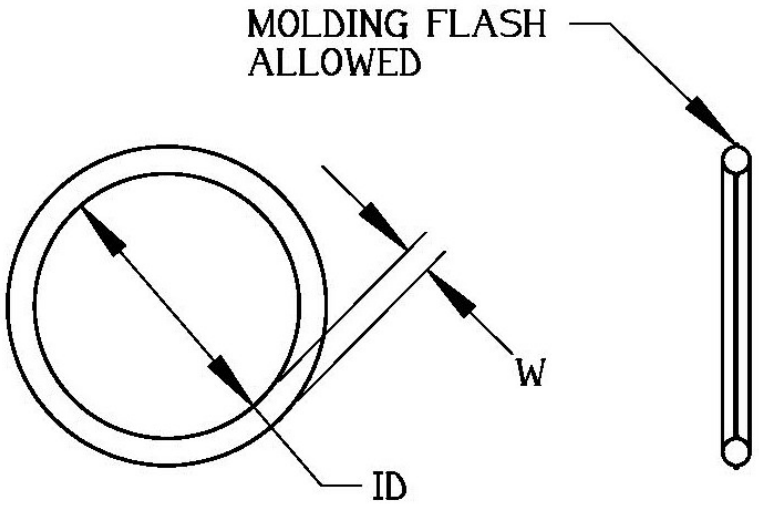
O-Ring Design Considerations:

The lowly o-ring is often overlooked in design courses. The o-ring seals most cylindrical products, lasts for years, and is incredibly inexpensive in application and maintenance. The humble o-ring changed the course of WWII (in North Africa). Without the humble o-ring, the jet age and space age would likely not have happened. It is hard to find an area of human endeavor that has not been improved by the lowly o-ring.

The o-ring is a torus of elastomeric material that is squeezed between smooth surfaces to make a seal that will withstand remarkable pressure. The two primary uses of an o-ring are to seal **bore** and **flange** joints. Bore type seals are either male (applied to the piston) or female (applied to the cylinder). Flange type seals are either internally pressurized or externally pressurized (which usually means internal vacuum). Bore seals are further categorized into static or dynamic seals. This monograph describes the dimensional design of glands for these types of seals **without** the use of back-up rings that increase the pressure a given o-ring may seal.

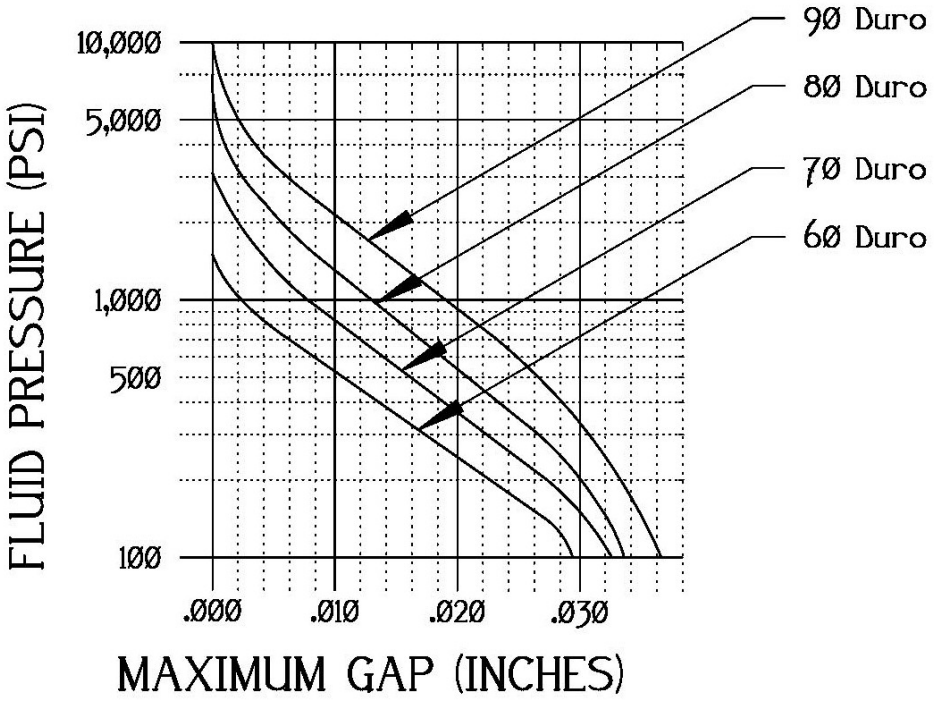


O-RING NOMENCLATURE

O-rings are sized according to their inside diameter (ID) and width (W). The outside diameter is calculated as: OD = ID + 2W. Standard identifiers called dash numbers exist for commonly available o-ring sizes. The most universal of these identifiers are defined and maintained under Society of Automotive Engineers (SAE) specification AS-568. Additional identifiers exist under (American) Military Standards and private commercial standards most notably Parker-Hannifen's part numbers which are made up of a prefix, the SAE AS-568 dash number, and a suffix identifying the molding compound. The SAE

identifiers break o-rings down by size (width and ID) with a suffix that identifies the compound. The –0XX o-rings (excepting –001, -002, and –003) have a nominal 1/16" (0.070" actually) width, –1XX o-rings have a nominal 3/32" (0.103" actually) width, –2XX o-rings have a nominal 1/8" (0.139" actually) width, -3XX o-rings have a nominal 3/16" (0.210" actually) width, -4XX o-rings have a nominal 1/4" (0.275" actually) width, and the –9XX o-rings were designed to work with Joint Industrialization Committee (JIC) and Military Specification hydraulic connections. Additional inch and metric sizes are also available, but are non-standard outside of the countries that have developed specific (usually metric) size progressions and are often designated with a 5-XXX dash number.

The compound used to make the o-ring is usually chosen for compatibility with the fluids being used or temperatures of operation. Catalogs from major o-ring manufacturers give details on environmental considerations in selecting an o-ring compound that is outside the scope of this monograph. Parker-Hannifin and National O-Ring are good sources for this information.



PRESSURE VS. GAP
BY HARDNESS

The hardness of the o-ring compound determines the radial gap that may be sealed at any given operating pressure. The harder the compound, the higher the pressure and/or the wider the gap that may be handled by the design. Hardness of most o-ring compounds is

measured using the Shore A (often called Durometer) scale. The gap referred to is the maximum gap obtainable in a particular design. If the piston is light enough or squeeze is heavy enough to center the piston in the bore at all times, it is purely the radial clearance between the piston and cylinder. Otherwise it is (nearly) twice the nominal radial clearance. Experimentation is often required to determine this value.

Another variable in the design of o-ring seals is the amount of squeeze applied to the o-ring's cross-section. It is somewhat inversely proportional to the hardness of the o-ring (i.e. the harder the o-ring, the less the squeeze). 15% squeeze is generally accepted as the minimum nominal squeeze – though circumstances exist where a squeeze of 10% may be too much (this is an exception outside the scope of this monograph). The lesser the squeeze, the lower the friction losses in dynamic applications. A squeeze of 40% may sometimes be allowed in static applications, but 30% is the generally accepted maximum nominal squeeze. A general *rule of thumb* is that 15%-18% nominal squeeze is good for dynamic applications while 20%-25% is good for static applications. It is, of course, the exceptions that prove the rule(s), right?

One of the key aspects of o-ring seal design is the material property known as **Poisson's ratio**. This is a ratio that reflects the way in which strain applied along one axis of a part creates a (usually) negative strain along other axis. Values of Poisson's ratio range from 0.5 to –1.0. Negative Poisson's ratios describe materials that expand along adjacent axis when stretched along a primary axis. Such materials are being developed today, but they are beyond the scope of this discussion and, while noted, ignored. Typical engineering materials have Poisson's ratios in the 0.5 to 0.0 range. Natural rubber has a Poisson's ratio that is 0.5 in practice. This means that no matter how you strain it, a part made from natural rubber will maintain the same volume. At the other end of the practical spectrum is cork with a Poisson's ratio close to 0.0. This means that the cross-section adjacent to the primary axis will not vary as the primary axis is strained (a very nice property in a material used to seal bottle necks). Most metals have a Poisson's ratio of approximately 0.3. Poisson's ratio is a measure of how much energy is stored internally in a material as a strain is applied.

Material:	ν	Set:	Abrasion:	Tearing:	Max/Min:
Buna-N	0.46	Fair	Good	Fair	230°F/-30°F
Viton	0.45	Good	Good	Fair	400°F/-10°F
Silicone	0.47	Good	Poor	Poor	400°F/-65°F
EPDM	0.43	Good	Good	Good	212°F/-40°F
Neoprene	0.49	Good	Good	Good	212°F/-40°F

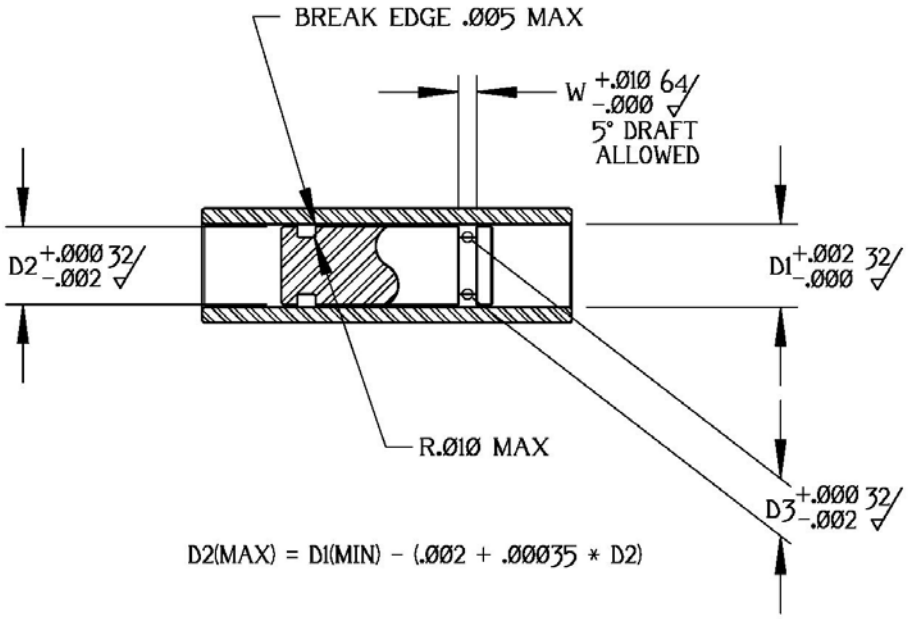
Applying Poisson's ratio to design involves simplifications that are only approximately correct. The simplified model assumes that the transverse negative strain induced by application of a longitudinal strain is constant along the length of the part. This is very obviously incorrect at the macro level to anyone who has ever done a tensile test to a metallic sample. A metal part strained into its plastic zone will reduce in cross-section

along a very localized section of the sample. However, if you average the total reduction in area along the cross-section, the **total** is equal to the $4\delta\nu^2$ (δ = change in length, ν is the symbol used most commonly for Poisson's ratio) simplification we use.

The δ cited above creates a stretch in the length of the o-ring that assists in making the seal. Stretch for male glands should never exceed 15% -- and more than 12% stretch can cause problems in some applications. Female glands should have 1%-2% stretch.

We further simplify our analysis by considering the o-ring to be a cylinder that is bent into a circle. There is a very small error introduced into our calculations as a result, but the error is very small and the calculations are vastly simplified by accepting this error. In actual practice, this error amounts to less than 0.03% of the resulting values. Greater "error" is allowed by standard tolerances used in manufacture of o-ring seal glands.

Please note that in the following calculations, the design is predicated on 0.006 maximum radial gap which is slightly more than 1000 psi using a 70 Durometer o-ring (the most common hardness). If you are using a different basis, the (0.002) allowance and tolerances (+.002/-.000 or +.000/-.002) must be adjusted.



NOMENCLATURE:
BORE SEAL, MALE GLAND

Gland geometry for this kind of seal is controlled by SAE ARP-1232 (Static) or SAE ARP-1233 (Dynamic).

Given: Bore ID (D1), O-Ring size (ID and W), Desired Squeeze (Sq), and Poisson's Ratio for o-ring material (ν).

$L_i = \pi(ID + W)$, $V_i = \pi L_i(W/2)^2$.

$H_i = W(1 - Sq/100)$, $D3_i = D1\text{-}2H_i$.

$L_{si} = \pi(D1 - H_i)$, $\delta_i = L_{si} - L_i$.

$L_{ei} = L_i + 4\delta_i\nu^2$, $A_e = V_i/L_{ei}$.

$R_{ai} = (D1 - D3_i)/4$, $L_s = \pi(D1\text{-}R_{ai})$.

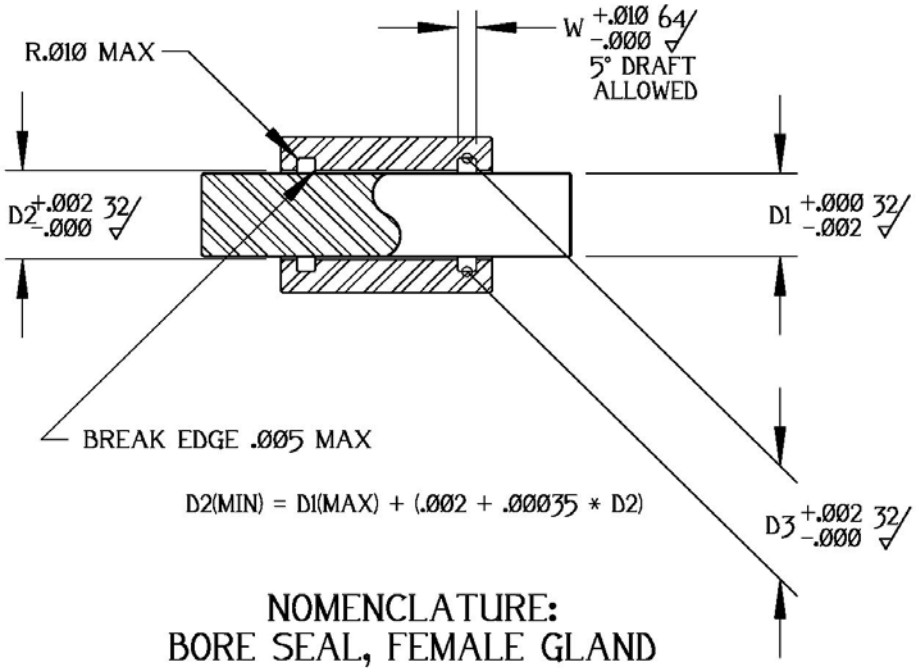
$H = 2R_{ai}(1 - Sq/100)$, $\delta = L_s - L_i$, $L_e = L_i + 4\delta\nu^2$, $A_e = V_i/L_e$, **D3 = D1 – 2H.**

$R_a = (D1 - D3)/4$, $R_b = A_e/(\pi R_a)$.

$W = 2.25R_b$ (Dynamic Applications).

$W = 2.15R_b$ (Static Applications).

Stretch = $100((L_s/L_i) - 1)$.



Gland geometry for this kind of seal is controlled by SAE ARP-1232 (Static) or SAE ARP-1233 (Dynamic).

Given: Shaft Dia (D1), O-Ring size (ID and W), Desired Squeeze (Sq), and Poisson's Ratio for o-ring material (ν).

$L_i = \pi(ID + W)$, $V_i = \pi L_i(W/2)^2$.

$H = W(1 - Sq/100)$, **$D3 = D1+2H$**, $L_s = \pi(D1 + H)$.

$\delta = L_s - L_i$, $L_e = L_i + 4\delta\nu^2$, $A_e = V_i/L_e$.

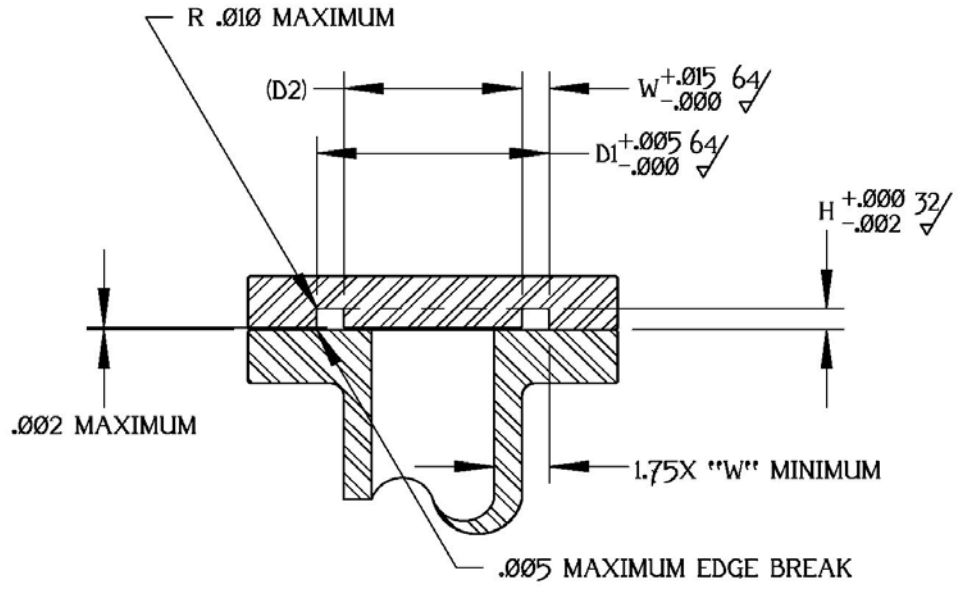
$R_a = (D3 - D1)/4$, $R_b = A_e/(\pi R_a)$.

$W = 2.25R_b$ (Dynamic Applications).

$W = 2.15R_b$ (Static Applications).

Stretch = $100((L_s/L_i) - 1)$.

Note: Slot width (W) may calculate to values narrower than the o-ring's Width value. In such cases the nominal width of the o-ring should be used as the minimum slot width value.



NOMENCLATURE:
FACE SEAL, INTERNAL PRESSURE

Gland geometry for this kind of seal is controlled by SAE ARP-1234.

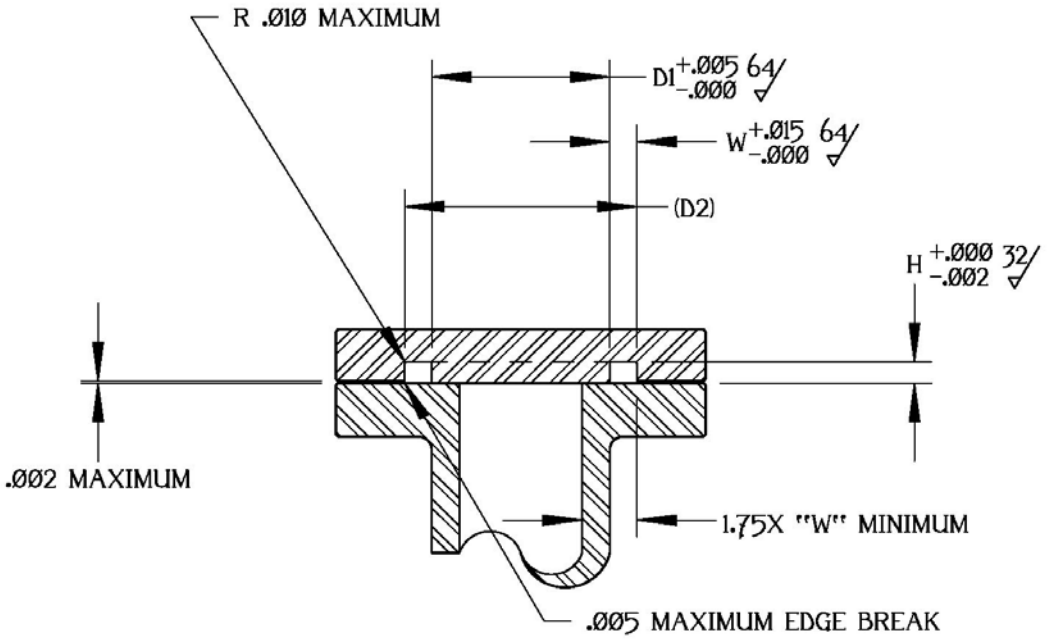
Given: O-Ring size (ID and W), Desired Squeeze (Sq), and Poisson's Ratio for o-ring material (ν).

H = W(1 - Sq/100), $L = \pi(ID + W)$, $V = \pi L(W/2)^2$, $A = V/L$, $R_a = H/2$.

D1 = 1.005(ID) + 2.002(W) +.010, $R_b = A/(\pi R_a)$.

$W = 2.15R_b$.

Stretch = $100((L_f/L_i) - 1)$.



NOMENCLATURE:
FACE SEAL, EXTERNAL PRESSURE

Gland geometry for this kind of seal is controlled by SAE ARP-1234.

Given: O-Ring size (ID and W), Desired Squeeze (Sq), and Poisson's Ratio for o-ring material (ν).

D1 = 1.10(ID), $L_i = \pi(ID + W)$, $L_f = \pi(D1 + W)$, $\delta = L_f - L_i$, $L_e = L_i + 4\delta\nu^2$.

$V = \pi^2(ID + W)(W/2)^2$, $A = V/L_e$, $R_a = (A/\pi)^{1/2}$, **$H = 2R_a(1 - Sq/100)$**.

$R_b = A/(\pi R_a)$, **$W = 2.15R_b$.**

Stretch = $100((L_f/L_i) - 1)$.

Appendix A – Examples:

Example 1: Suppose we want to seal a nominal 1.000 ID bore using a male seal to withstand 2000 psi of air pressure in a dynamic operation?

The first question we have to ask ourselves is: Will the piston be heavy enough to crush the o-ring to one side under the dynamic loading? We will assume for the purposes of this example that this is unlikely. A standard 60 Duro o-ring would require the maximum radial gap to be less than 0.002 at 2000 psi. (see *Pressure vs. Gap by Hardness* chart on page 2). This would require us to machine our bore and piston to within 0.0005 inches to maintain even 0.001 inch of clearance. This would be very expensive.

Referring to the *Pressure vs. Gap by Hardness* chart on page 2, we can see that using an o-ring of 80 Duro hardness would allow us a 0.0075 inch total gap while an o-ring of 90 Duro hardness would allow us a 0.010 inch total gap. The 80 Duro hardness will give us a reasonable machining tolerance without being too hard to squeeze easily. We can get by with a desired squeeze of 15% in this application.

As we are sealing against air and no temperature restrictions have been stated, we will base our design on a Buna-N material. This gives us operational properties of: $\nu = 0.46$, fair resistance to set, good resistance to abrasion, and fair resistance to tearing. We must watch to see of later conditions include temperatures outside of the 230°F/-30°F range are added to the requirements.

Referring to *Nomenclature: Bore Seal, Male Gland*, **D1** = ø1.000 +.002/-.000 and **D2** = ø0.998 +.000/-.002. We need an o-ring with just under a 1.000 OD. Looking at appendix B (*O-Ring Sizes Sorted by OD*), we find the following o-rings:

Size:	ID:	W:	OD:
5-964	0.744	0.109	0.962
5-138	0.898	0.031	0.960
5-273	0.879	0.040	0.959
2-311	0.537	0.210	0.957
5-006	0.796	0.080	0.956
5-003	0.836	0.059	0.954
2-209	0.671	0.139	0.949
3-910	0.755	0.097	0.949

The 5-XXX series are metric sizes often not available without a quantity order. I would make the 2-311 size my initial choice. Thus, my "givens" are: 1.000 minimum bore ID (**D2**), 0.537 **ID** and 0.210 **W** for a 2-311 o-ring, 15% **Sq**, and **ν** = 0.46.

$L_i = \pi(ID + W) = \pi(0.537 + 0.210) = 2.3468$ in.
$V_i = \pi L_i(W/2)^2 = 2.347\pi(0.210/2)^2 = 0.081283$ in³.

$H_i = W(1 - Sq/100) = 0.210(1-15/100) = 0.1785$ in.
$D3_i = D1-2H_i = 1.000 – 2(0.1785) = 0.6430$ in.
$L_{si} = \pi(D1 – H_i) = \pi(1.000 - 0.1785) = 2.5808$ in.
$\delta_i = L_{si} – L_i = 2.5808 – 2.3468 = 0.2340$ in.
$L_{ei} = L_i + 4\delta_i\nu^2 = 2.3468 + 4(0.2340)(0.46^2) = 2.1487$ in.
$A_e = V_i/L_{ei} = 0.081283/2.1487 = 0.037829$ in².
$R_{ai} = (D1 – D3_i)/4 = (1.000 – 0.6430)/4 = 0.0893$ in.
$L_s = \pi(D1-R_{ai}) = \pi(1.000 – 0.0893) = 2.8612$ in.
$H = 2R_{ai}(1 – Sq/100) = 2(0.0893)(1 – 15/100) = 0.1518$ in.
$\delta = L_s – L_i = 2.8612 – 2.3468 = 0.5144$ in.
$L_e = L_i + 4\delta\nu^2 = 2.3468 + 4(0.5144)(0.46^2) = 2.7822$ in.
$A_e = V_i/L_e = 0.081283/2.7822 = 0.029215$ in².
D3 = D1 – 2H = 1.000 – 2(0.1518) = 0.6964 in = (practical) 0.696 in.
$R_a = (D1 – D3)/4 = (1.000 – 0.696)/4 = 0.076$ in.
$R_b = A_e/(\pi R_a) = 0.029215/\pi(0.076) = 0.123$ in.
$W = 2.25R_b$ (Dynamic Applications) = 2.25(0.123) = 0.276 in.
Stretch = $100((L_s/L_i) – 1)$ = 100[(2.7822/2.3468) – 1] = 18.6%.

At 18.5% stretch, this o-ring is likely to fail. Therefore, let's look at the 2-209 size. This provides: 1.000 minimum bore ID (**D2**), 0.671 (**ID**) and 0.139 (**W**) for a 2-209 o-ring, 15% **Sq**, and **ν** = 0.46.

$L_i = \pi(ID + W) = \pi(0.671 + 0.139) = 2.5447$ in.
$V_i = \pi L_i(W/2)^2 = 2.5477\pi(0.139/2)^2 = 0.038615$ in³.
$H_i = W(1 - Sq/100) = 0.139(1-15/100) = 0.1182$ in.
$D3_i = D1-2H_i = 1.000 – 2(0.1182) = 0.7637$ in.
$L_{si} = \pi(D1 – H_i) = \pi(1.000 - 0.1182) = 2.7703$ in.
$\delta_i = L_{si} – L_i = 2.7703 – 2.5447 = 0.2256$ in.
$L_{ei} = L_i + 4\delta_i\nu^2 = 2.5447 + 4(0.2256)(0.46^2) = 2.7356$ in.
$A_e = V_i/L_{ei} = 0.038615/2.7356 = 0.014116$ in².
$R_{ai} = (D1 – D3_i)/4 = (1.000 – 0.7637)/4 = 0.0591$ in.
$L_s = \pi(D1-R_{ai}) = \pi(1.000 – 0.0591) = 2.9560$ in.
$H = 2R_{ai}(1 – Sq/100) = 2(0.0591)(1 – 15/100) = 0.1005$ in.
$\delta = L_s – L_i = 2.9560 – 2.5447 = 0.4113$ in.
$L_e = L_i + 4\delta\nu^2 = 2.5447 + 4(0.4113)(0.46^2) = 2.8928$ in.
$A_e = V_i/L_e = 0.038615/2.8928 = 0.013349$ in².
D3 = D1 – 2H = 1.000 – 2(0.1005) = 0.7990 in = (practical) 0.799 in.
$R_a = (D1 – D3)/4 = (1.000 – 0.799)/4 = 0.0503$ in.
$R_b = A_e/(\pi R_a) = 0.013349/\pi(0.0503) = 0.0845$ in.
$W = 2.25R_b$ (Dynamic Applications) = 2.25(0.0845) = 0.190 in.
Stretch = $100((L_s/L_i) – 1)$ = 100[(2.8928/2.5447) – 1] = 13.7%.

At 13.7% stretch, this o-ring is likely to fail in long-term service. Let's look at the 5-964 size. It can be had from (Seattle area) warehouse stock on 3 days notice without paying too much for a small quantity of o-rings. This gives us: 1.000 minimum bore ID (**D2**), 0.744 (**ID**) and 0.109 (**W**) for a 5-964 o-ring, 15% **Sq**, and **ν** = 0.46.

$L_i = \pi(ID + W) = \pi(0.744 + 0.109) = 2.6798$ in.
$V_i = \pi L_i(W/2)^2 = 2.6798\pi(0.109/2)^2 = 0.025006$ in³.
$H_i = W(1 - Sq/100) = .109(1\text{-}15/100) = 0.0927$ in.
$D3_i = D1\text{-}2H_i = 1.000 – 2(0.0927) = 0.8147$ in.
$L_{si} = \pi(D1 – H_i) = \pi(1.000 – 0.0927) = 2.8504$ in.
$\delta_i = L_{si} – L_i = 2.8504 – 2.6798 = 0.1706$ in.
$L_{ei} = L_i + 4\delta_i\nu^2 = 2.6798 + 4(0.1706)(0.46^2) = 2.8242$ in.
$A_e = V_i/L_{ei} = 0.025006/2.8242 = 0.008854$ in².
$R_{ai} = (D1 – D3_i)/4 = (1.000 – 0.8147)/4 = 0.0463$ in.
$L_s = \pi(D1\text{-}R_{ai}) = \pi(1.000 – 0.0436) = 2.9961$ in.
$H = 2R_{ai}(1 – Sq/100) = 2(0.0463)(1 – 15/100) = 0.0787$ in.
$\delta = L_s – L_i = 2.9961 – 2.6798 = 0.3163$ in.
$L_e = L_i + 4\delta\nu^2 = 2.6798 + 4(0.3163)(0.46^2) = 2.9475$ in.
$A_e = V_i/L_e = 0.025006/2.9475 = 0.008484$ in².
$D3 = D1 – 2H$ $= 1.000 – 2(0.0787) = 0.8426$ in = (practical) 0.843 in.
$R_a = (D1 – D3)/4 = (1.000 – 0.843)/4 = 0.0394$ in.
$R_b = A_e/(\pi R_a) = 0.008484/\pi(0.0394) = 0.0685$ in.
$W = 2.25R_b$ (Dynamic Applications) $= 2.25(0.0685) = 0.154$ in.
Stretch $= 100((L_s/L_i) – 1)$ $= 100[(2.8928/2.5447) – 1] = 11.2\%$.

Which gets us a generally good seal. Please note that my initial guesses did not result in a good design. A phone call to your local stocking warehouse will fill in blanks for you that will otherwise cause problems. While using the most common SAE sizes is easiest, it sometimes leads you into trouble. A quick phone call will assure that the mechanics are not needlessly swearing at you.

The o-ring groove in this application will have an ID (**D3**) of ø0.843 (+.000/-.002) and a width (**W**) of 0.154 (+.010/-.000) and should be cited in accordance with SAE ARP-1233.

Example 2: Suppose we want to seal a nominal 1.250 ID bore using a female seal to withstand 250 psi of air pressure in a static operation at 350°F?

As this is a static seal that will use a fairly high squeeze, it is unlikely that the piston will move off-center in this application. Therefore, we may assume a gap will be purely the radial clearance. A standard 60 Duro o-ring will seal a gap of .020 inch at 250 psi. (see *Pressure vs. Gap by Hardness* chart on page 2). This is a massive tolerance allowance, so we need not be concerned about o-ring hardness. 70 Durometer o-rings tend to be the least expensive, so we will focus on that hardness.

As we are sealing against air at 250°F, we are limited to either silicone or viton o-ring materials (see chart on page 3). As this is a static seal, the limitations of either silicone or viton in abrasion and tearing are immaterial. Viton is less expensive than silicone, so that is the main "driver" here. This gives us operational properties of: $\nu = 0.46$, good resistance to set, good resistance to abrasion, poor resistance to tearing, and an operational temperature range of +400°F/-10°F.

Referring to *Nomenclature: Bore Seal, Female Gland*, **D2** = ø1.250 +.002/-.000 and **D1** = ø1.248 +.000/-.002. We need an o-ring with an OD equal to or just larger than 1.250. Looking at appendix C (*O-Ring Sizes Sorted by ID*), we find the following o-rings:

Size:	ID:	W:	OD:
5-603	1.279	0.141	1.561
5-301	1.259	0.092	1.443
2-026	1.239	0.070	1.379
2-124	1.237	0.103	1.443
2-218	1.234	0.139	1.512
5-297	1.230	0.197	1.624

The 5-301, if available, looks to be the obvious first choice here. The 2-026 size is a also a very good choice. The 5-301 size is currently available only for orders of 1000 units or more, so let's start with the 2-026 size which is available from local stock. Thus, my "givens" are: 1.250 minimum bore ID (**D2**), 1.239 **ID** and 0.070 **W** for a 2-026 o-ring, 20% **Sq**, and **ν** = 0.46.

$L_i = \pi(ID + W) = \pi(1.239 + 0.070) = 4.1123$ in.

$V = \pi L_i(W/2)^2 = \pi 1.239(0.070/2)^2 = 0.004768$ in³.

$H = W(1 - Sq/100) = 0.070(1-20/100) = 0.0560$ in.

D3 = D2+2H = 1.250 + 2(0.0560) = 1.3620 in.

$L_s = \pi(D2 + H) = \pi(1.250 + 0.0560) = 4.1029$ in.

$\delta = L_s - L_i = 4.1029 - 4.1123 = -0.0094$ in.

$L_e = L_i + 4\delta\nu^2 = 4.1123 + 4(-.0094)(.46^2) = 4.1044$ in.

$A_e = V_i/L_e = 0.004768/4.1044 = 0.001162$ in².

$R_a = (D3 - D2)/4 = (1.3620 - 1.250)/4 = 0.0280$ in.

$R_b = A_e/(\pi R_a) = 0.0132$ in.

$W = 2.15R_b$ (Static Applications) = 0.0284 in. => which defaults to the minimum 0.0700 in noted in the section on this application.

Stretch = $100((L_s/L_i) - 1)$ = -0.19%

This is a pretty good choice. The o-ring groove in this application will have an OD (**D3**) of ø1.362 (+.002/-.000) and a width (**W**) of 0.070 (+.010/-.000) and should be cited in accordance with SAE ARP-1232.

Example 3: Suppose we want to seal a nominal 1.500 ID bore using a flange seal to withstand 750 psi of air pressure at 205°F?

Referring to the o-ring materials properties chart on page 3 we can see that EPDM and neoprene have maximum service temperatures of 212°F. Thus we will rule out those two

materials for this application. Buna-N has a maximum service temperature of 230°F. So long as the 205°F maximum service temperature does not change, this would be the material of choice from a cost standpoint. As flange seals are, by definition, static seals none of the other mechanical properties come into play except set. Buna-N has "fair" resistance to set, so we want to set the squeeze a bit higher than normal. Instead of using a nominal 20% squeeze, we will baseline a 25% squeeze for this design.

In order to assure a good fit with the flange, I will assume that I will be using a .210 inch wide o-ring to establish my nominal gland OD (**D1** on page 7) in the formula: OD = ID + 4W = 1.500 + 4(.210) = ø2.340 inch. I can go a slight bit smaller than this – especially if I use an o-ring narrower than .210 inch wide. I can go larger than this at the cost of more material in the flange. Thus, when I search my o-rings by OD in Appendix B (*O-Ring Sizes Sorted by OD*), I end up with a selection of:

Size:	ID:	W:	OD:
2-138	2.112	0.103	2.318
5-346	2.046	0.139	2.324
3-928	2.090	0.118	2.326
5-1042	1.817	0.257	2.331
5-1044	2.060	0.139	2.338
5-338	1.925	0.210	2.345
2-035	2.239	0.070	2.379
2-139	2.175	0.103	2.381

The 5-338 size is an obviously good choice if it can be had from local stock without a huge minimum order. The 2-139 would be my second choice because of the larger value for W. However, 5-338 o-ring sizes are available from a large stock on hand with a 3-day delivery time in a 70 Durometer Buna-N material. A quick check of the *Pressure vs. Gap by Hardness* chart on page 2 shows us that we can allow a fairly large gap (0.010 inch) at 750 psi.

Thus, we have givens of: 1.925 inch **ID**, 0.210 inch **W**, **Sq** = 25%, and **ν** = 0.46.

H = W(1 - Sq/100) = 0.210(1 – 25/100) = 0.1575 inch (0.158 inch practical)

$L = \pi(ID + W) = \pi(1.925 + 0.210) = 6.7073$ inch.

$V = \pi L(W/2)^2 = \pi(6.7073)(0.210/2)^2 = 0.232314$ in³.

$A = V/L = 0.232314/6.7073 = 0.034636$ in².

$R_a = H/2 = 0.158/2 = 0.0790$ inch.

D1 = 1.005(ID) + 2.002(W) +.010 = 1.005(1.925) + 2.002(0.210) + .010 = 2.3650 inch.

$R_b = A/(\pi R_a) = 0.034636/(\pi(0.0790)) = 0.1396$ inch.

$W = 2.15R_b$ = 2.15(0.1396) = 0.3000 inch (0.300 inch practical).

This leaves us with an o-ring groove of: 2.365 +.005/-.000 inch OD (**D1**), 0.300 +.015/-.000 inch W, 0.158 +.000/-.002 inch deep (**H**) gland in accordance with SAE ARP-1234.

Example 4: Suppose we want to seal a nominal 1.500 ID bore using a flange seal to withstand 12 psi of vacuum at -15°F?

Referring to the o-ring materials properties chart on page 3 we can see that any material **except** viton will work for this application. As flange seals are, by definition, static seals none of the other mechanical properties come into play except set. Neoprene is probably the best overall material for this application. Because of the low pressure involved and desirability of having no leakage, this is the time to apply exceptions to the rules. We will get the best seal in this application with a soft (i.e. 60 Durometer) seal that is highly compressed – 30% compression is good in many vacuum applications. Similarly, we will want as large a cross-sectional area (i.e. W) as we can get. We want an o-ring with a **minimum** ID that is (1.15 * bore diameter = 1.15 * 1.500 =) 1.725 inch. When I search Appendix C (*O-Ring Sizes Sorted by ID*), I get the following sizes as possible seals:

Size:	ID:	W:	OD:
2-133	1.799	0.103	2.005
5-1023	1.788	0.070	1.928
5-035	1.786	0.139	2.064
5-025	1.765	0.125	2.015
2-031	1.739	0.070	1.879
2-132	1.737	0.103	1.943
2-224	1.734	0.139	2.012
2-327	1.725	0.210	2.145

Note that the 2-327 size is a perfect match for this application. Sometimes you get lucky. This gives us givens of: 1.725 inch **ID**, 0.210 inch **W**, **Sq** = 30%, and **ν** = 0.49.

D1 = 1.10(ID) = 1.10(1.725) = 1.8975 inch (1.898 inch practical)

$L_i = \pi(ID + W) = \pi(1.725 + 0.210) = 6.0790$ inch.

$L_f = \pi(D1 + W) = \pi(1.8975 + 0.210) = 6.6209$ inch.

$\delta = L_f - L_i = 0.5419$ inch.

$L_e = L_i + 4\delta\nu^2 = 6.0790 + 4(0.5419)(0.49^2) = 6.5994$ inch.

$V = \pi^2(ID + W)(W/2)^2 = \pi^2(1.725 + 0.210)(0.210/2)^2 = 0.210552$ in³.

$A = V/L_e = 0.210552/6.5994 = 0.031905$ in².

$R_a = (A/\pi)^{1/2} = (0.031905/\pi)^{1/2} = 0.1008$ inch.

$H = 2R_a(1 - Sq/100)$ = 2(0.1008)(1 – 30/100) = 0.1411 inch (0.141 inch practical)

$R_b = A/(\pi R_a) = 0.031905/(\pi(0.1008)) = 0.1009$ inch.

W = 2.15R_b = 2.15(0.1009) = 0.2169 inch (0.217 inch practical)

Stretch = 100((L_f/L_i) – 1) = 8.9%

Which leaves us with a gland specified as: **D1** = 1.898 +.005/-.000, **W** = 0.217 +.015/-.000, and **H** = 0.141 +.000/-.002 in accordance with SAE ARP-1234.

Appendix B – O-Ring Sizes Sorted by OD:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-001	0.029	0.040	0.109	2-001	5-106	0.154	0.066	0.286	5-106
5-118	0.059	0.040	0.139	5-118	2-103	0.081	0.103	0.287	2-103
2-002	0.042	0.050	0.142	2-002	5-124	0.176	0.056	0.288	5-124
5-187	0.070	0.036	0.142	5-187	3-901	0.185	0.056	0.297	3-901
5-051	0.070	0.040	0.150	5-051	5-107	0.176	0.066	0.308	5-107
2-003	0.056	0.060	0.176	2-003	5-194	0.228	0.040	0.308	5-194
5-101	0.100	0.038	0.176	5-101	5-580	0.165	0.074	0.313	5-580
5-632	0.110	0.040	0.190	5-632	2-008	0.176	0.070	0.316	2-008
5-102	0.116	0.038	0.192	5-102	2-104	0.112	0.103	0.318	2-104
5-178	0.120	0.040	0.200	5-178	5-179	0.239	0.040	0.319	5-179
5-646	0.126	0.040	0.206	5-646	5-197	0.242	0.040	0.322	5-197
2-004	0.070	0.070	0.210	2-004	5-581	0.192	0.074	0.340	5-581
5-669	0.146	0.040	0.226	5-669	5-151	0.239	0.051	0.341	5-151
5-103	0.128	0.050	0.228	5-103	5-180	0.248	0.048	0.344	5-180
5-148	0.154	0.038	0.230	5-148	2-009	0.208	0.070	0.348	2-009
2-005	0.101	0.070	0.241	2-005	2-105	0.143	0.103	0.349	2-105
5-683	0.122	0.063	0.248	5-683	5-152	0.301	0.025	0.351	5-152
5-578	0.102	0.074	0.250	5-578	5-698	0.283	0.040	0.363	5-698
2-006	0.114	0.070	0.254	2-006	3-902	0.239	0.064	0.367	3-902
5-105	0.154	0.050	0.254	5-105	5-202	0.278	0.046	0.370	5-202
2-102	0.049	0.103	0.255	2-102	5-582	0.224	0.074	0.372	5-582
5-193	0.176	0.040	0.256	5-193	5-056	0.301	0.038	0.377	5-056
5-125	0.180	0.040	0.260	5-125	2-010	0.239	0.070	0.379	2-010
5-190	0.132	0.070	0.272	5-190	2-106	0.174	0.103	0.380	2-106
5-108	0.176	0.050	0.276	5-108	5-1004	0.290	0.045	0.380	5-1004
5-579	0.133	0.074	0.281	5-579	5-204	0.312	0.036	0.384	5-204
2-007	0.145	0.070	0.285	2-007	5-638	0.233	0.076	0.385	5-638
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-127	0.239	0.074	0.387	5-127	5-586	0.350	0.074	0.498	5-586
5-133	0.332	0.031	0.394	5-133	2-012	0.364	0.070	0.504	2-012
5-685	0.208	0.094	0.396	5-685	2-109	0.299	0.103	0.505	2-109
5-583	0.251	0.074	0.399	5-583	5-682	0.426	0.040	0.506	5-682
5-710	0.301	0.054	0.409	5-710	2-202	0.234	0.139	0.512	2-202
5-052	0.270	0.070	0.410	5-052	5-160	0.312	0.103	0.518	5-160
2-107	0.206	0.103	0.412	2-107	5-212	0.384	0.070	0.524	5-212
5-712	0.313	0.051	0.415	5-712	5-058	0.426	0.050	0.526	5-058
3-903	0.301	0.064	0.429	3-903	5-206	0.326	0.103	0.532	5-206
5-1007	0.330	0.050	0.430	5-1007	5-002	0.416	0.059	0.534	5-002
5-584	0.283	0.074	0.431	5-584	5-699	0.353	0.094	0.541	5-699
5-686	0.248	0.094	0.436	5-686	5-200	0.265	0.139	0.543	5-200
2-011	0.301	0.070	0.441	2-011	3-905	0.414	0.072	0.558	3-905
2-108	0.237	0.103	0.443	2-108	5-587	0.350	0.106	0.562	5-587
2-201	0.171	0.139	0.449	2-201	5-223	0.458	0.053	0.564	5-223
5-209	0.370	0.040	0.450	5-209	2-013	0.426	0.070	0.566	2-013
5-673	0.305	0.074	0.453	5-673	2-110	0.362	0.103	0.568	2-110
5-057	0.364	0.045	0.454	5-057	2-203	0.296	0.139	0.574	2-203
5-664	0.320	0.070	0.460	5-664	5-613	0.437	0.070	0.577	5-613
5-585	0.314	0.074	0.462	5-585	5-018	0.352	0.113	0.578	5-018
5-1006	0.322	0.070	0.462	5-1006	5-1002	0.239	0.174	0.587	5-1002
5-134	0.410	0.031	0.472	5-134	5-135	0.526	0.031	0.588	5-135
5-687	0.287	0.094	0.475	5-687	5-700	0.354	0.118	0.590	5-700
5-218	0.425	0.025	0.475	5-218	5-726	0.484	0.056	0.596	5-726
5-718	0.395	0.040	0.475	5-718	5-614	0.391	0.103	0.597	5-614
5-612	0.344	0.070	0.484	5-612	5-716	0.362	0.118	0.598	5-716
3-904	0.351	0.072	0.495	3-904	5-566	0.489	0.055	0.599	5-566
5-205	0.312	0.092	0.496	5-205	5-215	0.418	0.094	0.606	5-215
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-675	0.508	0.049	0.606	5-675	5-590	0.535	0.106	0.747	5-590
5-652	0.473	0.071	0.615	5-652	5-211	0.375	0.187	0.749	5-211
3-906	0.468	0.078	0.624	3-906	5-230	0.500	0.125	0.750	5-230
5-588	0.413	0.106	0.625	5-588	5-250	0.627	0.062	0.751	5-250
5-231	0.501	0.062	0.625	5-231	2-016	0.614	0.070	0.754	2-016
2-014	0.489	0.070	0.629	2-014	2-113	0.549	0.103	0.755	2-113
2-111	0.424	0.103	0.630	2-111	5-251	0.631	0.062	0.755	5-251
2-204	0.359	0.139	0.637	2-204	2-206	0.484	0.139	0.762	2-206
5-001	0.547	0.051	0.649	5-001	5-239	0.570	0.106	0.782	5-239
5-1011	0.447	0.103	0.653	5-1011	5-609	0.600	0.094	0.788	5-609
5-225	0.469	0.094	0.657	5-225	5-254	0.660	0.064	0.788	5-254
5-563	0.583	0.040	0.663	5-563	5-735	0.583	0.103	0.789	5-735
5-1014	0.525	0.071	0.667	5-1014	5-252	0.652	0.070	0.792	5-252
5-615	0.469	0.103	0.675	5-615	5-005	0.640	0.080	0.800	5-005
5-236	0.562	0.062	0.686	5-236	5-181	0.725	0.040	0.805	5-181
2-015	0.551	0.070	0.691	2-015	5-591	0.594	0.106	0.806	5-591
2-112	0.487	0.103	0.693	2-112	5-242	0.600	0.105	0.810	5-242
3-907	0.530	0.082	0.694	3-907	5-243	0.604	0.103	0.810	5-243
5-162	0.554	0.070	0.694	5-162	2-017	0.676	0.070	0.816	2-017
5-156	0.575	0.060	0.695	5-156	2-114	0.612	0.103	0.818	2-114
2-205	0.421	0.139	0.699	2-205	3-908	0.644	0.087	0.818	3-908
5-136	0.643	0.031	0.705	5-136	2-207	0.546	0.139	0.824	2-207
5-222	0.455	0.128	0.711	5-222	5-617	0.625	0.103	0.831	5-617
5-616	0.516	0.103	0.722	5-616	2-309	0.412	0.210	0.832	2-309
5-248	0.625	0.050	0.725	5-248	5-137	0.775	0.031	0.837	5-137
5-676	0.610	0.058	0.726	5-676	5-021	0.603	0.125	0.853	5-021
5-736	0.590	0.070	0.730	5-736	5-1017	0.709	0.079	0.867	5-1017
5-643	0.650	0.045	0.740	5-643	5-263	0.750	0.061	0.872	5-263
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-247	0.623	0.125	0.873	5-247	2-210	0.734	0.139	1.012	2-210
5-592	0.665	0.106	0.877	5-592	2-312	0.600	0.210	1.020	2-312
2-018	0.739	0.070	0.879	2-018	5-139	0.987	0.031	1.049	5-139
2-115	0.674	0.103	0.880	2-115	5-595	0.779	0.141	1.061	5-595
2-208	0.609	0.139	0.887	2-208	2-021	0.926	0.070	1.066	2-021
5-264	0.752	0.070	0.892	5-264	2-118	0.862	0.103	1.068	2-118
2-310	0.475	0.210	0.895	2-310	2-211	0.796	0.139	1.074	2-211
3-909	0.706	0.097	0.900	3-909	2-313	0.662	0.210	1.082	2-313
5-256	0.707	0.103	0.913	5-256	3-911	0.863	0.116	1.095	3-911
5-266	0.766	0.080	0.926	5-266	5-753	0.857	0.123	1.103	5-753
5-593	0.724	0.106	0.936	5-593	5-709	1.000	0.055	1.110	5-709
5-708	0.850	0.045	0.940	5-708	5-751	0.820	0.150	1.120	5-751
2-019	0.801	0.070	0.941	2-019	5-596	0.838	0.141	1.120	5-596
5-743	0.660	0.141	0.942	5-743	2-022	0.989	0.070	1.129	2-022
2-116	0.737	0.103	0.943	2-116	2-119	0.924	0.103	1.130	2-119
5-257	0.722	0.113	0.948	5-257	5-761	1.010	0.062	1.134	5-761
2-209	0.671	0.139	0.949	2-209	2-212	0.859	0.139	1.137	2-212
3-910	0.755	0.097	0.949	3-910	5-022	0.890	0.125	1.140	5-022
5-003	0.836	0.059	0.954	5-003	2-314	0.725	0.210	1.145	2-314
5-006	0.796	0.080	0.956	5-006	5-049	0.871	0.140	1.151	5-049
2-311	0.537	0.210	0.957	2-311	3-912	0.924	0.116	1.156	3-912
5-273	0.879	0.040	0.959	5-273	5-677	1.004	0.081	1.166	5-677
5-138	0.898	0.031	0.960	5-138	5-140	1.112	0.031	1.174	5-140
5-964	0.744	0.109	0.962	5-964	5-763	1.080	0.050	1.180	5-763
5-594	0.720	0.141	1.002	5-594	5-278	0.979	0.103	1.185	5-278
2-020	0.864	0.070	1.004	2-020	5-745	0.687	0.250	1.187	5-745
2-117	0.799	0.103	1.005	2-117	5-597	0.905	0.141	1.187	5-597
5-725	0.470	0.270	1.010	5-725	2-023	1.051	0.070	1.191	2-023
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-120	0.987	0.103	1.193	2-120	2-027	1.301	0.070	1.441	2-027
2-213	0.921	0.139	1.199	2-213	5-301	1.259	0.092	1.443	5-301
5-004	1.070	0.065	1.200	5-004	2-124	1.237	0.103	1.443	2-124
2-315	0.787	0.210	1.207	2-315	2-217	1.171	0.139	1.449	2-217
3-913	0.986	0.116	1.218	3-913	2-319	1.037	0.210	1.457	2-319
5-598	0.968	0.141	1.250	5-598	5-602	1.212	0.141	1.494	5-602
2-024	1.114	0.070	1.254	2-024	2-028	1.364	0.070	1.504	2-028
2-121	1.049	0.103	1.255	2-121	2-125	1.299	0.103	1.505	2-125
2-214	0.984	0.139	1.262	2-214	5-294	1.213	0.149	1.511	5-294
2-316	0.850	0.210	1.270	2-316	2-218	1.234	0.139	1.512	2-218
3-914	1.047	0.116	1.279	3-914	2-320	1.100	0.210	1.520	2-320
5-141	1.226	0.031	1.288	5-141	5-157	1.338	0.092	1.522	5-157
5-618	1.016	0.139	1.294	5-618	5-769	1.176	0.183	1.542	5-769
5-599	1.031	0.141	1.313	5-599	5-142	1.450	0.047	1.544	5-142
2-025	1.176	0.070	1.316	2-025	5-780	1.412	0.073	1.558	5-780
2-122	1.112	0.103	1.318	2-122	5-603	1.279	0.141	1.561	5-603
2-215	1.046	0.139	1.324	2-215	5-309	1.436	0.063	1.562	5-309
5-291	1.186	0.070	1.326	5-291	2-126	1.362	0.103	1.568	2-126
2-317	0.912	0.210	1.332	2-317	2-219	1.296	0.139	1.574	2-219
5-296	1.229	0.070	1.369	5-296	5-670	1.437	0.070	1.577	5-670
5-600	1.094	0.141	1.376	5-600	5-008	1.421	0.080	1.581	5-008
2-026	1.239	0.070	1.379	2-026	2-321	1.162	0.210	1.582	2-321
2-123	1.174	0.103	1.380	2-123	3-918	1.355	0.116	1.587	3-918
2-216	1.109	0.139	1.387	2-216	5-290	1.180	0.210	1.600	5-290
2-318	0.975	0.210	1.395	2-318	5-297	1.230	0.197	1.624	5-297
3-916	1.171	0.116	1.403	3-916	5-604	1.342	0.141	1.624	5-604
5-601	1.153	0.141	1.435	5-601	2-029	1.489	0.070	1.629	2-029
5-279	1.004	0.218	1.440	5-279	2-127	1.424	0.103	1.630	2-127
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-220	1.359	0.139	1.637	2-220	2-131	1.674	0.103	1.880	2-131
2-322	1.225	0.210	1.645	2-322	2-223	1.609	0.139	1.887	2-223
5-312	1.454	0.105	1.664	5-312	2-325	1.475	0.210	1.895	2-325
5-657	1.465	0.103	1.671	5-657	5-327	1.640	0.139	1.918	5-327
5-320	1.540	0.070	1.680	5-320	5-335	1.802	0.062	1.926	5-335
5-605	1.401	0.141	1.683	5-605	5-1023	1.788	0.070	1.928	5-1023
5-1028	1.190	0.250	1.690	5-1028	2-132	1.737	0.103	1.943	2-132
2-128	1.487	0.103	1.693	2-128	5-1018	1.671	0.139	1.949	5-1018
2-221	1.421	0.139	1.699	2-221	5-794	1.812	0.070	1.952	5-794
2-323	1.287	0.210	1.707	2-323	3-924	1.720	0.118	1.956	3-924
3-920	1.475	0.118	1.711	3-920	5-332	1.687	0.139	1.965	5-332
5-009	1.553	0.080	1.713	5-009	5-144	1.891	0.047	1.985	5-144
5-788	1.591	0.071	1.733	5-788	5-795	1.850	0.070	1.990	5-795
5-158	1.550	0.092	1.734	5-158	5-337	1.873	0.062	1.997	5-337
5-606	1.468	0.141	1.750	5-606	2-032	1.864	0.070	2.004	2-032
2-030	1.614	0.070	1.754	2-030	2-133	1.799	0.103	2.005	2-133
2-129	1.549	0.103	1.755	2-129	2-224	1.734	0.139	2.012	2-224
2-222	1.484	0.139	1.762	2-222	5-025	1.765	0.125	2.015	5-025
5-143	1.670	0.047	1.764	5-143	2-326	1.600	0.210	2.020	2-326
5-024	1.515	0.125	1.765	5-024	5-011	1.860	0.080	2.020	5-011
2-324	1.350	0.210	1.770	2-324	5-980	1.475	0.275	2.025	5-980
5-295	1.225	0.275	1.775	5-295	5-796	1.913	0.070	2.053	5-796
5-329	1.670	0.070	1.810	5-329	5-342	1.980	0.038	2.056	5-342
2-130	1.612	0.103	1.818	2-130	5-035	1.786	0.139	2.064	5-035
5-321	1.559	0.139	1.837	5-321	2-134	1.862	0.103	2.068	2-134
5-034	1.559	0.139	1.837	5-034	5-330	1.674	0.210	2.094	5-330
5-671	1.680	0.080	1.840	5-671	5-1043	1.882	0.118	2.118	5-1043
2-031	1.739	0.070	1.879	2-031	2-033	1.989	0.070	2.129	2-033
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-135	1.925	0.103	2.131	2-135	5-981	1.850	0.275	2.400	5-981
2-225	1.859	0.139	2.137	2-225	2-140	2.237	0.103	2.443	2-140
2-327	1.725	0.210	2.145	2-327	5-015	2.296	0.080	2.456	5-015
5-343	2.000	0.075	2.150	5-343	5-1047	2.281	0.093	2.467	5-1047
5-655	2.020	0.070	2.160	5-655	2-036	2.364	0.070	2.504	2-036
5-642	2.051	0.070	2.191	5-642	2-141	2.300	0.103	2.506	2-141
2-136	1.987	0.103	2.193	2-136	2-228	2.234	0.139	2.512	2-228
5-701	1.937	0.139	2.215	5-701	2-330	2.100	0.210	2.520	2-330
5-145	2.141	0.047	2.235	5-145	2-142	2.362	0.103	2.568	2-142
2-034	2.114	0.070	2.254	2-034	3-932	2.337	0.118	2.573	3-932
2-137	2.050	0.103	2.256	2-137	5-702	2.312	0.139	2.590	5-702
2-226	1.984	0.139	2.262	2-226	5-354	2.471	0.070	2.611	5-354
2-328	1.850	0.210	2.270	2-328	2-037	2.489	0.070	2.629	2-037
5-347	2.163	0.062	2.287	5-347	2-143	2.425	0.103	2.631	2-143
5-348	2.172	0.070	2.312	5-348	2-229	2.359	0.139	2.637	2-229
5-037	2.036	0.139	2.314	5-037	2-331	2.225	0.210	2.645	2-331
2-138	2.112	0.103	2.318	2-138	5-805	2.535	0.070	2.675	5-805
5-346	2.046	0.139	2.324	5-346	5-039	2.411	0.139	2.689	5-039
3-928	2.090	0.118	2.326	3-928	2-144	2.487	0.103	2.693	2-144
5-1042	1.817	0.257	2.331	5-1042	5-355	2.524	0.103	2.730	5-355
5-1044	2.060	0.139	2.338	5-1044	5-358	2.576	0.082	2.740	5-358
5-338	1.925	0.210	2.345	5-338	2-038	2.614	0.070	2.754	2-038
2-035	2.239	0.070	2.379	2-035	2-145	2.550	0.103	2.756	2-145
2-139	2.175	0.103	2.381	2-139	2-230	2.484	0.139	2.762	2-230
2-227	2.109	0.139	2.387	2-227	5-1046	2.140	0.315	2.770	5-1046
5-027	2.140	0.125	2.390	5-027	2-332	2.350	0.210	2.770	2-332
5-014	2.230	0.080	2.390	5-014	5-800	2.225	0.275	2.775	5-800
2-329	1.975	0.210	2.395	2-329	2-146	2.612	0.103	2.818	2-146
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-703	2.563	0.139	2.841	5-703	2-336	2.850	0.210	3.270	2-336
2-039	2.739	0.070	2.879	2-039	5-982	2.725	0.275	3.275	5-982
2-147	2.675	0.103	2.881	2-147	5-815	3.156	0.060	3.276	5-815
2-231	2.609	0.139	2.887	2-231	5-811	3.060	0.112	3.284	5-811
2-333	2.475	0.210	2.895	2-333	5-1052	3.080	0.111	3.302	5-1052
5-159	2.683	0.115	2.913	5-159	5-816	3.162	0.070	3.302	5-816
2-148	2.737	0.103	2.943	2-148	5-044	3.036	0.139	3.314	5-044
5-361	2.671	0.139	2.949	5-361	5-813	3.130	0.100	3.330	5-813
5-807	2.782	0.103	2.988	5-807	5-557	3.125	0.103	3.331	5-557
2-040	2.864	0.070	3.004	2-040	2-042	3.239	0.070	3.379	2-042
2-149	2.800	0.103	3.006	2-149	2-235	3.109	0.139	3.387	2-235
2-232	2.734	0.139	3.012	2-232	2-337	2.975	0.210	3.395	2-337
2-334	2.600	0.210	3.020	2-334	5-819	3.210	0.103	3.416	5-819
5-697	2.878	0.080	3.038	5-697	5-045	3.161	0.139	3.439	5-045
2-150	2.862	0.103	3.068	2-150	5-821	3.300	0.070	3.440	5-821
5-704	2.812	0.139	3.090	5-704	2-152	3.237	0.103	3.443	2-152
5-042	2.846	0.139	3.124	5-042	5-1053	3.354	0.070	3.494	5-1053
2-041	2.989	0.070	3.129	2-041	2-236	3.234	0.139	3.512	2-236
5-367	2.924	0.103	3.130	5-367	2-338	3.100	0.210	3.520	2-338
2-233	2.859	0.139	3.137	2-233	5-938	2.975	0.275	3.525	5-938
2-335	2.725	0.210	3.145	2-335	2-043	3.489	0.070	3.629	2-043
5-810	3.041	0.062	3.165	5-810	2-237	3.359	0.139	3.637	2-237
2-151	2.987	0.103	3.193	2-151	2-339	3.225	0.210	3.645	2-339
5-705	2.937	0.139	3.215	5-705	5-380	3.363	0.155	3.673	5-380
5-368	3.020	0.103	3.226	5-368	2-153	3.487	0.103	3.693	2-153
5-369	3.037	0.103	3.243	5-369	2-238	3.484	0.139	3.762	2-238
5-374	3.112	0.070	3.252	5-374	2-340	3.350	0.210	3.770	2-340
2-234	2.984	0.139	3.262	2-234	5-984	3.225	0.275	3.775	5-984
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-828	3.661	0.090	3.841	5-828	2-345	3.975	0.210	4.395	2-345
2-044	3.739	0.070	3.879	2-044	2-156	4.237	0.103	4.443	2-156
2-239	3.609	0.139	3.887	2-239	5-060	4.390	0.044	4.478	5-060
5-031	3.640	0.125	3.890	5-031	5-1054	4.080	0.209	4.498	5-1054
2-341	3.475	0.210	3.895	2-341	2-244	4.234	0.139	4.512	2-244
5-825	3.350	0.275	3.900	5-825	2-346	4.100	0.210	4.520	2-346
2-154	3.737	0.103	3.943	2-154	5-987	3.975	0.275	4.525	5-987
5-979	3.443	0.275	3.993	5-979	2-047	4.489	0.070	4.629	2-047
2-240	3.734	0.139	4.012	2-240	2-245	4.359	0.139	4.637	2-245
2-342	3.600	0.210	4.020	2-342	2-347	4.225	0.210	4.645	2-347
5-381	3.475	0.275	4.025	5-381	5-988	4.100	0.275	4.650	5-988
5-385	3.603	0.220	4.043	5-385	5-401	4.531	0.070	4.671	5-401
2-045	3.989	0.070	4.129	2-045	2-157	4.487	0.103	4.693	2-157
2-241	3.859	0.139	4.137	2-241	5-836	4.427	0.140	4.707	5-836
2-343	3.725	0.210	4.145	2-343	2-246	4.484	0.139	4.762	2-246
5-985	3.600	0.275	4.150	5-985	2-348	4.350	0.210	4.770	2-348
2-155	3.987	0.103	4.193	2-155	5-989	4.225	0.275	4.775	5-989
5-394	4.096	0.070	4.236	5-394	5-1056	4.484	0.172	4.828	5-1056
5-390	3.957	0.147	4.251	5-390	2-048	4.739	0.070	4.879	2-048
5-395	4.117	0.070	4.257	5-395	5-843	4.674	0.103	4.880	5-843
2-242	3.984	0.139	4.262	2-242	2-247	4.609	0.139	4.887	2-247
2-344	3.850	0.210	4.270	2-344	2-349	4.475	0.210	4.895	2-349
5-986	3.725	0.275	4.275	5-986	5-840	4.630	0.139	4.908	5-840
5-833	4.085	0.103	4.291	5-833	5-842	4.664	0.122	4.908	5-842
5-396	4.171	0.070	4.311	5-396	5-1060	4.609	0.150	4.909	5-1060
5-831	4.020	0.147	4.314	5-831	2-158	4.737	0.103	4.943	2-158
2-046	4.239	0.070	4.379	2-046	5-844	4.682	0.140	4.962	5-844
2-243	4.109	0.139	4.387	2-243	5-848	4.875	0.060	4.995	5-848
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-248	4.734	0.139	5.012	2-248	5-856	5.465	0.070	5.605	5-856
2-350	4.600	0.210	5.020	2-350	5-414	5.487	0.062	5.611	5-414
2-425	4.475	0.275	5.025	2-425	5-412	5.414	0.103	5.620	5-412
5-402	4.750	0.188	5.126	5-402	2-253	5.359	0.139	5.637	2-253
2-049	4.989	0.070	5.129	2-049	2-355	5.225	0.210	5.645	2-355
5-403	4.930	0.103	5.136	5-403	2-430	5.100	0.275	5.650	2-430
2-249	4.859	0.139	5.137	2-249	5-559	5.236	0.214	5.664	5-559
2-351	4.725	0.210	5.145	2-351	5-855	5.444	0.124	5.692	5-855
2-426	4.600	0.275	5.150	2-426	2-161	5.487	0.103	5.693	2-161
2-159	4.987	0.103	5.193	2-159	5-062	5.604	0.070	5.744	5-062
2-250	4.984	0.139	5.262	2-250	2-254	5.484	0.139	5.762	2-254
2-352	4.850	0.210	5.270	2-352	2-356	5.350	0.210	5.770	2-356
2-427	4.725	0.275	5.275	2-427	2-431	5.225	0.275	5.775	2-431
5-851	4.984	0.147	5.278	5-851	5-416	5.553	0.120	5.793	5-416
2-050	5.239	0.070	5.379	2-050	5-413	5.475	0.164	5.803	5-413
2-251	5.109	0.139	5.387	2-251	5-858	5.500	0.168	5.836	5-858
2-353	4.975	0.210	5.395	2-353	5-417	5.616	0.127	5.870	5-417
2-428	4.850	0.275	5.400	2-428	2-255	5.609	0.139	5.887	2-255
2-160	5.237	0.103	5.443	2-160	5-063	5.750	0.070	5.890	5-063
5-850	4.925	0.260	5.445	5-850	2-357	5.475	0.210	5.895	2-357
5-852	5.030	0.210	5.450	5-852	2-432	5.350	0.275	5.900	2-432
5-410	5.340	0.070	5.480	5-410	2-162	5.737	0.103	5.943	2-162
5-407	5.249	0.123	5.495	5-407	2-256	5.734	0.139	6.012	2-256
2-252	5.234	0.139	5.512	2-252	2-358	5.600	0.210	6.020	2-358
2-354	5.100	0.210	5.520	2-354	2-433	5.475	0.275	6.025	2-433
5-853	5.057	0.233	5.523	5-853	5-969	5.875	0.103	6.081	5-969
2-429	4.975	0.275	5.525	2-429	5-863	5.815	0.140	6.095	5-863
5-408	5.265	0.139	5.543	5-408	5-421	5.882	0.110	6.102	5-421
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-573	5.968	0.070	6.108	5-573	2-261	6.734	0.139	7.012	2-261
5-567	5.985	0.070	6.125	5-567	2-439	6.475	0.275	7.025	2-439
2-257	5.859	0.139	6.137	2-257	2-364	6.725	0.210	7.145	2-364
2-359	5.725	0.210	6.145	2-359	2-167	6.987	0.103	7.193	2-167
2-434	5.600	0.275	6.150	2-434	2-262	6.984	0.139	7.262	2-262
2-163	5.987	0.103	6.193	2-163	2-440	6.725	0.275	7.275	2-440
5-1041	6.023	0.103	6.229	5-1041	5-691	7.139	0.072	7.283	5-691
2-258	5.984	0.139	6.262	2-258	5-696	7.110	0.103	7.316	5-696
2-360	5.850	0.210	6.270	2-360	5-873	7.230	0.070	7.370	5-873
2-435	5.725	0.275	6.275	2-435	2-365	6.975	0.210	7.395	2-365
5-862	5.789	0.252	6.293	5-862	5-871	6.850	0.275	7.400	5-871
2-361	5.975	0.210	6.395	2-361	2-168	7.237	0.103	7.443	2-168
2-436	5.850	0.275	6.400	2-436	2-263	7.234	0.139	7.512	2-263
2-164	6.237	0.103	6.443	2-164	2-441	6.975	0.275	7.525	2-441
5-420	5.826	0.314	6.454	5-420	2-366	7.225	0.210	7.645	2-366
2-259	6.234	0.139	6.512	2-259	5-434	7.108	0.275	7.658	5-434
2-437	5.975	0.275	6.525	2-437	2-169	7.487	0.103	7.693	2-169
5-428	6.361	0.108	6.577	5-428	5-438	7.613	0.070	7.753	5-438
2-362	6.225	0.210	6.645	2-362	2-264	7.484	0.139	7.762	2-264
5-666	6.520	0.070	6.660	5-666	2-442	7.225	0.275	7.775	2-442
2-165	6.487	0.103	6.693	2-165	5-439	7.640	0.125	7.890	5-439
2-260	6.484	0.139	6.762	2-260	2-367	7.475	0.210	7.895	2-367
2-438	6.225	0.275	6.775	2-438	2-170	7.737	0.103	7.943	2-170
5-430	6.482	0.170	6.822	5-430	5-975	7.425	0.260	7.945	5-975
5-869	6.609	0.139	6.887	5-869	5-875	7.580	0.210	8.000	5-875
2-363	6.475	0.210	6.895	2-363	5-877	7.802	0.104	8.010	5-877
5-064	6.350	0.275	6.900	5-064	2-265	7.734	0.139	8.012	2-265
2-166	6.737	0.103	6.943	2-166	2-443	7.475	0.275	8.025	2-443
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-876	7.674	0.210	8.094	5-876	2-447	8.975	0.275	9.525	2-447
2-368	7.725	0.210	8.145	2-368	5-635	9.370	0.103	9.576	5-635
2-171	7.987	0.103	8.193	2-171	5-882	9.162	0.210	9.582	5-882
2-266	7.984	0.139	8.262	2-266	2-374	9.225	0.210	9.645	2-374
2-444	7.725	0.275	8.275	2-444	2-177	9.487	0.103	9.693	2-177
5-442	8.015	0.187	8.389	5-442	2-272	9.484	0.139	9.762	2-272
2-369	7.975	0.210	8.395	2-369	5-454	9.565	0.103	9.771	5-454
2-172	8.237	0.103	8.443	2-172	2-375	9.475	0.210	9.895	2-375
2-267	8.234	0.139	8.512	2-267	2-178	9.737	0.103	9.943	2-178
2-445	7.975	0.275	8.525	2-445	2-273	9.734	0.139	10.012	2-273
2-370	8.225	0.210	8.645	2-370	2-448	9.475	0.275	10.025	2-448
2-173	8.487	0.103	8.693	2-173	5-883	9.820	0.103	10.026	5-883
2-268	8.484	0.139	8.762	2-268	5-884	9.984	0.070	10.124	5-884
5-445	8.277	0.275	8.827	5-445	2-376	9.725	0.210	10.145	2-376
5-971	8.590	0.139	8.868	5-971	2-274	9.984	0.139	10.262	2-274
2-371	8.475	0.210	8.895	2-371	2-377	9.975	0.210	10.395	2-377
5-880	8.350	0.275	8.900	5-880	5-886	10.178	0.112	10.402	5-886
2-174	8.737	0.103	8.943	2-174	5-885	10.171	0.139	10.449	5-885
2-269	8.734	0.139	9.012	2-269	5-457	10.232	0.139	10.510	5-457
5-575	8.875	0.070	9.015	5-575	2-449	9.975	0.275	10.525	2-449
2-446	8.475	0.275	9.025	2-446	5-889	10.372	0.104	10.580	5-889
2-372	8.725	0.210	9.145	2-372	5-458	10.340	0.139	10.618	5-458
2-175	8.987	0.103	9.193	2-175	5-165	10.359	0.139	10.637	5-165
5-450	9.071	0.062	9.195	5-450	5-463	10.504	0.125	10.754	5-463
2-270	8.984	0.139	9.262	2-270	2-275	10.484	0.139	10.762	2-275
2-373	8.975	0.210	9.395	2-373	5-464	10.656	0.070	10.796	5-464
2-176	9.237	0.103	9.443	2-176	5-890	10.606	0.103	10.812	5-890
2-271	9.234	0.139	9.512	2-271	5-656	10.702	0.070	10.842	5-656
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-887	10.343	0.275	10.893	5-887	5-901	12.234	0.139	12.512	5-901
2-378	10.475	0.210	10.895	2-378	2-453	11.975	0.275	12.525	2-453
5-623	10.630	0.139	10.908	5-623	5-485	12.260	0.139	12.538	5-485
5-976	10.425	0.260	10.945	5-976	5-484	12.250	0.150	12.550	5-484
5-891	10.734	0.139	11.012	5-891	5-486	12.299	0.137	12.573	5-486
2-450	10.475	0.275	11.025	2-450	5-164	12.160	0.210	12.580	5-164
5-893	10.945	0.071	11.087	5-893	5-480	12.017	0.285	12.587	5-480
5-469	10.883	0.103	11.089	5-469	5-487	12.380	0.139	12.658	5-487
5-466	10.749	0.210	11.169	5-466	5-488	12.463	0.103	12.669	5-488
5-894	10.996	0.103	11.202	5-894	5-569	12.475	0.139	12.753	5-569
2-276	10.984	0.139	11.262	2-276	5-902	12.360	0.210	12.780	5-902
5-471	10.995	0.149	11.293	5-471	5-906	12.705	0.070	12.845	5-906
2-379	10.975	0.210	11.395	2-379	5-905	12.623	0.140	12.903	5-905
2-451	10.975	0.275	11.525	2-451	2-454	12.475	0.275	13.025	2-454
5-898	11.335	0.103	11.541	5-898	5-908	12.840	0.139	13.118	5-908
2-277	11.484	0.139	11.762	2-277	5-619	12.915	0.139	13.193	5-619
5-474	11.331	0.275	11.881	5-474	5-611	12.900	0.159	13.218	5-611
2-380	11.475	0.210	11.895	2-380	2-279	12.984	0.139	13.262	2-279
5-650	11.570	0.210	11.990	5-650	5-907	12.725	0.275	13.275	5-907
2-452	11.475	0.275	12.025	2-452	5-570	13.002	0.139	13.280	5-570
5-069	11.750	0.139	12.028	5-069	2-382	12.975	0.210	13.395	2-382
5-476	11.562	0.275	12.112	5-476	2-455	12.975	0.275	13.525	2-455
5-478	11.860	0.139	12.138	5-478	5-492	13.248	0.139	13.526	5-492
2-278	11.984	0.139	12.262	2-278	5-070	13.270	0.139	13.548	5-070
5-576	12.000	0.159	12.318	5-576	5-071	13.410	0.139	13.688	5-071
5-900	12.000	0.187	12.374	5-900	5-493	13.490	0.139	13.768	5-493
5-482	12.109	0.139	12.387	5-482	5-910	13.375	0.210	13.795	5-910
2-381	11.975	0.210	12.395	2-381	5-495	13.601	0.139	13.879	5-495
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
5-072	13.460	0.210	13.880	5-072	5-922	14.990	0.104	15.198	5-922
5-496	13.616	0.141	13.898	5-496	2-281	14.984	0.139	15.262	2-281
5-498	13.650	0.139	13.928	5-498	5-923	15.062	0.104	15.270	5-923
5-1097	13.750	0.103	13.956	5-1097	2-384	14.975	0.210	15.395	2-384
5-494	13.541	0.210	13.961	5-494	5-512	15.171	0.139	15.449	5-512
5-912	13.734	0.139	14.012	5-912	2-459	14.975	0.275	15.525	2-459
2-456	13.475	0.275	14.025	2-456	5-077	15.300	0.139	15.578	5-077
5-073	13.820	0.139	14.098	5-073	5-076	15.260	0.210	15.680	5-076
2-280	13.984	0.139	14.262	2-280	5-079	15.540	0.139	15.818	5-079
5-500	13.718	0.275	14.268	5-500	5-924	15.410	0.210	15.830	5-924
5-564	14.062	0.139	14.340	5-564	5-925	15.465	0.188	15.841	5-925
5-624	14.111	0.139	14.389	5-624	5-515	15.548	0.210	15.968	5-515
2-383	13.975	0.210	14.395	2-383	5-516	15.740	0.139	16.018	5-516
5-502	14.088	0.210	14.508	5-502	5-1099	16.014	0.102	16.218	5-1099
5-074	14.234	0.139	14.512	5-074	2-282	15.955	0.139	16.233	2-282
2-457	13.975	0.275	14.525	2-457	5-517	15.750	0.275	16.300	5-517
5-626	14.470	0.087	14.644	5-626	2-385	15.955	0.210	16.375	2-385
5-504	14.430	0.139	14.708	5-504	2-461	15.955	0.275	16.505	2-461
5-505	14.470	0.139	14.748	5-505	5-571	16.234	0.139	16.512	5-571
5-506	14.570	0.141	14.852	5-506	5-518	16.031	0.256	16.543	5-518
5-916	14.369	0.278	14.925	5-916	5-520	16.435	0.139	16.713	5-520
5-921	14.795	0.071	14.937	5-921	5-930	16.285	0.250	16.785	5-930
5-508	14.674	0.139	14.952	5-508	5-521	16.455	0.210	16.875	5-521
5-166	14.722	0.139	15.000	5-166	5-080	16.575	0.187	16.949	5-080
5-507	14.600	0.210	15.020	5-507	5-522	16.507	0.225	16.957	5-522
2-458	14.475	0.275	15.025	2-458	2-462	16.455	0.275	17.005	2-462
2-460	14.475	0.275	15.025	2-460	5-525	16.765	0.125	17.015	5-525
5-920	14.780	0.175	15.130	5-920	5-524	16.640	0.210	17.060	5-524
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:
2-283	16.955	0.139	17.233	2-283	2-466	18.455	0.275	19.005	2-466
5-081	16.830	0.210	17.250	5-081	5-944	18.880	0.139	19.158	5-944
5-622	16.750	0.275	17.300	5-622	2-388	18.955	0.210	19.375	2-388
2-386	16.955	0.210	17.375	2-386	5-943	18.870	0.275	19.420	5-943
2-463	16.955	0.275	17.505	2-463	2-467	18.955	0.275	19.505	2-467
5-526	17.250	0.187	17.624	5-526	5-946	19.310	0.140	19.590	5-946
5-935	17.100	0.275	17.650	5-935	5-947	19.380	0.139	19.658	5-947
5-937	17.390	0.139	17.668	5-937	5-541	19.500	0.250	20.000	5-541
5-936	17.296	0.210	17.716	5-936	5-086	19.580	0.210	20.000	5-086
5-082	17.250	0.240	17.730	5-082	2-468	19.455	0.275	20.005	2-468
5-529	17.455	0.139	17.733	5-529	5-948	19.725	0.210	20.145	5-948
5-528	17.268	0.242	17.752	5-528	5-540	19.437	0.375	20.187	5-540
5-1100	17.500	0.139	17.778	5-1100	5-950	19.960	0.139	20.238	5-950
2-464	17.455	0.275	18.005	2-464	2-389	19.955	0.210	20.375	2-389
5-083	17.910	0.139	18.188	5-083	5-1019	20.180	0.125	20.430	5-1019
5-532	18.000	0.103	18.206	5-532	2-469	19.955	0.275	20.505	2-469
2-284	17.955	0.139	18.233	2-284	5-1022	19.941	0.289	20.519	5-1022
5-621	17.875	0.187	18.249	5-621	5-087	20.020	0.275	20.570	5-087
5-939	17.870	0.210	18.290	5-939	5-1010	20.609	0.139	20.887	5-1010
5-533	18.169	0.096	18.361	5-533	2-390	20.955	0.210	21.375	2-390
2-387	17.955	0.210	18.375	2-387	5-088	21.180	0.147	21.474	5-088
2-465	17.955	0.275	18.505	2-465	2-470	20.955	0.275	21.505	2-470
5-084	18.062	0.281	18.624	5-084	5-547	21.564	0.139	21.842	5-547
5-1102	18.265	0.210	18.685	5-1102	2-391	21.955	0.210	22.375	2-391
5-085	18.350	0.210	18.770	5-085	2-471	21.955	0.275	22.505	2-471
5-534	18.405	0.210	18.825	5-534	5-953	22.360	0.132	22.624	5-953
5-1104	18.500	0.188	18.876	5-1104	5-549	22.500	0.250	23.000	5-549
5-1105	18.635	0.139	18.913	5-1105	2-392	22.940	0.210	23.360	2-392
Dash No:	ID	W	OD	Dash No:	Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:
2-472	22.940	0.275	23.490	2-472
5-551	23.540	0.139	23.818	5-551
5-090	23.576	0.139	23.854	5-090
5-089	23.406	0.281	23.968	5-089
5-552	23.612	0.275	24.162	5-552
2-393	23.940	0.210	24.360	2-393
2-473	23.940	0.275	24.490	2-473
5-167	23.780	0.375	24.530	5-167
2-394	24.940	0.210	25.360	2-394
5-168	24.875	0.250	25.375	5-168
2-474	24.940	0.275	25.490	2-474
5-169	25.153	0.214	25.581	5-169
5-091	25.474	0.139	25.752	5-091
5-170	25.500	0.275	26.050	5-170
2-395	25.940	0.210	26.360	2-395
2-475	25.940	0.275	26.490	2-475
5-173	26.188	0.210	26.608	5-173
5-171	26.125	0.275	26.675	5-171
5-631	26.408	0.139	26.686	5-631
5-172	27.485	0.275	28.035	5-172
5-092	27.625	0.275	28.175	5-092
5-955	28.801	0.275	29.351	5-955
Dash No:	ID	W	OD	Dash No:

Appendix C -- O-Ring Sizes Sorted by ID:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-955	28.801	0.275	29.351	5-955		5-547	21.564	0.139	21.842	5-547
5-092	27.625	0.275	28.175	5-092		5-088	21.180	0.147	21.474	5-088
5-172	27.485	0.275	28.035	5-172		2-390	20.955	0.210	21.375	2-390
5-631	26.408	0.139	26.686	5-631		2-470	20.955	0.275	21.505	2-470
5-173	26.188	0.210	26.608	5-173		5-1010	20.609	0.139	20.887	5-1010
5-171	26.125	0.275	26.675	5-171		5-1019	20.180	0.125	20.430	5-1019
2-395	25.940	0.210	26.360	2-395		5-087	20.020	0.275	20.570	5-087
2-475	25.940	0.275	26.490	2-475		5-950	19.960	0.139	20.238	5-950
5-170	25.500	0.275	26.050	5-170		2-389	19.955	0.210	20.375	2-389
5-091	25.474	0.139	25.752	5-091		2-469	19.955	0.275	20.505	2-469
5-169	25.153	0.214	25.581	5-169		5-1022	19.941	0.289	20.519	5-1022
2-394	24.940	0.210	25.360	2-394		5-948	19.725	0.210	20.145	5-948
2-474	24.940	0.275	25.490	2-474		5-086	19.580	0.210	20.000	5-086
5-168	24.875	0.250	25.375	5-168		5-541	19.500	0.250	20.000	5-541
2-393	23.940	0.210	24.360	2-393		2-468	19.455	0.275	20.005	2-468
2-473	23.940	0.275	24.490	2-473		5-540	19.437	0.375	20.187	5-540
5-167	23.780	0.375	24.530	5-167		5-947	19.380	0.139	19.658	5-947
5-552	23.612	0.275	24.162	5-552		5-946	19.310	0.140	19.590	5-946
5-090	23.576	0.139	23.854	5-090		2-388	18.955	0.210	19.375	2-388
5-551	23.540	0.139	23.818	5-551		2-467	18.955	0.275	19.505	2-467
5-089	23.406	0.281	23.968	5-089		5-944	18.880	0.139	19.158	5-944
2-392	22.940	0.210	23.360	2-392		5-943	18.870	0.275	19.420	5-943
2-472	22.940	0.275	23.490	2-472		5-1105	18.635	0.139	18.913	5-1105
5-549	22.500	0.250	23.000	5-549		5-1104	18.500	0.188	18.876	5-1104
5-953	22.360	0.132	22.624	5-953		2-466	18.455	0.275	19.005	2-466
2-391	21.955	0.210	22.375	2-391		5-534	18.405	0.210	18.825	5-534
2-471	21.955	0.275	22.505	2-471		5-085	18.350	0.210	18.770	5-085
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-1102	18.265	0.210	18.685	5-1102		5-521	16.455	0.210	16.875	5-521
5-533	18.169	0.096	18.361	5-533		2-462	16.455	0.275	17.005	2-462
5-084	18.062	0.281	18.624	5-084		5-520	16.435	0.139	16.713	5-520
5-532	18.000	0.103	18.206	5-532		5-930	16.285	0.250	16.785	5-930
2-284	17.955	0.139	18.233	2-284		5-571	16.234	0.139	16.512	5-571
2-387	17.955	0.210	18.375	2-387		5-518	16.031	0.256	16.543	5-518
2-465	17.955	0.275	18.505	2-465		5-1099	16.014	0.102	16.218	5-1099
5-083	17.910	0.139	18.188	5-083		2-282	15.955	0.139	16.233	2-282
5-621	17.875	0.187	18.249	5-621		2-385	15.955	0.210	16.375	2-385
5-939	17.870	0.210	18.290	5-939		2-461	15.955	0.275	16.505	2-461
5-1100	17.500	0.139	17.778	5-1100		5-517	15.750	0.275	16.300	5-517
5-529	17.455	0.139	17.733	5-529		5-516	15.740	0.139	16.018	5-516
2-464	17.455	0.275	18.005	2-464		5-515	15.548	0.210	15.968	5-515
5-937	17.390	0.139	17.668	5-937		5-079	15.540	0.139	15.818	5-079
5-936	17.296	0.210	17.716	5-936		5-925	15.465	0.188	15.841	5-925
5-528	17.268	0.242	17.752	5-528		5-924	15.410	0.210	15.830	5-924
5-526	17.250	0.187	17.624	5-526		5-077	15.300	0.139	15.578	5-077
5-082	17.250	0.240	17.730	5-082		5-076	15.260	0.210	15.680	5-076
5-935	17.100	0.275	17.650	5-935		5-512	15.171	0.139	15.449	5-512
2-283	16.955	0.139	17.233	2-283		5-923	15.062	0.104	15.270	5-923
2-386	16.955	0.210	17.375	2-386		5-922	14.990	0.104	15.198	5-922
2-463	16.955	0.275	17.505	2-463		2-281	14.984	0.139	15.262	2-281
5-081	16.830	0.210	17.250	5-081		2-384	14.975	0.210	15.395	2-384
5-525	16.765	0.125	17.015	5-525		2-459	14.975	0.275	15.525	2-459
5-622	16.750	0.275	17.300	5-622		5-921	14.795	0.071	14.937	5-921
5-524	16.640	0.210	17.060	5-524		5-920	14.780	0.175	15.130	5-920
5-080	16.575	0.187	16.949	5-080		5-166	14.722	0.139	15.000	5-166
5-522	16.507	0.225	16.957	5-522		5-508	14.674	0.139	14.952	5-508
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-507	14.600	0.210	15.020	5-507		5-070	13.270	0.139	13.548	5-070
5-506	14.570	0.141	14.852	5-506		5-492	13.248	0.139	13.526	5-492
2-458	14.475	0.275	15.025	2-458		5-570	13.002	0.139	13.280	5-570
2-460	14.475	0.275	15.025	2-460		2-279	12.984	0.139	13.262	2-279
5-626	14.470	0.087	14.644	5-626		2-382	12.975	0.210	13.395	2-382
5-505	14.470	0.139	14.748	5-505		2-455	12.975	0.275	13.525	2-455
5-504	14.430	0.139	14.708	5-504		5-619	12.915	0.139	13.193	5-619
5-916	14.369	0.278	14.925	5-916		5-611	12.900	0.159	13.218	5-611
5-074	14.234	0.139	14.512	5-074		5-908	12.840	0.139	13.118	5-908
5-624	14.111	0.139	14.389	5-624		5-907	12.725	0.275	13.275	5-907
5-502	14.088	0.210	14.508	5-502		5-906	12.705	0.070	12.845	5-906
5-564	14.062	0.139	14.340	5-564		5-905	12.623	0.140	12.903	5-905
2-280	13.984	0.139	14.262	2-280		5-569	12.475	0.139	12.753	5-569
2-383	13.975	0.210	14.395	2-383		2-454	12.475	0.275	13.025	2-454
2-457	13.975	0.275	14.525	2-457		5-488	12.463	0.103	12.669	5-488
5-073	13.820	0.139	14.098	5-073		5-487	12.380	0.139	12.658	5-487
5-1097	13.750	0.103	13.956	5-1097		5-902	12.360	0.210	12.780	5-902
5-912	13.734	0.139	14.012	5-912		5-486	12.299	0.137	12.573	5-486
5-500	13.718	0.275	14.268	5-500		5-485	12.260	0.139	12.538	5-485
5-498	13.650	0.139	13.928	5-498		5-484	12.250	0.150	12.550	5-484
5-496	13.616	0.141	13.898	5-496		5-901	12.234	0.139	12.512	5-901
5-495	13.601	0.139	13.879	5-495		5-164	12.160	0.210	12.580	5-164
5-494	13.541	0.210	13.961	5-494		5-482	12.109	0.139	12.387	5-482
5-493	13.490	0.139	13.768	5-493		5-480	12.017	0.285	12.587	5-480
2-456	13.475	0.275	14.025	2-456		5-576	12.000	0.159	12.318	5-576
5-072	13.460	0.210	13.880	5-072		5-900	12.000	0.187	12.374	5-900
5-071	13.410	0.139	13.688	5-071		2-278	11.984	0.139	12.262	2-278
5-910	13.375	0.210	13.795	5-910		2-381	11.975	0.210	12.395	2-381
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
2-453	11.975	0.275	12.525	2-453		5-889	10.372	0.104	10.580	5-889
5-478	11.860	0.139	12.138	5-478		5-165	10.359	0.139	10.637	5-165
5-069	11.750	0.139	12.028	5-069		5-887	10.343	0.275	10.893	5-887
5-650	11.570	0.210	11.990	5-650		5-458	10.340	0.139	10.618	5-458
5-476	11.562	0.275	12.112	5-476		5-457	10.232	0.139	10.510	5-457
2-277	11.484	0.139	11.762	2-277		5-886	10.178	0.112	10.402	5-886
2-380	11.475	0.210	11.895	2-380		5-885	10.171	0.139	10.449	5-885
2-452	11.475	0.275	12.025	2-452		5-884	9.984	0.070	10.124	5-884
5-898	11.335	0.103	11.541	5-898		2-274	9.984	0.139	10.262	2-274
5-474	11.331	0.275	11.881	5-474		2-377	9.975	0.210	10.395	2-377
5-894	10.996	0.103	11.202	5-894		2-449	9.975	0.275	10.525	2-449
5-471	10.995	0.149	11.293	5-471		5-883	9.820	0.103	10.026	5-883
2-276	10.984	0.139	11.262	2-276		2-178	9.737	0.103	9.943	2-178
2-379	10.975	0.210	11.395	2-379		2-273	9.734	0.139	10.012	2-273
2-451	10.975	0.275	11.525	2-451		2-376	9.725	0.210	10.145	2-376
5-893	10.945	0.071	11.087	5-893		5-454	9.565	0.103	9.771	5-454
5-469	10.883	0.103	11.089	5-469		2-177	9.487	0.103	9.693	2-177
5-466	10.749	0.210	11.169	5-466		2-272	9.484	0.139	9.762	2-272
5-891	10.734	0.139	11.012	5-891		2-375	9.475	0.210	9.895	2-375
5-656	10.702	0.070	10.842	5-656		2-448	9.475	0.275	10.025	2-448
5-464	10.656	0.070	10.796	5-464		5-635	9.370	0.103	9.576	5-635
5-623	10.630	0.139	10.908	5-623		2-176	9.237	0.103	9.443	2-176
5-890	10.606	0.103	10.812	5-890		2-271	9.234	0.139	9.512	2-271
5-463	10.504	0.125	10.754	5-463		2-374	9.225	0.210	9.645	2-374
2-275	10.484	0.139	10.762	2-275		5-882	9.162	0.210	9.582	5-882
2-378	10.475	0.210	10.895	2-378		5-450	9.071	0.062	9.195	5-450
2-450	10.475	0.275	11.025	2-450		2-175	8.987	0.103	9.193	2-175
5-976	10.425	0.260	10.945	5-976		2-270	8.984	0.139	9.262	2-270
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
2-373	8.975	0.210	9.395	2-373		5-438	7.613	0.070	7.753	5-438
2-447	8.975	0.275	9.525	2-447		5-875	7.580	0.210	8.000	5-875
5-575	8.875	0.070	9.015	5-575		2-169	7.487	0.103	7.693	2-169
2-174	8.737	0.103	8.943	2-174		2-264	7.484	0.139	7.762	2-264
2-269	8.734	0.139	9.012	2-269		2-367	7.475	0.210	7.895	2-367
2-372	8.725	0.210	9.145	2-372		2-443	7.475	0.275	8.025	2-443
5-971	8.590	0.139	8.868	5-971		5-975	7.425	0.260	7.945	5-975
2-173	8.487	0.103	8.693	2-173		2-168	7.237	0.103	7.443	2-168
2-268	8.484	0.139	8.762	2-268		2-263	7.234	0.139	7.512	2-263
2-371	8.475	0.210	8.895	2-371		5-873	7.230	0.070	7.370	5-873
2-446	8.475	0.275	9.025	2-446		2-366	7.225	0.210	7.645	2-366
5-880	8.350	0.275	8.900	5-880		2-442	7.225	0.275	7.775	2-442
5-445	8.277	0.275	8.827	5-445		5-691	7.139	0.072	7.283	5-691
2-172	8.237	0.103	8.443	2-172		5-696	7.110	0.103	7.316	5-696
2-267	8.234	0.139	8.512	2-267		5-434	7.108	0.275	7.658	5-434
2-370	8.225	0.210	8.645	2-370		2-167	6.987	0.103	7.193	2-167
5-442	8.015	0.187	8.389	5-442		2-262	6.984	0.139	7.262	2-262
2-171	7.987	0.103	8.193	2-171		2-365	6.975	0.210	7.395	2-365
2-266	7.984	0.139	8.262	2-266		2-441	6.975	0.275	7.525	2-441
2-369	7.975	0.210	8.395	2-369		5-871	6.850	0.275	7.400	5-871
2-445	7.975	0.275	8.525	2-445		2-166	6.737	0.103	6.943	2-166
5-877	7.802	0.104	8.010	5-877		2-261	6.734	0.139	7.012	2-261
2-170	7.737	0.103	7.943	2-170		2-364	6.725	0.210	7.145	2-364
2-265	7.734	0.139	8.012	2-265		2-440	6.725	0.275	7.275	2-440
2-368	7.725	0.210	8.145	2-368		5-869	6.609	0.139	6.887	5-869
2-444	7.725	0.275	8.275	2-444		5-666	6.520	0.070	6.660	5-666
5-876	7.674	0.210	8.094	5-876		2-165	6.487	0.103	6.693	2-165
5-439	7.640	0.125	7.890	5-439		2-260	6.484	0.139	6.762	2-260
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-430	6.482	0.170	6.822	5-430		2-435	5.725	0.275	6.275	2-435
2-363	6.475	0.210	6.895	2-363		5-417	5.616	0.127	5.870	5-417
2-439	6.475	0.275	7.025	2-439		2-255	5.609	0.139	5.887	2-255
5-428	6.361	0.108	6.577	5-428		5-062	5.604	0.070	5.744	5-062
5-064	6.350	0.275	6.900	5-064		2-358	5.600	0.210	6.020	2-358
2-164	6.237	0.103	6.443	2-164		2-434	5.600	0.275	6.150	2-434
2-259	6.234	0.139	6.512	2-259		5-416	5.553	0.120	5.793	5-416
2-362	6.225	0.210	6.645	2-362		5-858	5.500	0.168	5.836	5-858
2-438	6.225	0.275	6.775	2-438		5-414	5.487	0.062	5.611	5-414
5-1041	6.023	0.103	6.229	5-1041		2-161	5.487	0.103	5.693	2-161
2-163	5.987	0.103	6.193	2-163		2-254	5.484	0.139	5.762	2-254
5-567	5.985	0.070	6.125	5-567		5-413	5.475	0.164	5.803	5-413
2-258	5.984	0.139	6.262	2-258		2-357	5.475	0.210	5.895	2-357
2-361	5.975	0.210	6.395	2-361		2-433	5.475	0.275	6.025	2-433
2-437	5.975	0.275	6.525	2-437		5-856	5.465	0.070	5.605	5-856
5-573	5.968	0.070	6.108	5-573		5-855	5.444	0.124	5.692	5-855
5-421	5.882	0.110	6.102	5-421		5-412	5.414	0.103	5.620	5-412
5-969	5.875	0.103	6.081	5-969		2-253	5.359	0.139	5.637	2-253
2-257	5.859	0.139	6.137	2-257		2-356	5.350	0.210	5.770	2-356
2-360	5.850	0.210	6.270	2-360		2-432	5.350	0.275	5.900	2-432
2-436	5.850	0.275	6.400	2-436		5-410	5.340	0.070	5.480	5-410
5-420	5.826	0.314	6.454	5-420		5-408	5.265	0.139	5.543	5-408
5-863	5.815	0.140	6.095	5-863		5-407	5.249	0.123	5.495	5-407
5-862	5.789	0.252	6.293	5-862		2-050	5.239	0.070	5.379	2-050
5-063	5.750	0.070	5.890	5-063		2-160	5.237	0.103	5.443	2-160
2-162	5.737	0.103	5.943	2-162		5-559	5.236	0.214	5.664	5-559
2-256	5.734	0.139	6.012	2-256		2-252	5.234	0.139	5.512	2-252
2-359	5.725	0.210	6.145	2-359		2-355	5.225	0.210	5.645	2-355
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
2-431	5.225	0.275	5.775	2-431		2-247	4.609	0.139	4.887	2-247
2-251	5.109	0.139	5.387	2-251		5-1060	4.609	0.150	4.909	5-1060
2-354	5.100	0.210	5.520	2-354		2-350	4.600	0.210	5.020	2-350
2-430	5.100	0.275	5.650	2-430		2-426	4.600	0.275	5.150	2-426
5-853	5.057	0.233	5.523	5-853		5-401	4.531	0.070	4.671	5-401
5-852	5.030	0.210	5.450	5-852		2-047	4.489	0.070	4.629	2-047
2-049	4.989	0.070	5.129	2-049		2-157	4.487	0.103	4.693	2-157
2-159	4.987	0.103	5.193	2-159		2-246	4.484	0.139	4.762	2-246
2-250	4.984	0.139	5.262	2-250		5-1056	4.484	0.172	4.828	5-1056
5-851	4.984	0.147	5.278	5-851		2-349	4.475	0.210	4.895	2-349
2-353	4.975	0.210	5.395	2-353		2-425	4.475	0.275	5.025	2-425
2-429	4.975	0.275	5.525	2-429		5-836	4.427	0.140	4.707	5-836
5-403	4.930	0.103	5.136	5-403		5-060	4.390	0.044	4.478	5-060
5-850	4.925	0.260	5.445	5-850		2-245	4.359	0.139	4.637	2-245
5-848	4.875	0.060	4.995	5-848		2-348	4.350	0.210	4.770	2-348
2-249	4.859	0.139	5.137	2-249		2-046	4.239	0.070	4.379	2-046
2-352	4.850	0.210	5.270	2-352		2-156	4.237	0.103	4.443	2-156
2-428	4.850	0.275	5.400	2-428		2-244	4.234	0.139	4.512	2-244
5-402	4.750	0.188	5.126	5-402		2-347	4.225	0.210	4.645	2-347
2-048	4.739	0.070	4.879	2-048		5-989	4.225	0.275	4.775	5-989
2-158	4.737	0.103	4.943	2-158		5-396	4.171	0.070	4.311	5-396
2-248	4.734	0.139	5.012	2-248		5-395	4.117	0.070	4.257	5-395
2-351	4.725	0.210	5.145	2-351		2-243	4.109	0.139	4.387	2-243
2-427	4.725	0.275	5.275	2-427		2-346	4.100	0.210	4.520	2-346
5-844	4.682	0.140	4.962	5-844		5-988	4.100	0.275	4.650	5-988
5-843	4.674	0.103	4.880	5-843		5-394	4.096	0.070	4.236	5-394
5-842	4.664	0.122	4.908	5-842		5-833	4.085	0.103	4.291	5-833
5-840	4.630	0.139	4.908	5-840		5-1054	4.080	0.209	4.498	5-1054
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-831	4.020	0.147	4.314	5-831		5-1053	3.354	0.070	3.494	5-1053
2-045	3.989	0.070	4.129	2-045		2-340	3.350	0.210	3.770	2-340
2-155	3.987	0.103	4.193	2-155		5-825	3.350	0.275	3.900	5-825
2-242	3.984	0.139	4.262	2-242		5-821	3.300	0.070	3.440	5-821
2-345	3.975	0.210	4.395	2-345		2-042	3.239	0.070	3.379	2-042
5-987	3.975	0.275	4.525	5-987		2-152	3.237	0.103	3.443	2-152
5-390	3.957	0.147	4.251	5-390		2-236	3.234	0.139	3.512	2-236
2-241	3.859	0.139	4.137	2-241		2-339	3.225	0.210	3.645	2-339
2-344	3.850	0.210	4.270	2-344		5-984	3.225	0.275	3.775	5-984
2-044	3.739	0.070	3.879	2-044		5-819	3.210	0.103	3.416	5-819
2-154	3.737	0.103	3.943	2-154		5-816	3.162	0.070	3.302	5-816
2-240	3.734	0.139	4.012	2-240		5-045	3.161	0.139	3.439	5-045
2-343	3.725	0.210	4.145	2-343		5-815	3.156	0.060	3.276	5-815
5-986	3.725	0.275	4.275	5-986		5-813	3.130	0.100	3.330	5-813
5-828	3.661	0.090	3.841	5-828		5-557	3.125	0.103	3.331	5-557
5-031	3.640	0.125	3.890	5-031		5-374	3.112	0.070	3.252	5-374
2-239	3.609	0.139	3.887	2-239		2-235	3.109	0.139	3.387	2-235
5-385	3.603	0.220	4.043	5-385		2-338	3.100	0.210	3.520	2-338
2-342	3.600	0.210	4.020	2-342		5-1052	3.080	0.111	3.302	5-1052
5-985	3.600	0.275	4.150	5-985		5-811	3.060	0.112	3.284	5-811
2-043	3.489	0.070	3.629	2-043		5-810	3.041	0.062	3.165	5-810
2-153	3.487	0.103	3.693	2-153		5-369	3.037	0.103	3.243	5-369
2-238	3.484	0.139	3.762	2-238		5-044	3.036	0.139	3.314	5-044
2-341	3.475	0.210	3.895	2-341		5-368	3.020	0.103	3.226	5-368
5-381	3.475	0.275	4.025	5-381		2-041	2.989	0.070	3.129	2-041
5-979	3.443	0.275	3.993	5-979		2-151	2.987	0.103	3.193	2-151
5-380	3.363	0.155	3.673	5-380		2-234	2.984	0.139	3.262	2-234
2-237	3.359	0.139	3.637	2-237		2-337	2.975	0.210	3.395	2-337
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-938	2.975	0.275	3.525	5-938		5-355	2.524	0.103	2.730	5-355
5-705	2.937	0.139	3.215	5-705		2-037	2.489	0.070	2.629	2-037
5-367	2.924	0.103	3.130	5-367		2-144	2.487	0.103	2.693	2-144
5-697	2.878	0.080	3.038	5-697		2-230	2.484	0.139	2.762	2-230
2-040	2.864	0.070	3.004	2-040		2-333	2.475	0.210	2.895	2-333
2-150	2.862	0.103	3.068	2-150		5-354	2.471	0.070	2.611	5-354
2-233	2.859	0.139	3.137	2-233		2-143	2.425	0.103	2.631	2-143
2-336	2.850	0.210	3.270	2-336		5-039	2.411	0.139	2.689	5-039
5-042	2.846	0.139	3.124	5-042		2-036	2.364	0.070	2.504	2-036
5-704	2.812	0.139	3.090	5-704		2-142	2.362	0.103	2.568	2-142
2-149	2.800	0.103	3.006	2-149		2-229	2.359	0.139	2.637	2-229
5-807	2.782	0.103	2.988	5-807		2-332	2.350	0.210	2.770	2-332
2-039	2.739	0.070	2.879	2-039		3-932	2.337	0.118	2.573	3-932
2-148	2.737	0.103	2.943	2-148		5-702	2.312	0.139	2.590	5-702
2-232	2.734	0.139	3.012	2-232		2-141	2.300	0.103	2.506	2-141
2-335	2.725	0.210	3.145	2-335		5-015	2.296	0.080	2.456	5-015
5-982	2.725	0.275	3.275	5-982		5-1047	2.281	0.093	2.467	5-1047
5-159	2.683	0.115	2.913	5-159		2-035	2.239	0.070	2.379	2-035
2-147	2.675	0.103	2.881	2-147		2-140	2.237	0.103	2.443	2-140
5-361	2.671	0.139	2.949	5-361		2-228	2.234	0.139	2.512	2-228
2-038	2.614	0.070	2.754	2-038		5-014	2.230	0.080	2.390	5-014
2-146	2.612	0.103	2.818	2-146		2-331	2.225	0.210	2.645	2-331
2-231	2.609	0.139	2.887	2-231		5-800	2.225	0.275	2.775	5-800
2-334	2.600	0.210	3.020	2-334		2-139	2.175	0.103	2.381	2-139
5-358	2.576	0.082	2.740	5-358		5-348	2.172	0.070	2.312	5-348
5-703	2.563	0.139	2.841	5-703		5-347	2.163	0.062	2.287	5-347
2-145	2.550	0.103	2.756	2-145		5-145	2.141	0.047	2.235	5-145
5-805	2.535	0.070	2.675	5-805		5-027	2.140	0.125	2.390	5-027
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-1046	2.140	0.315	2.770	5-1046		2-225	1.859	0.139	2.137	2-225
2-034	2.114	0.070	2.254	2-034		5-795	1.850	0.070	1.990	5-795
2-138	2.112	0.103	2.318	2-138		2-328	1.850	0.210	2.270	2-328
2-227	2.109	0.139	2.387	2-227		5-981	1.850	0.275	2.400	5-981
2-330	2.100	0.210	2.520	2-330		5-1042	1.817	0.257	2.331	5-1042
3-928	2.090	0.118	2.326	3-928		5-794	1.812	0.070	1.952	5-794
5-1044	2.060	0.139	2.338	5-1044		5-335	1.802	0.062	1.926	5-335
5-642	2.051	0.070	2.191	5-642		2-133	1.799	0.103	2.005	2-133
2-137	2.050	0.103	2.256	2-137		5-1023	1.788	0.070	1.928	5-1023
5-346	2.046	0.139	2.324	5-346		5-035	1.786	0.139	2.064	5-035
5-037	2.036	0.139	2.314	5-037		5-025	1.765	0.125	2.015	5-025
5-655	2.020	0.070	2.160	5-655		2-031	1.739	0.070	1.879	2-031
5-343	2.000	0.075	2.150	5-343		2-132	1.737	0.103	1.943	2-132
2-033	1.989	0.070	2.129	2-033		2-224	1.734	0.139	2.012	2-224
2-136	1.987	0.103	2.193	2-136		2-327	1.725	0.210	2.145	2-327
2-226	1.984	0.139	2.262	2-226		3-924	1.720	0.118	1.956	3-924
5-342	1.980	0.038	2.056	5-342		5-332	1.687	0.139	1.965	5-332
2-329	1.975	0.210	2.395	2-329		5-671	1.680	0.080	1.840	5-671
5-701	1.937	0.139	2.215	5-701		2-131	1.674	0.103	1.880	2-131
2-135	1.925	0.103	2.131	2-135		5-330	1.674	0.210	2.094	5-330
5-338	1.925	0.210	2.345	5-338		5-1018	1.671	0.139	1.949	5-1018
5-796	1.913	0.070	2.053	5-796		5-143	1.670	0.047	1.764	5-143
5-144	1.891	0.047	1.985	5-144		5-329	1.670	0.070	1.810	5-329
5-1043	1.882	0.118	2.118	5-1043		5-327	1.640	0.139	1.918	5-327
5-337	1.873	0.062	1.997	5-337		2-030	1.614	0.070	1.754	2-030
2-032	1.864	0.070	2.004	2-032		2-130	1.612	0.103	1.818	2-130
2-134	1.862	0.103	2.068	2-134		2-223	1.609	0.139	1.887	2-223
5-011	1.860	0.080	2.020	5-011		2-326	1.600	0.210	2.020	2-326
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-788	1.591	0.071	1.733	5-788		3-918	1.355	0.116	1.587	3-918
5-321	1.559	0.139	1.837	5-321		2-324	1.350	0.210	1.770	2-324
5-034	1.559	0.139	1.837	5-034		5-604	1.342	0.141	1.624	5-604
5-009	1.553	0.080	1.713	5-009		5-157	1.338	0.092	1.522	5-157
5-158	1.550	0.092	1.734	5-158		2-027	1.301	0.070	1.441	2-027
2-129	1.549	0.103	1.755	2-129		2-125	1.299	0.103	1.505	2-125
5-320	1.540	0.070	1.680	5-320		2-219	1.296	0.139	1.574	2-219
5-024	1.515	0.125	1.765	5-024		2-323	1.287	0.210	1.707	2-323
2-029	1.489	0.070	1.629	2-029		5-603	1.279	0.141	1.561	5-603
2-128	1.487	0.103	1.693	2-128		5-301	1.259	0.092	1.443	5-301
2-222	1.484	0.139	1.762	2-222		2-026	1.239	0.070	1.379	2-026
3-920	1.475	0.118	1.711	3-920		2-124	1.237	0.103	1.443	2-124
2-325	1.475	0.210	1.895	2-325		2-218	1.234	0.139	1.512	2-218
5-980	1.475	0.275	2.025	5-980		5-297	1.230	0.197	1.624	5-297
5-606	1.468	0.141	1.750	5-606		5-296	1.229	0.070	1.369	5-296
5-657	1.465	0.103	1.671	5-657		5-141	1.226	0.031	1.288	5-141
5-312	1.454	0.105	1.664	5-312		2-322	1.225	0.210	1.645	2-322
5-142	1.450	0.047	1.544	5-142		5-295	1.225	0.275	1.775	5-295
5-670	1.437	0.070	1.577	5-670		5-294	1.213	0.149	1.511	5-294
5-309	1.436	0.063	1.562	5-309		5-602	1.212	0.141	1.494	5-602
2-127	1.424	0.103	1.630	2-127		5-1028	1.190	0.250	1.690	5-1028
5-008	1.421	0.080	1.581	5-008		5-291	1.186	0.070	1.326	5-291
2-221	1.421	0.139	1.699	2-221		5-290	1.180	0.210	1.600	5-290
5-780	1.412	0.073	1.558	5-780		2-025	1.176	0.070	1.316	2-025
5-605	1.401	0.141	1.683	5-605		5-769	1.176	0.183	1.542	5-769
2-028	1.364	0.070	1.504	2-028		2-123	1.174	0.103	1.380	2-123
2-126	1.362	0.103	1.568	2-126		3-916	1.171	0.116	1.403	3-916
2-220	1.359	0.139	1.637	2-220		2-217	1.171	0.139	1.449	2-217
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
2-321	1.162	0.210	1.582	2-321		5-598	0.968	0.141	1.250	5-598
5-601	1.153	0.141	1.435	5-601		2-021	0.926	0.070	1.066	2-021
2-024	1.114	0.070	1.254	2-024		2-119	0.924	0.103	1.130	2-119
5-140	1.112	0.031	1.174	5-140		3-912	0.924	0.116	1.156	3-912
2-122	1.112	0.103	1.318	2-122		2-213	0.921	0.139	1.199	2-213
2-216	1.109	0.139	1.387	2-216		2-317	0.912	0.210	1.332	2-317
2-320	1.100	0.210	1.520	2-320		5-597	0.905	0.141	1.187	5-597
5-600	1.094	0.141	1.376	5-600		5-138	0.898	0.031	0.960	5-138
5-763	1.080	0.050	1.180	5-763		5-022	0.890	0.125	1.140	5-022
5-004	1.070	0.065	1.200	5-004		5-273	0.879	0.040	0.959	5-273
2-023	1.051	0.070	1.191	2-023		5-049	0.871	0.140	1.151	5-049
2-121	1.049	0.103	1.255	2-121		2-020	0.864	0.070	1.004	2-020
3-914	1.047	0.116	1.279	3-914		3-911	0.863	0.116	1.095	3-911
2-215	1.046	0.139	1.324	2-215		2-118	0.862	0.103	1.068	2-118
2-319	1.037	0.210	1.457	2-319		2-212	0.859	0.139	1.137	2-212
5-599	1.031	0.141	1.313	5-599		5-753	0.857	0.123	1.103	5-753
5-618	1.016	0.139	1.294	5-618		5-708	0.850	0.045	0.940	5-708
5-761	1.010	0.062	1.134	5-761		2-316	0.850	0.210	1.270	2-316
5-677	1.004	0.081	1.166	5-677		5-596	0.838	0.141	1.120	5-596
5-279	1.004	0.218	1.440	5-279		5-003	0.836	0.059	0.954	5-003
5-709	1.000	0.055	1.110	5-709		5-751	0.820	0.150	1.120	5-751
2-022	0.989	0.070	1.129	2-022		2-019	0.801	0.070	0.941	2-019
5-139	0.987	0.031	1.049	5-139		2-117	0.799	0.103	1.005	2-117
2-120	0.987	0.103	1.193	2-120		5-006	0.796	0.080	0.956	5-006
3-913	0.986	0.116	1.218	3-913		2-211	0.796	0.139	1.074	2-211
2-214	0.984	0.139	1.262	2-214		2-315	0.787	0.210	1.207	2-315
5-278	0.979	0.103	1.185	5-278		5-595	0.779	0.141	1.061	5-595
2-318	0.975	0.210	1.395	2-318		5-137	0.775	0.031	0.837	5-137
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-266	0.766	0.080	0.926	5-266		5-005	0.640	0.080	0.800	5-005
3-910	0.755	0.097	0.949	3-910		5-251	0.631	0.062	0.755	5-251
5-264	0.752	0.070	0.892	5-264		5-250	0.627	0.062	0.751	5-250
5-263	0.750	0.061	0.872	5-263		5-248	0.625	0.050	0.725	5-248
5-964	0.744	0.109	0.962	5-964		5-617	0.625	0.103	0.831	5-617
2-018	0.739	0.070	0.879	2-018		5-247	0.623	0.125	0.873	5-247
2-116	0.737	0.103	0.943	2-116		2-016	0.614	0.070	0.754	2-016
2-210	0.734	0.139	1.012	2-210		2-114	0.612	0.103	0.818	2-114
5-181	0.725	0.040	0.805	5-181		5-676	0.610	0.058	0.726	5-676
2-314	0.725	0.210	1.145	2-314		2-208	0.609	0.139	0.887	2-208
5-593	0.724	0.106	0.936	5-593		5-243	0.604	0.103	0.810	5-243
5-257	0.722	0.113	0.948	5-257		5-021	0.603	0.125	0.853	5-021
5-594	0.720	0.141	1.002	5-594		5-609	0.600	0.094	0.788	5-609
5-1017	0.709	0.079	0.867	5-1017		5-242	0.600	0.105	0.810	5-242
5-256	0.707	0.103	0.913	5-256		2-312	0.600	0.210	1.020	2-312
3-909	0.706	0.097	0.900	3-909		5-591	0.594	0.106	0.806	5-591
5-745	0.687	0.250	1.187	5-745		5-736	0.590	0.070	0.730	5-736
2-017	0.676	0.070	0.816	2-017		5-563	0.583	0.040	0.663	5-563
2-115	0.674	0.103	0.880	2-115		5-735	0.583	0.103	0.789	5-735
2-209	0.671	0.139	0.949	2-209		5-156	0.575	0.060	0.695	5-156
5-592	0.665	0.106	0.877	5-592		5-239	0.570	0.106	0.782	5-239
2-313	0.662	0.210	1.082	2-313		5-236	0.562	0.062	0.686	5-236
5-254	0.660	0.064	0.788	5-254		5-162	0.554	0.070	0.694	5-162
5-743	0.660	0.141	0.942	5-743		2-015	0.551	0.070	0.691	2-015
5-252	0.652	0.070	0.792	5-252		2-113	0.549	0.103	0.755	2-113
5-643	0.650	0.045	0.740	5-643		5-001	0.547	0.051	0.649	5-001
3-908	0.644	0.087	0.818	3-908		2-207	0.546	0.139	0.824	2-207
5-136	0.643	0.031	0.705	5-136		2-311	0.537	0.210	0.957	2-311
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-590	0.535	0.106	0.747	5-590		2-205	0.421	0.139	0.699	2-205
3-907	0.530	0.082	0.694	3-907		5-215	0.418	0.094	0.606	5-215
5-135	0.526	0.031	0.588	5-135		5-002	0.416	0.059	0.534	5-002
5-1014	0.525	0.071	0.667	5-1014		3-905	0.414	0.072	0.558	3-905
5-616	0.516	0.103	0.722	5-616		5-588	0.413	0.106	0.625	5-588
5-675	0.508	0.049	0.606	5-675		2-309	0.412	0.210	0.832	2-309
5-231	0.501	0.062	0.625	5-231		5-134	0.410	0.031	0.472	5-134
5-230	0.500	0.125	0.750	5-230		5-718	0.395	0.040	0.475	5-718
5-566	0.489	0.055	0.599	5-566		5-614	0.391	0.103	0.597	5-614
2-014	0.489	0.070	0.629	2-014		5-212	0.384	0.070	0.524	5-212
2-112	0.487	0.103	0.693	2-112		5-211	0.375	0.187	0.749	5-211
5-726	0.484	0.056	0.596	5-726		5-209	0.370	0.040	0.450	5-209
2-206	0.484	0.139	0.762	2-206		5-057	0.364	0.045	0.454	5-057
2-310	0.475	0.210	0.895	2-310		2-012	0.364	0.070	0.504	2-012
5-652	0.473	0.071	0.615	5-652		2-110	0.362	0.103	0.568	2-110
5-725	0.470	0.270	1.010	5-725		5-716	0.362	0.118	0.598	5-716
5-225	0.469	0.094	0.657	5-225		2-204	0.359	0.139	0.637	2-204
5-615	0.469	0.103	0.675	5-615		5-700	0.354	0.118	0.590	5-700
3-906	0.468	0.078	0.624	3-906		5-699	0.353	0.094	0.541	5-699
5-223	0.458	0.053	0.564	5-223		5-018	0.352	0.113	0.578	5-018
5-222	0.455	0.128	0.711	5-222		3-904	0.351	0.072	0.495	3-904
5-1011	0.447	0.103	0.653	5-1011		5-586	0.350	0.074	0.498	5-586
5-613	0.437	0.070	0.577	5-613		5-587	0.350	0.106	0.562	5-587
5-682	0.426	0.040	0.506	5-682		5-612	0.344	0.070	0.484	5-612
5-058	0.426	0.050	0.526	5-058		5-133	0.332	0.031	0.394	5-133
2-013	0.426	0.070	0.566	2-013		5-1007	0.330	0.050	0.430	5-1007
5-218	0.425	0.025	0.475	5-218		5-206	0.326	0.103	0.532	5-206
2-111	0.424	0.103	0.630	2-111		5-1006	0.322	0.070	0.462	5-1006
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:
5-664	0.320	0.070	0.460	5-664		2-010	0.239	0.070	0.379	2-010
5-585	0.314	0.074	0.462	5-585		5-127	0.239	0.074	0.387	5-127
5-712	0.313	0.051	0.415	5-712		5-1002	0.239	0.174	0.587	5-1002
5-204	0.312	0.036	0.384	5-204		2-108	0.237	0.103	0.443	2-108
5-205	0.312	0.092	0.496	5-205		2-202	0.234	0.139	0.512	2-202
5-160	0.312	0.103	0.518	5-160		5-638	0.233	0.076	0.385	5-638
5-673	0.305	0.074	0.453	5-673		5-194	0.228	0.040	0.308	5-194
5-152	0.301	0.025	0.351	5-152		5-582	0.224	0.074	0.372	5-582
5-056	0.301	0.038	0.377	5-056		2-009	0.208	0.070	0.348	2-009
5-710	0.301	0.054	0.409	5-710		5-685	0.208	0.094	0.396	5-685
3-903	0.301	0.064	0.429	3-903		2-107	0.206	0.103	0.412	2-107
2-011	0.301	0.070	0.441	2-011		5-581	0.192	0.074	0.340	5-581
2-109	0.299	0.103	0.505	2-109		3-901	0.185	0.056	0.297	3-901
2-203	0.296	0.139	0.574	2-203		5-125	0.180	0.040	0.260	5-125
5-1004	0.290	0.045	0.380	5-1004		5-193	0.176	0.040	0.256	5-193
5-687	0.287	0.094	0.475	5-687		5-108	0.176	0.050	0.276	5-108
5-698	0.283	0.040	0.363	5-698		5-124	0.176	0.056	0.288	5-124
5-584	0.283	0.074	0.431	5-584		5-107	0.176	0.066	0.308	5-107
5-202	0.278	0.046	0.370	5-202		2-008	0.176	0.070	0.316	2-008
5-052	0.270	0.070	0.410	5-052		2-106	0.174	0.103	0.380	2-106
5-200	0.265	0.139	0.543	5-200		2-201	0.171	0.139	0.449	2-201
5-583	0.251	0.074	0.399	5-583		5-580	0.165	0.074	0.313	5-580
5-180	0.248	0.048	0.344	5-180		5-148	0.154	0.038	0.230	5-148
5-686	0.248	0.094	0.436	5-686		5-105	0.154	0.050	0.254	5-105
5-197	0.242	0.040	0.322	5-197		5-106	0.154	0.066	0.286	5-106
5-179	0.239	0.040	0.319	5-179		5-669	0.146	0.040	0.226	5-669
5-151	0.239	0.051	0.341	5-151		2-007	0.145	0.070	0.285	2-007
3-902	0.239	0.064	0.367	3-902		2-105	0.143	0.103	0.349	2-105
Dash No:	ID	W	OD	Dash No:		Dash No:	ID	W	OD	Dash No:

Dash No:	ID	W	OD	Dash No:
5-579	0.133	0.074	0.281	5-579
5-190	0.132	0.070	0.272	5-190
5-103	0.128	0.050	0.228	5-103
5-646	0.126	0.040	0.206	5-646
5-683	0.122	0.063	0.248	5-683
5-178	0.120	0.040	0.200	5-178
5-102	0.116	0.038	0.192	5-102
2-006	0.114	0.070	0.254	2-006
2-104	0.112	0.103	0.318	2-104
5-632	0.110	0.040	0.190	5-632
5-578	0.102	0.074	0.250	5-578
2-005	0.101	0.070	0.241	2-005
5-101	0.100	0.038	0.176	5-101
2-103	0.081	0.103	0.287	2-103
5-187	0.070	0.036	0.142	5-187
5-051	0.070	0.040	0.150	5-051
2-004	0.070	0.070	0.210	2-004
5-118	0.059	0.040	0.139	5-118
2-003	0.056	0.060	0.176	2-003
2-102	0.049	0.103	0.255	2-102
2-002	0.042	0.050	0.142	2-002
2-001	0.029	0.040	0.109	2-001