Refuelling UAV Pressurised Cylinders

Intelligent Energy UAV Fuel Cell Power Modules operate from a fuel supply of hydrogen gas. The hydrogen gas is stored on-board the UAV in high pressure cylinders. **Below are details of three refuelling options available for filling the UAV fuel cylinders.**

### 1 Decanting

Decanting is the direct connection from the source cylinder to the destination cylinder using a decanting hose.

It is usually used for initial testing as the UAV cylinder can only be filled to the pressure remaining in the source cylinder. The graph (see graph to the right hand side) indicates the pressure that can be achieved on consecutive fills using a 2L UAV cylinder filling from a BOC/Linde G20 (Genie) cylinder. First fill is to 90% pressure (270bar), second fill to 81% (243bar) etc.

The decanting hose comes complete with Nevoc (ISO5145) fitting to mate with the BOC/Linde G20 Genie cylinder. The hose has a pressure gauge, a bleed valve, and an 8mm PCP connector that will connect directly to the UAV fill port.

Decanting hoses are available from the following suppliers:

**Intelligent Energy**
Contact us at sales@intelligent-energy.com

**NanoSUN**
Unit 25, Lake Enterprise Park, Caton Park, Lancaster LA1 3NX
info@nanosun.co.uk

**Fuel Cell Systems Ltd**
Station Yard, Hungerford, Berkshire, RG17 0DY, UK.
Part no. 1010/000 FCSL PCP Drone Refuelling Hose.
www.fuelcellsystems.co.uk

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**Fill Pressure for BOC/Linde Genie cylinder with decanting hose**

**Decanting hose connected to Genie cylinder**
**2 Booster pumps**

A booster pump allows the UAV cylinder to be filled to full working pressure. The booster pump can be driven by a second gas (compressed air or nitrogen), hydraulics or electricity. Booster pumps can be obtained from the following suppliers:

1. **Haskel Europe Ltd**
   North Hylton Road, Sunderland, SD5 3JD.
   Part description: Portable Hydrogen Booster pump in hardened plastic case plus accessories Kit Part No. 100225.
   www.haskel.com

2. **MAXIMATOR GmbH**
   Lange Strasse 6, 99734 Nordhausen, Germany
   Several options for filling hydrogen cylinders.
   www.maximator.de

3. **Staffordshire Hydraulic Services Ltd**
   Mount Road, Kidsgrove, Stoke-on-Trent, Staffordshire ST7 4AZ, UK
   www.staffshydraulics.co.uk

4. **Hydraulics International, Inc.**
   20961 Knapp Street, Chatsworth, CA 91311, USA
   Several options for filling hydrogen cylinders both electrically driven and air driven.
   www.hipumps.com

5. **MPS (Italy)**
   Via Po 2, 33054 Lignano Sabbiadoro (Italy). Several options for filling hydrogen cylinders both electrically driven and air driven.
   www.mpstechnology.it

If you are going to buy a booster pump then contact us and we can help you to order the correct specification from your chosen supplier.

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**3 Cascade filling**

Cascading refuelling enables filling of significantly more UAV fuel cylinders to higher fill pressures than the decant option.

This approach optimises utilisation of hydrogen from a standard source cylinder. The graph (see graph to the right) indicates the relative performance of the two solutions when filling a 2L UAV tank from an industry standard 300bar (20L) supply.

Filling protocols and safety checks on the Cascade Refueller are controlled by the onboard PLC and operation is via simple push button interface.

Unlike booster pumps, Cascade Refuellers require no external power source, hence they work well for field and mobile refueling.

Cascade Refuellers are available from the following suppliers:

**NanoSUN**
Unit 25, Lake Enterprise Park, Caton Road, Lancaster, LA1 3NX, UK.
www.nanosun.co.uk

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<table>
<thead>
<tr>
<th>Part No</th>
<th>Description</th>
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<tbody>
<tr>
<td>R-300-00-3G</td>
<td>Pioneer™ M 3-Stage Cascade Refueller – 300 bar EU Spec</td>
</tr>
<tr>
<td>R-414-00-3C</td>
<td>Pioneer™ M 3-Stage Cascade Refueller – 6000 psi US Spec</td>
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</table>
4 Filling service

Cylinders can be filled if you take them to the filling location or they can be delivered directly to you and emptied collected by a carrier. USA only at present.

**US**

IGX Group, Inc. (H2 Fueling division)
820 Greenville Road, Livermore, CA 94550 (Fill location)
Sales Contact: Delisa Leighton, telephone: 415-763-9790
Fill capability: up to 6,000psig
Email: delisa@igxgroup.com

**Europe**

NanoSUN
Unit 25, Lake Enterprise Park, Caton Park,
Lancaster LA1 3NX
info@nanosun.co.uk

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**Hydrogen availability**

Hydrogen is widely available across Europe, from the three major industrial gas suppliers; Air Products, Air Liquide and Linde. In some countries they operate under different names but essentially these three suppliers dominate the market.

**Hydrogen is typically delivered throughout Europe in the following cylinder sizes and pressures:**

- **K** size, mass 65kg with 648g of hydrogen at 200bar
- **B** size, mass 16kg with 133g of hydrogen at 200bar
- **G20** (Genie) size, mass 22.4kg with 424g at 300bar

Multi cylinder packs, larger trailer packs and other packaged solutions are available.

**In the USA alternative cylinders are available** (Praxair options shown below):

- **6K** size, mass 139kg with 1260g of hydrogen at 460bar
- **T** size, mass 66kg with 653g of hydrogen at 183bar
- **K** size, mass 61kg with 491g of hydrogen at 138bar
- **Q** size, mass 30kg with 163g of hydrogen at 138bar

### Supplier Web site

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Web site</th>
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<tbody>
<tr>
<td>BOC/Linde (most of Europe)</td>
<td><a href="http://www.boconline.co.uk">www.boconline.co.uk</a></td>
</tr>
<tr>
<td>Air Products (most of Europe)</td>
<td><a href="http://www.airproducts.co.uk">www.airproducts.co.uk</a></td>
</tr>
<tr>
<td>Gas Direct (UK)</td>
<td><a href="http://www.gas-direct.co.uk">www.gas-direct.co.uk</a></td>
</tr>
<tr>
<td>Hygear (The Netherlands)</td>
<td><a href="http://www.hygear.com/gases">www.hygear.com/gases</a></td>
</tr>
<tr>
<td>SOL Group (Italy)</td>
<td><a href="http://www.solgroup.com">www.solgroup.com</a></td>
</tr>
<tr>
<td>Praxair (USA), Part of Linde</td>
<td><a href="http://www.praxair.com">www.praxair.com</a></td>
</tr>
<tr>
<td>Air Liquide (most of Europe)</td>
<td><a href="http://www.industry.airliquide.us">www.industry.airliquide.us</a></td>
</tr>
<tr>
<td>Airgas (USA – owned by Air Liquide)</td>
<td><a href="http://www.airgas.com">www.airgas.com</a></td>
</tr>
</tbody>
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**Supplier and Web site**

**BOC/Linde**

- **United Kingdom**: www.boconline.co.uk
  - **Europe**: www.boconline.co.uk
  - **North America**: www.bocgases.com
  - **Rest of World**: www.boc.com

**Air Products**

- **Europe**: www.airproducts.co.uk
  - **United Kingdom**: www.airproducts.co.uk
  - **Europe**: www.airproducts.co.uk
  - **North America**: www.airproducts.com
  - **Rest of World**: www.airproducts.com

**Gas Direct**

- **United Kingdom**: www.gas-direct.co.uk
  - **Europe**: www.gas-direct.co.uk
  - **North America**: www.gas-direct.com
  - **Rest of World**: www.gas-direct.com

**Hygear**

- **Europe**: www.hygear.com/gases
  - **The Netherlands**: www.hygear.com/gases

**SOL Group**

- **Europe**: www.solgroup.com
  - **Italy**: www.solgroup.com
  - **Rest of World**: www.solgroup.com

**Praxair**

- **United States**: www.praxair.com
  - **USA**: www.praxair.com
  - **Canada**: www.praxair.ca
  - **Global**: www.praxair.com

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**Europe**

- **Air Liquide (most of Europe)**: www.industry.airliquide.us
  - **Europe**: www.industry.airliquide.us
  - **North America**: www.airliquide.com
  - **Rest of World**: www.airliquide.com

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**Airgas**

- **USA – owned by Air Liquide**: www.airgas.com
  - **USA**: www.airgas.com
  - **Canada**: www.airgas.ca
  - **Rest of World**: www.airgas.com

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* +44 1509 271 271  E servicing@intelligent-energy.com

Intelligent Energy Charnwood Building, Ashby Road, Loughborough, LE11 3GB, UK
www.intelligent-energy.com