Shieldseal® 663 radiation resistant elastomer

Issue 2

- PMUC approved material
- Radiation resistant EPDM-based elastomer
- Radiation/ageing tested to replicate 40-year lifespan
- For moulded seals & components used in ionizing radiation
James Walker in the nuclear sector

James Walker supplies only the highest integrity materials and specialised fluid sealing products to the nuclear industry.

With over 35 years of service to the nuclear sector, our client base covers:
• Fuel processing and handling.
• Power generation.
• Waste processing.
• Transportation and storage.

Our capabilities are firmly based on our knowledge of the processes involved, their highly specialised sealing requirements, plus the need for exacting quality control and assurance regimes.

James Walker’s 130-year history of materials technology, backed by top level design, development and test laboratory facilities, positions us as a leader in the provision of fluid sealing products and systems.

We fully appreciate our customers’ high expectations and inherent need for a top quality service — complete with precision manufacturing expertise and total traceability of all products and materials.

Partnerships & confidentiality

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

We work with a number of clients on a confidential basis. Therefore we fully appreciate and respect the security issues involved.

Quality assurance

Shieldseal® materials and components are manufactured under accreditations to: ISO 9001, Quality Management; AS/EN 9100 Series, Aviation, Space and Defense; OHSAS 18001, Occupational Health & Safety Management, and ISO 14001, Environmental Management.

Shieldseal® 663

This extensively evaluated material is the latest addition to our Shieldseal® 600 Series of elastomers. These have been developed specifically for their resistance to ionizing radiation.

Description

Shieldseal 663 is an ethylene-propylene terpolymer (EPDM) reinforced with carbon black and peroxide cured. It is PMUC approved (17-0383) for use in French nuclear plant.

General properties

Specifically formulated to offer a long service life of 40+ years in applications where ionizing radiation is present, particularly where the elastomer is in contact with:
• Air.
• Hot water.
• Steam (maximum 150°C constant).

This elastomer is also suitable for long-term contact with a wide variety of media associated with nuclear waste, including:
• Dilute acids and alkalis.
• Ketones.
• Lower alcohols.
• Silicone oils and greases.

Leachable ion content

Shieldseal 663 contains a very low level of leachable ions such as Cl− and SO₄²⁻, to ensure that items made of this material do not contribute to corrosion in metalwork. In tests, water soluble contents of sulphate and chloride were below the 3ppm limit of quantitation (LOQ).

Temperature capability

Minimum: -47°C (at atmospheric pressure)
Maximum: +125°C constant, or +150°C intermittent, but can survive very short exposures to higher temperatures (please consult James Walker).

Mechanical properties (typical)

Hardness (nominal): 80 IRHD.
Tensile strength: 18MPa
Elongation at break: 200%
Compression set (70h @ 125°C): 10.5%

Radiation/thermal resistance

Third-party tests carried out in accordance with international standards (see opposite page), show that Shieldseal 663 has good generic radiation resistance up to a dose of 1600kGy in radiation conditions that include elevated temperatures up to 70°C.

Thermal pre-ageing of the samples did not significantly alter the end-of-life ageing characteristics.

Typical applications

‘O’ rings and many other fluid seals and general items can be precision moulded in Shieldseal 663 up to 2.2m outside diameter.

High integrity ‘O’ rings can readily be manufactured to well in excess of 2.2m diameter (eg, for larger types of nuclear waste container) using our special, highly proven, mould and mould-joining technique.
Shieldseal® 663 has been subjected to rigorous environmental qualification (EQ) to ensure that it can function efficiently as a fluid sealing material within a nuclear power plant throughout the plant’s 40-year working life.

There are two main approaches for attaining EQ. The first follows IEEE 383 and IEC 60780 standards, that subject polymeric components to sequential thermal and radiation ageing. The French RCC-E standard outlines the second approach, that assesses the potential for any synergistic effects by simultaneous thermal and radiation ageing.

Third-party testing by AMEC
Samples of initially un-aged and thermally pre-aged Shieldseal 663 from two different batches were irradiated at a dose rate of 1kGy.h⁻¹ up to 1000kGy in a Co-60 irradiation facility. A number of samples were also irradiated at 70°C to assess synergistic effects.

Samples were then exposed to a further 600kGy, at room temperature, to simulate additional radiation from a Design Basis Event (DBE) such as a loss of coolant accident (LOCA).

Levels of degradation were monitored periodically during radiation/thermal ageing by compression set measurement of button samples. Tensile test samples were aged in the same manner and tested at James Walker Technology Centre for hardness, elongation at break (E@B), and tensile strength.

Mechanical testing of aged Shieldseal 663 dumbbell samples showed that, overall, the hardness, E@B and tensile strength for both the initially un-aged and the thermally pre-aged samples were similar for each test condition.

Summary of test results

**E@B test results**
Showed that the generally accepted end-of-life condition, defined as 50% E@B, was reached at a dose of 1600kGy. (Typical E@B value for an un-aged, un-irradiated sample of Shieldseal 663 is 200%.)

**Compression set test results**
These showed that the generally accepted end-of-life value of 90% was reached at 1600kGy. Irradiation at 70°C made little difference to the end-of-life point.

Other Shieldseal® 600 radiation resistant grades

- **Shieldseal® 621**: nitrile (NBR) elastomer of nominal 60 IRHD. Excellent resistance to mineral oils, water/glycol hydraulic fluids and a wide range of chemicals.
- **Shieldseal® 641**: fluoroelastomer (FKM) of nominal 55 IRHD, with excellent high temperature capabilities.
- **Shieldseal® 661**: EPDM-based elastomer of nominal 55 IRHD, for liquid and gas sealing at lower closing forces.
- **Shieldseal® 662**: EPDM-based elastomer of nominal 70 IRHD, for general applications where ionizing radiation is present.
General information

Health warning: If PTFE or fluoroelastomer (e.g., FKM, FFKM, FEPM) products are treated 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. Safety Data Sheets (SDS) are available on request.

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To ensure 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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