8. Qualifications

Functional requirements should always be given first. A functional test is worth more than a physical and chemical property test. Thus the first step is to set the original physical property limits which will assure that the mechanical properties desired in the O-ring are present. Be aware of the fact that there is a difference between the original physical properties and the aged physical properties.

Original Physical Properties:

Hardness
Determine the IRHD hardness best suited for the application and round off to 40°, 50°, 60°, 70°, 80°, 90° or 95°-shore A or IHRD. A ±5 point tolerance is established to allow the manufacturer a realistic working range and permit normal variations experienced in measuring hardness.

Tensile Strength
Determine the minimum tensile strength necessary for the application. Always take into consideration the inherent strength of the elastomers most likely to be used to meet the specification. Most silicones have a much lower tensile strength than other elastomers. Once the minimum tensile strength has been set, multiply it by 1.20. This is the limit set for tensile strength variation of ±15% experienced between production batches of a compound.

Elongation
Investigate and determine the maximum amount of stretch a seal must undergo for assembly in the application. Multiply this figure by 1.25 to allow a safety factor and to provide for normal production variation of ±20%.

Modulus
Choose a minimum modulus which will assure a good state of cure, good extrusion resistance, and a good recovery from peak loads. Modulus is directly and related to tensile and elongation, and refers to the stress at a predetermined elongation, usually 100%.

Specific Gravity
A value for specific gravity should not be set in the qualification section of the specification but the value must be reported "as determined". The realistic figure will then be used in the control section.

Age Physical Properties

Determine the resistance of the O-ring to the anticipated service environment. This is done by measuring the change in volume and physical properties of test samples after exposure to various conditions for a specified time at a specified temperature. Recommended times, temperatures, and test fluids for accelerated tests can be found in ASTM D471. It is usually desirable to use the actual service fluid. Because these fluids are not as controlled as test fluids, there can be some variations. This fluid variation accounts for differences in test results.

Hardness Change
Hardness Change is usually controlled to avoid excessive softening (causing extrusion from pressure) or hardening (causing cracking).

Tensile Strength Change
A reasonable tolerance limit is usually set as insurance against excessive deterioration and early seal failure. Each individual fluid dictates its own specific limits. Experience will probably dictate these limits. However, 10%
tolerance is not realistic since much wider variance in tensile strength can be experienced on two test specimens cut from the same sample.

Elongation Change
Experience will dictate this limit as noted under tensile change.

Volume Change
Determine the maximum amount of swell which can be tolerated in the O-ring application (usually 15% to 20% for dynamic and 50% for static applications). Determine the maximum amount of shrinkage which can be
tolerated in the O-ring application (usually 3 % for both dynamic and static). Include a dry-out test after the immersion test to provide a control for dry-out shrinkage. Shrinkage of O-rings can be a cause of failure. It is necessary to stress the difference between test results on different size seals. An O-ring with a thinner cross section will not have the same volume swell as an O-ring with a thicker cross section when tested under the same conditions. This difference is at its peak
during the first 70 hours of testing (most accelerated testing is specified within this period). Only after four to six weeks the volume swell of different cross section rings approaches an equilibrium value.

Compression Set
A realistic value for compression set is often all that is necessary to assure a good state of cure and resilience of a compound.

Low Temperature Resistance
Determine the lowest temperature at which the O-ring is expected to function. Most low temperature tests are designed to indicate the brittle point of a material which only tells at what temperature the compound is most likely to be completely useless as a seal in a standard O-ring design, but very little about the temperature at which it is useful. Only the TR-10 test gives information about the lowest temperature at which the compound exhibits rubber-like properties and therefore relates to low temperature sealing capabilities. O-rings in dynamic applications will seal at the TR-10 value. O-rings in static applications will function satisfactorily to about 10°C (ca. 15°F) below this value.