

### PIPE DIMENSIONS

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The dimensions of pipe – carbon steel and stainless steel – are shrouded in the mystery of an arcane designation system; its origins go back to ASME recommendations of 1886!

#### SPECIFICATIONS

Pipe used in Australia and New Zealand is almost exclusively specified to American standards; carbon steel “hollow sections” are additionally specified to AS/NZS 1163. The usual specifications are ...

|                   |   |
|-------------------|---|
| ASTM A53M         | standard ERW welded carbon steel pipe   |
| ASTM A106M        | standard seamless carbon steel pipe   |
| ASTM A333M        | seamless and welded carbon steel pipe for low temperature service             |
| ASTM A312M        | most stainless steel pipe produced on continuous pipe mills and seamless pipe |
| ASTM A358M        | larger diameter welded stainless steel pipe                                   |
| ASTM A790M        | welded and seamless duplex stainless steel pipe                               |
| API 5L / ISO 3183 | carbon steel line pipe for the petroleum and natural gas industries           |
| AS/NZS 1163       | carbon steel structural steel “hollow sections”                               |

The American standards all refer to ASME B36.10M or ASME B36.19M for nominal dimensions of carbon steel and stainless steel respectively, but dimensional tolerances are in the ASTM or API standards.

Pipe produced to multiple specifications is common; Atlas ERW carbon steel is generally to API 5L Grade B & X42 PSL1 / ASTM A53M GR B / AS/NZS1163 C350 and 0.23% carbon maximum.

#### OUTSIDE DIAMETER

The outside diameters of pipes are described by the “Nominal Pipe Size”, shown in specifications as NPS and often incorrectly called “inches”. In more recent times with the introduction of the metric system and with the usage of the same pipes in Europe, a metric version has been developed called DN, or “Diameter Nominal”, often incorrectly called “millimetres” and also incorrectly referred to as Nominal Bore or NB. The pipe sizing system did originate with an understanding that then standard pipe sizes when used at the then most typical wall thickness gave an internal diameter approximately equal to the nominal size. With the current multiplicity of wall thicknesses available the Nominal Bore concept has long since ceased to be relevant, and in fact is now misleading. All pipe is specified by outside diameter, never by inside diameter.

#### WALL THICKNESS

Wall thicknesses of carbon steel and stainless steel pipe are most commonly (but not exclusively; see later comments) described by a “Schedule Number”. The wall thickness for a schedule varies according to the pipe size and is given in tables in the relevant specifications; refer to the table on page 3 of this TechNote. These schedules are derived from two different specifications, for carbon steels and for stainless steels, so although they share much there are some important differences. “S” schedules are specific to stainless steels and schedules without the “S” are intended for carbon steels. Carbon steel pipe to AS/NZS 1163 is also specified to hard millimetre thicknesses; these are close enough to the ASME schedules that multiple compliance product is possible.

#### WHERE CARBON STEEL SCHEDULES EQUAL STAINLESS SCHEDULES

Up to DN 300 (NPS 12) all Sch 10 and Sch 10S wall thicknesses are the same.

Up to DN 250 (NPS 10) all Sch 40, Std Wt and Sch 40S wall thicknesses are the same.

Up to DN 200 (NPS 8) all Sch 80, XS and Sch 80S wall thicknesses are the same.

## THE DIFFERENCES BETWEEN CARBON STEEL AND STAINLESS PIPE

In larger nominal sizes Std Wt and XS schedules remain constant, but schedules 10, 40 and 80 continue to increase with larger pipe sizes. (The ASME committee had hoped that these older Std Wt, XS and XXS wall thicknesses would gradually disappear, when the standard was revised – in 1939!) The stainless steel “S” schedules are aligned with the Std Wt and XS series ...

- Sch 40S matches Std Wt and Sch 80S matches XS, throughout the full size range.
- Sch 10S deviates from Sch 10 above DN 300 – there is no carbon steel equivalent to 10S.

In carbon steels there is a very rich range of schedules, including a thin wall Sch 5 (identical to stainless steel Sch 5S) and many other wall thicknesses not in the list on page 3. Only the common pipe sizes and schedules are held in stock.

### STAINLESS STEEL PIPE WITH SCH 80?

Occasionally specifiers require larger size (over DN 200) stainless steel pipe with a heavier wall than Sch 80S. This can be covered by calling for Sch 80. This is an uncommon but legitimate deviation and the dimensions are covered by ASME B36.10M. Stainless pipe to Sch 80 is a “special” that is not commonly stocked. There will be a price premium.

**In most instances, when a stainless steel pipe is requested with a Sch 40, Sch 80 etc, this is due to somebody taking a short-cut – what they really want is standard Sch 40S or Sch 80S. This must be confirmed for all contracts involving larger sized stainless steel pipe.**

## TOLERANCES

### Outside Diameter

| Nominal Pipe Size |                 | Carbon Steel |               | Stainless Steel |
|-------------------|-----------------|--------------|---------------|-----------------|
| DN                | NPS             | ASTM A53M    | ASTM A106M    | ASTM A999M      |
| 6 to 40           | 1/8 to 1 1/2    | ±0.4mm       | ±0.4mm        | +0.4 / -0.8mm   |
| Over 40 to 100    | Over 1 1/2 to 4 | ±1%          | ±0.8mm        | ±0.8mm          |
| Over 100 to 200   | Over 4 to 8     | ±1%          | +1.6 / -0.8mm | +1.6 / -0.8mm   |
| Over 200 to 450   | Over 8 to 18    | ±1%          | +2.4 / -0.8mm | +2.4 / -0.8mm   |
| Over 450 to 650   | Over 18 to 26   | ±1%          | +3.2 / -0.8mm | +3.2 / -0.8mm   |
| Over 650 to 850   | Over 26 to 34   | ±1%          | +4.0 / -0.8mm | +4.0 / -0.8mm   |
| Over 850 to 1200  | Over 34 to 48   | ±1%          | +4.8 / -0.8mm | +4.8 / -0.8mm   |

### Wall Thickness

| Nominal Pipe Size    |                      | Carbon Steel  | Stainless Steel |
|----------------------|----------------------|---|-----------------|
| DN                   | NPS                  | ASTM A53M & 106M  | ASTM A312M      |
| 6 to 65              | 1/8 to 2 1/2         | -12.5% minimum  | +20.0 / -12.5%  |
| 80 to 450, t/D ≤ 5%  | 3 to 18, t/D ≤ 5%    | -12.5% minimum  | +22.5 / -12.5%  |
| t/D > 5%             | t/D > 5%             |   | +15.0 / -12.5%  |
| 500 and over ...     | 20 and over ...      | -12.5% minimum<br>(maximum wall thickness limited only by mass – see below) | +17.5 / -12.5%  |
| • welded             | • welded             |   | +22.5 / -12.5%  |
| • seamless, t/D ≤ 5% | • seamless, t/D ≤ 5% |   | +15.0 / -12.5%  |
| • seamless, t/D > 5% | • seamless, t/D > 5% |   |                 |

t = nominal wall thickness, D = ordered outside diameter. Refer to next page for these values.

The mass of all carbon steel pipe and seamless stainless steel pipe is limited to +10% and a minus limit that varies depending on size – refer to standards for details.

### Straightness

The carbon steel pipe standards require only that “the finished pipe shall be reasonably straight”.

ASTM A312M (in ASTM A999M) requires welded stainless steel pipe to be straight to within 3.2mm over 3.0m length.

| Nominal Pipe Size |       | Outside Diameter (mm) | Wall Thickness (mm) |         |         |         |              |        |        |        |      |        |        |       |         |         |         |         |       |
|-------------------|-------|-----------------------|---------------------|---------|---------|---------|--------------|--------|--------|--------|------|--------|--------|-------|---------|---------|---------|---------|-------|
|                   |       |                       | Stainless Steel     |         |         |         | Carbon Steel |        |        |        |      |        |        |       |         |         |         |         |       |
| DN                | NPS   |                       | Sch 5S              | Sch 10S | Sch 40S | Sch 80S | Sch 10       | Sch 20 | Sch 30 | Sch 40 | STD  | Sch 60 | Sch 80 | XS    | Sch 100 | Sch 120 | Sch 140 | Sch 160 | XXS   |
| 6                 | 1/8   | 10.3                  |                     | 1.24    | 1.73    | 2.41    | 1.24         |        | 1.45   | 1.73   | 1.73 |        | 2.41   | 2.41  |         |         |         |         |       |
| 8                 | 1/4   | 13.7                  |                     | 1.65    | 2.24    | 3.02    | 1.65         |        | 1.85   | 2.24   | 2.24 |        | 3.02   | 3.02  |         |         |         |         |       |
| 10                | 3/8   | 17.1                  |                     | 1.65    | 2.31    | 3.20    | 1.65         |        | 1.85   | 2.31   | 2.31 |        | 3.20   | 3.20  |         |         |         |         |       |
| 15                | 1/2   | 21.3                  | 1.65                | 2.11    | 2.77    | 3.73    | 2.11         |        | 2.41   | 2.77   | 2.77 |        | 3.73   | 3.73  |         |         |         | 4.78    | 7.47  |
| 20                | 3/4   | 26.7                  | 1.65                | 2.11    | 2.87    | 3.91    | 2.11         |        | 2.41   | 2.87   | 2.87 |        | 3.91   | 3.91  |         |         |         | 5.56    | 7.82  |
| 25                | 1     | 33.4                  | 1.65                | 2.77    | 3.38    | 4.55    | 2.77         |        | 2.90   | 3.38   | 3.38 |        | 4.55   | 4.55  |         |         |         | 6.35    | 9.09  |
| 32                | 1 1/4 | 42.2                  | 1.65                | 2.77    | 3.56    | 4.85    | 2.77         |        | 2.97   | 3.56   | 3.56 |        | 4.85   | 4.85  |         |         |         | 6.35    | 9.70  |
| 40                | 1 1/2 | 48.3                  | 1.65                | 2.77    | 3.68    | 5.08    | 2.77         |        | 3.18   | 3.68   | 3.68 |        | 5.08   | 5.08  |         |         |         | 7.14    | 10.15 |
| 50                | 2     | 60.3                  | 1.65                | 2.77    | 3.91    | 5.54    | 2.77         |        | 3.18   | 3.91   | 3.91 |        | 5.54   | 5.54  |         |         |         | 8.74    | 11.07 |
| 65                | 2 1/2 | 73.0                  | 2.11                | 3.05    | 5.16    | 7.01    | 3.05         |        | 4.78   | 5.16   | 5.16 |        | 7.01   | 7.01  |         |         |         | 9.53    | 14.02 |
| 80                | 3     | 88.9                  | 2.11                | 3.05    | 5.49    | 7.62    | 3.05         |        | 4.78   | 5.49   | 5.49 |        | 7.62   | 7.62  |         |         |         | 11.13   | 15.24 |
| 90                | 3 1/2 | 101.6                 | 2.11                | 3.05    | 5.74    | 8.08    | 3.05         |        | 4.78   | 5.74   | 5.74 |        | 8.08   | 8.08  |         |         |         |         |       |
| 100               | 4     | 114.3                 | 2.11                | 3.05    | 6.02    | 8.56    | 3.05         |        | 4.78   | 6.02   | 6.02 |        | 8.56   | 8.56  |         | 11.13   |         | 13.49   | 17.12 |
| 125               | 5     | 141.3                 | 2.77                | 3.40    | 6.55    | 9.53    | 3.40         |        |        | 6.55   | 6.55 |        | 9.53   | 9.53  |         | 12.70   |         | 15.88   | 19.05 |
| 150               | 6     | 168.3                 | 2.77                | 3.40    | 7.11    | 10.97   | 3.40         |        |        | 7.11   | 7.11 |        | 10.97  | 10.97 |         | 14.27   |         | 18.26   | 21.95 |
| 200               | 8     | 219.1                 | 2.77                | 3.76    | 8.18    | 12.70   | 3.76         | 6.35   | 7.04   | 8.18   | 8.18 | 10.31  | 12.70  | 12.70 | 15.09   | 18.26   | 20.62   | 23.01   | 22.23 |
| 250               | 10    | 273.1                 | 3.40                | 4.19    | 9.27    | 12.70   | 4.19         | 6.35   | 7.80   | 9.27   | 9.27 | 12.70  | 15.09  | 12.70 | 18.26   | 21.44   | 25.40   | 28.58   | 25.40 |
| 300               | 12    | 323.9                 | 3.96                | 4.57    | 9.53    | 12.70   | 4.57         | 6.35   | 8.38   | 10.31  | 9.53 | 14.27  | 17.48  | 12.70 | 21.44   | 25.40   | 28.58   | 33.32   | 25.40 |
| 350               | 14    | 355.6                 | 3.96                | 4.78    | 9.53    | 12.70   | 6.35         | 7.92   | 9.53   | 11.13  | 9.53 | 15.09  | 19.05  | 12.70 | 23.83   | 27.79   | 31.75   | 35.71   |       |
| 400               | 16    | 406.4                 | 4.19                | 4.78    | 9.53    | 12.70   | 6.35         | 7.92   | 9.53   | 12.70  | 9.53 | 16.66  | 21.44  | 12.70 | 26.19   | 30.96   | 36.53   | 40.49   |       |
| 450               | 18    | 457                   | 4.19                | 4.78    | 9.53    | 12.70   | 6.35         | 7.92   | 11.13  | 14.27  | 9.53 | 19.05  | 23.83  | 12.70 | 29.36   | 34.93   | 39.67   | 45.24   |       |
| 500               | 20    | 508                   | 4.78                | 5.54    | 9.53    | 12.70   | 6.35         | 9.53   | 12.70  | 15.09  | 9.53 | 20.62  | 26.19  | 12.70 | 32.54   | 38.10   | 44.45   | 50.01   |       |
| 550               | 22    | 559                   | 4.78                | 5.54    |         |         | 6.35         | 9.53   | 12.70  |        | 9.53 | 22.23  | 28.58  | 12.70 | 34.93   | 41.28   | 47.63   | 53.98   |       |
| 600               | 24    | 610                   | 5.54                | 6.35    | 9.53    | 12.70   | 6.35         | 9.53   | 14.27  | 17.48  | 9.53 | 24.61  | 30.96  | 12.70 | 38.89   | 46.02   | 52.37   | 59.54   |       |
| 650               | 26    | 660                   |                     |         |         |         | 7.92         | 12.70  |        |        | 9.53 |        |        | 12.70 |         |         |         |         |       |
| 700               | 28    | 711                   |                     |         |         |         | 7.92         | 12.70  | 15.88  |        | 9.53 |        |        | 12.70 |         |         |         |         |       |
| 750               | 30    | 762                   | 6.35                | 7.92    |         |         | 7.92         | 12.70  | 15.88  |        | 9.53 |        |        | 12.70 |         |         |         |         |       |

These dimensions are nominal – substantial tolerances apply to both OD and WT – refer to the standards for details.  
 Stainless steel pipe nominal dimensions based on ASTM A312M and ASME B36.19M-2004.  
 Carbon steel pipe nominal dimensions based on ASTM A106M and ASME B36.10M-2004. For other wall thicknesses and for sizes of carbon steel pipe above DN 750 consult ASME B36.10M.

## THE OTHER PIPE SIZES – AUSTRALIAN STANDARD

There is a range of carbon steel “tube” covered by AS 1074 and AS 1579 that also has DN designations for nominal size. There are some differences between these and the ASTM / ASME pipes of the same designation as shown in the table of nominal outside diameters at right. The AS tubes do not have schedules of wall thickness but rather come in Light, Medium and Heavy wall.

Flanges intended for use with ASTM pipe or AS 1074 tube may need different internal bore sizes; note particularly DN 65, DN 125 and DN 150.

The AS/NZS 1163 product has the same outside diameters as these other Australian standards, but does not refer to DN sizes, only to nominal millimetres.

| Nominal Size (DN) | ASME (mm) | AS 1074 / AS 1579 (mm) |
|-------------------|-----------|------------------------|
| 15                | 21.3      | 21.3                   |
| 20                | 26.7      | 26.9                   |
| 25                | 33.4      | 33.7                   |
| 32                | 42.2      | 42.4                   |
| 40                | 48.3      | 48.3                   |
| 50                | 60.3      | 60.3                   |
| 65                | 73.0      | 76.2                   |
| 80                | 88.9      | 88.9                   |
| 90                | 101.6     | 101.6                  |
| 100               | 114.3     | 114.3                  |
| 125               | 141.3     | 139.7                  |
| 150               | 168.3     | 165.1                  |

## PIPE DESIGNATED BY SIZE

Some manufacturers supply standard pipe to the usual DN / Schedule sizes, but they describe the size as OD x WT in millimetres. So an inspection certificate describes the pipe as 88.9 x 3.05mm for instance. This is still just a DN 80 Sch 10S. All Atlas products are designated by ASME DN and Sch or designator (eg STD, XS or XXS) unless clearly identified as compliant to Australian Standards.

## REFERENCES & FURTHER INFORMATION

ASTM A53M-07 “Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless”

ASTM A106M-06a “Seamless Carbon Steel Pipe for High Temperature Service”

ASTM A312M “Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes”

ASTM A333M-05 “Seamless and Welded Steel Pipe for Low Temperature Service”

ASTM A358M-05 “Electric Fusion Welded Austenitic Chromium Nickel Stainless Steel Pipe for High Temperature Service and General Applications”

ASTM A790M-07 “Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe”

API 5L/ISO 3183:2007 “Specification for Line Pipe”

ASME B36.10M-2000 “Welded and Seamless Wrought steel Pipe”

ASME B36.19M-2004 “Stainless Steel Pipe”

AS/NZS 1163-2009 “Cold-Formed Structural Steel Hollow Sections”

## ATLAS STEELS TECHNICAL SERVICES DEPARTMENT

Atlas Steels maintains a Technical Services Department to assist customers and the engineering community generally on correct selection, fabrication and application of specialty metals. Our metallurgists are supported by our laboratory and have a wealth of experience and readily available information.

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