

# O-Ring Failure Chart

## EXTRUSION OR NIBBLING

**DESCRIPTION:**  
The seal develops ragged edges, generally on the low pressure side, which appear tattered. This condition is more common with high pressure systems



**CONTRIBUTING FACTORS:**

- Excessive clearances
- Excessive system pressure
- Irregular clearance gaps due to eccentricity
- Sharp groove edges
- Low-modulus/low-hardness elastomer
- Softening of elastomer due to fluid incompatibility
- Excessive gland fill
- Expansion of cylinder wall due to pressure

**SUGGESTED SOLUTIONS:**

- Decrease clearances
- Decrease system pressure if possible
- Use back-up ring
- Increase rigidity and concentricity of metal components
- Break edges of groove to minimum of .004" (0.10mm)
- Use higher-modulus/higher-hardness elastomer
- Use more chemically compatible elastomer
- Increase groove width or change o-ring size
- Stiffen cylinder wall to limit expansion

## OVER-COMPRESSION

**DESCRIPTION:**  
The seal exhibits parallel flat surfaces corresponding to the sealing surfaces. May also develop circumferential splits within flattened surfaces.



**CONTRIBUTING FACTORS:**

- Excessive compression squeeze
- Elastomer with poor compression set properties
- Elastomer with inadequate heat resistance
- Elastomer that swells excessively in system fluid
- Improperly cured part used

**SUGGESTED SOLUTIONS:**

- Use smaller o-ring or adjust gland dimensions
- Use material with better compression set resistance
- Use more heat resistant elastomer
- Use more chemically resistant elastomer
- Check cure state of parts prior to installation

## SPIRAL FAILURE

**DESCRIPTION:**  
The seal surface exhibits a series of deep, spiral, 45° angle cuts. This failure is often seen with long-stroke, hydraulic piston seals.



**CONTRIBUTING FACTORS:**

- Eccentric components
- Wide clearances in combination with side locks
- Uneven surface finishes
- Inadequate lubrication
- Elastomer is too soft
- Stroke speed too slow - dynamic reciprocating

**SUGGESTED SOLUTIONS:**

- Increase rigidity and concentricity of metal components
- Decrease clearances
- Machine metal surfaces to 10 to 20 pinch surface finish
- Specify an external lubricant or use an internally lubricated material
- Use a higher durometer material
- Increase stroke speed or use D-ring instead of O-ring

## HEAT HARDENING/THERMAL DEGRADATION

**DESCRIPTION:**  
The seal may exhibit radial cracking on the highest temperature surfaces, often accompanied by the flattening of the seal characteristics of over-compression. Certain elastomers may exhibit signs of softening, such as a shiny surface.



**CONTRIBUTING FACTORS:**

- Thermal properties of elastomer
- Excessive temperatures, temperature excursions or temperature cycling

**SUGGESTED SOLUTIONS:**

- Select more heat-resistant elastomer
- Select elastomer containing antioxidants
- Consider possibility of cooling sealing surfaces
- Increase thermal mass to dampen temperature cycling or excursions
- Change the position of the gland away from heat source

## EXPLOSIVE DECOMPRESSION

**DESCRIPTION:**  
Explosive decompression results when high-pressure gases are absorbed by the seal, and then, as the pressure is rapidly dropped, the expanding gases are trapped in the micropores of the elastomer, causing surface blisters and ruptures as they escape. The effected seals will exhibit random short splits or ruptures deep into the seal cross-section. When first removed the surface may also be covered with small blisters.



**CONTRIBUTING FACTORS:**


- Rapid pressure drop from high pressure
- Low-modulus/low-hardness elastomer

**SUGGESTED SOLUTIONS:**

- Slow the release of system pressure
- Specify a higher-modulus/higher-hardness material
- Specify a decompression-resistant material

## CHEMICAL DEGRADATION

**DESCRIPTION:**  
The seal may exhibit many signs of degradation including blisters, cracks, voids, or discoloration. However, in some cases the degradation is only detectable by measurement of physical properties.



**CONTRIBUTING FACTORS:**

- Incompatibility with chemical environment

**SUGGESTED SOLUTIONS:**

- Use more chemically resistant elastomer
- Use PTFE encapsulated o-ring
- Decrease temperature that o-rings sees, as higher temperatures accelerate chemical degradation

## ABRASION

**DESCRIPTION:**  
Abrasion occurs only with dynamic seals - seals involved with a rotary, oscillating or reciprocating motion. The seal or parts of the seal exhibit a single flat surface parallel to the direction of motion. Loose particles and scrapes may be found on the seal surface.



**CONTRIBUTING FACTORS:**

- Rough sealing surface
- Sealing surfaces too smooth to allow for adequate lubrication
- Process environment containing abrasive particles

**SUGGESTED SOLUTIONS:**

- Use recommended gland surface finishes
- Use recommended gland surface finishes
- Eliminate abrasive components or protect seal from exposure to them

## PLASTICIZER EXTRACTION

**DESCRIPTION:**  
Seen primarily in fuel systems, plasticizer extraction is characterised by a loss of volume or weight of the seal. It is often difficult to detect with only a visual inspection.



**CONTRIBUTING FACTORS:**

- Heavy use of plasticizers to achieve low-temperature properties or hardness
- Exposure to organic solvents compatible with plasticizers used

**SUGGESTED SOLUTIONS:**

- Switch to elastomer with low-temperature properties so plasticizers aren't needed
- Change plasticizers used to ones less compatible with process fluids

## INSTALLATION DAMAGE

**DESCRIPTION:**  
The seal or parts of the seal may exhibit small cuts, nicks or gashes.



**CONTRIBUTING FACTORS:**


- Sharp surfaces on glands or components
- Inadequate lead-in chamfer
- O-ring too large for gland
- Low-modulus/low-hardness elastomer

**SUGGESTED SOLUTIONS:**

- Break all sharp metal edges and cover threads with tubes or tape for installation
- Provides a 15° lead-in chamfer of adequate length so o-ring sees only chamfer
- Review gland and o-ring design per recommended design standards
- Specify a higher-modulus/higher-hardness material

## WEATHER OR OZONE CRACKING

**DESCRIPTION:**  
Occurring in seals exposed to ozone, UV radiation or other air pollutants, weather or ozone cracking is characterised by small surface cracks perpendicular to the direction of stress.



**CONTRIBUTING FACTORS:**

- Exposure to ozone, UV radiation or other pollutants
- Excessive seal stretch (>5% ID stretch)

**SUGGESTED SOLUTIONS:**

- Select more ozone and UV-resistant elastomer
- Apply anti-ozonant or wax coating to seal
- Modify the design to avoid the damaging exposure
- Modify design to reduce stretch to less than 5%