tip breaker and ⟶ insert a tube into a tube holder. Attach the rubber tube holder to the flow meter outlet. Make certain the tube arrow on the tube pointing in a down direction.
- When breaking the tube ends, keep away from the eyes. Do not touch the broken glass tube, pieces and reagent with bare hands.
- Turn on the valve and confirm the flow meter set to 100ml/min. Pull handle all the way out until it locks on p stroke (100 ml). Wait for 1 minute. The sampling time represents the time necessary to draw the air sample through the tube. The tube must be positioned in the desired sampling area for the entire sampling time or until the flow finish indicator indicates the end of the sample.
- As soon as sampling time of 1 minute has elapsed turn off the valve and remove the tube from the tube holder and repeat the process for one more stroke. Read the color change layer immediately.
- As soon as sampling time of 1 minute has elapsed turn of the valve and remove the tube from the tube holder and then read the color change layer immediately.

- If hydrocarbon content present White to Blackish Brown.

11.8.4 Acceptance Criteria: Total CnH_{2n+2} content shall be less than 500 ppm.

11.8.5 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

11.9 Dew point test:

11.9.1 Objective:

The objective of this test is to verify that, Dew point of the nitrogen gas that is used for various processes is up to the acceptable level.

The dew point, or more precisely the dew point temperature, is the temperature at which the liquid and gaseous phases of a material present in a gas, such as water in air, are in equilibrium at a given gas pressure. In other words, the dew point temperature, or dew point, is the temperature at which the liquid water, or dew, evaporates at the same rate at which it condenses. The dew point temperature depends on the air temperature, since hotter air can hold more water vapor per unit volume than can colder

11.9.2 Equipment use: Dew Point Temperature, Digital sensor, Dry ice.

11.9.3 Methodology:

- Flush the nitrogen gas from user point for 2 minutes, before sampling.
- Put the dry ice in the chamber.
- Monitor the temperature of the sensor which must be constantly lowered by periodic addition of Dry ice.
- When the temperature reaches the dew point temperature, moisture will condense on the brightly Surface and make it cloudy.
- Record the temperature, this temperature is the dew point temperature.
- Repeat the above steps for confirmation.

11.9.4 Acceptance Criteria:

Nitrogen gas due point should not more than -40^{o}C.

11.9.5 Observation:

Record the results in Performance Qualification Report for Nitrogen Gas Generation and Distribution system.

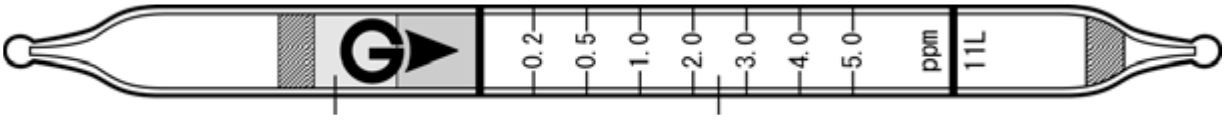
11.10 Nitrogen Oxide (NO_2) Test

11.10.1 Objective:

The objective of this test is to ensure that, the nitrogen gas that is used for various processes is free from Nitrogen Oxide (NO + NO_2) or is removed up to acceptable level from nitrogen gas during air drying and filtration stage.

11.10.2 Principle:

The test is performed to determine the Nitrogen Oxide (NO + NO_2) content in the nitrogen gas. Test is carried out using the Gastec tubes (Gastec Detector Tubes No. 11L).



Oxidising layer **Detecting Layer**

Specifications for Gastec Detector Tubes No. 11 L are as follows:

S. No.	Parameter	Specification
1.	Measuring Range	0.2 – 5.0 ppm
2.	Sampling Volume	100 ml
3.	Flow Rate	50 ml per minute
4.	Sampling Time	2 minutes
5.	Detecting Limit	0.01 ppm (n = 8)
6.	Colour Change	White →Yellowish orange
7.	Reaction Principle	$NO+Cr_6+ + H_2SO_4 \rightarrow NO_2$ NO_2 + o-Tolidine→ Nitro o-tolidine

11.10.3 Measuring Procedure:

- Attach a pressure reducer with gauze and flow meter to a cylinder, compressor or nitrogen gas line and adjust the pressure between 2.0 – 2.5 kg/cm^2 for supply of nitrogen gas to the flow meter assembly.
- Adjust the flow rate by setting knob of flow meter assembly to set the flow rate of 50 ml per minute.
- Stop supply of nitrogen gas to the test unit.

- Break tips of Gastec tube using tube tip breaker. Attach the Gastec Tube to the assembly keeping the arrow on flow meter side (Side A shown in the picture).
- Start supply of nitrogen gas to the test assembly.
- If required adjust the flow rate by setting knob of flow meter.
- Record the time.
- On completion of 2 minute stop supply of nitrogen gas to test assembly.
- Record the reading for NO_2 content shown on the scale by yellowish orange color.
- Detach Gastec tube from the test assembly.

11.10.4 Acceptance Criteria:

- Nitrogen Oxide (NO_2) should be less than 2 ppm.

11.10.5 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

11.11 Sterility of Nitrogen:

11.11.1 Objective:

Objective of this test is to ensure that, the nitrogen gas that is used in various user points should comply the test for sterility.

11.11.2 Methodology:

- Connect nitrogen gas test assembly to the nitrogen gas supply point.
- Adjust knob of assembly to set pressure of 2.0 kg/cm^2.
- Adjust knob of flow regulator to set flow rate of 1000 ml per minute.
- Stop supply of nitrogen gas to the unit.
- Remove cotton plug of flask containing nutrient media and immerge tube of assembly in the media.
- Start supply of nitrogen gas to the unit to start purging of nitrogen gas in the nutrient media.
- Perform purging of nitrogen gas through nutrient media for 2 minutes.
- On completion of purging time stop supply of nitrogen gas and close the flask containing nutrient media with cotton plug and seal by wrapping with aluminum foil.

11.11.3 Acceptance Criteria:

Testing to be performed for 05 consecutive days. No growth should be observed after completion of sterility test.

11.11.4 Observation:

Record the results in Performance Qualification Report for nitrogen gas generation and distribution system.

11.12 Non Viable Particulate Count Test:

11.12.1 Objective:

The objective of this test is to ensure that, the filtered nitrogen air at critical user points meet the specified limit for cleanliness class with respect to the level of Non viable particle count and are in line with the regulatory requirements.

11.12.2 Methodology:

Connect the particle counter to nitrogen air point with diffuser. Take one sample (one m^3) of Nitrogen air at each point.

11.12.3 Acceptance Criteria:

Acceptance Criteria for Non-viable air borne particle count

S. No.	Limit for non viable particle count monitoring for Nitrogen air.	
	Particle size	Acceptance criteria
1.	$0.5 < d \leq 1.0\ \mu$	NMT 1000/m^3 particles
2.	$1.0 < d \leq 5.0\ \mu$	NMT 10/m^3 particles

11.12.4 Observation:

Record the results in Performance Qualification Report for **Nitrogen Gas Generation and Distribution System.**

11.13 System Supply Reliability Test:

11.13.1 Objective:

The objective of this test is to ensure that, the pressure of nitrogen gas at individual user point is available as per the specified limit mentioned in the design specification.

11.13.2 Methodology:

Determine the nitrogen gas pressure at individual user points.

11.13.3 Acceptance Criteria:

0.2 to 6.5 kg/cm^2

11.13.4 Observation:

Record the results in Performance Qualification Report for N**itrogen Gas Generation and Distribution System.**

12.0 REFERENCES:

The Principle Reference is the following:

- Validation Master Plan.
- Schedule-M – "Good Manufacturing Practices and Requirements of Premises, Plant and Equipment for Pharmaceutical Products."
- WHO Essential Drugs and Medicines Policy, QA of Pharmaceuticals, Vol-2 – Good Manufacturing Practices and Inspection.

13.0 DOCUMENTS TO BE ATTACHED:

- Operation And Maintenance Manual
- Copy of Draft SOPs
- Any Other Relevant Documents

14.0 NON – COMPLIANCE:

All the Non-compliances of procedure, specifications, and sampling, analysis and documentation activities shall be monitored & recorded.

15.0 DEVIATION FROM PRE-DEFINED SPECIFICATION, IF ANY:

- In case of any deviation observed during PQ, inform to Head QA for necessary action.

- Document the deviation detail in observed deviation section.
- The Head QA will study the impact of deviation. If deviation is acceptable and it does not have an Impact on operation as well as on performance of the machine & prepare final conclusion.

16.0 CHANGE CONTROL, IF ANY:

- If any change control is required during PQ, inform to Head QA for necessary action.
- Document the details observed.
- The Head QA will study the impact of change. If change is acceptable and it does not have an Impact on operation as well as on performance of the machine & prepare final conclusion.

17.0 ABBREVIATIONS:

No.	:	Number
WHO	:	World Health Organization
QA	:	Quality Assurance
ID	:	Identification
No.	:	Number
PPQ	:	Protocol Performance Qualification
UB	:	Utility Block
PSA	:	Pressure Swing Adsorption
CMS	:	Carbon molecular sieve
Kg	:	Kilo gram
°C	:	Degree centigrade
DQ	:	Design qualification
IQ	:	Installation qualification
OQ	:	Operational qualification
Mg	:	milligram
m^3	:	meter cube
HR	:	Hour
N	:	Newton

ANNEXURE-I

LIST OF CRITICAL AND NON-CRITICAL USER POINTS

S. No.	Area/Location	Sampling Points	Critical/Non Critical
1.	Utility block	01	Non Critical
2.	Manufacturing room -1	01	Critical
3.	Manufacturing room -2	01	Critical
4.	Filtration room-1	01	Critical
5.	Filtration room-2	01	Critical
6.	Filling Room (Three Piece)	01	Critical
7.	Disinfectant preparation room	01	Critical
8.	Filling Room (Dry Powder)	01	Critical

Note:

- **Critical Points: Critical points are defined as point where the Nitrogen gas being supplied by the point is carried to direct contact with the product and has impact on the product.**
- **Non-Critical Points: Is defined as point where the nitrogen gas being supplied by the point does not come in contact with the product but used in the operating system to run the equipment.**