GB-K-75 and GB-K-152

Gas Booster Packages
For PPCK+ Pressure Controller/Calibrator
Operation and Maintenance Manual

This equipment described in this manual is designed and manufactured for the intended purpose of generating high pressure gas and regulating two independent gas output pressures. Certain precautions need to be followed during installation and operation of this device. Reading and understanding the material is essential to the safe and correct operation of the unit.

Pressurized equipment is potentially dangerous. The equipment described in this manual generates and controls very high gas pressures. It should not be operated by anyone who has not thoroughly familiarized themselves with this manual. Additional training in general and pressure specific safety procedures will help assure protection from harm or damage to personnel or property. Responsibility for the proper and safe operation of this instrument rests with the user.

Do not use oxygen. This instrument is not compatible with the use of oxygen. Hydrocarbon elastomers and lubricants are present.

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

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TABLE OF CONTENTS

TABLES

FIGURES

ABOUT THIS MANUAL

Manual Conventions

(CAUTION) is used in throughout the manual to identify user warnings and cautions.

(NOTE) is used throughout the manual to identify operating and applications advice and additional explanations.

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

GB-K-75 and GB-K-152 are gas booster packages intended to be used to provide the gas pressure supplies required by **DHI** PPCK+ controller/calibrators for high pressure gas.

Both models include a pneumatically driven, piston type, self-cycling gas booster with regulated output to provide the PPCK+ high pressure supply. The gas booster boosts a lower pressure (3.5 MPa minimum), generally supplied from a bottle to higher pressure. The high pressure gas is stored in an accumulator volume to assure stable supply to the PPCK+. GB-K-75 has a maximum output pressure of 50 MPa (7 500 psi) and is used with PPCK+ A3000 and A6000. GB-K-152 has a maximum output of 76 MPa (11 000 psi) and is used with PPCK+ A10000.

Both models also include an independent low pressure regulator and gauge to supply the PPCK+ drive air requirement.

With a GB-K gas booster, all of the PPCK+ pressure supply requirements are taken care of in one simple package requiring on the connection of a clean gas source of 2 MPa (300 psi) or higher clean compressed gas source and a shop air supply to power the booster.

1.2 LOCATION AND DESCRIPTION OF THE COMPONENTS

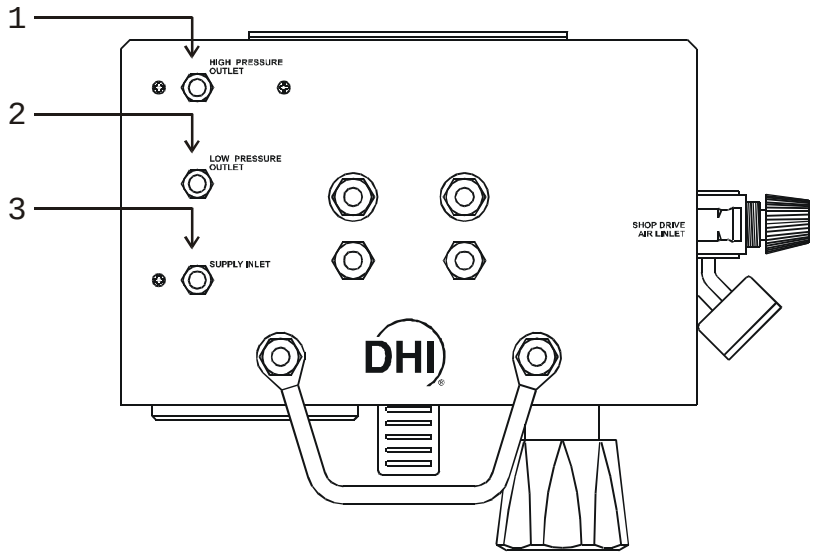


Figure 1. Pneumatic Connection Panel

PNEUMATIC CONNECTION PANEL:

1. **High Pressure Outlet Fitting:** a stainless steel DH 200 female coned end fitting used to connect the high pressure output to a point-of-use (usually the PPCK+ SUPPLY port).

> DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6.35 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc. DO NOT USE INCORRECT FITTINGS; DAMAGE TO THE FITTING AND DANGER TO THE OPERATOR COULD RESULT.

2. **Low Pressure Outlet Fitting:** a stainless steel 1/8 in. NPT female fitting used to connect the low pressure output to a point-of-use (usually the PPCK+ DRIVE IN port).

3. **Supply Inlet Fitting:** a stainless steel 1/8 in. NPT female fitting used to connect an external source of high pressure gas. This is the gas pressure that will be boosted to obtain very high pressure at the High Pressure Outlet and regulated to provide low pressure at the Low Pressure Outlet.

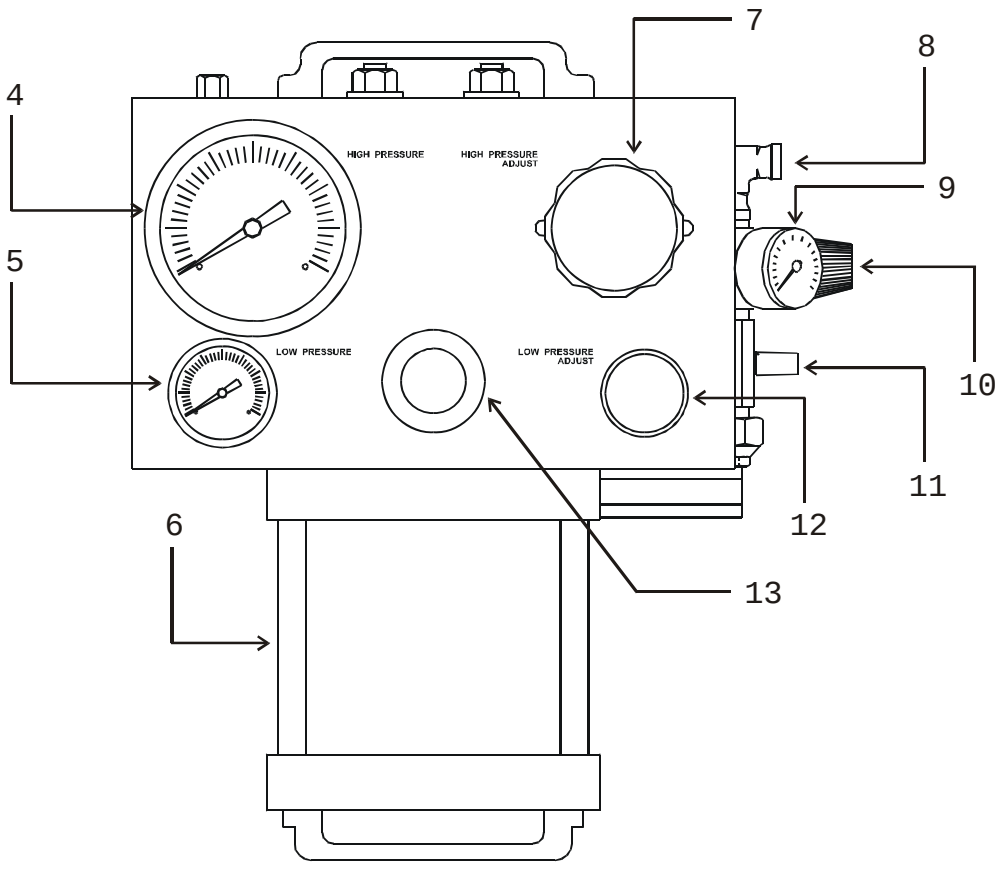


Figure 2. Control Panel

CONTROL PANEL:

4. **High Pressure Outlet Gauge:** a 4 in. (102 mm) diameter dial gauge constructed of stainless steel with a range of zero to 70 MPa (10 000 psig) or zero to 103 MPa (15 000 psig). It is used to indicate the output of the High Pressure Outlet Regulator (7).

5. **Low Pressure Outlet Gauge:** a 2 in. (51 mm) diameter dial gauge constructed of stainless steel with a range of zero to 300 psig (2 MPa). It is used to indicate the output of the Low Pressure Outlet Regulator (12).

6. **Pneumatically Operated Gas Booster Pump:** a Pascal press utilizing two pistons connected together on the same axis having a nominal area ratio of either 75:1 or 152:1. The booster is a two-stroke, single stage reciprocating pump.

7. **High Pressure Outlet Regulator:** a self-venting type regulator constructed of 303 stainless steel, Kel-F, Buna-N, and Teflon wetted materials with an outlet pressure control range of 1.5 MPa (200 psi) to 50 MPa (7 500 psig) or 76 MPa (11 000 psig).

8. **Shop Drive Air Inlet Fitting:** a brass fitting with a 1/4 in. NPT female connection.

9. **Shop Drive Air Pressure Gauge:** a 1.5 in. (38 mm) diameter dial gauge constructed of brass with a range of zero to 1.4 MPa (200 psig). It is used to indicate the output pressure of the Shop Drive Air Regulator (10).

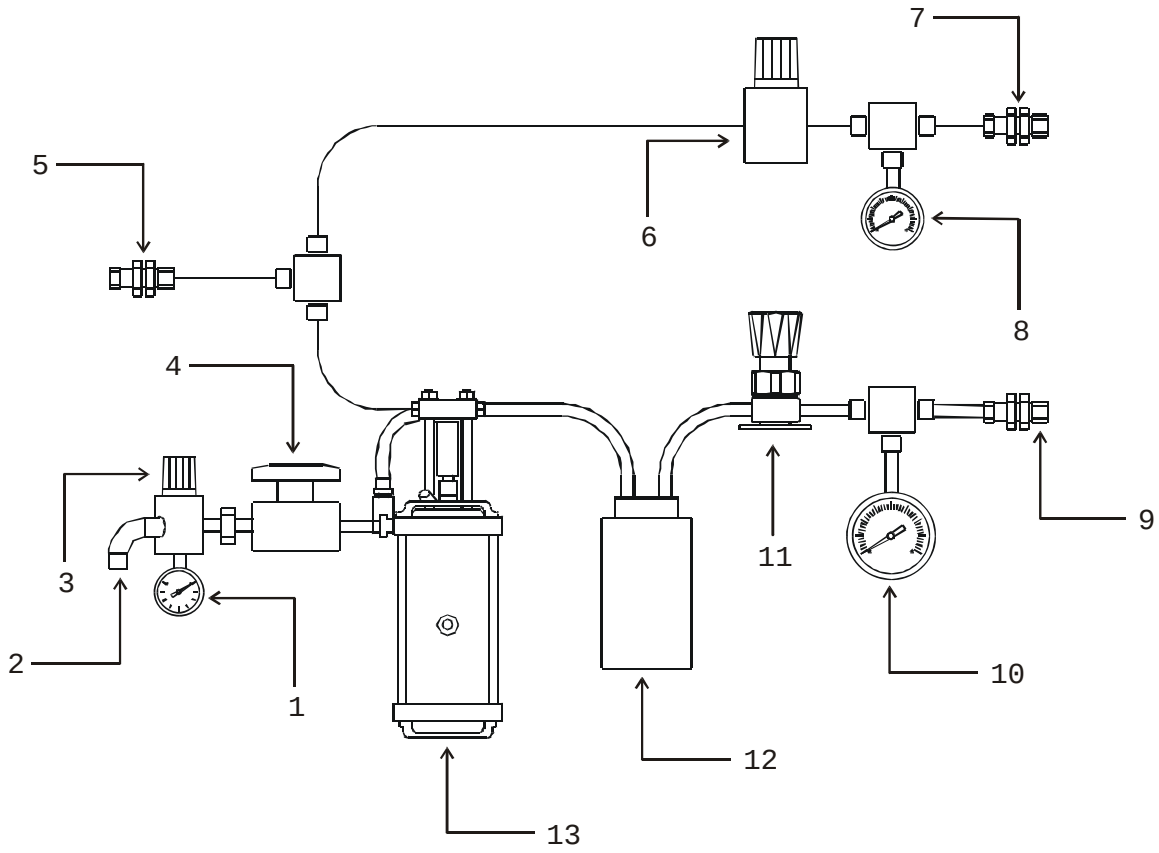
10. **Shop Drive Air Regulator:** a self-venting type regulator constructed of 316 stainless steel and nylon wetted components with an outlet pressure control range of 0.9 MPa (125 psig). Maximum supply pressure is 1 MPa (150 psig). The control knob is pulled out to make adjustments; pushed in to lock into position. To prevent accidental pressure changes the knob can easily be removed (pulled off).

11. **Shop Drive Air Shut-off Valve:** a brass ball-type, shut-off valve with a 90° full turn operation. It is used to prevent flow of shop drive air to the booster. This valves turns the booster on and off.

12. **Low Pressure Outlet Regulator:** a non-venting regulator constructed of aluminum, Viton, stainless steel and Nylatron wetted materials with an outlet pressure control range of 0.15 to 1.25 MPa (20 to 180 psig). Maximum pressure supply is 20 MPa (3 000 psig).

13. **Drive Air Exhaust Muffler:** a painted aluminum tube with vent slits, 1/2 in. NPT female connection fittings and noise reduction material inside. Used to muffle the noise of the booster drive air exhaust.

1.3 SYSTEM SCHEMATIC



1. Drive Air Gauge
2. SHOP DRIVE AIR INLET Port
3. Drive Air Regulator
4. Drive Air Shut-Off Valve
5. SUPPLY INLET Port
6. LOW PRESSURE ADJUST Regulator
7. LOW PRESSURE OUTLET Port
8. Low Pressure Outlet Gauge
9. HIGH PRESSURE OUTLET Port
10. High Pressure Outlet Gauge
11. HIGH PRESSURE ADJUST Regulator
12. Volume Cylinder (Accumulator)
13. Booster Pump

Figure 3. System Schematic

1.4 SPECIFICATIONS

Dimensions:	430 mm (17 in.) H x 355 mm (14 in.) W x 290 mm (11.5 in.) D
Weight:	18.6 kg (41 lbs)
Pressure Supply	
Pressure Range:	Shop Drive Air: 0.15 to 1 MPa (20 to 150 psi)
	High Pressure Supply Gas: 2 to 20 MPa (300 to 3 000 psi)
Supply Flow Rates:	Shop Drive Air: 425 to 2 125 slm (15 to 75 scfm)
	High Pressure Supply Gas: 140 to 560 slm (5 to 20 scfm)
Cleanliness:	Shop Drive Air: 60 micron filtration @ 20 to 50 % relative humidity
	High Pressure Supply Gas: 10 micron filtration with dew point of –20 °C
Pressure Connections:	Shop Drive Air Supply Inlet: 1/4 in. NPT female
	High Pressure Gas Supply Inlet: 1/8 in. NPT female
	Low Pressure Outlet: 1/8 in. NPT female
	High Pressure Outlet: DH 200 female (DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6.35 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc.)
Output Pressure Ranges:	Low Pressure Regulator: 0.14 to 1.2 MPa (20 to 180 psi)
	High Pressure Regulator (GB-K-75): 0.35 to 50 MPa (200 to 7 500 psi)
	High Pressure Regulator (GB-K-152): 0.35 to 86 MPa (200 to 11 000 psi)
Booster Piston Ration:	75:1 for GB-K-75
	152:1 for GB-K-152

Due to a policy of continual product improvement, all specifications are subject to change without notice.

NOTES

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

GB-K-75 and GP-K-152 are delivered enclosed in plastic film and secured by foam in place in a corrugated box. All ports are plugged, the valve is closed and pressure regulators are set to zero.

Remove the instrument from the shipping box and plastic bag. Take care not to lose or discard the accessories that are included.

Place the instrument at a convenient working height. Remove all plugs from the fittings and inspect for damage and contamination. If damage is noted, report it to your Receiving Department for appropriate action.

Inspect for any missing components or accessories using Table 1. Should any items be missing, contact **DHI** or you local supplier.

Table 1. GB-K-75 or GB-K-152 Parts List

DESCRIPTION	PART #
GB-K-75 Instrument or GB-K-152	401092 401086
Accessories including:	
1 Operation and Maintenance Manual	550082
Interconnections Kit:	401513
1 ea. Adaptor, DH200 M x 2T M (1/8 in. swage M)	400518
3 ea. Adaptor, 1/8 in. M x 2T M (1/8 in. swage M)	100319
200 cm 1/8 in. PFA tubing	101392-Z
200 cm 1/8 in. stainless steel tubing (0.125 in. x 0.055 in.)	101988-Z

2.2 SITE REQUIREMENTS

Two sources of compressed gas are required to operate the instrument: 1) shop drive air supply to power the booster; 2) high pressure gas that the booster will compress to higher pressures. Due to the different flow rate and cleanliness requirements for each of these supplies, they should come from two separate sources. It is not recommended that hazardous gases be used unless appropriate precautions are taken.

1) Shop drive air supply:

   The shop air drive supply powers the booster. The booster output is approximately 75 times the drive air supply (GB-K-75) or 152 times the drive air supply (GB-K-152).

   Shop drive air requirements are:

   Pressure:
   - For operation up to 25 MPa (3 500 psi) with GB-K-75: 0.4 MPa (60 psi) minimum
   - For operation up to 50 MPa (7 500 psi) with GB-K-75: 0.7 MPa (100 psi) minimum
   - For operation up to 50 MPa (7 500 psi) with GB-K-152: 0.4 MPa (60 psi) minimum
   - For operation up to 76 MPa (11 000 psi) with GB-K-152: 0.5 MPa (75 psi) minimum

   Flow rate:
   - 425 slm (15 scfm) minimum

   Cleanliness: Not critical, use 60 micron filter
   Humidity: 20 to 50 % RH. Do not use dry gas. Do not use hazardous gases.

2) High pressure instrument gas supply:

   High pressure instrument gas is boosted by the booster and supplied to the PPCK+ SUPPLY port. It is also regulated down and supplied to the PPCK+ DRIVE IN port.

   High pressure instrument gas supply requirements are:

   Pressure:
   - 2 MPa (300 psig) minimum, 20 MPa (3 000 psig) maximum

   Flow rate:
   - 140 slm (5 scfm) minimum

   Cleanliness: Use clean, dry instrument grade gases only. Filtration of 10 micron and moisture content of –20 °C is recommended.

2.3 INSTALLATION AND SETUP

Installation of the GB-K depends on the specific application. For a detailed description of the theory of operation see Section 3.1. Refer to Section 2.2 before attempting installation.

The orientation of the instrument is of no consequence to its operation. It may be installed vertically, horizontally or any combination of the two with no effect on performance or maintenance.

A variety of factors must be considered when determining where to locate the BP-K. Factors include, but are not limited to:

- the high pressure being generated and associated safety concerns
- the source of gas supplies (shop drive air supply and high pressure instrument gas supply)
- noise levels
- vibration during use
- access to the unit for operation of the regulators and valve
- point of use of output pressures
- vents to atmosphere

To install the GB-K, follow the steps below:

❶ Place the GB-K in the appropriate location. Use the attached mounting brackets to secure the instrument to a fixed location if desired.

Due to the reciprocating nature of the instrument, it is advised that shock mounts be used when rigidly mounting the GB-K.

❷ Close all three regulators (7), (10), and (12) by rotating the knobs counter-clockwise until no spring force is felt.

The Shop Drive Air (10) and High Pressure Outlet (7) Regulators have a stop that prevents continued counter-clockwise rotation.

The Low Pressure Outlet Regulator (12) does not have a stop and therefore will result in the removal of the knob from the body if counter-clockwise rotation is continued beyond the shut-off point.

The Shop Drive Air Regulator (10) has a locking mechanism to prevent accidental adjustment. To unlock, pull the knob up. The knob can be removed completely to make adjustment tamper resistant.

❸ Close the Drive Air Shut-off Valve (11).

❹ Connect shop drive air supply to the 1/4 in. NPTF connection (9) of the Pressure Regulator (labeled Shop Drive Air Supply on the System Schematic) using tubing rated for at least 1 MPa (150 psig) working pressure.

Maximum input pressure to the Shop Drive Air Regulator (10) is 0.9 MPa (130 psig). Pressures above this level may result in a failure that could damage the instrument and/or cause personal injury. Using connecting tubing rated for working pressures below 130 psig is not recommended.

The regulator housing is glass-filled nylon. To overtorque the Shop Drive Air Inlet Fitting (8) when connecting drive air will result in damage to the regulator housing.

❺ Connect the instrument gas supply to the 1/8 in. NPTF fitting (3 – labeled Supply Inlet on the panel) using tubing rated at 3 000 psig (20 MPa) working pressure.

Maximum input pressure to the Supply Inlet Fitting (3) is 20 MPa (3 000 psig). Pressure above this level may result in a failure that could damage the instrument and/or cause personal injury. Using connecting tubing rated below 20 MPa (3 000 psig) working pressure is not recommended.

Pressure present at the Supply Inlet Fitting (3) will be present at the inlet ports of both the High (7) and Low (12) Pressure Regulators. Instrument gas supply is not stopped at the Pneumatically Operated Gas Booster Pump (6) as may be expected. The check valves in the booster prevent flow in the reverse direction of the source flow. To prevent gas pressure from reaching the point of use, ensure the regulators are closed. See Point 2 and related NOTE above for regulator closure.

❻ Connect the 1/8 in. NPTF Low Pressure (LP) Outlet Fitting (2) to the point of use with tubing rated for at least 180 psig (1.24 MPa) working pressure.

When using the GB-K with a PPCK+ Pressure Controller/Calibrator use the hardware provided in the interconnect kit to:
- Install a 1/8 in. M x 2T (1/8 in. swage) adaptor in the GB-K Low Pressure Outlet.
- Install a 1/8 in. M x 2T (1/8 in. swage) adaptor in the PPCK+ DRIVE IN port.
- Use the desired length of 1/8 in. PFA tubing to connect the two adaptors together.

Using connecting tubing with a working pressure below 180 psig (1.24 MPa) may result in a failure in the tubing that could cause damage to the instrument and/or cause personal injury.

If the Low Pressure Outlet is not being used, plug the fitting using a 1/8 in. NPTM plug.

❼ Connect the DH 200F High Pressure Outlet Fitting (1) to the point of use with the tubing rated for at least 50 MPa (7 500) psig with GB-K-75 or 76 MPa (11 000 psig) with GB-K-152 working pressure.

When using the GB-K with a PPCK+ Pressure Controller/Calibrator use the hardware provided in the interconnect kit to:
- Install a DH200 M x 2T (1/8 in. swage) adaptor in the GB-K High Pressure Outlet.
- Install a 1/8 in. M x 2T (1/8 in. swage) adaptor in the PPCK+ SUPPLY port.
- Use the desired length of 1/8 in. stainless steel tubing to connect the two adaptors together. Be sure to very carefully clean the tube ends of metallic particles if the tube is shortened.

Using connecting tubing with a working pressure below the maximum rated output pressure may result in a failure in the tubing that could cause damage to the instrument and/or cause personal injury.

If the High Pressure Outlet is not being used, plug the fitting.

❽ If the shop drive air used to operate the GB-K is to be vented to a location other than where the booster is being used or if the noise levels are to be reduced, proceed as follows:

- ⓐ Remove the Drive Air Exhaust Muffler (13). The Drive Air Exhaust Muffler (13) and booster exhaust port are both 1/2 in. NPTF connected via a 1/2 in. NPT nipple. Therefore, the fitting available for connection is a 1/2 in. NPT male (when using the nipple) or female (when not using the nipple).

- ⓑ Connect a hose with an I.D. of at least 1/2 in. (13 mm) and maximum length of 50 ft. (16 meters) to the booster fitting (1/2 in. NPT male or female). A hose length of greater than 50 ft (16 meters) can be used provided the I.D. of the hose is increased.

- ⓒ Connect the loose end of the hose to an appropriate termination point.

NOTES

3. OPERATION

3.1 GENERAL OPERATING PRINCIPLE AND INFORMATION

Numerical references in this section refer to Figure 2.

The purpose of the GB-K is to provide two independent, regulated gas pressure outputs: 1) a low pressure that is regulated down directly from the instrument high pressure gas supply; 2) a very high pressure that is generated by the unit. The unit generates high pressure using a Pneumatically Operated Gas Booster Pump (6), a Shop Drive Air Shut-off Valve (11), an accumulator volume (not labeled), regulators (7), (10), (12), and gauges (4), (5), (9). Fittings on an attached panel provide ports for supply input (3) and pressure outputs (1), (2). The system is contained in one compact unit and is ready to operate once gas supplies are connected.

3.1.1 PNEUMATICALLY OPERATED GAS BOOSTER PUMP (6)

The booster pump is a Pascal press utilizing two pistons connected together on the same axis having a normal area ration of 75:1 or 152:1. The booster is a two-stroke, single stage reciprocating pump that generates gas pressures 75 or 152 times greater than the shop drive air applied to the pump.

The pump operates automatically, provided shop drive air is supplied to the Shop Drive Air Regulator (10) and the regulator is set to at least 140 kPa (20 psig). Operation is continuous until the outlet pressure is 75 (GB-K-75) or 152 (GB-K-152) times the shop drive air pressure. At this point, the opposing forces within the pump reach equilibrium and the pump stalls. For example, using a GB-K-75 with the shop drive air pressure set to 0.35 MPa (50 psig), the pump will run until the instrument gas pressure in the high pressure chamber reaches 75 x 0.35 = 26.3 MPa (3 750 psig).

1. The Shop Drive Air section (low pressure) consists of a piston, cylinder, air cycling valve, pilot valve and vent section. This section provides the reciprocating action and compression force needed to operate the booster and generate the high pressure gas. Drive air is channeled to the appropriate side of the piston (compression or suction stroke) by the air cycling valve. When the piston reaches full stroke, a pilot valve is mechanically activated causing the air cycling valve to change position. Shop drive air is routed to the opposite side of the piston reversing piston direction where a second pilot valve is activated repeating the process.

2. The instrument gas section (high pressure) consists of a small piston and an inlet/outlet check valve assembly. The small piston moves forward and backward with the air drive piston. During the suction stroke (backward movement), the outlet check valve closes and the inlet check valve opens letting instrument gas enter the compression chamber. During the compression stroke, the inlet check valve closes and the outlet check valve opens letting compressed gas out of the pump.

   The compression ratio of the high pressure piston is 25:1 (for both models). Maximum output pressure is limited by the instrument gas supply pressure. For example, with 2 MPa (300 psi) applied, maximum output pressure cannot exceed 2 x 25 = 50 MPa (7 500 psi).

3.1.2 VALVE

The shut-off valve is a ball-type, 90° turn valve. It is used to prevent flow of shop drive air to the pump which shuts off the booster. This valve can be considered a booster ON/OFF switch.

3.1.3 VOLUME CYLINDER (ACCUMULATOR)

The volume cylinder is a stainless steel chamber with an internal volume of about 50 cc. Two fittings on the front face of the chamber provide inlet and outlet connections. It is used to dampen pressure fluctuations during the reciprocating action of the pump and to provide a reservoir of high pressure compressed gas.

3.1.4 REGULATORS

Three regulators are used in the system for control of the Shop Drive Air, Low Pressure Outlet and High Pressure Outlet pressures.

All regulators should be adjusted in the increase direction due to hysteresis in the regulators. Should a regulator be adjusted from a higher pressure to a lower pressure, once gas begins to flow in the regulator the pressure ultimately set will be lower than that initially set. To avoid this situation, set the initial pressure below the setpoint then adjust the regulator up to the final setpoint.

1. The Shop Drive Air Pressure Regulator (10) is constructed of 316 stainless steel and nylon wetted components. It is a self-venting type regulator with an outlet pressure control range of 0 to 0.86 MPa (125 psig). Maximum inlet pressure is 1 MPa (50 psig). The control knob is pulled out to make adjustments; pushed in to lock into position and prevent accidental changes. It can also be pulled off for tamper resistance.

2. The Low Pressure Outlet Regulator (12) is constructed of aluminum, Viton, stainless steel and Nylatron wetted materials. It is a non-venting type regulator with an outlet pressure control range of 0.15 to 1.25 MPa (20 to 180 psig). Maximum inlet pressure is 20 MPa (3 000 psig).

3. The High Pressure Outlet Regulator (7) is constructed of 303 stainless steel, Kel-F, Buna-N, and Teflon wetted materials. It is a venting type regulator with an outlet pressure control range of 1.5 to 50 MPa (200 to 7 500 psig) or 2 to 76 MPa 300 to 11 000 psig. Maximum inlet pressure is equal to the maximum outlet pressure.

3.1.5 GAUGES

There are three gauges in the unit used to indicate the Shop Drive Air Pressure, Low Pressure Outlet and High Pressure Outlet settings.

1. The Shop Drive Air Pressure Gauge (9) is constructed of brass and is 1.5 in. (38 mm) in diameter with a range of 0 to 1.38 MPa (200 psig). It is used to indicate the output pressure of the Shop Drive Air Regulator (10) supplying gas to the air drive section of the gas booster pump.

2. The Low Pressure Outlet Gauge (5) is constructed of stainless steel and is 2 in. (51 mm) in diameter with a range of 0 to 2 MPa (300 psig). It is used to indicate the output of the Low Pressure Outlet Regulator (12).

3. The High Pressure Outlet Gauge (4) is constructed of stainless steel and is 4. in (102 mm) in diameter with a range of 0 to 70 MPa (10 000 psig) or 0 to 103 MPa (15 000 psig). It is used to indicate the output of the High Pressure Outlet Regulator (7).

3.2 SETTING LOW PRESSURE OUTPUT

All previous sections (especially Section 2.3) should be read, understood and instructions completed before continuing.

It is not necessary to open the Shop Drive Air Shut-off Valve (11) when using the low pressure circuit. The gas booster pump is not used for generating these pressures.

All regulators should be adjusted in the increase direction due to hysteresis in the regulators. Should a regulator be adjusted from a higher pressure to a lower pressure, once gas begins to flow in the regulator the pressure ultimately set by the regulator will be lower than that initially set. To avoid the situation, set the initial pressure below the setpoint then adjust the regulator up to the final setpoint.

3.2.1 INCREASING PRESSURE

❶ Close the Low Pressure Outlet Regulator (12) by rotating the knob counter-clockwise until no spring force is felt. The Low Pressure Outlet Regulator (12) does not have a stop and therefore will result in the removal of the knob from the body if counter-clockwise rotation is continued beyond the shut-off point.

❷ Apply instrument gas to the supply inlet.

Ensure the supply does not exceed 20 MPa (3 000 psi). Pressures above this range may result in a failure that could damage the instrument and/or cause personal injury.

❸ Close or plug the low pressure outlet circuit to prevent gas flow (circuit is dead ended).

❹ Adjust the Low Pressure Outlet Regulator (12) by rotating the knob clockwise until the desired pressure is indicated on the Low Pressure Outlet Gauge (5).

To correctly set the pressure, gas flow must not occur. If flow is present in the circuit when the regulator is adjusted, the pressure will increase when flow is reduced. If the setpoint is exceeded see Section 3.2.2.

3.2.2 DECREASING PRESSURE

The Low Pressure Outlet Regulator (12) is a non-venting type. It is not possible to regulate pressure down without gas flow through the regulator.

❶ Open the low pressure circuit to atmosphere to allow a slow gas flow through the regulator. The amount of flow through the circuit should not be greater than the regulator's ability to flow gas. If this occurs, a flow related pressure drop will be created across the regulator resulting in erroneous pressure settings.

❷ Adjust the Low Pressure Outlet Regulator (12) by rotating the knob counter-clockwise until a pressure below the setpoint is achieved.

❸ Close the low pressure circuit to prevent gas flow through the regulator.

❹ Adjust the regulator by rotating the knob clockwise until the desired pressure is indicated on the low pressure gauge.

3.3 SETTING HIGH PRESSURE OUTPUT UP TO SUPPLY PRESSURE

All previous sections (especially Section 2.3) should be read, understood and instructions carried out before continuing.

It is not necessary to operate the gas booster pump when setting pressures up to the value of the source. The gas booster pump will not stop the flow of gas to the input of the Low Pressure and High Pressure Regulators. Source pressure is always present at the inlet of the regulators whenever it is supplied to the GB-K.

3.3.1 INCREASING PRESSURE

❶ Close the High Pressure Outlet Regulator (7) by rotating the knob counter-clockwise until no spring force is felt.

❷ Apply instrument gas to the supply inlet.

Ensure the supply does not exceed 20 MPa (3 000 psi). Pressures above this range may result in a failure that could damage the instrument and/or cause personal injury.

❸ Plug the high pressure outlet circuit to prevent gas flow (circuit is dead ended).

❹ Adjust the High Pressure Outlet Regulator (7) by rotating the knob clockwise until the desired pressure is indicated on the High Pressure Outlet Gauge (4). To correctly set the pressure, gas flow must not occur. If flow is present in the circuit when the regulator is adjusted, the pressure will increase when flow is reduced. If the setpoint is exceeded, see Section 3.3.2.

3.3.2 DECREASING PRESSURE

The High Pressure Outlet Regulator (7) is a venting type. Therefore, it is possible to regulate pressure down without gas flow through the regulator.

❶ Adjust the pressure down using the High Pressure Outlet Regulator (7) by rotating the knob counter-clockwise until a pressure below the setpoint is achieved as indicated on the High Pressure Outlet Gauge (4).

❷ Set the pressure to the final setpoint by rotating the knob clockwise until the desired pressure is indicated on the High Pressure Outlet Gauge (4).

3.4 SETTING HIGH PRESSURE OUTPUT ABOVE SUPPLY PRESSURE

All previous sections (especially Section 2.3) should be read, understood and instructions carried out before continuing.

Emergency shut-down of the gas booster pump can be performed at any time by closing the Shop Drive Air Shut-off Valve (11). This will prevent further generation of gas pressure by the pump but WILL NOT NECESSARILY reduce pressure to high pressure point-of-use.

All regulators should be adjusted in the increase direction due to hysteresis in the regulators. Should a regulator be adjusted from a higher pressure to a lower pressure, once gas begins to flow in the regulator the pressure ultimately set by the regulator will be lower than that initially set. To avoid this situation, set the initial pressure below the setpoint, then adjust the regulator up to the final setpoint.

3.4.1 SETTING BOOSTER DRIVE PRESSURE

❶ Close the Shop Drive Air Shut-off Valve (11).

❷ Close the High Pressure Outlet Regulator (7) by rotating the knob counter-clockwise until no spring force is felt.

❸ Calculate the required shop drive air pressure needed to generate the desired high pressure. (Shop drive air is used to operate the booster pump.) To calculate the appropriate regulator setting: divide the booster ratio (either 75 or 152) into the desired maximum output pressure. For example, using the Model GB-K-75 with a requirement of maximum output pressure of 40 MPa (6 000 psi), divide 75 into 40. This yields 0.5 MPa (80 psig) which is the pressure setting that should be made to the Shop Drive Regulator (10). For Model GB-K-152, perform the calculation substituting 152 for 75.

It is often desirable to have a pressure setting to the inlet of the High Pressure Outlet Regulator (7) that is in excess of that required. The primary benefit is a minimal fluctuation of the supply pressure to the inlet of the High Pressure Regulator. Minimizing this fluctuation provides better stability of the output. This is especially important when working near the regulator's set output pressure. The disadvantage is that an overpressure condition could occur at the test should the regulator fail to open or if the operator improperly sets the pressure. It is normally recommended that the shop drive air pressure be set 10 to 20 % above the calculated value.

Pressure supply to the PPCK+ SUPPLY port should be about 5 % higher than the maximum range of the PPC2+.

❹ Adjust the Shop Drive Air Regulator (10) by rotating the knob clockwise until the desired pressure is indicated on the Shop Drive Air Pressure Gauge (9).

Maximum shop drive pressure should not exceed 0.9 MPa (130 psig). Pressures in excess of this range may result in an overpressure condition on the inlet side of the High Pressure Outlet Regulator (7).

❺ Open the Shop Drive Air Shut-off Valve (11). The booster will begin operating when the valve is opened. Exhausting gas noise may startle the operator. Be prepared for this operation.

3.4.2 INCREASING PRESSURE

❶ Close or plug the high pressure outlet circuit to prevent gas flow (circuit is dead ended).

❷ Adjust the High Pressure Outlet Regulator (7) by rotating the knob clockwise until the desired pressure is indicated on the Low Pressure Outlet Gauge (5). To correctly set the pressure, gas flow must not occur. If flow is present in the circuit when the regulator is adjusted, the pressure will increase when flow is reduced.

3.4.3 DECREASING PRESSURE

The High Pressure Outlet Regulator (7) is a venting type. Therefore, it is possible to regulate pressure down without gas flow through the regulator.

❶ Adjust the pressure down using the High Pressure Outlet Regulator (7) by rotating the knob counter-clockwise until a pressure below the setpoint is achieved as indicated on the High Pressure Outlet Gauge (4).

❷ Set the pressure to the final setpoint by rotating the knob clockwise until the desired pressure is indicated on the high pressure gauge.

NOTES

4. MAINTENANCE AND ADJUSTMENTS

4.1 MAINTENANCE

GB-K gas booster packages require no standard maintenance or adjustments.

NOTES

5. TROUBLESHOOTING

5.1 GENERAL INFORMATION

Numerical references in this section refer to Figure 2.

The GB-K consists of a Pneumatically Operated Gas Booster Pump (6), a valve, a volume cylinder, three regulators, three pressure gauges and various tubing and fittings. Several predictable problems can arise and are addressed in this section.

It is recommended that whomever performs the following troubleshooting procedures described in this section become familiar with the system. Please see the introductory WARNING, Section 2.3, Section 3.1, Figures 1 ~ 3 for important information.

For problems not covered in this section or direct technical assistance, please contact a **DHI** Authorized Service Center (see Section 6).

5.2 BOOSTER WILL NOT RUN

The booster is a pneumatically operated pump. The reciprocating action is caused by an imbalance of forces within the pump due to the opposing drive air pressure and the instrument gas supply that is being boosted. If the booster is not operating, it means that all forces are equal or that the pistons are seized.

- Check that the Shop Drive Air Shut-off Valve (11) is open. If not, fully open the valve.
- Check that shop drive air pressure supply is actually present at the Shop Drive Air Inlet Fitting (8). If not, ensure gas is supplied at the proper pressure and flow value (see Section 2.2).
- Check that the Shop Drive Air Regulator (10) is set to a pressure of 0.15 MPa (20 psig) or higher and that minimum flow requirements are met (see Section 2.2).
- Check that the High Pressure Outlet Regulator (7) is not closed. If closed, set it to the desired pressure; see Section 3.3 or Section 3.4.
- Check that there are no gas leaks in the shop drive air circuit. Repair any existing leaks.

- Check that gas is not continuously venting from the exhaust muffler. If gas is venting through the muffler, see Section 5.8.

- Check that the booster is not in a stall state. If booster is stalled, determine reason and remedy. A stall state will occur when the pressure in the high pressure section of the booster is equal to the pressure in the low pressure section times the ratio (75:1 or 152:1). A stall can only occur if the high pressure circuit is plugged. See Section 3.1.1 and Figure 3 for additional information on the gas booster.

If the above suggestions do not result in proper operation of the booster, contact a **DHI** Authorized Service Provider (see Section 6).

5.3 BOOSTER RUNS TOO SLOWLY

A slow running booster can be confused with Section 5.4. A slow running booster means that the pump itself is running slowly which also causes the pressure to be generated slowly.

- Check that Shop Drive Air Shut-off Valve (11) is fully open. If not, open valve fully.

- Check that the Shop Drive Air Regulator (10) is set to a pressure of 0.15 MPa (20 psig) or higher and that minimum flow requirements are met (see Section 2.2).

- Check there are no restrictions in the shop drive air supply circuit. Remove any existing restrictions. If a filter is installed on the shop drive air circuit, it may cause a flow restriction.

- Check that there are no leaks in the shop drive air circuit. Repair any existing leaks.

If the above suggestions do not result in the proper operation of the booster, contact a **DHI** Authorized Service Provider (see Section 6).

5.4 PRESSURE GENERATES TOO SLOWLY OR NOT AT ALL

A slow running booster will cause the pressure to be generated slowly. Ensure the booster is running properly before continuing; see Section 5.3.

- Check that the instrument gas (high pressure) supply is not below 2 MPa (300 psi). If the supply is too low, increase supply pressure. Speed of pressure generation is directly related to the pressure of the supply instrument gas. For example, pressure will be generated twice as fast with the instrument gas supply is at 14 MPa (2 000 psi) than with the supply at 7 MPa (1 000 psi).

- Check that there are no restrictions in the instrument gas supply line to the booster. If a restriction exists, remove it. Restriction may be a valve not fully opened, a regulator with a low flow constant (CV), an inline filter, small diameter tubing, etc.

- Check that there are no leaks in the high pressure line from the output of the booster at the outlet check valve to the point-of-use. Repair any existing leaks.

- Check that the inlet and outlet check valves in the high pressure booster piston are operating properly. Close the Shop Drive Air Shut-off Valve (11). Adjust the High Pressure Outlet Regulator (7) to zero pressure by rotating the knob counter-clockwise until no spring force is felt.

  Open the Shop Drive Air Shut-off Valve (11). The booster should cycle several times then stall. If the booster does not stall when the instrument gas supply pressure is above 2 MPa (300 psi) and the shop drive air pressure is below 0.5 MPa (75 psig) for GB-K-75 or 0.25 MPa (40 psig) for GB-K-152, the check valves are the most likely cause. Contact a **DHI** Authorized Service Provider if the booster continues to run.

5.5 BOOSTER CONTINUOUSLY RUNS

The booster is a pneumatically operated pump. The reciprocating action is caused by an imbalance of forces within the pump due to the opposing drive air pressure and the high pressure instrument gas supply that is being boosted. If the booster runs continuously, it means that forces do not equalize.

- Check that the instrument gas supply is present at the Supply Inlet Fitting (3) and that minimum pressure is 2 MPa (300 psi). If not, ensure that supply meets required specifications.

- Check that the high pressure circuit is not open to atmosphere.

- Check that there are no leaks in the high pressure line from the output of the booster at the check valve to the point-of-use. Repair any leaks. If shop driver air supply pressure is above 0.5 MPa (75 psig) for GB-K-152 or 0.25 MPa (40 psig) for GB-K-152, adjust to below this limit. If booster stops running, increase instrument gas supply.

- Check that the inlet and outlet check valves in the high pressure booster piston are operating properly. Close the Shop Drive Air Shut-off Valve (11). Adjust the High Pressure Outlet Regulator (7) to zero pressure by rotating the knob counter-clockwise until no spring force is felt.

- Open the Shop Drive Air Shut-off Valve (11). The booster should cycle several times then stall. If the booster does not stall when the instrument gas supply pressure is above 2 MPa (300 psi) and the shop drive air pressure is below 0.5 MPa (75 psig) for GB-K-152 or 0.25 MPa (40 psig) for GB-K-152, the check valves are the most likely cause. If the booster does not stall, contact a **DHI** Authorized Service Provider.

5.6 CANNOT ACHIEVE PRESSURE (LP & HP)

5.6.1 LOW PRESSURE

Maximum output pressure of the Low Pressure Outlet Regulator (12) is 1.25 MPa (180 psi).

- Check that instrument gas supply is set above 2 MPa (300 psi).

- Check that no leaks exist in the pressure circuit from the instrument gas supply to the point-of-use. Repair any leaks.

5.6.2 HIGH PRESSURE

- Check that the instrument gas supply is set above 2 MPa (300 psi) (the minimum value). In some cases, the minimum pressure supply is 4 MPa (600 psi). When in doubt, increase instrument gas supply to 4 MPa (600 psi).

- Check that shop drive air is set at the correct value (depending on model) and that it is supplied to the booster. See Section 3.4.1.

- Check that no leaks exist in the pressure circuit from the instrument gas supply to the point-of-use. Repair any leaks.

5.7 LEAKS

Pressure leaks are the most common problem found in pressure handling equipment. Normally the first step is to determine if the leak is within the GB-K or outside of the unit.

To determine if the leak is within the unit, you must disconnect it at the OUTLET port and plug it. Establish similar conditions under which the leak was observed and determine if the leak is still present. For small leaks, it may be necessary to install an appropriate pressure sensing device at the OUTLET port. In some cases, it is useful to perform simple leak checks on the most common outside sources before disconnecting the test system. Note that leaks inside the GB-K are unusual unless there has been some disassembly.

Because of the close fitting components and short tubing runs, some users may find it beneficial to return the GB-K to a **DHI** Authorized Service Provider for repair rather than performing the troubleshooting and repair themselves (see Section 6).

More than one leak can exist in a system. Fixing one leak does not guarantee a leak tight system. Therefore, continue executing the troubleshooting procedures until all leaks are located and corrected. Since it is impractical to produce a troubleshooting guide that will cover every conceivable leak, the source of your leak may not be covered in this guide.

The following procedures may require you to tighten a leaking fitting. There are two precautions that need to be observed when doing this:

- Never tighten a fitting while it is under pressure. If pressure is in the system and the fitting should fail while tightening it, you or those around you may be injured.

- Do not over-torque the compression-type fittings that are inside the GB-K. To do so will damage them requiring their replacement.

Check all fittings and components for leaks. Use leak detection fluid for small leaks. Tighten loose fittings or replace damaged fittings. Repair or replace leaking regulators.

It is possible that a leak exists in the high pressure section of the gas booster. These leaks are very difficult to isolate and detect. If no leaks can be found following the above procedures, it is likely the problem is within the booster. Please contact a **DHI** Authorized Service Provider for assistance (see Section 6).

5.8 GAS CONTINUOUSLY VENTS THROUGH EXHAUST MUFFLER

When the booster does not run and gas is venting through the muffler, the air cycling valve (spool valve) is stuck between its toggle points. This is normally caused by a low gas flow rate. There are two methods for restoring proper operation. It is recommended to perform them in the order shown:

❶ Close the High Pressure Outlet Regulator (7) and Shop Drive Air Shut-off Valve (11), then increase shop drive air pressure to about 0.5 MPa (75 psi). Open the Shop Drive Air Shut-off Valve (11) quickly. If the booster begins to operate normally, close the Shop Drive Air Shut-off Valve (11) and reset regulators to previous settings. Repeat the process until the booster begins normal operation.

❷ Close the High Pressure Outlet Regulator (7) and Shop Drive Air Shut-off Valve (11), then increase shop drive air pressure to about 0.5 MPa (75 psi). Remove the exhaust muffler and use your hand to plug the vent port. Quickly open the Shop Drive Air Shut-off Valve (11). When the build-up of pressure begins to leak past your hand, quickly remove it. If booster begins to operate normally, close the Shop Drive Air Shut-off Valve (11), reinstall the muffler and reset regulators to previous settings. Repeat the process until the booster begins normal operation.

If normal operation cannot be restored, contact a **DHI** Authorized Service Provider.

NOTES

6. WARRANTY STATEMENT

6.1 WARRANTY STATEMENT

Except to the extent limited or otherwise provided herein, **DH Instruments, Inc.** (**DHI)** warrants for one year from purchase, each new product sold by it or one of its authorized distributors, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

DHI and any of its Authorized Service Providers' obligations with respect to this warranty are limited to the repair or replacement of defective products after their inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to **DHI**, or its Authorized Service Provider, freight prepaid, after receiving authorization from **DHI** or its Authorized Service Provider. The buyer assumes all liability vis-à-vis third parties in respect of its acts or omissions involving use of the products. In no event shall **DHI** be liable to purchaser for any unforeseeable or indirect damage, it being expressly stated that, for the purpose of this warranty, such indirect damage includes, but is not limited to, loss of production, profits, revenue, or goodwill, even if **DHI** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

Items returned to **DHI** under warranty claim but determined to not have a defect covered under warranty or to not have a defect at all are subject to an evaluation and shipping charge as well as applicable repair and/or calibration costs.

The provisions of this warranty and limitation may not be modified in any respect except in writing signed by a duly authorized officer of **DHI.**

The above warranty and the obligations and liability of **DHI** and its Authorized Service Providers exclude any other warranties or liabilities of any kind.

Table 2. DHI Authorized Service Providers

DH INSTRUMENTS, INC. www.dhinstruments.com AUTHORIZED SERVICE PROVIDERS 2000 JULY			
COMPANY	**ADDRESS**	**TELEPHONE, FAX EMAIL**	**NORMAL SUPPORT REGION**
DH Instruments, Inc.	4765 East Beautiful Lane Phoenix AZ 85044-5318 USA	Tel 602.431.9100 Fax 602.431.9559 jbaines@dhinstruments.com	Worldwide
Minerva I.P.&M. B.V.	Handelsweg 13 Postbus 76-1270 AB Huizen NETHERLANDS	Tel 31/35.52.54.887 Fax 31/35.52.64.560 minervaipm@compuserve.com	European Union
Nippon CalService, Inc.	2-9-1 Sengen, Tsukuba-Shi Ibaraki Prefecture 305 JAPAN	Tel 0298-55-8778 Fax 0298-55-8700 aohte@ohtegiken.co.jp	Japan/Asia
DH Products Technical Service Division	National Institute of Metrology Heat Division Pressure & Vacuum Lab NO. 18, Bei San Huan Donglu Beijing 100013, PR China	Tel 010-64291994 ext 5 Tel 010-64218637 ext 5 Fax 010-64218703 cxcen@mx.cei.go.cn	Peoples Republic of China