

**Starrett®**

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# TWIN Rockwell Hardness Tester

**Model No. 3815**

**Operation Manual**



**Technical Support**

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# TWIN Rockwell Hardness Tester

## Operating Instructions & Parts Manual

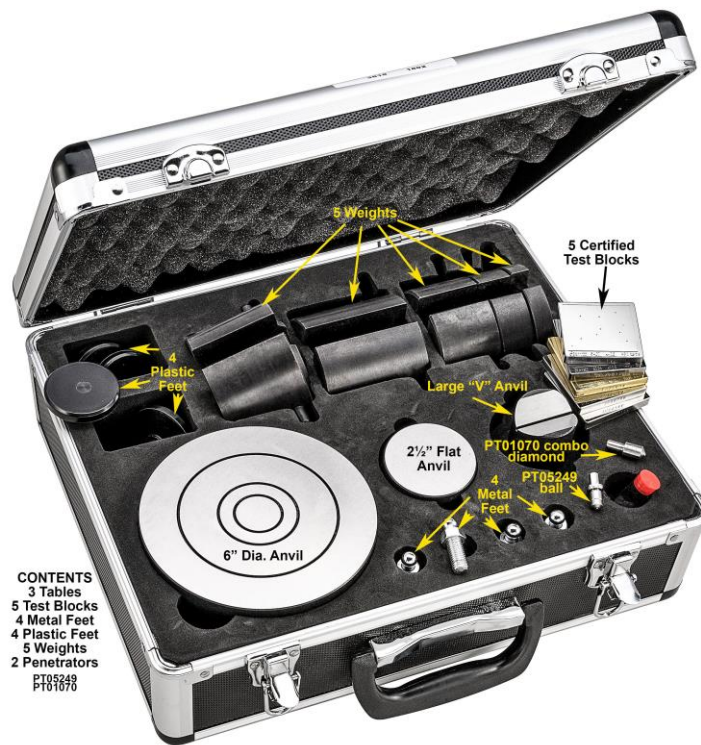
Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the products described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain Instructions for future reference.

## Description

The 3815 Hardness Tester accurately measures hardness of materials in standard Rockwell scales as well as Superficial Rockwell scales. Heat-treated steels are tested using a 120° diamond indenter. Soft/thin materials are tested using a 1/16" carbide ball indenter. This tester features a weight adjustment knob for quick and easy adjustments between different scales. Release/reset lever is provided for quick and accurate testing.

## Tool Kit Accessories:

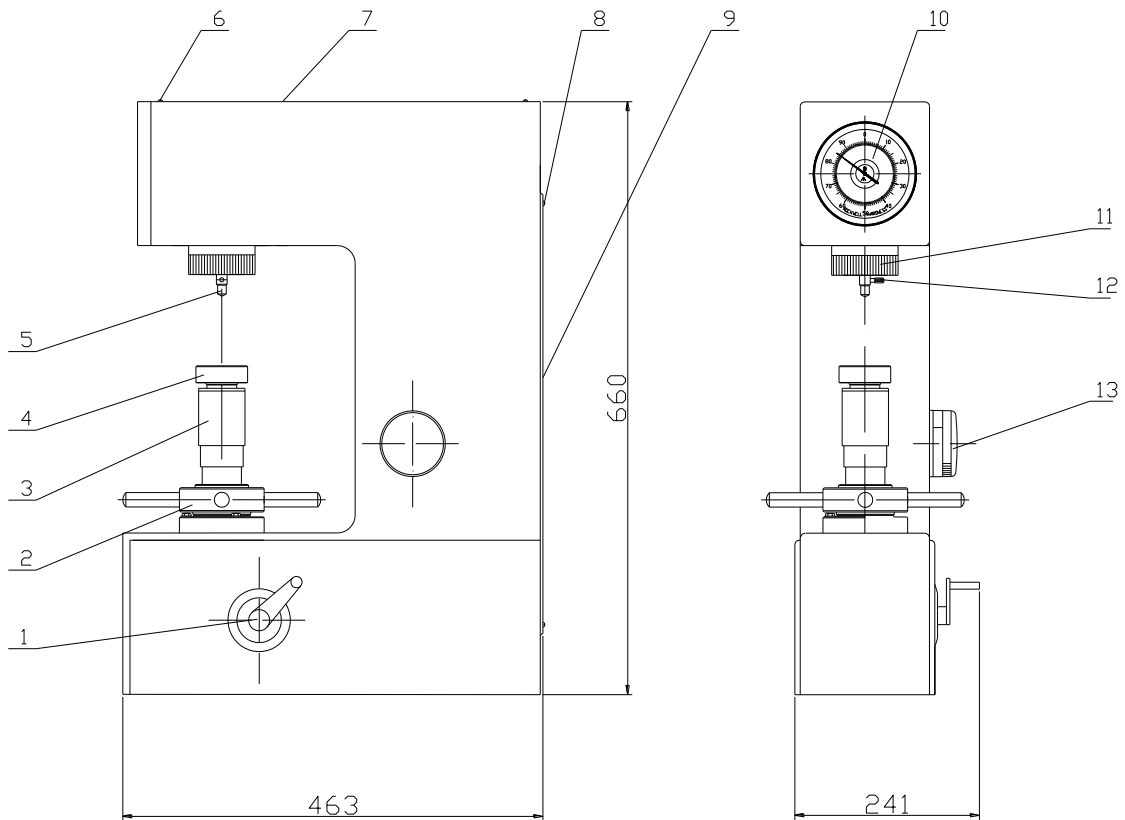
- A. Large Anvil
- B. V-shaped Anvil
- C. Small Round Anvil
- D. Spot Anvil
- E. 5 Rockwell Test Blocks
  - 1. Two each, HRC
  - 2. One each, HRB
  - 3. Two each, HRN
  - 4. One each, HRT
- F. 120° Diamond Indenter
- G. 1/16" Carbide Ball indenter
- H. Machine Cover
- I. Set of leveling Feet
- J. 5-Weights



# IMPORTANT!

Do Not Discard Shipping Crate as This May  
be Needed for Future Transportation.

# Operating Instructions & Parts Manual



- 1.** Load/Unload Handle **2.** Handwheel **3.** Elevation Screw Cover  
**4.** Anvil **5.** Indenter **6.** Screw for cover **7.** Top cover  
**8.** Screw for rear cover **9.** Rear cover **10.** Indicator  
**11.** Rockwell "R" — Surface Rockwell "SR" conversion dial  
**12.** Indenter Locking Screw **13.** Weight Selector Knob

## General Safety Instructions

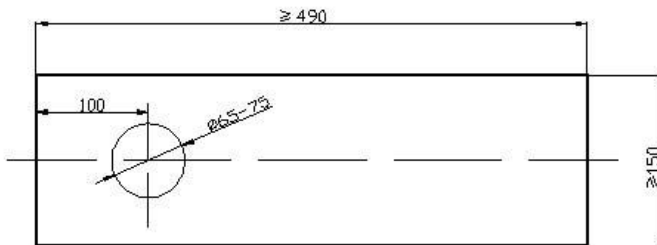
1. Never use clamps, straps, any other tooling or equipment to mount specimen to the tester anvil.
2. Always use the proper anvil supplied.
3. Be sure to use proper indenter and weight for material and hardness to be tested. (See Figure 3).

## Hardness Tester Should Be Maintained

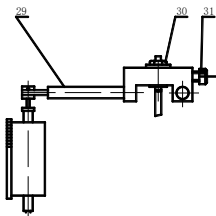
1. Consult operation instructions for specific maintaining and adjusting procedures.
2. Keep the tool clean for best results.
3. Remove adjusting tools and wrenches. Form habit of checking that adjusting tools are removed before using machine.
4. Keep all parts in working order. Check to determine that the parts will operate properly and perform their intended function.
5. Check for damaged parts. Check for alignment, binding, breakage, mounting and any other condition that may affect tool's operation.
6. Part that is damaged should be properly repaired or replaced. Do not perform makeshift repairs. (Use the parts list provided to order replacement parts.)

## Basic Set-Up Information:

- 1) Remove Top crate cover from base. Carefully lift straight up to avoid scratching the side of the machine
- 2) Remove the tool kit and manual from the base of the crate
- 3) Remove plastic machine cover
- 4) With assistance, remove the two bolts under the base of the crate to remove the machine from the base.
- 5) Place machine on a sturdy vibration free table or bench. Bench should be rated for up to 500lbs.
- 6) It is recommended that the machine gets bolted to the table. To do this you should reference Figure 1 shown below



- 7) In order for the elevation screw to be lowered to accept maximum size part, you must drill a hole in the table to allow the elevation screw to travel through. Diagram shown above.
- 8) Remove top cover and remove white string from extension rod (shown below). Replace Cover



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- 9) Remove back cover and begin to remove white string from all moving parts
- 10) Place weights on weight bar in order as shown below
- 11) Proceed to lower the main lead screw and remove the rubber block that is protecting the indenter housing
- 12) **Clean and lubricate the lead screw using light duty spindle oil.** The best way to do this is lower the elevation screw and then unscrew the handwheel from the elevation screw. Wipe down all surfaces, lightly coat with oil and put the handwheel back on the elevation screw.
- 13) Be sure tester is level both front/back and left/right to 0.002 in/in.

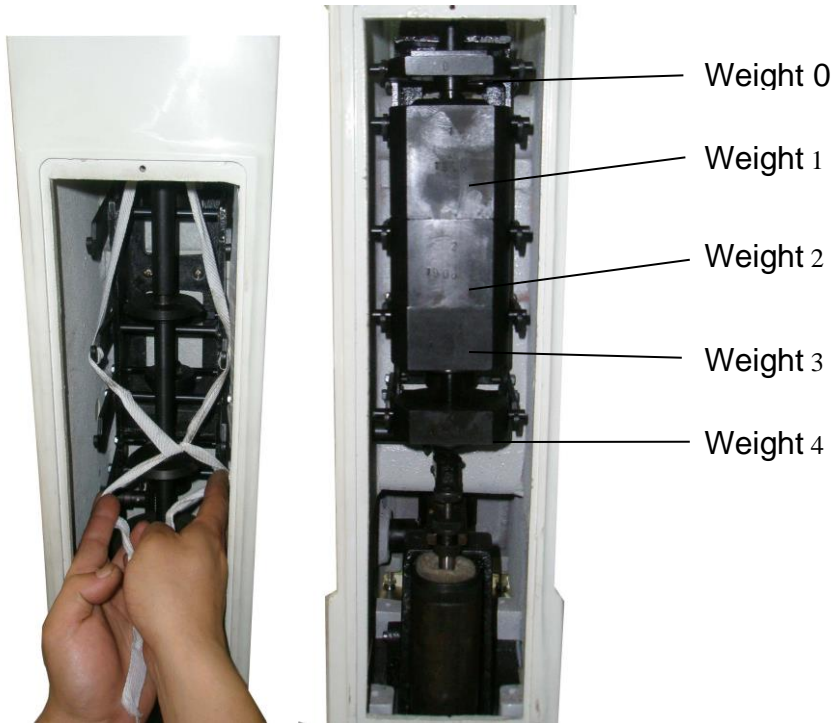


Figure 2

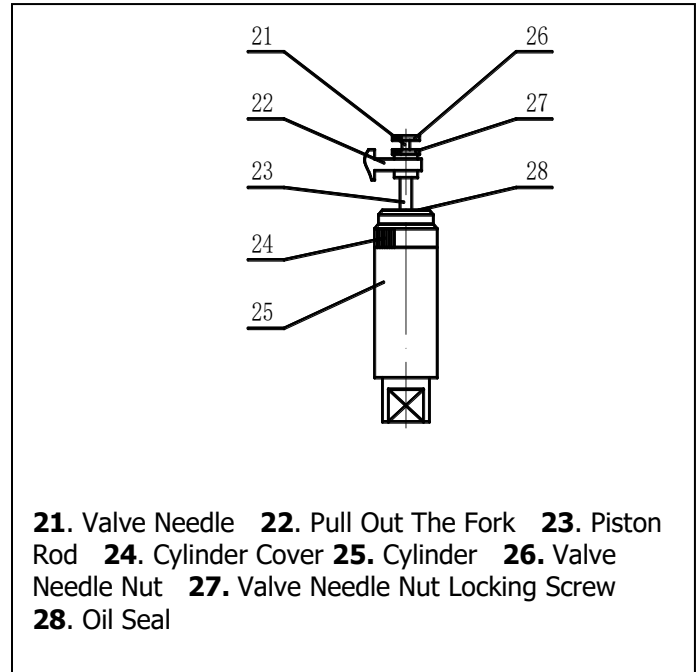


Figure 3

## How to fill oil in the dashpot (Figure 3)

The cylinder is filled with oil at the factory. In case of oil leakage during transportation, user can refill the dashpot by following these simple instructions:

- a) loosen and take off two (8) screws on rear cover (9),
- b) remove the cover and push the pressure applying handle (1) forward. (see Figure
- c) Lift up felt cover(28) and fill machine oil slowly.
- d) Use good quality light duty hydraulic oil

**Note : the oil level shall not exceed the joint surface between cylinder cover and cylinder body, otherwise oil will leak out.**

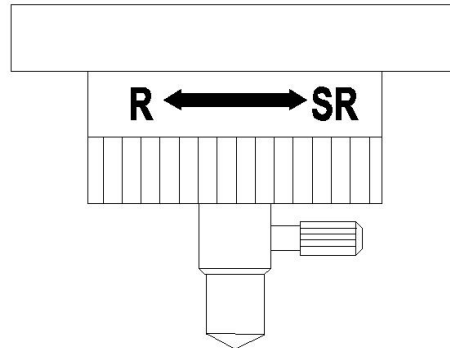
# Operating Instructions & Parts Manual

## Operation:

1. Determine the proper indenter, scale and weight for the material hardness to be tested (**see charts in back of manual**) Mount the required indenter in the indenter holder using the set screw on the side of the holder.
2. Set Preliminary test force setting using dial shown below.

**R** = Standard Rockwell scales

**SR** = Superficial Rockwell scales



## Seating Your Diamond:

**Caution:** To ensure accuracy, mount the indenter by sliding it in the holder as far as possible and then securing the indenter by tightening the set screw finger-tight only.

Place HRC test block on the small round anvil and begin by turning the handwheel clockwise until the block just touches the diamond. At this point, continue rotating the handwheel until the large needle goes around approx. 3 revolutions. Let the machine sit idle for a few seconds and then loosen the set screw. Wait a few more seconds and then tighten the set screw back up. This will allow the diamond to be “seated” in the shank. Take the load off by turning the handwheel counter-clockwise and you can begin following instructions below.

Rotate the weight adjustment knob until the required weight scale is aligned with the alignment mark on the frame of the machine.

3. Prepare the test specimen properly. Be sure that the top and bottom surfaces of the specimen are clean and free of any grease, oil dirt, etc and free of any burrs or debris.
4. For small specimens (under 3" maximum length or diameter) use the small round anvil. Use the large anvil for larger specimens. Use the V-shaped anvil for round or curved specimens.

**Warning: Do not test any specimen that cannot be safely and properly positioned on and supported by the tester anvil.**

## Test Procedure

Test procedure consists of a preload of the specimen using the force of the elevation screw and a test load using the weights and lever arm assembly. Be sure that the weight reset handle is in rest (“unload”) position.

1. Mount specimen on required anvil. Rotate the elevation screw threaded collar clockwise slowly until the specimen contacts the indenter. Be sure to position specimen so the indenter contacts clean, untested material.
2. Preload the specimen by rotating the leadscrew collar slowly until the large needle on the dial indicator rotates two to three (2-3) revolutions. Stop rotation of handwheel when the large needle is within 3 hash marks of vertical (TDC)

**Caution: As the large needle is properly rotated 2-3 revolutions, the small needle rotates counterclockwise 90° to vertical at the red dot. If the large needle overshoots vertical by more than 5 hash marks, the test is invalid and must be repeated from step 1.**

3. Rotate the bezel so that the hash mark at the “0” mark at the top of the dial is aligned with the large needle.
4. Pull the weight release handle to apply the major load. Wait until the large needle stops rotating, approx. 5-8 seconds. This 5-8 second “dwell” time can be adjusted by turning valve on dashpot.
5. Slowly push the weight reset handle back until it resets and locks in the reset position.
6. Read the material hardness from the required scale on the dial.
7. Rotate the handwheel counterclockwise to lower and release the specimen.



## Fine Adjustment:

Although the hardness tester has been calibrated at the factory, transportation can sometimes cause the machine to be slightly out of tolerance. Therefore it is suggested that the end user make slight adjustments to bring the machine back into the allowable tolerance.

Please be sure to make very slight adjustments when calibrating the 3815 as this machine is extremely sensitive to any movement.

Remove the top cover off the 3815.

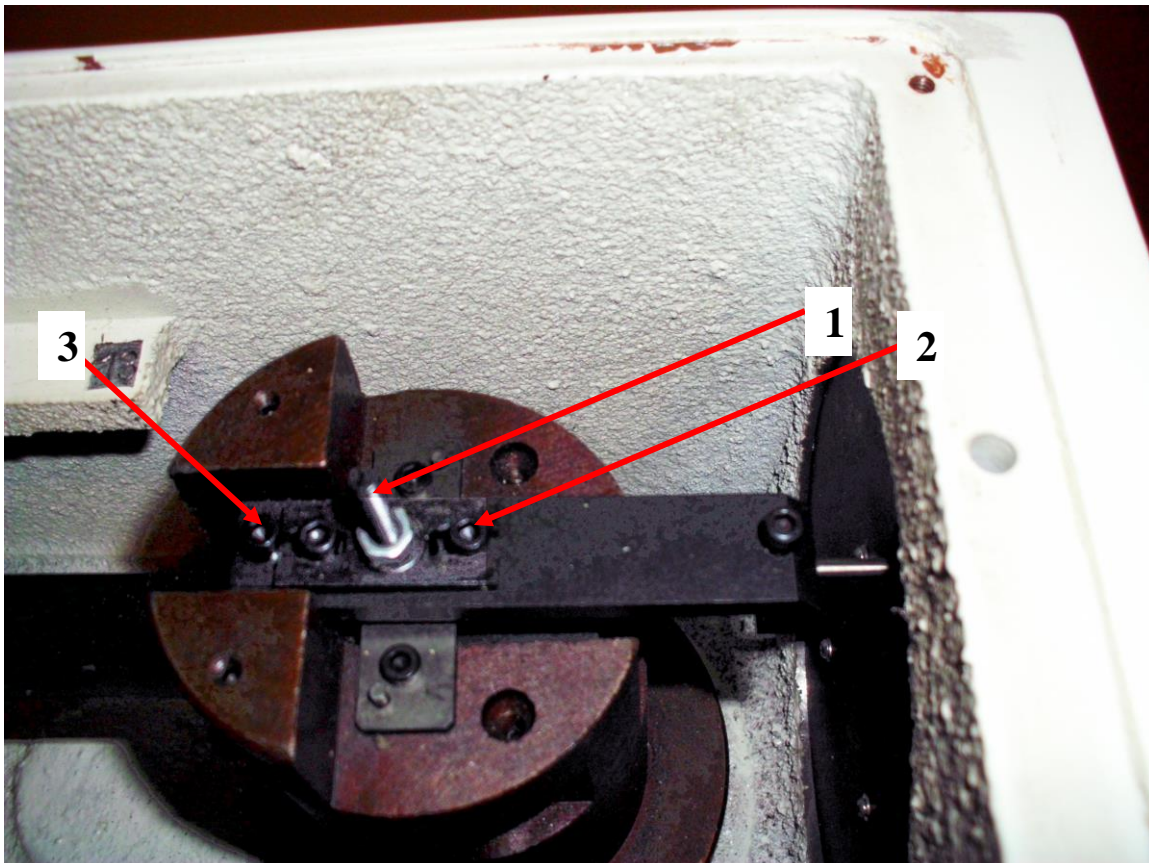
Always test first in Rockwell C scale. Install diamond indenter and set weight selector to 150kg(1471N).

## Adjusting the set screw that controls the Indicator needle starting point:

Carefully hold the #1 set screw with a thin blade regular screwdriver. While holding this screw steady, carefully loosen the set screw hex nut. Slightly turn the set screw until the Large needle on the dial is between 3-5 hash marks to the LEFT of the "0".

Take a minimum of 3 tests on your test block to make sure the machine is reading correctly. If readings are low, you must loosen Allan screw #2 & #3 as shown below and gently slide the plate towards the front of the machine. if the readings were high then you must move the plate slightly towards the back of the machine. Take 3 more tests on each block to verify your readings are within the allowable tolerance. If still out then you must repeat the steps above.

*Please see picture below:*



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## Maintenance

1. If large needle on the dial indicator rotates suddenly at first and then slows during a test, then the dash pot may be low on oil. To fill the dash pot, go to Page 5 in this manual and follow instructions. Bleed the air from the dash pot by manually raising and lowering the dash pot piston until all air bubbles have been released from under the piston.
2. Be sure elevation screw and threaded collar are clean and lubricated. Lubricate with general purpose wheel bearing grease.
3. Keep top of leadscrew, collar and anvils clean and free of grease, oil, dirt, burrs, etc.
4. Use the test blocks periodically to check tester accuracy.

## Troubleshooting Chart

| Symptom  | Possible cause(s)  | Corrective Action   |
|--|--|---|
| Incorrect hardness measurement   | <ol style="list-style-type: none"> <li>1. Contaminants effecting measurement</li> <li>2. Elevation screw cover &amp; top, are interfering with specimen, anvil or elevation screw.</li> <li>3. Indentor is damaged.</li> <li>4. Dash pot is low on oil.</li> </ol> | <ol style="list-style-type: none"> <li>1. Be sure the anvil, top of elevation screw, threaded collar, indentor and specimen are all clean and free of oil, grease, dirt, shavings, debris, etc.</li> <li>2. Be sure elevation screw cover and top is clean and free of any dirt, oil, grease, etc. Position cover properly on the elevation screw.</li> <li>3. Inspect indentor for damage, replace diamond indentor if chipped or broken, replace 1/16" carbide ball if deformed or damaged.</li> <li>4. Refill dash pot, see Maintenance, above.</li> </ol> |
| When using the test block, a different hardness is measured at different locations on the block. | <ol style="list-style-type: none"> <li>1. Burrs on bottom of test block.</li> <li>2. Air trapped under test block.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Use oil sharpening stone to remove burrs.</li> <li>2. When testing different locations on a test block, slide test block on anvil, maintaining contact between anvil and block.</li> </ol>  |
| Dial indicator needle rotates too fast at start of test  | <ol style="list-style-type: none"> <li>1. Dash pot is low on oil.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Refill dash pot<br/>See Maintenance, above.</li> </ol>  |



# Operating Instructions & Parts Manual

**Approximate Hardness Conversion Numbers for Non-Austenitic Steels (Rockwell C Hardness Range)<sup>A</sup>**

| Rockwell C<br>150kgf<br>(HRC) | Vickers<br>(HV) | Brinell Hardness Number <sup>c</sup>          |  | Knoop<br>500-gf<br>and<br>Over<br>(HK) | Rockwell                      |                               | Superficial Rockwell Number        |                                    |                                    | Scleroscope<br>Hardness <sub>s</sub> |
|-------------------------------|-----------------|---|--|--|-------------------------------|-------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|
|                               |                 | 10-mm<br>Standard<br>ball<br>3000kgf<br>(HBS) | 10-mm<br>Carbide<br>ball<br>3000kgf<br>(HBW) |  | A<br>Scale<br>60 kgf<br>(HRA) | D<br>Scale<br>100kgf<br>(HRD) | 15-N<br>Scale<br>15-kgf<br>(HR15N) | 30-N<br>Scale<br>30-kgf<br>(HR30N) | 45-N<br>Scale<br>45-kgf<br>(HR45N) |                                      |
| 68                            | 940             | ...   | ...  | 920                                    | 85.6                          | 76.9                          | 93.2                               | 84.4                               | 75.4                               | 97.3                                 |
| 67                            | 900             | ...   | ...  | 895                                    | 85.0                          | 76.1                          | 92.9                               | 83.6                               | 74.2                               | 95.0                                 |
| 66                            | 865             | ...   | ...  | 870                                    | 84.5                          | 75.4                          | 92.5                               | 82.8                               | 73.3                               | 92.7                                 |
| 65                            | 832             | ...   | (739)  | 846                                    | 83.9                          | 74.5                          | 92.2                               | 81.9                               | 72.0                               | 90.6                                 |
| 64                            | 800             | ...   | (722)  | 822                                    | 83.4                          | 73.8                          | 91.8                               | 81.1                               | 71.0                               | 88.5                                 |
| 63                            | 772             | ...   | (705)  | 799                                    | 82.8                          | 73.0                          | 91.4                               | 80.1                               | 69.9                               | 86.5                                 |
| 62                            | 746             | ...   | (688)  | 776                                    | 82.3                          | 72.2                          | 91.1                               | 79.3                               | 68.8                               | 84.5                                 |
| 61                            | 720             | ...   | (670)  | 754                                    | 81.8                          | 71.5                          | 90.7                               | 78.4                               | 67.7                               | 82.6                                 |
| 60                            | 697             | ...   | (654)  | 732                                    | 81.2                          | 70.7                          | 90.2                               | 77.5                               | 66.6                               | 80.8                                 |
| 59                            | 674             | ...   | 634  | 710                                    | 80.7                          | 69.9                          | 89.8                               | 76.6                               | 65.5                               | 79.0                                 |
| 58                            | 653             | ...   | 615  | 690                                    | 80.1                          | 69.2                          | 89.3                               | 75.7                               | 64.3                               | 77.3                                 |
| 57                            | 633             | ...   | 595  | 670                                    | 79.6                          | 68.5                          | 88.9                               | 74.8                               | 63.2                               | 75.6                                 |
| 56                            | 613             | ...   | 577  | 650                                    | 79.0                          | 67.7                          | 88.3                               | 73.9                               | 62.0                               | 74.0                                 |
| 55                            | 595             | ...   | 560  | 630                                    | 78.5                          | 66.9                          | 87.9                               | 73.0                               | 60.9                               | 72.4                                 |
| 54                            | 577             | ...   | 543  | 612                                    | 78.0                          | 66.1                          | 87.4                               | 72.0                               | 59.8                               | 70.9                                 |
| 53                            | 560             | ...   | 525  | 594                                    | 77.4                          | 65.4                          | 86.9                               | 71.2                               | 58.6                               | 69.4                                 |
| 52                            | 544             | (500)   | 512  | 576                                    | 76.8                          | 64.6                          | 86.4                               | 70.2                               | 57.4                               | 67.9                                 |
| 51                            | 528             | (487)   | 496  | 558                                    | 76.3                          | 63.8                          | 85.9                               | 69.4                               | 56.1                               | 66.5                                 |
| 50                            | 513             | (475)   | 481  | 542                                    | 75.9                          | 63.1                          | 85.5                               | 68.5                               | 55.0                               | 65.1                                 |
| 49                            | 498             | (464)   | 469  | 526                                    | 75.2                          | 62.1                          | 85.0                               | 67.6                               | 53.8                               | 63.7                                 |
| 48                            | 484             | 451   | 455  | 510                                    | 74.7                          | 61.4                          | 84.5                               | 66.7                               | 52.5                               | 62.4                                 |
| 47                            | 471             | 442   | 443  | 495                                    | 74.1                          | 60.8                          | 83.9                               | 65.8                               | 51.4                               | 61.1                                 |
| 46                            | 458             | 432   | 432  | 480                                    | 73.6                          | 60.0                          | 83.5                               | 64.8                               | 50.3                               | 59.8                                 |
| 45                            | 446             | 421   | 421  | 466                                    | 73.1                          | 59.2                          | 83.0                               | 64.0                               | 49.0                               | 58.5                                 |
| 44                            | 434             | 409   | 409  | 452                                    | 72.5                          | 58.5                          | 82.5                               | 63.1                               | 47.8                               | 57.3                                 |
| 43                            | 423             | 400   | 400  | 438                                    | 72.0                          | 57.7                          | 82.0                               | 62.2                               | 46.7                               | 56.1                                 |
| 42                            | 412             | 390   | 390  | 426                                    | 71.5                          | 56.9                          | 81.5                               | 61.3                               | 45.5                               | 54.9                                 |
| 41                            | 402             | 381   | 381  | 414                                    | 70.9                          | 56.2                          | 80.9                               | 60.4                               | 44.3                               | 53.7                                 |
| 40                            | 392             | 371   | 371  | 402                                    | 70.4                          | 55.4                          | 80.4                               | 59.5                               | 43.1                               | 52.6                                 |
| 39                            | 382             | 362   | 362  | 391                                    | 69.9                          | 54.6                          | 79.9                               | 58.6                               | 41.9                               | 51.5                                 |
| 38                            | 372             | 353   | 353  | 380                                    | 69.4                          | 53.8                          | 79.4                               | 57.7                               | 40.8                               | 50.4                                 |
| 37                            | 363             | 344   | 344  | 370                                    | 68.9                          | 53.1                          | 78.8                               | 56.8                               | 39.6                               | 49.3                                 |
| 36                            | 354             | 336   | 336  | 360                                    | 68.4                          | 52.3                          | 78.3                               | 55.9                               | 38.4                               | 48.2                                 |
| 35                            | 345             | 327   | 327  | 351                                    | 67.9                          | 51.5                          | 77.7                               | 55.0                               | 37.2                               | 47.1                                 |
| 34                            | 336             | 319   | 319  | 342                                    | 67.4                          | 50.8                          | 77.2                               | 54.2                               | 36.1                               | 46.1                                 |
| 33                            | 327             | 311   | 311  | 334                                    | 66.8                          | 50.0                          | 76.6                               | 53.3                               | 34.9                               | 45.1                                 |
| 32                            | 318             | 301   | 301  | 326                                    | 66.3                          | 49.2                          | 76.1                               | 52.1                               | 33.7                               | 44.1                                 |
| 31                            | 310             | 294   | 294  | 318                                    | 65.8                          | 48.4                          | 75.6                               | 51.3                               | 32.5                               | 43.1                                 |
| 30                            | 302             | 286   | 286  | 311                                    | 65.3                          | 47.7                          | 75.0                               | 50.4                               | 31.3                               | 42.2                                 |
| 29                            | 294             | 279   | 279  | 304                                    | 64.8                          | 47.0                          | 74.5                               | 49.5                               | 30.1                               | 41.3                                 |
| 28                            | 286             | 271   | 271  | 297                                    | 64.3                          | 46.1                          | 73.9                               | 48.6                               | 28.9                               | 40.4                                 |
| 27                            | 279             | 264   | 264  | 290                                    | 63.8                          | 45.2                          | 73.3                               | 47.7                               | 27.8                               | 39.5                                 |
| 26                            | 272             | 258   | 258  | 284                                    | 63.3                          | 44.6                          | 72.8                               | 46.8                               | 26.7                               | 38.7                                 |
| 25                            | 266             | 253   | 253  | 278                                    | 62.8                          | 43.8                          | 72.2                               | 45.9                               | 25.5                               | 37.8                                 |
| 24                            | 260             | 247   | 247  | 272                                    | 62.4                          | 43.1                          | 71.6                               | 45.0                               | 24.3                               | 37.0                                 |
| 23                            | 254             | 243   | 243  | 266                                    | 62.0                          | 42.1                          | 71.0                               | 44.0                               | 23.1                               | 36.3                                 |
| 22                            | 248             | 237   | 237  | 261                                    | 61.5                          | 41.6                          | 70.5                               | 43.2                               | 22.0                               | 35.5                                 |
| 21                            | 243             | 231   | 231  | 256                                    | 61.0                          | 40.9                          | 69.9                               | 42.3                               | 20.7                               | 34.8                                 |
| 20                            | 238             | 226   | 226  | 251                                    | 60.5                          | 40.1                          | 69.4                               | 41.5                               | 19.6                               | 34.2                                 |

# Operating Instructions & Parts Manual

**Approximate Hardness Conversion Numbers for Non-Austenitic Steels (Rockwell B Hardness Range)<sup>A</sup>**

| Rockwell B<br>100kgf<br>(HRB) | Vickers<br>(HV) | 10-mm<br>Standard<br>ball<br>3000kgf<br>(HBS) | Knoop<br>500-gf<br>and<br>Over<br>(HK) | Rockwell Superficial Rockwell Number |                           |                                 |                                 |                                 |
|-------------------------------|-----------------|---|--|--------------------------------------|---------------------------|---------------------------------|---------------------------------|---------------------------------|
|                               |                 |   |  | A<br>Scale<br>60 kgf<br>(HRA)        | F Scale<br>60kgf<br>(HRF) | 15-T Scale<br>15-kgf<br>(HR15T) | 30-T Scale<br>30-kgf<br>(HR30T) | 45-T Scale<br>45-kgf<br>(HR45T) |
| 100                           | 240             | 240   | 251                                    | 61.5                                 | ...                       | 93.1                            | 83.1                            | 72.9                            |
| 99                            | 234             | 234   | 246                                    | 60.9                                 | ...                       | 92.8                            | 82.5                            | 71.9                            |
| 98                            | 228             | 228   | 241                                    | 60.2                                 | ...                       | 92.5                            | 81.8                            | 70.9                            |
| 97                            | 222             | 222   | 236                                    | 59.5                                 | ...                       | 92.1                            | 81.1                            | 69.9                            |
| 96                            | 216             | 216   | 231                                    | 58.9                                 | ...                       | 91.8                            | 80.4                            | 68.9                            |
| 95                            | 210             | 210   | 226                                    | 58.3                                 | ...                       | 91.5                            | 79.8                            | 67.9                            |
| 94                            | 205             | 205   | 221                                    | 57.6                                 | ...                       | 91.2                            | 79.1                            | 66.9                            |
| 93                            | 200             | 200   | 216                                    | 57.0                                 | ...                       | 90.8                            | 78.4                            | 65.9                            |
| 92                            | 195             | 195   | 211                                    | 56.4                                 | ...                       | 90.5                            | 77.8                            | 64.8                            |
| 91                            | 190             | 190   | 206                                    | 55.8                                 | ...                       | 90.2                            | 77.1                            | 63.8                            |
| 90                            | 185             | 185   | 201                                    | 55.2                                 | ...                       | 89.9                            | 76.4                            | 62.8                            |
| 89                            | 180             | 180   | 196                                    | 54.6                                 | ...                       | 89.5                            | 75.8                            | 61.8                            |
| 88                            | 176             | 176   | 192                                    | 54.0                                 | ...                       | 89.2                            | 75.1                            | 60.8                            |
| 87                            | 172             | 172   | 188                                    | 53.4                                 | ...                       | 88.9                            | 74.4                            | 59.8                            |
| 86                            | 169             | 169   | 184                                    | 52.8                                 | ...                       | 88.6                            | 73.8                            | 58.8                            |
| 85                            | 165             | 165   | 180                                    | 52.3                                 | ...                       | 88.2                            | 73.1                            | 57.8                            |
| 84                            | 162             | 162   | 176                                    | 51.7                                 | ...                       | 87.9                            | 72.4                            | 56.8                            |
| 83                            | 159             | 159   | 173                                    | 51.1                                 | ...                       | 87.6                            | 71.8                            | 55.8                            |
| 82                            | 156             | 156   | 170                                    | 50.6                                 | ...                       | 87.3                            | 71.1                            | 54.8                            |
| 81                            | 153             | 153   | 167                                    | 50.0                                 | ...                       | 86.9                            | 70.4                            | 53.8                            |
| 80                            | 150             | 150   | 164                                    | 49.5                                 | ...                       | 86.6                            | 69.7                            | 52.8                            |
| 79                            | 147             | 147   | 161                                    | 48.9                                 | ...                       | 86.3                            | 69.1                            | 51.8                            |
| 78                            | 144             | 144   | 158                                    | 48.4                                 | ...                       | 86.0                            | 68.4                            | 50.8                            |
| 77                            | 141             | 141   | 155                                    | 47.9                                 | ...                       | 85.6                            | 67.7                            | 49.8                            |
| 76                            | 139             | 139   | 152                                    | 47.3                                 | ...                       | 85.3                            | 67.1                            | 48.8                            |
| 75                            | 137             | 137   | 150                                    | 46.8                                 | 99.6                      | 85.0                            | 66.4                            | 47.8                            |
| 74                            | 135             | 135   | 147                                    | 46.3                                 | 99.1                      | 84.7                            | 65.7                            | 46.8                            |
| 73                            | 132             | 132   | 145                                    | 45.8                                 | 98.5                      | 84.3                            | 65.1                            | 45.8                            |
| 72                            | 130             | 130   | 143                                    | 45.3                                 | 98.0                      | 84.0                            | 64.4                            | 44.8                            |
| 71                            | 127             | 127   | 141                                    | 44.8                                 | 97.4                      | 83.7                            | 63.7                            | 43.8                            |
| 70                            | 125             | 125   | 139                                    | 44.3                                 | 96.8                      | 83.4                            | 63.1                            | 42.8                            |
| 69                            | 123             | 123   | 137                                    | 43.8                                 | 96.2                      | 83.0                            | 62.4                            | 41.8                            |
| 68                            | 121             | 121   | 135                                    | 43.3                                 | 95.6                      | 82.7                            | 61.7                            | 40.8                            |
| 67                            | 119             | 119   | 131                                    | 42.8                                 | 95.1                      | 82.4                            | 61.0                            | 39.8                            |
| 66                            | 117             | 117   | 129                                    | 42.3                                 | 94.5                      | 82.1                            | 60.4                            | 38.7                            |
| 65                            | 116             | 116   | 127                                    | 41.8                                 | 93.9                      | 81.8                            | 59.7                            | 37.7                            |
| 64                            | 114             | 114   | 125                                    | 40.9                                 | 93.4                      | 81.4                            | 59.0                            | 36.7                            |
| 63                            | 112             | 112   | 124                                    | 40.4                                 | 92.8                      | 81.1                            | 58.4                            | 35.7                            |
| 62                            | 110             | 110   | 122                                    | 40.0                                 | 92.2                      | 80.8                            | 57.7                            | 34.7                            |
| 61                            | 108             | 108   | 120                                    | 39.5                                 | 91.7                      | 80.5                            | 57.0                            | 33.7                            |
| 60                            | 107             | 107   | 118                                    | 39.0                                 | 91.1                      | 80.1                            | 56.4                            | 32.7                            |
| 59                            | 106             | 106   | 117                                    | 38.6                                 | 90.5                      | 79.8                            | 55.7                            | 31.7                            |
| 58                            | 104             | 104   | 115                                    | 38.1                                 | 90.0                      | 79.5                            | 55.0                            | 30.7                            |
| 57                            | 103             | 103   | 114                                    | 37.7                                 | 89.4                      | 79.2                            | 54.4                            | 29.7                            |
| 56                            | 101             | 101   | 112                                    | 37.2                                 | 88.8                      | 78.8                            | 53.7                            | 28.7                            |
| 55                            | 100             | 100   | 111                                    | 36.8                                 | 88.2                      | 78.5                            | 53.0                            | 27.7                            |
| ...                           | ...             | ...   | 110                                    | 36.3                                 | 87.7                      | 78.2                            | 52.4                            | 26.7                            |
| ...                           | ...             | ...   | 109                                    | 35.9                                 | 87.1                      | 77.9                            | 51.7                            | 25.7                            |
| ...                           | ...             | ...   | 108                                    | 35.5                                 | 86.5                      | 77.5                            | 51.0                            | 24.7                            |
| ...                           | ...             | ...   | 107                                    | 35.0                                 | 86.0                      | 77.2                            | 50.3                            | 23.7                            |
| ...                           | ...             | ...   | 106                                    | 34.6                                 | 85.4                      | 76.98                           | 49.7                            | 22.7                            |
| ...                           | ...             | ...   | 105                                    | 34.1                                 | 84.8                      | 76.6                            | 49.0                            | 21.7                            |
| ...                           | ...             | ...   | 104                                    | 33.7                                 | 84.3                      | 76.2                            | 48.3                            | 20.7                            |
| ...                           | ...             | ...   | 103                                    | 33.3                                 | 83.7                      | 75.9                            | 47.7                            | 19.7                            |
| ...                           | ...             | ...   | 102                                    | 32.9                                 | 83.1                      | 75.6                            | 47.0                            | 18.7                            |
| ...                           | ...             | ...   | 101                                    | 32.4                                 | 82.6                      | 75.3                            | 46.3                            | 17.7                            |
| ...                           | ...             | ...   | 100                                    | 32.0                                 | 82.0                      | 74.9                            | 45.7                            | 16.7                            |
| ...                           | ...             | ...   | 99                                     | 31.6                                 | 81.4                      | 74.6                            | 45.0                            | 15.7                            |
| ...                           | ...             | ...   | 98                                     | 31.2                                 | 80.8                      | 74.3                            | 44.3                            | 14.7                            |
| ...                           | ...             | ...   | 97                                     | 30.7                                 | 80.3                      | 74.0                            | 43.7                            | 13.6                            |
| ...                           | ...             | ...   | 96                                     | 30.3                                 | 79.7                      | 73.6                            | 43.0                            | 12.6                            |
| ...                           | ...             | ...   | 95                                     | 29.9                                 | 79.1                      | 73.3                            | 42.3                            | 11.6                            |
| ...                           | ...             | ...   | 94                                     | 29.5                                 | 78.6                      | 73.0                            | 41.6                            | 10.6                            |
| ...                           | ...             | ...   | 93                                     | 29.1                                 | 78.0                      | 72.7                            | 41.0                            | 9.6                             |
| ...                           | ...             | ...   | 92                                     | 28.7                                 | 77.4                      | 72.3                            | 40.3                            | 8.6                             |
| ...                           | ...             | ...   | 91                                     | 28.2                                 | 76.9                      | 72.0                            | 39.6                            | 7.6                             |
| ...                           | ...             | ...   | 90                                     | 27.8                                 | 76.3                      | 71.7                            | 39.0                            | 6.6                             |
| ...                           | ...             | ...   | 89                                     | 27.4                                 | 75.7                      | 71.4                            | 38.3                            | 5.6                             |
| ...                           | ...             | ...   | 88                                     | 27.0                                 | 75.2                      | 71.0                            | 37.6                            | 4.6                             |
| ...                           | ...             | ...   | 87                                     | 26.6                                 | 74.6                      | 70.7                            | 37.0                            | 3.6                             |
| ...                           | ...             | ...   | ...                                    | ...                                  | 74.0                      | 70.4                            | 36.3                            | 2.6                             |

# Operating Instructions & Parts Manual

Approximate Leeb (Type D) Hardness Conversion for Non-Austenitic Steels (Rockwell C Hardness Range)<sup>A</sup>

| Leeb Hardness, Type D<br>Impact Device (HLD) | Rockwell C Hardness<br>150kgf (HRC) | Vickers Hardness<br>(HV 10) | Brinell Hardness<br>10mm Steel Ball<br>3000kgf (HBS) |
|--|-------------------------------------|-----------------------------|--|
| 828  | 62                                  | 762                         | (721)  |
| 819  | 61                                  | 737                         | (699)  |
| 809  | 60                                  | 711                         | (675)  |
| 800  | 59                                  | 688                         | (654)  |
| 791  | 58                                  | 667                         | 634  |
| 782  | 57                                  | 645                         | 614  |
| 773  | 56                                  | 625                         | 595  |
| 764  | 55                                  | 605                         | 577  |
| 755  | 54                                  | 586                         | 559  |
| 746  | 53                                  | 568                         | 542  |
| 737  | 52                                  | 550                         | 526  |
| 729  | 51                                  | 534                         | 511  |
| 720  | 50                                  | 517                         | 496  |
| 712  | 49                                  | 503                         | 482  |
| 703  | 48                                  | 487                         | 467  |
| 695  | 47                                  | 473                         | 455  |
| 687  | 46                                  | 460                         | 442  |
| 679  | 45                                  | 447                         | 430  |
| 671  | 44                                  | 434                         | 418  |
| 663  | 43                                  | 422                         | 407  |
| 655  | 42                                  | 410                         | 395  |
| 647  | 41                                  | 398                         | 385  |
| 640  | 40                                  | 388                         | 375  |
| 632  | 39                                  | 377                         | 365  |
| 625  | 38                                  | 368                         | 356  |
| 618  | 37                                  | 358                         | 347  |
| 611  | 36                                  | 349                         | 338  |
| 603  | 35                                  | 339                         | 328  |
| 596  | 34                                  | 330                         | 320  |
| 590  | 33                                  | 323                         | 313  |
| 583  | 32                                  | 314                         | 305  |
| 576  | 31                                  | 306                         | 297  |
| 570  | 30                                  | 299                         | 291  |
| 563  | 29                                  | 291                         | 283  |
| 557  | 28                                  | 284                         | 276  |
| 551  | 27                                  | 277                         | 270  |
| 545  | 26                                  | 271                         | 264  |
| 539  | 25                                  | 264                         | 258  |
| 533  | 24                                  | 258                         | 252  |
| 527  | 23                                  | 251                         | 246  |
| 521  | 22                                  | 245                         | 240  |
| 516  | 21                                  | 240                         | 235  |
| 510  | 20                                  | 234                         | 229  |

# Operating Instructions & Parts Manual

## Weight - Load - Indentor Chart

| Scale Symbol | Indentor Type         | Preliminary Force N (kgf) | Total Force N (kgf) | Typical Applications  |
|--------------|-----------------------|---------------------------|---------------------|---|
| A            | Spheroconical Diamond | 98.07 (10)                | 588.4 (60)          | Cemented carbides, thin steel, and shallow case hardened steel  |
| B            | 1/16" Carbide Ball    | 98.07 (10)                | 980.7 (100)         | Copper alloys, soft steels, aluminum alloys, malleable iron, etc.   |
| C            | Spheroconical Diamond | 98.07 (10)                | 1471 (150)          | Steel, hard cast irons, pearlitic malleable iron, titanium, deep case hardened steel, other harder than HRB 100           |
| D            | Spheroconical Diamond | 98.07 (10)                | 980.7 (100)         | Thin steel and medium case hardened steel, and pearlitic malleable iron   |
| E            | 1/8" Carbide Ball     | 98.07 (10)                | 980.7 (100)         | Cast Iron, Aluminum and magnesium alloys, and bearing metals  |
| F            | 1/16" Carbide Ball    | 98.07 (10)                | 588.4 (60)          | Annealed copper alloys and thin soft sheet metals   |
| G            | 1/16" Carbide Ball    | 98.07 (10)                | 1471 (150)          | Malleable irons, copper-nickel-zinc and cupro-nickel alloys   |
| H            | 1/8" Carbide Ball     | 98.07 (10)                | 588.4 (60)          | Aluminum, zinc and lead   |
| K            | 1/8" Carbide Ball     | 98.07 (10)                | 1471 (150)          | Bearing Metals and other very soft or thin materials. Use smallest ball and heaviest load that doesn't give anvil effect. |
| L            | ¼" Carbide Ball       | 98.07 (10)                | 588.4 (60)          |   |
| M            | ¼" Carbide Ball       | 98.07 (10)                | 980.7 (100)         |   |
| P            | ¼" Carbide Ball       | 98.07 (10)                | 1471 (150)          |   |
| R            | ½" Carbide Ball       | 98.07 (10)                | 588.4 (60)          |   |
| S            | ½" Carbide ball       | 98.07 (10)                | 980.7 (100)         |   |
| V            | ½" Carbide ball       | 98.07 (10)                | 1471 (150)          |   |
| 15N          | Spheroconical Diamond | 29.42 (3)                 | 147.1 (15)          |   |
| 30N          | Spheroconical Diamond | 29.42 (3)                 | 294.2 (30)          |   |
| 45N          | Spheroconical Diamond | 29.42 (3)                 | 441.3 (45)          |   |
| 15T          | 1/16" Carbide Ball    | 29.42 (3)                 | 147.1 (15)          | Similar to B, F and G scales but for thinner gage material.   |
| 30T          | 1/16" Carbide Ball    | 29.42 (3)                 | 294.2 (30)          |   |
| 45T          | 1/16" Carbide Ball    | 29.42 (3)                 | 441.3 (45)          |   |
| 15W          | 1/8" Carbide Ball     | 29.42 (3)                 | 147.1 (15)          | Very Soft Material  |
| 30W          | 1/8" Carbide Ball     | 29.42 (3)                 | 294.2 (30)          |   |
| 45W          | 1/8" Carbide Ball     | 29.42 (3)                 | 441.3 (45)          |   |
| 15X          | ¼" Carbide Ball       | 29.42 (3)                 | 147.1 (15)          |   |
| 30X          | ¼" Carbide Ball       | 29.42 (3)                 | 294.2 (30)          |   |
| 45X          | ¼" Carbide Ball       | 29.42 (3)                 | 441.3 (45)          |   |
| 15Y          | ½" Carbide Ball       | 29.42 (3)                 | 147.1 (15)          |   |
| 30Y          | ½" Carbide Ball       | 29.42 (3)                 | 294.2 (30)          |   |
| 45Y          | ½" Carbide Ball       | 29.42 (3)                 | 441.3 (45)          |   |

# Operating Instructions & Parts Manual

## Round Correction Factors

*Corrections to be added to test results in the following scales for various diameter parts.*

**Corrections to be added to Rockwell C, A and D values**

**Diameter of Convex Cylindrical Surfaces**

| Hardness Reading | ¼"<br>6.4mm | 3/8"<br>10mm | ½"<br>13mm | 5/8"<br>16mm | ¾"<br>19mm | 7/8"<br>22mm | 1"<br>25mm | 1-1/4"<br>32mm | 1-1/2"<br>38mm |
|------------------|-------------|--------------|------------|--------------|------------|--------------|------------|----------------|----------------|
| 20               | 6.0         | 4.5          | 3.5        | 2.5          | 2.0        | 1.5          | 1.5        | 1.0            | 1.0            |
| 25               | 5.5         | 4.0          | 3.0        | 2.5          | 2.0        | 1.5          | 1.0        | 1.0            | 1.0            |
| 30               | 5.0         | 3.5          | 2.5        | 2.0          | 1.5        | 1.5          | 1.0        | 1.0            | 0.5            |
| 35               | 4.0         | 3.0          | 2.0        | 1.5          | 1.5        | 1.0          | 1.0        | 0.5            | 0.5            |
| 40               | 3.5         | 2.5          | 2.0        | 1.5          | 1.0        | 1.0          | 1.0        | 0.5            | 0.5            |
| 45               | 3.0         | 2.0          | 1.5        | 1.0          | 1.0        | 1.0          | 0.5        | 0.5            | 0.5            |
| 50               | 2.5         | 2.0          | 1.5        | 1.0          | 1.0        | 0.5          | 0.5        | 0.5            | 0.5            |
| 55               | 2.0         | 1.5          | 1.0        | 1.0          | 0.5        | 0.5          | 0.5        | 0.5            | 0              |
| 60               | 1.5         | 1.0          | 1.0        | 0.5          | 0.5        | 0.5          | 0.5        | 0              | 0              |
| 65               | 1.5         | 1.0          | 1.0        | 0.5          | 0.5        | 0.5          | 0.5        | 0              | 0              |
| 70               | 1.0         | 1.0          | 0.5        | 0.5          | 0.5        | 0.5          | 0.5        | 0              | 0              |
| 75               | 1.0         | 0.5          | 0.5        | 0.5          | 0.5        | 0.5          | 0          | 0              | 0              |
| 80               | 0.5         | 0.5          | 0.5        | 0.5          | 0.5        | 0            | 0          | 0              | 0              |
| 85               | 0.5         | 0.5          | 0.5        | 0            | 0          | 0            | 0          | 0              | 0              |
| 90               | 0.5         | 0            | 0          | 0            | 0          | 0            | 0          | 0              | 0              |

**Corrections to be added to Rockwell B, F and G values**

**Diameter of Convex Cylindrical Surfaces**

| Hardness Reading | ¼"<br>6.4mm | 3/8"<br>10mm | ½"<br>13mm | 5/8"<br>16mm | ¾"<br>19mm | 7/8"<br>22mm | 1"<br>25mm |
|------------------|-------------|--------------|------------|--------------|------------|--------------|------------|
| 0                | 12.5        | 8.5          | 6.5        | 5.5          | 4.5        | 3.5          | 3.0        |
| 10               | 12.0        | 8.0          | 6.0        | 5.0          | 4.0        | 3.5          | 3.0        |
| 20               | 11.0        | 7.5          | 5.5        | 4.5          | 4.0        | 3.5          | 3.0        |
| 30               | 10.0        | 6.5          | 5.0        | 4.5          | 3.5        | 3.0          | 2.5        |
| 40               | 9.0         | 6.0          | 4.5        | 4.0          | 3.0        | 2.5          | 2.5        |
| 50               | 8.0         | 5.5          | 4.0        | 3.5          | 3.0        | 2.5          | 2.0        |
| 60               | 7.0         | 5.0          | 3.5        | 3.0          | 2.5        | 2.0          | 2.0        |
| 70               | 6.0         | 4.0          | 3.0        | 2.5          | 2.0        | 2.0          | 1.5        |
| 80               | 5.0         | 3.5          | 2.5        | 2.0          | 1.5        | 1.5          | 1.5        |
| 90               | 4.0         | 3.0          | 2.0        | 1.5          | 1.5        | 1.5          | 1.0        |
| 100              | 3.5         | 2.5          | 1.5        | 1.5          | 1.0        | 1.0          | 0.5        |

## Minimum Thickness Requirements

*Minimum allowable thickness for a corresponding hardness in the respective scales*

| Minimum Thickness<br>Inch | Minimum Thickness<br>mm | Rockwell<br>C | Rockwell<br>A | Rockwell<br>B | Superficial<br>15N | Superficial<br>30N | Superficial<br>45N | Superficial<br>15T | Superficial<br>30T | Superficial<br>45T |
|---------------------------|-------------------------|---------------|---------------|---------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| 0.006                     | 0.15                    | ...           | ...           | ...           | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.008                     | 0.20                    | ...           | ...           | ...           | 92                 | ...                | ...                | ...                | ...                | ...                |
| 0.010                     | 0.25                    | ...           | ...           | ...           | 90                 | ...                | ...                | 91                 | ...                | ...                |
| 0.012                     | 0.30                    | ...           | ...           | ...           | 88                 | 82                 | 77                 | 86                 | ...                | ...                |
| 0.014                     | 0.36                    | ...           | ...           | ...           | 83                 | 78.5               | 74                 | 81                 | 80                 | ...                |
| 0.016                     | 0.41                    | ...           | 86            | ...           | 76                 | 74                 | 72                 | 75                 | 72                 | 71                 |
| 0.018                     | 0.46                    | ...           | 84            | ...           | 68                 | 66                 | 68                 | 68                 | 64                 | 62                 |
| 0.020                     | 0.51                    | ...           | 82            | ...           | ...                | 57                 | 63                 | ...                | 55                 | 53                 |
| 0.022                     | 0.56                    | 69            | 79            | ...           | ...                | 47                 | 58                 | ...                | 45                 | 43                 |
| 0.024                     | 0.61                    | 67            | 76            | 94            | ...                | ...                | 51                 | ...                | 34                 | 31                 |
| 0.026                     | 0.66                    | 65            | 71            | 87            | ...                | ...                | 37                 | ...                | ...                | 18                 |
| 0.028                     | 0.71                    | 62            | 67            | 80            | ...                | ...                | 20                 | ...                | ...                | 4                  |
| 0.030                     | 0.76                    | 57            | 60            | 71            | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.032                     | 0.81                    | 52            | ...           | 62            | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.034                     | 0.86                    | 45            | ...           | 52            | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.036                     | 0.91                    | 37            | ...           | 40            | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.038                     | 0.96                    | 28            | ...           | 28            | ...                | ...                | ...                | ...                | ...                | ...                |
| 0.040                     | 1.02                    | 20            | ...           | ...           | ...                | ...                | ...                | ...                | ...                | ...                |

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