

# DISC SPRINGS





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## Company Introduction

AIGI Environmental Inc. is an established manufacturer specializing in static sealing technologies. Our aim is to provide a full range of solutions for our customers' static sealing requirements, along with being a strategic partner for their static sealing needs. Through continuous efforts, we have become a leading company in static sealing technologies in the Chinese market.

With our industry leading manufacturing and technical capabilities, our Nanjing headquarters and factories use state-of-the-art international manufacturing equipment and automated processes. We utilize proven methods in process control to ensure each product and manufacturing process are controlled under a strict standardized quality system and tested in our advanced sealing test centre. Through this, we provide the most advanced product quality, lead time and services in the Chinese sealing industry.



*Clean, Safe and Reliable Workshop*

## **Our Mission**

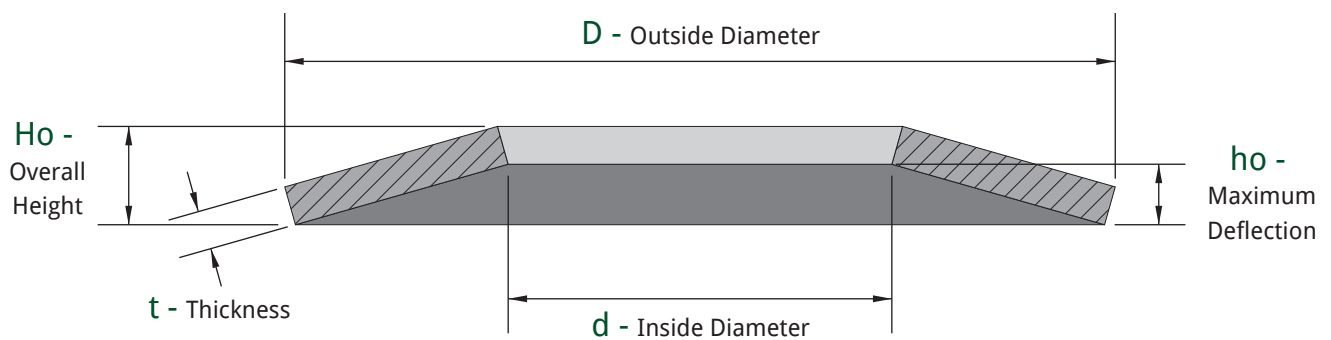
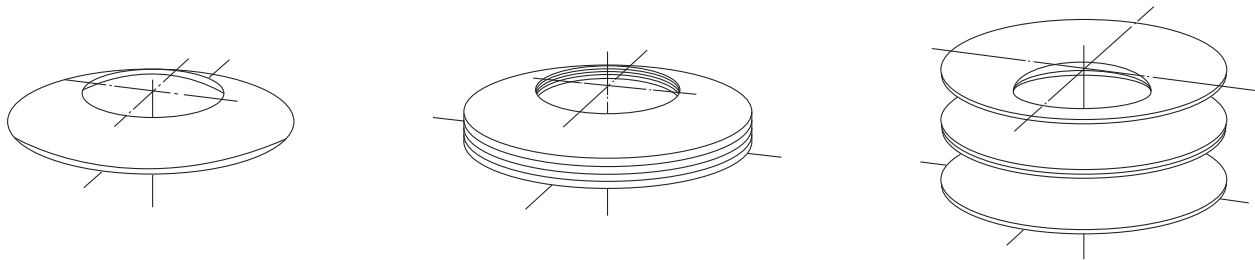
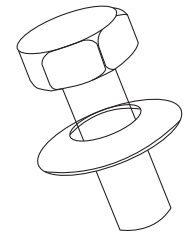
*“Create a Safer, Cleaner and More Reliable Manufacturing Environment”*

## Instruction for Disc springs

During the mid-nineteenth-century the conical shaped disc spring also, known as the Belleville washer after its inventor, Julian F. Belleville was invented. Today in the 21st century disc springs or Belleville washers are utilized in many applications such as spacecraft, satellites, medical devices, defense systems, automobiles, machine tools, valves, piping systems to name just a few.

Disc springs are non-flat washers with a conical shape which gives the washers their spring characteristics and are designed to be loaded in the axial direction only. They are typically used as springs or to apply a preload with a flexible quality to a bolted joint.

Disc springs are used singularly or stacked in different combinations allows for variable spring characteristics suiting the given application.

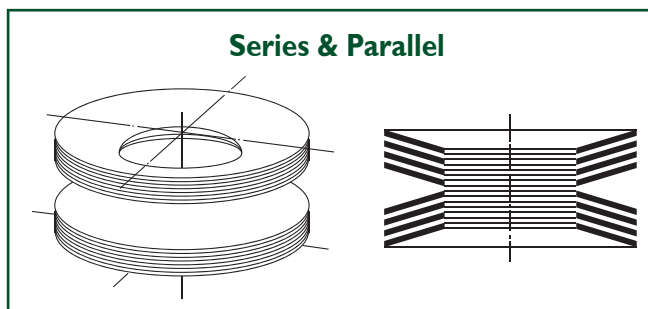
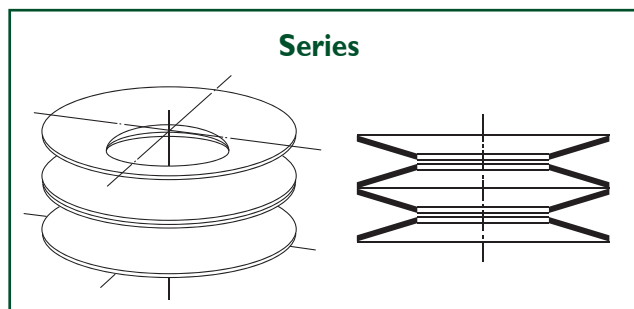
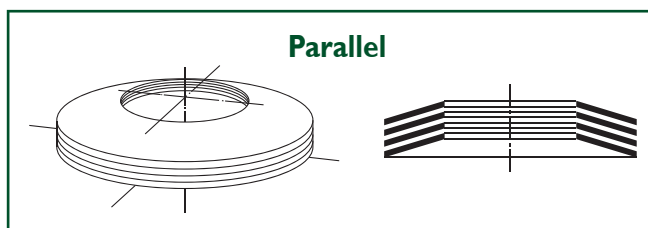
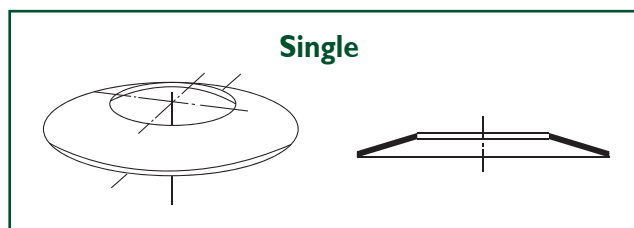


## ● Good Reasons for Disc Springs

- Efficient Space Use
- High Loads with Little Deflection
- Long Life & Self Damping
- Parallel Stacking to Increase Load
- Series Stacking to Increase Deflection
- Add or Subtract Springs to Increase or Decrease Load and or Deflection

Disc Springs can be used in many applications where high loads are needed, such as vibration, thermal expansion and contraction, relaxation and bolt creep are issues.

## ● Disc Spring Stacking Combinations

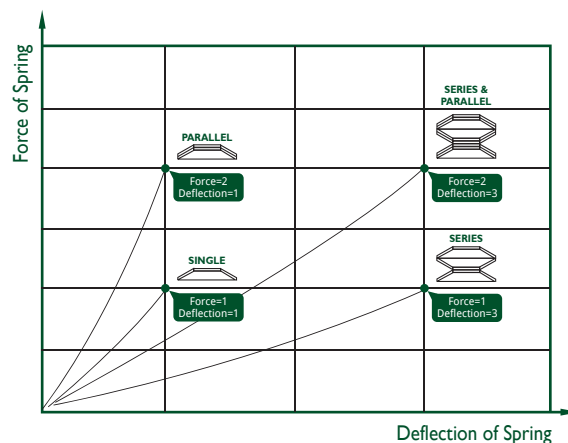


Individual disc springs have specific load and deflection. Using various stacking arrangements allows for increased load and or deflections. See sample below.

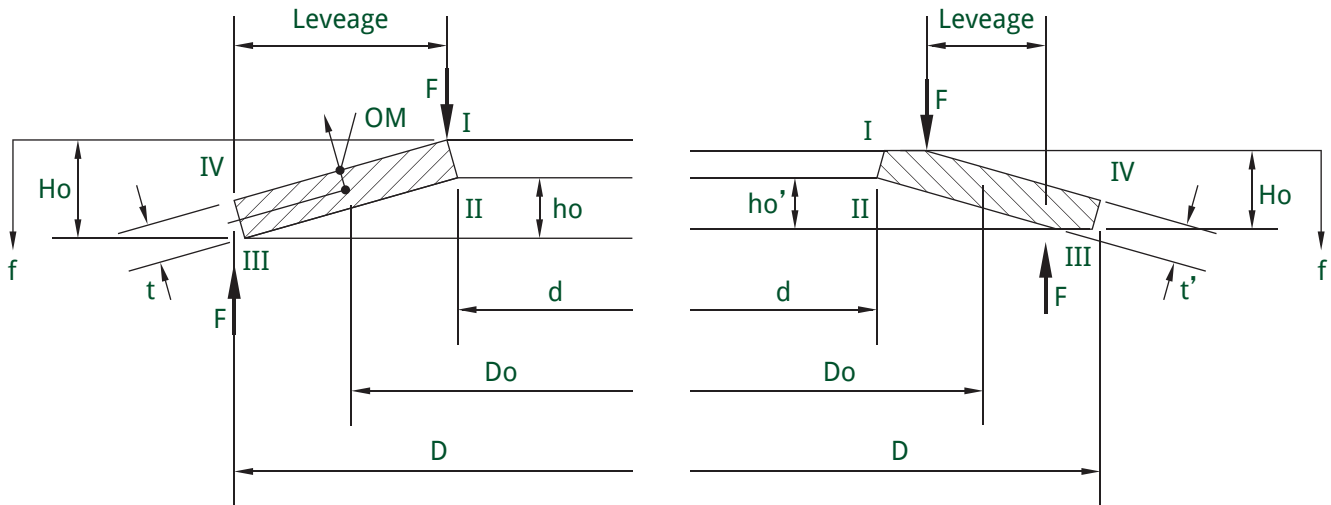
### Ordering Disc Springs

When ordering disc springs please specify outside diameter, inside diameter, and thickness.

Example: Disc spring with OD 6mm, ID 3.2mm, thickness 0.3mm = RD6-3.2-0.3



## ● Disc Spring Symbols and Units



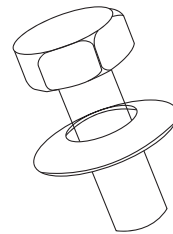
| Symbol                | Unit | Description                                               |
|-----------------------|------|-----------------------------------------------------------|
| D                     | mm   | Outside Diameter                                          |
| d                     | mm   | Inside Diameter                                           |
| Do                    | mm   | Diameter of Centre of Rotation                            |
| t                     | mm   | Thickness                                                 |
| t'                    | mm   | Reduced Thickness for Disc Springs with Contact Flats     |
| Ho                    | mm   | Overall Height                                            |
| ho                    | mm   | Maximum Deflection for Disc Springs without Contact Flats |
| ho'                   | mm   | Maximum Deflection for Disc Springs with Contact Flats    |
| b                     | mm   | Bearing Surface                                           |
| F                     | N    | Spring Force for an Individual Disc Spring                |
| f                     | mm   | Deflection of an Individual Disc Spring                   |
| OM, I, II,<br>III, IV | N    | Calculated stress at points OM, I, II, III, IV            |



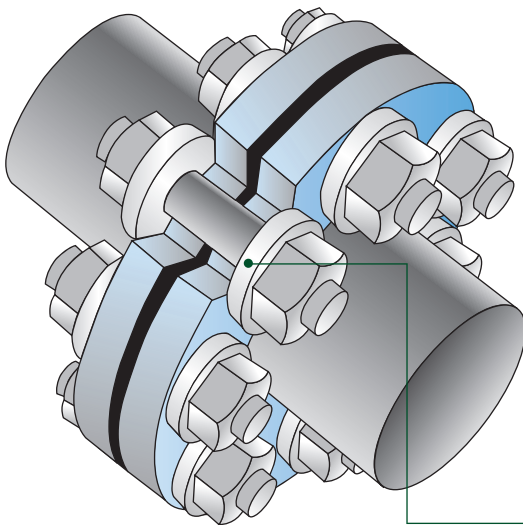
## Live Loading Disc Springs

### ● Live Loading Principles

In industry, there are many pipe connections usually combining flanges, bolts and gaskets and other components. Often, people think leakage is caused by failed gaskets, but the truth is 50% ~ 80% of all leakage is caused by pre-load relaxation of bolting. Because of equipment temperature changes, pressure changes and mechanical vibration, bolt pre-load will relax, below the minimum sealing force required. Disc springs, as an elastic compensation part, could provide prevent flange leakage through their “live-load” capability.



As the bolt is tightened, the absorbed mechanical energy is converted into potential energy which is stored in the disc spring. Due to temperature changes, pressure changes, or mechanical vibrations, bolt pre-load decays and the disc spring releases potential energy which will be converted into mechanical energy to provide compensation load, so that the bolt's pre-load is always maintained in the appropriate sealing force range.



17-7 PH Stainless Steel



H-13 Tool Steel



## ● 17-7 PH Stainless Steel (Metric)

Used for: Corrosive environment (indoor/outdoor), not applicable for chloride and fluoride application.

Operating temperature: - 240°C ~ 288°C, highly magnetic. Nickel plating (AMS 2424D) is supplied.

Recommended bolt internal stress ≤ 200 MPa.



### 17-7 Selection

| Part No.   | Load 100% (N ±10%) | Torque (NM ±10%) |
|------------|--------------------|------------------|
| 17-7-M6-A  | 3063               | 3.7              |
| 17-7-M8-A  | 4102               | 6.6              |
| 17-7-M10-A | 11581              | 23.2             |
| 17-7-M12-A | 15161              | 36.4             |
| 17-7-M14-A | 15160              | 42.4             |
| 17-7-M16-A | 28438              | 91.0             |
| 17-7-M18-A | 32508              | 117.0            |
| 17-7-M20-A | 42104              | 168.4            |
| 17-7-M22-A | 42317              | 186.2            |
| 17-7-M24-A | 40288              | 193.4            |
| 17-7-M27-A | 39998              | 216.0            |
| 17-7-M30-A | 65416              | 392.5            |
| 17-7-M32-A | 61881              | 396.0            |
| 17-7-M33-A | 87659              | 578.5            |
| 17-7-M36-A | 63185              | 454.9            |
| 17-7-M36-B | 115656             | 832.7            |
| 17-7-M38-A | 109629             | 833.2            |
| 17-7-M39-A | 111663             | 871.0            |
| 17-7-M42-A | 113892             | 956.7            |
| 17-7-M45-A | 133775             | 1204.0           |
| 17-7-M48-A | 173108             | 1661.8           |
| 17-7-M52-A | 168243             | 1749.7           |
| 17-7-M64-A | 254722             | 3260.4           |
| 17-7-M72-A | 263790             | 3798.6           |
| 17-7-M72-B | 423388             | 6096.8           |

※ 17-7 PH is applicable for Valve, Pipe flange, Heat exchanger, etc.

## ● H-13 Tool Steel (Metric)

Used for: high temperature service (indoor/outdoor).

Operating temperature: - 157°C ~ 593°C, fully magnetic.

Finish treatment: machined with little oil.

### H-13 Selection

| Part No.      | Load 100% (N ±10%) | Torque (NM ±10%) |
|---------------|--------------------|------------------|
| H-13-M10-200M | 10452              | 20.9             |
| H-13-M10-300M | 15959              | 31.9             |
| H-13-M10-400M | 19918              | 39.8             |
| H-13-M12-200M | 14527              | 34.9             |
| H-13-M12-300M | 22336              | 53.6             |
| H-13-M12-400M | 31052              | 74.5             |
| H-13-M14-200M | 20402              | 57.1             |
| H-13-M14-300M | 30185              | 84.5             |
| H-13-M14-400M | 42611              | 119.3            |
| H-13-M16-200M | 28841              | 92.3             |
| H-13-M16-300M | 42667              | 136.5            |
| H-13-M16-400M | 55675              | 178.2            |
| H-13-M18-200M | 38665              | 139.2            |
| H-13-M18-300M | 57526              | 207.1            |
| H-13-M18-400M | 78785              | 283.6            |
| H-13-M20-200M | 42958              | 171.8            |
| H-13-M20-300M | 66991              | 268.0            |
| H-13-M20-400M | 86894              | 347.6            |
| H-13-M22-200M | 58071              | 255.5            |
| H-13-M22-300M | 90894              | 399.9            |
| H-13-M22-400M | 115292             | 507.3            |
| H-13-M24-200M | 64801              | 311.0            |
| H-13-M24-300M | 98623              | 473.4            |
| H-13-M24-400M | 126255             | 606.0            |
| H-13-M27-200M | 85689              | 462.7            |
| H-13-M27-300M | 128677             | 694.9            |
| H-13-M27-400M | 171044             | 923.6            |

## H-I3 Selection

| Part No.      | Load 100% (N $\pm$ 10%) | Torque (NM $\pm$ 10%) |
|---------------|-------------------------|-----------------------|
| H-13-M30-200M | 104135                  | 624.8                 |
| H-13-M30-300M | 155599                  | 933.6                 |
| H-13-M30-400M | 200693                  | 1204.2                |
| H-13-M32-200M | 131822                  | 843.7                 |
| H-13-M32-300M | 194707                  | 1246.1                |
| H-13-M32-400M | 262029                  | 1677.0                |
| H-13-M33-200M | 125203                  | 826.3                 |
| H-13-M33-300M | 198366                  | 1309.2                |
| H-13-M33-400M | 261557                  | 1726.3                |
| H-13-M36-200M | 144894                  | 1043.2                |
| H-13-M36-300M | 226534                  | 1631.0                |
| H-13-M36-400M | 306569                  | 2207.3                |
| H-13-M39-200M | 196463                  | 1532.4                |
| H-13-M39-300M | 288955                  | 2253.8                |
| H-13-M39-400M | 390329                  | 3044.6                |
| H-13-M40-200M | 220213                  | 1761.7                |
| H-13-M40-300M | 314648                  | 2517.2                |
| H-13-M40-400M | 449971                  | 3599.8                |
| H-13-M42-200M | 229572                  | 1928.4                |
| H-13-M42-300M | 339725                  | 2853.7                |
| H-13-M42-400M | 439796                  | 3694.3                |
| H-13-M48-200M | 315910                  | 3032.7                |
| H-13-M48-300M | 446811                  | 4289.4                |
| H-13-M48-400M | 489717                  | 4701.3                |
| H-13-M52-200M | 383615                  | 3989.6                |
| H-13-M52-300M | 562124                  | 5846.1                |
| H-13-M52-400M | 731715                  | 7609.8                |

## H-13 Selection

| Part No.       | Load 100% (N ±10%) | Torque (NM ±10%) |
|----------------|--------------------|------------------|
| H-13-M56-300M  | 1484347            | 21374.6          |
| H-13-M64-300M  | 1104666            | 15907.2          |
| H-13-M70-300M  | 741202             | 10673.3          |
| H-13-M72-200M  | 831907             | 13310.5          |
| H-13-M72-300M  | 1315578            | 21049.2          |
| H-13-M72-400M  | 1728676            | 27658.8          |
| H-13-M80-200M  | 1028551            | 17485.4          |
| H-13-M80-300M  | 1581182            | 26880.1          |
| H-13-M80-400M  | 1943993            | 33047.9          |
| H-13-M85-200M  | 996771             | 17941.9          |
| H-13-M85-300M  | 2091919            | 37654.5          |
| H-13-M85-400M  | 1750499            | 38511.0          |
| H-13-M90-200M  | 2571185            | 56566.1          |
| H-13-M90-400M  | 3332014            | 73304.3          |
| H-13-M100-200M | 1114804            | 22296.1          |
| H-13-M110-200M | 1753944            | 38586.8          |
| H-13-M110-300M | 2484915            | 54668.1          |
| H-13-M110-400M | 3365628            | 74043.8          |

※ H-13 is applicable for Valve, Pipe flange, Heat exchanger, etc.



H-13 Tool Steel

## Washers

### ● 6150 Washers

6150 a non-flat washer with a conical shape which gives the washers their spring characteristics and are designed to be loaded in the axial direction only. Typically used as springs or to apply a pre-load with a flexible quality to a bolted joint. GB/T 1972-1992 (DIN 2093)



6150 Washers

※ 6150 is applicable for Brakes, Bearing pre-load, Overload device, Mechanical actuator, Industrial furnace, Mould, Clutch in Metallurgy, Mechanical vehicle, Electricity, Construction industry.

## 6150 washers Selection

| Code            | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|-----------------|----------|----------|---------------|------------------|---------------------|----------|
| RD6-3.2-0.3     | 6        | 3.2      | 0.3           | 0.15             | 0.45                | 50       |
| RD8-3.2-0.2     | 8        | 3.2      | 0.2           | 0.2              | 0.4                 | 50       |
| RD8-3.2-0.3     | 8        | 3.2      | 0.3           | 0.25             | 0.55                | 50       |
| RD8-3.2-0.4     | 8        | 3.2      | 0.4           | 0.2              | 0.6                 | 50       |
| RD8-4.2-0.2     | 8        | 4.2      | 0.2           | 0.25             | 0.45                | 50       |
| RD8-4.2-0.3     | 8        | 4.2      | 0.3           | 0.25             | 0.55                | 50       |
| RD8-4.2-0.4     | 8        | 4.2      | 0.4           | 0.2              | 0.6                 | 50       |
| RD10-3.2-0.3    | 10       | 3.2      | 0.3           | 0.35             | 0.65                | 50       |
| RD10-3.2-0.4    | 10       | 3.2      | 0.4           | 0.3              | 0.7                 | 50       |
| RD10-3.2-0.5    | 10       | 3.2      | 0.5           | 0.25             | 0.75                | 50       |
| RD10-4.2-0.4    | 10       | 4.2      | 0.4           | 0.3              | 0.7                 | 50       |
| RD10-4.2-0.5    | 10       | 4.2      | 0.5           | 0.25             | 0.75                | 50       |
| RD10-5.2-0.25   | 10       | 5.2      | 0.25          | 0.3              | 0.55                | 50       |
| RD10-5.2-0.4    | 10       | 5.2      | 0.4           | 0.3              | 0.7                 | 50       |
| RD10-5.2-0.5    | 10       | 5.2      | 0.5           | 0.25             | 0.75                | 50       |
| RD12-4.2-0.4    | 12       | 4.2      | 0.4           | 0.4              | 0.8                 | 50       |
| RD12-4.2-0.5    | 12       | 4.2      | 0.5           | 0.35             | 0.85                | 50       |
| RD12-4.2-0.6    | 12       | 4.2      | 0.6           | 0.4              | 1                   | 50       |
| RD12-5.2-0.5    | 12       | 5.2      | 0.5           | 0.4              | 0.9                 | 50       |
| RD12-5.2-0.6    | 12       | 5.2      | 0.6           | 0.35             | 0.95                | 50       |
| RD12-6.2-0.5    | 12       | 6.2      | 0.5           | 0.35             | 0.85                | 50       |
| RD12-6.2-0.6    | 12       | 6.2      | 0.6           | 0.35             | 0.95                | 50       |
| RD12.5-5.2-0.5  | 12.5     | 5.2      | 0.5           | 0.35             | 0.85                | 50       |
| RD12.5-6.2-0.35 | 12.5     | 6.2      | 0.35          | 0.45             | 0.8                 | 50       |
| RD12.5-6.2-0.5  | 12.5     | 6.2      | 0.5           | 0.35             | 0.85                | 50       |
| RD12.5-6.2-0.7  | 12.5     | 6.2      | 0.7           | 0.3              | 1                   | 50       |
| RD14-7.2-0.35   | 14       | 7.2      | 0.35          | 0.45             | 0.8                 | 50       |
| RD14-7.2-0.5    | 14       | 7.2      | 0.5           | 0.4              | 0.9                 | 50       |
| RD14-7.2-0.8    | 14       | 7.2      | 0.8           | 0.3              | 1.1                 | 50       |
| RD15-5.2-0.4    | 15       | 5.2      | 0.4           | 0.55             | 0.95                | 50       |
| RD15-5.2-0.5    | 15       | 5.2      | 0.5           | 0.5              | 1                   | 50       |
| RD15-5.2-0.6    | 15       | 5.2      | 0.6           | 0.45             | 1.05                | 50       |

## 6150 washers Selection

| Code          | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|---------------|----------|----------|---------------|------------------|---------------------|----------|
| RD15-5.2-0.7  | 15       | 5.2      | 0.7           | 0.4              | 1.1                 | 50       |
| RD15-6.2-0.5  | 15       | 6.2      | 0.5           | 0.5              | 1                   | 50       |
| RD15-6.2-0.6  | 15       | 6.2      | 0.6           | 0.45             | 1.05                | 50       |
| RD15-6.2-0.7  | 15       | 6.2      | 0.7           | 0.4              | 1.1                 | 50       |
| RD15-8.2-0.7  | 15       | 8.2      | 0.7           | 0.4              | 1.1                 | 50       |
| RD15-8.2-0.8  | 15       | 8.2      | 0.8           | 0.4              | 1.2                 | 50       |
| RD16-8.2-0.4  | 16       | 8.2      | 0.4           | 0.5              | 0.9                 | 50       |
| RD16-8.2-0.6  | 16       | 8.2      | 0.6           | 0.45             | 1.05                | 50       |
| RD16-8.2-0.7  | 16       | 8.2      | 0.7           | 0.45             | 1.15                | 50       |
| RD16-8.2-0.8  | 16       | 8.2      | 0.8           | 0.4              | 1.2                 | 50       |
| RD16-8.2-0.9  | 16       | 8.2      | 0.9           | 0.35             | 1.25                | 50       |
| RD18-6.2-0.4  | 18       | 6.2      | 0.4           | 0.6              | 1                   | 50       |
| RD18-6.2-0.5  | 18       | 6.2      | 0.5           | 0.6              | 1.1                 | 50       |
| RD18-6.2-0.6  | 18       | 6.2      | 0.6           | 0.6              | 1.2                 | 50       |
| RD18-6.2-0.7  | 18       | 6.2      | 0.7           | 0.55             | 1.25                | 50       |
| RD18-6.2-0.8  | 18       | 6.2      | 0.8           | 0.5              | 1.3                 | 50       |
| RD18-8.2-0.5  | 18       | 8.2      | 0.5           | 0.6              | 1.1                 | 50       |
| RD18-8.2-0.7  | 18       | 8.2      | 0.7           | 0.55             | 1.25                | 50       |
| RD18-8.2-0.8  | 18       | 8.2      | 0.8           | 0.5              | 1.3                 | 50       |
| RD18-8.2-1    | 18       | 8.2      | 1             | 0.4              | 1.4                 | 50       |
| RD18-9.2-0.45 | 18       | 9.2      | 0.45          | 0.6              | 1.05                | 50       |
| RD18-9.2-0.7  | 18       | 9.2      | 0.7           | 0.5              | 1.2                 | 50       |
| RD18-9.2-1    | 18       | 9.2      | 1             | 0.4              | 1.4                 | 50       |
| RD20-8.2-0.6  | 20       | 8.2      | 0.6           | 0.7              | 1.3                 | 50       |
| RD20-8.2-0.7  | 20       | 8.2      | 0.7           | 0.65             | 1.35                | 50       |
| RD20-8.2-0.8  | 20       | 8.2      | 0.8           | 0.6              | 1.4                 | 50       |
| RD20-8.2-0.9  | 20       | 8.2      | 0.9           | 0.55             | 1.45                | 50       |
| RD20-8.2-1    | 20       | 8.2      | 1             | 0.55             | 1.55                | 50       |
| RD20-10.2-0.5 | 20       | 10.2     | 0.5           | 0.65             | 1.15                | 50       |
| RD20-10.2-0.8 | 20       | 10.2     | 0.8           | 0.55             | 1.35                | 50       |
| RD20-10.2-0.9 | 20       | 10.2     | 0.9           | 0.55             | 1.45                | 50       |
| RD20-10.2-1   | 20       | 10.2     | 1             | 0.55             | 1.55                | 50       |



## 6150 washers Selection

| Code             | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|------------------|----------|----------|---------------|------------------|---------------------|----------|
| RD20-10.2-1.1    | 20       | 10.2     | 1.1           | 0.45             | 1.55                | 50       |
| RD20-10.2-1.25   | 20       | 10.2     | 1.25          | 0.5              | 1.75                | 25       |
| RD20-10.2-1.5    | 20       | 10.2     | 1.5           | 0.3              | 1.8                 | 25       |
| RD22.5-11.2-0.6  | 22.5     | 11.2     | 0.6           | 0.8              | 1.4                 | 50       |
| RD22.5-11.2-0.8  | 22.5     | 11.2     | 0.8           | 0.65             | 1.45                | 50       |
| RD22.5-11.2-1.25 | 22.5     | 11.2     | 1.25          | 0.5              | 1.75                | 25       |
| RD23-8.2-0.7     | 23       | 8.2      | 0.7           | 0.8              | 1.5                 | 50       |
| RD23-8.2-0.8     | 23       | 8.2      | 0.8           | 0.75             | 1.55                | 50       |
| RD23-8.2-0.9     | 23       | 8.2      | 0.9           | 0.7              | 1.6                 | 50       |
| RD23-8.2-1       | 23       | 8.2      | 1             | 0.7              | 1.7                 | 50       |
| RD23-10.2-0.9    | 23       | 10.2     | 0.9           | 0.75             | 1.65                | 50       |
| RD23-10.2-1      | 23       | 10.2     | 1             | 0.7              | 1.7                 | 50       |
| RD23-10.2-1.25   | 23       | 10.2     | 1.25          | 0.65             | 1.9                 | 25       |
| RD23-12.2-1      | 23       | 12.2     | 1             | 0.6              | 1.6                 | 50       |
| RD23-12.2-1.25   | 23       | 12.2     | 1.25          | 0.6              | 1.85                | 25       |
| RD23-12.2-1.5    | 23       | 12.2     | 1.5           | 0.6              | 2.1                 | 25       |
| RD25-10.2-1      | 25       | 10.2     | 1             | 0.75             | 1.75                | 50       |
| RD25-12.2-0.7    | 25       | 12.2     | 0.7           | 0.9              | 1.6                 | 50       |
| RD25-12.2-0.9    | 25       | 12.2     | 0.9           | 0.7              | 1.6                 | 50       |
| RD25-12.2-1      | 25       | 12.2     | 1             | 0.8              | 1.8                 | 50       |
| RD25-12.2-1.25   | 25       | 12.2     | 1.25          | 0.7              | 1.95                | 25       |
| RD25-12.2-1.5    | 25       | 12.2     | 1.5           | 0.55             | 2.05                | 25       |
| RD28-10.2-0.8    | 28       | 10.2     | 0.8           | 0.95             | 1.75                | 50       |
| RD28-10.2-1      | 28       | 10.2     | 1             | 0.9              | 1.9                 | 50       |
| RD28-10.2-1.25   | 28       | 10.2     | 1.25          | 0.8              | 2.05                | 25       |
| RD28-10.2-1.5    | 28       | 10.2     | 1.5           | 0.7              | 2.2                 | 25       |
| RD28-12.2-1      | 28       | 12.2     | 1             | 0.95             | 1.95                | 50       |
| RD28-12.2-1.25   | 28       | 12.2     | 1.25          | 0.85             | 2.1                 | 25       |
| RD28-12.2-1.5    | 28       | 12.2     | 1.5           | 0.75             | 2.25                | 25       |
| RD28-14.2-0.8    | 28       | 14.2     | 0.8           | 1                | 1.8                 | 50       |
| RD28-14.2-1      | 28       | 14.2     | 1             | 0.8              | 1.8                 | 50       |
| RD28-14.2-1.25   | 28       | 14.2     | 1.25          | 0.85             | 2.1                 | 25       |

## 6150 washers Selection

| Code             | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|------------------|----------|----------|---------------|------------------|---------------------|----------|
| RD28-14.2-1.5    | 28       | 14.2     | 1.5           | 0.65             | 2.15                | 25       |
| RD31.5-12.2-1    | 31.5     | 12.2     | 1             | 1.1              | 2.1                 | 50       |
| RD31.5-12.2-1.25 | 31.5     | 12.2     | 1.25          | 0.95             | 2.2                 | 25       |
| RD31.5-12.2-1.5  | 31.5     | 12.2     | 1.5           | 0.85             | 2.35                | 25       |
| RD31.5-16.3-0.8  | 31.5     | 16.3     | 0.8           | 1.05             | 1.85                | 50       |
| RD31.5-16.3-1.25 | 31.5     | 16.3     | 1.25          | 0.9              | 2.15                | 25       |
| RD31.5-16.3-1.5  | 31.5     | 16.3     | 1.5           | 0.9              | 2.4                 | 25       |
| RD31.5-16.3-1.75 | 31.5     | 16.3     | 1.75          | 0.7              | 2.45                | 25       |
| RD31.5-16.3-2    | 31.5     | 16.3     | 2             | 0.75             | 2.75                | 25       |
| RD34-12.2-1      | 34       | 12.2     | 1             | 1.25             | 2.25                | 50       |
| RD34-12.2-1.25   | 34       | 12.2     | 1.25          | 1.1              | 2.35                | 25       |
| RD34-12.2-1.5    | 34       | 12.2     | 1.5           | 1                | 2.5                 | 25       |
| RD34-14.3-1.25   | 34       | 14.3     | 1.25          | 1.15             | 2.4                 | 25       |
| RD34-14.3-1.5    | 34       | 14.3     | 1.5           | 1.05             | 2.55                | 25       |
| RD34-16.3-1.5    | 34       | 16.3     | 1.5           | 1.05             | 2.55                | 25       |
| RD34-16.3-2      | 34       | 16.3     | 2             | 0.85             | 2.85                | 25       |
| RD35.5-18.3-0.9  | 35.5     | 18.3     | 0.9           | 1.15             | 2.05                | 50       |
| RD35.5-18.3-1.25 | 35.5     | 18.3     | 1.25          | 1                | 2.25                | 25       |
| RD35.5-18.3-2    | 35.5     | 18.3     | 2             | 0.8              | 2.8                 | 25       |
| RD40-14.2-1.25   | 40       | 14.2     | 1.25          | 1.4              | 2.65                | 10       |
| RD40-14.2-1.5    | 40       | 14.2     | 1.5           | 1.25             | 2.75                | 10       |
| RD40-14.2-2      | 40       | 14.2     | 2             | 1.05             | 30.5                | 10       |
| RD40-16.3-1.5    | 40       | 16.3     | 1.5           | 0.3              | 2.8                 | 10       |
| RD40-16.3-2      | 40       | 16.3     | 2             | 1.1              | 3.1                 | 10       |
| RD40-18.3-2      | 40       | 18.3     | 2             | 1.15             | 3.15                | 10       |
| RD40-20.4-1      | 40       | 20.4     | 1             | 1.3              | 2.3                 | 10       |
| RD40-20.4-1.5    | 40       | 20.4     | 1.5           | 1.15             | 2.65                | 10       |
| RD40-20.4-2      | 40       | 20.4     | 2             | 1.1              | 3.1                 | 10       |
| RD40-20.4-2.25   | 40       | 20.4     | 2.25          | 0.9              | 3.15                | 10       |
| RD40-20.4-2.5    | 40       | 20.4     | 2.5           | 0.95             | 3.45                | 10       |
| RD45-22.4-1.25   | 45       | 22.4     | 1.25          | 1.6              | 2.85                | 10       |
| RD45-22.4-1.75   | 45       | 22.4     | 1.75          | 1.3              | 3.05                | 10       |

## 6150 washers Selection

| Code           | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|----------------|----------|----------|---------------|------------------|---------------------|----------|
| RD45-22.4-2.5  | 45       | 22.4     | 2.5           | 1                | 3.5                 | 10       |
| RD50-18.3-1.25 | 50       | 18.3     | 1.25          | 1.6              | 2.85                | 10       |
| RD50-18.3-1.5  | 50       | 18.3     | 1.5           | 1.8              | 3.3                 | 10       |
| RD50-18.3-2    | 50       | 18.3     | 2             | 1.5              | 3.5                 | 10       |
| RD50-18.3-2.5  | 50       | 18.3     | 2.5           | 1.35             | 3.85                | 10       |
| RD50-18.3-3    | 50       | 18.3     | 3             | 1                | 4                   | 10       |
| RD50-20.4-2    | 50       | 20.4     | 2             | 1.5              | 3.5                 | 10       |
| RD50-20.4-2.5  | 50       | 20.4     | 2.5           | 1.35             | 3.85                | 10       |
| RD50-22.4-2    | 50       | 22.4     | 2             | 1.6              | 3.6                 | 10       |
| RD50-22.4-2.5  | 50       | 22.4     | 2.5           | 1.4              | 3.9                 | 10       |
| RD50-25.4-1.25 | 50       | 25.4     | 1.25          | 1.6              | 2.85                | 10       |
| RD50-25.4-1.5  | 50       | 25.4     | 1.5           | 1.6              | 3.1                 | 10       |
| RD50-25.4-2    | 50       | 25.4     | 2             | 1.4              | 3.4                 | 10       |
| RD50-25.4-2.5  | 50       | 25.4     | 2.5           | 1.4              | 3.9                 | 10       |
| RD50-25.4-3    | 50       | 25.4     | 3             | 1.1              | 4.1                 | 10       |
| RD56-28.5-1.5  | 56       | 28.5     | 1.5           | 1.95             | 3.45                | 5        |
| RD56-28.5-2    | 56       | 28.5     | 2             | 1.6              | 3.6                 | 5        |
| RD56-28.5-3    | 56       | 28.5     | 3             | 1.3              | 4.3                 | 5        |
| RD60-20.4-2    | 60       | 20.4     | 2             | 2.1              | 4.1                 | 5        |
| RD60-20.4-2.5  | 60       | 20.4     | 2.5           | 1.8              | 4.3                 | 5        |
| RD60-20.4-3    | 60       | 20.4     | 3             | 1.7              | 4.7                 | 5        |
| RD60-25.5-2.5  | 60       | 25.5     | 2.5           | 1.9              | 4.4                 | 5        |
| RD60-25.5-3    | 60       | 25.5     | 3             | 1.65             | 4.65                | 5        |
| RD60-30.5-2.5  | 60       | 30.5     | 2.5           | 2                | 4.5                 | 5        |
| RD60-30.5-3    | 60       | 30.5     | 3             | 1.7              | 4.7                 | 5        |
| RD60-30.5-3.5  | 60       | 30.5     | 3.5           | 1.5              | 5                   | 5        |
| RD63-31-1.8    | 63       | 31       | 1.8           | 2.35             | 4.15                | 5        |
| RD63-31-2.5    | 63       | 31       | 2.5           | 1.75             | 4.25                | 5        |
| RD63-31-3      | 63       | 31       | 3             | 1.8              | 4.8                 | 5        |
| RD63-31-3.5    | 63       | 31       | 3.5           | 1.4              | 4.9                 | 5        |
| RD70-25.5-2    | 70       | 25.5     | 2             | 2.5              | 4.5                 | 5        |
| RD70-30.5-2.5  | 70       | 30.5     | 2.5           | 2.4              | 4.9                 | 5        |

## 6150 washers Selection

| Code         | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|--------------|----------|----------|---------------|------------------|---------------------|----------|
| RD70-30.5-3  | 70       | 30.5     | 3             | 2.1              | 5.1                 | 5        |
| RD70-35.5-3  | 70       | 35.5     | 3             | 2.1              | 5.1                 | 5        |
| RD70-35.5-4  | 70       | 35.5     | 4             | 1.8              | 5.8                 | 5        |
| RD70-40.5-4  | 70       | 40.5     | 4             | 1.6              | 5.6                 | 5        |
| RD70-40.5-5  | 70       | 40.5     | 5             | 1.2              | 6.2                 | 5        |
| RD71-36-2    | 71       | 36       | 2             | 2.6              | 4.6                 | 5        |
| RD71-36-2.5  | 71       | 36       | 2.5           | 2                | 4.5                 | 5        |
| RD71-36-4    | 71       | 36       | 4             | 1.6              | 5.6                 | 5        |
| RD80-31-2.5  | 80       | 31       | 2.5           | 2.8              | 5.3                 | -        |
| RD80-31-3    | 80       | 31       | 3             | 2.5              | 5.5                 | -        |
| RD80-31-4    | 80       | 31       | 4             | 2.1              | 6.1                 | -        |
| RD80-36-3    | 80       | 36       | 3             | 2.7              | 5.7                 | -        |
| RD80-36-4    | 80       | 36       | 4             | 2.2              | 6.2                 | -        |
| RD80-41-2.25 | 80       | 41       | 2.25          | 2.95             | 5.2                 | -        |
| RD80-41-3    | 80       | 41       | 3             | 2.3              | 5.3                 | -        |
| RD80-41-4    | 80       | 41       | 4             | 2.2              | 6.2                 | -        |
| RD80-41-5    | 80       | 41       | 5             | 1.7              | 6.7                 | -        |
| RD90-46-2.5  | 90       | 46       | 2.5           | 3.2              | 5.7                 | -        |
| RD90-46-3.5  | 90       | 46       | 3.5           | 2.5              | 6                   | -        |
| RD90-46-5    | 90       | 46       | 5             | 2                | 7                   | -        |
| RD100-41-4   | 100      | 41       | 4             | 3.2              | 7.2                 | -        |
| RD100-41-5   | 100      | 41       | 5             | 2.75             | 7.75                | -        |
| RD100-51-2.7 | 100      | 51       | 2.7           | 3.5              | 6.2                 | -        |
| RD100-51-3.5 | 100      | 51       | 3.5           | 2.8              | 6.3                 | -        |
| RD100-51-4   | 100      | 51       | 4             | 3                | 7                   | -        |
| RD100-51-5   | 100      | 51       | 5             | 2.8              | 7.8                 | -        |
| RD100-51-6   | 100      | 51       | 6             | 2.2              | 8.2                 | -        |
| RD112-57-3   | 112      | 57       | 3             | 3.9              | 6.9                 | -        |
| RD112-57-4   | 112      | 57       | 4             | 3.2              | 7.2                 | -        |
| RD112-57-6   | 112      | 57       | 6             | 2.5              | 8.5                 | -        |
| RD125-41-4   | 125      | 41       | 4             | 4.2              | 8.2                 | -        |
| RD125-51-4   | 125      | 51       | 4             | 4.5              | 8.5                 | -        |

## 6150 washers Selection

| Code         | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|--------------|----------|----------|---------------|------------------|---------------------|----------|
| RD125-51-5   | 125      | 51       | 5             | 3.9              | 8.9                 | -        |
| RD125-51-6   | 125      | 51       | 6             | 3.4              | 9.4                 | -        |
| RD125-61-5   | 125      | 61       | 5             | 4                | 9                   | -        |
| RD125-61-6   | 125      | 61       | 6             | 3.6              | 9.6                 | -        |
| RD125-61-8   | 125      | 61       | 8             | 2.9              | 10.9                | -        |
| RD125-64-3.5 | 125      | 64       | 3.5           | 4.5              | 8                   | -        |
| RD125-64-5   | 125      | 64       | 5             | 3.5              | 8.5                 | -        |
| RD125-64-8   | 125      | 64       | 8             | 2.6              | 10.6                | -        |
| RD125-71-6   | 125      | 71       | 6             | 3.3              | 9.3                 | -        |
| RD125-71-8   | 125      | 71       | 8             | 2.4              | 10.4                | -        |
| RD125-71-10  | 125      | 71       | 10            | 1.8              | 11.8                | -        |
| RD140-72-3.8 | 140      | 72       | 3.8           | 4.9              | 8.7                 | -        |
| RD140-72-5   | 140      | 72       | 5             | 4                | 9                   | -        |
| RD140-72-8   | 140      | 72       | 8             | 3.2              | 11.2                | -        |
| RD150-61-5   | 150      | 61       | 5             | 5.3              | 10.3                | -        |
| RD150-61-6   | 150      | 61       | 6             | 4.8              | 10.8                | -        |
| RD150-71-6   | 150      | 71       | 6             | 4.8              | 10.8                | -        |
| RD150-71-8   | 150      | 71       | 8             | 4                | 12                  | -        |
| RD150-81-8   | 150      | 81       | 8             | 3.7              | 11.7                | -        |
| RD150-81-10  | 150      | 81       | 10            | 3                | 13                  | -        |
| RD160-82-4.3 | 160      | 82       | 4.3           | 5.6              | 9.9                 | -        |
| RD160-82-6   | 160      | 82       | 6             | 4.5              | 10.5                | -        |
| RD160-82-10  | 160      | 82       | 10            | 3.5              | 13.5                | -        |
| RD180-92-4.8 | 180      | 92       | 4.8           | 6.2              | 11                  | -        |
| RD180-92-6   | 180      | 92       | 6             | 5.1              | 11.1                | -        |
| RD180-92-10  | 180      | 92       | 10            | 4                | 14                  | -        |
| RD200-82-8   | 200      | 82       | 8             | 6.2              | 14.2                | -        |
| RD200-82-10  | 200      | 82       | 10            | 5.5              | 15.5                | -        |
| RD200-82-12  | 200      | 82       | 12            | 4.6              | 16.6                | -        |
| RD200-92-10  | 200      | 92       | 10            | 5.6              | 15.6                | -        |
| RD200-92-12  | 200      | 92       | 12            | 4.8              | 16.8                | -        |
| RD200-92-14  | 200      | 92       | 14            | 4.1              | 18.1                | -        |

## 6150 washers Selection

| Code          | O.D. (D) | I.D. (d) | Thickness (t) | Cone Height (ho) | Overall Height (Ho) | Min Qty. |
|---------------|----------|----------|---------------|------------------|---------------------|----------|
| RD200-102-5.5 | 200      | 102      | 5.5           | 7                | 12.5                | -        |
| RD200-102-8   | 200      | 102      | 8             | 5.6              | 13.6                | -        |
| RD200-102-10  | 200      | 102      | 10            | 5.6              | 15.6                | -        |
| RD200-102-12  | 200      | 102      | 12            | 4.2              | 16.2                | -        |
| RD200-102-14  | 200      | 102      | 14            | 4.2              | 18.2                | -        |
| RD200-112-12  | 200      | 112      | 12            | 4.2              | 16.2                | -        |
| RD200-112-14  | 200      | 112      | 14            | 3.5              | 17.5                | -        |
| RD200-112-16  | 200      | 112      | 16            | 2.8              | 18.8                | -        |
| RD225-112-6.5 | 225      | 112      | 6.5           | 7.1              | 13.6                | -        |
| RD225-112-8   | 225      | 112      | 8             | 6.5              | 14.5                | -        |
| RD225-112-12  | 225      | 112      | 12            | 5                | 17                  | -        |
| RD250-102-10  | 250      | 102      | 10            | 8                | 18                  | -        |
| RD250-102-12  | 250      | 102      | 12            | 7                | 19                  | -        |
| RD250-127-7   | 250      | 127      | 7             | 7.8              | 14.8                | -        |
| RD250-127-10  | 250      | 127      | 10            | 7                | 17                  | -        |
| RD250-127-12  | 250      | 127      | 12            | 7.3              | 19.3                | -        |
| RD250-127-14  | 250      | 127      | 14            | 5.6              | 19.6                | -        |
| RD250-127-16  | 250      | 127      | 16            | 5.8              | 21.8                | -        |

All products listed manufactured to Environmental Gasket Co., Ltd. standard materials and finishes, please consult with Environmental Gasket Co., Ltd. on any special materials and or finishes.

## ● **I075 Washers**

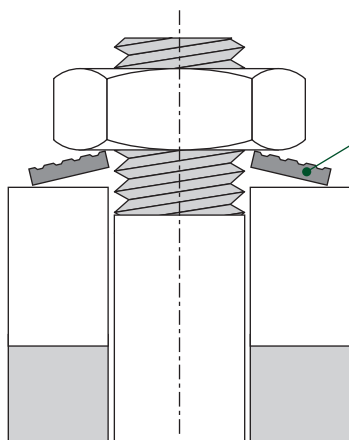
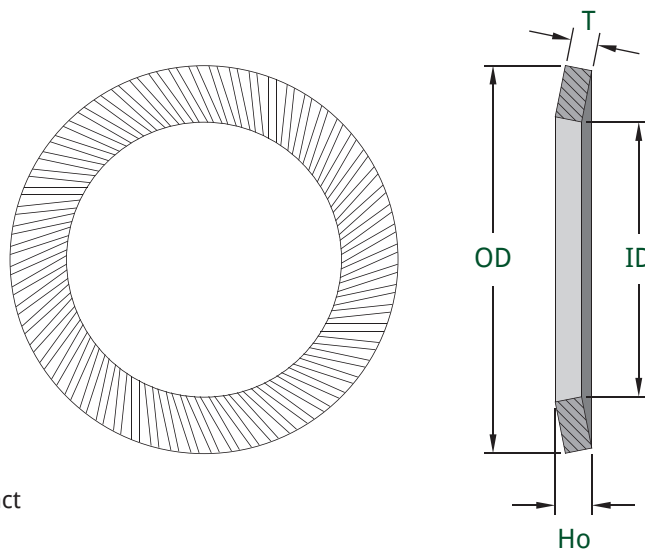
I075 washers are Disc Springs with a Trapezoidal Cross Section on both sides for gripping.

I075 washers are ready to fit washers for sustaining a preload and avoiding loosening. As the bolts are tightened the serrations bite into the mating faces and preventing the bolt from loosening due to vibration. Also the disc shape holds the necessary pre-load.

The diameters for I075 Washers are matched to bolt dimensions. The outer diameter of the washer is matched to the head diameter of the screw. This allows the use of screws and bolts including recessed heads, except countersunk screws.

Advantages of I075 Washers are:

- Used for high vibration resistance due to positive rib contact
- Excellent pre-loading
- Through proper radius selection, no splitting/cracking occurs during tightening
- The concentric force of the washer eliminates the chances of bending the fastener
- Extensive application and flexibility, minimizes stocks



**I075 Washers**

## I075 Washer Selection (Light Duty)

| Code   | O.D. (D) | I.D. (d) | Thickness (t) | Overall Height (Ho) | Screw Size |        | Package Qty. |
|--------|----------|----------|---------------|---------------------|------------|--------|--------------|
| RS1.6  | 3.2      | 1.7      | 0.35          | 0.6                 | 1.6mm      | -      | 1000         |
| RS2    | 4        | 2.2      | 0.35          | 0.6                 | 2mm        | -      | 1000         |
| RS2.5  | 4.8      | 2.7      | 0.45          | 0.9                 | 2.5mm      | -      | 1000         |
| RS3    | 5.5      | 3.2      | 0.45          | 0.9                 | 3mm        | 1/8"   | 1000         |
| RS3.5  | 6        | 3.7      | 0.45          | 0.9                 | 3.5mm      | -      | 1000         |
| RS4    | 7        | 4.3      | 0.5           | 1                   | 4mm        | 5/32"  | 1000         |
| RS5    | 9        | 5.3      | 0.6           | 1.1                 | 5mm        | 3/16"  | 1000         |
| RS6    | 10       | 6.4      | 0.7           | 1.2                 | 6mm        | -      | 1000         |
| RS6.35 | 9.5      | 6.7      | 0.7           | 1.2                 | -          | 1/4"   | 1000         |
| RS7    | 12       | 7.4      | 0.7           | 1.3                 | 7mm        | -      | 1000         |
| RS8    | 13       | 8.4      | 0.8           | 1.4                 | 8mm        | 5/16"  | 1000         |
| RS10   | 16       | 10.5     | 1             | 1.6                 | 10mm       | 3/8"   | 1000         |
| RS11.1 | 15.9     | 11.6     | 1             | 1.6                 | -          | 7/16"  | 500          |
| RS12   | 18       | 13       | 1.1           | 1.7                 | 12mm       | -      | 500          |
| RS12.7 | 19       | 13.7     | 1.1           | 1.8                 | -          | 1/2"   | 500          |
| RS14   | 22       | 15       | 1.2           | 2                   | 14mm       | 9/16"  | 500          |
| RS16   | 24       | 17       | 1.3           | 2.1                 | 16mm       | 5/8"   | 500          |
| RS18   | 27       | 19       | 1.5           | 2.3                 | 18mm       | -      | 250          |
| RS19   | 30       | 20       | 1.5           | 2.5                 | -          | 3/4"   | 250          |
| RS20   | 30       | 21       | 1.5           | 2.5                 | 20mm       | -      | 250          |
| RS22   | 33       | 23       | 1.5           | 2.7                 | 22mm       | 7/8"   | -            |
| RS24   | 36       | 25.6     | 1.8           | 2.9                 | 24mm       | -      | -            |
| RS25.4 | 38       | 27       | 2             | 3.1                 | -          | 1"     | -            |
| RS27   | 39       | 28.6     | 2             | 3.1                 | 27mm       | -      | -            |
| RS30   | 45       | 31.6     | 2             | 3.6                 | 30mm       | 1 1/8" | -            |
| RS36   | 54       | 38       | 2.5           | 4.2                 | 36mm       | 1 3/8" | -            |

All products listed manufactured to Environmental Gasket Co., Ltd. standard materials and finishes, please consult with Environmental Gasket Co., Ltd. on any special materials and or finishes.



**I075 Washer Selection cont. (Medium Duty)**

| <b>Code</b> | <b>O.D. (D)</b> | <b>I.D. (d)</b> | <b>Thickness (t)</b> | <b>Overall Height (Ho)</b> | <b>Screw Size</b> |        | <b>Package Qty.</b> |
|-------------|-----------------|-----------------|----------------------|----------------------------|-------------------|--------|---------------------|
| RVS5        | 9               | 5.3             | 1                    | 1.3                        | 5mm               | 3/16"  | 1000                |
| RVS6        | 10              | 6.4             | 1                    | 1.4                        | 6mm               | -      | 1000                |
| RVS8        | 13              | 8.4             | 1.2                  | 1.7                        | 8mm               | 5/16"  | 1000                |
| RVS10       | 16              | 10.5            | 1.5                  | 2                          | 10mm              | 3/8"   | 1000                |
| RVS12       | 18              | 13              | 1.5                  | 2.1                        | 12mm              | -      | -                   |
| RVS14       | 22              | 15              | 1.5                  | 2.2                        | 14mm              | 9/16"  | -                   |
| RVS16       | 24              | 17              | 2                    | 2.6                        | 16mm              | 5/8"   | -                   |
| RVS18       | 27              | 19              | 2                    | 2.7                        | 18mm              | -      | -                   |
| RVS20       | 30              | 21              | 2                    | 2.8                        | 20mm              | -      | -                   |
| RVS22       | 33              | 23              | 2                    | 2.9                        | 22mm              | 7/8"   | -                   |
| RVS24       | 36              | 25.6            | 2.5                  | 3.3                        | 24mm              | -      | -                   |
| RVS27       | 39              | 28.6            | 2.5                  | 3.4                        | 27mm              | -      | -                   |
| RVS30       | 45              | 31.6            | 2.5                  | 3.6                        | 30mm              | 1 1/8" | -                   |
| RVS36       | 54              | 38              | 3.0                  | 4.2                        | 36mm              | 1 3/8" | -                   |

All products listed manufactured to Environmental Gasket Co., Ltd. standard materials and finishes, please consult with Environmental Gasket Co., Ltd. on any special materials and or finishes.

## ● Washers Dimensional Tolerances

Dimensional tolerances to GB/T 1972-1992 (DIN 2093)

| Name                                                          | Tolerance                          |           |             |            |           |          |
|---------------------------------------------------------------|------------------------------------|-----------|-------------|------------|-----------|----------|
| Outside Diameter<br>D                                         | Extra fine grade                   | h12       |             |            |           |          |
|                                                               | Fine grade                         | h13       |             |            |           |          |
| Inside Diameter<br>d                                          | Extra fine grade                   | H12       |             |            |           |          |
|                                                               | Fine grade                         | H13       |             |            |           |          |
| Thickness<br>t(t)'                                            | t(t)'/mm                           | 0.2 ~ 0.6 | > 6 ~ < 1.5 | 1.25 ~ 3.8 | > 3.8 ~ 8 | > 6 ~ 14 |
|                                                               | Extra fine grade<br>and fine grade | +0.2      | +0.03       | +0.04      | +0.05     | ±0.10    |
|                                                               |                                    | -0.06     | -0.09       | -0.12      | -0.15     |          |
|                                                               |                                    |           |             |            |           |          |
| Free Height<br>Ho                                             | t/mm                               | < 1.25    | 1.25 ~ 2    | > 2 ~ 3    | > 3 ~ 6   | > 6 ~ 14 |
|                                                               | Extra fine grade<br>and fine grade | +0.10     | +0.15       | +0.20      | +0.30     | ±0.30    |
|                                                               |                                    | -0.05     | -0.08       | -0.10      | -0.15     |          |
|                                                               |                                    |           |             |            |           |          |
| Spring Force<br>Range (%)<br>when Load<br>F is at<br>f=0.75ho | t/mm                               | < 1.2 5   |             | 1.25 ~ 3   | > 3 ~ 6   | > 6 ~ 14 |
|                                                               | Extra fine grade                   | +25       |             | +15        | +10       | 5        |
|                                                               |                                    | -7.5      |             | -7.5       | -5        |          |
|                                                               | Fine grade                         | +30       |             | +20        | +15       | ±10      |
|                                                               |                                    | -10       |             | -10        | -7.5      |          |
|                                                               |                                    |           |             |            |           |          |

## **Finishes**

Listed below are some of the most commonly requested finishes. If the finish you are considering is not listed, please discuss your requirements with us.

### **Browning**

A process producing an oxidized surface upon which corrosion inhibiting oil can be applied.

### **Phosphating (zinc phosphate and oil)**

The standard surface treatment applied to carbon steel disc springs are usually sufficient to prevent corrosion in unexposed applications, during transport and storage. In applications which will subject disc springs to the elements, a higher level of protection would be required.

### **Mechanical Zinc Plating**

A mechanical plating process applies a substantial layer of zinc to the surface of the disc spring.

### **Electroless Nickel Plating**

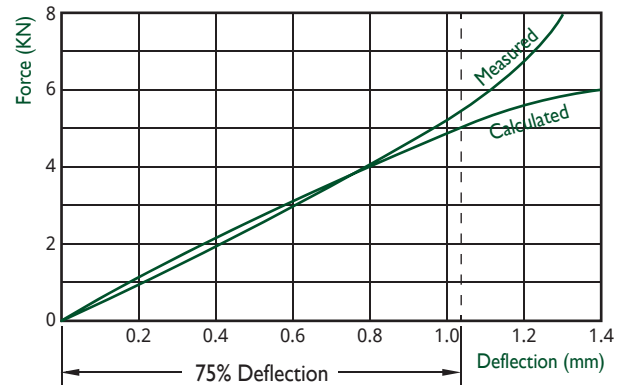
Chemically depositing a nickel coating to the disc spring, this process produces a smooth satin finish with a high degree of corrosion resistance which justifies its increased cost.

## Washer Characteristic Curves

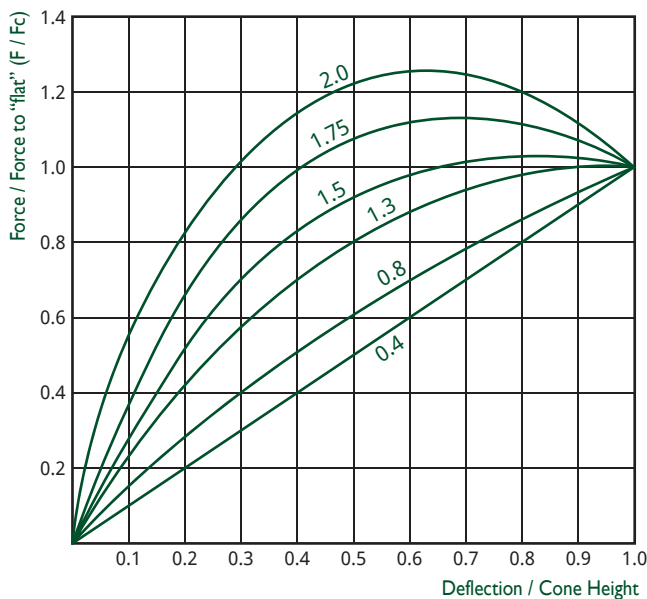
### Calculated Characteristics vs. Actual Test Results

The graph to the right displays a typical example, of disc springs, emphasizing the necessity of limiting maximum deflection to 75 percent to avoid sharply increasing force and stress characteristics.

As the compressed disc spring nears its 'flattened' condition, the reduced cone angle results in the movement of bearing point toward the centre, thus effectively shortening the 'lever' length and 'stiffening' the spring.



### Examples of Varying Ratio of Cone Height to Thickness



The ability to alter force-deflection, by varying the cone-height-to-thickness ratio, is a particularly useful feature of the disc spring.

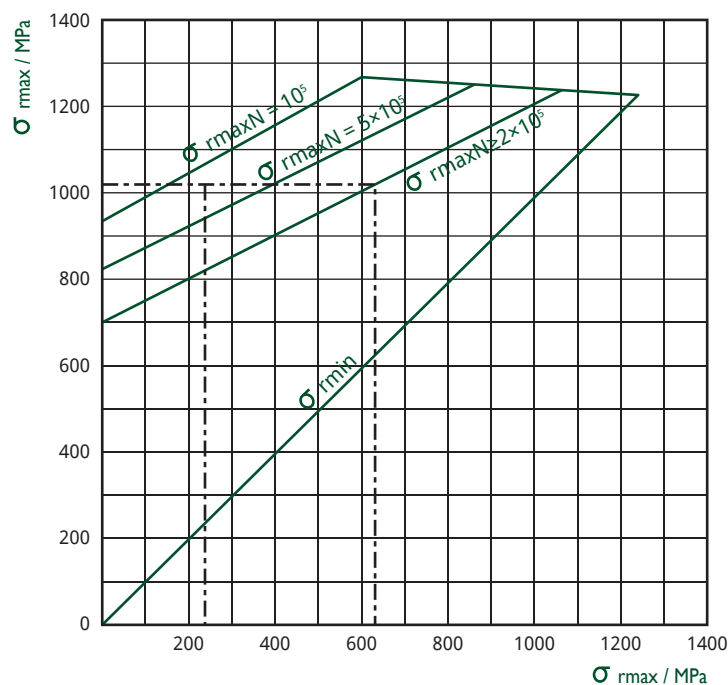
Shown at left are some examples of different cone-height-to-thickness ratios, and up to a ratio of 1.5 the disc springs may safely be taken to a 'flat' state or stacked in columns.

Above ratio 1.5 the disc spring will adopt a regressive characteristic, and is capable of 'push-through.' if not fully supported. Disc springs with cone height/thickness ratios above 2.0 may invert when compressed toward the 'flat' condition.

## ● Fatigue Values

Graphs apply to Group 2 and 3 disc springs made of 50 Cr V 4 and Group 1 disc springs made of Ck 67. The maximum fatigue life can be achieved with a statistical probability of 99 % under the following conditions:

- Disc spring stacks with a maximum of 10 individual disc springs stacked facing alternate ways
- Sinusoidal deflection - time function with a constant stroke and at a constant frequency below, permissible thermal limit
- Guidance on guides (rod or sleeve) as noted in and hardened and ground surfaces of stack disc springs
- Proper lubrication
- Operating at room temperature



Number of load cycles achieved may reduce if operating conditions deviate from test conditions. This applies in particular to sudden load changes occurring during operation, faulty lubrication, or with corrosion and surface imperfections.

When the number of stacked disc springs increases, the number of load cycles is reduced in comparison to a single disc spring. This is influenced by:

- Friction between the disc springs and guides
- Friction between the disc springs in parallel

※ All stated results are from random tests on ongoing production and established based on standard international tests with the intention of indicating general characteristics only.

## ● Washer Stacking Design Information

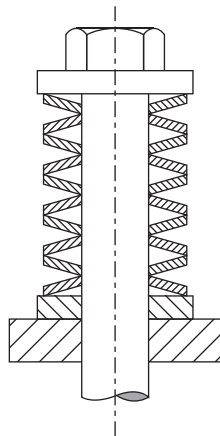
Following conditions should be satisfied for the design of a disc spring stack:

- Single springs stacked in series are used when the deflection of a single disc spring is not sufficient.
- Single disc springs stacked in parallel are used if high loads have to be achieved in limited space.
- Large spring diameters enable low overall heights.
- Usually no more than 2 to 4 disc springs should be stacked, with increasing the number of disc springs the discrepancies between the calculated and measured characteristics increases due to friction (the influence of friction cannot be taken into consideration in the calculation program).

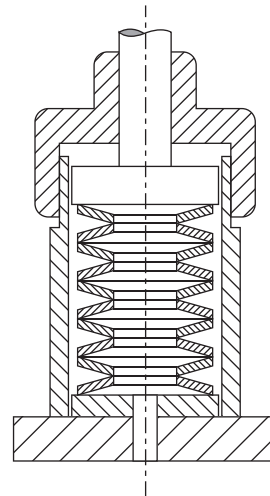
### Guides

Disc spring stacks should be guided. This is achieved with a guiding element as:

- Guide rod (internal guidance)
- Guide sleeve (external guidance)



**Internal**



**External**

*Different types of guides for spring stacks*

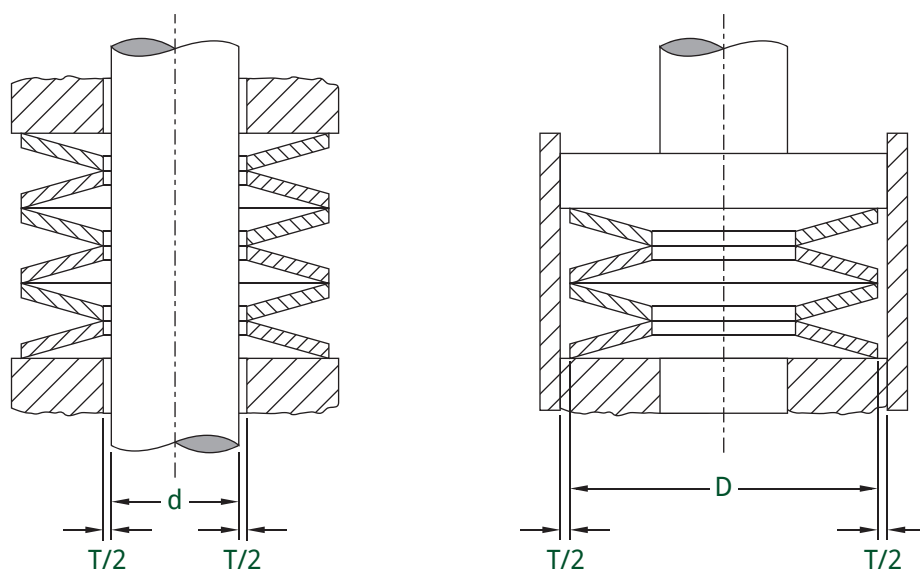
Both internal and external guides should be ground their entire length and hardened to at least 55 HRC.

In the case of static or infrequent load changes, an un-hardened guide may be used. In disc spring stacks the force can be applied via either the inner or outer diameter. Note that if force is applied on the inner diameter, higher surface pressures may occur.

## Guides

Internal and external guides require some clearance  $T$  between the disc springs and guide to allow for displacement of the lubricant and proper guidance.

The table shows total clearance  $T$  for both types of guides, depending on the disc springs inner diameter  $d$  (internal guides) or the disc springs outer diameter  $D$  (external guides).



*Disc spring guides, internal and external, clearance  $T$  between disc springs and guide*

| <b>D / d (mm)</b> | <b>Total clearance <math>T</math> (mm)</b> |
|-------------------|--------------------------------------------|
| 16                | 0.2                                        |
| 16 ~ 20           | 0.3                                        |
| 20 ~ 26           | 0.4                                        |
| 26 ~ 31.5         | 0.5                                        |
| 31.5 ~ 50         | 0.6                                        |
| 50 ~ 80           | 0.8                                        |
| 80 ~ 140          | 1.0                                        |
| 140 ~ 250         | 1.6                                        |
| > 250             | 2.0                                        |

*Total clearance between the disc springs and guides*

## Helpful Tips

### ● Helpful Tips for Selecting Disc Springs

In applications involving large numbers of cycles, e.g. dynamic applications, or when the required forces or deflections are critical, it is strongly recommended that disc springs conforming to the GB/T 1972-1992 (DIN 2093) specification are used.

From the available range, if possible select the largest disc spring compatible with the required characteristics. This will assist with maintaining the lowest stresses, enhancing fatigue life, and in stacked columns greater deflection by the larger disc springs will ensure the shortest stack length.

In static or dynamic applications, select disc springs that at 75% of total deflection offer maximum force and/or deflection. Between 75% and the “flattened position, the actual force characteristics become greater than those calculated.

As a result of the manufacturing process, residual tensile stresses occur at d, the upper inside diameter edge, which will revert to normal compressive stress when the disc spring is deflected up to approx. 15% of total deflection.

The fatigue life in applications with high cyclic deflections will be reduced by these stress reversals. For this reason, it is important that disc springs used for dynamic applications are pretloaded to a minimum of 15%.

### ● Helpful Tips for Installing Disc Springs

Proper guidance and location of disc springs is essential, and will ensure the desired reliability and consistency.

Note that the disc spring is sufficient for providing static clamping on steel or cast/forged steel, but that if the seating faces are of other materials (aluminum, copper, brass etc.), it is better to a hardened washer to prevent face damage. Dynamic applications, having a high number of cycles, will require hardened guidance surfaces to prevent excessive wear. For both washers and guides, a polished surface of 58HRC hardness is sufficient.

An important aid to efficient and extended life is lubrication. For low cycle number applications the application of a solid lubricant to the contact points and locating surface, e.g. MoS<sub>2</sub> grease, is adequate.

For dynamic or corrosive applications, the disc will benefit from continuous lubrication or being housed in an oil or grease filled housing.



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## **AIGI ENVIRONMENTAL INCORPORATED**

*A Subsidiary of AIGI Group*

81 Suyuan Avenue, Jiangning District, Nanjing 211100, PR China

[www.aigienviroental.com](http://www.aigienviroental.com)

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