Cryogenic, Low Temperature and High Pressure Gas Testing Facility
The following is a brief resume of Goodwin supply to LNG projects where, over the last decade, Goodwin has furnished more than US$ 20,000,000 of product.

<table>
<thead>
<tr>
<th>Year</th>
<th>Project</th>
<th>Country</th>
<th>Customer</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>MLNG: DUA Plant</td>
<td>Malaysia</td>
<td>Malaysia LNG</td>
<td>JGC Corp/MW Kellogg, Japan</td>
</tr>
<tr>
<td>1995</td>
<td>Incheon LNG Import Terminal</td>
<td>Korea</td>
<td>Korea Gas Corp</td>
<td>Daesin Ind Co Ltd, Korea</td>
</tr>
<tr>
<td>1995</td>
<td>Qatargas LNG Utilities</td>
<td>Qatar</td>
<td>Qatar Liquified Gas Co</td>
<td>Chiyoda, Japan</td>
</tr>
<tr>
<td>1996/98</td>
<td>Bonny Island Trains 1&amp;2</td>
<td>Nigeria</td>
<td>Nigeria LNG Ltd/Shell</td>
<td>MW Kellogg, UK</td>
</tr>
<tr>
<td>1997/8</td>
<td>RasGas Trains 1&amp;2</td>
<td>Qatar</td>
<td>Ras Laffan LNG Co</td>
<td>JGC Corp, Japan</td>
</tr>
<tr>
<td>1998</td>
<td>Oman LNG</td>
<td>Oman LNG</td>
<td>Oman LNG/Shell</td>
<td>MHI, Japan</td>
</tr>
<tr>
<td>1998</td>
<td>Incheon LNG Import Terminal</td>
<td>Korea</td>
<td>Korea Gas Corp</td>
<td>Daesin Ind Co Ltd, Korea</td>
</tr>
<tr>
<td>1999</td>
<td>Ournoud LNG</td>
<td>Oman LNG</td>
<td>Oman LNG/Shell</td>
<td>Bechtel Corp, Texas USA</td>
</tr>
<tr>
<td>2000</td>
<td>Tongyeong LNG Import Terminal</td>
<td>Korea</td>
<td>Korea Gas Corp</td>
<td>Daesin Industrial, Korea</td>
</tr>
<tr>
<td>2000</td>
<td>Pinson LNG Peak Shaving Plant</td>
<td>USA</td>
<td>Alabama Gas Co</td>
<td>Black &amp; Veatch Pritchard, USA</td>
</tr>
<tr>
<td>2000</td>
<td>Trinidad Atlantic Train 2</td>
<td>Trinidad</td>
<td>Trinidad LNG</td>
<td>Bechtel Corp, Texas USA</td>
</tr>
<tr>
<td>2000</td>
<td>Tiga LNG</td>
<td>Malaysia</td>
<td>MLNG Tiga SDN BHD</td>
<td>JGC/KBR/SMIC/JSIN/Maxim, Japan</td>
</tr>
<tr>
<td>2000</td>
<td>Bonny Island Train 3</td>
<td>Nigeria</td>
<td>Nigeria LNG Ltd/Shell</td>
<td>MW Kellogg, UK</td>
</tr>
<tr>
<td>2001/02</td>
<td>RasGas Trains 3</td>
<td>Qatar</td>
<td>Ras Laffan LNG Co</td>
<td>Chiyoda/Smiprogetti/Mitsui, Japan</td>
</tr>
<tr>
<td>2002</td>
<td>North-West Shelf Ph IV</td>
<td>Australia</td>
<td>Woodside Energy Ltd</td>
<td>KBR/JGC/Hatch/Clough (Australia)</td>
</tr>
</tbody>
</table>

Goodwin International is capable of incremental pressure testing at temperatures from room temperature down to -196°C.

Goodwin has a custom built test chamber that allows the safe testing of valves with helium at the full design pressure of the valve (6000psig/414barg).

The test procedure is in accordance with Shell International specification SPE 77/306 and British Standard BS6364. Valves to be used in cryogenic or low temperature service are prepared and conditioned. With its range of Dual Plate Check Valve, Goodwin can offer the following achievable leakrates:

- 700 cc/minute/inch diameter nominal bore (API 598)
- 300 cc/minute/inch diameter nominal bore (SPE 77/306) – additional cost
- 100 cc/minute/inch diameter nominal bore (special) – additional cost

These leakrates are for metal to metal sealing with no overlay on either the body or plate seats.

Should stellitting on the valve body seat be required then the minimum achievable leakrate is 700cc/min/inch diameter nominal bore.
Goodwin International’s cryogenic test facilities are available for use to suppliers and manufacturers of other types of valves requiring testing to SPE 77/306 or like procedure. With its supply history to LNG and other liquid gas applications Goodwin, with its proven expertise, is highly qualified to be a cryogenic valve “test house” facility for other companies.

Features
- BS EN ISO 9001 accredited facility
- Onsite technical support from qualified engineers
- Onsite skilled fitters
- Provision of Test Report certification

Facilities
- Explosion proof chamber
- On-site bulk liquid nitrogen supply
- On-site portable PMI (Positive Material Identification)
- Thermocouple connections
- State-of-the-art portable microprocessor for temperature and time recording and graph plotting
- Calibrated equipment/regular calibration
- Helium Mass Spectrometer
- Drying out/warming furnace

Capabilities
- High pressure gas testing (6000psig/414barg)
- Testing down to -196°C
- Incremental pressure testing
- Testing to SPE 77/306 (and BS 6364)
- Maximum size: to 2m (80") overall dimension
- Maximum weight: 10,000 kg
Whether the valve is to be low temperature tested or cryogenic tested, the test method will be in accordance with *SPE 77/306 (latest revision) or similar procedure e.g. BS 6364. The sequence of testing per SPE 77/306 is as follows:

- **Hydrottest at ambient temperature**
  - Acceptance standard API 598

- **Pneumatic test at ambient temperature**
  - Acceptance specification SPE 77/306

- **Cryogenic/Low temperature testing**
  
  **Coolant Selection:**
  - Cryogenic testing at -196°C: Immersion of valve in liquid nitrogen.
  - Low temperature testing -46°C: Immersion in liquid nitrogen vapour.
  - Intermediate temperature testing: Immersion in liquid nitrogen or liquid nitrogen vapour.

  **Temperature Control:**
  - Temperature is monitored by the use of thermocouples located both internally and externally of the valve body and internally and externally of the test tank. Once the required valve temperature has been achieved and stabilised the pressure test commences.

  **Selection of leak test medium:**
  - Cryogenic ie. -196°C: pure helium.
  - Low temperature ie. -46°C: 99% helium/1% nitrogen mix or pure helium.
  - Intermediate temperature: pure helium, or 99% helium/1% nitrogen mix dependent on test temperature.

  **Test Method – SPE 77/306:**
  - Pressure within the test valve is increased in 3 equal increments and seat leakage is measured using a series of calibrated flowmeters.
  - The maximum pressure at which the valve is tested is limited by the Cold Working Pressure (CWP) as designated in ANSI B16.34 for the rating of valve under test.

  **Shell (body) Leakage Test:**
  - Following seat leakage test, the valve is removed from the tank and the valve body integrity is tested whereby the body cavity is pressurised and a shell leak detection test carried out using a Helium Mass Spectrometer. The detection limit for acceptance is 5 x 10^-4 ml/sec, this being defined as zero leakage.

  **Operational Test:**
  - The test valve can be operated 5 times (open and closed) at the maximum allowable rated seat test pressure. The open and close torque forces can be recorded.

- **Test Reports**
  - All observations, data and results shall be recorded in sequence with dates and times into a single Test Report document.
Based in the United Kingdom and seen as the market leader in the manufacture and design of Dual Plate Check Valves, Goodwin has a strong international presence exporting to over 50 countries. With over 20 years of supply to the world’s hydrocarbon, energy and process industries, Goodwin has an enviable reputation for quality and reliability of product complimented by internationally competitive prices.

From its UK manufacturing base and through its network of agents and distributors holding some US$ 5,000,000 of inventory in 14 stocking locations worldwide, Goodwin offers outstanding support to its customers, listed amongst whom are many of the world’s end users, oil majors and international engineering contractors.

With 20 years of experience of valve supply into cryogenic applications coupled with in-house cryogenic testing, the last decade in particular has seen Goodwin become a major supplier to the world’s LNG industry. With its range of Dual Plate Check Valves, Goodwin has been the successful check valve supplier to a number of the world’s most prestigious LNG export projects as well as many LNG ships and receiving terminal projects. The vast majority of valves are of 316 Stainless Steel construction for use in Liquefied Natural Gas at a temperature of -161°C. Often these valves are accompanied by a large number of valves of Low Temperature Carbon Steel (LTCS) construction for low temperature service applications and which require low temperature testing.

In support of its increasing involvement and increasing business in the LNG and liquid gases industries, Goodwin has built a new cryogenic test facility where, under supervision of its qualified engineers, Dual Plate Check Valves as large as 72” diameter can be tested at temperatures down to -196°C and to pressures of 6,000 psig (414 bar).

Information on the complete range of Goodwin Dual Plate Check Valves is available on our website: www.checkvalves.co.uk