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SULZER METCO
The Coatings Company™

Metco® 601NS Aluminum-Polyester Powder

Technical Bulletin #10-141

Metco® 601NS Aluminum-Polyester Powder

Metco 601NS is a blend of silicon-aluminum and polyester powders which was especially developed for machine element clearance control. Field testing in aircraft engines confirms that coatings of Metco 601NS have a high degree of abrasability with essentially no blade tip wear, excellent resistance to oxidation at temperatures up to (345° C) 650° F and good resistance to thermal shock.

Metco 601NS was designed to be sprayed with Metco Plasma Spray Systems. The Metco Plasma Spray System can be utilized using either argon/hydrogen or argon/helium as the plasma gases.

This revision of the bulletin includes:

1. The addition of parameters for the Types 9MB, 10MB, 11MB, and MBN Plasma Spray Guns.
2. The update of the properties of sprayed coatings.
3. The addition of Type 4MP and Type 4MP-DUAL Powder Feed Unit parameters.
4. The addition of Garret Turbine Engine Company, SNECMA, Williams International and Detroit Diesel Allison specification conformances.

Specification Conformance

Metco 601NS is certifiable as meeting the requirements of Pratt and Whitney Aircraft Specification PWA 1349, Rolls Royce Ltd. Specification MSRR 9507/15, Avco Lycoming Division Specification M 3955, Garrett Turbine Engine Specification 52467 and FP5091, SNECMA Specification DMR 33-087, Williams International Material Specification WIMS 647 and Detroit Diesel Allison Specification EMS 38900.

Applications

Metco 601NS is recommended for the following applications:

Coating No.	Coating Function	Typical Application
P601-10	Jet engine - abrasable coatings below (345° C) 650° F	Air Seal to replace silver and RTV rubber, Inner and outer air seals on both high and low pressure air compressors

Powder Characteristics

Typical Composition: A blend	-12% Silicon-Aluminum Alloy Polyester	60% Balance
Typical Size Range:	-140 mesh +10 microns (-106 + 10 microns)	
Melting Point: (approximate)	Softens at (425° C) 800° F	

Typical Physical Properties of the Coatings

Coatings of Metco 601NS have good resistance to impact and excellent internal strength. The microstructure is a continuous matrix of aluminum with fairly well dispersed particles of polyester. The aluminum provides good bond strength, good interparticle strength and good thermal properties. The polyester provides abrasability and a low coefficient of friction.

Coating Number:	Coating Pg 01-10	Coating Pg 01-11	Coating Pg 01-12
Gun:	3MB, 7MB, 9MB 10MB, MBN	11MB	3MB, 7MB, 9MB 10MB, MBN
Spray Rate:	3-3 ¹ / ₂ lbs./hr (1.4-1.6 kg/hr)	5-8 lbs./hr (2.3-3.6 kg/hr)	8-10 lbs./hr (3.6-4.5 kg/hr)
Macrohardness R15_v:	73 ±5	70 ±10	70 ±5
As-sprayed Surface:			
microinches aa	600-900	600-900	600-900
microns	15-33	15-33	15-33
As-buffed Surface:			
microinches aa	300-400	300-400	300-400
microns	8-10	8-10	8-10
As-machined Surface:			
microinches aa	75-90	75-90	75-90
microns	2-2.5	2-2.25	2-2.5
Coating Density g/cc:	1.7	1.7	1.6
Coating Weight:			
lbs/ft ² /.001"	.0089	.0089	.0084
kg/m ² /.1 mm	.17	.17	.16
Thickness Limitation:	None	None	None
Porosity: (less than)	3%	5%	5%
Coefficient of Friction: (against hardened steel)	0.47	0.47	0.47
Bond Strength: (substrate CRS - with Metcolite® C blast)			
psi	1,400	1,000	1,000
N/cm²:	965	690	690

Four separate coating spray parameters are provided on page 7 to produce coating P601-11 with the Type 11MB Plasma Spray Gun. Individual coating parameters can be selected to produce a specific coating hardness requirement as follows:

Coating Parameter Set	Macrohardness
#7	15 _y 70
#8	15 _y 80
#9	15 _y 70
#10	15 _y 65

Coating hardness can be decreased by increasing amperage, i.e. parameter set #8 amperage can be increased to 600 amps to achieve a 15_y 55-60 coating hardness.

Hardness measurement is recommended as a technique of process control. A 1/2" (12.7mm) ball and a 15 kg load should be utilized. The hardness is recorded as R15Y. Correct measurement of the hardness of Metco® abrasable coatings requires procedures different from those usually used for testing soft surfaces. In addition, careful preparation of the specimen being tested is necessary. Use the preparation methods and testing procedures described in the Metco® Technical Bulletin on "Measuring Hardness of Abradable Coatings".

Spraying

Metco 610NS should be sprayed only utilizing the Metco Types 3MB, 7MB, 9MB, 10MB, 11MB or MBN Plasma Spray Guns. It is recommended that a bond coat of Metco 450 Nickel Aluminum Composite Powder be used under Metco 601NS.

Spraying Metco 610NS using the high spray rate parameter Set #3 and #6 requires the use of either the following equipment:

Type 4MP and Type 4MP-DUAL Powder Feed Units

1. Two Type 4MP Powder Feed Units and Cat. No. 4MP 600 Powder Feed Unit Interface Assembly, or one Type 4MP-DUAL Powder Feed Unit.
2. Two #2 Powder Ports
3. One of either Cat. Nos. 3M 780A, 7M 801, 9MB 302, or 10MB 302 Dual Powder Port Clamp, or MBN 375 Triple Powder Port Air Jet Assembly for use with the Types 3MB, 7MB, 9MB, 10MB, and MBN Plasma Spray Guns, respectively.

All additional interconnecting cables and hoses are provided with the equipment. The Cat. No. 4MP 600 is supplied with two Cat. No. 4MP 612 Air Connection "Wye" Fittings, which are used to split carrier and vibrator air from one course, i.e. Type 7MC-II, to supply two individual Type 4MP Powder Feed Units. Instructions for connecting two Type 4MP Powder Feed Units and the Cat. No. 4MP 600 are provided in the Cat. No. 4MP 600 Instruction Manual. Installation procedure for the Type 4MP-DUAL is provided in the equipment instruction manual.

The spray rate achieved with the Type 11MB Plasma Spray Gun is limited to (3.6 kg/hr) 8 lbs./hr .

Type 3MP Powder Feeder

1. Two Type 3MP Powder Feeders equipped with air vibrators and “H” metering wheels.
2. Two Cat. No. 3M 514 Carrier Gas Hose Assemblies.
3. One Cat. No. 22 Oxygen “Y” Connection.
4. One Cat. No. 3M 533 Adapter Cable Assembly.
5. Two Cat. No. 3M 365 Powder Feed Hose Assemblies.
6. Two #2 Powder Ports.
7. One Dual Powder Port Air Jet Assembly is required for gun used as described under (3) above.

Using the two Cat. No. 3M 514 carrier gas hoses, install one end of each to the inlet carrier gas hose connection on each of the two Type 3MP Powder Feeders. Connect the other end of each hose to the Cat. No. 22 “Y” connection. Connect the remaining side of the “Y” connection to the Type 3MCF or Type 7MCF Flow Control Unit, where the carrier gas hose is normally connected. Using the two Cat. No. 3M 365 Powder Feed Hoses, connect one end of each to the outlet powder hose connection on each of the two Type 3MP Powder Feeders. Connect the other end of each hose to the #2 Powder Ports mounted on the Cat. No. 3M 780A or 7M 80 Dual Powder Port Air Jet Assembly.

Connect (electrically) one of the Type 3MP Powder Feeders in the normal manner as described in the 3MP Instructions. Connect the second feeder to the AC outlet (#7) at the rear of the Type 3MCF Flow Control Unit using the Cat. No. 3M 533 Adapter Cable Assembly. Make sure that the switch on the cable assembly is in the “on” position.

Note that the production hoppers should be used for this material especially when determining the spray rate. Determine the spray rate for each feeder and adjust the RPM settings to achieve the spray rate shown.

Finishing

The best finishes on coatings of Metco 601NS are obtained by machining, using a sharp pointed, high-speed steel tool bit, light feeds, fast work speed and fast traverse rate. The machined surface will be dull, rather than bright, as the result of particle pullout. It is recommended that the machined coating be thoroughly cleaned before the sprayed part is put into service.

The coating appearance can be improved by buffing it with a soft brass wheel. However, this will smear the surface.

The coatings should not be ground. The pressure and heat generated by grinding will compress the coating and alter its properties.

Safety Measures

Flame spraying is a completely safe process when performed in accordance with “Metco’s” Safety Measures”. Familiarize yourself with local safety regulations before starting spraying operations. **Do Not** operate your spraying equipment or use the spray material supplied before you have thoroughly read the Metco® Instruction Manual.

DISREGARDING THESE INSTRUCTIONS MAY BE DANGEROUS TO YOUR HEALTH.

System Parameters/Plasma Spray

	Set #1 A/H₂	Set #2 A/He	Set #3 A/H₂
Spray Gun:			
Type:	3MB/7MB	3MB/7MB	3MB/7MB
Nozzle:	GP	GP	GP
Powder Port:	#2	#2	#2
Uni-Jet Ring: (Note 1)	Yes	Yes	Yes
Insulator:	7M 50	7M 50	7M 50
Cooler: (Note 3)	Yes	Yes	Yes
Air Pressure, psi:	75	75	75
bars:	5.17	5.17	5.17
Cross Jets, inches:	Parallel	Parallel	Parallel
Gas:			
Pressure - Primary, psi:	100	100	100
bars:	6.9	6.9	6.9
Secondary, psi:	50	50	50
bars:	3.45	3.45	3.45
Flow - Primary:	190	150	190
Secondary: (Note 4)	5	10	5
Power:			
Unit: (Note 5)			
Arc Amps:	500	500	500
Arc Volts:	65-75	45-50	65-75
Powder Feed:			
Unit: (Note 9)	3MP/4MP	3MP/4MP	3MP/4MP (Note 7)
Meter Wheel:	H/-	H/-	H/-
RPM: (Note 6)	45/-	45/-	45/-
Feed Rate Indicator Setting: (Note 6)	-/40	-/40	-/180
Air Vibrator:	Yes	Yes	Yes
Vibrator Air Pressure, psi:	45/25	45/25	45/25
bars:	3.15/1.75	3.15/1.75	3.15/1.75
Carrier Gas Flow:	50	50	50
Spraying:			
Spray Distance, inches:	3-4	3-4	3-4
mm:	75-102	75-102	75-102
Spray Rate, lb/hr:	3-3.5	3-3.5	10 (Note 7)
kg/hr:	1.4-1.6	1.4-1.6	4.5
Coverage, ft ² /.001":	250	210	710
m ² /hr/0.1mm:	5.8	5	16.5
Powder Required, lb/ft ² /.001":	.014	.017	0.14
kg/m ² /0.1mm:	.27	.33	.27
Deposit Efficiency, %: (Note 8)	65	50	65

Notes:

1. The Type 3MB Gun only uses Cat. No. 3M 275 Uni-Jet Ring with the Cat. No. 3M 276 Electrode Nut. Install ring with the 45° internal recess facing the nut and with the hole toward the top of the gun, approximately 180° from the gas inlet.
2. With the Type 7MB Gun, use Cat. No. 7M 50 Insulator with Argon.
3. Use Cat. No. 3M 780 Cooler with the Type 3MB Gun and Cat. No. 7M 80 Cooler with the Type 7MB Gun.
4. The secondary gas flow shown in the chart may be adjusted as much as ± 5 points, if necessary, to obtain voltage within the range shown; except that the secondary gas flow may **not** be reduced to zero and hydrogen flow may **not** exceed 25. If the required voltage is not obtained with this preliminary gas flow adjustment, check the equipment for a worn nozzle, a worn electrode or a gas leak between the flowmeter and the gun. If there is no gas leak and the nozzle and electrode are not badly worn, further adjustment of the secondary gas flow, up to an additional ± 5 points, is permissible if this second adjustment does not result in a flow of zero or a hydrogen flow exceeding 25. If the required voltage is not then obtained, replace the worn part.
5. The Metco Types 2MR, 4MR, 6MR, 7MR or 8MR Power Supply Units can be used. **Caution:** When using the Type 6MR, 7MR or 8MR units with a Type 3MB Gun, do not exceed 40kW operation.
6. Use as a starting point. Adjust as necessary to obtain spray rate shown.
7. The use of two Type 3MP Powder Feeders, two Type 4MP Powder Feeders and Cat. No. 4MP 600, or Type 4MP-DUAL Powder Feeder is required to obtain (4.5 kg/hr) 10 lbs/hr spray rate. Use settings provided and adjust as necessary to obtain (2.25 kg/hr) 5 lbs/hr per feeder.
8. Rounded off for easy calculation.
9. Parameter settings are also used for Type 3MP-DUAL and Type 4MP-DUAL.
10. Use powder port shaft "A" and black 9 ft powder feed hose with Type 4MP and Type 4MP-DUAL.

System Parameters/Plasma Spray

	Set #4 A/H2	Set #5 A/He	Set #6 A/H2
Spray Gun:			
Type:	9MB/10MB/MBN	9MB/10MB	9MB/10MB/MBN
Nozzle:	9MB733/10MB 835 MBN 433	9MB/733/ 10MB 835	9MB/733/10MB 835/ MBN 835
Powder Port:	#2	#2	#2
Insulator:	9MB 50/10MB 57 MBN 65	9MB 50/ 10MB 57	9MB 50/10MB 57/ MBN 65
Cooler: (Note 3)	Yes	Yes	Yes
Air Pressure, psi:	75	75	75
bars:	5.17	5.17	5.17
Cross Jets, inches:	Parallel	Parallel	Parallel
Gas:			
Pressure -Primary, psi:	100	100	100
bars:	6.9	6.9	6.9
Secondary, psi:	50	50	50
bars:	3.45	3.45	3.45
Flow - Primary:	190	150	190
Secondary: (Note 4)	5	10	5
Power:			
Unit: (Note 5)			
Arc Amps:	500	500	500
Arc Volts:	65-75	45-50	65-75
Powder Feed:			
Unit: (Note 1)	3MP/4MP	3MP/4MP	3MP/4MP (Note 7)
Meter Wheel:	H/-	H/-	H/-
RPM: (Note 6)	45/-	45/-	45/-
Feed Rate Indicator Setting: (Note 6)	-/40	-/40	-/180
Air Vibrator:	Yes	Yes	Yes
Vibrator Air Pressure, psi:	45/25	45/25	45/25
bars:	3.15/1.75	3.15/1.75	3.15/1.75
Carrier Gas Flow:	50	50	50
Spraying:			
Spray Distance, inches:	3-4	3-4	3-5
mm:	75-102	75-102	75-102
Spray Rate, 1b/hr:	3-3.5	3-3.5	10 (Note 7)
kg/hr:	1.4-1.6	1.4-1.6	4.5
Coverage, ft ² /hr./0.001":	250	210	710
m ² /hr/0.1mm:	5.8	5	16.5
Powder Required, lb/ft ² /0.001":	.014	.017	.014
kg/m ² /0.1mm:	.27	.33	.27
Deposit Efficiency, %: (Note 8)	65	50	65

Notes:

1. Parameter settings are also used for Type 3MP-DUAL and Type 4MP-DUAL.
2. Use powder port shaft "A" and black 9 ft powder feed hose with Type 4MP and Type 4MP-DUAL.
3. Install the Cat. Nos. 9MB 80, 10MB-10N 80, or MBN-MN 350 for use with 9MB, 10MB or MBN respectively.
4. The secondary gas flow shown in the chart may be adjusted as much as ± 5 points, if necessary, to obtain voltage within the range shown; Except that the secondary gas flow may **not** be reduced to zero and hydrogen flow may **not** exceed 25. If the required voltage is not obtained with this preliminary gas flow adjustment, check the equipment for a worn nozzle, a worn electrode or a gas leak between the flowmeter and the gun. If there is no gas leak and the nozzle and electrode are not badly worn, further adjustment of the secondary gas flow, up to an additional ± 5 points, is permissible if this second adjustment does not result in a flow of zero or a hydrogen flow exceeding 25. If the required voltage is not obtained, then replace the worn parts.
5. The Metco Types 2MR, 4MR, 6MR, 7MR, 8MR, or MRN Power Supply Units can be used.
Caution: When using the Types 6MR, 7MR or 8MR units with a Type MBN Gun, do not exceed 40 kW operation.
6. Use as a starting point. Adjust as necessary to obtain spray rate shown.
7. The use of two Type 3MP Powder Feeders, two Type 4MP Powder Feeders and Cat. No. 4MP 600, or Type 4MP-DUAL Powder Feeder is required to obtain 10 lbs/hr. (4.5 kg/m) spray rate. Use settings provided and adjust as necessary to obtain 5 lbs/hr (2.25 kg/m) per feeder.
8. Rounded off for easy calculation.

System Parameters/Plasma Spray

	Set #7 Ar	Set #8 Ar	Set #9 Ar	Set #10 Ar
Spray Gun:				
Type:	11MB	11MB 112	11MB 112	11MB 112
Nozzle:	11MB 112	11MB 112	11MB 112	11MB 112
Air Cooled Cover:	(Note 4)	(Note 4)	(Note 4)	(Note 4)
psi:	30	30	30	30
bars:	2.1	2.1	2.1	2.
Gas:				
Pressure -Primary, psi:	75	75	75	75
bars:				
Secondary, psi:				
bars:				
Flow -Primary: (Note 5)	50	50	50	50
Secondary:	-	-	-	-
Power:				
Unit:	7MR or 8MR	7MR or 8MR	7MR or 8MR	7MR or 8MR
Arc Amps:	300	500	300	300
Arc Volts:	25-35	25-30	25-35	25-35
Powder Feed:				
Unit: (Note 6)	3MP/4MP (Note 1)	3MP/4MP (Note 1)	3MP/4MP (Note 1)	3MP/4MP (Note1)
Meter Wheel:	H/-	H/-	H/-	H/-
RPM: (Note 2)	45/-	45/-	45/-	45/-
Feed Rate Indicator Setting:	-/140	-/140	-/140	-/140
(Note 2)				
Air Vibrator:	Yes	Yes	Yes	Yes
Vibrator Air Pressure, psi:	45/25	45/25	45/25	45/25
bars:	3.15/1.75	3.15/1.75	3.15/1.75	3.15/1.75
Carrier Gas Flow	50	50	50	50
Spraying: (Note 3)				
Spray Distance, inches:	2	1	2	2
mm:	51	25	51	51
Spray Rate, lb/hr:		6	6	8 6
kg/hr:	2.7	2.7	3.6	2.7
Deposit Efficiency %:	55	70	70	65

Notes:

1. Use Powder Port Shaft “A” with the 4MP Powder Feed Unit and black 9 ft. powder feed hose. Use 5 psi (.3 bar) vibrator air pressure.
2. Use as a starting point. Adjust as necessary to obtain spray rate shown.
3. Spray rates and deposit efficiencies shown were obtained by skilled operators with all equipment in first-class condition.
4. Use when spraying I.D.’s approximately 4” (102 mm) or less. Set gun cooling air at 50 psi (3.4 bar).
5. When zero secondary flow is specified, pressure is required to activate the secondary gas pressure switch. The same gas as used for the primary may be used for this purpose. Be sure to keep the secondary flowmeter closed.
6. Parameter settings are also used for Type 3MP-DUAL and Type 4MP-DUAL.
7. Use 40 psi (2.8 bar) on gun cooling air.

Producing Recommended Coatings

Coating No.	Instructions
P601-10	Surface Preparation: Use any standard method plus bond coat of P450-10. Spraying: Parameter set # 1, 2, or 3. Finishing: Machine, if required.
P601-11	Surface Preparation: Use any standard method plus bond coat of P450-10. Spraying: Parameter set # 7, 8, 9, or 10. Finishing: Machine, if required.
P601-12	Surface Preparation: Use any standard method plus bond coat of P45-10. Spraying: Parameter set # 4, 5, or 6. Finishing: Machine, if required.

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