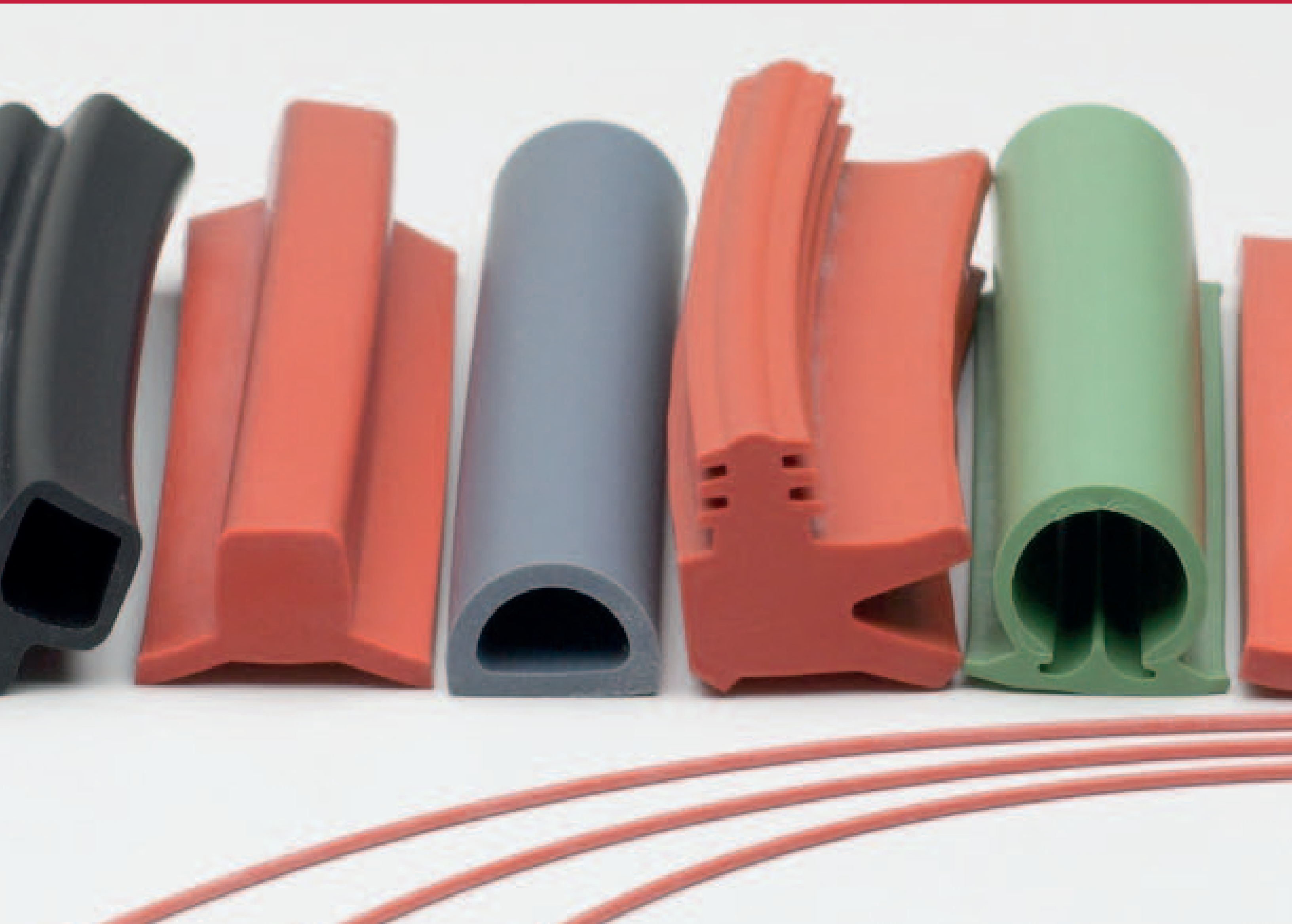
UNITED SEAL & RUBBER CO., INC

# Designing and Producing a **High** Performance Gasket or Seal



# Introduction

Gaskets and seals come in many different designs to fit a wide range of applications. During the engineering process it is often the last feature to be considered for finishing the preliminary design. It is too often the case that stock manufacturing gaskets and seals fail to meet the design requirements for current engineering innovation.  The need for customizable products adhering to each project specific properties is growing in demand.

The purpose of this paper is to provide information of the processes, materials, or design considerations involved in developing a custom-made rubber gasket, sealing and EMI/RFI shielding products. Awareness of these considerations is crucial in controlling costs and improving the performance of your project.

United Seal & Rubber Company we strive in developing solutions that fit your design, ensuring quality that we stand behind.

# Design Considerations

For a gasket or seal to effectively support your application without hindering its performance, certain considerations need to be addressed:

## Use or Function of the Part

- ☐ Expected temperature ranges of your product.
- ☐ What environmental factors do you intend to have the product exposed too. (Chemical, Types of Light, Moisture, etc.)
- ☐ Types of materials the product will mate with. (Plastic or metal)
- ☐ Will the product need to withstand static or differential pressure loads. High or low pressure applications.
- ☐ Will you require a product for a static or dynamic application?
- ☐ Will the product need special geometric considerations to fit assembly?
- ☐ Which materials suit your project best?
- ☐ Tolerance specification of your project.
- ☐ Cost considerations for prototyping and manufacturing production.

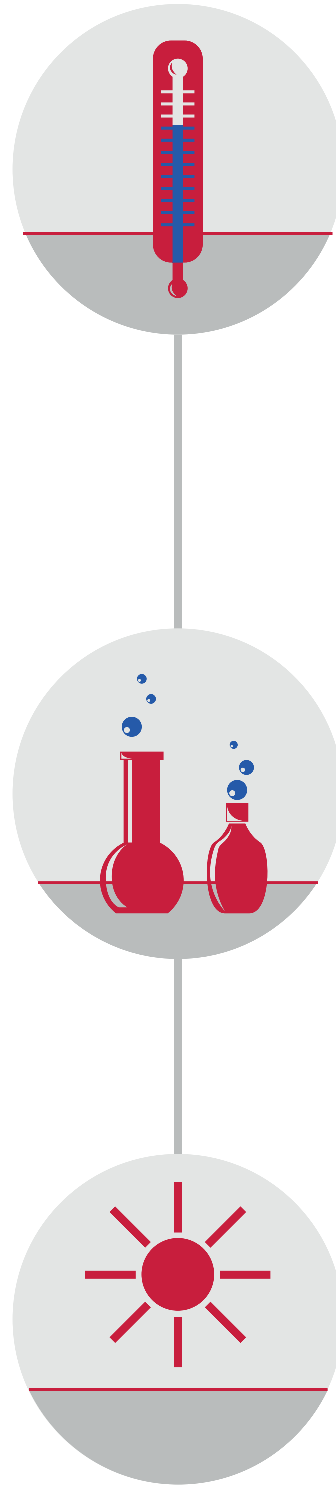
Engineering a rubber gasket or seal to suit your product's specific requirements must be considered in order to eliminate hindrance from the product. In the long run, a well-designed custom gasket or seal can improve performance, longevity and function, therefore reducing overall costs.  United Seal & Rubber prides itself on being the rubber supplier who goes above and beyond others to provide the highest quality products for our customers.

# Environmental Factors

## Effects of Temperature

Operating temperatures of the project will have a profound effect of the longevity of the elastomer and rubber seals. If the proper material is not selected for the intended operational temperature ranges, the possibility of product failure increases. Exceeding temperature limitations of product can lead to one or several of the following.

- Increased hardening
- Product becomes more brittle
- Loss of resilience
- Material cracking
- Excessive wear and tear
- Deformation of original shape
- Degradation of physical strength
- Swelling of material



Temperature will have a significant effect on the overall performance of the product. Cold temperatures could also reduce seal size and possibly leak due to reduce contact surface. Lower temperatures could also affect flexibility and make material brittle. If temperature limitations are exceeded the change in these characterizations will increase the failure rate of the component and possibly hinder overall performance of your project.

## Chemical Exposure

If a gasket is not compatible with process media, chemical degradation of product will begin. Chemical degradation will eventually deform the product until eventual failure, which will result in leakage.

With a wide variety of sealing materials available, it is crucial to match the right material with the chemical service to avoid potential failure of the joint. It is important to know that with high temperature applications the chemical resistance of the material can also change.

## Effects of Ultra-Violet Light on Plastics

UV energy absorbed by plastics can excite photons, which then produce free-radicals. These free-radicals can eventually cause degradation. If your part will be exposed to oxygen or the ozone, a process called photo-oxidation can occur. This is a chemical change that reduces the molecular weight of the material. This results in a change in the physical properties of the material making the seal brittle, with a reduction in tensile strength, and impact and elongation strength. It is important to consider the type of lighting exposure your part will encounter. This can be anything ranging from sunlight to artificial light sources.

## Oxygen/Ambient Air Reactions

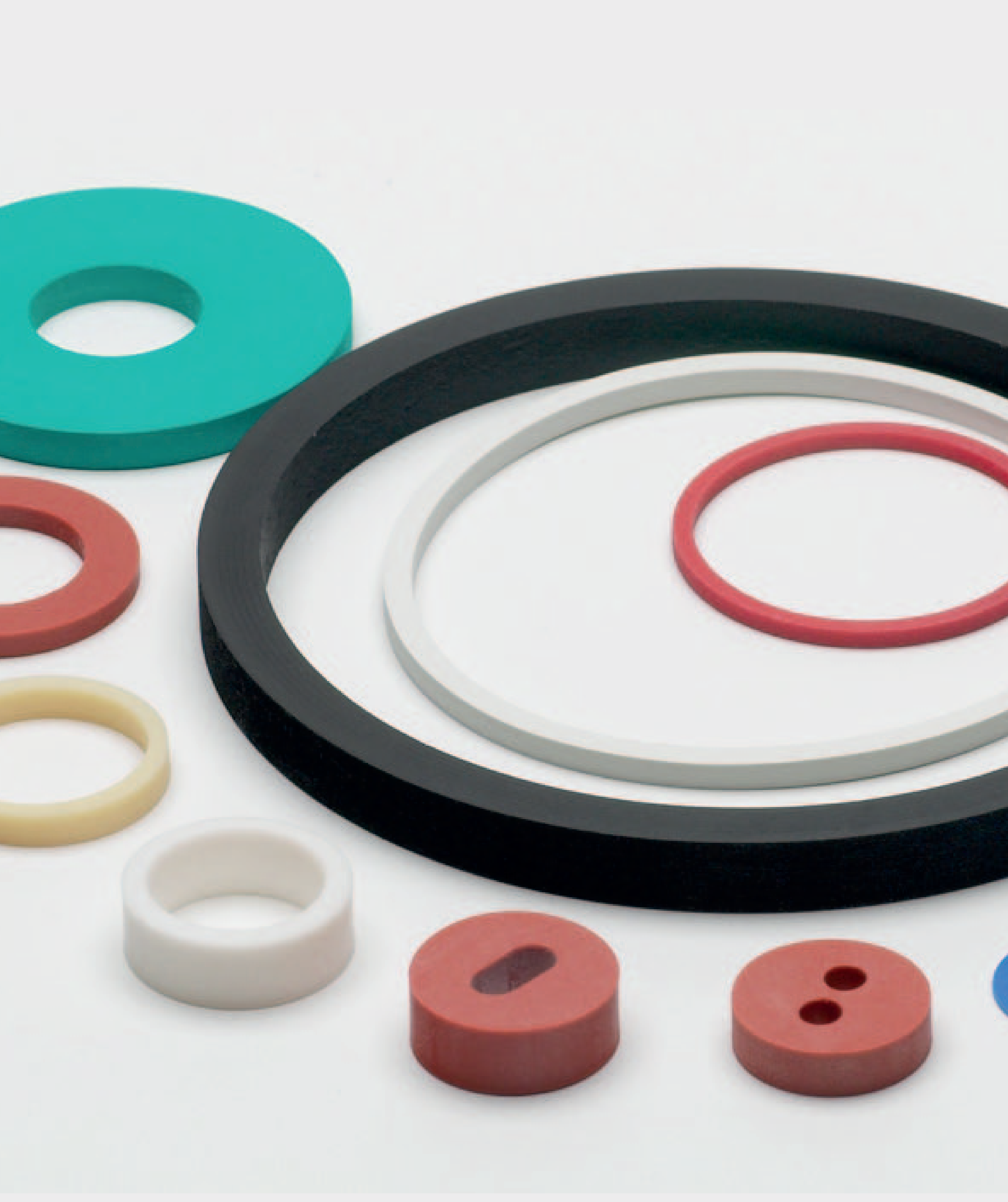
Moisture in combination with oxygen/ambient air reacts with ferrous metals to form iron oxide (rust) that will degrade the material. As iron oxide forms on the surface the original material is reduced, weakening the product until eventually causing failure and leaking. Copper seals have a similar reaction to air called patina which results in a slightly green tint indicating exposure. Copper's physical properties are virtually unaffected compared to effects on ferrous metals.

## Elastomer Selection

Proper material selection is a crucial aspect for designing any sealing application. There is a wide range of elastomeric materials to select from. Each material has its own specific properties that need to be balanced for your part. Properties to consider include but not limited too:

- ☐ Abrasion resistance
- ☐ Impact resistance
- ☐ Creep resistance
- ☐ Oil resistance
- ☐ Tear resistance
- ☐ Resilience
- ☐ Tensile strength
- ☐ Vibration damping
- ☐ Temperature flex
- ☐ Modulus
- ☐ Hardness/Elongation
- ☐ Structural Integrity

Choosing the appropriate material for your application involves settling on which properties your application requires over others. A change in one property will result in change in the other. For example an improvement in oil resistance will improve tear resistance, but temperature flex will suffer. Or, improving vibration dampening will also improve impact resistance, but cut down on structural integrity. Prioritizing which properties are important to your application and which properties have less significance will help determine the proper material.



# Common Types of Rubber Materials

## Ethylene Propylene (EPR)

It works well with hydraulic fluids that are acidic and dangerous when exposed to human skin. It has resistance to heat, oxidation, ozone, and the weather. It is also not susceptible to color loss.

## Fluorocarbon

Fluorocarbon is an all-purpose rubber used in many types of applications such as oils, fluids, gases, and certain types of acids. It has properties to resist harsh chemicals and ozone attacks. It has a wide range of operational temperatures and for short working periods will withstand higher temperature applications. Fluorocarbon should be considered for aircraft, automotive, and other mechanical applications that require maximum resistance to higher temperatures and many types of fluids.

## Neoprene

Neoprene is a synthetic rubber which has good aging properties in ozone and weather environments. It has good abrasion, flex cracking, and desirable for low temperature ranges. It is often used with refrigerants in refrigeration and air conditioner systems.

## Nitrile

Common material used in making rubber gaskets. It has a good resistance to oil, fuel, ordinary diluted acids, alkaline, and other chemicals. It is used in automotive and aeronautical industry for fuel and oil handling hoses, seals, and grommet.

## Polyurethane

Polyurethane rubbers are another low temperature thermoplastic that have outstanding abrasion resistance. It has high resilience, excellent resistance to compression set and gas permeability resistance. It has good resistance to oils, oxygen, and ozone.

## PTFE (Thermoplastic)

PTFE is one of the most commonly available gasket materials today, and is known for its excellent chemical resistance. It can handle high heat applications while maintaining dielectric strength and chemical dullness.

## Silicone

Silicone is typically used in extreme temperatures and low temperature flexibility, but does not perform well in applications that require extreme tear resistance and tensile stress. It has resistance to air, ozone, UV light, and oils. Silicone is very clean and used in food and medical applications.

### Note

In addition to the common rubber polymers listed, more options are available that might be better suited for your operational conditions.

Metallic or semi-metallic seals are suitable for medium and high pressure applications, in comparison to rubber polymers that have a lower pressure threshold. Also metallic seals require a much higher quality of the sealing surface than their non-metallic counter parts.

## Mating Surfaces

The mating surfaces are the parts of components that require sealing. The mating surface material and its dynamic characteristics are important when considering seal selection.

## Static Seal

A static seal functions against mating surfaces that have no relative motion between each other. Depending on the direction of compression a static seal can classify as either axial or radial.

## Axial Seal

Axial seals act by applying compression (squeeze) the upper and lower surfaces of the seal. In pressure applications the dimensions of the seal need to be considered to fully utilize the product. The seal should be seated on the low pressure side surface, to limit motion and wear within the part.

## Radial Seal

Radial seals are compressed (squeezed) between the inner and outer surface of the product. Cap and plug type configurations commonly utilize radial seals.

## Dynamic Seals

Dynamic seals exist when there is motion between surfaces. Typical motions include reciprocating, oscillating, and rotation. Operational factors can greatly affect how dynamic seals perform. Factors such as swelling of seals in fluids, surface roughness of mating metals, lubrication, internal pressures, thermal cycling, compression (squeeze), elasticity, and friction from surfaces.

## Oscillating Seals

Oscillating seals are commonly use in faucet valves. Shaft rotates through a limited number of turns around the axis causing oscillation. Due to twisting in the shaft, self-lubricated seals with higher hardness ratings are recommended for these applications.

## Reciprocating Seals

These seals are utilized when reciprocating motion along an axis between inner and outer surfaces. Reciprocating seals are seated within glands where relative motion exists. Applications of reciprocating seals include pistons in internal combustion engines, linear actuators, and hydraulic cylinders.

## Precautions

Thermal cycling from high to low temperatures can cause seals to permanently deform (compression set) and change the original structure shape. Such leaks are especially prone in low pressure, reciprocating applications. If thermal cycles are anticipated, it is suggested that the seal material should be selected to exceed the temperature operations range, compression set, and resilience necessary.
With abrupt halting and holding of heavy loads, certain systems can create internal pressures that exceed seal extrusion resistance capabilities. To prevent excess extrusion and possible product failure, pressure shocks should be effectively dealt with when selecting the seal and system design.
The amount of seal compression will define how well the product performs. Seals with low compression result in reduced friction from mating surfaces, at the price of possible leakage in low pressure events. High compression will increase surface friction between components and sealing capabilities. High compression result in difficult assembly, faster wear, and increase chance for spiral failure.

## Rotary Seals

Rotary seals involve rotational motion from a shaft and housing. Important factors to consider in designing rotary seal glands are frictional heat buildup, material stretch, compression (squeeze), operational temperature limits, and shaft and glandular machining.

## Precaution

Rotary seals are not recommended for applications with extremely low and high operational temperatures. Room temperature is ideal for overall product life. With rotating surfaces the generation of frictional heat is undeniable. For prolonged periods of time the mating surfaces will gradually increase in temperature due to mechanical braking of friction. This friction will convert mechanical energy into thermal energy (heat) causing increasing temperatures. To minimize frictional heat buildup, it is recommend to select materials with maximum heat resistance and minimal friction generating properties. Lubrication is used in rotary applications to reduce friction between surfaces and act as a cooling agent. In rotary applications stretch must be eliminated by using shaft diameters no larger than the relaxed state of the product. This application design must account for no stretching over the shaft. An elastomer in tension with increasing temperatures can contract instead of expanding which increases the heat and additional contraction until seal failure.

# Compound Data Specification

This section will provide compound data specification on the most common types of material used in today's industry. This will reiterate on material properties discussed earlier and elaborate on numerical data that correspond to its qualities and functionality.

## ASTM #1 Oil

**Product Name:** IRM 901
**Component:** Severely Solvent Refined Heavy Paraffinic Petroleum Oil (wt. 30-70%)
Severely Solvent Refined Residuum (wt. 30-70%)

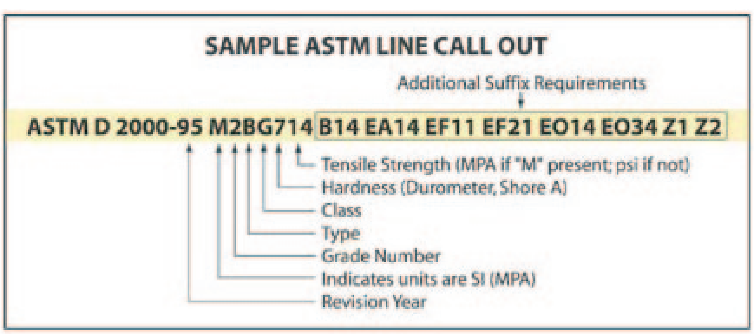
## ASTM #3 Oil

**Product Name:** IRM 903
**Component:** Heavy Hydrotreated Naphthenic Distillates Petroleum (wt. 100%)

## ASTM D2000

In order to provide guidance in the selection of vulcanized rubber materials and to offer a method for specifying these materials by the use of a simple line call-out specification, the Society of Automotive Engineers (SAE) and the American Society for Testing and Materials (ASTM) established SAE J200 / ASTM D2000. ASTM D2000 is the more common tool among rubber manufacturers. Specifying elastomers via standardized line call-outs is a good idea because it allows the flexibility of using different manufacturers' compounds while ensuring that material quality and performance remain constant.

ASTM D2000 is based on the premise that the properties of all rubber products can be arranged into characteristic material designators. These designations are determined by types, based on resistance to heat aging, classes and resistance to swelling.




Basic Requirements for Establishing TYPE by Temperature

| TYPE | TEST TEMP. (°C) |
|---|---|
| A | 70 |
| B | 100 |
| C | 125 |
| D | 150 |
| E | 175 |
| F | 200 |
| G | 225 |
| H | 250 |
| J | 275 |
| K | 300 |

Basic Requirements for Establishing CLASS by Volume Swell

| CLASS | SWELL (MAX %) |
|---|---|
| A | NONE |
| B | 140 |
| C | 125 |
| D | 100 |
| E | 80 |
| F | 60 |
| G | 40 |
| H | 30 |
| J | 20 |
| K | 10 |

Meaning of Suffix Letters

| | |
|---|---|
| A | Heat Resistance |
| B | Compression Set |
| C | Ozone/Weather Resist. |
| D | Comp. Deflection Resist. |
| EA | Fluid Resist. (Aqueous) |
| EF | Fluid Resist. (Fuels) |
| EO | Fluid Resist. (Oils/Lube) |
| F | Low Temp. Resist. |
| G | Tear Resistance |
| H | Flex Resistance |
| J | Abrasion Resistance |
| K | Adhesion |
| M | Flammability Resistance |
| N | Impact Resistance |
| P | Staining Resistance |
| R | Resilience |
| Z | Any Special Requirement |

Material Designations and Corresponding Commonly Used Elastomers

| MATERIAL DESIGNATION | COMMONLY USED ELASTOMER |
|---|---|
| AA | Natural Rubber |
| BA | Ethylene Propylene |
| BC | Neoprene® |
| BE | Neoprene® |
| BF | Nitrile |
| BG | Nitrile, Polyurethane |
| BK | Nitrile |
| CA | Ethylene Propylene |
| CH | Nitrile |
| DA | Ethylene Propylene |
| DF | Polyacrylate |
| DH | Polyacrylate |
| EF | Vamac® |
| FC | Silicone |
| FE | Silicone |
| FK | Fluorosilicone |
| GE | Silicone |
| HK | Viton® |

# Nitrile – Buna N

Nitrile Rubber (NBR) is a general term for Acrylonitrile butadiene terpolymer. The ACN (acrylonitrile) content of nitrile compounds varies from 18% to 50%. With increasing acrylonitrile content the rubber shows higher strength, greater resistance to swelling by hydrocarbon oils, and lower permeability to gases. Polymers with higher ACN content exhibit less swelling in gasoline and aromatic solvents, while lower ACN polymers exhibit better compression set and low temperature flexibility.


**Recommended for:**
Petroleum oils, water (up to 212 F), Salt & Alkali solutions, and weak acids.
**Not Recommended for:**
Aromatic fuels, strong acids, glycols, ozone, polar solvents
**Recommended Operational Temperature Range:**
-30 to 250 F
**Basic Physical Properties (ASTM D2000)**
Hardness: 70 +/-5 Shore A
Tensile Strength, psi min: 2000
Elongation %: 250
**Industry Applications:**
Automotive, Textiles, HVAC, Aerospace

# Ethylene Propylene (EPR, EPDM)

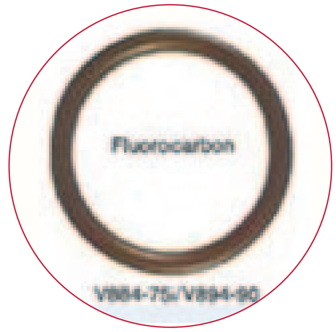
EPR is a copolymer of ethylene and propylene, EPDM is a terpolymer of ethylene, propylene, and diene third monomer used for cross-linking. Main properties of EPR are its outstanding heat, ozone and weather resistance. The resistance to polar substances and steam are also good. It has excellent electrical insulting properties. Good resistance to ketones, ordinary diluted acids and alkalines.


**Recommended for:**
Hot water and steam, glycol based brake fluid, many organic and inorganic acids, cleaning agent, sodium and potassium alkalis, phosphate-ester based hydraulic fluids, silicone oil and grease, polar solvents, ozone, aging and weather resistance.
**Not Recommended for:**
Mineral oil products
**Recommended Operational Temperature Range:**
-70 to 250 F
**Basic Physical Properties (ASTM D2000)**
Hardness: 70 +/- 5 Shore A
Tensile Strength, psi min: 2031
Elongation %: 200
**Industry Applications:**
Cold-room doors (insulator), face seals of industrial respirators in automotive paint spray environments, garden and appliances washers, vibrators, O-rings. Most common use is in vehicles. It is used in door seals, window seals, trunk seals, and sometimes hood seals.

# Fluorocarbon (FKM, FPM)

A fluoropolymer is a fluorocarbon based polymer with multiple strong carbon-fluorine bonds. It has excellent resistance to high temperature and a brand range of resistance to solvents, acids, and bases. Permeability and compression set are excellent. Fluorocarbons have high resistance to swelling when exposed to diesel. It is also resistant to degradation from UV exposure and ozone.

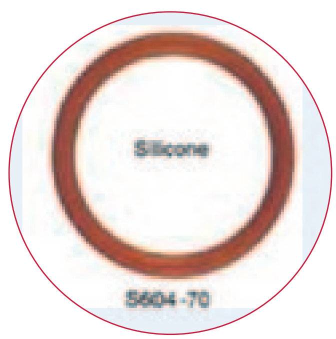
**Recommended for:**
Petroleum, mineral, vegetable oils, silicone fluids, aromatic hydrocarbons (benzene, toluene), chlorinated hydrocarbons, high vacuum, ozone, weather, and good age resistant.
**Not Recommended for:**
Hot water and steam, auto or aircraft brake fluids, amines, ketones, and low molecular weight esters and ethers.
**Recommended Operational Temperature Range:**
-15ºF - 400ºF
**Basic Physical Properties (ASTM D2000)**
Hardness: 54 Shore A
Tensile Strength, psi min: 1425
Elongation %: 450
**Industry Applications:**
Automotive fuel handling, Aircraft engine seals, high temperature applications requiring good compression set, and general industrial seals and gaskets.




# Silicone

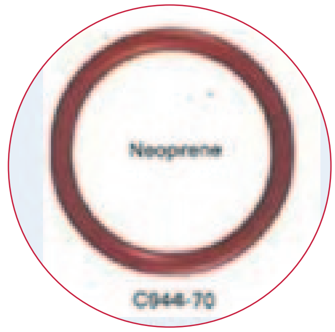
Silicone is a semi-organic elastomer with excellent resistance to extreme temperatures and resistant to compression set and retention of flexibility. This elastomer provides good resistance to ozone, oxygen, radiation, weathering, chemical attack, and moisture.

**Recommended for:**
Dry heat, some petroleum oils, moderate water resistance, fire resistant hydraulic fluids (HFD-R and HFD-S), low temperatures, and ozone, aging, and weather resistance.
**Not Recommended for:**
Ketones, acids, silicone oils, and auto or aircraft brake fluids.
**Recommended Operational Temperature Range:**
-65ºF - 450ºF
**Basic Physical Properties (ASTM D2000)**
Hardness: 70 +/- 5 Shore A
Tensile Strength, psi min: 700
Elongation %: 150
**Industry Applications:**
O-ring rubber seals and custom molded rubber components for: static seals for extreme temperature application, food application, medical devices, FDA application.



## Neoprene

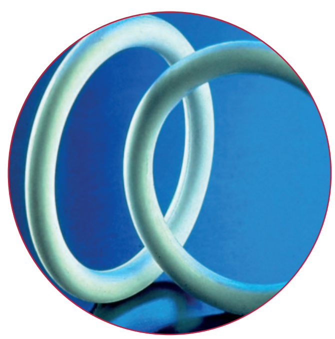
Neoprene is a homopolymer of chlorobutadiene and is used in moderate resistance to petroleum oils, ozone, UV radiation, and oxygen. Neoprene is classified as a general purpose elastomer which has relatively low compression set, good resilience, and abrasion, and is flex cracking resistant. It has excellent adhesion qualities to metals for rubber to metal bond applications.




**Recommended for:**
Carbon dioxide, ammonia, refrigerants, silicone oils and grease, water, and water solvents at low temperatures.
**Not Recommended for:**
Aromatic hydrocarbons (benzene), chlorinated hydrocarbons, and polar solvents (ketones, esters, ethers, acetones).
**Recommended Operational Temperature Range:**
-35ºF - 225ºF
**Basic Physical Properties (ASTM D2000)**
Hardness: 70 +/- 5 Shore A
Tensile Strength, psi min: 1500
Elongation %: 250
**Industry Applications:**
Refrigeration industry applications and general purpose seals.

## PTFE – Polytetrafluoroethylene

PTFE is a soft, low friction fluoropolymer with outstanding chemical resistance and weather resistance. It has high stable temperatures and excellent electrical insulating properties. It has extremely low friction, soft and formable, good bearing and wear properties, performs well at elevated temperatures, and FDA compliant. Not to be confused with the preceding materials, but PTFE is a thermoplastic and not a rubber.



**Recommended for:**
Chemical resistance, high service temperatures, high performance bearing and bushings, and applications that require resistance to corrosive chemicals. Not susceptible to saturation of high-pressure gas, no swelling due to moisture, and low coefficient of friction.
**Recommended Operational Temperature Range:**
-238ºF - 574ºF
**Basic Physical Properties (ASTM D2000)**
Hardness: 56 Shore D
Tensile Strength, psi min: 3000
Elongation %: 300
**Industry Applications:**
Pneumatic seals, hydraulics cylinders, high speed applications, aerospace, energy, oil and gas.

# Polyurethane

Polyurethane is a polymer composed of a chain of organic joined urethane links. It exhibits excellent abrasion resistance and tensile strength. Good resistance to petroleum oils and good weather resistance.

**Recommended for:**
Applications that require strength and abrasion resistance, use for application that need chemical resistance and rebound qualities. Good for applications that anticipate shock loads.

**Not Recommended for:**
Water applications or high temperature capabilities.

**Recommended Operational Temperature Range:**
-35ºF - 225ºF

**Basic Physical Properties (ASTM D2000)**
Hardness: 90 +/- 5 Shore A
Tensile Strength, psi min: 7129
Elongation %: 514

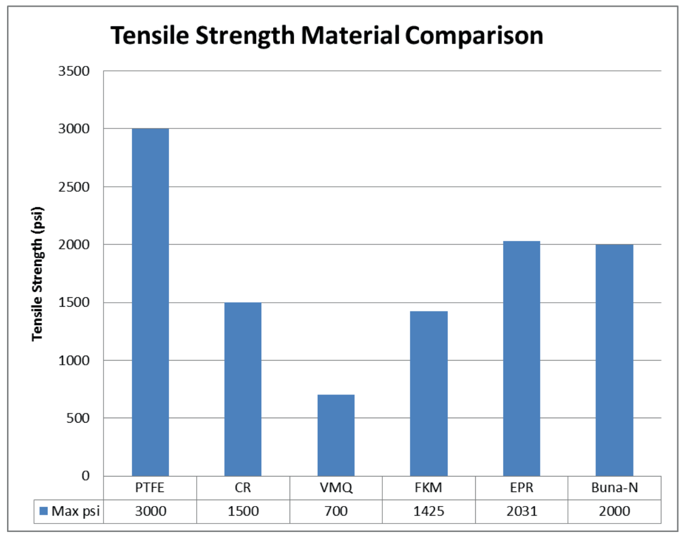
**Industry Applications:**
Hydraulic, pneumatic, fluid power, energy, oil & gas market, drive belts, gel pads, print rollers, mining & transportation

# Comparison of General Purpose Materials

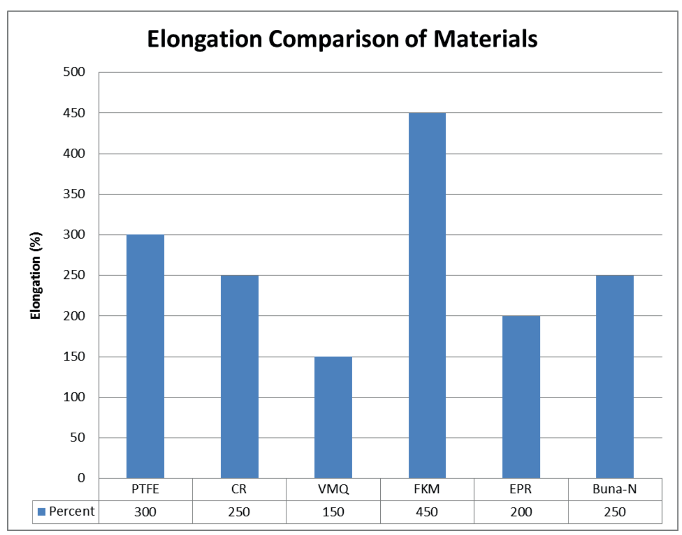
In order to gain a good understanding of all the general purpose materials and their physical properties a basic comparison analysis is presented with a key of materials.

| Material | Corresponding Abbreviation |
|---|---|
| Polytetrafluoroethylene | PTFE |
| Neoprene | CR |
| Silicone | VMQ |
| Fluorocarbon | FKM |
| Ethylene Propylene | EPR |
| Nitrile | Buna-N |

Tensile strength is the maximum stress that a material can withstand while being pulled until failing or breaking. Comparison of maximum tensile stress/strength properties of materials.




Elongation measures the percentage change of the original structure's length until it fractures or fails. Comparison chart of percent elongation properties of materials.



# Fabrication and Design of Rubber Components

There are three methods for manufacturing rubber parts; transfer molding, compression molding, or injection molding. Which process method to choose for your part depends on the size, shape, function of part, quality, and cost of raw material. The three methods share similar qualities in manufacturing of rubber parts that are important to know when designing custom molded rubber parts.

## Mold Design and Fabrication

Custom fabricated steel plates are designed with the parts dimension and tolerance in mind.  The steel plates developed will mold the selected rubber material into the desired design. The plates are exposed to pressure and heat that cure the parts. Material properties will determine the total cure time needed for the molding process to complete.

Excess amount of material is used to ensure that the cavity is filled and the empty space is eliminated. When pressure is applied, material will extrude from the cavity along the joining steel plates, this is commonly known as flash. Flash can be avoided by designing the separation point of the cavity elsewhere on the steel mold.

A molded part may be too small or firm to remove from the cavity by hand. Depending on the viscosity of the material, air pockets could be trapped under the material resulting in weak sections of the finished part.

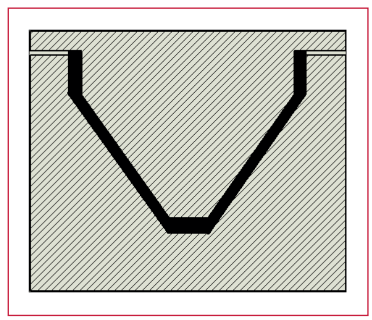
Simple solutions to what could become detrimental to the final product, is to increase the number of steel plates on the entire mold. Each plate will house a different part section allowing easy access and removal without damage.

## Molding Process

This section will provide detailed information on each of the molding processes mention previously. Selecting which process to use is determined by several key factors; size and shape of the part, the hardness, flow of material, cost of material, and number of parts to produce.

## Compression Molding

Compression molding is similar in how a waffle iron works. The waffle iron is the compression mold and the waffle mix is the raw material being compressed. Initial setup starts with an excessive amount of raw material placed in the steel mold for the cavity to fill properly. When compression begins, pressure and heat is applied to the sample causing the compound to flow and extrudes excess into the overflow cavities.

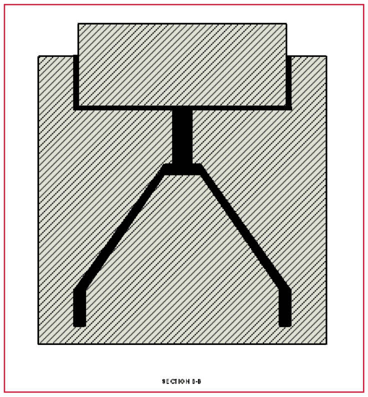


Compression molding is preferred for medium hardness compounds, high volume production, or applications requiring fairly more expensive materials.

The excess material, or flash, created by larger parts is a concern when the material is more expensive. Compression molding helps by limiting the excess overflow. As designs become complex the pre-load could have issues when inserting into the compression mold. Flow requirements of harder compounds don’t generally agree with the compression mold.

## Transfer Molding

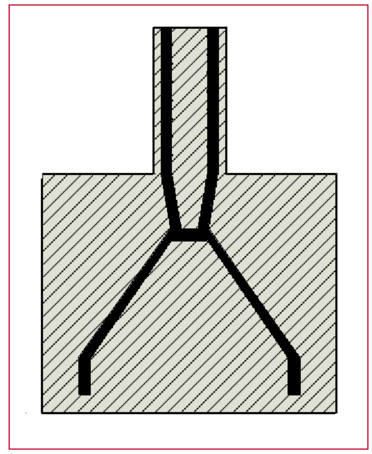
Transfer molding differs from compression molding in that the material is placed in a pot, located between the top steel plate and the compression plunger. The material is hydraulically pressed from the pot through perforations on the top plate into the cavity. The mold walls are heated to a temperature above the melting point of the material to allow for faster flow into the cavity. The mold is held closed while the material is cured. Once finished the mold is opened and the part can be removed.



Transfer molding has a good surface finish and dimensional stability. This type of molding process is ideal for large volumes of products as they have short production cycles. Since the mold is closed during production, the development of smaller tolerance and intricate part designs can be achieved.

## Injection Molding

Injection molding is the most automated process out of the three. Injection molding utilizes a screw-type plunger to molten rubber material into a molded cavity. The material is heated until it reaches a flowing state and injected into the mold by pressure from a heated chamber through a series of runners. This process is preferred for mass production of a simple configuration of molded rubber parts.



## Extrusion

Extrusion is a process used to create objects of a fixed, cross-sectional profile. Rubber material is pushed or drawn through a pin & die of the desired cross-section. The two main advantages of this process over other manufacturing processes are its ability to create very complex cross-sections and work with materials that are brittle, because the material only encounters compressive and shear stresses. It also forms finished parts with an excellent surface finish.

It is often produced in continuous lengths (long lengths) or in cut-to-lengths. Rubber extrusions can be provided in solids, hollow, sponges & include all shapes and sizes. Extruded options include all type of rubber materials, conductive and non-conductive, TPR (plastics), sponges, urethanes and more…

## Splicing and Vulcanizing

As mentioned above, with rubber extrusions we offer both conductive and non-conductive materials. We have in-house capabilities that allow us to splice and vulcanize these extrusions with the end results being an O-ring, four corner gasket and other types of gaskets. Splicing involves cutting the extrusion to a desired length. The cut can be at an angle or a straight joint (butt-joint) splice. The vulcanizing process involves gluing the ends (proprietary adhesives) and placing them into high heat conducting aluminum die(s) with the ends matched up together. Next the aluminum tool is placed under a pneumatic press that applies heat and pressure to the rubber to aid in vulcanizing the ends together. The dies are kept under the presses for a predetermined time limit and allowed to cool down after being removed from the presses. This process is often not recommended for vacuum, high pressure or dynamic applications.

Other options included under this category are:

- ☐ **Serpentine Molding**
  Fully molded in serpent shape with no splicing joints, can provide larger ID sizes but there are limits. Tooling and mold cost will be much higher than the dies for splicing and vulcanizing. Not a good option for sealing gasses, high pressure or dynamic seals.

- ☐ **Continuous Molding**
  Highest cost due to time, scrap rates and tooling. The performance is similar to fully molded products. This option can be good for sealing gasses, vacuum and dynamic applications.

## Lathe Cut/Precision Cut Gaskets or Washers

This process starts with the extruded tube. The tube is loaded onto a mandrel, wrapped and placed in an auto-clave for curing. After it has been cured, the tube is unwrapped, often placed on another mandrel and goes through a grinding process to achieve the required OD size and finish for the part. After achieving the correct OD size and finish the tube/mandrel is loaded into a cutter and the operator produces the cut thickness of the part. The cut thickness often takes the shape of a square cut with flat edges. However, radial, axial and specialty profiles can also be achieved through this process.

**Advantages of this type of process are:**

- ☐ Low-to-no-cost tooling. Our supply partners have thousands of dies and pins to produce these type parts. They also have a vast inventory of mandrels in stock. It is when they don't have a die/pin combo or mandrel available for a particular size that tooling is involved. Yet when tooling is involved, it is less expensive than tooling required for their counterparts the molded rubber.

- ☐ Another advantage is tighter tolerances than a traditional die cut gasket can be held. The funnel shape and/or hourglass shape often associated with die cut gaskets is eliminated due to the mandrel, grinding & cutting processes.

**Disadvantages for this process include:**

- ☐ There are size limitations to the extrusion that can be produced. Generally speaking, with an ID/OD round lathe cut the size limitation would be around 19" ID. With custom profiles, size limitations have to be addressed on a case by case basis. Please contact United Seal and Rubber to discuss the design you have in mind.

- ☐ There are minimums placed on the amount of material that must be produced. The process itself will require that a minimum amount of material is fed through the extrusion process in order to produce the rubber extrusion. As a general rule of thumb, an extrusion run will produce at a minimum of 50 ft. of material. Depending on the thickness cut, there may be a required minimum footage that is higher than your needs.

## Gasket Cutting

In its simplest form, this process involves material(s), some type of die cutting equipment/tools and often includes a steel rule die. The presses involved have traditionally been hydraulic punch presses of different varieties.  At United Seal & Rubber we have presses that are capable of producing small to large size gasket shapes.  Depending on which press we utilize, we can produce a hundred, couple hundred or couple thousand gaskets per hour.  If you need only a couple to a few gaskets, we have you covered too. In other words, we are ready to produce both small and large volume orders at our facility.  Also machines that slit materials are part of the die cutting process.  Think of this process as producing a product similar to weather-stripping.

**Advantages of die cutting process include but not limited to:**

- ☐ Low cost tooling that on average is a couple to a few hundred dollars.
- ☐ Can be water jet cut or laser cut when it makes sense and tooling is avoided.
- ☐ Prototype parts can be provided in less than 7-10 days when the material is readily available.
- ☐ A wide variety of materials are available for use, including solid rubber, sponge, foam, non-asbestos, conductive and non-conductive, mil-spec and more…

**Disadvantages of die cutting:**

- ☐ The tolerance will not be as tight as a lathe-cut gasket (for example).
- ☐ When the material gets thicker, the gasket's ID and OD can begin to take the form of a funnel and/or hourglass shape.
- ☐ How pronounced the funnel or hourglass shape is depends on the material used to produce the gasket(s).

## Design Considerations for Prototyping

Prototype build and testing allows for detailed analysis of material selection and part design. Prototyping allows for proper time to test product before going into production. Typical mold prototyping involves fabrication of several steel molds for product testing and materials are chosen based on the operational parameters provided.

## Finite Element Analysis (FEA)

United Seal and Rubber utilizes computer generated Finite Element Analysis software specifically designed for elastomeric evaluation. Seal performance can be predicted in a variety of medians, temperatures, and pressures before the product is made. This eliminates costly tooling, speeds up the production process and ensures that the right material is selected for the application.

## Quality Control

United Seal and Rubber Co. has a high standardized process to deliver the right product at the right price. Our team of engineers understand the pressures of industry and the importance of deadlines. We hold both ISO 9001 and AS 9100 Quality Certifications. Engineer with us a product you can rely on, and prevent seal failure.

## From 6.5 million to 20 million parts per year

Check out a simple seal made all the difference

**Download Case Studies**