

Aluminium Alloys are supplied in a very wide range of tempers with two principal groups:

**Non-heat treatable alloys** - Alloys whose strength/mechanical properties are achieved by cold working (rolling, extruding, etc.). Sometimes called work hardening alloys, Temper is denoted by letter H.

**Heat treatable alloys** - Alloys whose strength/mechanical properties are achieved by heat treatment followed by cooling and natural or artificial ageing. Temper denoted by letter T.

### HEAT-TREATABLE ALLOYS

**Solution heat treating** - The process of heating aluminium at prescribed temperature for a prescribed time and then cooling rapidly usually by quenching in water.

**Natural ageing (T1, T2, T3, T4)** - The process which occurs spontaneously at ordinary temperature until the metal reaches a stable condition. This hardens the metal after solution heat treatment.

**Artificial ageing (T5, T6, T9)** - The process of heating for a prescribed period (2-30 hours) at a prescribed low temperature (100-200°C) until the metal reaches a stable condition. This hardens/increases strength after solution heat treating quicker than natural ageing and to a greater level.

### NON HEAT-TREATABLE ALLOYS

**Work hardening (H14)** - General term for processes which increase strength of aluminium and reduce the ductility, (e.g. rolling, drawing, pressing, stamping). Sometimes called strain-hardening.

**Partial annealing (H24)** - A heating process which reduces strength and increases ductility of aluminium after work hardening. Sometimes called temper let-down.

**Stabilising (H34)** - A low temperature thermal treatment or heat introduced during manufacture which stabilises the mechanical properties. This process usually improves ductility and is only applied to those alloys which, unless stabilised, gradually age-soften at room temperature, (i.e. non-heat treatable range.) The purpose of stabilising is to relieve the residual internal stress in the metal. Mainly used for 5000 series alloys.

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### REVISION HISTORY

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### Non-Heat Treatable Alloy Designations

| Term | Description                                               |
|------|-----------------------------------------------------------|
| H1X  | Work hardened                                             |
| H2X  | Work hardened and partially annealed                      |
| H3X  | Work hardened and stabilized by low temperature treatment |
| H4X  | Work hardened and stoved                                  |
| HX2  | Quarter-Hard                                              |
| HX4  | Half-Hard                                                 |
| HX6  | Three-quarter Hard                                        |
| HX8  | Fully Hardened                                            |

### Temper Codes for Plate

| Code | Description                                                                                                                                                                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H111 | Some work hardening imparted by shaping processes but less than required for H11 temper                                                                                                                                                                                                                    |
| H112 | Alloys that have some tempering from shaping but no special control over the amount of strain-hardening or thermal treatment. Some strength limits apply.                                                                                                                                                  |
| H321 | Strain hardened less than required for a controlled H32 temper.                                                                                                                                                                                                                                            |
| H323 | A version of H32 that has been specially fabricated to provide acceptable resistance to stress corrosion cracking.                                                                                                                                                                                         |
| H34  | Stabilised, Half Hard - A low temperature thermal treatment or heat introduced during manufacture which stabilises the mechanical properties and relieves residual internal stress, usually improves ductility. Only applied to alloys which, unless stabilised, gradually age-soften at room temperature. |
| H343 | H34 specially fabricated to provide acceptable resistance to stress corrosion cracking.                                                                                                                                                                                                                    |
| H115 | Armour plate.                                                                                                                                                                                                                                                                                              |
| H116 | Special corrosion-resistant temper.                                                                                                                                                                                                                                                                        |

### Full List of Temper Codes

| Code | Description                                                                           |
|------|---------------------------------------------------------------------------------------|
| F    | As Fabricated (no property limits specified)                                          |
| O    | Fully Annealed, Soft                                                                  |
| H111 | <i>see adjacent table</i>                                                             |
| H112 | <i>see adjacent table</i>                                                             |
| H115 | Armour Plate                                                                          |
| H116 | Special corrosion resistant temper                                                    |
| H12  | Work hardened to quarter hard, not annealed after rolling                             |
| H14  | Work hardened to half hard, not annealed after rolling                                |
| H16  | Work hardened to three-quarter hard, not annealed after rolling                       |
| H18  | Work hardened to fully hard, not annealed after rolling                               |
| H19  | Work hardened to Extra Hard, not annealed after rolling                               |
| H24  | Work hardened then partially annealed to half hard                                    |
| H26  | Work hardened then partially annealed to three-quarter hard                           |
| H28  | Work hardened then partially annealed to fully hard                                   |
| H32  | Work hardened then stabilised by low-temperature heat treatment to quarter hard       |
| H321 | <i>see adjacent table</i>                                                             |
| H323 | <i>see adjacent table</i>                                                             |
| H34  | <i>see adjacent table</i>                                                             |
| H343 | <i>see adjacent table</i>                                                             |
| H36  | Work hardened then stabilised by low-temperature heat treatment to three-quarter hard |
| H38  | Work hardened then stabilised by low-temperature heat treatment to fully hard         |
| O    | Fully Annealed, Soft                                                                  |

### Full List of Temper Codes *continued*

|       |                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------|
| T1    | Cooled from an elevated temperature and naturally aged                                                            |
| T2    | Cooled from an elevated temperature, cold worked and naturally aged                                               |
| T3    | Solution heat treated, cold worked and naturally aged                                                             |
| T351  | Solution heat treated then stress relieved by stretching - Equivalent to T4 condition                             |
| T352  | Solution heat treated, stress relieved by compressing to produce a permanent set of 1% to -5% then naturally aged |
| T3510 | Solution heat treated and stress-relieved by stretching - Equivalent to T4 condition                              |
| T3511 | Solution heat treated and stress-relieved by stretching - Equivalent to T4 condition                              |
| T36   | Solution heat treated then cold worked by a reduction of 6%                                                       |
| T361  | Solution heat treated then stress relieved by stretching.                                                         |
| T4    | Solution heat treated and naturally aged to a substantially stable condition                                      |
| T42   | Solution heat treated and naturally aged to a substantially stable condition                                      |
| T451  | Solution heat treated then stress relieved by stretching - Equivalent to T4                                       |
| T4510 | Solution heat treated and stress-relieved by stretching - Equivalent to T4 condition                              |
| T4511 | Solution heat treated and stress-relieved by stretching - Equivalent to T4 condition                              |
| T5    | Cooled from an elevated temperature shaping process and artificially aged                                         |
| T6    | Solution heat treated and artificially aged                                                                       |
| T62   | Solution heat treated then artificially aged by the user                                                          |

|       |                                                                                                                                                  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| T651  | Solution heat treated, stress relieved by stretching then artificially aged                                                                      |
| T6510 | Solution heat treated and stress-relieved by stretching then artificially aged with no straightening after aging - Equivalent to T4 condition    |
| T6511 | Solution heat treated and stress-relieved by stretching then artificially aged with minor straightening after aging - Equivalent to T4 condition |
| T7    | Solution heat treated then stabilised                                                                                                            |
| T72   | Solution heat treated then specially artificially aged for resistance to stress corrosion                                                        |
| T73   | Solution heat treated then specially artificially aged for resistance to stress corrosion                                                        |
| T7351 | Solution heat treatment then specially artificially aged for resistance to stress corrosion                                                      |
| T8    | Solution heat treated, cold worked then artificially aged                                                                                        |
| T81   | Solution heat treated, cold worked then artificially aged                                                                                        |
| T851  | Solution heat treated then stress relieved by stretching then artificially aged                                                                  |
| T8510 | Solution heat treated, stress-relieved by stretching then artificially aged                                                                      |
| T8511 | Solution heat treated, stress-relieved by stretching then artificially aged                                                                      |
| T9    | Solution heat treated, artificially aged and cold worked                                                                                         |
| T10   | Cooled from an elevated temperature, artificially aged then cold worked                                                                          |