LPG Equipment Training Manual
INDEX: Blackmer LPG Pumps and Compressors

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Dover Resources / Dover Corp.

A multi-billion dollar corporation comprised of over 100 industrial manufacturing facilities.

Committed to being a leader in each market it serves via:
- Product Quality
- Innovation
- Responsive Service
- Long-term Orientation to the Market
blackmer - A Worldwide Supplier of Rotary Liquid Pumps and Gas Compressors

Over 100 years of experience:

1901 Robert Blackmer invents first rotary-vane pump.
1903 Company incorporates in Petoskey, Michigan as Blackmer Pump, Power and Manufacturing Co.
1914 Blackmer becomes supplier to U.S. military.
1915 Blackmer originates first truck-mounted pump.
1925 Blackmer relocates to Grand Rapids, Michigan; establishes foundry.
1950 Integral mechanical seal pump introduced.
1954 First liquefied gas pumps designed.
1964 Company is purchased by the Dover Corporation.
1968 Stainless steel non-galling pump introduced.
1980 First Blackmer compressor introduced.
1987 ML4 modular pump line introduced.
1990 'HD' industrial compressors introduced.
1991 Company name changed from 'Blackmer Pump' to 'Blackmer' to reflect growing product line.
1991 Seal-less technology pumps introduced.
1993 Grand Rapids plant received ISO-9001 certification.
1994 Acquired Tarby, a progressing cavity pump manufacturer.
1995 Oklahoma City plant received ISO-9001 certification.
1997 Acquired Mouvex, a pump manufacturer in France.
2000 Acquired System One centrifugal pumps.

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Blackmer is a manufacturer with total responsibility for the design, production and sales of its products.

Engineering - Design the Products

Foundry - Produce the Castings

Manufacturing / Assembly - Build the Products

Sales / Marketing - Determine the Markets. Work with our distribution channels and end users to ensure that our products meet or exceed the needs of the marketplace.
Engineering - Design the Product

Professional Engineers

FEA - Finite Element Analysis

CAD - Computer Aided Design

Testing Laboratories
Foundry - Produce the Castings

Cast Iron

Ductile Iron

State of the art sand castings

State of the art Electric Furnaces

Heat Treating Facilities

Test Facilities

Quality Control
Manufacturing / Assembly
- Build the Products

Two Plants: Grand Rapids, MI - Vane Pumps, Handpumps, System One Pumps, Recip. Compressors, Gear Reducers Auxerre, France - Mouvex Pumps, Hydrive, Enterprise Compressors

Computer Controlled Machining Centers

All finished products are tested before shipment

Quality Control, ISO-9001 Certified
Sales / Marketing
- Present the Product to the Customer

Market Managers -
  Ensure that products match market needs.

Application Engineers -
  Select the best solution for each application.

Customer Service -
  Ensure that orders are processed smoothly.

Field Sales -
  Train and Backup Distributors / Agents.
  Strive for Complete End User Satisfaction.
Blackmer: Major Markets

Government Contract Products

Mobile Transfer Equipment
Fuel Oil Truck Pumps and Accessories
Pumps for Bulk Liquid Transports & Trailers

Fluid Processing and Transfer Pumps
Pumps for Lube Oil, Asphalt, Solvents, Inks, Paints, Abrasives, Syrups, Caustics, Soaps, Latex, Molasses, etc.

Liquefied and Compressed Gas Equipment
LPG & NH₃ Transfer Pumps & Compressors
Transfer or Recovery of Carbon Dioxide, Refrigerants, other Liquefied Gasses, various Industrial gases.
International Marketing

A Global Network
# Selected Blackmer Customers

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<tr>
<th>General Motors</th>
<th>Shell</th>
<th>PPG</th>
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<td>Federal-Mogul</td>
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<td>R.J. Reynolds</td>
<td>GTE</td>
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<td>China Petroleum</td>
<td>Croda Inks</td>
<td>Chevron</td>
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<tr>
<td>Fairchild Aircraft</td>
<td>Wal-Mart</td>
<td>Tadlagaz</td>
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Blackmer Products

Rotary-Vane Positive Displacement Pumps
1" to 10" Ports
Cast Iron, Ductile Iron, Steel, Stainless Steel
Packed, Mechanical Seals, Sealless

Hand Pumps

Pump Related Equipment
Relief Valves
Gear Reducers
Hydraulic Oil Cooling Systems
DMX Air Elimination Systems

Abaque Peristaltic Hose Pumps

System One Centrifugal Pumps

Enterprise Rotary Vane Compressors

Gas Compressors
2 to 50 HP (1.5 to 37 KW)
Ductile Iron Construction
Single-Stage / Two-Stage • Air-Cooled / Water-Cooled

Unit Packages
Per Customer Specification
Transfer of LPG with Blackmer Liquid Pumps

Transport to Storage
Bobtail to Storage
Storage to Cylinder

Storage to Rail
Storage to Bobtail
Storage to Vaporizer
What is LPG?

LPG: Liquefied Petroleum Gas

Usually refers to Propane, Butane or a mixture of Propane and Butane.

Used as a fuel in Homes, Business, and Industry.

Transported and Stored as a Liquid

Readily converted: Liquid ↔ Gas

<table>
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<tr>
<td></td>
<td>0.51</td>
<td>0.58</td>
</tr>
<tr>
<td>Liquid @ 60°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water = 1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vapor Pressure</td>
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<td></td>
</tr>
<tr>
<td>at 32°F (0°C)</td>
<td>psia</td>
<td>bar-a</td>
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<tr>
<td></td>
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<td>105.5</td>
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</tr>
<tr>
<td>at 100°F (38°C)</td>
<td>183.7</td>
<td>12.67</td>
</tr>
</tbody>
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www.blackmer.com
Typical LPG Pump Systems

- Storage Tank
- Bypass Valve
- Manual Bypass
- Gate or Ball Valve
- Discharge Line
- Strainer
- Pump
- Auxiliary Inlet Line

www.blackmer.com
How Rotary-Vane Pumps Work

Each revolution displaces a constant volume of fluid.

As the rotor turns, sliding vanes move outward at the intake port, expanding the pumping chamber and creating a void to draw fluid into the pump.

Fluid is transferred between the vanes from the inlet to the outlet port.

At the outlet, fluid is discharged as the pumping chamber is squeezed down and the vanes are forced back into their slots.
How Sliding-Vanes are Actuated

- Centrifugal force from the rotor's rotation.
- Push rods between opposing pairs of vanes.
- Liquid pressure entering through the vane grooves and acting on the bottom of the vanes.

![Diagram of sliding-vanes actuation](image-url)
How Sliding-Vanes Sustain High Level Performance

As Blackmer sliding-vanes wear, they simply move further out of the rotor slots. So the vanes self-compensate for wear to maintain high pump efficiency.

The result? Even after long use, Blackmer sliding-vane pumps maintain "like-new" levels of capacity, suction and volumetric efficiency.
Blackmer LPG Pump Design Features

- Replaceable casing liner and end discs
- Two-Piece threaded lock collars
- External ball bearings
- Ductile iron construction
- Internal safety relief valve
- Nonmetallic Duravanes
- Blackmer mechanical seals
Blackmer Mechanical Seals

Designed And Built Exclusively for Blackmer Pumps

- Design minimizes axial and radial seal movement.
- As pump wears, seal face alignment is maintained.
- Mechanical Seal is located to maximize flush and cooling of the seal faces.
- Low PV (pressure and velocity) factors.
- No set screws or seal stack-up problems.
- Economical and easy to replace.
Replaceable Liner and End Discs

- Featured on all LGL pumps.
- Protect the pump casing and head.
- Restores the pump to be to like-new efficiency.
- Simple, inexpensive replacement.
- Piping does not have to be disconnected.
Rugged Construction

- Ductile Iron Case
  High Strength
  Thermal and Mechanical Shock Resistant
  Working pressures of 350 psi (24.1 bar)

- Steel Shaft
  Oversized to allow operation at 150 psi (10.3 bar) differential pressures on many models.

- Ball Bearings
  External, isolated from the pumpage
  Grease lubricated
  Easy and inexpensive replacement

- Lock Collars
  Precisely position the rotor and shaft
  Allow higher differential pressures
  Prevent premature wear
UL Listed

All Blackmer LPG pumps are listed by Underwriters Laboratories for service on both LP-gas and Anhydrous Ammonia
Blackmer Sliding Vane Pump Advantages

- Vanes self adjust for wear
  Sustained high level performance

- No metal-to-metal contact
  Quieter, less wear

- Positive Displacement
  Moves product even under adverse conditions

- High energy efficiency

- Easy and inexpensive maintenance
# Motor Speed Pumps

<table>
<thead>
<tr>
<th>Cylinder Filling</th>
<th>Motor Fueling</th>
<th>Vaporizers</th>
</tr>
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<tbody>
<tr>
<td>LGB1C</td>
<td>LGF1PC</td>
<td>LGLF1.25</td>
</tr>
<tr>
<td>LGF1C</td>
<td>LGRLF1.25</td>
<td>LGL1.5</td>
</tr>
<tr>
<td>LGB1PC</td>
<td>LGF1PC</td>
<td></td>
</tr>
<tr>
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</table>

- 1750 or 1450 RPM Operation
- Combination ByPass/Safety-Relief Valve (1" Models)
- 3 to 35 GPM (11 to 130 lpm)

![Diagram of Motor Speed Pumps](attachment:diagram.png)
Stationary Transfer Pumps

Bulk Plants      Terminals      Vaporizers
Large Scale Cylinder Filling

LGLD2E       LGLD3E       LGLD4

- Built-in Relief Valves
- 20 to 300 GPM
- (75 to 1,135 lpm)

- 350 - 980 RPM
- 2 to 28 HP
- (1.5 to 21 Kw)

Gear Reduction Drive

V-Belt Drive
Truck Pumps

Bobtail Delivery Trucks

Chassis Mounted: LGLD2E
Flange Mounted: TLGLF3C

- PTO Driven
- Double-ended Drive Shafts

Transport Trucks

Chassis Mounted: LGLD3E
Flange Mounted: TLGLF4A

- 350 - 980 RPM
- 20 to 300 GPM
- 75 to 1,135 lpm

www.blackmer.com
ByPass Valves

BV3/4  BV1  BV1-1/4  BV1-1/2  BV2

All Blackmer pumps should be installed with a Back-to-Tank ByPass Valve

- Hydraulically Cushioned Closing Action
- Ductile Iron Body
- For Flows of 5 to 250 GPM (19 to 950 lpm)

Dash-pot chamber cushions closing of valve.
Proper Pump Installation

Benefits:

• Trouble free, consistent transfer of product

• Less wear and tear on the pump

• Quieter operation

• Lower operating costs

• Faster transfer rates

• Safer operation
Minimize losses in the Suction Line

- Use properly sized suction line
  One size larger than the pump suction connection (if possible)

- Place the tank as high as possible above the pump

- Place the pump as close as possible to the tank

- Use low restriction valves and other fittings

- Keep the strainer clean
Don't Let Vapor Form!

Vapor –
- Reduces pump capacity
- Reduces seal life
- Reduces vane life
- Reduces maximum differential pressure
- Increases noise
Stop Vapor Formation in the Suction Line

- Use low restriction valves and other fittings
- Use long radius ells
- Keep strainers and other fittings at least 10 pipe diameters from the pump
- Paint the lines white or silver
- Place suction lines in shade
Eliminate Vapor Pockets in the Suction Line

Use eccentric reducers, flat side up.

Make the suction line horizontal or slope downward.

Don't set the pump above the liquid level.
Use a Back-to-Tank ByPass Valve

- The bypass line must return to the tank.

- The bypass must not return to the suction line. Recirculated liquid will quickly heat and turn to vapor. The pump will run dry, greatly increasing wear on the vanes and seals.

- The bypass line may return to either the vapor section or liquid section of the tank.

- Set pressure should be 25 psi (1.7 bar) lower than the pump's built-in relief valve.
Use Vapor Return Lines  
(when possible)

Vapor Return Lines will:
• Reduce the pump differential pressure
• Decrease the power required
• Increase the flow rate

![Diagram of Vapor Return Lines]
Routine Maintenance

• Check the V-Belts
  Alignment
  Tension

• Check the Strainer
  Keep the element clean

• Grease Pump Bearings

• Grease Motor Bearings
Easy Pump Maintenance

- Easy Vane Replacement & Inspection
  Vanes replace in minutes in a simple slide in - slide out procedure. Vane inspection is equally easy.

- Replaceable Liners & End Discs (LGL series)
  If pump wears, a new liner and end discs will restore like-new efficiency - at a fraction of the cost of a new pump.

- Repairs Made Without Disconnecting the Pump
  Bearings, seals, vanes, end discs and the liner can all be replaced without disconnecting the pump piping.

- No special tools required.
LPG Transfer with a Compressor

Liquid Transfer
Emergency Transfer

Vapor Recovery
Cylinder Evacuation

www.blackmer.com
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Typical LPG Compressor Transfer System
Why Transfer LPG with a Compressor?

- Pumps leave all tanks full of vapor - equals 3% of total tank capacity.
- Top opening tanks = poor pump suction conditions
  Short vane and seal life
  Noisy operation
  Considerable liquid is left in the tank
- Vessel with no liquid openings
  Home delivery tanks (under 500 gal., 2,000 l)
  Cylinders
  Trucks or Rail Cars involved in accidents

Compressors
- Can transfer all the product - both liquid & vapor
- Are not subject to poor pump suction problems
- Can empty all vessels
LPG Liquid Transfer with a Compressor

Vapors are:
- Drawn off the top of the tank being filled
- Compressed slightly
- Discharged into the top of the tank being emptied

Pressures are:
- Slightly reduced in the tank being filled
- Raised in the tank being emptied

The pressure difference will push the liquid from one tank to the other.
Vapor Recovery with a Compressor

- Rotate the 4-way valve handle 90°
- Reroute the discharge piping to the LIQUID section of the tank being filled to cool the vapors
- Close the liquid line
- Recovery stops at 25 - 30% of the original pressure
Inside the Compressor
A Ductile Iron Crankshaft

B Roller Bearings

C Oil Pump Driven by the Crankshaft

D Drilled Crankshaft with Oil Ports
A  Seals
   PTFE V-ring design
   Self adjusting
   Cartridge design

B  Crosshead Guide
   Maintain piston &
   seal alignment

C  Crosshead / Piston Rod
   BSR steel rod
   Oil lubrication grooves

D  Steel Wrist Pin

E  Ductile Iron Connecting Rod
   Automotive babbitt bearings
   Bronze wrist pin bushing
   Rifle Drilled
**A** Piston Rings  
PTFE for nonlube service

**B** Pistons  
One piece design  
Ductile Iron

**C** Cylinder  
Ductile Iron  
O-ring seals
A  Valves
   Designed for nonlube service
   Liquid relief on suction
   Rebuild as a suction or discharge valve
   Easily inspected / replaced.

B  Cylinder Head
   Ductile Iron
   All O-ring sealing
Typical Compressor Packages for Liquid Transfer and Vapor Recovery

(LB942-LC with Optional Equipment Shown)
ISO 1096
4-Way Valve

- Allows both Liquid Transfer and Vapor Recovery
- Reverses the flow direction
Liquid Traps

Traps liquid before it can enter the compressor
• Liquid that condenses in the suction line
• Liquid from a wrongly connected line

Liquid traps work by:
• Providing a volume for the liquid to collect
• Using a mechanical float to block the line
• Using an electrical float switch
Standard Liquid Traps

- Use a mechanical float to block the suction line
- Electrical float switches are available
- Non-code vessel
- Vent Valve
- 1/4" Drain
ASME Code Liquid Traps

- Larger volume to collect more liquid
- Two electric float switches may be fitted
- Complete with a relief valve
- ASME code vessel
- May be fitted with a level gauge
- 1" manual drain valve
- 4" SS mist pad
Discharge Pressure Relief Valves

- MUST be installed
- 250 - 265 psig (17.2 - 18.3 bar-g) is typical
- Brass for LPG, Aluminum for NH₃

Inlet Strainers

- Standard on 'LU' and 'LC' Mountings
- Protect the compressor
- 30 mesh screen
- Clean regularly
Low Oil Pressure Switch
- Monitors crankcase oil pressure
- Prevent expensive damage
- 12 psig (0.83 bar-g) typical
- 10 second lockout at startup

Hi Discharge Temperature Switch
- Detects potential problems early
  (Blocked line, worn parts, etc.)
- Set just above normal discharge temperature
- Use a thermowell

Drivers
- V-belt or gear reduction drive
- Electric motor
- Engine with clutch (Gasoline, Diesel or LPG)
Blackmer LPG Compressors

### English Units

<table>
<thead>
<tr>
<th></th>
<th>LB161</th>
<th>LB361</th>
<th>LB601</th>
<th>LB942</th>
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<tbody>
<tr>
<td>No. of Cylinders</td>
<td>2</td>
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<td>2</td>
<td>2</td>
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<tr>
<td>Bore x Stroke, in.</td>
<td>3.0 x 2.5</td>
<td>4.0 x 3.0</td>
<td>4.625 x 4.0</td>
<td>4.625 x 4.0</td>
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<tr>
<td>MAWP, psia (kPa)</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Speed, rpm</td>
<td>350 - 825</td>
<td>350 - 825</td>
<td>350 - 825</td>
<td>350 - 825</td>
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<tr>
<td>Piston Displacement, CFM</td>
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<td></td>
<td></td>
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<tr>
<td>@ 350 rpm</td>
<td>7.16</td>
<td>15.3</td>
<td>27.2</td>
<td>52.46</td>
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<tr>
<td>@ 825 rpm</td>
<td>16.9</td>
<td>36.0</td>
<td>64.2</td>
<td>125.2</td>
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<tr>
<td>Max. BHP</td>
<td>7.5</td>
<td>15</td>
<td>30</td>
<td>50</td>
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<tr>
<td>Weight, lb.</td>
<td>~225</td>
<td>~365</td>
<td>~705</td>
<td>~905</td>
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<td>Inlet/Outlet Connections</td>
<td>0.75&quot; NPT</td>
<td>1.25&quot; NPT</td>
<td>*2.00&quot;, 1.50&quot;, 1.25&quot;</td>
<td>2&quot; 300# ANSI</td>
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### Metric Units

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</tr>
<tr>
<td>Bore x Stroke, mm</td>
<td>76.2 x 63.5</td>
<td>102 x 76</td>
<td>117 x 102</td>
<td>117 x 102</td>
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<tr>
<td>MAWP, psia (kPa)</td>
<td>2,413</td>
<td>2,413</td>
<td>2,413</td>
<td>2,413</td>
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<tr>
<td>Piston Displacement, m³/hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>@ 350 rpm</td>
<td>12.2</td>
<td>26.0</td>
<td>46.3</td>
<td>89.1</td>
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<tr>
<td>@ 825 rpm</td>
<td>28.7</td>
<td>61.2</td>
<td>109.0</td>
<td>212</td>
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<tr>
<td>Max. kw</td>
<td>5.5</td>
<td>11</td>
<td>22</td>
<td>37</td>
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<tr>
<td>Weight, kg</td>
<td>~102</td>
<td>~166</td>
<td>~320</td>
<td>~410</td>
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<tr>
<td>Inlet/Outlet Connections</td>
<td>0.75&quot; NPT</td>
<td>1.25&quot; NPT</td>
<td>*2.00&quot;, 1.50&quot;, 1.25&quot;</td>
<td>2&quot; 300# ANSI</td>
</tr>
</tbody>
</table>

*NPT & Weld type flanges available*
### PERFORMANCE

#### English Units

<table>
<thead>
<tr>
<th>Model</th>
<th>Approximate Liquid Transfer Rate at 70°F, GPM</th>
<th>Driver Size BHP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Propane</td>
<td>Butane</td>
</tr>
<tr>
<td>LB161</td>
<td>49 @ 425 rpm</td>
<td>46 @ 650 rpm</td>
</tr>
<tr>
<td></td>
<td>80 @ 695 rpm</td>
<td>62 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>95 @ 825 rpm</td>
<td>93 @ 790 rpm</td>
</tr>
<tr>
<td>LB361</td>
<td>83 @ 335 rpm</td>
<td>85 @ 560 rpm</td>
</tr>
<tr>
<td></td>
<td>123 @ 495 rpm</td>
<td>125 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>161 @ 650 rpm</td>
<td></td>
</tr>
<tr>
<td>LB601</td>
<td>175 @ 405 rpm</td>
<td>160 @ 640 rpm</td>
</tr>
<tr>
<td></td>
<td>245 @ 550 rpm</td>
<td>210 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>300 @ 680 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>345 @ 790 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>360 @ 825 rpm</td>
<td></td>
</tr>
<tr>
<td>LB942</td>
<td>360 @ 450 rpm</td>
<td>325 @ 760 rpm</td>
</tr>
<tr>
<td></td>
<td>435 @ 545 rpm</td>
<td>345 @ 805 rpm</td>
</tr>
<tr>
<td></td>
<td>490 @ 615 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>650 @ 805 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Actual transfer rate will depend on proper system design, pipe sizing, and valve capacity.

Horsepower is for liquid transfer and vapor recovery in moderate climates (80°F).

Blackmer can provide a detailed performance analysis on request.

www.blackmer.com
## PERFORMANCE Metric Units

<table>
<thead>
<tr>
<th>Model</th>
<th>Approximate Liquid Transfer Rate at 21°C, lpm</th>
<th>Driver Size KW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Propane</td>
<td>Butane</td>
</tr>
<tr>
<td>LB161</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>185 @ 425 rpm</td>
<td>174 @ 650 rpm</td>
</tr>
<tr>
<td></td>
<td>303 @ 695 rpm</td>
<td>235 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>360 @ 825 rpm</td>
<td></td>
</tr>
<tr>
<td>LB361</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>314 @ 335 rpm</td>
<td>322 @ 560 rpm</td>
</tr>
<tr>
<td></td>
<td>466 @ 495 rpm</td>
<td>473 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>609 @ 650 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>776 @ 825 rpm</td>
<td></td>
</tr>
<tr>
<td>LB601</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>662 @ 405 rpm</td>
<td>606 @ 640 rpm</td>
</tr>
<tr>
<td></td>
<td>927 @ 550 rpm</td>
<td>795 @ 825 rpm</td>
</tr>
<tr>
<td></td>
<td>1,136 @ 680 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,306 @ 790 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,362 @ 825 rpm</td>
<td></td>
</tr>
<tr>
<td>LB942</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,363 @ 450 rpm</td>
<td>1,230 @ 760 rpm</td>
</tr>
<tr>
<td></td>
<td>1,646 @ 545 rpm</td>
<td>1,306 @ 805 rpm</td>
</tr>
<tr>
<td></td>
<td>1,855 @ 615 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,460 @ 805 rpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Actual transfer rate will depend on proper system design, pipe sizing, and valve capacity.

Horsepower is for liquid transfer and vapor recovery in moderate climates (27°C).

Blackmer can provide a detailed performance analysis on request.

www.blackmer.com
Proper Compressor Installation

Benefits:

• Trouble free, consistent transfer of product
• Less wear and tear on the compressor
• Lower operating costs
• Faster transfer rates
• Safer operation
Minimize Line Losses

- Lower pressure drops:
  - Less power required
  - Faster transfer

- Use larger line sizes

- Keep runs as short as possible

- Eliminate unneeded fittings,
  - Particularly on the liquid line

- Use low restriction fittings and valves

- Clean strainer elements
Minimize Heat Losses

- Place the compressor next to the vessel to be emptied.

\[
\text{Long discharge lines} \quad = \quad \text{Heat loss} \\
\quad = \quad \text{Premature condensation} \\
\quad = \quad \text{Slow transfer rate}
\]
Watch Out For Liquid

- Use a Liquid Trap
- Use a larger trap with long suction lines
- Don't put the compressor at a low point
Install the Compressor Properly

- Compressors are a reciprocating device
- Provide a solid foundation
- Support the baseplate along its entire length
- Support the piping
**ROUTINE SERVICE SCHEDULE**

<table>
<thead>
<tr>
<th>Task</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>6 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Visual Check</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Crankcase Oil Pressure</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Suction Pressure</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Discharge Pressure</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain Liquid Trap</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Clean Compressor Cooling Fins</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Check Crankcase Oil Level *</td>
<td></td>
<td></td>
<td></td>
<td>X*</td>
</tr>
<tr>
<td>Check V-Belt Tension</td>
<td></td>
<td></td>
<td></td>
<td>X*</td>
</tr>
<tr>
<td>Change Oil *</td>
<td></td>
<td></td>
<td></td>
<td>X*</td>
</tr>
<tr>
<td>Clean Inlet Strainer Element</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Inspect Valves</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Lubricate Motor Bearings per Manufacturers Suggestions</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

* Change oil every 1,000 hours of operation, or every 6 months which ever occurs first. If the oil becomes unusually dirty, change oil as often as needed to maintain clean oil.
Compressor Maintenance Repair

• Valves -
  Inspect / replace without disturbing the piping

• Piston rings

• Seals
Use a Pump or a Compressor?

### Pumps

<table>
<thead>
<tr>
<th>+ + + + + + +</th>
<th>- - - - - -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor return line is not mandatory</td>
<td>Must have adequate NPSH available</td>
</tr>
<tr>
<td>Suitable for higher differential pressures</td>
<td>Requires careful suction piping design</td>
</tr>
<tr>
<td>Can use with meters</td>
<td>Will usually leave some liquid in the tank</td>
</tr>
<tr>
<td>Less expensive</td>
<td>Cannot recover vapors</td>
</tr>
<tr>
<td>Simpler</td>
<td>May be noisier</td>
</tr>
</tbody>
</table>

### Compressors

<table>
<thead>
<tr>
<th>+ + + + + + +</th>
<th>- - - - - -</th>
</tr>
</thead>
<tbody>
<tr>
<td>No NPSH problems</td>
<td>Must have both vapor and liquid lines</td>
</tr>
<tr>
<td>Transfers all the liquid</td>
<td>Best for moderate differential pressures</td>
</tr>
<tr>
<td>Can Recover Vapors</td>
<td>Cannot use with meters</td>
</tr>
<tr>
<td>Less critical piping design</td>
<td>More expensive</td>
</tr>
<tr>
<td>Quieter</td>
<td>More complex</td>
</tr>
</tbody>
</table>
When to Use a Pump

- Product is to be metered
  Home delivery
  Motor fueling

- Adequate available NPSH
  Bottom opening vessels

- High differential pressures
  Truck pumps
  Cylinder filling
When to Use a Compressor

- Low NPSH available
  Rail cars
  Tank with top openings
  Overturned vessels

- Vapor recovery desired
  Fewer loads for the same capacity

- Vessel must be 'emptied'
  Inspection / repair
  Environmental / safety
When to Use a Pump & Compressor Together

- Poor pump suction conditions + high differential pressures

- Rail car and storage vessel separated by:
  Distance
  Elevation
  Undersized piping