

Model: 18-4306-0000
Four Bottle Helium Cart with
Booster and Manifold/Regulator



11/2013 - Rev. 03

CAUTION



It is **MANDATORY** that this instruction manual be read and understood by all persons operating this High Pressure Helium Booster.

REVISION	DATE	TEXT AFFECTED
01	09/2007	Original Release
02	03/2008	Added CE marling and Declaration of Conformity
03	11/2013	Modified 6.0 Maintenance, 7.0 Trouble Shooting, Appendix I
04	11/2018	Major revision

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This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., its suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.



CAUTION!

It is MANDATORY that this instruction manual be read and understood by all persons operating this High Pressure Helium Booster.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

The Tronair Four Bottle Cart with Booster is designed to transport Helium bottles which are used in the aviation industry. The system contains two regulators. The high pressure regulator is for regulating booster output pressure from 25 - 4000 psi (276 bar), and the low pressure regulator is for operating Helium booster and servicing needs of 0 – 500 psi (34.5 bar).

The booster provides the capability of boosting remaining lower pressure Helium from supply bottles to the required higher aircraft system pressure; up to 4000 psig maximum.



WARNING!

To Avoid Serious Injury, Loss of Limb, or Death:

1. **DO NOT use High Pressure Regulator on Low Pressure aircraft components or systems such as tires, etc. This is a Regulated Helium Source equal to supply pressure.**
2. **DO NOT use with Oxygen or gases other than Helium.**
3. **DO NOT exceed 4000 psig (276 bar) Helium pressure.**

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

1.4 SPECIFICATIONS/FEATURES

Dimensions:

- Height 37 in (94 cm)
- Length..... 80-1/8 in (203.5 cm)
- Width..... 30-1/2 in (77.5 cm)
- Weight..... 360 lbs (163 kg)

Cart:

- Easy loading
- Use with all standard nine inch (9 in/22.9 cm) diameter Helium bottles; CGA 580 connection
- Adjustable bottle stop
- Bottles fully captured
- Pneumatic tires
- Parking brake
- Hose compartment
- Instrument Panel

Booster:

- Output hose: 25 ft (7.6 m) long with #4, 37° JIC (female flared swivel fitting) at aircraft hook-up end
- Helium output rating..... 3500 psig (241 bar), maximum
- Minimum supply bottle pressure 250 psig (17 bar)
- Helium input to booster pump..... 80 SCFM at 150 psig (10.3 bar) maximum
- Booster high pressure air pilot..... 4000 psig (276 bar)
- Booster high pressure relief..... 4400 psig (303.4 bar)

Low Pressure Regulator:

- 0-500 psi (34.5 bar) output
- 15 ft (4.6 m) service hose

Temperature Range:

- 0° to 200°F (17.7° to 93.3° C)

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions which are explained below. Please read carefully.



WARNING!

Warning is used to indicate the presence of a hazard that can cause **severe personal injury, death, and/or substantial property damage** if the Warning Notice is ignored.



CAUTION!

Caution is used to indicate the presence of a hazard, which will or can cause **minor personal injury or property damage** if the Caution Notice is ignored.

2.2 SAFETY INSTRUCTIONS

CAUTION!



It is mandatory that this instruction manual be read and understood by all persons operating this High Pressure Helium Booster.

2.3 GENERAL

Information presented in this manual and on various labels, tags, and plates on the unit pertains to equipment design, installation, operation, maintenance and trouble shooting which should be read, understood, and followed for the safe and effective use of this equipment.

2.4 SAFETY

The operation, maintenance, and trouble shooting of this high pressure Helium booster requires practices and procedures which ensure personal operator safety and the safety of others. Therefore, this equipment is to be operated and maintained only by qualified persons in accordance with this manual and all applicable local codes.

NOTE: Safety instructions specifically pertaining to this unit appear throughout this manual highlighted by the signal words *WARNING, CAUTION, DANGER* which identify different levels of hazard.

Helium equipment must be kept clean and free from contaminants at all times. It is imperative that all inspection, maintenance, testing and servicing of Helium system components be done by trained and qualified personnel using approved procedures.

3.0 PREPARATION FOR USE/ASSEMBLY INSTRUCTION

CAUTION!



Only use bottles for which this unit was designed: Nine (9) inch (22.9 cm) diameter, 3000 psig (207 bar) maximum pressure with CGA 580 connection.

1. Install bottles by removing bottle stop pin and sliding bottle stop toward rear.
2. Place bottles in cart, slide bottles forward against front stop. If using only one or two bottles load the lower bottle compartment, this will prevent the cart from becoming too top heavy.
3. Slide bottle stop securely against the back of the bottles and install bottle stop pin.



CAUTION!

Maximum towing speed is 10 mph (16 km/h).

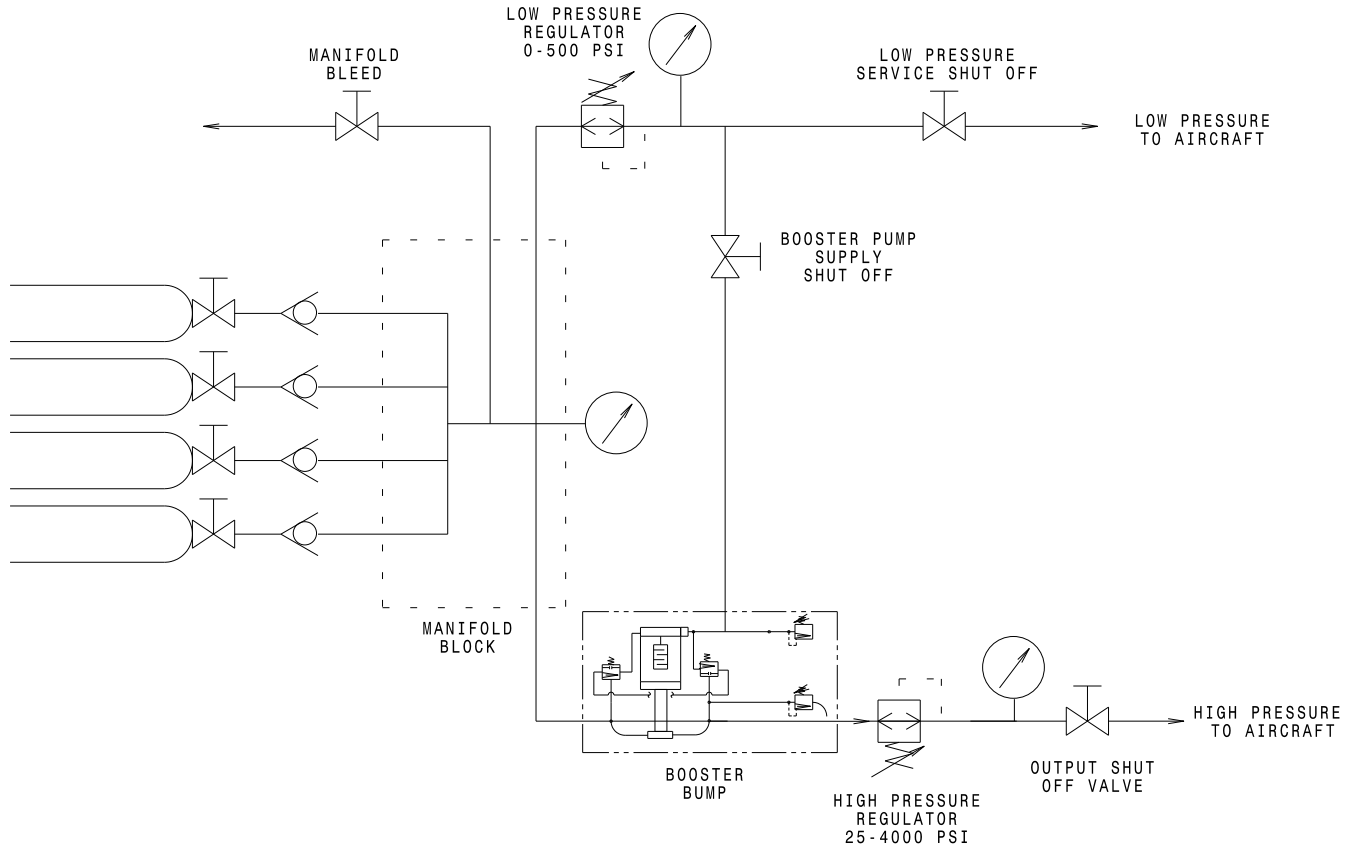


Figure 1 - Schematic

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the unit.

4.2 TRAINING PROGRAM

The employer provided operator training program should cover safety procedures concerning use of the unit in and around the intended aircraft at the intended aircraft servicing location.

4.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the unit.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.0 OPERATION OF HELIUM BOOSTER



WARNING!

To Avoid Serious Injury, Loss of Limb, or Death:

1. **DO NOT use high pressure Helium on aircraft components designed for low pressure Helium.**
2. **DO NOT use with oxygen or gas other than Helium.**
3. **DO NOT exceed 3000 psi (207 bar) inlet pressure.**
4. **Servicing and maintenance of Helium systems shall be done by only trained and qualified personnel using approved procedures.**

General: Information presented in this manual and on various labels on this unit pertains to equipment Specifications, Installation, Operation, Maintenance and Trouble Shooting which should be read, understood and followed for the safe and effective use of this equipment.

Training: Read this entire manual prior to operation of the unit. All personnel using this Helium Booster should understand and follow this manual and receive training. We encourage our customers to call Tronair to discuss any operating or testing requirements. Telephone 419-866-6301 or 800-426-6301.

5.1 GENERAL SAFETY REQUIREMENTS

Pressures: Gasses under pressure are a potential hazard in the form of stored energy. Accidents can occur when this energy is improperly handled. Be sure that all equipment used is compatible and designed to control the pressures encountered.

Handling: Helium handling must be done with care. The rapid expansion of Helium gas from a high pressure source to an area of low pressure, can produce cryogenic temperatures which cause severe burns.

5.2 BOTTLE CONNECTION INSTRUCTIONS

1. Rotate the Helium supply bottles so that the manifold inlet hoses may be easily connected to the bottles. Make sure the hoses are not kinked or damaged.
2. Check that Helium supply bottle shut off valve is closed. Recheck all fittings for tightness.
3. Clean out Helium supply gas bottle valve outlet on one bottle and install Helium booster inlet brass fitting and hose. Stop and inspect any indication of cross-threading or galling. Repeat for the remaining three (3) bottles.
4. If less than four (4) bottles are used, plug or cover unused inlet hoses to ensure Helium system cleanliness.

5.3 TO READ INDIVIDUAL BOTTLE PRESSURE

1. Open a bottle shutoff valve
2. Read pressure on bottle pressure gauge
3. Close bottle shutoff valve
4. Open manifold bleed valve to relieve pressure
5. Close manifold to bleed valve
6. Repeat procedure for other bottles

5.0 Operation of helium booster continued on following page.

5.0 OPERATION OF HELIUM BOOSTER (continued)

5.4 EFFICIENT USE OF SYSTEM

Maximum pressure may be removed from supply bottles if aircraft are serviced from the lowest pressure bottle first. In this manner, the most Helium may be removed from each bottle. Even bottles with relatively low pressures may be used to service aircraft if the aircraft has a depleted system.

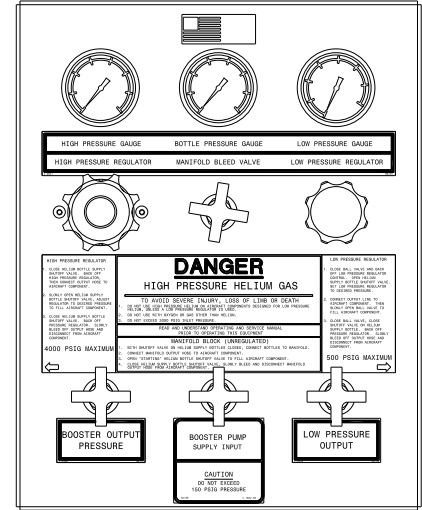
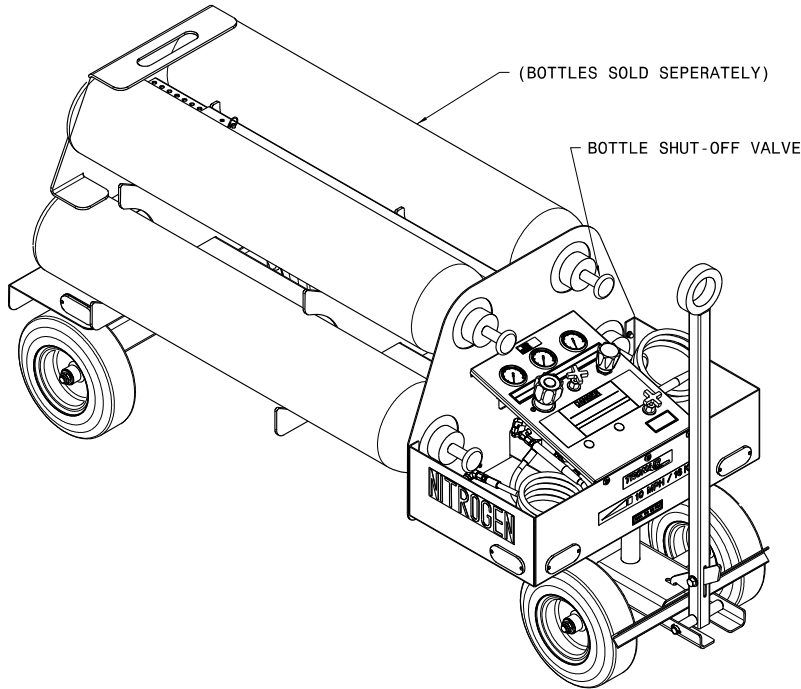


FIGURE 2 - Efficient Bottle Usage

5.5 HELIUM SYSTEM CONNECTION



WARNING!

If there are any differences between the following instructions and the aircraft maintenance manual, the aircraft maintenance manual will take precedence.

Reference Illustrated Parts Lists for replacement components

1. Be sure all needle valves are in the closed (clockwise) position.
2. Decrease all pressure regulators to the minimum pressure setting. The regulator adjustment knobs are the rotating type. Clockwise rotation of the knob increases pressure and counter-clockwise rotation reduces pressure.
3. Connect Helium fill line loosely to aircraft and purge line by slowly cracking open Helium supply bottle shutoff valve.
4. Tighten Helium fill line connection at aircraft.
5. Generally check unit and assure the tightness of all fittings, nuts and bolts.
6. The high pressure Helium booster is now ready to charge an aircraft Helium system.



WARNING!

Be sure fill line is secured prior to purging the unit. This will prevent the hose end from “whipping” if too much Helium is allowed to flow through the unit.

- 5.0 OPERATION OF HELIUM BOOSTER (continued)
- 5.6 CHARGING AIRCRAFT HELIUM SYSTEM (High Pressure)

Note: If the Helium supply bottle pressure is lower than the aircraft Helium system pressure, check valves in the Helium booster will prevent back flow from the aircraft.



WARNING!

DO NOT use on low pressure Helium system or components.

Continued operation of this Helium booster at pressures above 4300 psi (296.5 bar) may result in premature disc rupture.

1. Connect the “RED” high pressure output hose from the booster to the aircraft.
2. Fully open Helium supply bottles valve (250 min on bottle pressure gauges).
3. Slowly adjust low-pressure regulator valve to 140 psi (9.7 bar) max to send Helium to the Helium booster. Clockwise rotation increases pressure, and counter-clockwise rotation reduces pressure. Since the Helium booster pump compression ratio is 30:1, 135 psi (9.3 bar) of low pressure regulator inlet will develop approximately 4000 psi (276 bar) of output Helium pressure.
4. Open booster pump supply valve.
5. With output valve closed, adjust the high pressure regulator to obtain desired output Helium pressure required by the chart.
6. Open booster output valve.

5.7 DISCONNECTING HELIUM BOOSTER FROM AIRCRAFT

1. **Slowly** close Helium supply bottle shut off valve and booster output valve. This will stop inlet Helium flow.
2. Decrease the manifold low pressure regulator to minimum pressure setting.
3. **Slowly** open, manifold bleed valve, and disconnect aircraft Helium fill line from aircraft.
4. Cap aircraft Helium fill line to prevent contamination.
5. Close all needle valves and decrease pressure regulators.

5.8 AIRCRAFT HELIUM SYSTEM (Low Pressure)

1. Ensure that all needle valves are in the closed (clockwise) position.
2. Ensure that all pressure regulators are decreased to minimum pressure settings (counterclockwise).
3. Connect the “BLUE” low pressure output hose to the low pressure application.
4. **Fully** open the Helium supply bottle valve.
5. Slowly increase the low pressure regulator to obtain desired low pressure output. (Clockwise rotation increases pressure).
6. Open Low pressure output valve.

5.9 DISCONNECT LOW PRESSURE

1. **Slowly** close Helium supply bottle shut-off valve.
2. Decrease low pressure regulator to minimum pressure setting after completing low pressure charge. (Counter-clockwise rotation decreases pressure).
3. **Slowly** open, manifold bleed valve, and disconnect aircraft Helium fill line from aircraft.
4. Cap aircraft Helium fill line to prevent contamination.
5. Close all needle valves and decrease pressure regulators.

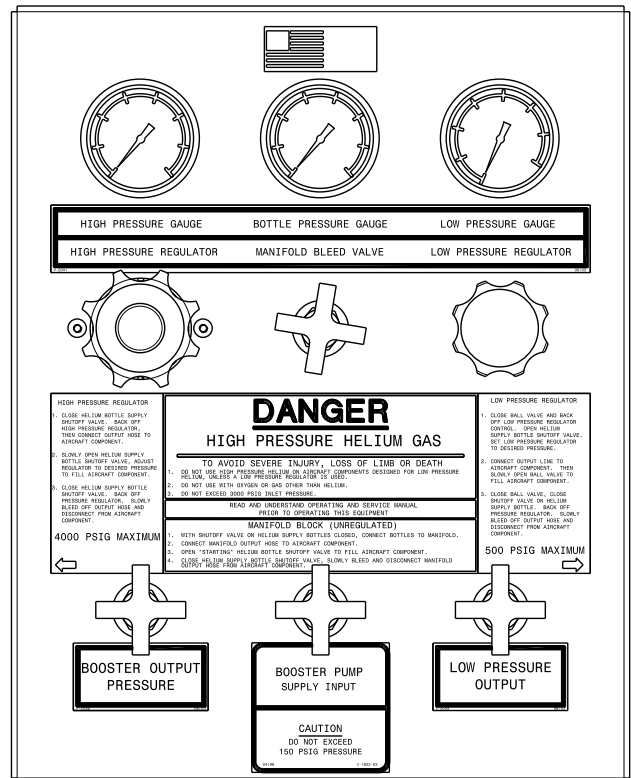


FIGURE 8 - Instrument Panel

6.0 MAINTENANCE

- Maintain pressure listed on tires.
- Grease wheel bearings quarterly.
- All maintenance performed on this high pressure Helium booster shall be conducted in accordance with all applicable codes governing the handling, operation, installation and trouble shooting for high pressure Helium operation. Maintenance is to only be done by qualified persons.
- See Appendix I Hydraulic International Installation and Maintenance Manual.
- The gauges on this unit should be inspected and calibrated annually to maintain and ensure accuracy.
- Manifold inlet hoses should be inspected weekly for signs of cracking or kinking, replace as necessary.
- Inspect Helium output hoses prior to each use for signs of cracking or kinking, replace as necessary.
- Generally keep the entire unit clean and free from any contaminants. Visually inspect for any system leaks or damage. Correction of any problems prior to unit operation is imperative for safe operation.



WARNING!

Never apply high pressure gas to the high pressure section of this booster whenever the air driven section of this unit is disassembled or when maintenance is being performed on unit.

6.1 STORAGE

Store the unit in a clean, dry area when not in use.

Ensure that all hoses are capped. The unit should be covered for the duration of unit storage to ensure Helium system cleanliness for future aircraft system recharging.

7.0 TROUBLE SHOOTING

Reference Appendix I: Hydraulic International Installation and Maintenance Manual

8.0 PROVISION OF SPARES

8.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

TRONAIR, Inc.

1 Air Cargo Pkwy East

Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301

Fax: (419) 867-0634

E-mail: sales@tronair.com

Website: www.tronair.com

8.2 RECOMMENDED SPARE PARTS LISTS

Reference the following page(s) for Replacement Parts and Kits available.

9.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section 1.3 – Manufacturer.

10.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

- a) Parts required for normal maintenance
- b) Parts covered by a component manufacturers warranty
- c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

- a) Product Model Number
- b) Product Serial Number
- c) Description of the problem

If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

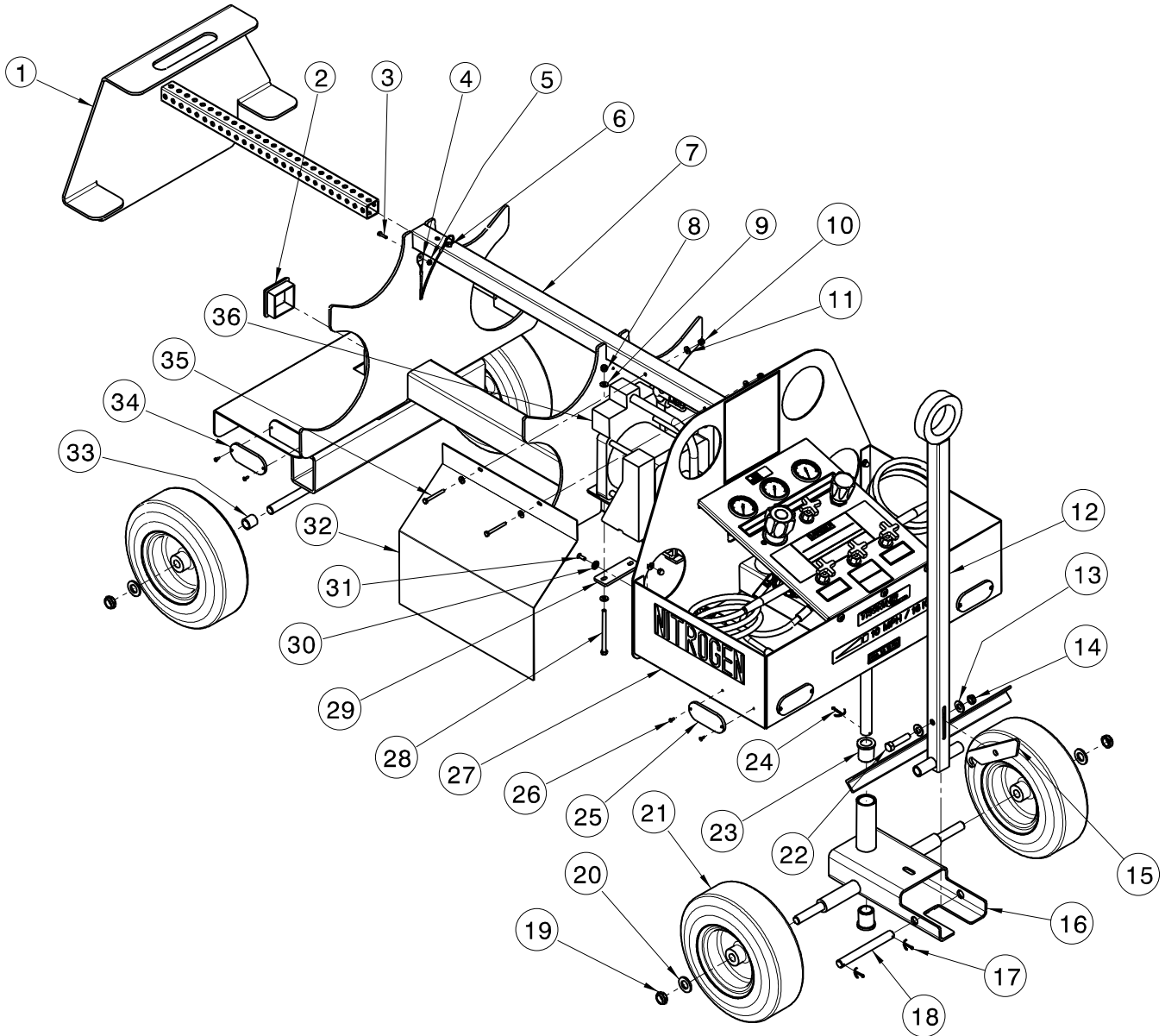
The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied and Tronair disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse.**

11.0 APPENDICES

APPENDIX I	Nitrogen Booster – Hydraulic International, Operation and Maintenance Instructions
APPENDIX II	Smith Installation & Operator's Guide
APPENDIX III	Instrument Certification Notice
APPENDIX IV	Declaration of Conformity

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	Z-5585-01	Weldment, Back Stop	1
2	H-2649-18	Cap	1
3	G-1150-103506	Screw, Hex Head Machine, #10-32 x 3/4" long	1
4	H-1026*12.0	Assembly, Lanyard	1
5	G-1202-1035	Elastic Stopnut, #10-32	1
6	G-1307-0618	Pin, Aerofast	1
7	Z-5582-01	Weldment, Bottle Cart	1
8	G-1202-1065	Elastic Stopnut, 5/16 - 24	4
9	G-1250-1060N	Flatwasher, 5/16 narrow	8
10	G-1463-1050	Nut, 1/4 - 20 Acorn	6
11	G-1250-1050N	Flatwasher, 1/4 narrow	12
12	Z-5584-01	Weldment, Towbar	1

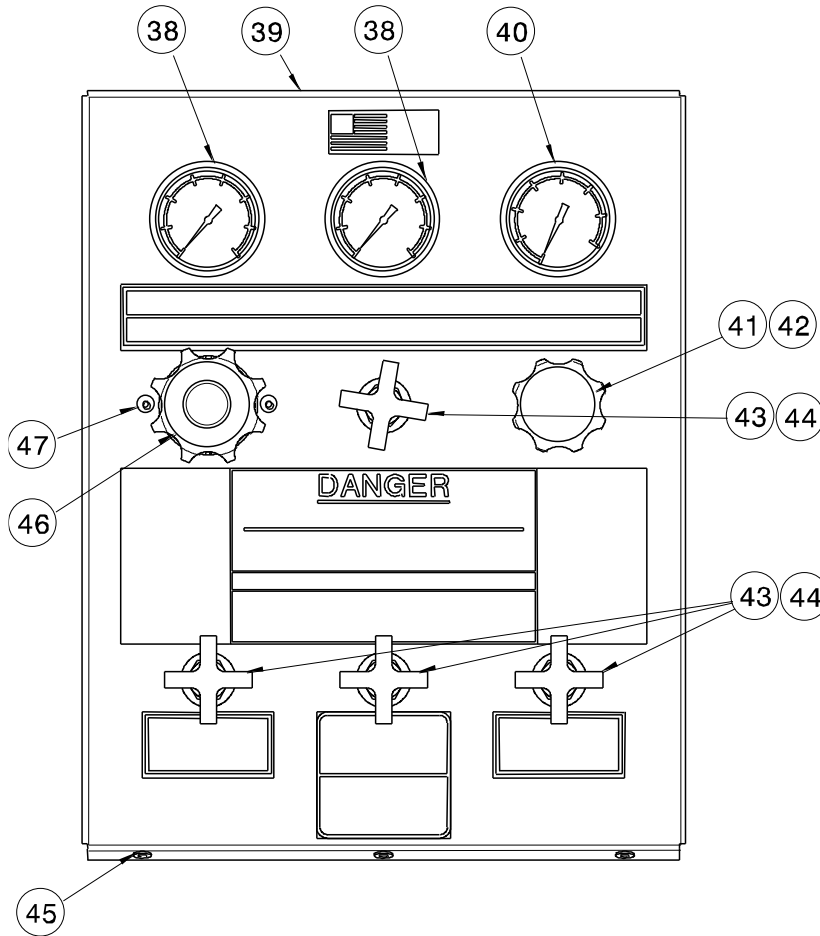
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
13	G-1250-1090N	Flatwasher, ½ narrow	2
14	G-1203-1095	Elastic Jamnut, ½ - 20	1
15	J-3427	Lever	1
16	Z-5580-01	Weldment, Front Truck	1
17	G-1301-02	Pin, Cotter	2
18	R-2096	Pin, Towbar	1
19	G-1203-1115	Elastic, Jamnut ¾ - 16	4
20	G-1250-1110N	Flatwasher, ¾ narrow	4
21	U-1041	Wheel, Pneumatic	4
	K-3107	Kit, Wheel Bearing	4
22	G-1100-109522	Bolt, Hex Head Grade 5, ½ - 20 x 2-1/4" long	1
23	H-2019-76	Bearing, Flange	2
24	G-1301-03	Pin, Cotter	1
25	H-1427-02	Reflector, Amber	4
26	G-1352-17	Rivet, Pop	16
27	S-1866-01	Shelf, 4-bottle cart	1
28	G-1100-106544	Bolt, Hex Head Grade 5, 5/16 - 24 x 4 ½ " long	4
29	J-3535-01	Plate, Booster Clamping	2
30	G-1489	Washer, Finish	4
31	G-1158-106106	Screw, Machine, ¼ - 20 x ¾" long	4
32	S-1907-01	Guard, Booster	2
33	TR-1813	Spacer, Wheel	2
34	H-1427-01	Reflector, Red	4
35	G-1100-105022	Bolt, Hex Head Grade 5, ¼ - 20 x 2- ¼ "	2
36	PC-1195	Booster, Nitrogen/Helium	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



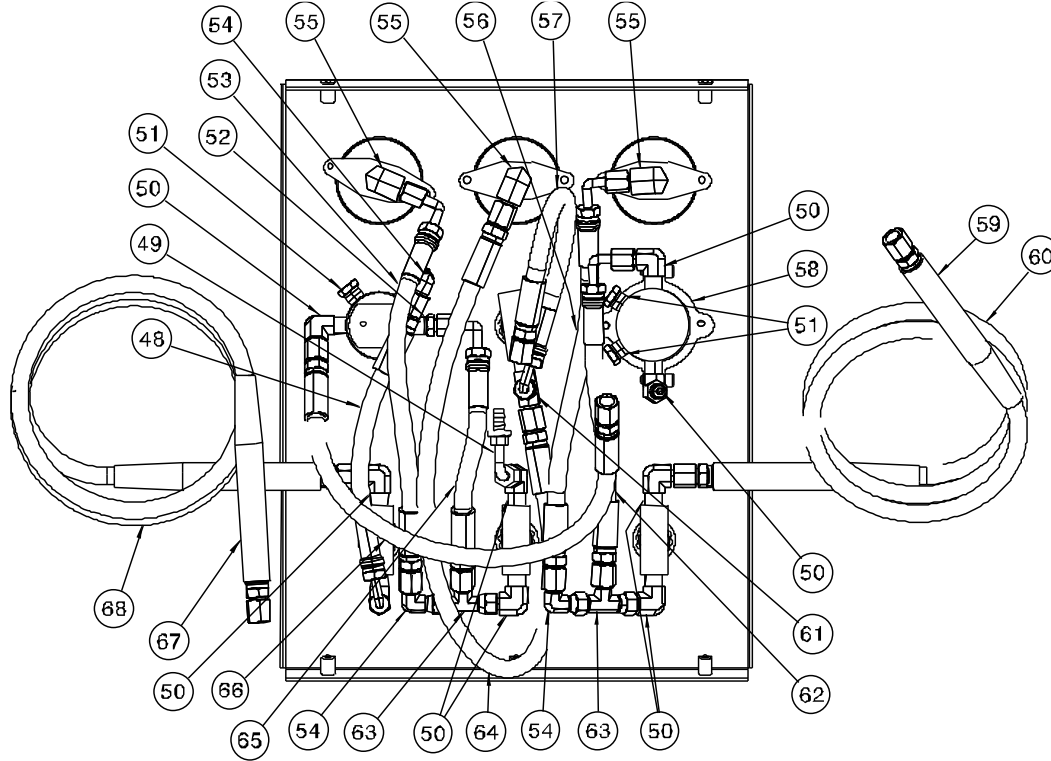
INSTRUMENT PANEL

TOP OF PANEL

Item	Part Number	Description	Qty
38	HC-2279	Gauge, Pressure 0-5000 psi	2
39	S-1906-01	Panel, Instrument	1
40	HC-2239	Gauge, Pressure 0-600 psi	1
41	PC-1089-01	Regulator, Low Pressure	1
42	H-2259	Locknut	1
43	HC-1081-01	Valve, Needle	4
44	HC-1122	Kit, Panel Mounting	4
45	G-1439-1050-S	Nutsert, ¼ - 20	5
46	PC-1037-01	Regulator, High Pressure	1
47	G-1154-105204	Screw, Socket Head Cap, ¼ - 20 x ½" long	2
48	TF-1043-11*09.5	Assembly, Hose	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



INSTRUMENT PANEL

BACK OF PANEL

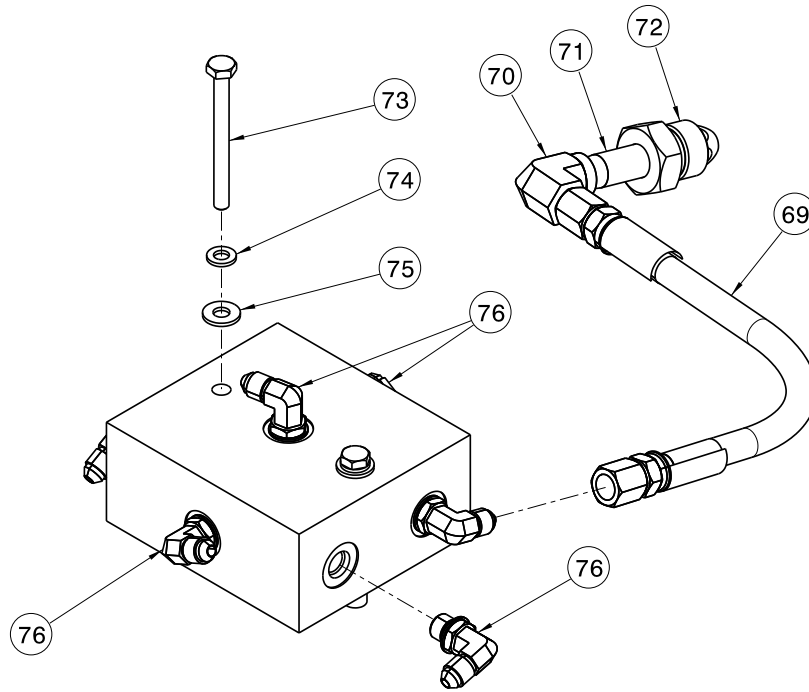
Item	Part Number	Description	Qty
49	N-2069-01-S	Elbow, 90°, #4 JIC x #4 Hose	1
50	N-2005-04-S	Elbow, 90°, ¼ NPT x #4 JIC	10
51	N-2206-03-S	Plug, ¼ NPT	3
52	N-2009-04-S	Connector, #4 JIC x ¼ NPT	1
53	TF-1043-11*11.8	Assembly Hose	1
54	N-2002-03-S	Elbow, 90°, #4 JIC	3
55	N-2006-04-S	Elbow, 90°, ¼ NPT x #4 JIC	3
56	TF-1043-11*11.8	Assembly, Hose	1
57	TF-1043-11*20.0	Assembly, Hose	1
58	PC-1103	Clamp, Regulator Mounting	1
*59	EC-1057-02*12.0	Tubing, Red Heat Shrink	2
*60	TF-1043-01*180	Assembly, Hose	1
61	N-2017-04-S	Tee, Male Run, ¼ NPT x #4 JIC	1
62	TF-1043-11*10.0	Assembly, Hose	1
63	N-2016-03-S	Tee, Run, #4 JIC	2
64	TF-1043-01*21*0	Assembly, Hose	1
65	TF-1043-11*07.8	Assembly, Hose	1
**67	EC-1057-05*12.0	Tubing, Blue Heat Shrink	2
**68	TF-1043-11*300	Assembly, Hose	1

* When ordering a replacement of TF-1043-01*180 High Pressure Output Hose, also order EC-1057-02*12.0, (qty. of 2)

** When ordering a replacement of TF-1043-01*300 Low Pressure Output Hose, also order EC-1057-05*12.0 (qty. of 2)

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

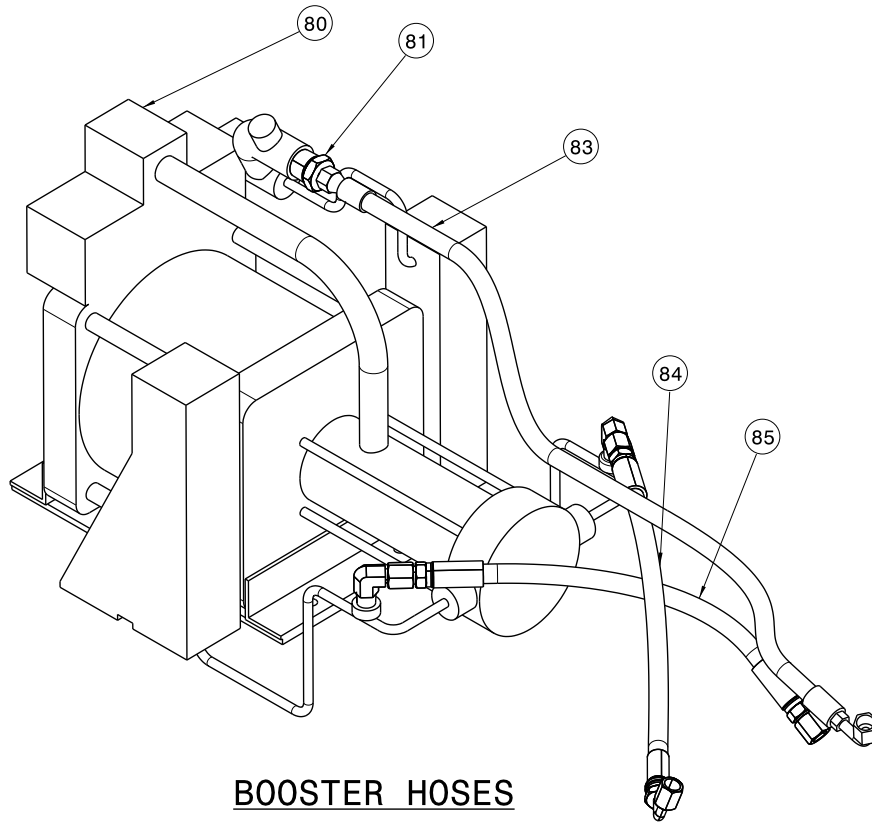


MANIFOLD AND BOTTLE HOSE ASSEMBLY

Item	Part Number	Description	Qty
69	TF-1043-01*21.0	Assembly Hose	4
70	N-2006-04-S	Elbow, 90°, ¼ NPT x #4 JIC	4
71	PC-1131	Nipple, Inlet w/check	4
72	PC-1001	Nut	4
73	G-1100-105026	Bolt, Hex Head Grade 5, ¼ - 20 x 2 ¾" long	2
74	G-1251-1050R	Lockwasher, ¼ regular	2
75	G-1250-1050N	Lockwasher, ¼ narrow	2
76	N-2001-03-S-B`	Elbow, 90°, #4 SAE x #4 JIC	7
80	PC-1186	Booster, Helium	1
81	N-2009-05-S	Connector, ½ NPT x #4 JIC	1
82	N-2026-01-S	Fitting, 37° Swivel	1
83	TF-1043-11*29.0	Hose, ¼" Push On	1
84	TF-1043-11-11.5	Assembly Hose	1
85	TF-1043-11-10.5	Assembly Hose	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



BOOSTER HOSES

Item	Part Number	Description	Qty
69	TF-1043-07*21.0	Assembly Hose	4
70	N-2006-04-S	Elbow, 90°, ¼ NPT x #4 JIC	4
71	PC-1131	Nipple, Inlet With Check	4
72	PC-1001	Nut	4
73	G-1100-105026	Bolt, Hex Head Grade 5, ¼ - 20 x 2 ¾" long	2
74	G-1251-1050R	Lockwasher, ¼ regular	2
75	G-1250-1050N	Lockwasher, ¼ narrow	2
76	N-2001-03-S-B`	Elbow, 90°, #4 SAE x #4 JIC	7
80	PC-1186	Booster, Nitrogen	1
81	N-2009-05-S	Connector, ½ NPT x #4 JIC	1
83	TF-1037-29*24.0	Hose, ¼" Push On	1
84	TF-1037-29*15.0	Assembly Hose	1
85	TF-1037-03*14.5	Assembly Hose	1
	◆ K-2147	Kit, CGA 580 Fittings; consist of:	
70		Elbow, Female (4-DTX-S)	1
71		Nipple, Inlet	1
72		Nut	1
	◆◆ K-2145	Kit, CGA 677 Fittings; consist of:	
70		Elbow, Female (4-DTX-S)	1
71		Nipple, Inlet	1
72		Nut	1

- ◆ Standard Helium bottle fittings
- ◆◆ Optional high pressure Helium bottle fittings



APPENDIX I

Haskel Operation and Maintenance Instructions

Operating and Maintenance Instructions

إرشادات الصيانة و التشغيل

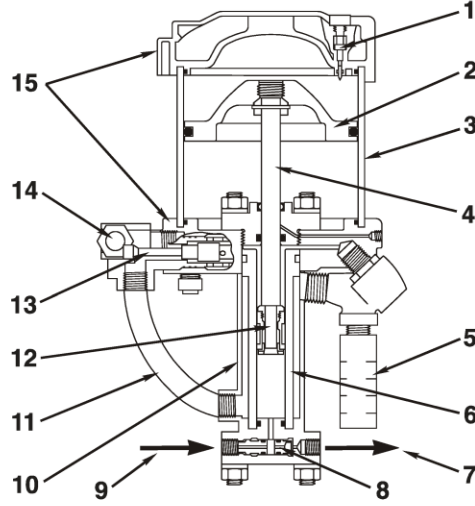
Инструкция По Эксплуатации и Техническому Обслуживанию

- Air Driven Gas Booster
Compressors
5-3/4" Drive AG, AGD & AGT Series

• ضواغط تقوية الغاز مُدَارَةٌ بالهواء
مجموعة AG, AGD & AGT لناقل قدرة
5-3/4 بوصة



- Газовый Нагнетатель С Пневматическим Приводом
Компрессоры С Приводом
5-3/4" Серии AG, AGD & AGT



- | | | |
|--------------------------|---------------------------------|--------------------------------------|
| 1. Pilot Valve | 1. صمام الدليل | 1. Управляющий Клапан |
| 2. Air Piston | 2. مكبس الهواء | 2. Поршень Пневмоцилиндра |
| 3. Air Drive Barrel | 3. اسطوانة ناقل القدرة الهوائية | 3. Цилиндр Пневмопривода |
| 4. Connecting Rod | 4. قضيب التوصيل | 4. Соединительная Тяга |
| 5. Exhaust Muffler | 5. عادم كاتم صوت ال | 5. Глушитель |
| 6. High Pressure Barrel | 6. اسطوانة الضغط العالي | 6. Цилиндр Высокого Давления |
| 7. Pump Outlet | 7. مخرج المضخة | 7. Выходное Отверстие Насоса |
| 8. Check Valves | 8. صمامات الضبط | 8. Обратные Клапаны А |
| 9. Pump Inlet | 9. مدخل المضخة | 9. Входное Отверстие Насоса |
| 10. Cooling Jacket | 10. قميص تبريد | 10. Охлаждающая Рубашка |
| 11. Air Exhaust Tube | 11. أنبوب طرد هواء | 11. Воздушная Выпускная Труба |
| 12. Pump Piston | 12. مكبس المضخة | 12. Поршень Насоса |
| 13. Air Cycling Valve | 13. صمام هواء دورى | 13. Воздушный Клапан Цикла Обращения |
| 14. Air Drive Inlet Port | 14. فتحة دخول هواء نقل القدرة | 14. Входное Отверстие Пневмопривода |
| 15. Upper & Lower Caps | 15. الغطاء العلوى و السفلى | 15. Верхние И Нижние Крышки |

Introduction

The Haskel "Oil Free" gas booster compressor is an air driven, non-lubricated, reciprocating piston type gas compressor available in single acting single stage, double acting single stage, and two stage configurations. Individual models may also be used in series for multiple staging. The model number is the approximate ratio of the air drive piston(s) area to the gas piston(s) area.

CAUTION: High pressure gas can be dangerous if improperly handled.

Description

General

The air drive piston(s) in all models are automatically cycled by a non-detented, unbalanced air valve spool that is alternately pressurized and vented by the pilot air system. This drive is directly connected to the booster section piston(s) which are designed to run dry without lubrication to supply gas free of hydrocarbon contamination. Exhaust air from the drive is used to cool the gas barrels and in 2 stage units, the gas intercooler. Some models depend on the cold air exhausting from the muffler slots directly against the gas barrel (without benefit of a cooling jacket). Therefore, the position of the exhaust muffler on these models should not be disturbed. Mufflers on models with cooling jackets may be relocated for noise or configuration convenience.

Air Drive Section

Refer to detailed assembly drawing of the air drive section provided with each unit. The air drive section consists of one or more air drive piston assemblies, an unbalanced spool type cycling control valve and pilot valves (one mounted in the valve end cap and one in the opposite end cap), a flow tube to direct drive air flow from the valve end cap to the opposite end cap, and pilot tube to connect the two pilot valves, which are in series. The drive control valve operates without springs or detents and is cycled by the pilot valves alternately pressurizing and venting the large area on the inside end of this spool valve.

The control valve, pilot valves and drive cylinder are lubricated with Haskel air drive grease, part no. 50866, at assembly. Occasional relube of the easily accessible control valve and pilot valves with this grease may be needed depending on the duty cycle of the installation.

It is recommended that only o-rings and seals of proper compounds and hardness for low friction be used in the air drive section. Haskel replacement seals are recommended.

If not otherwise installed by the factory, always install a conventional bowl type shop air filter/water separator of the same or larger pipe size on the incoming air drive plumbing. Drain and maintain it regularly. **Do not use an airline lubricator of any kind.**

Gas Section

Refer to the detailed assembly drawing on the gas section(s) provided with each unit. These sheets cover the individual parts and their installation for the gas section of the individual models. **Note that no lubrication of any kind is ever used on the dynamic seals of the gas pumping sections.** They are designed to run dry supported on the inherent low friction properties of the seal and bearing materials. The life of the gas section also depends on the cleanliness of the gas supply. Therefore, micron filtration is suggested at the gas inlet port. If compressed air or other moisture containing gas is to be pumped, the initial dew point should be low enough to prevent saturation at booster output pressure, and if any carry over of oil from the compressed air source is evident, special coalescing type filtration may be necessary. Over the life of the moving parts, some migration of inert particles into the gas output should be expected. Therefore, a small particle filter on the high pressure line may be advisable for critical applications.

COMPRESSION RATIO-VOLUMETRIC EFFICIENCY

The compression ratio is the ratio of output pressure to gas supply pressure. (To calculate, use psi absolute values.) The gas pumping sections are designed to have minimum unswept or clearance volume at the end of the compression stroke. On the return (suction) stroke of the piston, output pressure in the unswept volume expands to inlet pressure. This reduces the amount of potential fresh gas intake on the

suction stroke. Volumetric efficiency therefore decreases rapidly with an increase in compression ratio until the volumetric efficiency reaches zero when the unexpelled (expanded) gas completely fills the cylinder at the end of the intake stroke. A cylinder with a 4% unswept volume will reach zero efficiency at a compression ratio of approximately 25:1.

Production models of Haskel gas boosters are tested in the laboratory. Results of these tests indicate that compression ratios of up to 40:1 are possible for some models under ideal conditions. However, for satisfactory operation under production conditions in industrial applications, we recommend compression ratios (per stage) of about 10:1 or less. Operation at higher ratios may not damage the gas booster but because output flow and efficiency will be low, the use should be limited to pressurizing small volumes such as pressure gauge testing, etc.

COOLING

Effective cooling of the gas pumping section is of paramount importance as service life of piston seals, bearings, and static seals are dependent upon proper operating temperatures. Haskel gas boosters use the exhaust air from the driving system to cool the gas barrel (and gas intercooler on the two stage models). Driving air expands during the work cycle with a significant reduction in temperature. Therefore, the exhaust air is a very efficient cooling medium.

In theory, compression ratios above 3:1 with most gases produce temperatures above the allowable limits for the seals. In practice, however, the heat of compression is transferred to the air cooled gas barrel and adjacent metal components during the relatively slow speed of the piston on the compression stroke and these components will stay within allowable temperature limits. Laboratory tests indicate that maximum temperatures occur between compression ratios of 5:1 and 10:1 and have shown that exhaust air cooling is adequate even when the booster is running at full speed.

The gas discharge temperature may run as high as approximately 150°F above ambient temperature. Under certain severe operating conditions, it may be necessary to slow down the cycling of the gas booster to prevent overheating. It is very difficult to predict exactly when overheating may occur. To test, install a thermocouple approximately 1 inch from the discharge port of the gas pumping section. Temperatures above 300°F at this point will shorten piston seal life considerably.

Maintenance

Air Valve Section

Remove spool or sleeve in the following manner:

1. Remove air exhaust fitting located in cycling valve end cap. Pull out spool; inspect 568017 o-rings. **Relube; reinstall; retest before further disassembly.**
2. If necessary, remove sleeve and bumper (rubber faced spacer at inside end of sleeve) with tool P/N 28584 as shown in figures 1, 2, and 3.

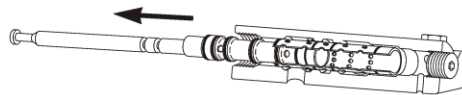


Figure 1: Insert tool in second row of holes in sleeve and if necessary, pry out with screwdriver.

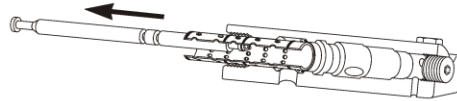


Figure 2: Pull straight out.

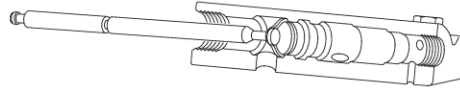


Figure 3: Insert bumper hook through center of bumper and pull straight out.

3. Replace any 568020 o-rings or the bumper/spacer if damaged, worn or swollen.
4. Lubricate o-rings with light coat of Haskel 50866 lubricant.
5. Use lubricant liberally to hold bumper/spacer to sleeve with rubber side facing sleeve.
6. Push lubricated sleeve and bumper into end cap bore, all the way in one quick motion. (If bumper drops off sleeve too soon, remove, regrease and repeat.)
7. Install spool.
8. Replace exhaust fitting.

Pilot System

1. Remove hex o-ring sealed plug.
2. Remove spring and 27375 pilot stem (figure 4).
3. Inspect pilot stem and seat for foreign material. Replace stem if shank is bent or scratched.
4. Replace stem if molded seat is damaged.
5. Apply 50866 lubricant and reassemble in the reverse manner.

NOTE: Unless excessive leakage occurs, it is not advisable to replace the o-ring seal for the shank of the stem. This requires disassembly of the air section. If replacement is required, care must be taken in installing the Tru-Arc retainer concentrically as shown in figure 5. Use the 27375 pilot stem valve as seating tool. Place the rubber valve face against the retainer and tap the top of the valve lightly with a light hammer to **evenly** bend the legs of the retainer.

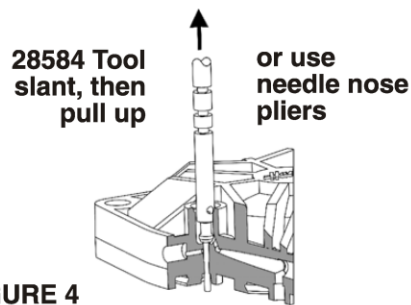
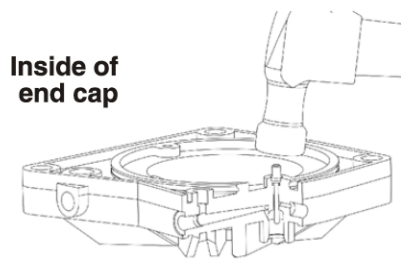


FIGURE 4



Seating the Retainer

FIGURE 5

Operating and Maintenance Instructions

CE Compliance Supplement

SAFETY ISSUES

- a. Please refer to the main section of this instruction manual for general handling, assembly and disassembly instructions.
- b. Storage temperatures are 25°F – 130°F (-3.9°C – 53.1°C).
- c. Lockout/tagout is the responsibility of the end user.
- d. If the machine weighs more than 39 lbs (18 kg), use a hoist or get assistance for lifting.
- e. Safety labels on the machines and meanings are as follows:



General Danger



Read Operator's Manual

- f. In an emergency, turn off the air supply.
- g. Warning: If the pump(s) were not approved to ATEX, it must NOT be used in a potentially explosive atmosphere.
- h. Pressure relief devices must be installed as close as practical to the system.
- i. Before maintenance, liquid section(s) should be purged if hazard liquid was transferred.
- j. The end user must provide pressure indicators at the inlet and final outlet of the pump.
- k. Please refer to the drawings in the main instruction manual for spare parts list and recommended spare parts list.

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Нашу продукцию подкрепляют выдающаяся техническая поддержка, отличная репутация надежных изделий и поставки по всему миру.

LIMITED WARRANTY

Haskel manufactured products are warranted free of original defects in material and workmanship for a period of one year from the date of shipment to first user. This warranty does not include packings, seals, or failures caused by lack of proper maintenance, incompatible fluids, foreign materials in the driving media, in the pumped media, or application of pressures beyond catalog ratings. Products believed to be originally defective may be returned, freight prepaid, for repair and/or replacement to the distributor, authorized service representative, or to the factory. If upon inspection by the factory or authorized service representative, the problem is found to be originally defective material or workmanship, repair or replacement will be made at no charge for labor or materials, F.O.B. the point of repair or replacement. Permission to return under warranty should be requested before shipment and include the following: The original purchase date, purchase order number, serial number, model number, or other pertinent data to establish warranty claim, and to expedite the return of replacement to the owner.

If unit has been disassembled or reassembled in a facility other than Haskel, warranty is void if it has been improperly reassembled or substitute parts have been used in place of factory manufactured parts.

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APPENDIX II

Smith's Installation & Operation Guide Pressure Regulators



INSTALLATION & OPERATION GUIDE FOR SMITH PRESSURE REGULATORS

Important safety and operational information contained in this booklet are emphasized by a system of classification using the words: **DANGER, WARNING, CAUTION, NOTICE.**

DANGER! Danger is used to indicate the presence of a hazard which will cause severe personal injury, death or substantial property damage, if the warning is ignored.

WARNING! Warning is used to indicate the presence of a hazard which can cause severe personal injury, death or substantial property damage, if the warning is ignored.

CAUTION! Caution is used to indicate the presence of a hazard which will or can cause minor personal injury, death or substantial property damage, if the warning is ignored.

NOTICE! Notice is used to notify people of installation, operation or maintenance information which is important but not hazard related.

SPECIALTY GASES ~ SAFETY AND TECHNICAL INFORMATION

Gaseous and liquefied compressed gases may be categorized in the following classifications: flammable, oxidant, corrosive, inert or toxic. Because these products may also be gases or liquids under pressure, the hazards accompanying high pressure and low temperature may also be present. The properties of a gas place it in one or a number of categories. Certain basic rules must be followed in order to handle specialty gases safely.

- A. Know the hazards associated with the gas.
- B. Know and understand the physical and chemical properties of the gas.
- C. Observe the necessary general precautions to be taken in the use of specialty gases and the precautions specific to the gas.

In addition to the safe handling and storage procedures presented in this section, the Compressed Gas Association and the Department of Transportation provide detailed gas safety information and regulations.

A. FLAMMABLE

Flammable gases when mixed with air, oxygen or other oxidants burn or explode upon ignition, depending upon the degree of confinement. Each flammable gas has a gas-in-oxidant concentration range within the limits of which the gas may be ignited. Flammable ranges are expressed in terms of air at ambient temperature and atmospheric pressure. A change in temperature, pressure or oxidant concentration may vary the flammable range considerably. Mixtures above and below the flammable range do not ignite. As a precaution in handling flammables, care must be taken to eliminate all possible sources of

ignition through the proper design of facilities, the installation of approved electrical systems, and the restriction of smoking and use of open flames. An explosimeter should be used to determine the existence of a flammable mixture in areas of suspected leakage.

B. OXIDANT

A number of gases, although nonflammable, may initiate and support combustion. Materials that burn in air burn more vigorously or even explosively in oxygen and certain other oxidants. All possible sources of ignition must be eliminated when handling oxidants. Oxidants must not be stored with combustible materials. Oil, grease, or other readily combustible substances must not come in contact with cylinders or equipment used in oxidant service.

C. CORROSIVE

Corrosives are those products that erode and deteriorate materials with which they come in contact; such as metals, fabrics, and human tissue. Some gases, although not corrosive in their anhydrous form, become corrosive in the presence of water. Special Care must be taken when selecting the proper construction materials for equipment in which corrosives are handled. Gases that do not cause deterioration but induce inflammation of human tissue are irritants. Inflammation of the tissue may occur after immediate, prolonged or repeated contact with the irritant. Protective clothing and equipment must be used to minimize exposure to corrosive or irritating materials.

D. INERT

Gases that at ordinary temperatures and pressure do not react with other materials are classified as inert. If released in a confined area, inert gases may displace the oxygen content of the air below the level necessary to sustain life. Asphyxiation, therefore, is the hazard associated with inert products. Adequate ventilation and monitoring of the oxygen content of confined areas minimizes the possibility of asphyxiation.

E. TOXIC

Toxic materials are those substances that may chemically produce injurious or lethal effects. The degree of toxicity and the effects vary with the compound. Some gases are especially noxious because they do not provide adequate warning of their presence (by color, odor, etc.) at low levels of concentration. Also, some products that are non-toxic in themselves may react with certain chemicals or decompose at elevated temperatures to produce toxic materials. Adequate ventilation, protective clothing, and suitable breathing equipment must be used to minimize exposure.

F. HIGH PRESSURE

Specialty gases are compressed to pressures up to 6000 psig. A sudden release of pressure may cause serious damage to personnel and equipment by propelling a cylinder or whipping a line. Factors that must be considered when choosing construction materials and designing gas-handling systems are the temperature, the pressure of the gas and the possibility of pressure buildup in the system.

NOTICE!

If you have a requirement or concern not covered in the booklet, contact your equipment supplier for assistance.

WARNING!

Read and observe all warnings and instructions before installing or operating any pressure regulating equipment. Improper application and operation of equipment with high pressure media (inerts, flammables, oxidizers or toxics) can result in damage to equipment or severe personal injury.

INTRODUCTION

Prior to installing or operating any pressure regulation equipment, read and follow the information in this booklet. Improper application and operation of regulators can result in damage to equipment or severe personal injury. All possible hazards and precautionary measures are not covered in this booklet. It is recommended that prior to using gas regulation equipment, you fully understand and comply with all established safety regulations.

SECTION I PRE-INSTALLATION PROCEDURES: COMPRESSED GAS CYLINDERS

WARNING!

Serious accidents can result from improper use and handling of high pressure compressed gas cylinders. Always follow instructions and safety precautions provided by your gas supplier.

WARNING!

Read and observe all warnings and instructions before installing or operating any pressure regulating equipment. Improper application and operation of equipment with high pressure media (inerts, flammables, oxidizers or toxics) can result in damage to equipment or severe personal injury.

Refer to CGA pamphlet page 1 for all regulations which apply to the safe handling and storage of combined gas cylinders.

1. Cylinders should always be kept in the vertical position and secured from falling.
2. Never use compressed gas cylinders without an approved gas pressure reducing regulator attached to the outlet of the cylinders.
3. Do not lubricate compressed gas fittings, gauges, regulators or regulator components.
4. Do not apply sealing tape to cylinder connections.
5. Do not use cylinders with damaged threads. Return the cylinder to your supplier indicating the problem.
6. Do not use cylinder connection adaptors. Use a regulator with the proper compressed gas fitting.

SECTION II PRE-INSTALLATION PROCEDURES: REGULATORS

WARNING

Regulators must be used only with the gases and pressures for which they are designed. Consult a material safety data sheet (MSDS) for media used to determine compatibility of gases and regulator components (available from your gas supplier). Failure to do this can result in an explosion, damage to equipment or severe personal injury.

1. Check the designed pressure rating of the regulator (stamped on the regulator body) and the scale range of the pressure gauges. They must be adequate for the cylinder pressure and the operating pressure.
2. Check that the materials used in the construction of the regulator are compatible with the intended media service.
3. Check that the regulator inlet connection is compatible with the cylinder outlet valve connections.
4. Fit the operating system with a check valve purge assembly and pressure relief devices as required.
5. Do not interchange pressure regulators or other equipment with different gases unless there is knowledge of the compatibility properties of the gases.
6. Do not use regulator equipment for oxygen service that has been in other gas service.

SECTION III INSTALLATION & OPERATION TEST FOR LEAKAGE

WARNING

Check cylinder valve connections and regulator inlet connections for foreign material before connecting. Use a clean dry lint-free cloth to remove contamination. When using oxygen or other oxidizers, it is extremely important that connections are clean and maintained. Failure to do this can result in an explosion, damage to equipment or severe personal injury.

1. Inspect the cylinder valve threads for damage and be sure the cylinder valve is free of oil, grease, dirt or any foreign material.
2. Attach the regulator to the cylinder valve and secure tightly using a wrench.
3. Connect the operation system to the regulator outlet.
4. Turn the regulator adjusting screw counterclockwise until the adjusting screw turns freely (no spring load) or until the adjusting screw is against the mechanical stop. (This allows the regulator valve to close).
5. Close the regulator outlet valve if one is used.

WARNING

Do not place yourself in front of or behind the regulator when opening the cylinder. Place yourself with the cylinder between you and the regulator.

6. Slowly open the cylinder valve until the full cylinder pressure is indicated on the high pressure regulator gauge. Then, open the cylinder valve all the way. This high pressure gauge should read the cylinder pressure. The delivery gauge should read zero.
7. With the valve at the outlet of the regulator closed and the

adjusting screw tension released, leave pressure on the inlet for 5 to 10 minutes. Delivery pressure gauge should not indicate any pressure increase. A pressure increase indicates leakage past the regulator valve seat.

WARNING

If leakage occurs, do not use the regulator.

8. Turn the adjusting screw clockwise to set a normal delivery pressure. If you are unable to attain a desired pressure or the pressure continues to rise above the setpoint, the regulator should not be used.
9. If the unit functioned properly in the previous step, close the cylinder valve and note the readings of both the inlet and delivery pressure gauges. After 5 to 10 minutes, a drop in the reading of either gauge indicates a leak in the system.

NOTICE!

Use an approved oil-free leak detection fluid to locate possible leaks at the inlet, threaded parts, through the regulator diaphragm or through the outlet valve.

10. If a leak is indicated at the inlet or at a threaded port, relieve all pressures from the regulator and retighten the connections. If a leak continues or is found at the diaphragm or outlet valve, do not use the regulator.
11. If the system is determined to be leak free, turn the adjusting screw clockwise until the desired pressure setting is indicated on the delivery pressure gauge.
12. Open the outlet valve to purge the system. Adjust the regulator adjusting screw to obtain the desired pressure setting at the flow conditions.

← CAUTION →

A regulator is not intended to be used as a shut-off device. When not in use, the cylinder valve should be closed. A pressure relief device should be installed downstream of the regulator or outlet valve to protect the process equipment in the case of a rise in operating pressures.

SECTION IV SYSTEM SHUTDOWN

1. Close the cylinder valve.
2. Release all media from the regulator and/or system so that both gauges read zero. If the gas is flammable, an oxidant, corrosive, or toxic, take appropriate measures to render it innocuous by employing suitable disposable system before venting the gas to the atmosphere.
3. Turn the adjusting screw counterclockwise until all spring load is released or the adjusting screw reaches the mechanical stop.
4. Close the outlet valve.
5. Disconnect the regulator.
6. If the regulator is to remain out of service, protect the inlet and outlet fittings from dirt, contamination or mechanical damage.
7. Replace the cylinder valve cap.

SECTION V PERFORMANCE CHARACTERISTICS

The following information is intended to assist you in identifying whether or not your regulator is performing properly.

A. Proper Performance

1. The delivery pressure will drop when flow is started and/or increased.
2. The delivery pressure will rise when flow is stopped. This difference in delivery pressure between flow and no flow condition is called lockup.
3. The delivery pressure of a single stage regulator will increase as the supply/cylinder pressure decays (as the cylinder is emptied). This will not happen with a 2-stage regulator until the supply pressure drops below the first stage set pressure of 250 psig (except 250 psig delivery range regulators, which are set at 400 psig).

B. Improper Performance

1. The delivery pressure continues to rise when flow is stopped (lock-up) without a change in adjusting screw position. This indicates valve seat wear or contamination with foreign materials allowing media to leak to the delivery side. This condition is referred to as "creep". Regulators that creep leakage must not be used until repaired.
2. A significant drop in delivery pressure during normal flow conditions, indicates internal blockage. Check inlet connection filters for contamination. If condition persists, regulator must be repaired.

SECTION VI CARE AND MAINTENANCE

WARNING

Periodic inspection and maintenance of your pressure regulator is essential for continued safe and satisfactory operation. The frequency of servicing will depend on duty cycle and type of media.

Equipment should have monthly inspection and annual maintenance (removing any deposits left by media and replacing any worn or damaged parts) under normal non-corrosive use and conditions. It is also recommended that when the system has high duty cycle or is used in corrosive service, more frequent inspection and maintenance may be necessary. Regulators requiring service repair should be sent to your equipment supplier.

A. Inspection

Use the following steps for regulator inspection:

1. Inspect gauges to assure they read zero when all pressure is released from the system.
2. With adjusting screw turned counterclockwise, to release all spring tension, slowly open cylinder valve. The high pressure gauge should read cylinder pressure and the delivery gauge should read zero.
3. With valve at outlet of regulator closed and adjusting screw tension released, leave pressure on inlet for 5 to 10 minutes. The delivery pressure gauge should not indicate any pressure

increase. A pressure increase indicates leakage past the regulator valve seat.

WARNING

If leakage is indicated, the regulator must be repaired and must not be used.

4. Then, turn adjusting screw clockwise to set a nominal delivery pressure. If unable to attain desired pressure setting or if delivery pressure continues to rise above setpoint, regulator should be repaired.
5. If unit functions properly in the previous step, close cylinder valve and note the readings of both the inlet and delivery pressure gauges. After 5 to 10 minutes a drop in reading of either gauge indicates a leak in the system.

NOTICE

Use an approved oil-free leak detection fluid to locate possible leaks at the inlet, any threaded port, through the regulator diaphragm or through the outlet valve.

6. If leak is at the inlet or at a threaded port, relieve all pressure from the regulator and then tighten. If leak continues or is found at the diaphragm and outlet valve, the regulator must be repaired and must not be used.

B. Storage

1. Regulators taken out of service for extended periods should receive proper care to extend their service life.
2. Regulators used in a non-corrosive media service should be wiped clean with a clean, dry, lint-free cloth and sealed in a plastic bag for storage in a dry area at room temperature.
3. Regulators used in a corrosive media service should be well flushed with dry nitrogen and sealed in a plastic bag. Regulators used for corrosive service may continue to corrode in storage after exposed to atmospheric oxygen and moisture.

C. Repair Service

Any regulator in need of service should be returned to your equipment supplier for evaluation.



APPENDIX III

Instrument Certification Notice



Instrument Certification Notice

The gauge Certificates of Calibration supplied for the gauge(s) on this unit contain the calibration data for the actual instrument calibrated, along with the calibration date of the **STANDARD** used to perform the calibration check.

The due date for re-calibration of the instrument should be based upon the date the instrument was placed in service in your facility. Re-calibration should be done on a periodic basis as dictated by the end user's quality system or other overriding requirements.

Note that Tronair, Inc. does not supply certificates of calibration on flow meters or pyrometers unless requested at the time of placed order. These instruments are considered reference indicators only and are not critical to the test(s) being performed on the aircraft.



APPENDIX IV

Declaration of Conformity



DECLARATION of CONFORMITY

The design, development and manufacture is in accordance with European Community guidelines

18-4306-0000

Relevant provisions complied with by the machinery:
2006/42/EC

Relevant standards complied with by the machinery:
EN ISO 12100-1

Identification of person empowered to sign on behalf of the Manufacturer:

A handwritten signature in black ink that reads "Patrick Finch". The signature is written in a cursive style with a large initial 'P' and 'F'. It is positioned above a solid horizontal line.

Quality Assurance Representative