# Handy & Harman/Lucas-Milhaupt Brazing Filler Metals

This table is intended to cover only a few typical applications of the most frequently used brazing filler metals. For special brazing applications, contact our Technical Services Department.

| | Filler Metal Name | Typical Applications | Heating Methods* | Solidus °F | Solidus °C | Liquidus °F | Liquidus °C | Max. Recom. Brazing Temp. °F | Nominal Composition, % Ag | Cu | Zn | Others | Joint Color as Brazed | Density** Troy oz/cu in | Electrical Characteristics: Conduct. % IACS | Electrical Characteristics: Resistivity microhm-cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cadmium-Bearing Filler Metals** | Easy-Flo® 45 | Joining ferrous, nonferrous and dissimilar metals and alloys with close joint clearances. | TFIR | 1125 | 605 | 1145 | 620 | 1350 | 45 | 15 | 16 | 24 Cd | Light Yellow | 4.96 | 27.6 | 6.06 |
| | Easy-Flo | Same as Easy-Flo 45. | TFIR | 1160 | 625 | 1175 | 635 | 1375 | 50 | 15.5 | 16.5 | 18 Cd | Light Yellow | 4.98 | 23.9 | 7.00 |
| | Easy-Flo 35 | Similar to Easy-Flo 45, but used where joint clearances are large and fillets are desired. | TFIR | 1125 | 605 | 1295 | 700 | 1400 | 35 | 26 | 21 | 18 Cd | Light Yellow | 4.84 | 28.6 | 6.02 |
| | Easy-Flo 30 | Similar to Easy-Flo 35, but used for more economical joints. | TFIR | 1125 | 605 | 1310 | 710 | 1400 | 30 | 27 | 23 | 20 Cd | Light Yellow | 4.79 | 31 | 5.5 |
| | Easy-Flo 25 | Same as Easy-Flo 30, but used for most economical joints. | TFIR | 1125 | 605 | 1375 | 745 | 1400 | 25 | 35 | 26.5 | 13.5 Cd | Light Yellow | 4.71 | 29.7 | 5.7 |
| | Easy-Flo 25HC | Same as Easy-Flo 35, but used for more economical joints. | TFIR | 1180 | 640 | 1320 | 715 | 1400 | 25 | 30 | 27.5 | 17.5 Cd | Light Yellow | 4.67 | 31.9 | 5.4 |
| | Easy-Flo 3 | For 300 series stainless steels; for joining tungsten carbide, beryllium copper and aluminum bronze to steel. | TIR | 1170 | 630 | 1270 | 690 | 1400 | 50 | 15.5 | 15.5 | 16 Cd, 3 Ni | Light Yellow | 5.02 | 18 | 9.58 |
| | Braze™ 053 | A high temperature solder for medium strength joints above that of soft solders. Use TEC flux. | TFIR | 640 | 340 | 740 | 395 | 900 | 5 | | | 95 Cd | Gray | 4.65 | 22 | 7.90 |
| | Braze 440 | Low melting filler metal for brazing electrical contacts and molybdenum or copper-tungsten electrodes. | TFIR | 1100 | 595 | 1220 | 660 | 1400 | 44 | 27 | 13 | 15 Cd, 1P | Light Yellow | 4.86 | 13.8 | 12.5 |
| **Cadmium-Free Filler Metals** | Braze 051 | Brazing nichrome resistance elements, or simultaneous brazing and heat treating of steels. | TFIR | 1545 | 840 | 1615 | 880 | 1700 | 5 | 58 | 37 | | Brass Yellow | 4.47 | 24.4 | 7.06 |
| | Braze 071 | Used when heat treatment follows brazing, as a lower melting alloy than copper, or in vacuum systems. | TFIHR | 1225 | 665 | 1805 | 985 | 2000 | 7 | 85 | | 8 Sn | Yellow | 4.80 | 12.8 | 13.50 |
| | Braze 090 | For copper base alloys such as in band instruments; or joint brazing/cyanide case hardening of steels. | TFIR | 1410 | 765 | 1565 | 850 | 1665 | 9 | 53 | 38 | | Brass Yellow | 4.49 | 20.5 | 8.43 |
| | Braze 202 | For simultaneous brazing and heat treating of steels. | TFIR | 1315 | 710 | 1500 | 815 | 1650 | 20 | 45 | 35 | | Brass Yellow | 4.58 | 23.5 | 7.36 |
| | Braze 250 | Low silver filler metal for joining ferrous and nonferrous alloys. | TFIR | 1250 | 675 | 1575 | 855 | 1665 | 25 | 52.5 | 22.5 | | Brass Yellow | 4.71 | 24.4 | 7.06 |
| | Braze 252 | Economical filler metal for tungsten carbide, stainless steel and steel. | TFIR | 1305 | 705 | 1475 | 800 | 1650 | 25 | 38 | 33 | 2 Mn, 2 Ni | Brass Yellow | 4.52 | 10.2 | 17.2 |
| | Braze 255 | Economical filler metal for ferrous and nonferrous joints not requiring high ductility or impact strength. | TFIR | 1270 | 690 | 1435 | 780 | 1600 | 25 | 40 | 33 | 2 Sn | Light Yellow | 4.62 | 19.4 | 9.0 |
| | Braze 300 | For steel and nonferrous alloys melting above 1450°F (790°C), nickel-silver knife handles, electrical equipment. | TFIR | 1250 | 675 | 1410 | 765 | 1600 | 30 | 38 | 32 | | Light Yellow | 4.66 | 24.4 | 6.85 |
| | Braze 351 | Intermediate temperature filler metal for use with ferrous and nonferrous materials. | TFIR | 1265 | 685 | 1390 | 755 | 1600 | 35 | 32 | 33 | | Yellow | 4.67 | 19.8 | 8.2 |
| | Braze 380 | Free flowing, cadmium-free filler metal used with ferrous and nonferrous base metals. | TFIR | 1200 | 650 | 1330 | 720 | 1500 | 38 | 32 | 28 | 2 Sn | Pale Yellow | 4.77 | 18 | 9.5 |
| | Braze 401 | For copper base alloys, mild steel, nickel and Monel, and where a narrow melt range is desired. | TFIR | 1245 | 675 | 1340 | 725 | 1550 | 40 | 30 | 30 | | Yellow | 4.63 | 20.5 | 8.40 |
| | Braze 402 | A free-flowing medium temperature filler metal for ferrous and nonferrous alloys. | TFIR | 1200 | 650 | 1310 | 710 | 1500 | 40 | 30 | 28 | 2 Sn | Pale Yellow | 4.76 | 18 | 9.6 |
| | Braze 403 | For tungsten carbides, and stainless steel food handling equipment allowing no cadmium. | TFIR | 1220 | 660 | 1435 | 780 | 1600 | 40 | 30 | 28 | 2 Ni | Light Yellow | 4.76 | 16.8 | 10.27 |
| | Braze 404 | For tungsten carbides and stainless steel. | TFIR | 1220 | 660 | 1580 | 860 | 1665 | 40 | 30 | 25 | 5 Ni | White | 4.81 | 13.5 | 12.80 |
| | Braze 450 | For ships' piping, band instruments, aircraft engine oil coolers, brass lamps. | TFIR | 1225 | 665 | 1370 | 745 | 1550 | 45 | 30 | 25 | | Yellow White | 4.80 | 19 | 9.08 |
| | Braze 452 | Low temperature, free-flowing, Cd-free alloy. | TFIR | 1185 | 640 | 1260 | 680 | 1500 | 45 | 27 | 25 | 3 Sn | Pale Yellow | 4.85 | 18.0 | 9.6 |
| | Braze 495 | For low-temperature brazing of tungsten carbides and stainless steels. | TFIR | 1260 | 680 | 1290 | 700 | 1450 | 49 | 16 | 23 | 7.5 Mn, 4.5 Ni | Yellow White | 4.70 | 5.7 | 30.27 |
| | Braze 501 | For steam turbine blading and heavily galvanized or tinned steel, aluminum brass tubing. | TFIR | 1250 | 675 | 1425 | 775 | 1600 | 50 | 34 | 16 | | Yellow White | 4.92 | 25.5 | 6.76 |
| | Braze 502; 503 (VTG) | For applications similar to Brazes 720 and 721 except where better gap filling is needed. | TFIHVR | 1435 | 780 | 1600 | 870 | 1800 | 50 | 50 | | | Yellow White | 5.08 | 78 | 2.2 |
| | Braze 505 | For 300 series stainless steel food handling equipment with close joint clearances. | TFIR | 1220 | 660 | 1305 | 705 | 1500 | 50 | 20 | 28 | 2 Ni | Yellow White | 4.73 | 15 | 11.75 |
| | Braze 541 | Atmosphere furnace brazing for high temperature applications (up to 700°F/370°C), such as on jet engines. | TFIR | 1340 | 725 | 1575 | 855 | 1700 | 54 | 40 | 5 | 1 Ni | White | 5.07 | 49.8 | 3.46 |
| | Braze 559 | Same as Braze 541, but used where zinc fumes in the furnace are not permissible. | HVR | 1420 | 770 | 1640 | 895 | 1800 | 56 | 42 | | 2 Ni | White | 5.14 | 51.2 | 3.37 |
| | Braze 560 | For food handling equipment requiring a low melting, cadmium-free alloy. | TFIR | 1145 | 620 | 1205 | 650 | 1400 | 56 | 22 | 17 | 5 Sn | White | 4.96 | 8.3 | 20.75 |
| | Braze 580 | A free flowing filler metal used in brazing tungsten carbide which is subsequently titanium nitrided. | TFIHV | 1120 | 605 | 1345 | 730 | 1550 | 57.5 | 32.5 | | 7.0 Sn, 3.0 Mn | White | 5.17 | 25.3 | 6.81 |
| | Braze 600 | For Monel and other nickel alloys, and in place of Braze 650 on silverware. | TFIR | 1245 | 675 | 1325 | 720 | 1500 | 60 | 25 | 15 | | White | 5.01 | 21 | 8.40 |
| | Braze 603; 604 (VTG) | For vacuum tube seals, brazing of ferrous and nonferrous alloys without flux, for brazing marine heat exchangers exposed to salt water at elevated temperatures (where zinc is objectionable). | TFIHVR | 1115 | 600 | 1325 | 720 | 1500 | 60 | 30 | | 10 Sn | White | 5.17 | 7.1 | 24.10 |
| | Braze 630 | On 400 series stainless steels for corrosion resistance to salt spray, chlorine solutions, etc. | TFIHVR | 1275 | 690 | 1475 | 800 | 1700 | 63 | 28.5 | | 6 Sn, 2.5 Ni | White | 5.19 | 12.8 | 13.40 |
| | Braze 650 | For silverware, iron and nickel alloys. | TFIR | 1240 | 670 | 1325 | 720 | 1500 | 65 | 20 | 15 | | White | 5.06 | 21.3 | 8.10 |
| | Braze 655 | For brazing Invar, Kovar and similar alloys to copper in vacuum tubes; as jet engine rubbing seals. | TFIVRH | 1385 | 750 | 1560 | 850 | 1700 | 65 | 28 | | 5 Mn, 2 Ni | White | 5.20 | 12.8 | 13.40 |
| | Braze 700 | For silverware, when subsequent joints are made with Braze 650. | TFIR | 1275 | 690 | 1360 | 740 | 1550 | 70 | 20 | 10 | | White | 5.15 | 26.7 | 6.45 |
| | Braze 715; 716 (VTG) | Filler metal and high conductivity, similar to Braze 720, but suitable for both ferrous and nonferrous alloys. | TFIHVR | 1435 | 780 | 1465 | 795 | 1700 | 71.5 | 28 | | .5 Ni | White | 5.27 | 78.8 | 2.19 |
| | Braze 720; 721 (VTG) | For nonferrous electronic components requiring highest electrical and thermal conductivity. The VTG grade has low volatile impurities, good for use in moderate temperature vacuum systems. | TFIHVR | 1435 | 780 | 1435 | 780 | 1700 | 72 | 28 | | | White | 5.25 | 87 | 2.0 |
| | Braze 750 | On silverware for step brazing or enameling; for iron or nickel base alloys. | TFIR | 1365 | 740 | 1450 | 790 | 1600 | 75 | 22 | 3 | | White | 5.24 | 53.4 | 3.23 |

*Recommended heating methods: F = Furnace; H = Inert atmosphere (e.g. H, Ar, He, N) without flux; I = Induction; R = Resistance; T = Torch and Gas-Air Burner; V = Vacuum.

**Specific Gravity = $\frac{\text{Density (Troy oz/in}^3)}{.527}$

*(This table continued on the following page.)*

**SAFETY NOTE:** While Cadmium-Bearing Alloys have been extremely popular and versatile filler metals for decades, there are potential hazards associated with them due to their toxic nature. These alloys should only be used in well ventilated areas. We are prepared to assist you in the proper and safe use of these alloys. For additional information, contact our Technical Services Department.

Fahrenheit to Celsius conversion formula F° to C° = .555 (F° - 32)

# Handy & Harman/Lucas-Milhaupt Brazing Filler Metals

This table is intended to cover only a few typical applications of the most frequently used brazing filler metals. For special brazing problems, contact our Technical Services Department.

| | Filler Metal Name | Typical Applications | Heating Methods* | Solidus | | Liquidus | | Max. Recom. Brazing Temp. °F | Nominal Composition, % | | | | | Joint Color as Brazed | Density** Troy oz/cu in | Electrical Characteristics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | °F | °C | °F | °C | | Ag | Cu | Ni | Zn | Others | | | Conduct. % IACS | Resistivity microhm-cm |
| **Cadmium-Free Filler Metals (cont'd)** | Braze™ 852 | Brazing stainless, Stellite, Inconel, complex carbides–for high-temperature service. | FIHV | 1760 | 960 | 1780 | 970 | 2000 | 85 | | | | 15 Mn | White | 4.98 | 4.6 | 37.50 |
| | Braze 999 | A VTG alloy for brazing ceramics to be used as semiconductors. | TFIHV | 1761 | 960 | 1761 | 960 | 1900 | 99.9 | | | | | White | 5.53 | 105.2 | 1.59 |
| | Lithobraze® 720 | For ferrous and nonferrous base alloys; especially thin sections of stainless steels. | H | 1400 | 760 | 1400 | 760 | 1600 | 71.7 | 28 | | | 0.3 Li | White | 5.09 | 50.8 | 3.39 |
| | Lithobraze 925 | To join skins to honeycomb cores, particularly precipitation-hardening stainless steels. | H | 1400 | 760 | 1635 | 890 | 1800 | 92.5 | 7.3 | | | 0.2 Li | White | 5.33 | 55.2 | 3.12 |
| | Premabraze® 616 (VTG) | For ferrous and nonferrous alloys used in moderate temperature vacuum tubes and systems. | HV | 1155 | 625 | 1305 | 705 | 1500 | 61.5 | 24 | | | 14.5 In | White | 5.19 | 16 | 10.70 |
| | Premabraze 130 | For stainless steel, Inconel X, A286, Kovar, etc., for oxidation and scaling resistance up to 1500°F (815°C). | TIHV | 1742 | 950 | 1742 | 950 | 1950 | | | 18 | | 82 Au | Gray | 8.33 | 5.85 | 29.30 |
| | | | | | | | | | | | | | | | **lb/cu in** | | |
| **Hi-Temp Alloys** | Hi-Temp® 080 | Economical high strength filler metal for joining carbides to alloy steels. | TFI | 1575 | 855 | 1675 | 915 | 1875 | | 54.85 | 8 | 25 | 12 Mn .15 Si | Light Yellow | .290 | 6.0 | 28.6 |
| | Hi-Temp 095 | High strength filler metal for joining carbides, steels and heat resistant alloys. | FIHV | 1615 | 880 | 1700 | 925 | 2000 | | 52.5 | 9.5 | | 38 Mn | Red-Gray | .277 | 14.7 | 11.7 |
| | Hi-Temp 548 | Tough, moderate strength, low melting improved nickel silver filler metal for carbides, tool steels, stainless steels and nickel alloys. | TFI | 1615 | 880 | 1685 | 920 | 1900 | | 55 | 6 | 35 | 4 Mn | Light Yellow | .302 | 10.6 | 16.2 |
| | Hi Temp 870 | A free flowing, high melting filler metal with good high temperature strength, for brazing carbides, tool steels, stainless steels and nickel alloys. | FIHV | 1760 | 960 | 1885 | 1030 | 2000 | | 87 | | | 10 Mn, 3 Co | Gray | .316 | 14.5 | 11.9 |
| **Silver-Copper-Phos-phorus Alloys** (See note below) | Sil-Fos® 18 | A ternary eutectic filler metal for joints where good fit-up can be maintained and low melting point is of prime importance. Clearance: .001" to .003" (.025 mm to .076 mm). Very fast flow. | TFIR | 1190 | 645 | 1190 | 645 | 1300 | 18 | 75.5 | | | 6.5 P | Gray | .293 | 5.9 | 29.4 |
| | Sil-Fos | For use where close fit-ups cannot be maintained and joint ductility is important. Recommended joint clearance: .002" to .005" (.051 mm to .127 mm). Slow flow. The only phos/copper silver filler metal available in strip or sheet form. | TFIR | 1190 | 645 | 1475 (1300) | 800 (705) | 1500 | 15 | 80 | | | 5 P | Gray | .305 | 9.9 | 17.4 |
| | Sil-Fos 6 | A very fluid filler metal for close fit-up work. Low melting range makes it ideal where temperature is a factor. Recommended joint clearance: .001" to .003" (.025 mm to .076 mm). Fast flow. Lowest melt and flow in the minimum silver class. | TFIR | 1190 | 645 | 1325 (1275) | 720 (690) | 1450 | 6 | 86.75 | | | 7.25 P | Gray | .284 | 7.9 | 21.9 |
| | Sil-Fos 6 M | Recommended for use where close fit-up cannot be maintained. Has the ability to fill gaps and form fillets without affecting joint strength. Recommended joint clearance: .002" to .005" (.051 mm to .127 mm). Slow flow. | TFIR | 1190 | 645 | 1460 (1300) | 795 (705) | 1500 | 6 | 88 | | | 6 P | Gray | .292 | 8.8 | 19.7 |
| | Sil-Fos 5 | Designed primarily for those applications where close fit-ups cannot be maintained. It has ability to fill gaps and form fillets without adversely affecting joint strength. Recommended joint clearance: .003" to .005" (.076 mm to .127 mm). Slow flow. | TFIR | 1190 | 645 | 1495 (1325) | 815 (720) | 1500 | 5 | 89 | | | 6 P | Gray | .294 | 9.6 | 18.1 |
| | Sil-Fos 2 | A filler metal with comparable characteristics to Fos-Flo 7. Recommended joint clearance: .001" to .005" (.025 mm to .127 mm). Medium flow. | TFIR | 1190 | 645 | 1450 (1325) | 785 (720) | 1500 | 2 | 91 | | | 7 P | Gray | .289 | 5.5 | 31.5 |
| | Sil-Fos 2M | Has ability to fill moderate gaps in poorly fitted joints. More ductile than Fos-Flo 7 or Sil-Fos 2. Intended for use on copper tube headers and similar applications where a sleeve fit is not practical. Recommended joint clearance: .002" to .005" (.051 mm to .127 mm). Slow flow. | TFIR | 1190 | 645 | 1495 (1350) | 815 (730) | 1550 | 2 | 91.4 | | | 6.6 P | Gray | .292 | 7.5 | 22.9 |
| **Copper-Phos-phorus Alloys** (See note below) | Fos-Flo® 7 | An economical, very fluid medium temperature filler metal for use with copper, brass and bronze. Withstands moderate vibration. Recommended joint clearance: .001" to .003" (.025 mm to .076 mm). Fast flow. | TFIR | 1310 | 710 | 1460 (1350) | 795 (730) | 1550 | | 92.75 | | | 7.25 P | Gray | .289 | 7.5 | 23.2 |
| | Fos-Flo 6 | An economical filler metal with a wide melting range and moderate flow. For use where close fit-ups cannot be maintained and ductability is important. Recommended joint clearance is .003" to .005" (.076 mm to .127 mm). | TFIR | 1310 | 710 | 1570 (1375) | 854 (746) | 1600 | | 93.85 | | | 6.15 P | Gray | .293 | 7.2 | 24.1 |

*Recommended heating methods: F = Furnace; H = Inert atmosphere (e.g. H. Ar, He, N) without flux; I = Induction; R = Resistance; T = Torch and Gas-Air Burner; V = Vacuum.

**Specific Gravity = $\frac{\text{Density (Troy oz/in}^3\text{)}}{.527}$

**NOTE:** The Sil-Fos and Fos-Flo filler metals are for use with copper and copper alloy base metals. Do not use these materials to join ferrous materials as brittle phosphide compounds will be formed at the interface. The Sil-Fos and Fos Flo filler metals have a unique characteristic called the "Flow Point" (listed in parentheses). The ''Flow Point'' is defined as the temperature at which the filler metal is fluid enough to capillary through a joint even though not completely liquid (i.e. above the liquidus temperature).