Improving valve sealing performance & emissions control

Issue 3
Over a century of experience

James Walker has been in the business of fluid sealing and control since the company’s founding over 125 years ago. From our earliest products and throughout our history the company has developed sealing solutions and components in parallel with advances in valve technology. As a result we have amassed specialised knowledge of applications across a very broad range of industries.

Driving advances in performance

From chemical processing and nuclear energy to subsea valve applications in oil and gas, our experience drives innovations in materials and sealing technology that help facilitate production and performance advances.

A respected reputation built on a history of innovation and proven performance

Products & services

We have an extensive range of world-class products and services which meet or exceed the required international standards in reducing volatile organic compound (VOC) fugitive emissions from valves, pipelines, processing plant and pressure vessels. Many of these products meet the strictest international standards and demonstrate Best Available Technique (BAT) under the European Union’s Integrated Pollution Prevention and Control (IPPC) directive.
Proving performance

Working in close co-operation with customers, industry bodies and academic institutions, our facilities provide some of the most advanced test regimes outside of actual operational application. This gives our customers the confidence that James Walker products have been fully tested to meet the required application conditions.

With our broad range of engineering resources and expertise we design and build custom test-rigs for many of the projects we undertake. In addition, and central to our research and development programmes, the James Walker Technology Centre houses the core of our world-class test facilities.

In addition to third-party assessment for international quality standards, our operations are also regularly assessed and quality approved by a wide range of industry bodies and individual clients including multinational corporations, utilities and government organisations.

James Walker products are found in critical applications at the forefront of key global industries ensuring that processes run safely and smoothly, day after day after day.

Extreme environments

Our capabilities in high performance materials science are relied upon worldwide by customers who need top quality materials that are validated and proven to operate.

- Testing capabilities
- Environmental chambers capable of replicating conditions from -70°C to +180°C
- Rapid gas decompression rigs – amongst the most advanced in the world
- Steam skid for testing seal longevity under harsh Sterilisation in Place (SIP) steam cycle cleaning
- Multiple rotary and reciprocating test rigs with a variety of shaft sizes and speeds from gentle oscillation to in excess of 6,000 revolutions per minute
- Chemical type-approval testing which allows customers the opportunity for third party-witnessed testing of elastomers and polymers in their anticipated chemical environment

With in-house materials compounding we also hold complete control over batch production – essential during critical testing and materials assessment.
Elastomeric seals

For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz

Elastomer technology

Products & Materials
We supply sealing products in a vast range of general and high-specification grades of elastomer including ranges of low-temperature and rapid gas decompression (RGD) resistant materials.

Within each material category we have numerous different compounds each specially formulated for specific applications or operational conditions including;

- Extremes of pressure
- Chemically aggressive environments
- Extremes of temperature
- Under rapid gas decompression conditions
- Abrasive environments

Our range of elastomeric sealing products for valve applications includes;

- ‘O’ rings
- ‘T’ seals
- Custom moulded products
- Dome seals

Quality & Traceability
Our Materials Technology Centre houses one of Europe’s most advanced facilities for elastomer batch production, materials development and product testing.

We hold over 300 compound formulae providing full batch traceability, production flexibility and the highest levels of quality control.

Our products and materials are extensively in-house validated, and are tested, approved and specified by end users and valve manufacturers around the world.

All products can be packaged and laser marked with identification details to customer requirements.

Availability & service
With our flexible production schedules, we are confident of meeting the most urgent requests from our customers anywhere in the world.

- Over 500 product ranges in stock for immediate dispatch
- Range of Xpress services for priority manufacture and dispatch
- Any quantity made to order
- Stocked ranges include James Walker high-performance RGD resistant materials

...batch production with full traceability of more than 300 of our own compound formulae

Case study
James Walker ‘O’ rings in RGD (rapid gas decompression) resistant FR25/90 fluoroelastomer are specified in valves for the undersea pipeline that will feed Southern Europe with Algerian natural gas.

The Medgaz project’s 24-inch pipeline runs for 210km beneath the Mediterranean in a maximum sea depth of 2160m, which means that RGD resistance is a prime consideration for any seals in the system.

Certification of FR25/90 to Total GS PVV 142 03/01 by French test house Cetim confirmed the material’s suitability.
Elastomeric seals

For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz

Elastomer technology

A range of class-leading elastomeric materials

<table>
<thead>
<tr>
<th>Compound</th>
<th>Material</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflas®</td>
<td>FEPM</td>
<td>Compounded for RGD resistance</td>
</tr>
<tr>
<td>Elast-O-Lion® 101</td>
<td>HNBR</td>
<td>Excellent RGD resistance operating to +160°C</td>
</tr>
<tr>
<td>Elast-O-Lion® 985</td>
<td>HNBR</td>
<td>Compounded for RGD resistance and extreme low temp duties</td>
</tr>
<tr>
<td>Elast-O-Pure® EP75</td>
<td>EPDM</td>
<td>Specifically formulated for biopharmaceutical applications</td>
</tr>
<tr>
<td>Elast-O-Pure® GF75</td>
<td>FKM</td>
<td>Specifically formulated for biopharmaceutical applications</td>
</tr>
<tr>
<td>Elast-O-Pure® SIL70</td>
<td>Platinum-cured silicone (VMQ)</td>
<td>Specifically formulated for biopharmaceutical applications</td>
</tr>
<tr>
<td>FR25/90</td>
<td>FKM</td>
<td>Compounded for RGD resistance and extreme low temp duties</td>
</tr>
<tr>
<td>FR58/90</td>
<td>FKM</td>
<td>Special RGD resistant grade with many oilfield approvals</td>
</tr>
<tr>
<td>FR68/90</td>
<td>FKM</td>
<td>‘0000’ Norsok RGD rating up to 10mm at 100°C and 5.33mm at 150°C</td>
</tr>
<tr>
<td>Kalrez®</td>
<td>FFKM</td>
<td>Ultimate performance material for chemical resistance and higher temperatures</td>
</tr>
</tbody>
</table>

Advanced material testing facilities

Our new purpose-built mechanical and analytical laboratories equal the very best facilities available for materials research and analysis.

- Differential scanning calorimetry and thermogravimetric analysis
- FTIR spectroscopy
- Tensile and compression testing facilities with an environmental chamber
- Environmental chamber offers testing at temperatures from -70°C to +180°C

...materials approved to the highest industry specifications including Norsok, API, USP Class VI, plus customer specific material and product performance criteria

Inflatable Dome Seals

Simple in design and low in maintenance, valves using a domed shut off are used in a wide range of industries for controlling the flow of bulk materials including abrasive, hazardous or toxic materials.

James Walker inflatable dome seals are available in a broad range of materials and colours to suit every application including FDA and other industry specifications.
**‘O’ rings**

The ‘O’ ring is widely accepted as a highly efficient and reliable sealing component. However, users rarely consider why this is so or how it actually works.

Although many types of seal are capable of performing the same function, the popularity of the ‘O’ ring is greatly influenced by commercial considerations. For example, when a less compact type of seal is used, the components that house the seal by necessity have to be larger and therefore more expensive. This in turn can make the complete unit much more bulky and costly than if a compact ‘O’ ring had been employed.

An ‘O’ ring is therefore very attractive for a number of reasons:

- It is highly cost-effective.
- It occupies little space.
- The housing is usually very simple, making it easy and inexpensive to incorporate into equipment design.
- It will seal in both directions – therefore on double acting applications only one seal is required.

The ‘O’ ring can be considered to be a truly automatic seal which makes it highly versatile and extremely useful. Figure 1 shows an ‘O’ ring fitted into a typical housing. In order to effect a seal under zero or very low pressure conditions, the ‘O’ ring is mechanically squeezed, typically by 6-15 per cent. This squeeze creates an initial sealing force $P$.

If system pressure $P_1$ is now introduced, this pressure will act over the exposed face of the seal and then be transferred through the rubber. Since rubber behaves rather like a very viscous fluid, $P_1$ will be transferred equally in all directions and as a result the sealing force $P_2$ will be greater than the system pressure $P_1$ by an amount equal to the initial sealing force $P$.

Typically, system pressure $P_1$ will become a significant component of the sealing force $P_2$ at pressures in excess of 3.5MPa/508psi.

**‘O’ ring housings**

For an ‘O’ ring to function correctly, it is essential that one face of the seal be exposed to the medium, in order that the system pressure can act upon that face and energise the seal. Consequently a square groove is not of a suitable geometry to house an ‘O’ ring and a rectangular groove must therefore be employed.

Since rubber is virtually incompressible, the volume of any ‘O’ ring must be less than the volume of the groove into which it is fitted. If this is not the case then the excess rubber will simply be extruded into the clearance present between adjacent metal components. For typical hydraulic applications the level of groove fill is in the region of 65 to 70 per cent. However ‘O’ rings for high pressure gas applications give superior performance when installed with higher levels of groove fill and squeeze.

Insufficient levels of squeeze and groove fill can allow rapid gas decompression damage to occur more readily. Conversely, excessive squeeze and groove fill can give rise to problems at higher temperatures and where swell of the ‘O’ ring occurs due to contact with certain media. For rapid gas decompression/high pressure gas service, the ‘O’ ring squeeze should be optimised. Contact the James Walker technical team for specific details in relation to your application.

**Anti-extrusion elements**

As mentioned, rubber generally behaves like a very viscous fluid and when subjected to pressure, it will be forced into the clearance gap of the housing’s low pressure side. This action is known as extrusion.

In applications where the pressure is reduced relatively gradually, the rubber will recover and no damage will occur. However where rapid pressure cycling occurs, the extruded volume of rubber does not have sufficient time to recover before the clearance gap closes and it is physically removed. Each subsequent pressure cycle results in more rubber being removed, until eventually seal failure occurs. This process is known as ‘nibbling’.

Although most likely to occur in dynamic applications where clearances between adjacent metal components are inevitable, seal extrusion can also occur in static, flange type applications, where stretching of assembly bolts can create extrusion clearances.

‘O’ rings are generally suitable for pressures up to 10MPa/1450psi. At higher pressures or where adverse mechanical conditions exist, the use of a back-up ring is recommended.

The most common back-up ring material used is PTFE which, although fairly rigid, is still soft enough to respond to the force transmitted to it by the ‘O’ ring under pressure. Under the influence of this force the back-up ring will flow into the extrusion clearance where, due to its poor recovery properties it remains and protects the ‘O’ ring.

The use of PTFE back-up rings extends the pressure capability of the simple ‘O’ ring up to at least 35MPa/5075psi. This limit can be extended further by selecting an alternative back-up ring material such as PEEK™, a thermoplastic engineering polymer which is highly resistant to chemical attack, wear and extrusion at elevated temperatures.
Elastomers for extreme oilfield applications

Advanced research

Applications within the oil and gas industry throw up specific challenges and James Walker continues to invest considerable time and money in its research programmes and facilities to investigate and understand the effects of these key criteria on elastomeric materials;

- Rapid gas decompression
- H₂S / sour conditions
- CO₂
- Low temperature

Our materials science team has published and presented numerous technical papers on these subjects and continue to extend our knowledge in these areas. These papers are available as PDF downloads at [www.jameswalker.biz](http://www.jameswalker.biz) or in hard copy format from your local James Walker company.

The James Walker Technology Centre also maintains a position as one of the leading analytical facilities in the world for RGD testing and assessment.

Performance under H₂S & sour conditions

Sour conditions are those where the acidic gas hydrogen sulphide (H₂S) is present.

H₂S is a highly corrosive gas to both metals and elastomers and the extent of chemical attack depends on temperature, H₂S level, fluid phase and time.

The chemical attack proceeds at a faster rate in the gaseous phase and slower in the liquid phase, as the gas must first diffuse through the liquid to reach the elastomer seal.

As temperature increases, so the rate of chemical reactions increases. Therefore the most severe environment for elastomers is hot sour gas and less severe in cooler liquid sour hydrocarbons.

Despite the presence of H₂S, other chemicals such as aromatics (BTEX) and amine corrosion inhibitors will also play a decisive role in elastomer selection.

James Walker has carried out extensive testing of its range of RGD resistant elastomers in 20% H₂S at elevated temperatures. Although the results of this test programme break new ground we are willing to share the information with our customers in the strictest confidence.

Contact your local James Walker office if you wish to find out more on this subject or to discuss the implications for your specific applications.

Effects of CO₂ on material performance

CO₂ is a small molecule and will readily diffuse into elastomers. At typical system pressures, CO₂ is in a supercritical state. At typical ambient conditions it behaves like a gas, though above 72.9bar and 31.1°C (the critical point for CO₂) it adopts properties midway between a gas and a liquid.

During depressurisation, CO₂ absorbed into the seal will generate large volumes of gas during the reverse transition. It is for this reason that CO₂ is so aggressive towards elastomeric seals in an RGD situation.

Due to the aggressive nature of CO₂ with elastomers, James Walker has invested in an extensive test programme to evaluate material performance in this environment. The results of this test programme can be seen in the table below:

<table>
<thead>
<tr>
<th>Material</th>
<th>Temperature</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR 68/90</td>
<td>100°C</td>
<td>0000</td>
</tr>
<tr>
<td>FR 25/90</td>
<td>50°C</td>
<td>0000</td>
</tr>
<tr>
<td>FR 58/90</td>
<td>23°C</td>
<td>0000</td>
</tr>
<tr>
<td>EOL 101</td>
<td>23°C</td>
<td>0000</td>
</tr>
</tbody>
</table>

Test protocol

Media: 100% CO₂
Test pressure: 150 bar
Decompression rate: 37.5bar/minute
Seal section 5.33mm
Soak time 72 hrs soak
Number of decompressions 8
Rating system used: Norsok M710 Annexe B
Elastomers for extreme oilfield applications

RGD specification approvals

In assessing RGD performance James Walker has chosen the Norsok M-710 qualification criteria, testing at 100°C (212°F) using a pressure of 150bar (15MPa) and a decompression rate of 37.5bar/minute (3.5MP/minute). This is well in excess of the 20bar/minute industry standard.

Observations are then rated from 0 to 5. Zero denotes no damage, 1 to 3 increasing damage sustained, 4 and 5 denoting too much damage sustained to pass the test.

A ‘0000’ rating represents the maximum achievable operational safety margin.

It must be remembered however that these levels of damage are being observed as a result of a carefully controlled test. Under operational conditions fluctuations in media composition and temperature can further compromise RGD performance and increase the possibility of seal failure.

In order to maximise operational safety in terms of resistance to RGD, James Walker utilises the ‘0000’ rating (zero damage) as the key pass criteria for its own materials as this is the only rating at which the material has suffered no visible damage under test.

A comparison between FR68/90 and an alternative elastomer material following RGD testing illustrates the importance of selecting the correct material for applications prone to RGD.

New Generation materials

James Walker RGD resistant elastomers such as Elast-O-Lion® 101 and 985, FR25/90 and 58/90 have lead the industry for many years.

Our New Generation elastomer technology now takes this leading RGD capability to new levels, achieving a remarkable step change without sacrifice or compromise in other material performance characteristics.

FR68/90 is James Walker’s premium fluoroelastomer (FKM) offering for RGD resistance where contact with amines, H2S, hot water or steam is an important secondary operational consideration. In addition, FR68/90 offers further class-leading performance with:

- Ultra-low compression set of 8% providing outstanding seal stress retention

Elevated temperature

FR68/90 has been subjected to Norsok M-710 RGD testing at elevated temperatures providing perfect pass ‘0000’ ratings for a 5.33mm section at up to 150°C.

<table>
<thead>
<tr>
<th>Section mm</th>
<th>100°C</th>
<th>125°C</th>
<th>150°C</th>
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<tr>
<td>10.00</td>
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</tr>
</tbody>
</table>

Testing in accordance with Norsok M-710 Rev 2 Annex B

Large cross-section

The standard ‘O’ ring cross-section assessed for qualification is 5.33mm, but in developing the New Generation materials we have currently tested sections of up to 10.00mm at the standard 100°C Norsok test.
Elastomers for extreme oilfield applications

Low temperature performance

Optimised sealing performance at low temperatures has many influencing factors. These include:

- Is the application static or dynamic?
- The system pressure
- Whether the pressure in the system is applied before or after the reduction in temperature
- Does the temperature and / or pressure cycle?

Designing elastomers for low temperature duties requires a detailed knowledge of both the application and elastomeric materials.

When elastomers are cooled to sufficiently low temperatures they exhibit the characteristics of glass, including hardness, stiffness and brittleness. In this state they do not behave in the readily deformable manner usually associated with elastomers.

The point at which this stiffening or brittleness occurs is known as the glass transition temperature (Tg). Between this and the normal deformable characteristics exhibited by elastomers is an intermediate ‘leathery phase’ where free volume reduces and the elastomer exhibits increasingly sluggish behaviour as brittleness is approached. The phases are illustrated in the chart below;

As part of our ongoing investment in sealing technology, and to advance further our understanding of the subject, we have developed alternative test regimes to assess low temperature functionality.

These protocols are based on product configured testing. As such, they replicate more accurately the service conditions found in the field by taking account of seal shape and sealing surface interaction, as well as material behaviour.

Using this testing capability, it is possible to simulate accurately the required sealing parameters, and thus optimise seal performance to match customers’ specific applications.

The James Walker TR2076 test regime for elastomer materials provides the most accurate assessment of low temperature sealing capabilities.

For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz
Technical expertise and support

Engineering solutions

James Walker manufactures many different grades of compression packing for valve stem duties, providing a broad range of operational benefits:

• World-beating fugitive emission control — often to below 50ppm
• Best value fluid sealing for your specific plant duties
• State-of-the-art materials to traditional ‘natural’ yarns
• Work in the most abrasive and chemically aggressive environments
• Tolerate poor mechanical conditions
• Meet requirements for potable water, food, pharmaceutical or liquid/gaseous oxygen duties
• Reduce your stockholding levels, as one packing can often be used for many different valves and other fluid handling plant at a site

Expertise & experience

Industries across the world rely on our packings to keep their valves operating efficiently day-in and day-out — with energy saving benefits and the minimum of fugitive emissions.

James Walker’s constant advances in materials and lubricants, product design and manufacturing techniques, bring you compression packings to match both your modern fluid handling systems and your older plant.

Whatever your requirement, our expertise and over 125 years of experience in compression packing materials can be brought to bear on providing a customised solution.

Technical Support

A team of experienced highly qualified application engineers located locally and globally provide advice and technical support on many issues including:

• Product recommendation
• Chemical compatibility
• Difficult application problem solving
• Fitting advice
• Imparting experience in successfully achieving fugitive emissions specifications in many valve manufacturers’ products.

A RANGE OF INDUSTRY APPROVED PRODUCTS

<table>
<thead>
<tr>
<th>Fugitive Emission Product</th>
<th>ISO 15848</th>
<th>TA-LUFT / VDI 2440</th>
<th>SHELL 77-312</th>
<th>API622</th>
<th>API 607 Fire Test</th>
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<tbody>
<tr>
<td>SUPAGRAF® PREMIER</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>Class BH CO3</td>
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<td></td>
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<tr>
<td>SUPAGRAF® CONTROL</td>
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<tr>
<td></td>
<td>Class BH CC3</td>
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</tbody>
</table>

World-leading fugitive emission control products with proven performance

For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz
Supagraf® Premier
World-beating fugitive emission control

Description
Supagraf® Premier is one of our top-of-the-range fugitive emission control products for valves. It is a best available technique (BAT) product for reducing industry’s fugitive emissions in line with the European Union’s IPPC Directive.

This cost-effective compression packing is manufactured in exfoliated graphite, reinforced in a novel way to provide additional strength plus resistance to pressure and extrusion. It incorporates an advanced lubricant system that prevents the pick-up of graphite on the valve stem.

Typical applications
- Harsh operating conditions where fugitive emissions from all types of valves need to be reduced to well below 100ppm.
- Widely used in systems handling fluid media such as hydrocarbon liquid fuels and gases, lubricating oils and process chemicals.

Valve stem duties
Maximum temperature
Oxidising conditions +450°C
Minimum temperature –200°C
Max system pressure 25MPa/250bar

Specifications
Supagraf Premier is third party tested and certified to:
- TA Luft Rev 07.2002 requirements, VDI 2440, for VOC emission control in valves. Sealing system met TA Luft High Grade requirement in tests for Ruhr Oel (Deutsche BP & Petróleos de Venezuela).
- Shell specification SPE 77/312 Rev 06.2007: Class B rating with 47.4MPa helium in Class 2500 valve. Seating stress of 101MPa (three-times normal) readily allowed valve stem rotation without excess actuator torque.

Supagraf® Premier — A world-leading history of success in beating fugitive emission control specifications.

Emission levels < 500ppm when subjected to over 12,000 valve operating cycles with methane at 4MPa / 40bar.

Top of its class in comparative tests run by the Materials Technology Centre of Akzo Nobel. Leakage rates between six and 100 times less than competitors’ brands — lasted 12 times longer than the next best valve packing.

Twice certified to TA-Luft requirements in independent tests:
< 10⁻⁴ mbar.l/(s.m) at system temperatures below 250°C
< 10⁻² mbar.l/(s.m) above 250°C

Third-party verified for emission control by CETIM to Shell SPE 77-312 Class A specification.
Compression packing

Supagraf® Control
Fugitive emission control for control valves to TA Luft requirements.

Description
This innovative compression packing for control valves is proven to reduce VOC fugitive emissions to well below 50ppm for over 100,000 stem strokes. Its use represents a best available technique (BAT) in line with the European Union’s IPPC Directive.

It is made of high purity exfoliated graphite, reinforced in a novel way with a non-metallic structure to provide additional strength and resistance to pressure and extrusion. An advanced lubricant system is incorporated to prevent the pick up of graphite on valve stems.

Typical applications
Control valves in systems that handle fluid media such as hydrocarbon liquid fuels and gases, lubricating oils and hazardous process chemicals.

It can be used as a long-term replacement for the PTFE V-type packing that is readily damaged by ingress of dirt and other foreign particles to the gland area.

Valve stem duties
Maximum temperature +350°C
Minimum temperature –200°C
Max system pressure 25MPa/250bar

Specifications
ISO 15848-1: Masoneilan control valves fitted with Supagraf Control are certified to ISO 15848-1 Class BH, CC3, at -29°C to +425°C. The valves showed helium leakage rates less than 10-4mg.s-1.m-1 for 100,000 stem cycles. This was achieved with pressure of 5.75MPa at a fluid flow temperature of +425°C and 10.34MPa at -29°C to +38°C.

TA Luft/VDI 2440:
Masoneilan control valves fitted with Supagraf Control are certified to TA Luft requirements at leak tightness with helium to <10-4mbar.litre.s-1.m-1. The tests were undertaken with 10MPa at 20°C and 5.7MPa at a fluid flow temperature of 425°C for 100,000 stem cycles, including four thermal cycles and two gland adjustments.

Supagraf® Control - World Class Sealing Performance beyond 100,000 mechanical stem cycles
ISO 15848 Class B sealing levels through 100,000 mechanical cycles after subjection to pressure cycles of 50 to 100 bar and 5 thermal cycles of ambient to +400°C
Combination packing

**Description**
Supagraf® PremiPak is a superior combination packing set for valves. It is based on two of our class-leading graphite products.

Soft braided end rings and moulded graphite intermediates form a classical combination set for fugitive emissions applications.

**Construction**
*End rings:* Supagraf® Premier braided graphite filament packing for high strength and extrusion resistance, with excellent sealability and third-party certification to TA Luft emission control requirements.

*Intermediate rings:* Special moulded rings of high purity graphite foil, that offer low friction and excellent heat transfer characteristics, plus high-efficiency sealing. These rings conform to Shell material specification MESC SPE 85/203.

**Typical applications**
Stop valves and control valves performing arduous duties with media such as hydrocarbon liquid fuel and gases. Most applications require VOC fugitive emission control to 100ppm or better, with a maximum working temperature capability of up to +450°C.

**Prime features**
- Reduced valve stem shudder/hesitation.
- Low break-out friction.
- Long working life; minimal maintenance.

**Valve stem duties**
- Maximum temperature: +450°C
- Minimum temperature: -200°C
- Max system pressure: 25MPa/250bar

**How supplied**
- Precision moulded rings in endless form or with single split to meet customers' requirements.
- Sections: 3mm+
- Diameters: 5mm+
- Full fitting instructions are included.

We also design and supply other high performance combination packing sets for valves to meet end users' defined standards and specifications with regard to materials, construction, and the level of fugitive emission control required.

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Supagraf® PremiPak - Excellent fugitive emissions performance from a classical combination set.

Results depicted here show excellent levels of fugitive emissions sealability through 5 thermal cycles (Packing temperatures of 160°C and ambient) and 1,100 mechanical cycles. Results are comparable with ISO15848 class B leakage levels.

Tests were carried out at the state of the art product development facilities based at the James Walker Technology Centre in the UK.
As with all sealing arrangements attention to detail is required to achieve acceptable fugitive emission levels of leakage from a packed valve gland. The following is the recommended arrangement for packing and stuffing box design for use with James Walker compression packing.

**Pressure side extrusion clearance - 0.25mm maximum**

The extrusion clearance on the atmospheric side of the packing is usually well controlled, that on the pressure side is sometimes neglected. If too large, externally applied compression can cause packing material to extrude into this clearance – if too excessive, possible damage and a substantial increase in valve friction.

**Surface finish**

The surface finish and method of producing this finish is neglected as unimportant by many seal suppliers. Through extensive test work and experimentation within the James Walker Technology Centre, James Walker can state with confidence that a stem surface finish of 0.4 to 0.6μmRa provides optimised performance of stem friction and low leakage levels with graphite based compression packing.

This detail is essential if specifications such as ISO 15848 and TA luft/VDI2440 are to be achieved.

**Production of the surface finish**

Using either a plunge grinding or transverse grinding method of generating this surface finish rather than ‘turning’ can prevent the tracking of gaseous media past the seal to atmosphere.

**Surface hardness**

The longevity of a valve stem can be improved by increasing the surface hardness. For ‘normal’ applications a hardness of between 40 and 60 Rockwell C is suggested.

**Number of packing rings**

It is recommended that between 4 and 6 packing rings are used. This number will vary depending on:
- The depth of the stuffing box
- Length of gland follower spigot
- The use of a lantern ring or bleed-off port
Housing Design

Housing lead-in - 15deg \times (\text{Housing Section in mm} / 2)

Many valves lack the provision of lead in chamfer to the gland and surface damage to the packing can often result during assembly.

Gland follower design / spigot entry

\[ A \leq (\text{No. Packing Rings}) \times (\text{nominal packing ring section}) \times 0.5 \]

\[ B = 0.2\text{mm typically. Larger extrusion gaps are acceptable however this may affect the packing and sealing system's pressure capability.} \]

\[ C = \text{nominal packing section} \]

Housing (packing) section

Below is a recommendation for housing width dependent on shaft diameter.

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Housing Width mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 12mm</td>
<td>3</td>
</tr>
<tr>
<td>12mm to 18mm</td>
<td>5</td>
</tr>
<tr>
<td>18mm to 25mm</td>
<td>6.5</td>
</tr>
<tr>
<td>25mm to 50mm</td>
<td>8</td>
</tr>
<tr>
<td>50mm to 90mm</td>
<td>10</td>
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<tr>
<td>90mm to 150mm</td>
<td>12.5</td>
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<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Housing Width mm</th>
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<tr>
<td>&lt; 18mm</td>
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<tr>
<td>18mm to 75mm</td>
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<tr>
<td>75mm to 150mm</td>
<td>8</td>
</tr>
<tr>
<td>&gt; 150mm</td>
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</table>

Please note these are for guidance only and selections outside of this may have no detrimental effect on valve performance.
Supagraf® LF Rings
Low friction rings for low-torque valve action plus fugitive emission control.

Description
Supagraf® LF rings represent a major enhancement of the operational capabilities of graphite sealing rings used on valve stems.

The rings are precision moulded from high purity expanded graphite foil to which a special low friction coating has been sinter bonded.

Laboratory tests
Independent tests confirm our low-friction, low-torque claims.

In comparative tests, sets of Supagraf LF Rings were compressed in a gland housing and the friction coefficients determined at two levels of compressive stress. The tests were repeated with sets of standard graphite rings.

In both cases, Supagraf LF displayed exactly half the friction coefficient of the standard graphite.

Friction

<table>
<thead>
<tr>
<th>Friction</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supagraf® LF Rings</td>
<td></td>
</tr>
<tr>
<td>@ 10MPa stress</td>
<td>0.11</td>
</tr>
<tr>
<td>@ 40MPa stress</td>
<td>0.07*</td>
</tr>
<tr>
<td>Standard graphite rings</td>
<td></td>
</tr>
<tr>
<td>@ 10MPa stress</td>
<td>0.22</td>
</tr>
<tr>
<td>@ 40MPa stress</td>
<td>0.14*</td>
</tr>
</tbody>
</table>

(*Surface characteristics improve on these graphite rings as the material compresses.)

Typical applications

- Valves where fugitive emission control to 50ppm or less is required
- Valves that handle dry gases or other fluids, where friction on standard graphite seals is unacceptably high
- Valves that suffer judder, hesitation or erratic action due to carbon pick-up or high-spot friction on the spindle

Torque figures taken during extended valve cycling tests showed that valve stem torque remained constant at 5Nm for Supagraf LF Rings (see graph).

For standard graphite rings, the torque rose from 21Nm to 25Nm during the first 300 operating cycles.

With a lubricated valve stem, the torque for standard graphite rings increased from 7Nm to 23Nm during the first 150 cycles as the lubricant was removed by valve action.

Valve stem duties
Maximum temperature +350°C
Minimum temperature -200°C
Max service pressure 25MPa/250bar

A genuine low friction alternative to pure graphite moulded rings at temperatures below 350 Deg C
Supagraf® Moulded Rings
Graphite rings with excellent qualities

Description
High efficiency graphite sealing rings moulded to precise density and size. Manufactured from expanded high purity graphite foil without binders, elastomers or fillers. Highest purity Nuclear Grade available. Also Wire Reinforced Supagraf® containing stainless steel wire orientated in all planes, for high loads; and Passivated Supagraf® with corrosion inhibitor to minimise galvanic action.

Typical applications
These rings are ideal for systems handling high-temperature steam, demineralised water, potable water, heat transfer media, petroleum products, inorganic and organic acids, alkalis, hot waxes and oils.

Specifications (plain Supagraf®)
• Material is WRAS approved for use with cold and hot potable water up to 85°C

Prime features
• Outstanding sealing performance over long adjustment-free periods
• Excellent chemical resistance
• Very wide temperature range
• Can seal liquid and gaseous oxygen up to 90°C Consult James Walker first

Chemical properties
Chemically inert within the range pH 0-14. Standard Grade: extractable chlorine ion content (typical) 25ppm; sulphur <100ppm. Nuclear Grade: chlorine ion <10ppm; sulphur <60ppm.

Valve stem duties
Maximum temperatures
Steam +650°C
Oxidising conditions +500°C
Non-oxidising +1000°C
Minimum temperature –200°C
Max system pressure 25MPa/250bar

Physical properties
Carbon content (grade dependent), %; 98 – 99.8
Density range, g/cm³ 1.1 – 1.8
Coefficient of linear expansion, ring of density 1.4g/cm³, 7x10⁻⁶
Thermal conductivity, ring of density 1.4g/cm³, W/mK; axial 400, radial 6
Coefficient of friction to steel 0.05

How supplied
Precision moulded rings in endless form, or with single split or matched scarf split (45° or 30°) halves. Sections 1.5mm+ diameters 2mm to 2000mm.

Supagraf® Moulded Rings – Low oxidation rates even at elevated temperatures

Results depicted here show excellent resistance to oxidation after 24 hours at elevated temperatures. Impurities and additives can detrimentally affect the oxidation rate and impair the lifetime performance of graphite moulded rings.

Only high quality graphite is used by James Walker, assuring world class performance.

Tests were carried out at the state of the art product development facilities of the James Walker Technology Centre in the UK.
Devlon® V-API valve seats

Proprietary material

Devlon® V-API has been developed by James Walker in close cooperation with the valve industry as the answer to the search for a superior valve seat material.

Specifically formulated to provide enhanced performance across a wide temperature and pressure range, Devlon V-API is now widely specified by valve manufacturers and has rapidly gained approval for use by major oil and gas producers.

In Devlon V-API, James Walker has created a material that offers a cost effective solution with superior performance.

What is Devlon® V-API?

Devlon materials are amongst the toughest and most hard wearing thermoplastics available. Through production by spin casting we achieve the highest possible material density compared with gravity casting or extrusion, providing a comprehensive range of properties including wear resistance, impact strength and improved resistance to moisture absorption.

Devlon V-API is a proprietary formula developed by James Walker, which includes additives that allow the material to perform at higher pressures and temperatures than the majority of soft valve seat materials.

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>ASTM Test Method</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength 23°C</td>
<td>D638</td>
<td>MPa</td>
<td>79.92</td>
</tr>
<tr>
<td>Tensile strength -40°C</td>
<td>D638</td>
<td>MPa</td>
<td>109.52</td>
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<tr>
<td>Hardness</td>
<td>D785</td>
<td>Shore D</td>
<td>78/80</td>
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<tr>
<td>Deformation under load 140Kgf/cm at 23°C for 24 hrs</td>
<td>D621</td>
<td>%</td>
<td>1.0 / 2.0</td>
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<tr>
<td>Charpy impact strength at 23°C</td>
<td>D256</td>
<td>J/M</td>
<td>54.8</td>
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<tr>
<td>Water absorption 24 hrs</td>
<td>D570</td>
<td>%</td>
<td>0.105</td>
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<tr>
<td>Water absorption saturation</td>
<td>D570</td>
<td>%</td>
<td>3</td>
</tr>
<tr>
<td>Co-efficient of friction</td>
<td></td>
<td></td>
<td>0.25 / 0.30 at 2000psi surface load dynamic on steel unlubricated</td>
</tr>
</tbody>
</table>
Devlon® V-API valve seats

Pressure / temperature performance comparison

![Pressure vs Temperature Graph]

Extensive testing carried out at the University of Leeds in the UK and by leading global valve OEMs, compared the performance of Devlon® V-API against a range of the most common thermoplastic materials used in valve seat applications.

Devlon® V-API offers better performance than standard polyamides or PTFE and is significantly more cost-effective than PEEK

The benefits of Devlon® V-API

- Superior pressure / temperature operating range in comparison to PTFE or Nylon 6
- Available in diameters from 1/2” (12mm) to 77” (1950mm)
- Available in billet form or as semi-finished or fully machined valve seats
- Excellent ‘machineability’ allows creation of desired surface finish
- Proven in operation up to a pressure of 414bar (6000psi), subject to valve and seat design
- Proven in operation from -50°C (-58°F) to +176°C (+350°F), subject to valve and seat design
- Low moisture absorption level enhances dimensional stability
- Superior dimensional stability over PTFE in high pressure applications
- Lower frictional losses than PEEK™ (trademark of Victrex plc) products
- Exceptional resistance to wear and abrasion
- Sufficiently conformable to seal in low pressure valve applications
- Excellent life performance in soft valve seat application
Chemical resistance

Thermoplastic materials are used in various applications throughout most industries, therefore their resistance to corrosion or chemical attack is well documented.

If a thermoplastic material absorbs or is attacked by a particular chemical either in liquid or gaseous form, then the effect on that material will depend on four factors:
1. The chemical concentration
2. Temperature
3. Applied stress
4. Duration of exposure

When absorption only occurs, the changes in the material are generally reversible if the chemical is removed, however if chemical attack takes place the changes are permanent.

When in a chemical environment allowances must be made for possible reductions in mechanical properties of plastic materials. The exception to this rule may be in the case of a bearing where the presence of liquids on the bearing surface may act as a lubricant and increase the PV limit of the material in question.

Key to chart

‘A’ No attack, possibly slight absorption. Negligible effect on mechanical properties.

‘B’ Slight attack by absorption. Some swelling and a small reduction in mechanical properties likely.

‘C’ Moderate attack or appreciable absorption. Material will have limited life.

‘D’ Material will decompose or dissolve in a short time.

Where aqueous solutions are shown the concentration as a weight percentage is given.

Aq = Aqueous Solution
SAT = Saturated Aqueous Solution
CONC = Concentrated Aqueous Solution

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>CONCENTRATION</th>
<th>Devlon® V-API</th>
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<tbody>
<tr>
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<td>B</td>
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<tr>
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<td>A</td>
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<tr>
<td>Acetic Acid Aq</td>
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<td>C</td>
</tr>
<tr>
<td>Acetone</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Allyl Alcohol</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Amines</td>
<td>D</td>
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<tr>
<td>Ammonia Aq</td>
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<td>A</td>
</tr>
<tr>
<td>Ammonia Gas</td>
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<td>Ammonium Carbonate Aq</td>
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<td>37</td>
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<td>Antimony Trichloride Aq</td>
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<td>C</td>
</tr>
<tr>
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<td>Benzaldehyde</td>
<td>B</td>
<td></td>
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<tr>
<td>Benzene</td>
<td>A</td>
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<td>Benzyl Alcohol</td>
<td>C</td>
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<tr>
<td>Benzoic Acid Aq</td>
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<td>Butylamine</td>
<td>C</td>
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<td>Cresols</td>
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Devlon® V-API technical data

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>CONCENTRATION</th>
<th>WEIGHT %</th>
<th>Devlon® V-API</th>
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<tr>
<td>Cupric Sulfate Aq</td>
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<td>B</td>
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<td>Formaldehyde Aq</td>
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</table>

CHEMICAL                          | CONCENTRATION | WEIGHT % | Devlon® V-API |

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>CONCENTRATION</th>
<th>WEIGHT %</th>
<th>Devlon® V-API</th>
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<tbody>
<tr>
<td>Lactic Acid Aq</td>
<td>90 B</td>
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<td>Linseed Oil</td>
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<tr>
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<td>C</td>
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<td>Methanol</td>
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For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz
Specialised metal components

Precision machining
James Walker supplies proprietary components and standard items to exacting specifications on a global basis, including:

- Ring Joints
- Valve seats
- Custom components
- Metal to metal seals

Major operators and OEMs in the oil and gas sector have relied on our renowned engineering expertise and skilled workmanship for over 40 years in the production of API metal ring joint gaskets.

- Established market leader in the manufacture of ring joints, metal seals and bespoke metal components for OEM and end-user clients
- Providing services on a 24/7 basis, 365 days a year, to meet customers’ most urgent demands worldwide

Materials
We are highly experienced at the machining of difficult-to-work exotic alloys, as well as all standard grade materials. The following is an inventory of metals that we machine regularly — many of these we hold in stock.

- Stainless A182 F316
- Duplex A182 F51
- Super duplex A182 F53
- Super duplex A182 F55
- Stainless Nitronic® 50 XM19
- Inconel® 825
- Inconel® 625
- Hastelloy® C 276
- Monel® K 500
- Titanium

Metallic seats
When leak-tight performance is required under severe service conditions such as high temperature or pressure or with corrosive or abrasive media, then metallic seats can be precision machined to customer specification from a wide range of specialist metals to suit the individual application.

Quality Assured
- API spec 6A PSL4 licence No. 6A-0038
- API spec Q1
- API accreditation in accordance with Standard 17D
- Full materials traceability
- Materials sourced from trusted supply chain, fully certified with permanent records held
- All machining undertaken is fully controlled in-house
- NDT, coatings and heat treatment conducted by approved and certified subcontractors

...expertise in thinwall machining and exotic alloys

For further details, call your local contact shown on rear cover or listed at www.jameswalker.biz
Metallic gaskets

Metallic ring joints
Manufactured to the highest standards including API 6A, Moorside® ring type metallic gaskets are used for high temperature or pressure applications in the oil, gas and process industries.

Only the best forged metals are used in manufacturing Moorside ring joint gaskets — no welded rings. All rings undergo a stringent machining process to ensure that close tolerances and smooth contact surfaces are rigidly maintained.

Standard materials
• Soft iron
• Low carbon steel
• Alloy steels
• Stainless steels

Specialist materials
• High nickel alloys (eg, Incoloy®)
• Super alloy steels (eg, Inconel®)

Quality is guaranteed by a strict series of tests and process quality control plus a final inspection to assure total compliance with customer specifications.

Traceability of material and constant monitoring of manufacture are essential for effective quality control. All Moorside ring joint gaskets carry a Material Reference Number, which directly relates to the batch of material from which it was manufactured.

• API 6A, ASME B16.20, and custom ring joints
• Manufacture in the UK by API licensee
• R type (oval and octagonal) solid sections
• RX and BX for pressures over 70MPa/700bar
• Wide ranges of materials

Semi-metallic

Kammprofile
The James Walker Metakamm® gasket type is generally a solid metal ring having a serrated tooth-form profile on each side.
A covering layer of graphite or PTFE is applied, which becomes compressed into the serrated surface when the gasket is loaded.
• Safer and easier to handle than spiralwound
• Operate at up to +650°C or 25MPa/250bar

Spiral-wound
The Metaflex® range of spiral-wound gaskets is widely used on high pressure joints including Metaflex type C and C/IR in valve bonnet and steam trap applications.
These are generally used for higher temperatures and pressures. A variety of metals are available for the winding strip as well as for the support rings.
• System pressures: high vacuum to over 35MPa/350bar
• Temperatures: cryogenic to 1000°C
• Material combinations for all operating conditions

Fire Test certification to API 607 – ISO 10497


CorruSafe FS
• Stainless steel corrugated ring
• PTFE inner envelope
• Graphite outer seal
• Maximum pressure 5MPa/50bar

Metaflex® SG/IR Fire Safe
• Spiral-wound construction
• Stainless steel inner support ring
• PTFE inner seal and winding strip
• Graphite outer seal
• Carbon steel outer ring
• Maximum pressure 35MPa/350bar
Sizes from ½” to 48” to all relevant gasket standards and flange designations.
Continuous operating temperatures of up to 260°C.
Leading technology

Tension control is essential in achieving 100% reliability. Our unique RotaBolt fasteners not only achieve the correct tension at installation, they maintain this throughout the life of the bolted joint. RotaBolt tension control fasteners are individually 100% load test calibrated and every bolt’s extension measurement is individually certified.

Joint integrity

A broad range of benefits can be derived from maintaining reliable bolted joint integrity.

• Reduced maintenance costs
• Better design efficiencies
• Reduced installation costs
• Improved safety
• Reduced build costs
• Enhanced design performance
• Lowest cost of ownership
• Greener environmental regimes
• Extended equipment life

Leak free environments

RotaBolt® tension control fasteners assure joint integrity wherever bolted joints are subject to pressure containment, vibration loosening, fatigue and structural slippage.

Pressure containment

RotaBolts are providing joint integrity on pressure vessels, reactors, heat exchangers and high integrity pipeline flanges. Our technology is helping to make leak-free environments a reality.

Fatigue

Bolted joints that are subject to cyclical loading are vulnerable to fatigue failure. Failure occurs when bolts are tightened with insufficient bolt tension — the cyclic load exceeds the fatigue strength of the bolt, resulting in a fatigue crack.

In process engineering and power generation RotaBolt fasteners are leading the way in regimes that are ‘fit and forget’.

Case Study

Application

Non-return valve carrying steam at 300°C in a nuclear power plant. The valve is pressurised during start-up of the plant to 16MPa/160bar but after three days the pressure reduces to a continuous 6.4MPa/64bar.

Problem

The valve suffered from heavy flange rotation due to pressure on start-up and had been leaking for a period of seven years.

Solution

RotaBolt® tension control fasteners were installed to ensure correct joint tension and optimum seating and loading of the gaskets. As a result of this solution the valve was completely leak free on start-up and it has remained leak free ever since (more than three years and counting).
Tension control bolting

Original RotaBolt®

Standard bolts from M12 to M135 can be converted to incorporate the unique RotaBolt® indicator featuring air gap technology.

Increased tension accuracy means that bolt quantity, diameter or strength grade can be reduced.

There is less machining, fewer holes drilled and fewer bolts to be tightened.

In on-site installations it is the quickest system to achieve assured design tension, reducing installation times by a factor of six.

It reduces all aspects of bolted joint maintenance, delivering quick and easy in-service monitoring and eliminating operational ‘first aid’.

No operator skill is required.

It empowers you to set bolt load and guarantee bolt tension throughout all your plant and machinery.

RotaBolt® 2

RotaBolt® 2 provides an even greater range of tension control on installation tightening and in-service checking by offering two tension settings in a single sensor.

It features a dual load indicator cap — the outer cap for high tension setting and the inner cap for low tension. This gives you the choice of an operational tension range, either for overload or maintenance control.

RotaBolt 2 has proven performance in offshore, petrochemical and nuclear applications.

RotaBolt® Vision

The world’s first safety bolt to give a clear, visual indication of loss of tension across the bolted joint.

The Vision operates on the same internal air gap technology as the original RotaBolt but has a specially developed, visual indicator which appears as an unbroken yellow line across the head of the bolt.

As soon as any tension is lost across the bolt, the indicator instantly rotates by 90 degrees to show a distinct right angle break in the yellow line.

This is clearly visible up to 25 metres away and is ideally suited for bolted joints in locations such as sea-bed valves where remote inspection by camera can be used.

Critical Factors

Bolted joint integrity relies on three critical factors:

- Joint design
- Bolt quality
- Tension control

The first two of these factors are controlled and measured.

The majority of bolted joints however are tightened in an uncontrolled manner and the bolt tension achieved at the end of the tightening cycle is unknown.

Traditional tightening methods, such as torque and hydraulic tensioning, measure the effort applied and not the tension achieved across the bolted joint.

The operator may well be highly trained and the installation procedures followed to the letter, but failure can still occur if all three reliability factors are not properly measured.

90 – 95% of all bolted joint failures are attributed to insufficient bolt tension on installation.

It is tension control that is critical to the reliability and safety of bolted joints.
Free copies of these technical brochures and papers can be requested from your local James Walker company or downloaded from the website at:
www.jameswalker.biz/pdf_docs
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Monel® Haynes International
Nitronic® Armco Inc
PEEK™ Victrex plc.

General information

Health warning: If PTFE or fluoroelastomer (eg, FKM, FFKM, FEPM) products are heated to elevated temperatures, fumes will be produced which may give unpleasant effects, if inhaled. Whilst some fumes are emitted below 250°C from fluoroelastomers or below 300°C from PTFE, the effect at these temperatures is negligible. Care should be taken to avoid contaminating tobacco with particles of PTFE or fluoroelastomer, or with PTFE dispersion, which may remain on hands or clothing. Material Safety Data Sheets (MSDS) are available on request. Information in this publication and otherwise supplied to users is based on our general experience and is given in good faith, but because of factors which are outside our knowledge and control and affect the use of products, no warranty is given or is to be implied with respect to such information. Unless governed by type approval or contract, specifications are subject to change without notice.

Statements of operating limits quoted in this publication are not an indication that these values can be applied simultaneously.

To ensure that you are working with the very latest product specifications, please consult the relevant section of the James Walker website www.jameswalker.biz.

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