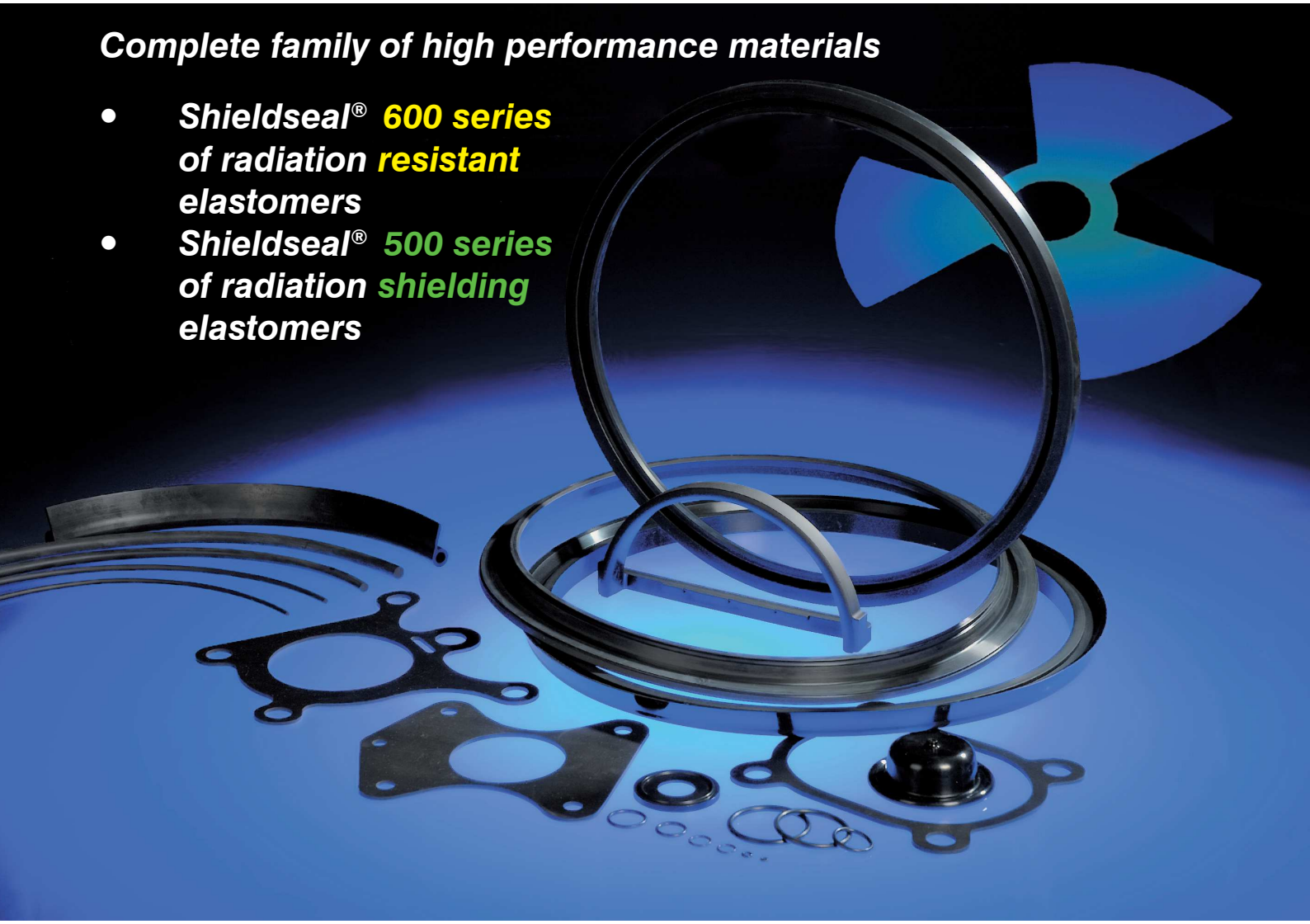
James Walker

Shieldseal® elastomers for use with ionising radiation



Complete family of high performance materials

- ***Shieldseal® 600 series of radiation resistant elastomers***
- ***Shieldseal® 500 series of radiation shielding elastomers***

High Performance Sealing Technology

James Walker

Shieldseal® elastomers for use with ionising radiation

Introduction

Only the highest quality sealing products, materials, services and technical advice are provided by James Walker to the nuclear sector and other users of ionising radiation.

With over 30 years of service to these industry areas, our client base now covers:

- **Nuclear power generation.**
- **Nuclear fuel processing and handling.**
- **Nuclear fuel transport.**
- **Defence equipment.**
- **Medical equipment.**
- **Industrial equipment.**

This document provides an overview of the most popular Shieldseal® 600 and 500 series elastomeric materials and products for applications with ionising radiation.

The capability we have developed for our many clients in these specialised sectors includes an extensive range of liquid and gas sealing products, on-site and off-site technical advice, full technical support, and product training.

Confidentiality

Much of our high-level work on special materials and customised products for use with ionising radiation is confidential. We are accustomed to operating under these conditions and fully respect the security issues involved.

We therefore gratefully acknowledge the permissions granted by numerous clients to publish the technical data on our materials that were derived from independent evaluation tests performed on their specific items.

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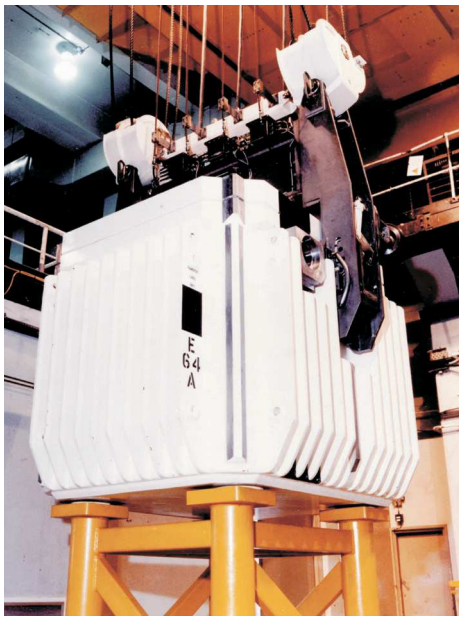


Shieldseal® elastomers for use with ionising radiation

Top quality production and inspection regimes

James Walker's Materials Technolgy Centre at Cockermouth, Cumbria, contains one of the world's most advanced elastomer research, test and prototyping facilities.

It also houses our fully automated state-of-the-art internal mixer for the full scale precision compounding for over 300 of our elastomer grades.

Precision compounding at Cockermouth

Quality elastomer compounding
Every batch of elastomer we compound in-house is assigned a unique number. This, together with the strict quality control test regime of our materials laboratory, gives complete batch traceability.

Batches are subjected to rigorous testing before being converted into a final product or component using a variety of the most advanced manufacturing techniques.

The post-curing of silicone and fluorocarbon elastomers is also under microprocessor control for temperature level and time. Each post-cure cycle is trace recorded as a vital link in our quality chain.

Flexible manufacturing
Our range of production techniques and plant provides us with total flexibility of manufacture.

This enables us to select precisely the correct production route for each of the vastly different types, sizes and quantities of elastomeric items that our clients want.

Our in-house production facilities include:

- Compression moulding up to 2.2m diameter.
- Vacuum moulding up to 2.1m diameter.
- Pull-through techniques allowing larger moulded diameters.
- Transfer moulding.
- Injection moulding.
- Extrusion process — with elastomers supplied in length form or as mould-joined rings.
- Rubber-to-metal bonding, with acid etch and phosphating of metal surfaces.
- CNC centre for machining of elastomer, polyurethane and engineering plastics.
- Elastomer impregnation of fabrics and fibres for composite materials.

Vacuum moulding

Product inspection
Every item we manufacture is given 100% visual inspection. This is backed by batch inspection of dimensions with a closer study of mismatch, flash and other specific parameters.

For complex items and those demanding exceptionally fine tolerances, we use our state-of-the-art XYZ-axes measuring centre with 3μm accuracy.

Micro-Vu Vertex

Quality standards

Our quality standards are third-party registered to BS EN ISO 9001:2000. We are also regularly assessed and quality approved by a wide range of industry bodies and individual clients including multinational corporations, utilities and government organisations.

In addition, we hold test equipment for all relevant BS, ISO, ASA, API, ANSI, DIN, DTD and NATO standards. Certificates of conformity are supplied on request. Packaging and labelling is available to individual specifications.

Materials Testing Laboratory

James Walker

Shieldseal® 600 radiation resistant elastomers

This family of fully developed, tested and industry-proven materials provides

- **Excellent compression set resistance.**
- **Resistance to high levels of radiation.**
- **Long service life.**
- **Excellent value for money.**

Our Shieldseal® 600 radiation resistant elastomers have been evaluated for resistance to ionising radiation by monitoring changes in important physical properties over time while irradiated with gamma radiation.

This work was carried out jointly by independent test house Centronic Raditec and James Walker Technology Centre.

On this and the following page, we show abbreviated results of customer specific tests for radiation resistance.

Further information is available on each material.

Ethylene-propylene (EPDM) based materials

Specially developed materials based on ethylene-propylene are highly regarded by the nuclear industry for their many invaluable features, including:

- Outstanding radiation resistance.
- Excellent resistance to a wide range of chemicals.
- Resistance to aging.
- Exceptional low temperature flexibility.
- Economical price.

Our EPDM elastomers are formulated to have very low levels of ions such as Cl^- and SO_4^{2-} that can leach from materials to promote metalwork corrosion within a nuclear reactor.

Our two leading grades of EPDM-based materials with radiation resistance are designated Shieldseal 661 and 662.

Shieldseal® 662

Description

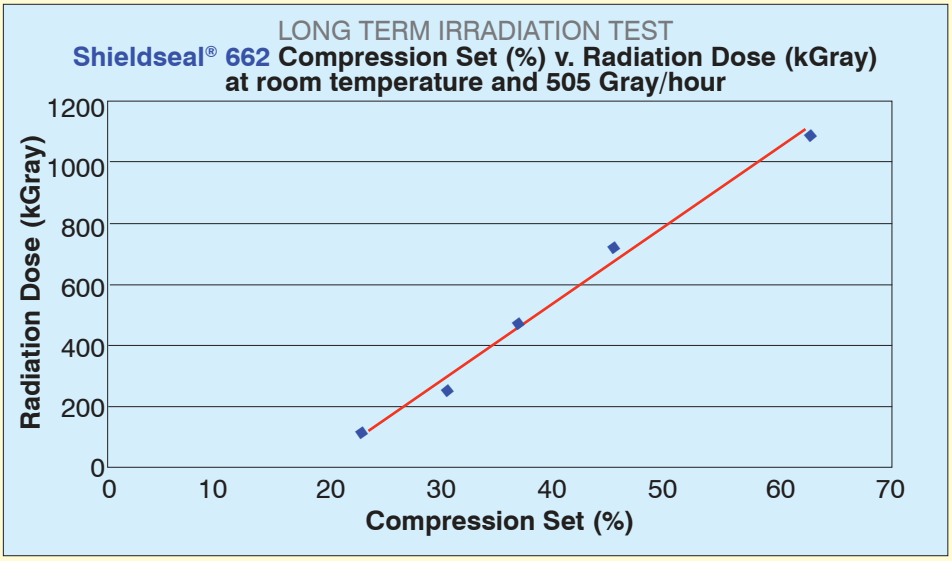
Shieldseal 662 is a medium-hard grade of EPDM-based elastomer, developed for general applications where ionising radiation is present.

Operational properties

Hardness: 70 IRHD

Compression set: 64%, when irradiated with a total dose of 1MGray at RT.

Compression set: 27%, when irradiated with a total dose of 80kGray at 90°C.



Shieldseal® 661

Description

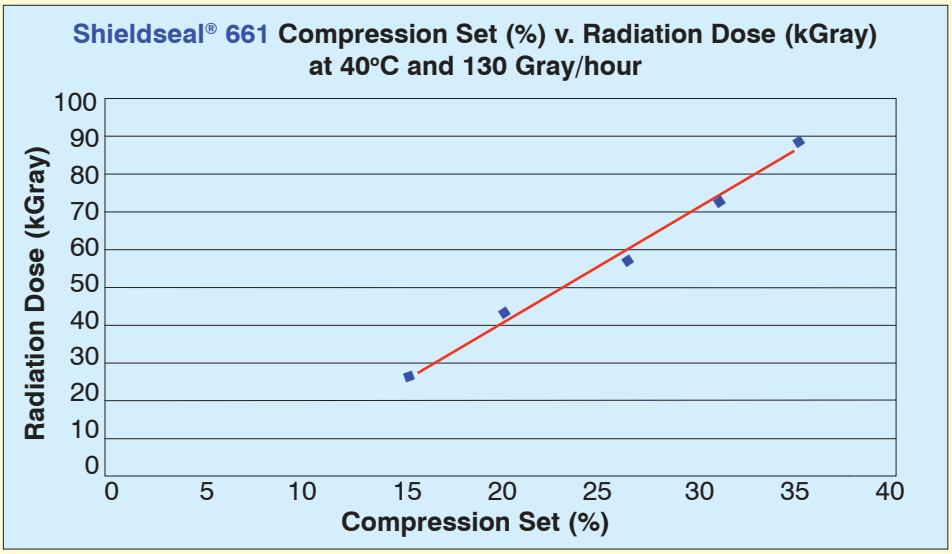
Shieldseal 661 is a soft grade of EPDM-based elastomer, especially developed for liquid and gas sealing in the presence of ionising radiation, where only low closing forces are available.

For use in static applications where superior compression set properties are an advantage.

Operational properties

Hardness: 50 IRHD

Compression set: 35%, when irradiated for 680 hours at a dose rate of 130Gray.h^{-1} (total dose 88kGray) at 40°C.



Shieldseal® 600 radiation resistant elastomers

Fluoroelastomer (FKM) based material

Shieldseal® 641

Description

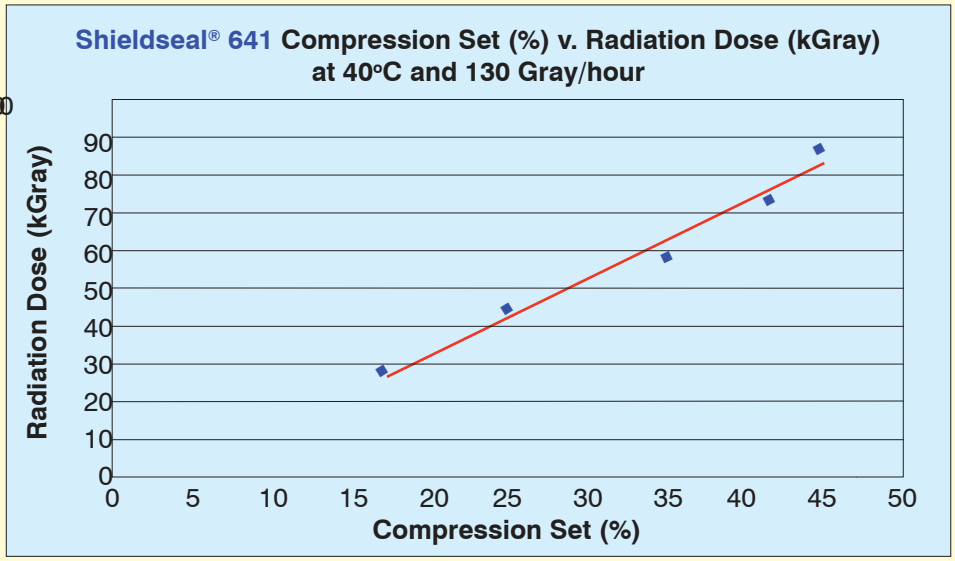
Shieldseal 641 is a soft grade of fluoroelastomer (FKM) with excellent radiation resistance and enhanced high temperature capability. It offers outstanding resistance to a wide range of chemicals, as well as sunlight, ozone and atmospheric aging.

Operational properties

Hardness: 55 IRHD

Temperature range: -18°C to +200°C.

Compression set: 44%, when irradiated for 680 hours at 130Gray.h^{-1} (total dose 88kGray) at 40°C.



Nitrile (NBR) based material

Shieldseal® 621

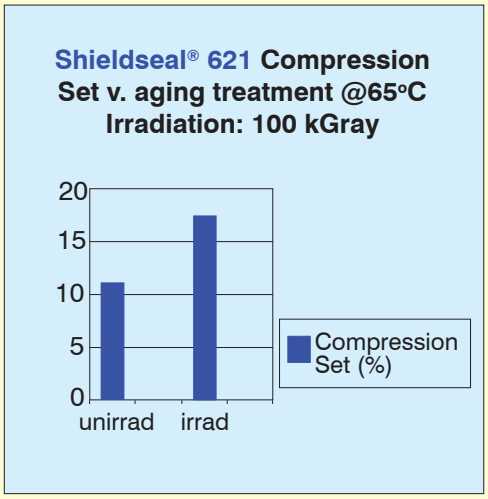
Description

Shieldseal 621 is a medium-soft grade of acrylonitrile-butadiene (NBR) formulated for radiation resistance. It offers excellent resistance to mineral oils, hydraulic fluids — including water/glycol grades — and a wide range of chemicals.

Operational properties

Hardness: 60 IRHD

Compression set: 18%, when irradiated with a total dose of 100kGray at 65°C.



Other elastomers

When selecting an elastomer for duties with ionising radiation, it is important to consider other factors in addition to radiation resistance. For example, the elastomer should also be evaluated for physical, chemical and temperature performance in the operational environment.

In addition to the materials detailed in this document, James Walker offers an extensive range of elastomeric compounds for evaluation by nuclear industry clients. These include compounds based on:

- **Polychloroprene (CR), eg, Neoprene.**
- **Polyurethane (AU/EU).**
- **Silicone (VMQ).**
- **Aflas® tetrafluoroethylene-propylene (TFE/P).**
- **Kalrez® perfluoroelastomer (FFPM).**

James Walker

Shieldseal® 500 radiation shielding elastomers

James Walker has developed two flexible Shieldseal® 500 materials for the shielding of X-ray and gamma radiation. These lead-free elastomer based materials contain specially formulated metallic fillers evenly dispersed throughout their structure. Each elastomer base has been selected for radiation resistance to ensure long service life.

Applications
Shieldseal 500 materials are designed for applications where a resilient rubber-based flexible seal is required to prevent shine paths in active areas.

A major advantage of these elastomeric materials compared to traditional filled PVC grades is their ability to maintain long term sealing forces. The flexibility of Shieldseal 500 materials makes them ideal for door seals and flange joints.

In sheet and strip form, Shieldseal 500 materials are easily folded, bent and draped, making them ideal for pipe wrapping.

Their flexibility is also a significant benefit in the manufacture of protective garments such as gloves and aprons.

Efficiency data
Evaluation work was carried out by independent test house Centronic Raditec. Separate literature is available containing full details of the tests.

How supplied
Our Shieldseal 500 materials are supplied as 'O' rings, custom mouldings, simple extrusions, and in sheets and strips of various sizes and thicknesses.

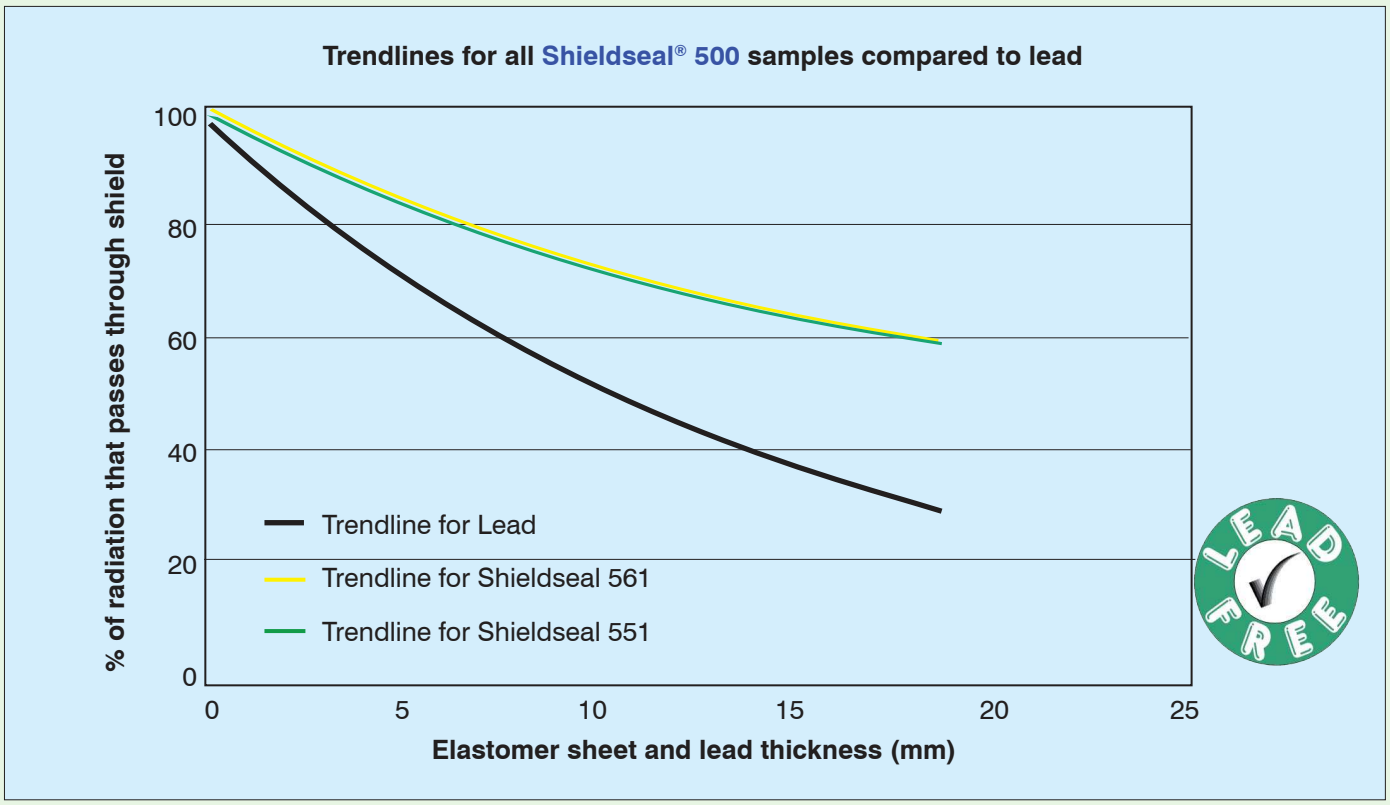
Shieldseal® 561

Description
Shieldseal 561 is a flexible material for radiation shielding duties, based on an ethylene-propylene (EPDM) elastomer.
Hardness: 80 IRHD
Shielding efficiency: 2.4mm of Shieldseal 561 has the same shielding efficiency as 1mm of lead.

Attenuation properties for specific applications can be customised within certain constraints to meet the needs of specialised applications, i.e. to give a thickness of 1.8mm of Shieldseal for the equivalent of 1mm lead.

Shieldseal® 551

Description
Shieldseal 551 is a flexible material for radiation shielding duties, based on a polychloroprene (CR) elastomer.
Hardness: 70 IRHD
Shielding efficiency: 2.4mm of Shieldseal 551has the same shielding efficiency as 1mm of lead.



Services to users of ionising radiation

James Walker works constantly at the forefront of materials science and fluid sealing technology to create engineered solutions to industry's problems.

We claim unrivalled experience in the design, development and manufacture of general and high performance elastomers. In these areas, the in-house expertise of James Walker Technology Centre is backed by academic bodies, technological centres of excellence and commercial laboratories.

For over 30 years we have applied our expertise in specialised elastomers to the nuclear sector. We have also developed and supplied elastomer-based EMC shielding materials to the defence and communications industries for 20 years.

Our Technical Services Team and nuclear industry specialists are readily available to discuss ionising radiation applications for elastomers, and are able to provide relevant documentation on request.

We are willing to partner with equipment manufacturers and end-users of radiation resistant and shielding elastomers to develop, prototype and evaluate materials and/or specific components for custom applications.

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Trademark acknowledgements

James Walker acknowledges the following trademarks as mentioned in this document. All other names bearing the ® symbol are registered trademarks of James Walker.

Aflas®	Asahi Glass
Kalrez®	Dupont Performance Elastomers.

General information

Health warning: If PTFE or fluoroelastomer (eg, FKM, FFKM, TFE/P) 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. 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.

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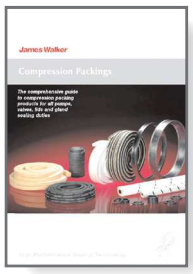
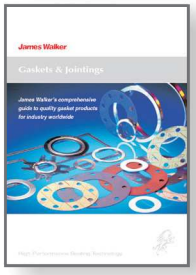
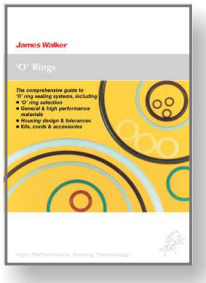


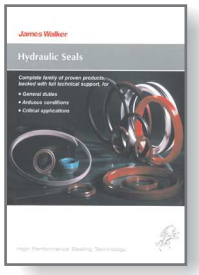
Compression Packings



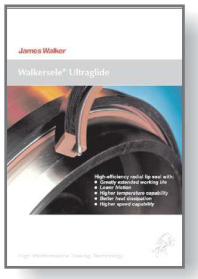
Gasket & Jointings



'O' rings



Hydraulic Sealing products



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PMS4307107/2m
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