



## TECHNICAL APPLICATION GUIDE

# Metal & X-Ray Detectable Seals

Selection, application and validation guidance for food, beverage, dairy, pharmaceutical and hygienic processing environments.

### Purpose of this guide

- Understand how detectable sealing compounds support foreign-body control.
- Compare metal detection and X-ray inspection approaches.
- Identify suitable applications and seal locations.
- Plan a practical, site-specific validation process.

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## 1 UNDERSTANDING DETECTABLE SEALS

# What are detectable seals?

Detectable seals are elastomeric sealing components formulated with specialist additives that increase their response to industrial metal detection and/or X-ray inspection equipment. They are used where damage to a seal could create a foreign-body contamination risk in the product stream.

The detectable function is an additional risk-control feature; it does not replace correct seal selection, preventive maintenance, inspection of equipment or an appropriate food-safety system.

## How the detection process works



## Metal detection vs X-ray detection

|                     | Metal detectable                                                  | X-ray detectable                                                         |
|---------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Designed for</b> | Industrial metal detectors                                        | Industrial X-ray inspection systems                                      |
| <b>Principle</b>    | Additives increase the compound's response to the detector field. | Additives increase contrast/density relative to the surrounding product. |

### Important: detectability is system-dependent

A seal described as detectable should not be treated as a guarantee that every fragment will be found. Minimum detectable fragment size varies with the compound, fragment geometry, product, equipment, settings, line conditions and inspection technology.

## 2 APPLICATIONS AND RISK ASSESSMENT

# Where detectable seals are commonly used

Detectable seals are typically considered where a sealing component is close to exposed product and a damaged fragment could enter the process or finished goods. They are particularly relevant when downstream metal detection or X-ray inspection is already part of the plant's foreign-body control strategy.

### Food & beverage

Mixing, filling, transfer, packaging and processing lines

### Pharmaceutical

Process equipment where elastomer fragments could create a contamination risk

### Dairy

Hygienic pipework, pumps, valves and filling equipment

### Hygienic OEM equipment

Machine builders specifying detectable components at product-contact points

### Brewing & beverages

Transfer systems, tanks, fillers and process connections

### Packaging & inspection lines

Applications with downstream metal detection or X-ray inspection

## Typical sealing components

- O-rings and custom moulded seals
- Tri-Clamp / sanitary clamp gaskets · RJT seals · DIN 11851 seals · SMS seals
- Valve, pump and equipment-specific elastomer components

## When should a detectable seal be considered?

- The seal is located on or close to a product-contact surface.
- Seal damage could plausibly release material into the process stream.
- A downstream inspection system is available to detect and reject foreign material.
- The site's hazard analysis identifies elastomer fragments as a credible foreign-body risk.
- A customer, retailer, OEM or internal quality standard specifies detectable components.

### HACCP context

Codex HACCP principles are risk-based. Detectable seals can support a wider foreign-body control strategy where the site hazard analysis identifies a relevant risk, but they should not be presented as a universal HACCP requirement.

## 3 SELECTING THE RIGHT SEAL AND MATERIAL

## Detectability is only one part of the specification

A detectable compound must still perform as a seal. Chemical compatibility, temperature, pressure, cleaning regime, mechanical loading and food-contact requirements should be evaluated before selecting a grade.

| Selection factor                 | Questions to confirm                                                                   |
|----------------------------------|----------------------------------------------------------------------------------------|
| <b>Process media</b>             | What product, cleaning chemical, steam, oil, solvent or other media contacts the seal? |
| <b>Temperature</b>               | What are the continuous and peak operating temperatures, including CIP/SIP cycles?     |
| <b>Pressure / vacuum</b>         | What pressure differential and mechanical loading will the seal experience?            |
| <b>Seal geometry</b>             | What profile, dimensions, tolerances and groove conditions apply?                      |
| <b>Inspection technology</b>     | Metal detector, X-ray system, or a requirement for both?                               |
| <b>Food-contact / regulatory</b> | Which market and which supporting declaration or standard is required?                 |

### Common detectable elastomer families

Depending on the application and specific compound, detectable options may be available in elastomer families such as NBR, EPDM, FKM and silicone. Availability, colour, hardness, temperature capability and compliance documentation vary by grade.

#### Food-contact documentation

Do not assume detectability automatically means food-contact compliance. For applicable grades, supporting documentation may reference requirements such as FDA 21 CFR 177.2600 or relevant European/UK food-contact legislation. Always confirm the exact compound, destination market and declaration supplied.

## 4 PERFORMANCE VALIDATION

# Validate on the actual production line

Detection capability depends on the complete inspection system, not the seal compound alone. A practical validation should use representative fragments, the actual product and normal production settings wherever possible.

## Factors that can influence detection

|                                  |                                                                                                  |
|----------------------------------|--------------------------------------------------------------------------------------------------|
| <b>Fragment size &amp; shape</b> | Small, thin or irregular fragments may be harder to identify than larger pieces.                 |
| <b>Fragment orientation</b>      | The position of a fragment as it passes through the inspection field can affect response.        |
| <b>Product effect</b>            | Moisture, salt, density, packaging and product composition can influence inspection performance. |
| <b>Inspection equipment</b>      | Detector type, aperture, X-ray energy, software and reject configuration all matter.             |
| <b>Sensitivity settings</b>      | The production setting may be less sensitive than a laboratory demonstration.                    |
| <b>Line conditions</b>           | Speed, product presentation, vibration and background interference can affect performance.       |

## Suggested validation workflow

- 1 Confirm the exact seal compound and inspection technology being evaluated.
- 2 Prepare representative fragments in agreed sizes and geometries.
- 3 Run the fragments with the actual product and packaging under normal line conditions.
- 4 Test multiple orientations and positions through the inspection aperture or X-ray field.
- 5 Verify the reject mechanism, alarm and documented response procedure.
- 6 Record the method, settings, sample details and results, then revalidate when significant variables change.

### Do not publish a universal “minimum detectable size” without test conditions

A size value is only meaningful when the compound, inspection equipment, product, settings and test method are defined. Site validation is the most reliable basis for a production specification.

## 5 SPECIFICATION CHECKLIST

## Information to provide for a detectable seal

Providing the following information allows the application to be reviewed more accurately and reduces the risk of selecting an unsuitable compound or seal profile.

|                              |                                                                                |
|------------------------------|--------------------------------------------------------------------------------|
| <b>Seal type / profile</b>   | O-ring, RJT, DIN 11851, SMS, Tri-Clamp, moulded component or drawing reference |
| <b>Dimensions</b>            | ID, OD, cross-section, nominal sanitary size or full drawing                   |
| <b>Material preference</b>   | NBR, EPDM, FKM, silicone or application-led recommendation                     |
| <b>Hardness</b>              | Shore A requirement if known                                                   |
| <b>Operating temperature</b> | Continuous and peak temperature                                                |
| <b>Process media</b>         | Product and cleaning / sterilisation chemicals                                 |
| <b>Inspection system</b>     | Metal detection, X-ray inspection or both                                      |
| <b>Compliance documents</b>  | Required food-contact, material or customer-specific documentation             |
| <b>Quantity / timing</b>     | Prototype, trial, maintenance stock or production requirement                  |

### How International Seal can support the application

- Review the seal profile, material requirements and operating environment.
- Identify suitable detectable compound options for metal detection, X-ray inspection or both.
- Supply prototype or trial quantities where available.
- Provide supporting technical and food-contact documentation for applicable grades.
- Support repeat supply across standard hygienic seals, O-rings and custom moulded components.

## 5 SPECIFICATION CHECKLIST (CONTINUED)

## Ready to specify a seal?

### Ready to specify a seal?

Send the seal type, dimensions, material requirement, process conditions and inspection technology to International Seal. Our team can review the application and recommend the most appropriate route.

### Technical references

- Codex Alimentarius — General Principles of Food Hygiene, CXC 1-1969 (including HACCP principles), revised 2022.
- U.S. eCFR — 21 CFR 177.2600, Rubber articles intended for repeated use.
- Regulation (EC) No 1935/2004 — materials and articles intended to come into contact with food.
- UK Food Standards Agency — Food contact materials regulations and guidance.