	Mg
6	Al
3	Zn

AZ 63 A

1. GENERAL

This alloy is a member of the aluminum and zinc containing family of heat treatable magnesium casting alloys. It has maximum ductility and an intermediate yield strength, and it is used up to about 300 F in various conditions of heat treatment. It is available in form of sand and permanent mold castings. This alloy is inferior to other casting alloys in regard to porosity and pressure tightness. The weldability of this alloy is inferior to that of most casting alloys.

1.01 Commercial Designation. AZ 63 A.

1.02 Alternate Designations. Dow Metal H, Mazlo AM-265 (obsolete).

1.03 Specifications. Table 1.03.

TABLE 1.03

AMS	Form	Federal
4420G	Sand castings (F Condition)	QQ-M-56a
4422H	Sand castings (T4 Condition)	
4424F	Sand castings (T6 Condition)	
-	Permanent mold castings	QQ-M-55a

1.04 Composition. Table 1.04.

TABLE 1.04

Source	AMS (1) (2) (3)	
	Percent	
	Min	Max
Aluminum	5.3	6.70
Zinc	2.5	3.50
Manganese	0.15	-
Silicon	-	0.30
Copper	-	0.10
Nickel	-	0.010
Other impurities total	-	0.30
Magnesium	Balance	

1.05 Heat Treatment

1.051 Stress relief after welding. 500 F, 1 hr.

1.052 Solution treat F Condition to T4 Condition. 720 to 730 F, 12 hr, rapid air cool. (5, p. 8).

1.053 Age

1.0531 F Condition to T5 Condition. 490 to 510 F, 4 hr. (5, p. 8).

1.0532 T4 Condition to T6 Condition. 415 to 435 F, 5 hr, (5, p. 8).

1.054 Heat and reheat treatments after welding F, T4 or T6 Conditions, see 4.03.

1.06 Hardenability. Hardens fully in all section sizes on rapid air cooling and subsequent aging.

1.07 Forms and Conditions Available

1.071 Alloy is available in the full commercial range of sizes for sand and permanent mold castings.

1.072 Castings are available in F, T4 and T6 Conditions. They can also be supplied in T5 Condition on special request.

1.08 Melting and Casting Practice. Standard magnesium alloy melting and casting practice, see 4.01.

1.09 Special Considerations

1.091 Stress relief is required after welding to prevent stress cracking.

1.092 For solution treating an atmosphere containing at least 0.5 percent sulfur dioxide is required.

2. PHYSICAL AND CHEMICAL PROPERTIES

2.01 Thermal Properties

2.011 Melting range. 685 to 1135 F.

2.012 Phase changes. Alloy is subject to precipitation.

2.013 Thermal conductivity, Table 2.013.

TABLE 2.013

Source	(4)			
Alloy	AZ 63 A			
Form	Sand cast			
Condition	F	T4	T5	T6
Thermal cond Btu ft per(hr sq ft F)	34.1	30.2	37.7	35.3

2.014 Thermal expansion. See AZ 31 B.

2.015 Specific heat. 0.25 Btu per (lb F).

2.016 Emissivity. See AZ 31 B.

2.017 Dimensional changes on exposure of castings to elevated temperatures, Fig. 2.017.

2.02 Other Physical Properties

2.021 Density. 0.0656 lb per cu in. 1.81 gr per cu cm, (8).

2.022 Electrical resistivity, Table 2.022.

TABLE 2.022

Source	(4)			
Form	Sand and permanent mold castings			
Condition	F	T4	T5	T6
Temp - F	Electrical resistivity, microhm in			
RT	4.8	5.5	4.33	4.65
100	4.91	-	4.45	4.76
200	5.23	-	4.8	5.08

2.023 Magnetic properties. Alloy is nonmagnetic.

2.03 Chemical Properties. See AZ 31 B also.

2.031 Corrosion resistance of Mg-Al-Zn casting alloys is slightly inferior to that of zirconium containing casting alloys and also to that of all wrought alloys.

2.032 Paint protection is advised where service in excess of a few years in industrial atmosphere is desired or generally for thin sections.

2.033 Exposure to marine and seawater atmosphere requires a protective coating.

2.034 Stress corrosion may occur after welding unless stress relieved.

2.04 Nuclear Properties. See AZ 31 B.

3. MECHANICAL PROPERTIES

3.01 Specified Mechanical Properties

3.011 AMS specified and producers' minimum mechanical properties, Table 3.011.

3.02 Mechanical Properties at Room Temperature. See 3.03 also.

3.021 Typical mechanical properties for alloy in various conditions, Table 3.021.

TABLE 3.021

Source	Dow (5, p. 6)			
Alloy	AZ 63 A			
Condition	F	T4	T5	T6
F_{tu}, ksi	29	40	29	40
F_{ty}, ksi	14	13	14	19
e(2 in), percent	6	12	4	5
F_{cy}, ksi	14	13	14	19
F_{bru}, ksi (e/D = 2.0)	60	60	60	75
F_{bry}, ksi (e/D = 2.0)	40	44	40	52
F_{su}, ksi	18	18	19	21
Hardness, BHN	50	55	55	73
RE	59	66	66	83

3.022 Effect of exposure to elevated temperatures on tensile properties of sand cast test bars in T6 Condition, Fig. 3.022.

3.023 Yield strength in compression of cast magnesium alloys is essentially the same as that in tension.

Mg
6 Al
3 Zn

AZ 63 A

TABLE 3.011

Source	AMS (1) Dow (6)		AMS (2) Dow (6)			Dow (6)	AMS (3) Dow (6)		
Alloy	AZ 63 A								
Form	Castings								
Condition	F		T4			T5	T6		
Specimen type	Cast test bars	From castings Avg (a)	Cast test bars	From Castings Avg (a)	From Castings Single specimen	Cast test bars	Cast test bars	From Castings Avg (a)	From Castings Single specimen
F_{tu}, min - ksi	24	18	34	25.5	17	24	34	25.5	17
F_{ty}, min - ksi	10	-	10	10	9	11	16	14.5	12
e(2 in), min - percent	4	1	7	1.75	-	2	3	0.75	-
F_{cy}, min - ksi	10(b)	-	10(b)	-	-	11	16(b)	-	-
F_{bru}, min									
(e/D=1.5) - ksi	36(b)	-	36(b)	-	-	-	50(b)	-	-
(e/D=2.0) - ksi	50(b)	-	50(b)	-	-	50	65(b)	-	-
F_{bry}, min									
(e/D=1.5) - ksi	28(b)	-	32(b)	-	-	-	36(b)	-	-
(e/D=2.0) - ksi	30(b)	-	36(b)	-	-	30	45(b)	-	-
F_{su}, min - ksi	16(b)	-	17(b)	-	-	17	19(b)	-	-
Hardness, BHN (500 kg, 10 mm)									
- min	-	48	-	48		-	-	65	
- max	-	-	-	60		-	-	85	

(a) Average values for at least 4, preferably 10, specimens
(b) Dow only

3.03 Mechanical Properties at Various Temperatures

3.031 Short time tension properties

3.0311 Stress strain curves for sand cast test bars in T4 Condition at room and elevated temperatures, Fig. 3.0311.

3.0312 Stress strain curves for sand cast test bars in T6 Condition at room and elevated temperatures, Fig. 3.0312.

3.0313 Effect of exposure and test temperature on tensile properties of sand cast test bars, Fig. 3.0313.

3.032 Short time properties other than tension

3.0321 Effect of test temperature on bearing properties of sand cast test bars, Fig. 3.0321.

3.0322 Effect of test temperature on shear strength of sand cast test bars, Fig. 3.0322.

3.0323 Effect of low test temperature on impact strength of sand cast test bars, Fig. 3.0323.

3.033 Static stress concentration effects

3.0331 Effect of stress concentration on notch strength ratio of sand cast test bars, Fig. 3.0331.

3.04 Creep and Creep Rupture Properties

3.041 Total strain curves for sand cast test bars in T6 Condition at 200 to 500 F, Fig. 3.041.

3.05 Fatigue Properties

3.051 Room temperature fatigue strength, Table 3.051.

TABLE 3.051

Source	(7)							
Form	Sand Cast Test Bars							
Cond	Method	Stress Ratio A	Stress Ratio R	Stress Concentration	Fatigue Strength - ksi at Cycles 10^5	10^6	10^7	10^8
F	Rot	∞	-1	Smooth	15 to 18	12 to 15	10 to 13	9.5 to 12
T4	beam			K=1	18 to 23	16 to 21	14 to 19	13 to 17
T6					17 to 20	15 to 18	12 to 16	11 to 15
F	Direct	0.60	0.25	Smooth	22 to 25	20 to 23	18 to 21	-
T4	stress			K=1	23 to 27	21 to 24	18 to 21	-
T6					25 to 30	23 to 26	22 to 25	-

3.052 Average stress range diagrams for direct stress and reverse bending for sand cast test bars, Fig. 3.052.

3.06 Elastic Properties

3.061 Modulus of elasticity. 6,500 ksi, (12).

3.062 Modulus of rigidity. 2,400 ksi, (12).

3.063 Poisson's ratio. 0.35, (12).

3.064 Tangent modulus curves in tension and compression for sand castings, Fig. 3.064.

4. FABRICATION

4.01 Forming and Casting

4.011 The production of magnesium alloy castings necessitates a variety of special measures.

4.0111 Melting and alloying is performed in cast or welded low carbon steel pots. Nickel containing steel is not permissible because of pickup of nickel.

4.0112 The metal is melted and kept under a special flux cover. Moisture should be avoided. Flux, sulfur powder, sand or a special powder (GI) are used to prevent and extinguish fires.

4.0113 The molding sand contains sulfur as an ingredient.

4.0114 Design of magnesium castings should allow generous fillets and avoid abrupt section changes due to high sensitivity to notching.

4.012 Good castings should possess about 90 to 95 percent of the tensile and yield strength values of the separately cast test bars if the section thickness does not exceed 1 1/2 in. Specifications usually require that specimens cut from actual sections should average 75 percent minimum of the test bar values.

4.013 Casting temperatures for this alloy are as follows. Sand castings 1350 to 1550 F. Permanent mold castings, 1200 to 1500 F. Remelt ingots, 1200 to 1300 F.

4.014 The castability of this alloy is inferior to that of the other Mg-Al-Zn alloys since it has a greater tendency to form microshrinkage and pressure tightness is more difficult to obtain.

4.02 Machining properties of cast magnesium alloys are the same as those of wrought alloys, see AZ 31 B.

4.03 Welding. See AZ 31 B also.

4.031 General. Although castings in this alloy can be repaired by fusion welding, using AZ 63 A or AZ 92 A welding rod, it is considered difficult to weld. It is inferior in this respect to the other Mg-Al-Zn casting alloys and considerably inferior to alloys containing rare earths or thorium as major alloying elements. Castings may be repaired, preferably by arc welding methods, if they are subsequently inspected for soundness and cracks. Gas welding is only used for field repairs. Preheating should precede welding, and heat treatment should be preferably performed after welding. Stress relief is not required if the casting is welded in F Condition and subsequently solution treated.

4.032 Heat treating and reheat treating after welding, Table 4.032.

TABLE 4.032

Source	(11, p. 76)				
Alloy	AZ 63 A				
Condition before welding	Condition after welding	Welding rod	Preheat at 715 to 735F*	Heat treatment after welding* ST** and RAC	Aging
F	T4	AZ 63 A	All Sections	720 to 730F 10 hr	-
F	T6				425F, 5hr
T4, T6	T4	AZ 63 A or AZ 92 A	Thin and restrained sections only	725 to 735F 30 min	-
T4, T6	T6				425F, 5hr

* Heating from 500F up should be at 150F per hr maximum

** SO_2 atmosphere not required for 725 to 735F, 30 min

4.04 Heating and Heat Treating

4.041 Castings in this and other Mg-Al-Zn alloys are usually loaded into the furnace at 500 F and brought to the solution treating temperature within about 2 hr at a uniform rate.

4.042 Heating at 750 F or higher should be performed in an air atmosphere containing 1/2 percent minimum sulfur dioxide. An exception see Table 4.032.

4.043 Support is required on solution treating thin sections.

4.044 Rapid air cooling after solution usually requires fans.

4.045 Overheating resulting in local melting and fires should be prevented. For extinguishing fires the furnace should be equipped with an inlet for borontrichloride or borontrifluoride.

4.05 Surface Treating

4.051 Castings can generally be surface treated in the same manner as wrought products.

4.052 Cleaning and pickling of sand castings consists commonly of blast cleaning, acid pickling and chrome pickling, to provide surface protection during shipment and storage. Chrome pickle is also used as a paint base, although other treatments may be specified.

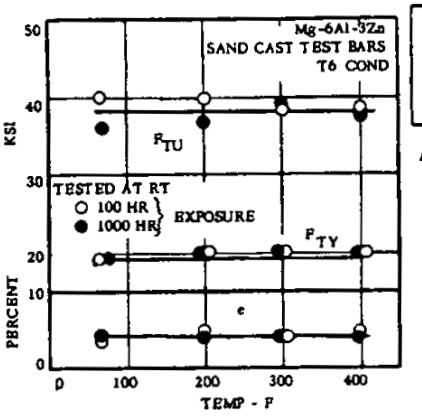

FIG. 3.022 EFFECT OF EXPOSURE TO ELEVATED TEMPERATURES ON TENSILE PROPERTIES OF SAND CAST TEST BARS IN T6 CONDITION (6)

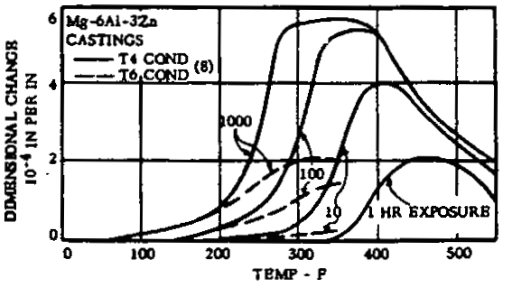

FIG. 2.017 DIMENSIONAL CHANGES ON EXPOSURE OF CASTINGS TO ELEVATED TEMPERATURES (8, FIG. 15, TBL. XV)

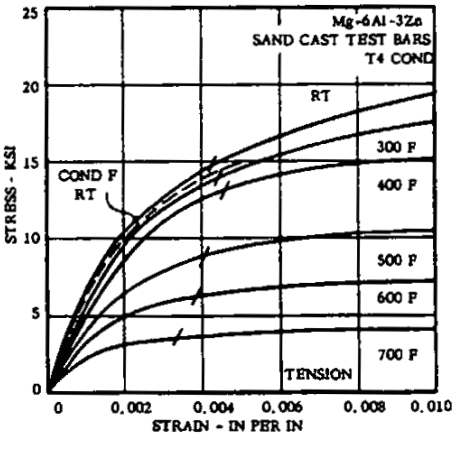

FIG. 3.0311 STRESS STRAIN CURVES FOR SAND CAST TEST BARS IN T4 CONDITION AT ROOM AND ELEVATED TEMPERATURES (8)

	Mg
6	Al
3	Zn

AZ 63 A

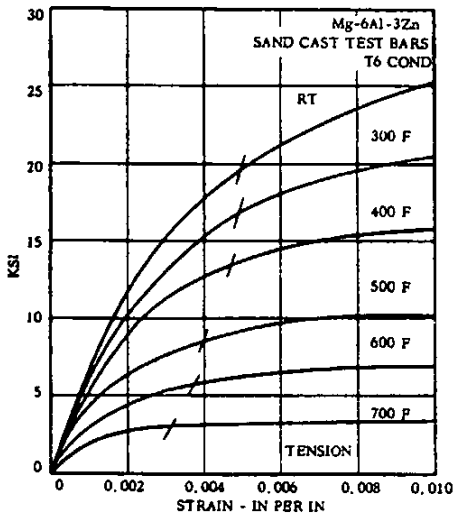

FIG. 3.0312 STRESS STRAIN CURVES FOR SAND CAST TEST BARS IN T6 CONDITION AT ROOM AND ELEVATED TEMPERATURES (8)

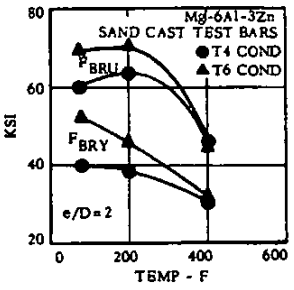

FIG. 3.0321 EFFECT OF TEST TEMPERATURE ON BEARING PROPERTIES OF SAND CAST TEST BARS (9)

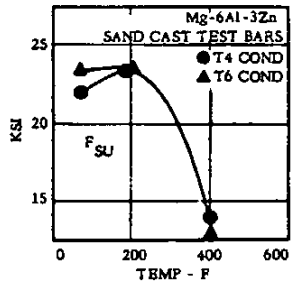

FIG. 3.0322 EFFECT OF TEST TEMPERATURE ON SHEAR STRENGTH OF SAND CAST TEST BARS (9)

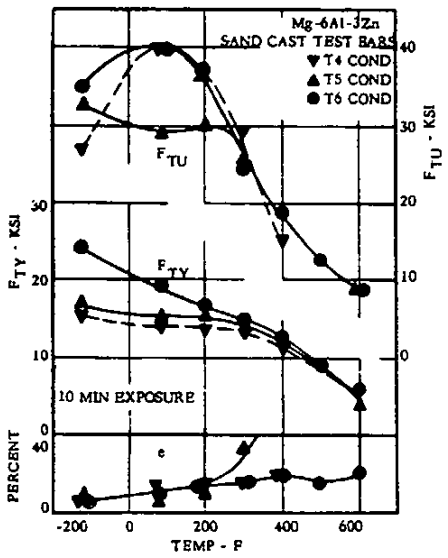

FIG. 3.0315 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF SAND CAST TEST BARS (6)

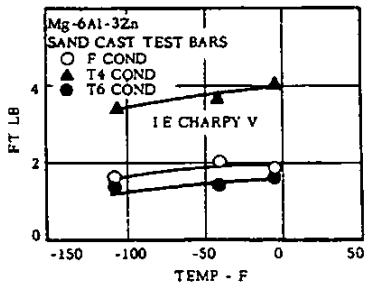

FIG. 3.0323 EFFECT OF LOW TEST TEMPERATURE ON IMPACT STRENGTH OF SAND CAST TEST BARS (6)

	Mg
6	Al
3	Zn

AZ 63 A

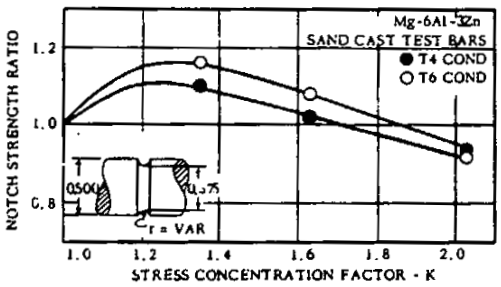

FIG. 3.0331 EFFECT OF STRESS CONCENTRATION ON NOTCH STRENGTH RATIO OF SAND CAST TEST BARS
(6)

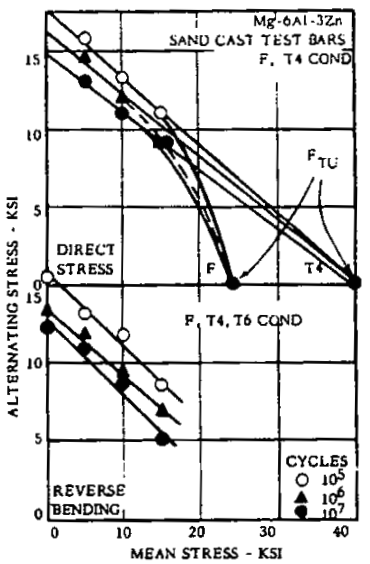

FIG. 3.052 AVERAGE STRESS RANGE DIAGRAMS FOR DIRECT STRESS AND REVERSE BENDING FOR SAND CAST TEST BARS
(10)

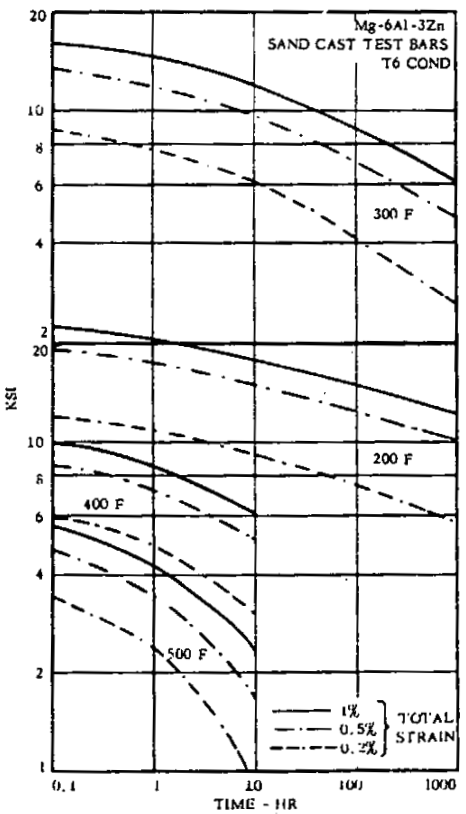

FIG. 3.041 TOTAL STRAIN CURVES FOR SAND CAST TEST BARS IN T6 CONDITION AT 200 TO 500 F
(8, Tbl. XIII)

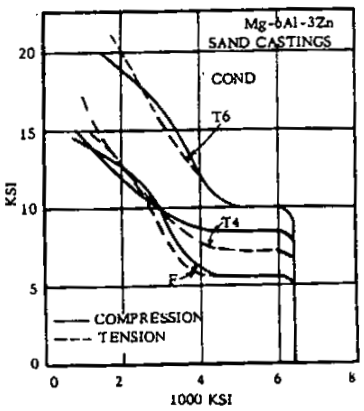

FIG. 3.064 TANGENT MODULUS CURVES IN TENSION AND COMPRESSION FOR SAND CASTINGS
(13)

	Mg
6	Al
3	Zn

AZ 63 A

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