## CONTENTS

- Principle of Operation, Benefits, Features, Typical Gas Booster Applications ............................................. 2
- Why Use Air Driven Gas Boosters?, International Equivalents .......................................................... 3
- How Do Buyers Choose Between Gas Booster Models? ................................................................. 3, 4
- Determining the Proper Gas Booster Model—Examples ................................................................. 4, 5
- Gas Booster Selection Table and Notes ......................................................................................... 6, 7, 8
- How to Use the Performance Curves, .......................................................................................... 9
- Performance Curves .................................................................................................................. 10, 11, 12
- Installation Dimensions, Weights .................................................................................................. 13, 14
- Standard Modifications .......................................................................................................... 15
- Hydraulics International, Inc. Overview .......................................................................................... 15
- Other HII Products ..................................................................................................................... 16
**PRINCIPLE OF OPERATION**

An air (or gas) driven gas booster has a continuously reciprocating drive piston section directly connected to one or two gas boosting sections, as illustrated in Figure 1. The drive section includes a four-way air cycling valve and dual air pilot valves to provide the continuous reciprocation. Normally, start/stop control is accomplished by cutting off drive- or pilot-air input. (For description of gas section operation, see Page 3, Volumetric Efficiency.)

**Figure 1. Typical Double Acting, Single Drive, Single Stage Unit (Model 5G-DS-Ratio)**

**BENEFITS OF GAS BOOSTERS**

- High pressure capability - up to 25,000 PSI.
- Boost directly from unregulated high pressure gas cylinders or pipelines.
- Maintain gas purity.
- One-man portable.
- No electrical or cooling connections needed.
- Intrinsically safe.
- Boost virtually any noncorrosive industrial or laboratory gas.
- Simple maintenance.
- Mount in any position.
- Weatherproof.

**FEATURES OF GAS BOOSTERS**

- Separation between drive and gas section uses three dynamic seals with dual vents.
- Air drive line lubrication not required.
- Rugged soft-seat, high-flow check valves in gas section(s).
- Only hydrocarbon-free stainless steel, bronze, PTFE and Viton gas section internal parts exposed to gas flow.
- Heat of compression reduced for long seal life because cold exhaust air surrounds gas barrel(s) inside cooling sleeve(s) (see Figure 1, Item 4 above).
- Standard trim is weatherproof and suitable for offshore service.

**TYPICAL GAS BOOSTER APPLICATIONS**

- Pressure Testing Piping and Hardware for Leakage: e.g., oil field, refinery, aircraft, automotive, instrumentation using gases.
- Gas Injection: chemical process, plastic forming.
- Gas Scavenging: collecting costly gas in partially used cylinders and transferring it into high pressure receiver(s) for further use.
- Life Support Gas Transfer and Charging: e.g., oxygen, helium, breathing air, diving, fire fighting/hazmat, aircrew.
- Compressed Natural Gas (CNG) Boosting for vehicle refueling stations.
WHY USE AIR DRIVEN GAS BOOSTERS?

GAS PURITY: Most gases used in industry and life support must be clean and dry. Otherwise, the end use is severely compromised. Gases needing purity include argon(Ar), carbon dioxide(CO₂), helium(He), hydrogen(H₂), neon(Ne), nitrogen(N₂), nitrous oxide(NO₂), oxygen(O₂) and breathing air. If gas purity is needed, all devices used to transfer gas or increase gas pressure must be completely dry and free of any lubricants. Hydraulics International, Inc.’s (HII’s) air driven gas boosters satisfy this requirement. No hydrocarbon lubrication is needed in the gas sections because the high pressure pistons slide on inert PTFE dynamic seals. And because gas barrel temperature is controlled with the cold drive air exhaust, long seal life is ensured.

HIGH PRESSURE OUTLET: Most mechanically driven gas compressors can only handle 5,000- to 6,000-PSI requirements. Mechanically driven units that can handle over 6,000 PSI are rare and costly. If gas purity is required, most of these higher-PSI units need high-pressure and high-maintenance purifiers installed—to compensate for hydrocarbon carryover created by oil-lubricated pistons. Air driven gas boosters do not suffer from these shortcomings and are therefore better suited for higher-PSI applications. HII’s standard air driven models are hydrocarbon-free and available in 50- to 25,000-PSI capacities.

BOOST DIRECTLY FROM HIGH PRESSURE GAS CYLINDERS: A mechanical compressor cannot inhale common industrial gas cylinder pressure. The inlet pressure must be reduced, usually close to 0 PSI. This is a costly waste of energy. Air driven gas boosters have no such limitation, greatly enhancing the efficiency and simplicity of high pressure gas applications where the gas source is typically supplied from portable DOT cylinders.

When are compressors better than air driven gas boosters?

LOW-PRESSURE GAS SUPPLY: Compressor design typically provides piston speeds 10 to 20 times faster than air driven gas boosters. The output of the compressor at 0 PSI inlet is therefore 10 to 20 times higher than the gas booster’s. For the gas booster to compete, the gas supply inlet pressure should be 10 to 20 times higher (10 to 20 ATM, i.e., 150 PSI or better).

GAS PURITY UNIMPORTANT: Lubricated compressors are already designed to handle the contamination of their own lubrication. If the supply gas is also not clean, the compressor probably is not bothered. But the air driven gas booster is designed to depend on a pure, oil-free, water-free gas supply.

When can air driven gas boosters and mechanically driven compressors work together?

USE A MECHANICAL COMPRESSOR FROM LOW PRESSURE TO MEDIUM PRESSURE (e.g., 3,000 PSI), THEN PURIFY. THEN BOOST TO HIGH PRESSURE WITH A GAS BOOSTER. This classic setup uses the attributes of each machine to complement the other. It has, for example, become the accepted combination for high pressure breathing air fill systems worldwide:

SCBA - (Self Contained Breathing Apparatus) and SCUBA - (Self Contained Underwater Breathing Apparatus).

INTERNATIONAL EQUIVALENTS QUICK REFERENCE

| VOLUME: | 1 Litre = 61 In³ = .26 US Gal. |
| PRESSURE: | 1 BAR = 14.5 PSI = 1.02 Kg/Cm² = 100 Kpa = .986 Absolute ATM |
| WEIGHT: | 1 Kg = 2.2 Lb. |
| LENGTH: | 1 In = 25.4 mm |

HOW DO BUYERS CHOOSE BETWEEN GAS BOOSTER MODELS?

EFFICIENCY vs. COST

The selection of most production equipment involves an efficiency/cost trade-off. In the case of gas boosters, considering the frequency of usage (sporadic vs. continuous) and type of usage (light vs. heavy duty) helps in the trade-off decision. For continuous heavy-duty usage, an efficient gas booster will pay for itself in reduced power consumption (drive air) and lower maintenance. If usage will be sporadic and light duty, meaning that the maximum amount of gas is moved from the unswept into swept space. If the gas is compressed to a very high ratio during the compression stroke, the unswept gas may come back during the suction stroke at a residual pressure high enough that the inlet supply pressure cannot open the inlet check valve. When this happens, volumetric efficiency and outlet gas flow reach zero, i.e., the unit has reached its maximum compression ratio; (chart 1, page 4).

At the other extreme, the gas in the unswept spaces is compressed very little by the compression stroke. In this case, as soon as the gas piston starts back on its suction stroke, the swept pressure immediately drops below the inlet supply pressure, the inlet check valve pops open, and a full charge of fresh gas is inhaled by the swept volume of the suction stroke. Volumetric efficiency reaches about 99%, meaning that the maximum amount of gas is moved from the gas supply to the outlet receiver during each cycle. Here the compression ratio is very low.

1 A few manufacturers do offer higher-PSI gas compressors that have oil-free dry pistons or oil-free metal diaphragms. These units are costly and limited in supply; they are usually used only in chemical-process and corrosive-gas applications.
Volumetric efficiency of gas boosters is affected by unswept space, internal leakage, and compression ratio. HII’s gas boosters are designed and manufactured to ensure unswept space is minimal and internal leakage is nonexistent. The compression ratio is therefore the most important factor to consider in selecting which HII model will provide the highest volumetric efficiency. To calculate or estimate the compression ratio, the outlet and inlet gas pressures must be known. If both outlet and inlet gas pressure are less than or equal to 5,000 PSI:

\[
\text{Compression Ratio} = \frac{\text{Outlet PSIA}}{\text{Inlet PSIA}}
\]

where both values < 5,000 and PSIA = PSI + 14.7.

If either inlet gas pressure or outlet gas pressure exceeds 5,000 PSI, consult Chart 2 below and calculate the compression ratio as:

\[
\text{Compression Ratio} = \frac{\text{Compress Factor for Outlet PSI}}{\text{Compress Factor for Inlet PSI}}
\]

where either value > 5,000.

*DIf inlet gas pressure is less than or equal to 5,000 PSI, the Compress Factor for Inlet PSI (to be plugged into above equation) can be estimated from Chart 2 or calculated as:

\[
\text{Compress Factor for Inlet PSI} = \frac{(\text{Inlet PSI} + 14.7)}{14.7}
\]

**DETERMINING THE PROPER GAS BOOSTER MODEL—EXAMPLES**

**Example 1:** You have marginal 100 PSI shop air drive pressure and need to test pressure gauges or transducers occasionally in your lab to 3,000 PSI minimum. Gas supply is high-purity helium in cylinders at 2,000 PSI. You should leave no more than 10% of the helium before returning the cylinder to your gas supplier.

Duty: light (occasional use, small test volumes).

Compression ratio, depleted cylinder (worst case):

\[
\frac{3014.7 \text{ PSIA Outlet}}{201.47 \text{ PSIA Inlet (10% of 2014.7)}} = 15 : 1
\]

Compression ratio, fresh cylinder (best case):

\[
\frac{3014.7 \text{ PSIA Outlet}}{2014.7 \text{ PSIA Inlet}} = 1.5 : 1
\]

MODEL SELECTION: Single Acting, Single Drive, Single Stage (lowest cost). Per Chart 1, Line 2, efficiency is about 40% at 15:1 (worst) to 98% at 1.5:1 (best).

From the stall point data, Table 1 on Page 6, pick a model that will easily reach 3,000 PSI with less than 100 PSI drive (Model 5G-SS-50). If time-to-test predictions are important, use the curves on Page 10 to estimate output flows as inlet pressure decreases.

**Example 2:** Assume same helium, same 3,000 PSI minimum, and same marginal 100 PSI shop air drive pressure as Example 1. But this time, your job is to charge 100-gallon gas receivers (for saturation divers) on a diving contractor’s barge.

Duty: heavy daily use.

Same compression ratios as Example 1.

At 3,000 PSI, the 100 Gal. receiver holds 2742 SCF:

\[
100 \text{ Gal.} \times \frac{3014.7 \text{ PSIA}}{14.7 \text{ PSIA}} = 2742 \text{ SCF}
\]

MODEL SELECTION: Two Stage for High Efficiency. Per Chart 1, Line 1, efficiency is about 85% at 15:1 (worst) to 98% at 1:5:1 (best).

From the stall point data, Table 1 on Page 6, pick a model that will reach 3,000 PSI with 95 PSI drive, yet not be subject to interstage stall (see Note (c) on Page 8). Model 5G-TS-30/50 appears to meet this requirement. But if outlet flow for this model (per curve on Page 10) is marginal to meet receiver fill time required, there are two potential solutions. Your could use multiple two stage units; or set up two or more double acting, single stage models in a series to provide two stages of compression, as illustrated in Example 4 on Page 5.
DETERMINING THE PROPER GAS BOOSTER MODEL—EXAMPLES (continued)

Example 4: A large-metropolitan ambulance service purchases liquid oxygen (LOX) because of the high volume consumed daily. The cost saved per cubic foot of oxygen is substantial vs. buying the gas in cylinders. (Purchasing LOX was recommended by their O2 supplier when their consumption began to exceed 50 cylinders per month.) Their on-site LOX storage is a large insulated "customer station" tank, refilled regularly by LOX tank truck. The external vaporizer coils of the tank provide O2 at 200 PSI maximum. They need to fill small 2,000 PSI oxygen bottles for the ambulance fleet seven days a week, four to five hours per day. Duty: heavy (8 to 10 SCFM outlet flow specified from a constant low pressure source).

Compression ratio, worst case:
\[
\frac{550 \text{ Compress Factor for Outlet PSI}}{273 \text{ Compress Factor for Inlet PSI}} = 2:1
\]

MODEL SELECTION: Single Stage, Double Acting, Double Drive to be able to reach 17,500 PSI. Per Chart 1, Line 2, efficiency is about 90% at 2:1.

See stall-point data on Table 1, Page 6. Note that no single acting, single stage model can reach 17,500 PSI with 95 PSI drive, but double acting model 5G-DD-150 can. Two-stage models-28/150 and -60/150 cannot accept the 4,000 PSI inlet for reasons discussed in Notes (b) and (c) on Page 8.

Example 3: You have a constant 4,000 PSI nitrogen supply (from an LN2, 4,000 PSI pump and vaporizer); on a semi-monthly basis, you need to leak-check oil field valves to 17,500 PSI per API specification. Shop air drive pressure of about 100 PSI is available.

Duty: moderate.

Per Chart 2, Compress Factor for 17,500 PSI outlet is 550.

Compress Factor for 4,000 PSI Inlet is 273 obtained by using Chart 2 or the Compress Factor for Inlet PSI equation (4014.7 PSIA/14.7 PSIA).

Per Chart 1, Line 2, efficiency is about 90% at 2:1.

See stall-point data on Table 1, Page 6. Note that no single acting, single stage model can reach 17,500 PSI with 95 PSI drive, but double acting model 5G-DD-150 can. Two-stage models-28/150 and -60/150 cannot accept the 4,000 PSI inlet for reasons discussed in Notes (b) and (c) on Page 8.

MODEL SELECTION: Two Stage, Using Two Single Stage Boosters Piped in a Series.

Using the curves on Pages 10-12 and the guide on Page 9, the proper staged combination would be:
First stage: Model 5G-DS-7
Second stage: Model 5G-DD-28

Per Chart 1, Line 2, assuming each unit will see about half the compression ratio (4.7:1), efficiency is about 85% for each unit.

\[
\text{Composition ratio (worst case):} \quad \frac{2014.7 \text{ PSIA Outlet}}{214.7 \text{ PSIA Inlet}} = 9.4:1
\]

Another possible second stage model is 5G-DS-30. But this lower-cost model has less than half the displacement per cycle of Model 5G-DD-28, causing higher potential maintenance.
<table>
<thead>
<tr>
<th>Model (Note: Final Dash No. is Area Ratio)</th>
<th>Schematic Symbol</th>
<th>Approximate Stall Point: ( \text{Area Ratio} \times \text{Drive Air PSI} + \text{Assist Factor} \times \text{Gas Inlet PSI} )</th>
<th>Approximate Practical Pressures Based on 85 PSI Drive, 50% Efficiency w/N₂</th>
<th>Maximum Safe Pressure(8) PSI</th>
<th>Actual In³ Per Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Acting, Single Drive (Single Stage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 5G-SS-7</td>
<td>7 x Drive Air (No assist from gas inlet)</td>
<td>650 50 2,500 2,500 13.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 5G-SS-14</td>
<td>14 x Drive Air (No assist from gas inlet)</td>
<td>1,300 100 4,500 4,500 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 5G-SS-30</td>
<td>30 x Drive Air (No assist from gas inlet)</td>
<td>2,800 200 9,000 9,000 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 5G-SS-50</td>
<td>50 x Drive Air (No assist from gas inlet)</td>
<td>4,500 300 15,000 15,000 1.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 5G-SS-75</td>
<td>75 x Drive Air (No assist from gas inlet)</td>
<td>7,000 500 25,000 25,000 1.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Acting, Double Drive (Single Stage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 5G-SD-60</td>
<td>60 x Drive Air (No assist from gas inlet)</td>
<td>5,700 400 9,000 9,000 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 5G-SD-100</td>
<td>100 x Drive Air (No assist from gas inlet)</td>
<td>9,000 450 15,000 15,000 1.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 5G-SD-150</td>
<td>150 x Drive Air (No assist from gas inlet)</td>
<td>14,000 500 25,000 25,000 1.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Acting, Single Drive (Single Stage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. 5G-DS-4</td>
<td>(4 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>400 50 1,250 1,250 24.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 5G-DS-7</td>
<td>(7 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>700 50 2,500 2,500 26.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. 5G-DS-14</td>
<td>(14 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>1,400 100 4,500 4,500 14.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. 5G-DS-30</td>
<td>(30 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>3,000 200 9,000 9,000 6.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. 5G-DS-50</td>
<td>(50 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>5,000 300 15,000 15,000 3.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. 5G-DS-75</td>
<td>(75 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>7,500 500 25,000 25,000 2.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Acting, Double Drive (Single Stage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. 5G-DD-14</td>
<td>(14 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>1,400 100 2,500 2,500 26.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. 5G-DD-28</td>
<td>(28 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>2,800 180 4,500 4,500 14.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. 5G-DD-60</td>
<td>(60 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>6,000 400 9,000 9,000 6.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. 5G-DD-100</td>
<td>(100 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>10,000 450 15,000 15,000 3.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. 5G-DD-150</td>
<td>(150 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>14,500 500 25,000 25,000 2.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Stage, Single Drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. 5G-TS-4</td>
<td>(4 x Drive Air) + (1.00 x Gas Inlet)</td>
<td>380 10 (b) 1,250 1,250 (b) 12.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. 5G-TS-14/14</td>
<td>(14 x Drive Air) + (2.00 x Gas Inlet) (b,c)</td>
<td>1,350 30 (b) 4,500 2,500 (b) 13.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. 5G-TS-7/30</td>
<td>(30 x Drive Air) + (4.29 x Gas Inlet) (b,c)</td>
<td>3,000 60 (b) 9,000 2,500 (b) 13.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. 5G-TS-14/30</td>
<td>(30 x Drive Air) + (2.14 x Gas Inlet) (b,c)</td>
<td>2,900 60 (b) 9,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. 5G-TS-14/50</td>
<td>(50 x Drive Air) + (3.57 x Gas Inlet) (b,c)</td>
<td>4,500 100 (b) 45,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. 5G-TS-14/75</td>
<td>(75 x Drive Air) + (5.36 x Gas Inlet) (b,c)</td>
<td>7,700 150 (b) 25,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. 5G-TS-30/50</td>
<td>(50 x Drive Air) + (1.66 x Gas Inlet) (b,c)</td>
<td>5,000 500 (b) 15,000 9,000 (b) 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. 5G-TS-30/75</td>
<td>(75 x Drive Air) + (2.50 x Gas Inlet) (b,c)</td>
<td>7,500 130 (b) 25,000 9,000 (b) 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. 5G-TS-30/92</td>
<td>(92 x Drive Air) + (3.06 x Gas Inlet) (b,c)</td>
<td>9,000 150 (b) 25,000 9,000 (b) 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. 5G-TS-50/92</td>
<td>(92 x Drive Air) + (1.84 x Gas Inlet) (b,c)</td>
<td>9,000 600 (b) 25,000 15,000 (b) 1.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Stage, Double Drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. 5G-TD-14/28</td>
<td>(28 x Drive Air) + (2.00 x Gas Inlet) (b,c)</td>
<td>2,600 200 (b) 4,500 2,500 (b) 13.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. 5G-TD-14/60</td>
<td>(60 x Drive Air) + (4.28 x Gas Inlet) (b,c)</td>
<td>6,000 200 (b) 9,000 2,500 (b) 13.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. 5G-TD-28/60</td>
<td>(60 x Drive Air) + (2.14 x Gas Inlet) (b,c)</td>
<td>6,000 120 (b) 9,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. 5G-TD-28/100</td>
<td>(100 x Drive Air) + (3.57 x Gas Inlet) (b,c)</td>
<td>10,000 500 (b) 15,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. 5G-TD-28/150</td>
<td>(150 x Drive Air) + (5.36 x Gas Inlet) (b,c)</td>
<td>14,500 150 (b) 25,000 4,500 (b) 7.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. 5G-TD-60/100</td>
<td>(100 x Drive Air) + (1.66 x Gas Inlet) (b,c)</td>
<td>10,000 1000 (b) 15,000 9,000 (b) 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. 5G-TD-60/150</td>
<td>(150 x Drive Air) + (2.50 x Gas Inlet) (b,c)</td>
<td>14,000 150 (b) 25,000 9,000 (b) 3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Model Designation System

**EXAMPLE: 5G-TS-30/75-X**  
Two Stage, Single Drive  
Nominal Area Ratios 30:1 and 75:1  
External Pilot Modification

**BOX 1: Gas Booster Type**  
- S - Single Acting  
- D - Double Acting  
- T - Two Stage

**BOX 2: Air Drive Option**  
- S - Single Drive Section  
- D - Double Drive Section

**BOX 3: Ratio—Single Stage Boosters Only**  
Nominal Ratio of Air Drive Piston(s) Area vs. Gas Piston(s) Area

**BOX 4: Ratio—Two Stage Boosters Only**  
Nominal First Stage Area Ratio/Second Stage Area Ratio

**BOX 5: Modifications (See Page 15)**  
- N - Lapped Cycling Valve Assembly  
- O - Oxygen Gas Service to 5,000 PSI  
- V - Viton Seals in the Air Drive Section  
- X - External Pilot Port on Air Drive Section

---

A multistage system package for boosting argon to 15,000 PSI from a liquid argon vaporizer.
TABLE 1 NOTES

(a) Maximum safe pressure. (Page 6) is based on a minimum 4:1 safety factor of the ultimate strength of the hardware exposed to this pressure. But this safe pressure could be exceeded due to external sources, such as thermal expansion or the use of other inlet boosters or compressors, or due to the action of the booster itself (e.g., high inlet pressure or high drive pressure). In these cases, safety relief valve or rupture disk protection must be provided.

(b) On TWO STAGE MODELS (Page 6, Items 20-36) the maximum allowable interstage pressure during the interstage stroke will be the same as the maximum safe inlet pressure. To determine potential maximum interstage pressure and whether an interstage relief valve would be needed:

First, find the model's net ratio in Table 2. (Net ratio is the air drive area vs. the first stage piston area minus the second stage piston area.)

Second, use the air drive PSI and net ratio to calculate maximum potential interstage pressure

Maximum potential interstage pressure = Air Drive PSI x Net Ratio

Finally, compare maximum potential interstage pressure to maximum safe inlet pressure. If the former exceeds the latter, an interstage relief valve is needed.

Examples using 100 PSI air drive: Model 5G-TS-7/14 does not need an interstage relief valve because maximum potential interstage pressure of 1,400 (100 x 14) is less than maximum safe inlet pressure of 2,500. With Model 5G-TC-28/60, an interstage relief valve set at 4,500 PSI is needed because maximum potential interstage pressure of 5,250 (100 x 52.5) exceeds maximum safe inlet pressure of 4,500.

(c) Interstage stall on two stage models (Items 20-36, Page 6). The swept volume of the first stage is always larger than that of the second stage. To complete its interstage stroke, the first stage must compress and move its gas volume into the second stage. The amount of compression will be the assist factor x the inlet PSI. But the drive may not be able to do this because its force is limited by its net ratio and it may stall (on the interstage stroke only). (See Table 2 for assist factors.)

Example using 100 PSI air drive and Model 5G-TS-14/30: Per Note (b) equation, maximum potential interstage pressure is 2,625 PSI; this is the maximum PSI the model can generate in its first stage. So if inlet gas is at 1,200 PSI (and system outlet maximum potential interstage pressure is 2,625 PSI; this is the maximum PSI the booster can generate in its first stage. So if inlet gas is at 1,200 PSI (and system outlet maximum potential interstage pressure of 2,500. With Model 5G-TC-28/60, an interstage relief valve set at 4,500 PSI is needed because maximum potential interstage pressure of 5,250 (100 x 52.5) exceeds maximum safe inlet pressure of 4,500.

Interstage stall poses no harm to the gas booster and no safety hazard. To release the stall and allow the booster to cycle normally, simply throttle the inlet gas line. This maneuver reduces the gas incoming volume and pressure enough to prevent stall. Eventually, the gas supply cylinder(s) in this example will deplete below 1,226 PSI, making interstage stall impossible (2,625 maximum potential interstage pressure/2.14 = 1,226.6).

(d) Combination port: This port will accept either:

• a 3/8" SAE tube fitting or adapter with O-ring or

• a 1/4" super pressure fitting with heavy wall, threaded and coned, 1/4" O.D. x .083 wall, S.S. tube (as illustrated).

Correct selection for gas service:

SAE O-ring boss fittings: up to 6,000 PSI; and 1/4" super pressure tube and fitting: 6,000 thru 25,000 PSI.

(e) 1/4" Super pressure only. This port will only accept a 1/4" super pressure fitting with heavy wall, threaded and coned 1/4" O.D. tubing.

(f) Double acting models include high pressure stainless steel tubing and fittings. Common tees connect the tubing and fittings to the outlet and inlet ports; see Table 3 for details and Table 1, Items 10-19, Page 6 for schematic symbols. Using this tubing, maximum safe pressures are the same as shown in Table 1 except as noted beneath Table 3.

Table 2. Net Ratios and Assist Factor of Two Stage Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Net Ratio</th>
<th>Assist Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5G-TS-7/14</td>
<td>14:1</td>
<td>2:1</td>
</tr>
<tr>
<td>5G-TS-7/30</td>
<td>9.13:1</td>
<td>4.29:1</td>
</tr>
<tr>
<td>5G-TS-14/30</td>
<td>26.25:1</td>
<td>2.14:1</td>
</tr>
<tr>
<td>5G-TS-14/50</td>
<td>19.44:1</td>
<td>3.57:1</td>
</tr>
<tr>
<td>5G-TS-14/75</td>
<td>17.2:1</td>
<td>5.36:1</td>
</tr>
<tr>
<td>5G-TS-30/50</td>
<td>75:1</td>
<td>1.66:1</td>
</tr>
<tr>
<td>5G-TS-30/75</td>
<td>50:1</td>
<td>2.5:1</td>
</tr>
<tr>
<td>5G-TS-30/92</td>
<td>44.52:1</td>
<td>3.06:1</td>
</tr>
<tr>
<td>5G-TS-50/92</td>
<td>109.5:1</td>
<td>1.84:1</td>
</tr>
<tr>
<td>5G-TD-14/28</td>
<td>28:1</td>
<td>2:1</td>
</tr>
<tr>
<td>5G-TD-14/60</td>
<td>18.26:1</td>
<td>4.28:1</td>
</tr>
<tr>
<td>5G-TD-28/60</td>
<td>52.5:1</td>
<td>2.14:1</td>
</tr>
<tr>
<td>5G-TD-28/100</td>
<td>38.89:1</td>
<td>3.57:1</td>
</tr>
<tr>
<td>5G-TD-28/150</td>
<td>34.4:1</td>
<td>5.36:1</td>
</tr>
<tr>
<td>5G-TD-60/100</td>
<td>150:1</td>
<td>1.66:1</td>
</tr>
<tr>
<td>5G-TD-60/150</td>
<td>100:1</td>
<td>2.5:1</td>
</tr>
</tbody>
</table>

Table 3. Data on Standard Tee Connections and Tubing Included on Double Acting Models

<table>
<thead>
<tr>
<th>Model No.</th>
<th>User Connection at Tee</th>
<th>Outlet</th>
<th>Inlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>5G-DS-7</td>
<td>37° Flare 1/2&quot;</td>
<td>37° Flare 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DS-14</td>
<td>37° Flare 1/4&quot;</td>
<td>37° Flare 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DS-30</td>
<td>37° Flare 1/4&quot;</td>
<td>37° Flare 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DS-50</td>
<td>37° Flare 1/4&quot;</td>
<td>37° Flare 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DS-75</td>
<td>Super Pr. 1/4&quot;</td>
<td>Super Pr. 1/4&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DD-14</td>
<td>37° Flare 1/2&quot;</td>
<td>37° Flare 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DD-28</td>
<td>37° Flare 1/4&quot;</td>
<td>37° Flare 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DD-60</td>
<td>37° Flare 1/4&quot;</td>
<td>37° Flare 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DD-100</td>
<td>37° Flare 1/4&quot;</td>
<td>Super Pr. 1/4&quot;</td>
<td></td>
</tr>
<tr>
<td>5G-DD-150</td>
<td>37° Flare 1/4&quot;</td>
<td>Super Pr. 1/4&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Selected SAE Port and Fitting Detail

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HII</td>
<td></td>
<td></td>
<td></td>
<td>-4</td>
<td>-6</td>
<td>-8</td>
<td>-10</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td>351</td>
<td>.072</td>
<td>7/16-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.488</td>
<td>.078</td>
<td>9/16-18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.644</td>
<td>.087</td>
<td>3/4-16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.755</td>
<td>.097</td>
<td>7/8-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.924</td>
<td>.116</td>
<td>1 1/16-12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HOW TO USE THE PERFORMANCE CURVES

MULTIPLE BOOSTERS PIPED IN SERIES

Example:

As described above, the higher the gas inlet pressure, the higher the outlet flow capability.

If the model selected can reach the final outlet pressure needed, but is short on outlet flow at that pressure, piping two gas boosters in a series is the solution. In this case, the "pre-booster" provides more-or-less constant elevated gas-inlet pressure to the "final" booster.

Example: See curves above. Model 5G-DS-7 curves show it can provide 20 SCFM outlet to the 5G-DD-28 inlet at 850 PSI or more, from a 400 PSI gas inlet source (Point 2). Model 5G-DD-28 will provide about 20 SCFM outlet flow at 2,850 PSI (Point 1) if the gas inlet PSI is held at 850 PSI.

Continuous duty applications can often justify the cost of multiple units (e.g., Example 4, Page 5). Maintenance is reduced because the final booster does its job with fewer cycles. If the gas is purchased in cylinders, gas cost is reduced because less gas remains in the cylinders that are returned to the vendor.

Air drive source for staged boosters should be from 3/4" ID piping or larger.
PERFORMANCE CURVES—Assume an air drive source of approximately 95 PSI from 1/2” ID piping.

Dashed lines represent approximate air drive consumption
(A) 15 SCFM   (B) 30 SCFM   (C) 50 SCFM   (D) 75 SCFM
PERFORMANCE CURVES—Assume an air drive source of approximately 95 PSI from 1/2” ID piping.

Dashed lines represent approximate air drive consumption

(A) 15 SCFM   (B) 30 SCFM   (C) 50 SCFM   (D) 75 SCFM
PERFORMANCE CURVES—Assume an air drive source of approximately 95 PSI from 1/2” ID piping.

Dashed lines represent approximate air drive consumption
(A) 15 SCFM   (B) 30 SCFM   (C) 50 SCFM   (D) 75 SCFM
INSTALLATION DETAIL CONT.  (Refer to Page 6 for item numbers)

DIMENSIONAL DATA

DD SERIES ITEMS 15, 16, 17, 18, 19

TS SERIES ITEM 20

ITEMS 21, 22, 23, 24, 25, 26, 27, 28, 29

TD SERIES ITEMS 30, 31, 32, 33, 34, 35, 36
STANDARD MODIFICATIONS

Order any gas booster modification by specifying the modification letter after the model number.

- **“N” Lapped Cycling Valve Assembly**: Designed for continuous duty applications where it is impractical to periodically grease and maintain the standard O-ring sealed spool. It should also be considered where the drive air or gas contains vapors that may swell rubber O-rings, or where the drive is extremely wet or extremely dry making O-ring grease difficult to maintain. This assembly consists of a lapped, match fit, spool and sleeve.

- **“O” Oxygen Gas Service to 5,000 PSI**: Before gas booster shipment, HII verifies suitability for pure O₂ using special high-pressure O₂ test. Labels attached to gas booster note oxygen rating and maximum pressure. Not available for -4 models.

  **Warning**: To avoid accidental contamination, mount gas booster horizontally and do not use gases other than oxygen.

- **“V” Viton Sealed Drive Section**: HII replaces all Buna static and dynamic seals in the drive section of the gas booster. This modification provides chemical resistance if drive air or gas has entrained substances incompatible with Buna. Examples of Buna-incompatible substances include hydrogen sulfide and some synthetic lubricants used in shop air compressors.

- **“X” External Pilot Port on Air Drive Section**: Enables start/stop control of the air drive using a small shutoff valve provided by end user. Connection is 1/4” SAE Boss. A simple kit is also available for conversion to external air pilot in the field.

HYDRAULICS INTERNATIONAL, INC. OVERVIEW

Founded in 1976, HII has evolved into a fully integrated manufacturer of hydraulic and pneumatic test equipment. HII maintains four modern facilities; three in Chatsworth, California and one in Forsyth, Georgia, totaling 690,000 square feet.

Along with air driven liquid pumps, HII offers air driven gas boosters, air pressure amplifiers, flowmeters, sophisticated custom systems and components. HII products are designed and manufactured in the USA.

OTHER HII QUALITY PRODUCTS

AIR DRIVEN LIQUID PUMPS
- Self lubricating
- No electrical power needed
- Portable, lightweight and economical
- Wide range of models in 3”, 5 3/4” and 7” drive sizes
- Pressures up to 80,000 PSI (5517 BAR)
- All models are rated for plain water or oil
- Ideal for OEM applications

ELECTRIC DRIVEN GAS BOOSTERS
- Boosts pressure from 50 PSI (3.4 BAR) to 10,000 PSI (689 BAR)
- Two-man portable
- Uses no belts or pulleys
- Quiet, only 65 dBA
- Offered in double acting and 2-stage configuration

AIR DRIVEN AIR PRESSURE AMPLIFIERS
- Boosting shop air to pneumatic tools, cylinders and devices
- Boosting shop air to drive high-pressure pneumatic diaphragm transfer pumps
- Boosting shop air to start oilfield and marine diesel engines
- Maximizing efficiency at pneumatic workstations or machinery
- Tire pressure top off on large mining vehicles
- Replace bottled nitrogen for gas testing, lab or production, up to 700 psi (48.3 BAR)

FLOWMETRICS
- Liquid Flowmeters - to 15,000 GPM (56,781 lit/min)
- Gas Flowmeters - to 15,000 CFM (425 Nm3/min)

COMPONENTS
- Check valves - up to 20,000 PSI (1379 BAR), up to 2”
- Needle valves - straight or angled to 5,000 PSI (345 BAR)
- In-line filters rated to 5,000 PSI (345 BAR), 3 to 25 micron
- Double acting hand pumps - to 3,000 PSI (207 BAR)
- Pressure relief valves - to 60,000 PSI (4137 BAR)

SYSTEMS
- Aircraft Ground Support Equipment (portable & stationary)
- Component Test Equipment
- Customer Designed Equipment
- Central Systems
- Commercial and Military Applications
- Self Propelled Aerial Lift Truck

Our products are designed, sourced and manufactured in the U.S.A.

HYDRAULICS INTERNATIONAL, INC.
9201 Independence Avenue, Chatsworth, CA 91311 USA
Tel: (818) 407-3400 • Fax: (818) 407-3428 • Email: sales@hiipumps.com
hiigroup.com

© HYDRAULICS INTERNATIONAL, INC. 2015