

# BRA Fact finders

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## A Guide to Selecting Copper Tube and Fittings for New Refrigeration & Air Conditioning Systems with Air Cooled Condensers to comply with BS 4434:1995

### INTRODUCTION

Factfinder No. 5 dealt with a number of issues in relation to BS4434:1995 including extracts of BS1300:1975 (1980) to assist in the selection of copper tube. Because many new refrigerants operate at higher pressures than the fluids they replace, care is necessary when considering the strength of copper tube to be selected.

This Factfinder explains relevant revisions to BS 4434:1995 and extends information given in previous Factfinder No 5. Commonly available copper tube is listed together with its suitability according to BS4434:1995 Table 6 for various refrigerants in both the high and the low side of the system, using minimum design temperature bubble point or saturation pressures corresponding to temperatures of 32°C for the low side and 55°C for the high side.

The tables used in this Factfinder include most commercially available refrigerants. However, the guidance in the Factfinder is primarily provided for NEW REFRIGERATION SYSTEMS. BRA expects that, with some minor exceptions, only ozone benign refrigerants will be selected for operation of new refrigeration systems, therefore the refrigerants shown in tables 1 and 2 should be selected with this in mind.

Note for the higher range of design temperatures in Table 6, of  $\geq 43^\circ\text{C}$  low side and  $63^\circ\text{C}$  high side, corresponding increases in allowable pressure will have to be applied.

### REVISIONS TO BS:4434:1995 - EXISTING SYSTEMS

A corrigendum to BS4434:1995 relating specifically to change of refrigerant in existing systems was published in March 1997 (AMD 9383) and may be interpreted as:-

For the **low side** of existing systems, the requirements of Table 6 of BS4434:1995 may be relaxed when converting from one A1 refrigerant to another A1 refrigerant of higher pressure, providing that the low pressure side of the system is protected by a relief device, with the relieving pressure selected to suit the **actual** conditions of the system (whether operating, standstill, commissioning, etc, all of which must be considered). The selected relief device setting will generally be lower than that demanded by Table 6, but must be selected so that it will relieve only when necessary for the safety of the system, but not under foreseeable normal local operating or standstill conditions.

For the **high side** under the stated conditions of refrigerant change, it is also recognised that the design conditions of Table 6 may not always be achievable. In such cases it is permissible to set the high side relief devices to a lower level, but this must be at least 1.1 times the pressure corresponding to the calculated maximum condensing temperature of the system. It is also conditional on having taken all reasonable precautions to protect the system from over-pressure, under foreseeable operating conditions. The system pipe work and components must then be capable of safely withstanding this pressure.

*These important relaxations DO NOT APPLY TO NEW SYSTEMS nor do they dilute the need for good safe working practices.*

### NEW REFRIGERATION SYSTEMS –

#### *Safe working pressures for copper tube and fittings*

#### How to use the tables

In the appropriate table find the row which contains the copper tube size and refrigerant you wish to use. The tube's minimum wall thickness (SWG) and maximum allowable pressure ( $P_s$ ) can then be read. Note that this is for **fully annealed copper tube** selected to comply with Table 6 of BS 4434:1995.

Where the low side is however exposed to high side pressures, including conditions associated with heat pumps, hot gas defrost etc., the high side ratings shown in Table 2 should be applied to the low side also.

Also shown in the tables is the maximum allowable pressure for the corresponding fittings for the tube size. To check whether this pressure is sufficient you need to refer to the saturation (or bubble point) pressure for the chosen refrigerant at  $\leq 32^\circ\text{C}$  (low side) or  $55^\circ\text{C}$  (high side).

See note 3 regarding the application and availability of copper fittings

REMEMBER, IF IN DOUBT, STUDY BS4434:1995 IN CONJUNCTION WITH THE CORRIGENDUM. Both available from BSI 389, Chiswick High Road, London, W4 4AL. Reference: ISBN 0 580 25130 6.

Table 1 Low side tube

| Copper tube <sup>1</sup> |     |   | Refrigerants   |
|--------------------------|-----|---|--|
| OD, in                   | SWG | P <sub>s</sub> (MAP) <sup>2</sup><br>in Bar G |  |
| 2½                       | 16  | 22.8  | R410A, R410B   |
| 2½                       | 18  | 17  | R12, R134a,<br>R410A/B, R409A<br>R502, R404A, R507<br>R406A/B, R402A/B<br>R403A/B, R408A,<br>R22, R407C, R411B |
| 2½                       | 16  | 18.4  | R404A, R507, R407B,<br>R402A, R403A/B,<br>R402B, R407A   |
| 2½                       | 18  | 13.7  | R12, R134a, R401A/B<br>R409A, R502, R408A<br>R22, R407C, R411B   |
| 3½                       | 14  | 9.3   | R410A/B  |
| 3½                       | 16  | 15.4  | R502, R404A, R507<br>R407A/B, R402A/B<br>R403A/B, R408A, R22<br>R407C, R411B                                   |
| 3½                       | 18  | 11.5  | R12, R134a, R401A/B<br>R409A   |
| 3½                       | 14  | 16.6  | R404A, R507, R407B<br>R402A/B, R403A/B<br>R407   |
| 3½                       | 16  | 13.2  | R502, R408A, R407C<br>R22, R411B   |
| 3½                       | 18  | 9.9   | R12, R134a, R410A/B<br>R409A   |
| 4½                       | 12  | 19  | R402A, R403B<br>R410A/B, R407B   |
| 4½                       | 14  | 14.6  | R502, R404A, R507<br>R407A, R402B<br>R403A, R408A, R407C   |
| 4½                       | 16  | 11.6  | R22, R401B, R409A<br>R411B   |
| 4½                       | 18  | 8.7   | R12, R134a, R401A  |

## Notes to tables

1. Diameters below those shown satisfy BS4434:1995 requirements for copper tube.
2. The minimum value for the Maximum Allowable Pressure, P<sub>s</sub>, calculated in accordance with the formula in BRA Factfinder No 5 using a maximum operating temperature of 50°C for the low side and 100°C for the high side.
3. Some manufacturers have tested their fittings to an appropriate parameter to meet the requirements of BS4434:1995 (as amended in March 1997). Certificates to this effect are now available from suppliers, effectively superseding issue 1 of this Factfinder.

**Care should be taken to use the correct wall thickness by checking tube marking during installation**

Table 2. High side tube

| Copper tube <sup>1</sup> |     |   | Refrigerants   |
|--------------------------|-----|---|--|
| OD, in                   | SWG | P <sub>s</sub> (MAP) <sup>2</sup><br>in Bar G |  |
| 1½                       | 18  | 32  | All except R410A/B   |
| 1½                       | 16  | 34.9  | R410A/B, R407B<br>R402A  |
| 1½                       | 18  | 25.9  | R12, R134a, R410A/B<br>R409A, R502, R404A<br>R507, R407A, R402B<br>R403A/B, R408A, R22<br>R407C, R411B |
| 1½                       | 16  | 29.3  | R502, R404A<br>R507, R407A/B<br>R402A/B, R403A/B<br>R408A  |
| 1½                       | 18  | 21.8  | R12, R134a, R401A/B<br>R409A, R22, R407<br>R411B   |
| 2½                       | 14  | 28  | R502, R404A, R507<br>R407A/B, R402A/B<br>R403A/B, R408A<br>R407C                                       |
| 2½                       | 16  | 22.3  | R22, R411B   |
| 2½                       | 18  | 16.6  | R12, R134a, R401A/B<br>R409A   |
| 2½                       | 12  | 29.6  | R404A, R507<br>R407A/B, R402A/B<br>R403A/B, R408A<br>R407C   |
| 2½                       | 14  | 22.5  | R502, R22, R411B   |
| 2½                       | 16  | 17.9  | R134a, R401A/B<br>R409A  |
| 2½                       | 18  | 13.4  | R12  |
| 3½                       | 12  | 24.71   | R502, R402B, R403A<br>R408A, R22, R407C<br>R411B   |
| 3½                       | 14  | 18.9  | R401A/B, R409A   |
| 3½                       | 16  | 15  | R12, R134a   |
| 3½                       | 12  | 21.2  | R22, R01B, R411B   |
| 3½                       | 14  | 16.2  | R134a, R401A, R409A  |
| 3½                       | 16  | 12.9  | R12  |
| 4½                       | 12  | 18.6  | R410A/B, R409A   |
| 4½                       | 14  | 14.2  | R12, R134a   |

**EXAMPLE 1 (Table 1 – low side)**

A suction line of 3½ in OD for a R404A system operating at any saturation temperature up to 32°C must be capable of withstanding the bubble point pressure at 32°C of 14 bar gauge to comply with Table 6. This results in a minimum tube wall thickness of 16SWG.

**EXAMPLE 2 (Table 2 – high side)**

A discharge line of 1½ in OD for a new R404A system designed to comply with Table 6 conditions of ≤ 32°C and 55°C saturation discharge temperature must be capable of withstanding a pressure of 24.8 bar gauge. From Table 2 a suitable tube requires a minimum wall thickness of 18SWG.

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