Tritium High Vacuum Pump Test Plan

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Tritium Facilities
Scope

- Comparison of Normetex vs. Eumeca/ Air Squared/ Edwards/ Busch
- Ultimate Vacuum
- Develop Flow Curve
- Provide basis for selecting the Normetex Pump Replacement
Performance

• Flow Rate
  – 9 cfm at 3 torr inlet pressure

• Ultimate Vacuum Pressure
  – Acceptable: Less than 0.01 torr at discharge pressure of 30 torr
  – Preferred: Less than 0.01 torr when discharging to atmosphere
The three shaft design keeps the orbital scroll motion very uniform. Same design is seen in Eumeca and Air Squared.
Eumeca: Duplicate of Normetex
Eumeca: Duplicate of Normetex

**MODEL 15 m³/h (9 cfm)**

**OPERATING PRINCIPAL:**
The pumping device is made up of 2 overlapped scrolls, one of them is moving and the other one is fixed. The movement is provided by 3 cranks-hafts (one is driving) with the same eccentricity. This movement causes the formation of chambers between the two spiral vanes. Once these chambers are formed, they remain closed, and as a result of the movement of one vane are progressively, continuously reduced in size and displaced towards a central exhaust port.

**APPLICATIONS:**
Our vacuum pumps are used all over the world to extract or circulate all kind of gases which can be aggressive, inert, toxic or radioactive (the only materials exposed to the vacuum environment are 316L and 420 stainless steel). Our model 15 m³/h is an ideal, dry, totally contamination-free roughing pump for applications such as evaporation, sputtering, scanning electron microscopes, tube evacuation and backfill stations. The pump has an ultimate vacuum capability of 5.10⁻² mbar (with diaphragm backing pump) and, therefore, can serve as a roughing pump for systems using cryo, ion or turbomolecular pumps.

**OVERVIEW:**
Our model 15 m³/h (9 cfm) is a scroll vacuum pump which is, like our other models, perfectly clean. Because of the simplicity of the design, low rotational speed, elimination of rubbing contact in the pump mechanism, and construction with corrosion-resistant materials, this pump is very reliable (30,000 hours of maintenance-free operation is typical in even the most severe applications). It is usually connected to a metal or elastomer diaphragm backing pump and then form a monobloc set which is easily transportable.

**BENEFITS:**
- Completely clean, dry and fluid tight vacuum pump
- Safety, reliability
- Low running and maintenance cost (no liquid nitrogen, no oil, long working life)
- Low noise and vibration level
- Air cooling (built-in fan)

**ACCESSORIES:**
- Fine inlet and outlet metal filter
- Transport trolley
### Technical Overview

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Vacuum</td>
<td>&lt; 200 mtorr</td>
<td>&lt; 0.28 mbar</td>
</tr>
<tr>
<td>Max. Flow</td>
<td>8 cfm</td>
<td>227 lpm</td>
</tr>
<tr>
<td>Rated Power</td>
<td>0.5 hp</td>
<td>373 W</td>
</tr>
<tr>
<td>Motor Type</td>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>Avg. Sound Level</td>
<td>55 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Max. Amb. Temp.</td>
<td>104°F</td>
<td>40°C</td>
</tr>
<tr>
<td>Model Number</td>
<td>V15H34N6.0</td>
<td></td>
</tr>
<tr>
<td>Part Number</td>
<td>031210</td>
<td></td>
</tr>
</tbody>
</table>

- 100% Oil-Free
- Low Sound Levels
- Balanced, Smooth, Rotary Motion
- High Efficiency
- Long Product Life
- Continuous Duty
- Minimal Pulsation
- Hermetic
- Handles Air, Helium, Natural Gas, Oxygen, Hydrogen
Single Shaft support of the orbital scroll allows the scroll to wobble slightly when the tips seals are removed. Common to most scroll pumps.
# Technical Data

<table>
<thead>
<tr>
<th></th>
<th>nXDS6i</th>
<th>nXDS10i</th>
<th>nXDS15i</th>
<th>nXDS20i</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal rotational speed</strong></td>
<td>1800 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Displacement</strong></td>
<td>6.8 m³/h / 4.0 ft³/min</td>
<td>12.7 m³/h / 7.5 ft³/min</td>
<td>17.1 m³/h / 10.1 ft³/min</td>
<td>28.0 m³/h / 16.5 ft³/min</td>
</tr>
<tr>
<td><strong>Peak pumping speed</strong></td>
<td>6.2 m³/h / 3.6 ft³/min</td>
<td>11.4 m³/h / 6.7 ft³/min</td>
<td>15.1 m³/h / 8.9 ft³/min</td>
<td>22.0 m³/h / 13.0 ft³/min</td>
</tr>
<tr>
<td><strong>Ultimate vacuum (total pressure)</strong></td>
<td>0.020 mbar/0.015 Torr</td>
<td>0.007 mbar/0.005 Torr</td>
<td>0.007 mbar/0.005 Torr</td>
<td>0.030 mbar/0.022 Torr</td>
</tr>
<tr>
<td><strong>Minimum standby rotational speed</strong></td>
<td>1200 rpm</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Speed control resolution (percentage of full rotation speed)</strong></td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Max inlet pressure for water vapour</strong></td>
<td>35 mbar</td>
<td>35 mbar</td>
<td>35 mbar</td>
<td>20 mbar</td>
</tr>
<tr>
<td><strong>Max water vapour pumping rate</strong></td>
<td>110 gh⁻¹</td>
<td>145 gh⁻¹</td>
<td>280 gh⁻¹</td>
<td>220 gh⁻¹</td>
</tr>
<tr>
<td><strong>Maximum continuous inlet pressure</strong></td>
<td>200 mbar</td>
<td>200 mbar</td>
<td>200 mbar</td>
<td>50 mbar</td>
</tr>
<tr>
<td><strong>Voltage input</strong></td>
<td>100-127, 200-240 (+/-10%)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Voltage frequency</strong></td>
<td>50/60Hz</td>
<td></td>
<td></td>
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<tr>
<td><strong>Motor power 1-ph</strong></td>
<td>260 W</td>
<td>280 W</td>
<td>300 W</td>
<td>260 W</td>
</tr>
<tr>
<td><strong>Power connector 1-ph</strong></td>
<td>IEC EN60320 C13</td>
<td></td>
<td></td>
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<tr>
<td><strong>Recommended fuse</strong></td>
<td>10A, 250Vac rms</td>
<td></td>
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<tr>
<td><strong>Weight</strong></td>
<td>26.2 kg / 58 lb</td>
<td>25.8 kg / 57 lb</td>
<td>25.2 kg / 56 lb</td>
<td>26.6 kg / 56 lb</td>
</tr>
<tr>
<td><strong>Inlet flange</strong></td>
<td>NW25</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Exhaust flange</strong></td>
<td>NW25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Noise level</strong></td>
<td>52 dB(A)</td>
<td></td>
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<tr>
<td><strong>Vibration at inlet flange</strong></td>
<td>&lt; 4.5 mms⁻¹ (rms)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Leak tightness (static)</strong></td>
<td>&lt; 1x10⁻⁶ mbar ls⁻¹</td>
<td></td>
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<tr>
<td><strong>Operating temperature range</strong></td>
<td>+10 C to +40 C / +41 to +104 F</td>
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</tbody>
</table>

* Typical. See graphs on page 6.

** For low fan speed, typical at ultimate end when load/ambient conditions allow.
Bellows

- To keep process gas clean – Separates process gas from bearing grease.
- This design was standard on Normetex; but, is a new addition to Edwards and Busch pumps.

Edwards

Busch
Modifications: Bronze Tip Seal

- Initially bronze flat wire replaced the Teflon tip seal. Polishing the bronze left too much contamination.
- All tip seals were removed and the aluminum scrolls were then lapped for flatness
Modifications

• Lap the scroll
Modifications

- Controlling clearance between 2 scrolls is a manual process and somewhat hit and miss.
- Shimming the Busch pump may prove to be more difficult. Shimming will have to be internal to the pump.
Test System

Measure ultimate vacuum with transducer close coupled to pump.
Test System

- Test rig will provide means to compare pumps under equal conditions.
- Met-Bel evacuates to less than 50 torr
- Evacuation volume 92.2 liters.
- Multiple pressure instruments and data collection system.
- Final testing done with nitrogen.
Ultimate Vacuum Comparison

Vacuum Pressure Achieved in Microns
Output: Example

Normetex Pumping Speed

Flow in CFM vs Tank Pressure in Torr

- Red: Normetex Pumping Speed
- Blue: 10 per. Mov. Avg. (Normetex Pumping Speed)
Output: Example

Modified Edwards Pump Speed

Tank Pressure - Torr

Pump Speed - CFM
Output: Example

Eumeca 1002 Flow

0.001 0.01 0.1 1 10 100 1000
The final report will provide test data to management on each pump and an engineering appraisal of the strengths and weaknesses of each pump/company. The report will include:

1. Flow curves for each pump
2. Ultimate vacuum for each pump
3. Pump down rate on the tank for each pump
4. Design review of each pump
5. Discussion of each company and how they fit our strategic plans
6. Pricing or cost estimates for each pump
7. A summary table of data
8. Recommendation for which vendor to select

Criteria will be based on the following in order:

A. Performance
B. Long term viability of the business
C. Price
D. Other as determined