

## 1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This service manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding, the manual is divided into the following sections.

### SECTION 1 GENERAL

This section explains the safety hints and gives the specification of the machine and major components.

### SECTION 2 STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

### SECTION 3 HYDRAULIC SYSTEM

This section explains the hydraulic circuit, single and combined operation.

### SECTION 4 ELECTRICAL SYSTEM

This section explains the electrical circuit, monitoring system and each component. It serves not only to give an understanding electrical system, but also serves as reference material for trouble shooting.

### SECTION 5 MECHATRONICS SYSTEM

This section explains the computer aided power optimization system and each component.

### SECTION 6 TROUBLESHOOTING

This section explains the troubleshooting charts correlating **problems** to **causes**.

### SECTION 7 MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

### SECTION 8 DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your HD Hyundai Construction Equipment distributor for the latest information.

## 2. HOW TO READ THE SERVICE MANUAL

### Distribution and updating

Any additions, amendments or other changes will be sent to HD Hyundai Construction Equipment distributors.

Get the most up-to-date information before you start any work.

### Filing method

1. See the page number on the bottom of the page.

File the pages in correct order.

2. Following examples shows how to read the page number.

Example 1

2 - 3

Item number (2. Structure and Function)  
Consecutive page number for each item.

3. Additional pages : Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.

8 - 4

8 - 4 - 1

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8 - 5

Added pages

### Revised edition mark (①②③···)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

### Revisions

Revised pages are shown at the list of revised pages on the between the contents page and section 1 page.

### Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

| Symbol                                                                              | Item    | Remarks                                                                                                             |
|-------------------------------------------------------------------------------------|---------|---------------------------------------------------------------------------------------------------------------------|
|   | Safety  | Special safety precautions are necessary when performing the work.                                                  |
|                                                                                     |         | Extra special safety precautions are necessary when performing the work because it is under internal pressure.      |
|  | Caution | Special technical precautions or other precautions for preserving standards are necessary when performing the work. |

### 3. CONVERSION TABLE

Method of using the Conversion Table

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

#### Example

##### 1. Method of using the Conversion Table to convert from millimeters to inches

Convert 55mm into inches.

- (1) Locate the number 50 in the vertical column at the left side, take this as (a), then draw a horizontal line from (a).
- (2) Locate the number 5 in the row across the top, take this as (b), then draw a perpendicular line down from (b).
- (3) Take the point where the two lines cross as (c). This point (c) gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.

##### 2. Convert 550 mm into inches.

- (1) The number 550 does not appear in the table, so divide by 10 (Move the decimal point one place to the left) to convert it to 55 mm.
- (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.
- (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (Move the decimal point one place to the right) to return to the original value.  
This gives 550 mm = 21.65 inches.

#### Millimeters to inches

(b)

1 mm = 0.03937 in

|        | 0     | 1     | 2     | 3     | 4     | 5         | 6     | 7     | 8     | 9     |
|--------|-------|-------|-------|-------|-------|-----------|-------|-------|-------|-------|
| 0      |       | 0.039 | 0.079 | 0.118 | 0.157 | 0.197     | 0.236 | 0.276 | 0.315 | 0.354 |
| 10     | 0.394 | 0.433 | 0.472 | 0.512 | 0.551 | 0.591     | 0.630 | 0.669 | 0.709 | 0.748 |
| 20     | 0.787 | 0.827 | 0.866 | 0.906 | 0.945 | 0.984     | 1.024 | 1.063 | 1.102 | 1.142 |
| 30     | 1.181 | 1.220 | 1.260 | 1.299 | 1.339 | 1.378     | 1.417 | 1.457 | 1.496 | 1.536 |
| 40     | 1.575 | 1.614 | 1.654 | 1.693 | 1.732 | 1.772     | 1.811 | 1.850 | 1.890 | 1.929 |
| (a) 50 | 1.969 | 2.008 | 2.047 | 2.087 | 2.126 | (c) 2.165 | 2.205 | 2.244 | 2.283 | 2.323 |
| 60     | 2.362 | 2.402 | 2.441 | 2.480 | 2.520 | 2.559     | 2.598 | 2.638 | 2.677 | 2.717 |
| 70     | 2.756 | 2.795 | 2.835 | 2.874 | 2.913 | 2.953     | 2.992 | 3.032 | 3.071 | 3.110 |
| 80     | 3.150 | 3.189 | 3.228 | 3.268 | 3.307 | 3.346     | 3.386 | 3.425 | 3.465 | 3.504 |
| 90     | 3.543 | 3.583 | 3.622 | 3.661 | 3.701 | 3.740     | 3.780 | 3.819 | 3.858 | 3.898 |

**Millimeters to inches**

1mm = 0.03937in

|    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0  |       | 0.039 | 0.079 | 0.118 | 0.157 | 0.197 | 0.236 | 0.276 | 0.315 | 0.354 |
| 10 | 0.394 | 0.433 | 0.472 | 0.512 | 0.551 | 0.591 | 0.630 | 0.669 | 0.709 | 0.748 |
| 20 | 0.787 | 0.827 | 0.866 | 0.906 | 0.945 | 0.984 | 1.024 | 1.063 | 1.102 | 1.142 |
| 30 | 1.181 | 1.220 | 1.260 | 1.299 | 1.339 | 1.378 | 1.417 | 1.457 | 1.496 | 1.536 |
| 40 | 1.575 | 1.614 | 1.654 | 1.693 | 1.732 | 1.772 | 1.811 | 1.850 | 1.890 | 1.929 |
| 50 | 1.969 | 2.008 | 2.047 | 2.087 | 2.126 | 2.165 | 2.205 | 2.244 | 2.283 | 2.323 |
| 60 | 2.362 | 2.402 | 2.441 | 2.480 | 2.520 | 2.559 | 2.598 | 2.638 | 2.677 | 2.717 |
| 70 | 2.756 | 2.795 | 2.835 | 2.874 | 2.913 | 2.953 | 2.992 | 3.032 | 3.071 | 3.110 |
| 80 | 3.150 | 3.189 | 3.228 | 3.268 | 3.307 | 3.346 | 3.386 | 3.425 | 3.465 | 3.504 |
| 90 | 3.543 | 3.583 | 3.622 | 3.661 | 3.701 | 3.740 | 3.780 | 3.819 | 3.858 | 3.898 |

**Kilogram to Pound**

1kg = 2.2046lb

|    | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0  |        | 2.20   | 4.41   | 6.61   | 8.82   | 11.02  | 13.23  | 15.43  | 17.64  | 19.84  |
| 10 | 22.05  | 24.25  | 26.46  | 28.66  | 30.86  | 33.07  | 35.27  | 37.48  | 39.68  | 41.89  |
| 20 | 44.09  | 46.30  | 48.50  | 50.71  | 51.91  | 55.12  | 57.32  | 59.5   | 61.73  | 63.93  |
| 30 | 66.14  | 68.34  | 70.55  | 72.75  | 74.96  | 77.16  | 79.37  | 81.57  | 83.78  | 85.98  |
| 40 | 88.18  | 90.39  | 92.59  | 94.80  | 97.00  | 99.21  | 101.41 | 103.62 | 105.82 | 108.03 |
| 50 | 110.23 | 112.44 | 114.64 | 116.85 | 119.05 | 121.25 | 123.46 | 125.66 | 127.87 | 130.07 |
| 60 | 132.28 | 134.48 | 136.69 | 138.89 | 141.10 | 143.30 | 145.51 | 147.71 | 149.91 | 152.12 |
| 70 | 154.32 | 156.53 | 158.73 | 160.94 | 163.14 | 165.35 | 167.55 | 169.76 | 171.96 | 174.17 |
| 80 | 176.37 | 178.57 | 180.78 | 182.98 | 185.19 | 187.39 | 189.60 | 191.80 | 194.01 | 196.21 |
| 90 | 198.42 | 200.62 | 202.83 | 205.03 | 207.24 | 209.44 | 211.64 | 213.85 | 216.05 | 218.26 |

**Liter to U.S. Gallon**
 $1 \ell = 0.2642 \text{ U.S. Gal}$ 

|    | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0  |        | 0.264  | 0.528  | 0.793  | 1.057  | 1.321  | 1.585  | 1.849  | 2.113  | 2.378  |
| 10 | 2.642  | 2.906  | 3.170  | 3.434  | 3.698  | 3.963  | 4.227  | 4.491  | 4.755  | 5.019  |
| 20 | 5.283  | 5.548  | 5.812  | 6.076  | 6.340  | 6.604  | 6.869  | 7.133  | 7.397  | 7.661  |
| 30 | 7.925  | 8.189  | 8.454  | 8.718  | 8.982  | 9.246  | 9.510  | 9.774  | 10.039 | 10.303 |
| 40 | 10.567 | 10.831 | 11.095 | 11.359 | 11.624 | 11.888 | 12.152 | 12.416 | 12.680 | 12.944 |
| 50 | 13.209 | 13.473 | 13.737 | 14.001 | 14.265 | 14.529 | 14.795 | 15.058 | 15.322 | 15.586 |
| 60 | 15.850 | 16.115 | 16.379 | 16.643 | 16.907 | 17.171 | 17.435 | 17.700 | 17.964 | 18.228 |
| 70 | 18.492 | 18.756 | 19.020 | 19.285 | 19.549 | 19.813 | 20.077 | 20.341 | 20.605 | 20.870 |
| 80 | 21.134 | 21.398 | 21.662 | 21.926 | 22.190 | 22.455 | 22.719 | 22.983 | 23.247 | 23.511 |
| 90 | 23.775 | 24.040 | 24.304 | 24.568 | 24.832 | 25.096 | 25.631 | 25.625 | 25.889 | 26.153 |

**Liter to U.K. Gallon**
 $1 \ell = 0.21997 \text{ U.K. Gal}$ 

|    | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0  |        | 0.220  | 0.440  | 0.660  | 0.880  | 1.100  | 1.320  | 1.540  | 1.760  | 1.980  |
| 10 | 2.200  | 2.420  | 2.640  | 2.860  | 3.080  | 3.300  | 3.520  | 3.740  | 3.950  | 4.179  |
| 20 | 4.399  | 4.619  | 4.839  | 5.059  | 5.279  | 5.499  | 5.719  | 5.939  | 6.159  | 6.379  |
| 30 | 6.599  | 6.819  | 7.039  | 7.259  | 7.479  | 7.699  | 7.919  | 8.139  | 8.359  | 8.579  |
| 40 | 8.799  | 9.019  | 9.239  | 9.459  | 9.679  | 9.899  | 10.119 | 10.339 | 10.559 | 10.778 |
| 50 | 10.998 | 11.281 | 11.438 | 11.658 | 11.878 | 12.098 | 12.318 | 12.528 | 12.758 | 12.978 |
| 60 | 13.198 | 13.418 | 13.638 | 13.858 | 14.078 | 14.298 | 14.518 | 14.738 | 14.958 | 15.178 |
| 70 | 15.398 | 15.618 | 15.838 | 16.058 | 16.278 | 16.498 | 16.718 | 16.938 | 17.158 | 17.378 |
| 80 | 17.598 | 17.818 | 18.037 | 18.257 | 18.477 | 18.697 | 18.917 | 19.137 | 19.357 | 19.577 |
| 90 | 19.797 | 20.017 | 20.237 | 20.457 | 20.677 | 20.897 | 21.117 | 21.337 | 21.557 | 21.777 |

kgf · m to lbf · ft

1 kgf · m = 7.233 lbf · ft

|     | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9       |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
|     |        | 7.2    | 14.5   | 21.7   | 28.9   | 36.2   | 43.4   | 50.6   | 57.9   | 65.1    |
| 10  | 72.3   | 79.6   | 86.8   | 94.0   | 101.3  | 108.5  | 115.7  | 123.0  | 130.2  | 137.4   |
| 20  | 144.7  | 151.9  | 159.1  | 166.4  | 173.6  | 180.8  | 188.1  | 195.3  | 202.5  | 209.8   |
| 30  | 217.0  | 224.2  | 231.5  | 238.7  | 245.9  | 253.2  | 260.4  | 267.6  | 274.9  | 282.1   |
| 40  | 289.3  | 296.6  | 303.8  | 311.0  | 318.3  | 325.5  | 332.7  | 340.0  | 347.2  | 354.4   |
| 50  | 361.7  | 368.9  | 376.1  | 383.4  | 390.6  | 397.8  | 405.1  | 412.3  | 419.5  | 426.8   |
| 60  | 434.0  | 441.2  | 448.5  | 455.7  | 462.9  | 470.2  | 477.4  | 484.6  | 491.8  | 499.1   |
| 70  | 506.3  | 513.5  | 520.8  | 528.0  | 535.2  | 542.5  | 549.7  | 556.9  | 564.2  | 571.4   |
| 80  | 578.6  | 585.9  | 593.1  | 600.3  | 607.6  | 614.8  | 622.0  | 629.3  | 636.5  | 643.7   |
| 90  | 651.0  | 658.2  | 665.4  | 672.7  | 679.9  | 687.1  | 694.4  | 701.6  | 708.8  | 716.1   |
| 100 | 723.3  | 730.5  | 737.8  | 745.0  | 752.2  | 759.5  | 766.7  | 773.9  | 781.2  | 788.4   |
| 110 | 795.6  | 802.9  | 810.1  | 817.3  | 824.6  | 831.8  | 839.0  | 846.3  | 853.5  | 860.7   |
| 120 | 868.0  | 875.2  | 882.4  | 889.7  | 896.9  | 904.1  | 911.4  | 918.6  | 925.8  | 933.1   |
| 130 | 940.3  | 947.5  | 954.8  | 962.0  | 969.2  | 976.5  | 983.7  | 990.9  | 998.2  | 10005.4 |
| 140 | 1012.6 | 1019.9 | 1027.1 | 1034.3 | 1041.5 | 1048.8 | 1056.0 | 1063.2 | 1070.5 | 1077.7  |
| 150 | 1084.9 | 1092.2 | 1099.4 | 1106.6 | 1113.9 | 1121.1 | 1128.3 | 1135.6 | 1142.8 | 1150.0  |
| 160 | 1157.3 | 1164.5 | 1171.7 | 1179.0 | 1186.2 | 1193.4 | 1200.7 | 1207.9 | 1215.1 | 1222.4  |
| 170 | 1129.6 | 1236.8 | 1244.1 | 1251.3 | 1258.5 | 1265.8 | 1273.0 | 1280.1 | 1287.5 | 1294.7  |
| 180 | 1301.9 | 1309.2 | 1316.4 | 1323.6 | 1330.9 | 1338.1 | 1345.3 | 1352.6 | 1359.8 | 1367.0  |
| 190 | 1374.3 | 1381.5 | 1388.7 | 1396.0 | 1403.2 | 1410.4 | 1417.7 | 1424.9 | 1432.1 | 1439.4  |

**kgf/cm<sup>2</sup> to lbf/in<sup>2</sup>**1kgf / cm<sup>2</sup> = 14.2233lbf / in<sup>2</sup>

|     | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|     |       | 14.2  | 28.4  | 42.7  | 56.9  | 71.1  | 85.3  | 99.6  | 113.8 | 128.0 |
| 10  | 142.2 | 156.5 | 170.7 | 184.9 | 199.1 | 213.4 | 227.6 | 241.8 | 256.0 | 270.2 |
| 20  | 284.5 | 298.7 | 312.9 | 327.1 | 341.4 | 355.6 | 369.8 | 384.0 | 398.3 | 412.5 |
| 30  | 426.7 | 440.9 | 455.1 | 469.4 | 483.6 | 497.8 | 512.0 | 526.3 | 540.5 | 554.7 |
| 40  | 568.9 | 583.2 | 597.4 | 611.6 | 625.8 | 640.1 | 654.3 | 668.5 | 682.7 | 696.9 |
| 50  | 711.2 | 725.4 | 739.6 | 753.8 | 768.1 | 782.3 | 796.5 | 810.7 | 825.0 | 839.2 |
| 60  | 853.4 | 867.6 | 881.8 | 896.1 | 910.3 | 924.5 | 938.7 | 953.0 | 967.2 | 981.4 |
| 70  | 995.6 | 1010  | 1024  | 1038  | 1053  | 1067  | 1081  | 1095  | 1109  | 1124  |
| 80  | 1138  | 1152  | 1166  | 1181  | 1195  | 1209  | 1223  | 1237  | 1252  | 1266  |
| 90  | 1280  | 1294  | 1309  | 1323  | 1337  | 1351  | 1365  | 1380  | 1394  | 1408  |
| 100 | 1422  | 1437  | 1451  | 1465  | 1479  | 1493  | 1508  | 1522  | 1536  | 1550  |
| 110 | 1565  | 1579  | 1593  | 1607  | 1621  | 1636  | 1650  | 1664  | 1678  | 1693  |
| 120 | 1707  | 1721  | 1735  | 1749  | 1764  | 1778  | 1792  | 1806  | 1821  | 1835  |
| 130 | 1849  | 2863  | 1877  | 1892  | 1906  | 1920  | 1934  | 1949  | 1963  | 1977  |
| 140 | 1991  | 2005  | 2020  | 2034  | 2048  | 2062  | 2077  | 2091  | 2105  | 2119  |
| 150 | 2134  | 2148  | 2162  | 2176  | 2190  | 2205  | 2219  | 2233  | 2247  | 2262  |
| 160 | 2276  | 2290  | 2304  | 2318  | 2333  | 2347  | 2361  | 2375  | 2389  | 2404  |
| 170 | 2418  | 2432  | 2446  | 2460  | 2475  | 2489  | 2503  | 2518  | 2532  | 2546  |
| 180 | 2560  | 2574  | 2589  | 5603  | 2617  | 2631  | 2646  | 2660  | 2674  | 2688  |
| 200 | 2845  | 2859  | 2873  | 2887  | 2901  | 2916  | 2930  | 2944  | 2958  | 2973  |
| 210 | 2987  | 3001  | 3015  | 3030  | 3044  | 3058  | 3072  | 3086  | 3101  | 3115  |
| 220 | 3129  | 3143  | 3158  | 3172  | 3186  | 3200  | 3214  | 3229  | 3243  | 3257  |
| 230 | 3271  | 3286  | 3300  | 3314  | 3328  | 3343  | 3357  | 3371  | 3385  | 3399  |
| 240 | 3414  | 3428  | 3442  | 3456  | 3470  | 3485  | 3499  | 3513  | 3527  | 3542  |

## TEMPERATURE

Fahrenheit-Centigrade Conversion.

A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

| °C    |     | °F    | °C    |    | °F    | °C   |    | °F    | °C   |     | °F    |
|-------|-----|-------|-------|----|-------|------|----|-------|------|-----|-------|
| -40.4 | -40 | -40.0 | -11.7 | 11 | 51.8  | 7.8  | 46 | 114.8 | 27.2 | 81  | 117.8 |
| -37.2 | -35 | -31.0 | -11.1 | 12 | 53.6  | 8.3  | 47 | 116.6 | 27.8 | 82  | 179.6 |
| -34.4 | -30 | -22.0 | -10.6 | 13 | 55.4  | 8.9  | 48 | 118.4 | 28.3 | 83  | 181.4 |
| -31.7 | -25 | -13.0 | -10.0 | 14 | 57.2  | 9.4  | 49 | 120.2 | 28.9 | 84  | 183.2 |
| -28.9 | -20 | -4.0  | -9.4  | 15 | 59.0  | 10.0 | 50 | 122.0 | 29.4 | 85  | 185.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -28.3 | -19 | -2.2  | -8.9  | 16 | 60.8  | 10.6 | 51 | 123.8 | 30.0 | 86  | 186.8 |
| -27.8 | -18 | -0.4  | -8.3  | 17 | 62.6  | 11.1 | 52 | 125.6 | 30.6 | 87  | 188.6 |
| -27.2 | -17 | 1.4   | -7.8  | 18 | 64.4  | 11.7 | 53 | 127.4 | 31.1 | 88  | 190.4 |
| -26.7 | -16 | 3.2   | -6.7  | 20 | 68.0  | 12.8 | 55 | 131.0 | 32.2 | 90  | 194.0 |
| -26.1 | -15 | 5.0   | -6.7  | 20 | 68.0  | 12.8 | 55 | 131.0 | 32.2 | 90  | 194.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -25.6 | -14 | 6.8   | -6.1  | 21 | 69.8  | 13.3 | 56 | 132.8 | 32.8 | 91  | 195.8 |
| -25.0 | -13 | 8.6   | -5.6  | 22 | 71.6  | 13.9 | 57 | 134.6 | 33.3 | 92  | 197.6 |
| -24.4 | -12 | 10.4  | -5.0  | 23 | 73.4  | 14.4 | 58 | 136.4 | 33.9 | 93  | 199.4 |
| -23.9 | -11 | 12.2  | -4.4  | 24 | 75.2  | 15.0 | 59 | 138.2 | 34.4 | 94  | 201.2 |
| -23.3 | -10 | 14.0  | -3.9  | 25 | 77.0  | 15.6 | 60 | 140.0 | 35.0 | 95  | 203.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -22.8 | -9  | 15.8  | -3.3  | 26 | 78.8  | 16.1 | 61 | 141.8 | 35.6 | 96  | 204.8 |
| -22.2 | -8  | 17.6  | -2.8  | 27 | 80.6  | 16.7 | 62 | 143.6 | 36.1 | 97  | 206.6 |
| -21.7 | -7  | 19.4  | -2.2  | 28 | 82.4  | 17.2 | 63 | 145.4 | 36.7 | 98  | 208.4 |
| -21.1 | -6  | 21.2  | -1.7  | 29 | 84.2  | 17.8 | 64 | 147.2 | 37.2 | 99  | 210.2 |
| -20.6 | -5  | 23.0  | -1.1  | 35 | 95.0  | 21.1 | 70 | 158.0 | 51.7 | 125 | 257.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -20.0 | -4  | 24.8  | -0.6  | 31 | 87.8  | 18.9 | 66 | 150.8 | 40.6 | 105 | 221.0 |
| -19.4 | -3  | 26.6  | 0     | 32 | 89.6  | 19.4 | 67 | 152.6 | 43.3 | 110 | 230.0 |
| -18.9 | -2  | 28.4  | 0.6   | 33 | 91.4  | 20.0 | 68 | 154.4 | 46.1 | 115 | 239.0 |
| -18.3 | -1  | 30.2  | 1.1   | 34 | 93.2  | 20.6 | 69 | 156.2 | 48.9 | 120 | 248.0 |
| -17.8 | 0   | 32.0  | 1.7   | 35 | 95.0  | 21.1 | 70 | 158.0 | 51.7 | 125 | 257.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -17.2 | 1   | 33.8  | 2.2   | 36 | 96.8  | 21.7 | 71 | 159.8 | 54.4 | 130 | 266.0 |
| -16.7 | 2   | 35.6  | 2.8   | 37 | 98.6  | 22.2 | 72 | 161.6 | 57.2 | 135 | 275.0 |
| -16.1 | 3   | 37.4  | 3.3   | 38 | 100.4 | 22.8 | 73 | 163.4 | 60.0 | 140 | 284.0 |
| -15.6 | 4   | 39.2  | 3.9   | 39 | 102.2 | 23.3 | 74 | 165.2 | 62.7 | 145 | 293.0 |
| -15.0 | 5   | 41.0  | 4.4   | 40 | 104.0 | 23.9 | 75 | 167.0 | 65.6 | 150 | 302.0 |
|       |     |       |       |    |       |      |    |       |      |     |       |
| -14.4 | 6   | 42.8  | 5.0   | 41 | 105.8 | 24.4 | 76 | 168.8 | 68.3 | 155 | 311.0 |
| -13.9 | 7   | 44.6  | 5.6   | 42 | 107.6 | 25.0 | 77 | 170.6 | 71.1 | 160 | 320.0 |
| -13.3 | 8   | 46.4  | 6.1   | 43 | 109.4 | 25.6 | 78 | 172.4 | 73.9 | 165 | 329.0 |
| -12.8 | 9   | 48.2  | 6.7   | 44 | 111.2 | 26.1 | 79 | 174.2 | 76.7 | 170 | 338.0 |
| -12.2 | 10  | 50.0  | 7.2   | 45 | 113.0 | 26.7 | 80 | 176.0 | 79.4 | 172 | 347.0 |