1. COMPRESSION SET

Description of failure appearance:

This failure is common to both static and dynamic sealing applications. This type of failure produces flat surfaces on the sides of the O-Ring that were compressed, usually the top and bottom if sitting flat on a desk.

The sources of COMPRESSION SET failure:

- The O-Ring material used has poor compression set resistance
- The O-Ring material used has limited resistance to heat
- The O-Ring is swelling in the groove due to fluid incompatability
- The O-Ring has too much squeeze in the groove

How to eliminate COMPRESSION SET failure:

- Use a higher quality, low compression set material
- Check the compatability of the O-Ring material to the fluid
- Select a material good for heat produced in operation
- Double check the groove dimensions for proper squeeze
- Check existing O-Ring stock for physical properties

二、ABRASION

Description of failure appearance:

This failure is most ommon in dynamic sealing applications - like reciprocating and rotating shafts. This type of failure produces a flattened surface on the side of the O-Ring body subjected to the movement.

The sources of ABRASION failure:

- The metal surfaces are too rough and are abrasive to the O-Ring
- The metal surfaces are too smooth, not allowing proper lubrication
- No lubrication in the design
- Operating temperatures are too high for the material
- The system fluid is contaminated with abrasive particles

How to eliminate ABRASION failure:

- Change surface finishes to recommended
- Arrange for better lubrication
- Use a material suitable for higher temperatures
- Eliminate any source of contamination
- Change to a more abrasion resistant O-Ring material

三、INSTALLATION DAMAGE

Description of failure appearance:

This failure can occur in both static and dynamic O-Rings. Short nicks or scratches or peeling on the surface of the O-Ring can be noticed.

The sources of INSTALLATION failure:

- The use of sharp edged tools
- Sharp corners on the O-Ring groove
- Sharp threads that the O-Ring passes over
- No lead-in chamfer
- O-Ring was not lubricated
- O-Ring was twisted or trapped between metal surfaces
- Poor quality of the material

How to eliminate INSTALLATION failure:

- Cover all threads with masking tape
- Break all sharp edges
- Create a 15 to 20 degree lead-in chamfer
- Lubricate O-Ring during installation
- Use correct sized O-Ring

四、EXPLOSIVE DECOMPRESSION

Description of failure appearance:

You will find random ruptures, crater-like pores and small slits, which have originated within the body of the O-Ring.

The sources of EXPLOSIVE DECOMPRESSION failure:

- Gases permeating the O-Ring material
- Rapid decompression of those gases
- Micro-explosions occuring as decompression takes place

How to eliminate EXPLOSIVE DECOMPRESSION failure:

- Slow system cycles down
- Increase time for decompression
- Replace with a harder material
- Select a smaller O-Ring cross section

五、HEAT HARDENING

Description of failure appearance:

You will see this failure in both static and dynamic O-Rings. A flattened area will appear on the dynamic surface. Sometimes cracked, hardened and pitted areas can be seen throughout the entire body of the O-Ring.

The sources of HEAT HARDENING AND OXIDATION:

- Temperatures higher than recommended for the material
- Elastomers becoming dry and portions of the material evaporating
- Oxidation

How to eliminate HEAT HARDENING AND OXIDATION:

- Lower the operating temperatures of the system
- Use O-Rings rated for higher temperatures

六、SPIRAL DAMAGE

Description of failure appearance:

The surface of the O-Ring appears to have been twisted, or to have rolled in its groove or against a reciprocating rod. It stays in this position when freed.

The sources of SPIRAL DAMAGE:

- Side loads causing excessive clearance
- Mis-fit components
- No suitable lubrication
- Material too soft
- Moving speed too slow
- Surfaces are uneven

How to eliminate SPIRAL DAMAGE:

- Decrease the clearances between components
- Check for roundness of fitting parts
- Machine surfaces to suitable finishes
- Provide lubrication
- Select a harder material
- Add a back-up ring

七、EXTRUSION FAILURE

Description of failure appearance:

You will see a ridge, nibbles and small missing pieces of the material along either the inner diameter or outer diameter due from the downstream side of the O-Ring.

The sources of EXTRUSION:

- Excessive system pressures
- Too much clearance between mating parts
- Material too soft
- O-Ring body too large for the groove
- Improperly machined groove
- Attack by system fluid

How to eliminate EXTRUSION:

- Decrease or regulate system pressure
- Refit mating parts, machining back to proper, concentric fit
- Select a harder material
- Determine correct O-Ring cross section size
- Add back-up rings
- Re-machine groove to include clean, smooth groove edges

- Replace O-Ring with different type of seal

八、SWELLING FAILURE

Description of failure appearance:

Identified by obvious dimension of the body of the O-Ring. Reduced physical properties, which causes improper fit. Heat and friction excelerates seal failure.

The source of EXCESSIVE SWELL:

- The material absorbs system fluids causing swelling
- An obvious chemical incompatability

How to eliminate EXCESSIVE SWELL:

- Test material for fluid compatability
- Consult a chemical compatability chart to determine suitable material

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九、AGING/OXIDATION FAILURE

Description of failure appearance:

Exposure of either static or dynamic sealing O-Ring to weather, atmosphere, polutions and ultra-violet light.

The source of WEATHERING OR OZONE CRACKING:

- Attack of the polymer chains, destruction of the material causing cracking

How to eliminate WEATHERING OR OZONE CRACKING:

- Select a material that resists ozone exposure

十、ATYPICAL FAILURE

Description of failure appearance:

Difficult to pin-point due to non-obvious, unseen reasons

The source of NO APPARENT REASON FOR FAILURE:

- Combined tolerances of all components not correct
- Not enough squeeze
- Parts not fitting properly

- Components not round
- Too much flash, remaining rubber on O-Ring
- Improper groove shape

How to eliminate NO APPARENT REASON FOR FAILURE:

- Re-machine all parts for proper sizing tolerances
- Make sure the amount of squeeze is correct
- Double check the design
- Replace components not fitted correctly
- Select a different material or O-Ring source for clean ground outer diameters
- Check published data for groove shapes and sizing