ENGINEERING REFERENCE

INFLATABLE SEAL DESIGN GUIDE

Engineering principles for specifying inflatable seals: groove design, inflation pressure, stroke requirements, seal profiles, media compatibility, and cycle life considerations.

> Inflatable seals are custom-engineered elastomer seals that use air or gas pressure to expand against a mating surface, creating an airtight, watertight, or gas-tight barrier. When deflated, the seal fully retracts — allowing repeated access for doors, hatches, chambers, and processing equipment. This guide covers the key engineering considerations for specifying an inflatable seal for your application.

HOW INFLATABLE SEALS WORK

OPERATING PRINCIPLE

Compressed air or gas is introduced through an inlet valve, inflating the seal and causing it to expand outward against a mating surface. The seal conforms to irregularities in the mating surface, creating a reliable seal even across gaps and uneven surfaces where conventional static seals would fail.

- Inflate to seal — deflate to release
- Conforms to irregular mating surfaces
- Bridges gaps that static seals cannot
- Retracts fully when deflated for clearance

WHEN TO USE INFLATABLE SEALS

Inflatable seals solve applications where conventional seals fall short — where surfaces are irregular, gaps vary, access is needed repeatedly, or mechanical clamping isn't practical.

- Doors, hatches, and access panels requiring repeated opening
- Irregular or non-uniform mating surfaces
- Variable gaps due to thermal expansion or tolerances
- Clean rooms, autoclaves, vacuum chambers
- Processing equipment requiring sanitary access
- Clamping, lifting, or pressure application

SEAL TYPES

NON-REINFORCED SEALS

Extruded homogeneous rubber profiles bonded into custom shapes. The most versatile and cost-effective option for standard applications.

- Straight, endless loop, or molded corners at any angle
- Any cross-section profile available
- Operating pressures up to 1–5 bar
- Rapid full retraction when deflated
- Lower tooling cost than reinforced seals
- Best for: standard gaps, moderate pressures, cost-sensitive applications

FABRIC REINFORCED SEALS

Fully molded seals with internal fabric reinforcement (Kevlar, Fiberglass, Nylon, Dacron) for dramatically higher pressure capacity and cycle life.

- Higher internal pressure capacity than non-reinforced
- Withstands heavier loads on seal face
- Superior cycle life in demanding environments
- Works in non-enclosed retainer environments
- Can match any competitor's cross-section profile
- Best for: high pressure, extreme cycles, harsh environments

How to choose: If your application involves standard gaps, moderate pressures, and typical cycle counts, start with a non-reinforced seal — it's more cost-effective and has shorter lead times. Move to fabric-reinforced when you need higher pressures, extreme cycle life, or the seal must perform without an enclosed groove/retainer.

GROOVE DESIGN & INFLATION PRESSURE

GROOVE DESIGN CONSIDERATIONS

PARAMETER	GUIDELINE
Groove Width	Should match the seal base width. Seal must sit securely without lateral movement when deflated.
Groove Depth	Deep enough to allow the seal to fully retract below the sealing surface when deflated, providing full clearance for door/hatch closure.
Groove Material	Aluminum extrusion retainers are most common. Stainless steel, plastic channels, and custom retainer profiles also available.
Corner Radius	Generous radii recommended. Tight corners increase stress on the seal and reduce cycle life. Molded corners available for 90° and custom angles.
Air Inlet Routing	Inlet valve location should allow easy access for air supply connection. Groove must accommodate inlet fitting without pinching the seal body.
Surface Finish	Groove surfaces should be smooth and free of burrs. Sharp edges can cut the seal during inflation/deflation cycles.
Retainer Method	Mechanical retention (clips, channels, dovetail) or adhesive bonding. Mechanical is preferred for serviceability.

INFLATION PRESSURE

PARAMETER	GUIDELINE
General Rule	Inflation pressure = 1.25× to 1.45× the pressure differential across the seal
Zero Differential	If no pressure differential (e.g., dust seal on a door), 15 psig (1 bar) inflation is typically sufficient
Moderate Differential	For 25 psig differential across the seal, use approximately 45 psig inflation pressure
Inflation Medium	Clean, dry compressed air is standard. Nitrogen for inert environments. Avoid oil-contaminated shop air.
Over-Inflation	Excessive pressure reduces seal life and can cause ballooning or rupture. Always stay within rated range.
Under-Inflation	Insufficient pressure results in incomplete sealing and leakage. Seal must fully contact mating surface.
Pressure Monitoring	Inline pressure gauge or monitoring system recommended for critical applications. Quick-connect fittings simplify installation.

STROKE & DEFLECTION

PARAMETER	GUIDELINE
Stroke (Deflection)	The distance the seal expands from its resting (deflated) state to full contact with the mating surface.
Gap Measurement	Measure the gap between the groove and mating surface at all points. Account for thermal expansion and mechanical tolerances.
Recommended Stroke	Seal stroke should exceed the maximum gap by a minimum margin to ensure positive contact. DRI engineers size this per application.
Variable Gaps	Inflatable seals accommodate variable gaps naturally — the seal conforms to the surface. Specify the min and max gap to DRI.
Seal Profile Selection	Profile cross-section determines stroke capability. Larger profiles provide more stroke. DRI offers 95+ standard profiles and unlimited custom options.

Design tip: Provide DRI with your groove dimensions, gap range (min/max), and operating pressure differential. Our engineers will recommend the optimal seal profile, inflation pressure, and retainer configuration for your specific application.

MATERIALS & COMPATIBILITY

ELASTOMER SELECTION GUIDE

MATERIAL	TEMP RANGE	BEST FOR	AVOID
EPDM	−40°F to +300°F	Steam, hot water, ozone, weathering, outdoor exposure, borated water	Petroleum oils, hydrocarbon solvents, fuels
Silicone	−65°F to +450°F	Extreme temperatures, clean rooms, FDA/food contact, low outgassing, medical	Steam (causes hydrolysis), high-pressure abrasion
Neoprene	−40°F to +230°F	General purpose, moderate oil resistance, flame resistance, weathering	Strong oxidizers, ketones, chlorinated solvents
Nitrile (NBR)	−40°F to +250°F	Petroleum oils, fuels, hydraulic fluids, grease	Ozone, weathering, ketones, strong acids
FKM (Viton)	−15°F to +400°F	Aggressive chemicals, fuels, acids, solvents, high temperature	Ketones, low-molecular-weight esters, amines
Butyl (IIR)	−40°F to +250°F	Gas impermeability, vacuum sealing, vibration damping, chemical tanks	Petroleum oils, hydrocarbon solvents

MECHANICAL PROPERTIES COMPARISON

PROPERTY	EPDM	SILICONE	NEOPRENE	NITRILE	FKM	BUTYL
Hardness (Shore A)	40–80	40–80	30–90	30–90	60–90	40–75
Tensile (psi)	500–2,500	200–1,500	500–3,000	500–3,000	500–2,000	300–2,000
Elongation	300–600%	100–700%	100–600%	100–600%	150–300%	300–600%
Compression Set	Low	Moderate	Moderate	Low–Mod	Low	Moderate
Tear Resistance	Good	Fair	Good	Good	Fair	Good
Abrasion	Good	Fair	Good	Excellent	Good	Fair

REINFORCEMENT FABRIC OPTIONS

KEVLAR

Ultra-high strength. Best for maximum pressure capability and cut/abrasion resistance. Highest cost.

FIBERGLASS

Excellent heat and chemical resistance. Dimensionally stable. Good for high-temperature applications.

NYLON

Good general-purpose reinforcement. Strong, flexible, and cost-effective. Most commonly specified.

DACRON (POLYESTER)

Excellent fatigue resistance, dimensional stability, and low moisture absorption. Good for high-cycle applications. Cost-effective.

CUSTOM BLENDS

DRI can specify custom fabric reinforcement combinations tailored to your application's pressure, temperature, and chemical requirements.

COTTON

Maximum flexibility and conformability. Best for irregular shapes where the seal must bend tightly.

Material selection tip: Start with the substance your seal will contact and the temperature range it must survive. That narrows the elastomer choice. Then consider pressure requirements to determine if fabric reinforcement is needed, and which fabric type. DRI engineers can recommend the optimal combination for your application.

CYCLE LIFE, PROFILES & ORDERING

CYCLE LIFE CONSIDERATIONS

FACTOR	IMPACT ON SEAL LIFE
Inflation Pressure	Higher pressure = more stress per cycle. Stay within recommended range to maximize life.
Stroke / Deflection	Greater deflection per cycle increases material fatigue. Size the seal to minimize over-deflection.
Temperature Exposure	Operating at temperature extremes accelerates aging. Select a compound rated for your environment.
Chemical Exposure	Incompatible media degrades the elastomer. Verify compound compatibility before specifying.
UV / Ozone Exposure	Outdoor seals need EPDM or Silicone. Nitrile and natural rubber degrade under UV/ozone.
Abrasion / Mechanical Wear	Rough or sharp mating surfaces shorten seal life. Smooth surfaces and generous radii extend it.
Fabric Reinforcement	Reinforced seals generally outlast non-reinforced in high-cycle applications. Consider Dacron or Nylon for fatigue resistance.
Inflation Speed	Rapid repeated cycling increases heat buildup and fatigue. Allow the seal to reach full inflation/deflation between cycles.

AVAILABLE SEAL PROFILES

STANDARD PROFILES

DRI offers 95+ standard inflatable seal profiles covering a wide range of cross-sections, sizes, and stroke capabilities. Standard profiles are available in all elastomer compounds and can be bonded into any shape or configuration.

- Round, D-shape, P-shape, rectangular, T-shape
- Foot-base, flat-base, grooved-base profiles
- Profiles from miniature to large diameter
- Download the Inflatable Seal Profile Overview for complete catalog

CUSTOM PROFILES

When a standard profile doesn't fit, DRI engineers design custom cross-sections matched to your groove geometry, stroke requirement, and pressure rating. We can also match any competitor's profile.

- Custom cross-sections designed to your specs
- Competitor profile matching
- Prototype seals for fit and function testing
- No minimum order quantities

WHAT TO PROVIDE WHEN REQUESTING A QUOTE

Groove Dimensions (W × D) | Gap to Mating Surface (Min / Max) | Seal Length / Perimeter | Shape (Straight / Loop / Corners) | Operating Pressure Differential | Media Contact (Air, Water, Chemical, etc.) | Temperature Range | Estimated Cycle Count | Indoor / Outdoor Environment | Drawing or Sketch (if available)

READY TO SPECIFY YOUR INFLATABLE SEAL?

DRI engineers work directly with you — no sales intermediaries. Send us your application details and we'll recommend the right seal profile, compound, and configuration. Quotes typically returned within one business day.

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