



TECHNICAL SELECTION GUIDE

Elastomer Temperature Range & Grade Guide

O-ring, gasket & seal operating limits — continuous service ranges, low-temperature behaviour, high-temperature ageing and material-selection guidance for common elastomer families.

Purpose of this guide

- Compare typical continuous-service temperature windows by elastomer family.
- Understand low-temperature and high-temperature failure behaviour.
- Identify what else changes the usable temperature limit.
- Plan the information needed for an accurate material quotation.

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1 HOW TO USE THIS GUIDE

Temperature range as a starting point

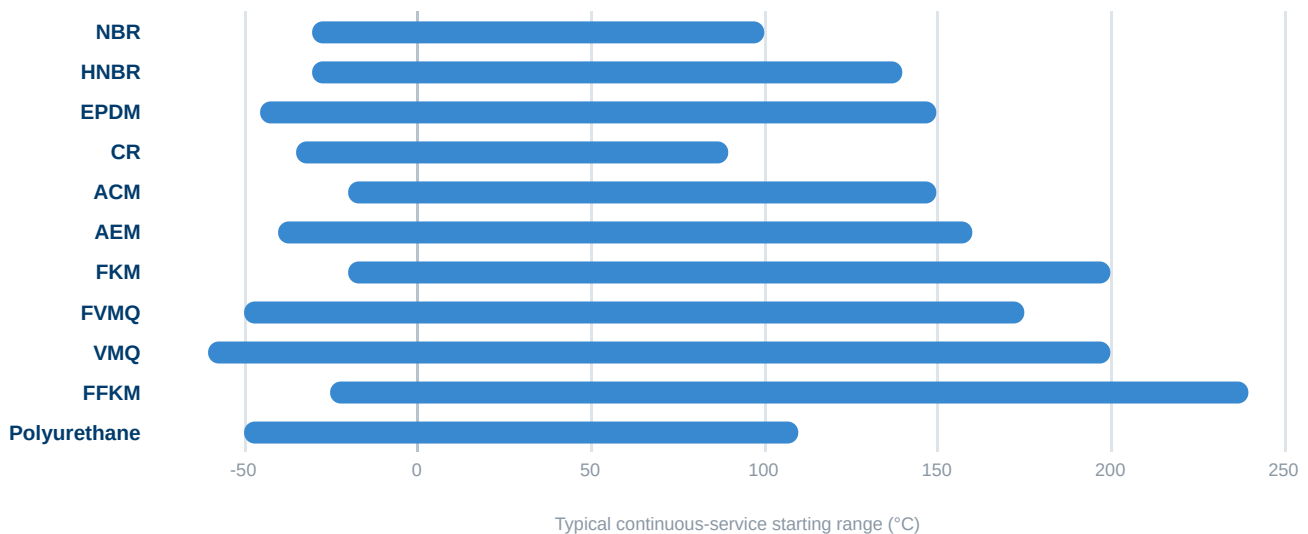
Temperature range is a starting point for seal selection, not a universal pass/fail boundary. The actual usable range depends on the exact compound, the process media, exposure time, pressure, seal geometry and whether the duty is static or dynamic.

Core rule

The grade-specific technical data sheet takes precedence over any general polymer-family range. When an application operates close to a stated limit, confirm the exact compound rather than relying on a generic material name.

Typical elastomer temperature windows

The chart below shows broad continuous-service starting ranges for common sealing materials. It is intended for preliminary comparison only; specialty formulations can extend either the low-temperature or high-temperature limit.



Four checks before selecting a seal

1. Normal temperature

Minimum and maximum temperature during ordinary service.

2. Peak / cleaning temperature

Short excursions, hot-water washdown, steam or CIP/SIP cycles.

3. Media

Fluid, concentration, cleaning chemicals and exposure duration.

4. Duty

Static or dynamic motion, pressure, friction, vacuum and cycling.

2 CONTINUOUS-SERVICE RANGES

Continuous-service temperature ranges

These values are broad industry starting points for compatible media and standard grades. They are useful for early material comparison, but must not be treated as guaranteed limits for every compound or application.

Material family	Typical °C	Typical °F	Selection note
NBR — Nitrile	-30 to +100	-22 to +212	Special grades can improve low-temperature performance; short excursions may be higher.
HNBR	-30 to +140	-22 to +284	Higher heat and ageing resistance than standard NBR.
EPDM — peroxide cured	-45 to +150	-49 to +302	Strong hot-water/steam potential where the exact compound is suitable.
EPDM — sulphur cured	-45 to +130	-49 to +266	Typically lower upper-temperature capability than peroxide-cured EPDM.
CR — Chloroprene	-35 to +90	-31 to +194	Useful weathering / refrigerant capability; specialty low-temp grades exist.
ACM — Polyacrylate	-20 to +150	-4 to +302	Good hot-oil resistance; limited cold flexibility.

Continued on the next page.

2 CONTINUOUS-SERVICE RANGES (CONTINUED)

Continuous-service temperature ranges

Material family	Typical °C	Typical °F	Selection note
AEM	-40 to +160	-40 to +320	Bridges many applications between HNBR and FKM.
FKM — Fluorocarbon	-20 to +200	-4 to +392	Special low-temperature FKM grades can extend the lower limit.
FVMQ — Fluorosilicone	-50 to +175	-58 to +347	Combines low-temperature flexibility with better fuel resistance than VMQ.
VMQ — Silicone	-60 to +200	-76 to +392	Very wide temperature flexibility; mechanical strength and media resistance must be checked.
FFKM	-25 to +240	-13 to +464	Some specific grades permit substantially higher peak temperatures.
Polyurethane	-50 to +110	-58 to +230	Excellent wear resistance; hydrolysis and high heat can be limiting depending on chemistry.

Note: the values above are deliberately conservative family-level guidance. A specific compound may have a narrower or wider approved range. Media compatibility can change the practical temperature limit significantly.

Continuous vs intermittent

A short-term or intermittent temperature rating is not the same as a continuous-service rating. A peak limit should only be used where the grade-specific data confirms the temperature, duration and exposure conditions are acceptable.

3 LOW-TEMPERATURE SEALING

Low-temperature sealing

Cold performance is governed by the ability of the elastomer to remain flexible and recover after deformation. As temperature falls, molecular mobility decreases and the seal becomes progressively stiffer. A seal can remain physically intact yet already be too rigid to maintain reliable contact pressure.

Low-temperature terms that matter

Term	What it tells you
TR10	Temperature at which a stretched vulcanised rubber has recovered 10% during controlled warming. It is commonly used as an indicator of low-temperature elastic recovery.
TR70	A higher retraction point that can correlate with low-temperature compression-set behaviour and crystallisation effects.
Glass transition (Tg)	A polymer transition below which molecular movement reduces sharply and rubber-like behaviour is progressively lost. Tg is not, by itself, an application sealing limit.
Brittleness temperature	A test-based indication of resistance to brittle failure under specified impact conditions. It should not be treated as the minimum reliable sealing temperature.
Low-temperature compression set	The ability of a compressed seal to recover at low temperature. Poor recovery can allow leakage after contraction or pressure changes.

Why cold leaks occur

- The elastomer stiffens and can no longer follow surface movement or tolerance changes.
- Thermal contraction can reduce interference or squeeze in the gland.
- Pressure cycling can expose a seal that is too slow to recover at the operating temperature.
- Dynamic seals may generate higher friction as flexibility falls.
- A material selected only by polymer family may miss a lower-temperature specialty grade requirement.

Practical low-temperature rule

For genuine cold service, specify the required minimum temperature and ask for compound-level low-temperature data. TR values, compression-set data and application trials can be more informative than a generic family minimum.

4 HIGH-TEMPERATURE SEALING

High-temperature sealing

At elevated temperature, elastomer failure is usually driven by ageing, permanent deformation and chemical attack rather than a sudden melting point. The rate of property loss rises as temperature increases, so operating continuously near the upper limit can shorten seal life even when the material appears acceptable initially.

Main high-temperature failure mechanisms

Mechanism	Why it matters
Compression set	The seal does not fully recover after prolonged compression, reducing contact pressure and increasing leakage risk.
Thermal ageing	Heat accelerates oxidation, chain scission or crosslink changes, causing hardening, softening or loss of tensile properties.
Chemical acceleration	A fluid that is tolerable at moderate temperature may attack the elastomer much faster at elevated temperature.
Extrusion / softening	Some compounds lose modulus as temperature rises, making pressure and gland-clearance control more important.
Thermal cycling	Repeated heating and cooling changes dimensions and stresses the seal, especially where different materials expand at different rates.
Steam / hot water	Steam and high-temperature water can create a different compatibility requirement from dry heat; compound chemistry and cure system matter.

Continuous heat vs peak exposure

A material rated for continuous service at a given temperature is expected to retain useful properties for sustained exposure under appropriate conditions. A peak or intermittent rating normally applies only for limited duration and may assume compatible media, low mechanical severity and adequate cool-down between excursions.

- Do not use a short-term peak figure as the normal design temperature.
- Allow temperature margin where seal life, maintenance access or leakage consequences are critical.
- Check cleaning and sterilisation cycles separately from the normal process temperature.
- Review compression set when the seal remains clamped for long periods at elevated temperature.

PTFE note

PTFE can operate over a very wide temperature range in many sealing duties, but it is a fluoropolymer rather than an elastomer. It does not provide the same elastic recovery and should be assessed separately for load, creep, energisation and gland design.

5 WHAT CHANGES THE USABLE TEMPERATURE LIMIT

What changes the usable temperature limit?

The catalogue temperature range is only one input. The practical limit moves according to the complete sealing system. These factors should be reviewed whenever the application is demanding or the proposed material sits close to either end of its range.

Application factor	Effect on temperature selection
Process media	Fluid type, concentration, contamination and additives can accelerate swelling, extraction, hardening or degradation.
Exposure time	Continuous immersion is usually more demanding than brief contact or splash exposure.
Pressure	Higher pressure increases contact stress and extrusion risk, especially as modulus changes with temperature.
Dynamic motion	Reciprocation or rotation generates frictional heat and places greater demand on low-temperature flexibility.
Seal squeeze	Excessive squeeze can increase compression set and heat generation; too little squeeze reduces sealing margin.
Gland clearance	Softening at heat can increase extrusion risk. Low temperature can reduce the effective interference fit.
Vacuum / gas service	Gas permeability, rapid decompression and low-temperature contraction can become more important than in liquid service.
Thermal cycling	Repeated hot/cold transitions combine expansion, contraction and ageing effects.
CIP / SIP	Cleaning agents, steam, temperature and cycle duration must be assessed together, not as separate variables.
Storage & start-up	A seal may start cold, then warm in operation. Start-up leakage or friction can occur before the material reaches its normal condition.

Temperature + chemical compatibility

A chemical compatibility rating obtained at room temperature does not automatically remain valid at elevated temperature. Reaction and diffusion rates generally increase as temperature rises, so aggressive media can lower the practical service ceiling. Always assess temperature and chemistry together.

For hygienic processing

Where seals are exposed to food, beverage or pharmaceutical product as well as washdown chemicals, review the product media and the cleaning media separately. The cleaning cycle can be the more severe condition even when it is shorter.

6 MATERIAL PROFILES: NBR, HNBR, EPDM & CR

Material profiles: NBR, HNBR, EPDM & CR

These profiles are preliminary selection guidance. Final suitability depends on the exact compound and media.

NBR — Nitrile

-30 to +100°C

STRENGTHS	Good oil and grease resistance, strong mechanical properties, economical and widely available.
WATCH	Ozone/weathering and high heat are limited compared with HNBR/FKM; low-temperature performance varies strongly with ACN content and formulation.
TYPICAL USES	General industrial O-rings, hydraulic/pneumatic sealing, oils and greases.

HNBR

-30 to +140°C

STRENGTHS	Improved heat, ozone and ageing resistance over NBR while retaining strong mechanical performance and oil compatibility.
WATCH	More expensive than NBR; chemical resistance is not as broad as FKM/FFKM.
TYPICAL USES	Automotive, oilfield, higher-temperature hydraulic and demanding industrial duties.

EPDM

-45 to +150°C (peroxide-cured)

STRENGTHS	Excellent weathering, ozone and hot-water capability; good low-temperature flexibility; widely used in hygienic processing.
WATCH	Generally unsuitable for mineral oils, hydrocarbon fuels and many petroleum-based media. Cure system can materially affect heat and steam performance.
TYPICAL USES	Water, steam, food/beverage, dairy, pharmaceutical, glycol-based fluids and outdoor service.

CR — Chloroprene

-35 to +90°C

STRENGTHS	Balanced weathering, ozone and mechanical properties with useful resistance in selected refrigerant and industrial applications.
WATCH	High-temperature capability is below EPDM/FKM; oil and fuel resistance is application dependent.
TYPICAL USES	Refrigeration, outdoor sealing, general industrial equipment and legacy specifications.

Selection shortcut

For oil-dominated service, NBR/HNBR are common starting points. For hot water, weathering and many hygienic duties, EPDM is often the stronger starting family — provided the process media are compatible.

6 MATERIAL PROFILES: FKM, FVMQ, VMQ & FFKM

Material profiles: FKM, FVMQ, VMQ & FFKM

These higher-performance families are frequently selected where temperature, fuel resistance or aggressive chemical service pushes beyond standard elastomers.

FKM — Fluorocarbon

-20 to +200°C

STRENGTHS	Excellent heat, ozone and ageing resistance with strong performance in many oils, fuels and hydrocarbons.
WATCH	Standard grades have limited cold flexibility; hot water, steam, bases and certain polar media require careful grade selection.
TYPICAL USES	High-temperature industrial seals, fuel systems, oils, aerospace and chemical service.

FVMQ — Fluorosilicone

-50 to +175°C

STRENGTHS	Very good low-temperature flexibility with improved resistance to fuels and hydrocarbons compared with standard silicone.
WATCH	Mechanical strength and compression-set behaviour can be weaker than some FKM/HNBR compounds; media limitations still apply.
TYPICAL USES	Aerospace fuel systems, cold environments and applications requiring fuel resistance plus low-temperature flexibility.

6 MATERIAL PROFILES: FKM, FVMQ, VMQ & FFKM (CONTINUED)

Material profiles: VMQ & FFKM

VMQ — Silicone

-60 to +200°C

STRENGTHS	Excellent cold flexibility, heat resistance, weathering and ozone resistance; widely available in food/contact grades.
WATCH	Lower tear and abrasion resistance than many elastomers; limited compatibility with many fuels, oils and aggressive chemicals.
TYPICAL USES	Food and beverage, medical, static seals, extreme-cold duties and applications requiring broad thermal flexibility.

FFKM

-25 to +240°C

STRENGTHS	Exceptional chemical resistance and very high temperature capability in appropriately selected grades.
WATCH	High material cost; low-temperature performance and compression set vary by formulation; exact grade selection is essential.
TYPICAL USES	Semiconductor, chemical processing, high-temperature aggressive media and critical service where downtime dominates material cost.

High-temperature shortcut

If the main driver is elevated temperature plus hydrocarbons, FKM is often a strong starting point. If the duty combines very aggressive chemistry and severe heat, FFKM may be justified — but it should be selected by exact grade, not by polymer name alone.

7 SPECIALTY MATERIALS AND GRADE SELECTION

Specialty materials & grade selection

Not every sealing problem is best solved with the most familiar elastomer. The materials below fill important gaps in temperature, wear, oil resistance and mechanical performance.

Material	Temperature starting point	Why select it	Main caution
ACM — Polyacrylate	Approx. -20 to +150°C	Hot oils, automatic-transmission and automotive fluid service.	Relatively limited low-temperature elasticity.
AEM	Approx. -40 to +160°C	High-temperature oils, weathering and applications between HNBR and FKM.	Confirm specific oil/additive and chemical compatibility.
Polyurethane (AU/EU)	Approx. -50 to +110°C	Excellent abrasion, extrusion and tensile performance.	Hydrolysis, hot water and high heat depend strongly on polyurethane chemistry.
PTFE — non-elastomer	Very broad; often around -200 to +260°C by grade/application	Chemical resistance, low friction, high temperature, aggressive media.	Creep/cold flow and lack of elastic recovery; often requires energisation or specific gland design.

7 SPECIALTY MATERIALS AND GRADE SELECTION (CONTINUED)

Do not select by temperature alone

Application driver	Common starting families	Technical note
Wide low-temperature flexibility	VMQ / FVMQ / specialty NBR or EPDM	Check media, compression set and mechanical strength.
Hot water / steam	EPDM or selected FFKM	Validate cure system, cleaning chemistry and cycle duration.
Hot oils / hydrocarbons	FKM / HNBR / ACM / AEM	Temperature and additive package can change compatibility.
Aggressive chemical + heat	FFKM or engineered PTFE solution	Exact media, pressure and cost-of-failure drive selection.
Wear / extrusion dominant	Polyurethane or engineered backup arrangement	Check temperature, hydrolysis and dynamic friction.
Food / pharma broad thermal range	EPDM / VMQ / selected FKM	Confirm food-contact compliance and cleaning regime for the exact grade.

Compound formulation matters

Polymer family describes the base chemistry, not the final performance. Hardness, filler system, plasticisers, cure system and post-cure can change compression set, low-temperature recovery, chemical resistance and usable temperature range.

8 TEMPERATURE SELECTION CHECKLIST

Temperature selection checklist

Use this checklist to define the duty before requesting a quotation or approving a material change. Supplying these conditions upfront allows the proposed compound to be assessed against the complete application rather than a single temperature figure.

Information to provide	Why it matters
Seal type & size	O-ring, gasket, moulded part, profile; include drawing or standard size.
Normal temperature	Minimum and maximum during steady-state operation.
Peak temperature	Maximum excursion, duration and frequency.
Cleaning / sterilisation	CIP/SIP temperature, steam, washdown chemicals and cycle length.
Process media	Fluid names, concentrations, mixtures and contaminants.
Pressure / vacuum	Normal and peak pressure; vacuum or rapid decompression if relevant.
Duty	Static, reciprocating, rotary, oscillating or intermittent movement.
Environment	Outdoor, ozone, radiation, food contact, cleanroom or other constraints.
Required documents	FDA / EU food contact, USP, AMS, NORSOK, material traceability or customer specification as applicable.
Service objective	Expected life, maintenance interval and consequences of leakage/failure.

9 QUICK REFERENCE

Quick reference

Term	Definition	Design use
°F from °C	$(^{\circ}\text{C} \times 9/5) + 32$	Useful when customer or equipment data uses Fahrenheit.
°C from °F	$(^{\circ}\text{F} - 32) \times 5/9$	Convert all operating conditions before comparing ranges.
TR10	10% retraction temperature	Low-temperature recovery indicator; not a universal minimum service temperature.
Continuous rating	Sustained service window	Use for normal design temperature.
Peak / intermittent	Limited-duration exposure	Use only when grade-specific data defines acceptable exposure.

Technical support

International Seal can help narrow the appropriate material and compound grade from the seal geometry, process media, operating temperature, pressure and duty. Send the drawing or seal size together with the application conditions for review.

Technical note: this guide is intended for preliminary material selection. Temperature capability can vary materially between compounds within the same polymer family. The current technical data sheet for the exact proposed grade, together with application testing where appropriate, should be used for final approval.

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