Metglas®, Inc.

Amorphous Brazing Foil

Metglas Brazing Foil

Delivering Advantages to Your Critical Applications

www.metglas.com

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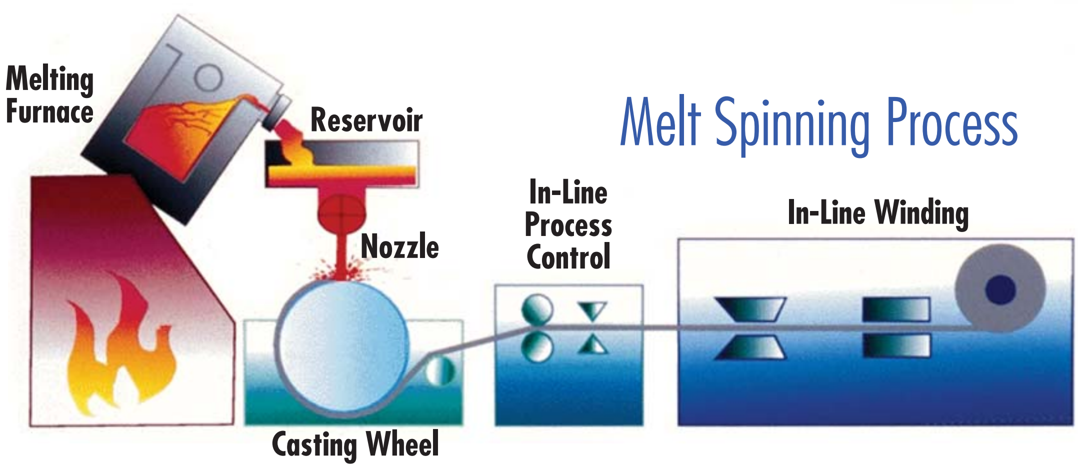
Metglas® Brazing Foil Outperforms Alternative Filler Metals

What Is Amorphous Foil?

Amorphous materials do not have long-range crystalline structure like typical steels, stainless steels and other alloys. The amorphous structure offers several advantages, such as greatly increased solid solubility allowing for a wider range of possible alloy combinations of Nickel, Chromium, Iron, Boron, Silicon, Molybdenum and Phosphorus as in the nickel based brazing family of alloys. Further, the amorphous structure delivers very uniform distribution of alloying elements, thus they melt over a very narrow temperature range as the alloying elements do not require long diffusion paths as with multi-phase polycrystalline materials.

How Is Amorphous Foil Made?

Metglas® Brazing Foils (MBFs) are produced by rapidly quenching molten metal at rates of over 1,000,000°C per second. This process creates very uniform, ductile and homogeneous brazing foils that can be used to create consistent, void-free and optimum strength joints. Environmentally-friendly MBFs also allow you to reduce your operating costs by reducing waste, improving yield, improving furnace performance and by easily lending themselves to automation. The ductility of Amorphous Brazing Foil allows the manufacture of precise preform shapes via stamping techniques or photo-etching.



Advantages over Powder/Pastes/Tapes

Metglas® Brazing Foil

- Ductile, Flexible, 100% Metallic Foil
- Melts Quickly within a Narrow Temperature Range
- Creates Strong and void-free Joints
- Can Be Placed with Precision Between Parts
- Very Economical and Effective Vs. Powder Metal Fillers
- Reduces Set Up and Assembly Process Time
- Does not Harm the Environment or Vacuum Brazing Furnaces

Conventional Brazing Fillers

- Generally Brittle Powders
- Melts Slower than MBF with Wider Temperature Range
- Excessive Amount of Detrimental Oxides
- Larger Quantities Required per Joint than MBF
- Prone to Form Porous Joints with Large Crystalline Grains
- Messy and Difficult Assembly Processing
- Contaminates the Environment and Degrades Vacuum Brazing Furnaces

Preforms

Metglas Amorphous Brazing Foil has high hardness but is ductile enough to be mechanically stamped and shaped to 3-D configurations. (MBF bends 180 degrees without fracturing.) Other Options for braze preform production include:

- Laser cutting
- Water jet cutting
- EDM cutting
- Photo or chemical etching

Available Alloys

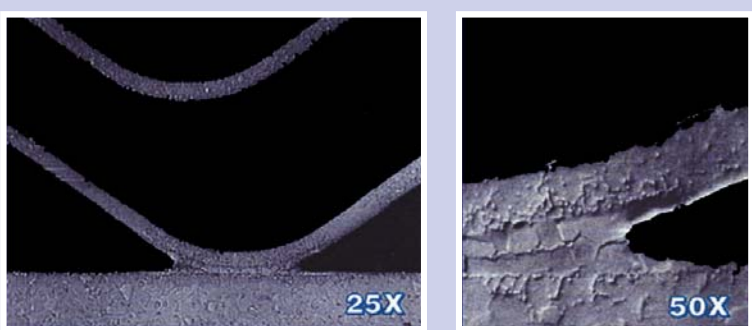
MBF Alloy	AWS & ASM Classifications	Nominal Composition, wt %								Melting Temp. C° (F°)		Braze Temp. (Approx.)	Density g/cm^3
		Cr	Fe	Si	C*	B	P	Mo	Ni	Solidus	Liquidus	°C (°F)	(lb/in^3)
15		13.0	4.2	4.5	0.03	2.8	–	–	Bal	965 (1769)	1103 (2017)	1135 (2075)	7.82 (0.283)
20	AWS BNi-2/AMS 4777	7.0	3.0	4.5	0.06	3.2	–	–	Bal	969 (1776)	1024 (1875)	1055 (1931)	7.88 (0.285)
30	AWS BNi-3/AMS 4778	–	–	4.5	0.06	3.2	–	–	Bal	984 (1803)	1054 (1929)	1085 (1985)	8.07 (0.291)
50	AWS BNi-5a	19.0	–	7.3	0.08	1.5	–	–	Bal	1052 (1924)	1144 (2091)	1170 (2138)	7.70 (0.278)
51	AWS BNi-5b	15.0	–	7.3	0.06	1.4	–	–	Bal	1030 (1886)	1126 (2058)	1195 (2183)	7.73 (0.278)
60	AWS BNi-6	–	–	–	0.1	–	11.0	–	Bal	890 (1634)	890 (1634)	920 (1688)	8.14 (0.294)
62		21.0	<1	0.5	–	0.5*	8.0	1.0	Bal	878 (1612)	940 (1724)	1020 (1868)	7.74 (0.280)
67		25.0	<1	1.5	–	0.5*	6.0	1.5	Bal	890 (1634)	970 (1778)	1020 (1868)	7.70 (0.278)
601		16.0	32	1.5	–	0.5*	6.0	1.5	Bal	960 (1760)	1030 (1886)	1060 (1940)	7.57 (0.273)
80	AWS BNi-9	15.0	–	–	0.06	4.0	–	–	Bal	1048 (1918)	1091 (1996)	1120 (2045)	7.94 (0.287)

*Maximum concentration

Specialty Alloys

MBF Alloy	Nominal Composition, wt %									Melting Temp. C° (F°)		Braze Temp. (Approx.)	Density g/cm^3
	Cr	Co	Pd	Si	C*	B	Mo	Nb	Ni	Solidus	Liquidus	°C (°F)	(lb/in^3)
90	–	20.0	–	4.0	–	2.7	–	–	Bal	966 (1770)	1060 (1940)	1090 (1994)	8.39 (0.303)
91	14.0	9.0	–	–	–	4.0	–	4.0	Bal	1065 (1949)	1104 (2019)	1140 (2084)	8.00 (0.289)
92	14.0	9.0	–	–	–	4.0	–	–	Bal	1064 (1947)	1082 (1980)	1110 (2030)	8.01 (0.289)
1005	–	–	46.7	6.1	–	–	–	–	Bal	810 (1490)	851 (1564)	880 (1616)	9.93 (0.358)
1011	–	5.0	45.5	5.0	–	–	4.5	–	Bal	847 (1557)	895 (1643)	925 (1697)	9.11 (0.329)
1012	10.5	–	36.0	0.5	–	3.0	–	–	Bal	820 (1508)	960 (1760)	990 (1814)	8.80 (0.318)

MBF-51 Microstructure



Shown here at 25X and 50X magnification, a strong and ductile single phase microstructure is formed in 316L stainless steel joints of an industrial heat exchanger brazed with Metglas MBF-51 amorphous brazing foil.

Maximum Width by Thickness (Inches)

Alloy	0.001	0.0015	0.002	0.003
MBF15	6.7	6.7		
MBF20	8.5	8.5	8.5	8.5
MBF30	8.5	8.5	8.5	8.5
MBF50*	6.7	6.7		
MBF51	8.5	8.5	8.5	
MBF60	3.0	2.0		
MBF62	6.7	8.5	5.6	
MBF67	6.7	8.5		
MBF601	6.7	8.5		
MBF80	2.0	2.0		

Specialty alloys available at 2 inches wide at varying thicknesses.

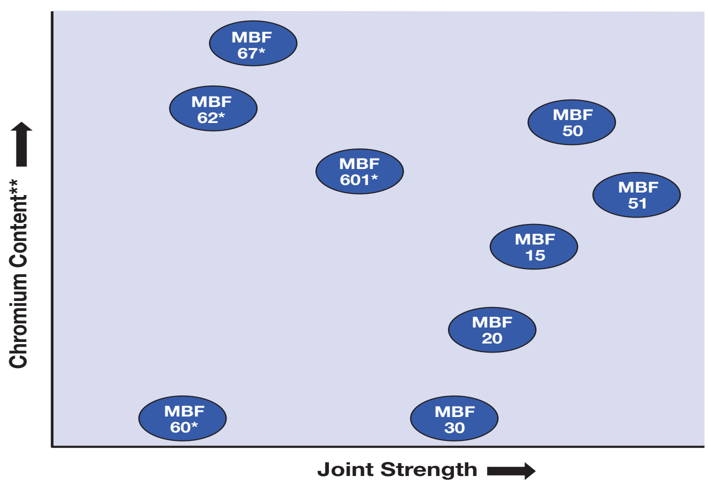
**MBF50 also available @ 0.00078" or 20 μm up to 2" wide.*

Specifications

MBF	AWS	AMS	Pratt & Whitney	General Electric	Garrett Engine Division EMS 54752	SNECMA DMR 35	Rolls Royce MSRR9500
15		4776	PWA996 CPW494		-XIII		705F
20	BNi-2	4777		B50TF204	-II	.302	97F
30	BNi-3	4778		B50TF205	-I	.304	114F
50	BNi-5a			B50TF217	-XXVI		722F
51	BNi-5b						
60	BNi-6		PWA36100		-XI		727F
80	BNi-9		PWA36962	B50TF207	-VIII	.307	719F
1012			PWA36099 CPW475				

From MBF30, BNi-3, to the improved corrosion resistance of MBF67 or the depressed melting temperature of MBF60, BNi-6, Metglas® has the nickel based brazing filler metal to meet your needs.

Strength vs Chromium Content

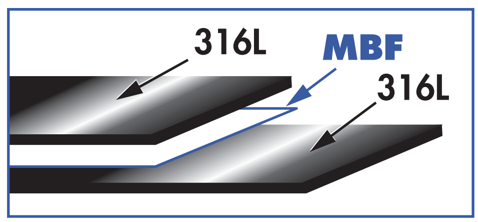


Please note that units are arbitrary and this chart is for illustrative purposes only. The figures represent general joint strength when joining austenitic stainless steels. Joint strength will vary depending on brazing cycle and base materials being joined.

* Due to the tendency of phosphorus to cause embrittlement in iron containing base materials the joint strength of these alloys is lower for stainless steels than B/Si containing Ni-based brazing alloys, however these alloys might be optimal in your application depending on the design requirements. Results might vary depending on base material and brazing cycles used with these alloys.

** An increase in chromium content typically increases the joints corrosion resistance and oxidation resistance.

Properties of Amorphous Braze Foil



Base Metal 316L 1/8" (0.317cm) thick plate

Filler Metal MBF51 (Ni-15Cr-7.25Si-1.4B)
Amorphous Brazing Foil
1 mil (25μm) and 2 mil (50μm) thickness

Joint Mechanical Strength

lap joint with 1:1 overlap

MBF Thickness, mil (μm)	Joint Stress at Maximum Load, MPa	Base Metal Stress at Maximum Load in Joint Vicinity, MPa	Failure Location
1 (25)	364	546	Base Metal
2 (50)	351	416	Base Metal – Joint

* 316L baseline sample subjected to annealing during braze – Yield Strength 199 MPa

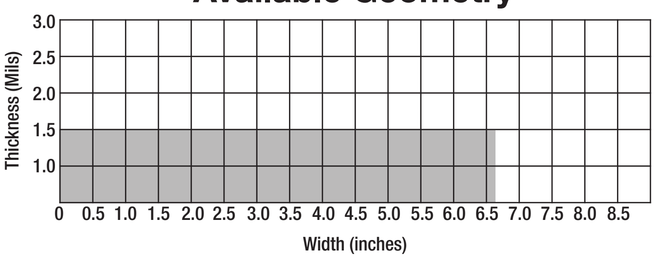
** Joint tensile / sheet testing is made using procedure similar to that recommended in American Welding Society AWS C3.2 Specifications for the lap-type joint configurations.

MBF15

MBF15 Nickel based brazing foil offers very good corrosion resistance and is successfully used in either vacuum or inert brazing atmospheres with conventional steels, stainless steels, nickel and cobalt alloys.

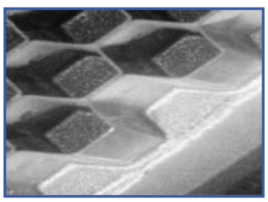
Nominal Chemical Composition, Weight %								Temperatures						Density	
								Solidus		Liquidus		Brazing (Approx.)			
Cr	Fe	Si	C	B	P	Mo	Ni	°C	°F	°C	°F	°C	°F	g/cm³	lb/in³
13.0	4.2	4.5	0.03	2.8	–	–	Bal	965	1769	1103	2017	1135	2075	7.82	0.283

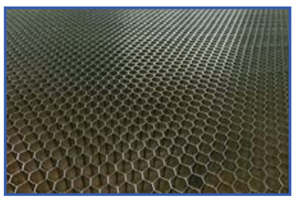
Available Geometry



Specifications

AWS	AMS	Pratt & Whitney	General Electric	Garrett Engine Division EMS 54752	SNECMA DMR 35	Rolls Royce MSRR9500
	4776	PWA996 CPW494		–XIII		705F





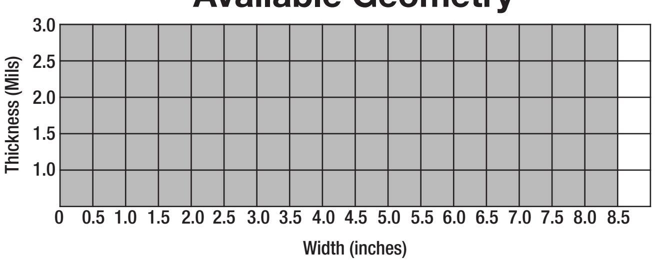
Successfully used in applications such as Exhaust Gas Recirculation (EGR) Coolers, Brazed Honeycomb and Feltmetal Seals for the Aerospace Industry.

MBF20 (BNi-2)

MBF20, BNi-2, offers good corrosion resistance for brazed joints of stainless steels, nickel and cobalt alloys in either vacuum or inert brazing atmospheres.

Nominal Chemical Composition, Weight %								Temperatures						Density	
								Solidus		Liquidus		Brazing (Approx.)			
Cr	Fe	Si	C	B	P	Mo	Ni	°C	°F	°C	°F	°C	°F	g/cm³	lb/in³
7.0	3.0	4.5	0.06	3.2	–	–	Bal	969	1776	1024	1875	1055	1931	7.88	0.285

Available Geometry



Specifications

AWS	AMS	Pratt & Whitney	General Electric	Garrett Engine Division EMS 54752	SNECMA DMR 35	Rolls Royce MSRR9500
BNi-2	4777		B50TF204	–II	.302	97F

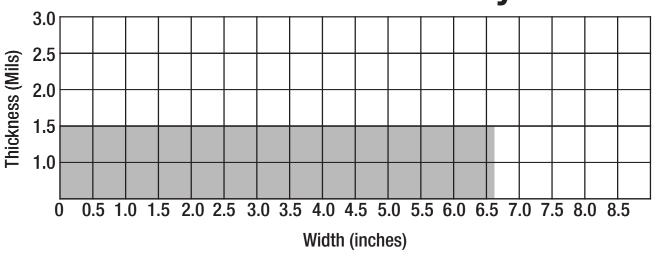
Successfully used in applications such as Exhaust Gas Recirculation (EGR) Coolers, Brazed Plate Heat Exchangers (BPHE), Fin and Tube Heat Exchangers and Aerospace Applications.

MBF50 (BNi-5a)

MBF-50 provides excellent oxidation and corrosion resistance for brazed joints of stainless steels, nickel and cobalt alloys and specialty alloys. Vacuum brazing should be used for best joint performance.

Nominal Chemical Composition, Weight %								Temperatures						Density	
								Solidus		Liquidus		Brazing (Approx.)			
Cr	Fe	Si	C	B	P	Mo	Ni	°C	°F	°C	°F	°C	°F	g/cm³	lb/in³
19.0	–	7.3	0.08	1.5	–	–	Bal	1052	1924	1144	2091	1170	2138	7.70	0.278

Available Geometry



Specifications

AWS	AMS	Pratt & Whitney	General Electric	Garrett Engine Division EMS 54752	SNECMA DMR 35	Rolls Royce MSRR9500
BNi-5a			B50TF217	-XXVI		722F

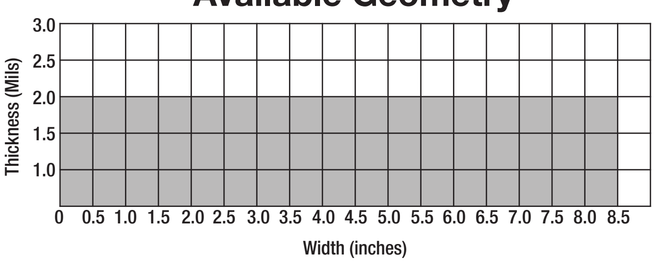
Successfully used in applications such as Metallic Catalytic Substrates (MCS), EGR Coolers, Brazed Plate HE, Fin and Tube HE.

MBF51 (BNi-5b)

MBF51 delivers excellent oxidation and corrosion resistance for demanding applications using stainless steels, nickel and cobalt alloys and specialty alloys. Vacuum brazing should be used for best joint performance.

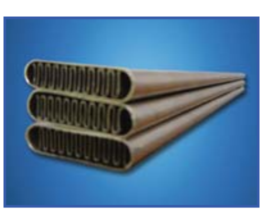
Nominal Chemical Composition, Weight %								Temperatures						Density	
								Solidus		Liquidus		Brazing (Approx.)			
Cr	Fe	Si	C	B	P	Mo	Ni	°C	°F	°C	°F	°C	°F	g/cm³	lb/in³
15.0	–	7.3	0.06	1.4	–	–	Bal	1030	1886	1126	2058	1195	2183	7.73	0.278

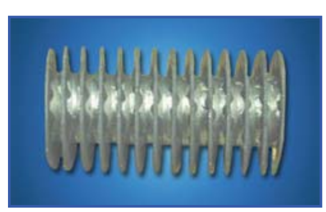
Available Geometry



Specifications

AWS	AMS	Pratt & Whitney	General Electric	Garrett Engine Division EMS 54752	SNECMA DMR 35	Rolls Royce MSRR9500
BNi-5b						





Successfully used in applications such as Metallic Catalytic Substrates, EGR Coolers, Brazed Plate Heat Exchangers, Fin and Tube Heat Exchangers.

Nickel Phosphorus Alloys

MBF Alloy	AWS & ASM Classifications	Nominal Composition, wt %								Melting Temp. °C (°F)		Braze Temp. (Approx.)	Density g/cm³
		Cr	Fe	Si	C*	B	P	Mo	Ni	Solidus	Liquidus	°C (°F)	(lb/in³)
60	AWS BNi-6	–	–	–	0.1	–	11.0	–	Bal	883 (1621)	883 (1621)	920 (1688)	8.14 (0.294)
62		21.0	<1	0.5	–	0.5*	8.0	1.0	Bal	878 (1612)	940 (1724)	1020 (1868)	7.74 (0.280)
67		25.0	<1	1.5	–	0.5*	6.0	1.5	Bal	890 (1634)	970 (1778)	1020 (1868)	7.70 (0.278)

The Nickel-based alloys that utilize Phosphorus as the melting point depressant range from the purely eutectic MBF60, to the very high chromium containing MBF67. MBF60 has successfully been used in joining dissimilar base materials like Nickel Based Super Alloys to Stainless Steels and stainless steels to copper based alloys. The high chromium alloys, MBF62 and 67 are predominately used in the automotive heat exchanger market where oxidation and corrosion resistance are critical.

Nickel Cobalt Alloys

MBF Alloy	Nominal Composition, wt %									Melting Temp. C° (F°)		Braze Temp. (Approx.)	Density g/cm³
	Cr	Co	Pd	Si	C*	B	Mo	Nb	Ni	Solidus	Liquidus	°C (°F)	(lb/in³)
90	–	20.0	–	4.0	–	2.7	–	–	Bal	966 (1770)	1060 (1940)	1090 (1994)	8.39 (0.303)
91	14.0	9.0	–	–	–	4.0	–	4.0	Bal	1065 (1949)	1104 (2019)	1140 (2084)	8.00 (0.289)
92	14.0	9.0	–	–	–	4.0	–	–	Bal	1064 (1947)	1082 (1980)	1110 (2030)	8.01 (0.289)

The MBF90 series brazing foils are specifically designed for applications in high temperature and highly corrosive environments. With boron as the only metalloid used in MBF91 and 92 these alloys lend themselves to achieving relatively quick microstructure uniformity in transient liquid phase diffusion bonded joints.

Nickel Palladium Alloys

MBF Alloy	Nominal Composition, wt %									Melting Temp. C° (F°)		Braze Temp. (Approx.)	Density g/cm³
	Cr	Co	Pd	Si	C*	B	Mo	Nb	Ni	Solidus	Liquidus	°C (°F)	(lb/in³)
1005	–	–	46.7	6.1	–	–	–	–	Bal	810 (1490)	851 (1564)	880 (1616)	9.93 (0.358)
1011	–	5.0	45.5	5.0	–	–	4.5	–	Bal	847 (1557)	895 (1643)	925 (1697)	9.11 (0.329)
1012	10.5	–	36.0	0.5	–	3.0	–	–	Bal	820 (1508)	960 (1760)	990 (1814)	8.80 (0.318)

The MBF1000 series of alloys are precious metal products with a range of palladium from 36 to 46.7 weight percent. These alloys were designed for applications in aerospace turbine blade repair and polycrystalline diamond tip brazing. MBF1005 and 1011 have a recommended brazing temperature below 900°C (1652°F) to reduce thermal stresses from the brazing process and prevent polycrystalline diamond from graphitization. The low silicon content and lack of boron help reduce intermetallic particles in the braze joint and increase joint strength.

Nickel Iron Alloys

MBF Alloy	Nominal Composition, wt %								Melting Temp. C° (F°)		Braze Temp. (Approx.)	Density g/cm³
	Cr	Fe	Si	C*	B	P	Mo	Ni	Solidus	Liquidus	°C (°F)	(lb/in³)
601	16.0	32	1.5	–	0.5*	6.0	1.5	Bal	960 (1760)	1030 (1886)	1060 (1940)	7.57 (0.273)

New Nickel-Iron alloy combines low melting temperatures, good corrosion resistance and oxidation resistance at a lower price then our typical Nickel based alloys. Joints brazed with the MBF600 series have also exhibited high joint strength when brazing stainless steels, cemented carbides and carbon steels.

*Maximum concentration

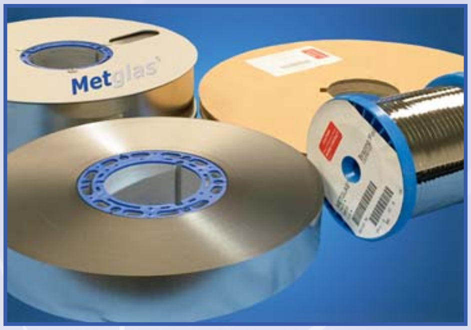
Materials Mag!c

Metglas®, Inc.

Available Forms

Stamped or Photo-etched Preforms

Spools and Coils



- The ductility of Amorphous Brazing Foil allows for the manufacture of precise shapes that improve the ease of assembly and lends itself to automation. Metglas® Brazing Foil & Preforms are available in a wide range of custom shapes and designs. Please send your inquiries to Metglas@metglas.com.
- Precision wound spools of specific width and thickness to fit your production requirements.

Contact Information

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