Pall Corporation

PALL GASKLEEN® BULK GAS PURIFIER ASSEMBLIES

With AresKleen™ Purification Materials

PG550	**PG550-MAN**
PG2400	**PG2400-MAN**
PG11000	**PG11000-MAN**

INSTALLATION / REPLACEMENT INSTRUCTIONS

Revision F: March 2014

Pall Gaskleen® Bulk Purifier Assemblies Installation / Replacement Instructions

These instructions are to be used with the following Pall Gaskleen® Bulk Purifier assemblies containing Pall AresKleen™ Purification Material:

Gaskleen® PG550 PURIFIER (0.4 µm or 3 nm filtration)
Part number: GLP9xxxxP(F)VMM4*

Gaskleen® PG2400 PURIFIER (0.4 µm or 3 nm filtration)
Part number: GLP24xxxxP(F)VMM4*

Gaskleen® PG2400 PURIFIER (0.4 µm or 3 nm filtration)
Part number: GLP24xxxxP(F)VMM8*

Gaskleen® PG11000 PURIFIER (0.4 µm filtration)
Part number: GLP110xxxxPVFM8*

Addition of (F) in the part number designates 3 nm filtration.

* Part numbers with addition of a "– MAN" designation indicates the purifier is part of a manifold. Use of a manifold allows for easy replacement of the purifier without any process interruption.

Please read all instructions carefully. Questions should be resolved prior to proceeding with the installation of any purifier. Contact Pall Corporation SLS Global Technical Support for technical assistance. Pall Gaskleen® Bulk Purifiers are engineered specifically to ensure gas consistency for high-flow specialty and inert gas purification requirements. Specific details for each type of purifier are listed in Table 1. Reference the part number of the assembly being installed to determine the appropriate conditions for the intended operation.

Table 1: Hardware

Product:	Purifier Housing Dimensions:	Purifier End Fittings:	Design Flow Rate and Maximum Allowable Working Pressure (MAWP):
PG550	Diameter = 3.00" (76 mm) Length = 7.94" (202 mm)	.25" Fixed male gasket seal*	75 slpm (2.65 scfm) 500 psig (3.45 MPa)
PG550-MAN**	Diameter = 3.00" (76 mm) Length = 7.94" (202 mm)	.25" Fixed female inlet / male outlet gasket seal*	75 slpm (2.65 scfm) 500 psig (3.45 MPa)
PG2400 (VMM4)	Diameter = 4.00" (102 mm) Length = 17.3" (439 mm)	.25" Fixed male gasket seal*	300 slpm (10.6 scfm) 500 psig (3.45 MPa)
PG2400 (VMM8)	Diameter = 4.00" (102 mm) Length = 17.3" (439 mm)	.50" Fixed male gasket seal*	500 slpm (17.6 scfm) 500 psig (3.45 MPa)
PG2400-MAN**	Diameter = 4.00" (102 mm) Length = 17.3" (439 mm)	.50" Fixed female inlet / male outlet gasket seal*	500 slpm (17.6 scfm) 300 psig (2.07 MPa)
PG11000**	Diameter = 6.00" (152 mm) Length = 29.7" (754 mm)	.50" Fixed female inlet / male outlet gasket seal*	1000 slpm (35.3 scfm) 250 psig (1.72 MPa)
PG11000-MAN**	Diameter = 6.00" (152 mm) Length = 29.7" (754 mm)	.50" Fixed female inlet / male outlet gasket seal*	1000 slpm (35.3 scfm) 250 psig (1.72 MPa)

* VCR compatible; VCR is a Swagelok Company trademark.

** Purifiers that are apart of a manifold (part numbers with -MAN) and the PG11000 are panel mounted; dimensions do not reflect end to end length of assembly with valves (reference customer drawings for assembly lengths).

Pall Gaskleen® Bulk Purifiers improve and maintain the purity of specific process gases or gas mixtures used in semiconductor manufacturing and other purity-critical applications. Purifier datasheets should be referenced for performance specifications.

IMPORTANT: Use of this equipment with other than intended gases may create potentially hazardous conditions. The process gas to be purified must correspond with the part number specified on the label attached to the purifier. Verify that purifier has the appropriate part number for its intended gas service (see Table 2 below).

Table 2: Purification Material Designations ("xxxxP" in part number) and Intended Process Gases

INP:	SIP:	FCP:
Helium (He)	Hydrogen (H_2)	Fluoromethane (CH_3F)
Nitrogen (N_2)	Methane (CH_4)	Difluoromethane (CH_2F_2)
Neon (Ne)	Ethene / Ethylene (C_2H_4)	Trifluoromethane (CHF_3)
Argon (Ar)	Ethane (C_2H_6)	Tetrafluoromethane (CF_4)
Krypton (Kr)	Propene / Propylene (C_3H_6)	Tetrafluoroethane ($C_2H_2F_4$)
Xenon (Xe)	Propane (C_3H_8)	Pentafluoroethane (C_2HF_5)
Tetrachlorosilane ($SiCl_4$) *	Butane (C_4H_{10})	Perfluoroethane (C_2F_6)
	Cyclopropane (*c*-C_3H_6)	Heptafluoropropane (C_3HF_7)
	Dimethyl Ether (($CH_3)_2O$)	Perfluoropropane (C_3F_8)
	Carbon Monoxide (CO)	Perfluorocyclobutane (C_4F_8)
	Silane (SiH_4)	
	Disilane (Si_2H_6)	
	Methylsilane (SiH_3CH_3)	
	Trimethylsilane ($SiH(CH_3)_3$)	
	Carbonyl Sulfide (COS)	

GEH4P:	SF6P:	NH3P:
Germane (GeH_4)	Sulfur Hexafluoride (SF_6)	Ammonia (NH_3)

Table 2 (continued): Purification Material Designations

CLXP:	HCLP:	OXP:
Boron Trichloride (BCl_3)	Hydrogen Chloride (HCl)	Air (CDA)
Chlorine (Cl_2)	Chlorosilanes (SiH_3Cl,	Oxygen (O_2)
Carbon Tetrachloride (CCl_4)	SiH_2Cl_2, $SiHCl_3$, and $SiCl_4$)*	Carbon Dioxide (CO_2)
Chlorosilane (SiH_3Cl)	All gases listed for use with	Nitrous Oxide (N_2O)
Dichlorosilane (SiH_2Cl_2)	OXP except Oxygen (O_2)	Inerts (see INP)
Trichlorosilane ($SiHCl_3$)	**HBRP:**	**CDAP:**
Tetrachlorosilane ($SiCl_4$) *	Hydrogen Bromide (HBr)	Air (CDA)

* Contact Pall Corporation SLS for technical assistance.

CAUTION: ***Purifiers are shipped under 5 – 15 psig argon pressure. Always wear safety glasses when removing caps.***

WARNINGS:

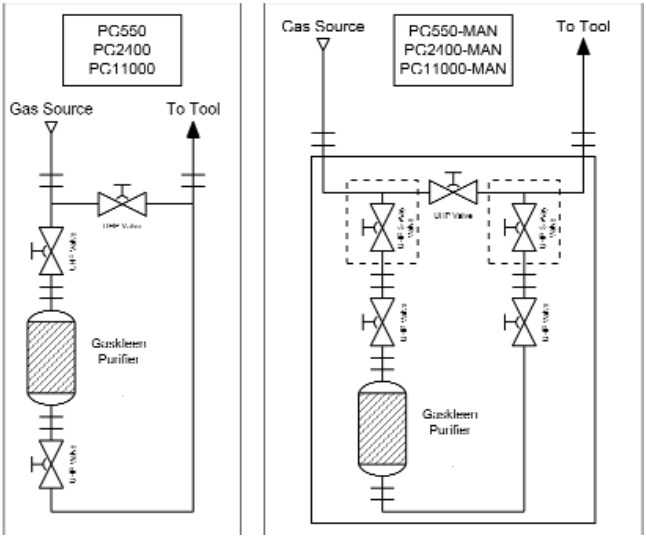
- Reaction of the purification material with large concentrations of air or water may evolve.
  - Heat and flammable gas for INP, SIP, and FCP purification materials.
  - Heat and corrosive gas for CLXP, HCLP, and HBRP purification materials.
  - Heat, flammable gas, and corrosive gas for SF6P and NH3P purification materials.
  - Heat, flammable gas, and toxic gas for GEH4P purification material.
  - Heat for OXP purification material.
- NEVER PASS PURE OXYGEN OR AIR THROUGH A PALL GASKLEEN® PURIFIER CONTAINING INP, SIP, FCP, GEH4P, SF6P, OR NH3P PURIFICATION MATERIALS.

Note: Purifier models PG2400 and PG11000 containing these materials have an aluminized label affixed to the housing which states “WARNING: Possible Burn Hazard, For Use With Substantially Oxygen-Free Process Gases Only!”

- Do not puncture the housing (or remove plug from fill port, models PG2400 and PG11000). Modification of the purifier assembly could result in contact with chemicals that may cause severe burns to the eyes and irritation of the skin (Reference Safety Data Sheets, SDS, supplied with assembly).
- Hazardous gas should never be introduced into the purifier or associated piping until a field leak test demonstrates the system is ready for service (see step 12 of this installation procedure). Pall Corporation assumes no liability for damage or injury resulting from improper installation or operation of the Gaskleen® purifier assembly. The user is ultimately responsible for equipment integrity and to comply with any applicable safety standards.

INSTALLATION PROCEDURE:

Figure 1: Flow Schematics



The schematics above show a suggested tubing arrangement for a Pall Gaskleen® Bulk Gas Purifier or Pall Gaskleen® Bulk Gas Purifier with bypass manifold. The PG550 and PG2400 models come without shut-off valves. The PG11000 model comes mounted on a panel with shut-off valves. Purifiers with bypass manifolds come with all the valves shown in the schematic. Additional gas lines and valves are necessary if the purification material requires conditioning before use (see Step 5 below).

Purifiers are supplied with an over-temperature indicator, which should be checked during installation. If the indicator turns black, contact Pall Corporation SLS for technical assistance.

INSTALLATION AND SAFETY NOTES:

- Only trained personnel should install, operate, and maintain gas control equipment.
- All compressed gases are potentially hazardous and must be handled only by trained personnel. Incorrect execution of operations can cause fire, explosion, atmospheric release of hazardous gas, or costly contamination of process equipment.
- Safety Data Sheets (SDS) for all gases and purification materials used in the facility should be available for consultation by all concerned personnel. These data sheets are obtainable from gas suppliers and Pall Corporation.
- An upstream process gas pressure regulator and pressure relief device must be installed when a potential exists for overpressurization (*i.e.* pressure surge beyond MAWP of assembly).
- For in-line purifiers (PG550 and PG2400 models) the inlet fitting must be installed finger-tight with inert gas purge flow introduced within one minute after removal of the protective cap. Delay may result in degradation of the purification material.
- For purifiers that are a part of a bypass manifold systems and the PG11000, do not at any time prior to purifier installation attempt to open manual valves or otherwise allow air to contact the purification material bed. Valves must remain closed until installation is complete and all equipment has been suitably leak tested and purged.
- Before starting a job, all personnel responsible for equipment installation or operation must fully understand the specific procedures to be accomplished and all pertinent safety considerations.

Table 3: Installation Information

Product:	Minimum Purge Gas Flow Rate:	Tools Required for Installation:
PG550	2 slpm (4.2 scfh)	.625" and .75" open-end wrenches
PG550-MAN	2 slpm (4.2 scfh)	.625" and .75" open-end wrenches
PG2400 (VMM4)	5 slpm (10.6 scfh)	Two .75" open-end wrenches
PG2400 (VMM8)	10 slpm (21.2 scfh)	0.9375" and 1.0625" open-end wrenches
PG2400-MAN	10 slpm (21.2 scfh)	0.9375" and 1.0625" open-end wrenches
PG11000	10 slpm (21.2 scfh)	0.9375" and 1.0625" open-end wrenches
PG11000-MAN	10 slpm (21.2 scfh)	0.9375" and 1.0625" open-end wrenches

1. SITE PREPARATION

- When working with components that contact process or purge gases (for example, gasket-seal connection gaskets) always wear new, clean latex gloves to prevent fingerprint contamination.
- Inspect all gasket-seal connector sealing surfaces for dirt, scratches, dents, pitting, or corrosion before assembly. Clean or replace affected connectors before assembly.
- Perform helium leak test on all affected process gas connections to ensure system is leak free prior to installing purifier. A spool piece with appropriate end connections can be used in place of the purifier for this test. If the leak test is failed, locate and repair the leak and repeat the test. Leak testing procedures are documented in SEMI F1, ASTM E 498, or ASTM E 499.
- Prior to installing purifier, purge all tubing, fittings, and components in the installation zone with inert gas (nitrogen or argon).

2. PURIFIER INSTALLATION

- Attach the purifier in a vertical orientation to a suitable interior wall or other architecturally stable element with suitable fasteners in accordance with Uniform Building Code (UBC) requirements. See product datasheet or drawings for bolting pattern. Most purifiers are not intended for exterior installation; however, bulk purifiers are often installed outdoors. Contact Pall Corporation SLS for technical assistance.
- User installation of bypass valve and piping is recommended to enable direct purging of the process gas line. When the manifold option is selected no additional piping is needed.

3. PROCESS GAS INLET AND OUTLET CONNECTIONS

- Do not remove purifier or manifold inlet and outlet gasket-seal connector terminators until immediately prior to equipment installation.
- When a purifier is used for hazardous gas purification, it must be installed within a suitable, exhausted enclosure. All connections external to the enclosure must be welded and supported in accordance with pertinent safety ordinances and regulations. Dual containment lines may be mandated for certain hazardous gases.
- Retain the inlet and outlet gasket-seal connection terminators for future use when disconnecting the purifier.
- Damage to the sealing surface may result if the gasket seal connector is over-tightened or installed without a gasket. New gaskets must be installed for each connection made (supplied with the purifier).

PG550, PG2400, and PG11000:

1. Start inert gas purge flow (Ref. Table 3, middle column) to the installation zone by opening an upstream valve. **MAINTAIN** purge gas flow until the installation of the assembly is complete.

2. If necessary, remove and dispose of existing component (or spool piece) by disconnecting fittings upstream and downstream of the component, removing the component and gaskets, and capping the component end connections. Use safety precautions appropriate for the type of process gas being purified.
3. Inspect sealing surface(s) of the gas line fittings. If damage exists, replace the fittings.
4. Attach the supplied gas-specific sticker to the aluminized label on purifier assembly (if applicable).
5. With purge gas flowing from the inlet line, remove the protective cap from the inlet of the purifier (or inlet valve for the PG11000) and immediately install the inlet gas line on the unit using a new gasket (supplied with the purifier). Tighten the nuts until finger tight.
6. Gasket seating begins when there is sudden resistance to nut rotation. Using an appropriate open-end wrench on the purifier and on the connection nut (Ref. Table 3, last column), tighten per connection make up instructions provided by the gasket seal supplier.

   Note: Gasket suppliers typically recommend that the connection nut be rotated an additional 45 degrees (⅛ turn) from the finger tight position for nickel, silver-plated nickel, or stainless steel gaskets.
7. For PG11000, slowly open inlet valve. Allow purifier to come to equilibrium with upstream gas supply pressure by introducing purge gas into the unit (Pall recommends setting the purge gas supply pressure between 30 – 60 psig, 0.21 – 0.41 MPa). Do not exceed MAWP for purifier. Once equilibrated (this may take up to 10 minutes) partially open outlet valve.

8. Remove the protective cap from the outlet end of the purifier.
9. If purge gas flow is not detected from the outlet end of the unit, increase gas pressure or flow rate until gas is detected (for the PG11000, opening the outlet valve more may be necessary to initiate purge gas flow).
10. Connect the outlet end of the purifier to the process gas delivery line leading to the equipment using a new gasket (supplied with the purifier). Tighten the nuts until finger tight and tighten the fitting as in Steps 5 and 6.
11. Open the isolation valve downstream of installation zone. Ensure the gas flow path in the outlet gas line is open to vent or scrubber.
12. Continue the flow of inert gas for 5 – 10 minutes.
13. Unit is now ready for helium leak testing.

PG550-MAN, PG2400-MAN, PG11000, and PG11000-MAN:

1. Start inert gas purge flow (Ref. Table 3, middle column) to the installation zone by opening an upstream valve. **MAINTAIN** purge gas flow until the installation of assembly is complete.
2. If necessary, remove and dispose of existing component (or spool piece) by disconnecting fittings upstream and downstream of the component, removing the component and gaskets, and capping the component end connections. Use appropriate safety precautions for the type of process gas being purified.
3. Inspect sealing surface(s) of the gas line fittings. If damage exists, replace the fittings.
4. Attach the supplied gas specific sticker to the aluminized label on purifier assembly (if applicable).

5. With purge gas flowing from the inlet line, remove the protective caps from the inlet and outlet valves on the purifier manifold and immediately install the inlet supply gas line on the unit using a new gasket (supplied with the purifier). Then, install the outlet of the unit to the process gas delivery line leading to the equipment using a new gasket (supplied with the purifier). Tighten the nuts until finger tight.
6. Gasket seating begins when there is sudden resistance to nut rotation. Using an appropriate open-end wrench on the purifier and on the connection nut (Ref. Table 3, last column), tighten per connection make up instructions provided by the gasket seal supplier.

   Note: Gasket suppliers typically recommend that the connection nut be rotated an additional 45 degrees (⅛ turn) from the finger tight position for nickel, silver-plated nickel, or stainless steel gaskets.
7. Open the isolation valve downstream of installation zone. Ensure the gas flow path in the outlet gas line is open to vent or scrubber.
8. Open bypass valve and flow gas through bypass line.
9. Close bypass valve, wait for 2 seconds, and then open bypass valve again. Repeat this procedure at least 10 times. These alternate pressurization and venting cycles will reduce impurities (atmospheric air and moisture) at the purifier inlet valve connection. This process works best if there is a flow check valve downstream of the purifier.
10. Close downstream isolation valve, then close bypass valve.
11. Open the manifold inlet valve then slowly open the purifier inlet valve. Allow purifier to come to equilibrium with upstream gas supply pressure by introducing purge gas into the unit (Pall recommends setting the purge gas supply pressure between 30 – 60 psig, 0.21 – 0.41 MPa). Do not exceed pressure rating, MAWP, for purifier. Equilibration process may take up to 10 minutes.

12. Once equilibrated, open the purifier outlet valve, the manifold outlet valve, and then the downstream isolation valve. This will initiate purge gas flow through the unit. Ensure the gas flow path in the outlet gas line is open to vent or scrubber.
13. If purge gas flow is not detected from the outlet end of the unit, increase gas pressure or flow rate until gas is detected.
14. Continue the flow of inert gas for 5 – 10 minutes.
15. Unit is now ready for helium leak testing.

4. HELIUM LEAK TESTING

Shut off system isolation valve downstream of the purifier (part of the process gas delivery line leading to the equipment), and then shut off purge gas source (via upstream isolation valve).

Testing in-line purifiers (PG550 and PG2400):

1. Supply purified helium gas to the installation zone.
2. Open upstream isolation valve at purifier.
3. Pressurize purifier with helium up to maximum rated pressure (MAWP) of unit.
4. Perform an outboard helium leak test on the purifier at the inlet and outlet gasket seal connections using a sniffer probe.
5. Should leakage be detected, contact Pall Corporation SLS for technical assistance. Do not attempt to repair purifier or valves in assembly.
6. Close upstream isolation valve at purifier.

Testing manifolded purifiers (PG550-MAN, PG2400-MAN, PG11000, and PG11000-MAN):

1. Shut off upstream and downstream isolation valves on the purifier manifold.

2. Supply purified helium gas to the installation zone.
3. Open by-pass valve (red handled) and pressurize manifold header with helium up to the maximum rated pressure (MAWP) of the unit.
4. Perform an outboard helium leak test on the valves and the inlet and outlet gasket seal connections using a sniffer probe.
5. Should leakage be detected, contact Pall Corporation SLS for technical assistance. Do not attempt to repair purifier or valves in assembly.
6. Close by-pass valve and then open upstream and downstream isolation valves on the purifier. ***Note:*** manifolded purifiers require opening of four valves (blue handled).
7. Pressurize purifier and the remainder of the manifold with helium up to maximum rated pressure (MAWP) of unit.
8. Perform an outboard helium leak test on the purifier, valves, and gasket seal connections using a sniffer probe.
9. Should leakage be detected, contact Pall Corporation SLS for technical assistance. Do not attempt to repair purifier or valves in assembly.
10. Close upstream and downstream isolation valves on the purifier manifold.

CAUTION: ***Inboard helium leak testing of the purifier is not recommended because of the possibility of contaminating the AresKleen purification material by air infiltration when returning from vacuum. Also, as shipped, Pall Gaskleen® Bulk Gas Purifiers contain trace amounts of helium due to standard manufacturing processes. A spool-piece can be used to perform an inboard helium leak test on the process lines prior to installation of the purifier. If inboard helium leak testing of the purifier is required contact Pall Corporation SLS for technical assistance.***

Following helium leak test:

1. Shut off purified helium supply and resume purge gas source (ensure that the purifier remains pressurized).
2. Depressurize the purifier of helium by opening downstream isolation valve(s) on the purifier and then system isolation valve downstream of the purifier.
3. Before the purifier reaches atmospheric pressure, open upstream isolation valve(s) on the purifier.
4. Post-purge the purifier assembly and gas line by flowing inert gas at the installation purge flow rate (ref. Table 3, middle column) for 5 – 10 minutes to displace remaining helium.

After completion of the above procedure, the purifier is ready for conditioning.

5. CONDITIONING

The purpose of the conditioning procedures is to displace inert gas used during installation of the purifier and either generate or activate certain functional groups that are chemically bonded to the AresKleen purification material. Any stray contaminants introduced during the installation procedure are also removed during the conditioning process.

WARNING:

Conditioning of purification material with reactive or corrosive gases is usually an exothermic (heat-producing) reaction. When conditioning is improperly executed, personal injury from fire or hazardous gas emissions can result. To preclude atmospheric pollution and to avoid contamination of process lines and process tool, effluent gases exiting the purifier during conditioning should be directed to a suitable scrubber. Should questions arise during conditioning, immediately interrupt process gas flow by closing the inlet and outlet valves on the purifier, then contact Pall Corporation SLS for technical assistance.

- When the purification material is initially exposed to some process gases, substantial amount of process gas may react or be adsorbed on the purification material, resulting in initially unstable purifier performance. For best results, such purification material must be conditioned with intended process gas before start up.
- The specific conditioning procedure required depends upon the nature of the process gas and the type of purification material used. Carefully follow the procedure that is provided. In particular, do not exceed the recommended process gas flow rate as overheating and damage to the purification material could result.
- Conditioning should be done after purifier installation. Conditioning is also recommended if a purifier has been out of service for two weeks or longer (especially for Intended Process Gases within Group IV). When the process gas consists of a blend of two or more gases, conditioning is recommended if the purifier has been out of service for three days or longer. Conditioning ensures that the relative percentage of the constituents remains unchanged upon passage through the purifier.
- Once the purification material is conditioned with the process gas, it should be kept under positive pressure of that process gas at all times. Should purging with an inert gas ever be required, the purification material will require conditioning again before returning to service. Consult with Pall Corporation SLS for technical assistance and recommendations.
- DO NOT subject previously conditioned purification material to a vacuum. Any hazardous gas physically adsorbed on the purification material surface may be released when the material is subjected to a vacuum. Contact Pall Corporation SLS for technical assistance with sub-atmospheric operation of purifier.

- Purification material on-site conditioning typically requires a process gas flow control and monitoring device, such as a delivery line throttling valve and a flow meter. Such components are not provided as standard equipment. The purchaser is solely responsible for obtaining and installing these components.

For conditioning, a minimum volume, V (liters), of the process gas is required. If a pure process gas (100% concentration) is used at a flow rate of F (slpm), the minimum time for gas flow, T minutes, during conditioning is given by:

T minutes = V/F

If a carrier gas is being used to dilute the process gas, then a longer conditioning time is required; the time increases proportional to the inverse of the dilution percentage (A% – percentage of active ingredient). For example, if the gas is actually a blend containing A% of the process gas, then the minimum time, T minutes, is given by:

T minutes = V/((A%/100) F)

Select the appropriate gas group by active ingredient (see following pages). Generally, the active ingredient is the Intended Process Gas as specified in the Part number of the purifier. Contact Pall Corporation SLS for technical assistance.

Table 4: Conditioning

Product and Bed Volumes:	COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E
	Min. Volume 100% Process Gas for Groups I & II	Min. Volume 100% Process Gas for Group III	Min. Volume 100% Process Gas for Group IV	Maximum Flow Rate for Groups I, II, & III	Maximum Flow Rate for Groups IV
Gaskleen® PG550, 0.6 liters (0.02 ft^3)	120 liters (4.24 ft^3)	180 liters (6.36 ft^3)	36 liters (1.27 ft^3)	10 slpm (21.2 scfh)	1.0 slpm (2.1 scfh)
Gaskleen® PG2400, 2.5 liters (0.09 ft^3)	500 liters (17.66 ft^3)	750 liters (26.48 ft^3)	150 liters (5.30 ft^3)	25 slpm (53.0 scfh)	2.5 slpm (5.3 scfh)
Gaskleen® PG11000, 11 liters (0.39 ft^3)	2200 liters (77.7 ft^3)	3300 liters (116.5 ft^3)	660 liters (23.30 ft^3)	50 slpm (105.9 scfh)	5.0 slpm (10.6 scfh)

Note: Contact Pall Corporation SLS for technical assistance with conditioning of any Gaskleen® Purifier for service in gases not listed below.

WARNING:
A purifier that has been conditioned for a particular process gas must be used for that process gas only. The AresKleen purification material is gas specific. Without prior authorization from Pall Corporation, Gaskleen® Bulk Gas Purifier assemblies purchased for one gas must not be used for any other gas.

With the exception of purifiers containing AresKleen HCLP, HBRP or CDAP material, all purifiers are supplied with an over-temperature indicator affixed to the housing. This indicator should be monitored during conditioning. If the indicator turns black discontinue conditioning by stopping flow of conditioning gas and initiating flow of inert gas, then contact Pall Corporation SLS for technical assistance. For purifiers containing HCLP, HBRP or CDAP material, the indicator is shipped in the purifier's original packaging but it is not affixed to the housing. During normal conditioning for service in HCl, HBr or CDA the temperature of the purifier may increase enough to cause the indicator to turn black. Therefore, Pall recommends that the indicator be affixed to the purifier after completion of the conditioning process.

Note: Before conditioning, verify that system is leak free and check that the contents of the gas cylinder / gas source match the intended process gas for use in the purifier (as per the product part #). If the no leaks are found and the cylinder contents are correct, then proceed with conditioning process.

Group I:

For He, N_2, Ne, Ar, Kr, Xe, H_2, CH_4, C_2H_6, *c*-C_3H_6, C_3H_8, C_4H_{10}, $(CH_3)_2O$, CO, CH_3F, CH_2F_2, CHF_3, CF_4, $C_2H_2F_4$, C_2HF_5, C_2F_6, C_3HF_7, C_3F_8, and C_4F_8 or blends of these constituent gases.

Refer to Table 4, columns A and D, for the minimum volume of process gas to flow through purifier and the maximum flow rate not to be exceeded during conditioning. As an example, condition a Gaskleen® PG2400 Purifier for H_2 service by flowing 5.0 slpm (10.6 scfh) of 100% process gas through the unit for 100 minutes.

Note: If the surface temperature of the purifier feels very warm to the touch at any time during the installation or conditioning procedure, immediately stop gas flow, recheck for leaks and recheck that the contents of the gas cylinder / gas source match the intended process gas for use in the purifier (as per the product part #). If no leaks are found and the cylinder contents are correct, then resume gas flow.

Group II:
For Air, O_2, N_2O, NH_3, CO_2, and SO_2.

Refer to Table 4, columns A and D, for the minimum volume of process gas to flow through purifier and the maximum flow rate not to be exceeded during conditioning. As an example, condition a Gaskleen® PG550 Purifier for O_2 service by flowing 2.0 slpm (4.2 scfh) of 100% process gas through the unit for 60 minutes.

Note: During the conditioning, the surface temperature of the purifier may feel warm to the touch. If the purifier feels hot, continue conditioning by reducing the gas flow rate or introducing an inert gas to create a dilute blend until the elevated temperature subsides then return to previous conditioning parameters. No damage to the purification material or purifier is expected. Once the unit has completely cooled, the purifier is ready for service.

Group III:
For HCl, HBr, CCl_4, BCl_3, Cl_2, SiH_3Cl, SiH_2Cl_2, $SiHCl_3$ and $SiCl_4$.

Slowly pressurize the purifier with 100% process gas and hold at line pressure ≥ 15 psig (0.10 MPa) for two (2) hours. Refer to Table 4, columns B and D, for the minimum volume of process gas to flow through purifier and the maximum flow rate not to be exceeded during conditioning. As an example, condition a Gaskleen® PG2400 Purifier for HCl service by

pressurizing unit with 30 psig (0.21 MPa) of HCl for 2 hours and then flowing 5.0 slpm (10.6 scfh) of 100% process gas through the unit for 150 minutes. Ensure that effluent gas during conditioning is directed to a scrubber or vent and NOT the process tool.

> **Note:** During the conditioning, the surface temperature of the purifier may feel warm to the touch. If the purifier feels hot, continue conditioning by reducing the gas flow rate or introducing an inert gas to create a dilute blend until the elevated temperature subsides then return to previous conditioning parameters. No damage to the purification material or purifier is expected. Once the unit has completely cooled, the purifier is ready for service.

For purifiers containing HCLP or HBRP material, the indicator is shipped with the assembly but is not affixed to the housing. After conditioning (*i.e.* when the housing has returned to room temperature) attach the supplied over-temperature indicator sticker to the housing where it can be easily seen.

Alternative Group III:
For SiH_3Cl, SiH_2Cl_2, $SiHCl_3$, $SiCl_4$ and BF_3.

For Group III gases, conditioning can alternately be done first with a dilute blend containing less than 20% process gas at a low flow rate. After using a dilute blend, the conditioning should be repeated using the actual (operating) blend of process gas. This two-step conditioning procedure will help prevent the generation of excess temperatures within the purifier. High temperature will not damage the AresKleen purification material but may lead to decomposition of the process gas and may cause a personnel hazard because of a hot surface.

Refer to Table 4, columns B and D. Slowly, pressurize purifier with dilute blend at ≥ 15 psig (0.10 MPa) for 2 hours (do not exceed maximum flow

rate for conditioning – column D). Then flow dilute blend gas for the minimum volume (column B) of process gas to flow through purifier and a flow rate that is ≤ the maximum flow rate not to be exceeded during conditioning. After completing the dilute blend conditioning, repeat with actual process gas concentration for an additional 200 – 300 bed volumes (Product column). If use of a dilute blend is not possible, use actual process gas concentration at a reduced flow rate (10% of value in column D). As an example, condition a Gaskleen® PG550 Purifier for SiH_2Cl_2 service by first pressurizing unit with 10% SiH_2Cl_2 blend for 2 hours. Follow this by flowing 1.0 slpm (2.1 scfh) of 10% SiH_2Cl_2 blend through the unit for 3 hours. Then switch flow to 5 slpm (10.6 scfh) of 100% SiH_2Cl_2 process gas through the unit for an additional 33 minutes.

Ensure that effluent gas during conditioning is directed to a suitable scrubber or vent and NOT to the process tool.

> **Note:** During conditioning of these Group III gases, the purifier may feel warm to the touch. If the purifier feels hot, reduce the gas flow rate or use a more dilute blend for conditioning.

Group IV:
For C_2H_4, C_3H_6, COS, SiH_4, Si_2H_6, SiH_3CH_3, $SiH(CH_3)_3$, GeH_4, SF_6, and B_2H_6.

For Group IV gases, it is strongly recommended that conditioning be done first with a dilute blend containing less than 20% process gas at a low flow rate. After using a dilute blend, the conditioning should be repeated using the actual (operating) blend of process gas. This two-step conditioning procedure will help prevent the generation of excess temperatures within the purifier. High temperature will not damage the AresKleen purification material but may lead to decomposition of the process gas and may cause a personnel hazard because of a hot surface.

Refer to Table 4, columns C and E. Slowly, pressurize purifier with dilute blend at ≥ 15 psig (0.10 MPa) for 2 hours (do not exceed maximum flow rate for conditioning – column E). Then flow dilute blend gas for the minimum volume (column C) of process gas to flow through purifier and the maximum flow rate not to be exceeded during conditioning. After completing the dilute blend conditioning, repeat with actual process gas concentration for an additional 20 – 30 bed volumes (Product column). If use of a dilute blend is not possible, use actual process gas concentration at a reduced flow rate (10% of value in column E). As an example, condition a Gaskleen® PG550 Purifier for SiH_4 service by first pressurizing unit with 10% SiH_4 blend for 2 hours. Follow this by flowing 0.5 slpm (1.1 scfh) of 10% SiH_4 blend through the unit for 72 minutes. Then switch flow to 1.0 slpm (2.1 scfh) of 100% SiH_4 process gas through the unit for an additional 18 minutes.

Ensure that effluent gas during conditioning is directed to a suitable scrubber or vent and NOT to the process tool.

Note: During conditioning of Group IV gases, the purifier may feel warm to the touch. If the purifier feels hot, reduce the gas flow rate or use a more dilute blend for conditioning.

Traces of argon may be present in effluent gas stream for some time after conditioning.

Upon completion of the above Conditioning Procedures, ensure that product label on the purifier corresponds to the process gas being used and purge all connecting lines and equipment. The Pall Gaskleen® Bulk Gas Purifier is now ready for service.

6. POST-CONDITIONING

1. Once the purifier is conditioned with a process gas, it must be left under pressure of that gas. If the process gas is subsequently purged with an inert gas, a second conditioning with the process gas may be required prior to re-use with the same process gas.

2. Conditioning may be required also if the process gas blend is replaced with a gas blend of different concentration. If a purifier in use with hydrides or gas blends has been out of service for an extended time, a purge of the purifier with 20 bed volumes (refer to Table 4, Product column) of the process gas is recommended.

3. DO NOT subject the purifier to a vacuum if material is conditioned with a toxic or corrosive gas. Release of toxic or corrosive gases may result under vacuum.

4. A purifier conditioned for a particular process gas must be used for that process gas only. The purification material is gas specific.

WARNING:

1. If a purifier has been conditioned with any gas other than an inert gas, then it must be assumed that the effluent will always contain some level of the conditioning gas (*e.g.* when a purifier is purged with inert gas prior to its removal from service).

2. Release of toxic or corrosive gases may result if care is not taken to contain or dispose of these gases properly.

7. OPERATION

In Case of Emergency

Immediate action. Should a potentially dangerous situation arise in the vicinity of the equipment, follow facility policy for shutting down equipment and evacuating personnel. If a facility policy does not exist:

1. Close the process gas cylinder or process gas source valve.
2. Evacuate all personnel from the region.

Malfunction. Should malfunction be suspected, immediately interrupt equipment operation, and then notify Pall Corporation SLS. Do not attempt to operate the equipment until it has been competently repaired and tested.

Purification material spills. Purification material spills and personnel exposure to purification material or evolved gases should be managed as recommended in pertinent Safety Data Sheets (SDS). Requisite SDS documents should be available for use at all times. If specific purification material SDS is required, contact Pall Microelectronics for a duplicate copy. SDS for process gases are obtainable from gas suppliers.

The purifier assembly is sufficiently durable to make purification material spillage most unlikely. Purification material spillage can occur only when the equipment is substantially abused or damaged.

In general, avoid breathing, ingestion, and all other bodily contact with purification material or gases. Should bodily contact with a purification material occur, immediately brush off the purification material, and then flush the affected tissues with tap water for 20 minutes. Consult a physician immediately.

8. MAINTENANCE

Depletion of Purifier

Depletion of the purification material typically is indicated when the purification material renders unacceptable impurity concentrations in the process gas delivery stream.

Depleted and partially depleted purification materials alike are classified as hazardous production materials. Accordingly, disposal of depleted or partially depleted purification material must be accomplished at an appropriate hazardous production material disposal facility only (ref. Disposal Procedure in Section 12).

9. PURGING PRIOR TO DISCONNECTING AND REMOVING PURIFIER (TYPICAL)

Neither purging equipment nor purging protocol is provided. Both remain the sole responsibility of the user. The typical protocol offered here is for "guideline" purposes only. It may need to be suitably adapted to specific applications. Should doubt exist as to whether a contemplated purging protocol is suitable, or for advice on purging equipment requirements, contact Pall Corporation SLS for technical assistance.

DANGER!

PURIFICATION MATERIAL BEDS THAT HAVE CONTACTED HAZARDOUS GASES MUST BE ADEQUATELY PURGED BEFORE DISCONNECTION

If a hazardous gas has been purified, its concentration within the purifier and associated piping must be reduced to less than the gas specific threshold limit value (TLV) prior to purifier disconnection. To accomplish this goal, purge purifier with at least the minimum

amount of inert gas shown below for each of the purifier. Monitor the effluent gas to determine when conditions are safe to remove the purifier.

Gaskleen® PG550 Purifier:
Minimum of 1,200 liters (42.4 ft^3) of inert purge gas

Gaskleen® PG2400 Purifier:
Minimum of 5,000 liters (176.6 ft^3) of inert purge gas

Gaskleen® PG11000 Purifier:
Minimum of 22,000 liters (776.8 ft^3) of inert purge gas

CAUTION: ***Maintenance personnel must be provided with suitable protective equipment.***

Even though a purifier that has served for hazardous gas purification may have been properly purged, small but dangerous amounts of process gas may nevertheless remain adsorbed to the purification material or equipment surfaces. For this reason, and to preclude potential personal injury when replacing a purifier that has served for purification of hazardous gases, personnel must be provided with suitable protective equipment.

Typical Procedure:

1. Open inlet and outlet valves on purifier.
2. For all process gases, purge the purifier with at least the minimum volume of purge gas as stated below. Ensure that effluent gas is directed to a suitable vent or scrubber and NOT to the process tool.
   - Purifiers exposed to “Intended Process Gases” listed for INP and OXP purification materials do not require purging (exceptions for $SiCl_4$, O_2, and N_2O which should be purged

with at least the minimum volume of inert gas listed above for the specific assembly being purged).

- Purifiers exposed to “Intended Process Gases” listed for SIP, FCP, NH3P and SF6P purification materials should be purged with at least the minimum volume of inert gas listed above for the specific assembly being purged (exceptions for SiH_4, Si_2H_6, SiH_3CH_3, and $SiH(CH_3)_3$ which should be purged with at least 10 times the volume of inert gas listed).
- Purifiers exposed to “Intended Process Gases” listed for CLXP, HCLP, and HBRP purification materials should be purged with at least 5 times the volume of inert gas listed above for the specific assembly being purged.

3. Reduce the pressure in the purifier by closing the inlet valve(s) on the purifier allowing the gas to vent to < 5 psig (0.03 MPa) – venting to just above atmospheric pressure is best.
4. Pressurize the purifier by closing outlet valve(s) and opening inlet valve(s) on the purifier allowing purge gas to enter the unit until the pressure is > 60 psig (0.41 MPa) – do not exceed pressure rating, MAWP, for purifier.
5. Measure the concentration of the toxic/hazardous gas in the effluent gas by suitable means, such as a toxic gas monitor.
6. Continue to vent-purge cycling the purifier by alternately performing steps 3 and 4 until the effluent no longer is hazardous.
7. Alternately, the process can be accelerated if venting (step 3) is enhanced by evacuating the purifier to a pressure of – 12 psig (– 0.83 MPa) or less; *i.e.* < 2.7 psia (< 186 millibar).

After purging, trace levels of hazardous gas in the purifier should be reduced to a level below the Occupational Safety and Health Administration (OSHA) TWA. If the concentrations cannot be

purged to the OSHA TWA, the purifier must be purged until the concentration of the hazardous/toxic gas is below the permissible OSHA Ceiling or Peak Concentration (TLV). Ensure that the hazardous/toxic gas concentration is less than the NIOSH IDLH of the gas. Specific values for each of these levels are contained within the SDS for each service gas.

TWA – Time Weighted Average
TLV – Threshold Limit Value
NIOSH – National Institute for Occupational Safety & Health
IDLH – Immediately Dangerous to Life and Health concentration
OSHA – Occupational Safety and Health Administration

After removing purifier from service install caps on end connections using new gaskets and seal gaskets to prevent any potential release of hazardous gases.

10. TROUBLESHOOTING

High Impurity Concentrations in Delivered Process Gas

Observation: Concentrations of impurities in purified process gas are greater than specified.

Possible Causes:

- Leak or equipment contamination downstream of purifier.
- Depleted purification material bed.
- Purification material bed inadequately conditioned for intended process gas.
- Purification material not suitable for removal of encountered impurities.

Excessive Heat Generated During Purification

Interpretation: The purifier assembly is uncomfortably warm to the touch while process gas is flowing through purification material. Also, purifiers are supplied with an over-temperature indicator, which should be checked periodically during normal operation. If the indicator turns black, contact Pall Corporation SLS for technical assistance.

Possible Causes:

- Major leak or equipment contamination upstream of purifier.
- Excessive impurity (perhaps water vapor) concentration in process gas supply.
- Purification material unsuitable for purification of supplied process gas. Purification material was not adequately conditioned against intended process gas.
- Wrong gas supplied to purifier.

Low Delivery Flow Rate or Pressure

Interpretation: Unable to achieve requisite process gas delivery flow or pressure.

Possible Causes:

- Clogged purifier filter, valve, purification material bed, or gas line.
- Inadequate process gas supply pressure.
- Defective valve.
- Valve operators improperly positioned
- Purifier assembly too small for application.

11. REFILL OPTION

PG2400 and PG11000 purifiers can be refilled with new purification material (not available for all intended gas types). Contact Pall Corporation Microelectronics for details and technical assistance.

Use of Pall purifiers that are a part of a manifold (PG2400-MAN and PG11000-MAN) allows for easy removal of the purifier without the need to shut down the process gas line. Closing the inlet and outlet valves on the manifold header while opening the by-pass valve allows the process gas flow through the manifold header even if the purifier and purifier inlet and outlet valves are removed. Note, process gas that bypasses the purifier will not be purified and therefore might not meet the required purity specification for downstream equipment.

12. DISPOSAL PROCEDURE

It is the customer's responsibility to dispose of the purifier in accordance with all Federal, State, and local regulations.

If the purifier is exposed to toxic gases or gases containing toxic elements, the purification material may contain these toxic materials or reaction products thereof. It may exhibit the characteristic of toxicity as defined in the hazardous waste regulations 40 CFR 261 Subpart C or D. Refer to applicable SDS for the specific toxic gas in use to determine appropriate containment and disposal requirements.

As a service to customers based in the USA, Pall Corporation has established a source for disposal information and handling of Gaskleen® Purifiers. Contact Waste Technology Service, Inc. (716)754-5400 for assistance.

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Pall Corporation

Microelectronics

25 Harbor Park Drive
Port Washington, NY 11050
+1 516 484 5400 telephone
+1 800 645 6532 toll free US
+1 516 801 9754 fax

Visit us on the Web at www.pall.com/MicroE

Pall Corporation has offices and plants throughout the world. For Pall representatives in your area, please go to www.pall.com/contact Because of technological developments related to the products, systems, and/or services described herein, the data and procedures are subject to change without notice. Please consult your Pall representative or visit www.pall.com to verify that this information remains valid.

Pall Gaskleen® purifiers comply with the applicable portions of the Pressure Equipment Directive (PED) 97/23/EC. Purifiers not carrying the CE mark comply with the directive, but do not require marking.

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