Combating Corrosion in Magnesium Using New Generation Alloys and Modern Coatings such as Tagnite

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EXCELLENCE IN MAGNESIUM SURFACE PROTECTION

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October 2010

Common Magnesium Concerns

- Surface Corrosion
- Galvanic Corrosion
- Low Abrasion Resistance
- Paint Adhesion

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Finishing Options
Typical for Magnesium

Conversion Coatings

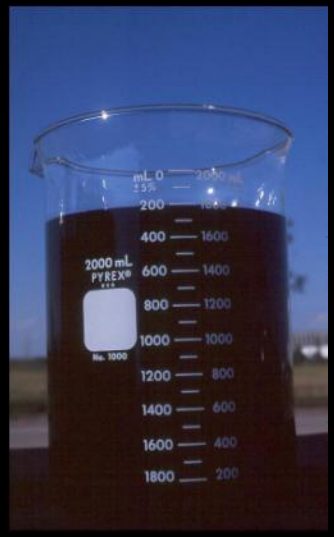
- Dow 7, created in the 1940's
- Dow 9, created in the 1940's
- Chrome Manganese, created in the 1940's

Anodize Coatings

- Dow 17, created 1942
- HAE, created 1955
- TAGNITE® , created 1992

HAE

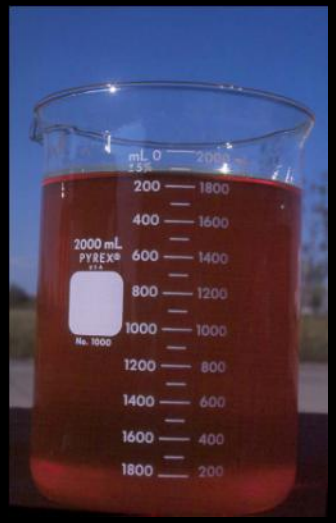
HAE, named after inventor Harry A. Evangelides, was patented in 1952. The very high alkaline solution has a pH of approximately 14 and should be operated between 70 and 86º Fahrenheit.



CHEMICAL	**Concentration (g/L)**
Hydroxide ***(extremely caustic)***	120
Fluoride	35
Potassium Permanganate ***(strong oxidizer)***	20
Aluminum Hydroxide	34
Sodium Phosphate	35

Dow 17

The Dow Chemical Company invented Dow 17 in the mid-1940's. The electrolyte has a pH of approximately 5 and should be operated at or above 160º Fahrenheit.



CHEMICAL	**Concentration g/L**
Ammonium BiFluroide	360
Sodium Dichromate *(hazardous chemical)*	100
Phosphoric Acid	97

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TAGNITE

Developed in the 1990's with the Clean Air & Clean Water Act in mind, TAGNITE® was designed as a replacement coating for Dow 17 and HAE. The electrolyte's pH range is 12.8-13.2 and operates below room temperature (40-60°F)

CHEMICAL	Concentration (g/L)
Hydroxide	4 - 8
Fluoride	5 - 10
Silicate	15 - 25

No Chromates or Heavy Metals

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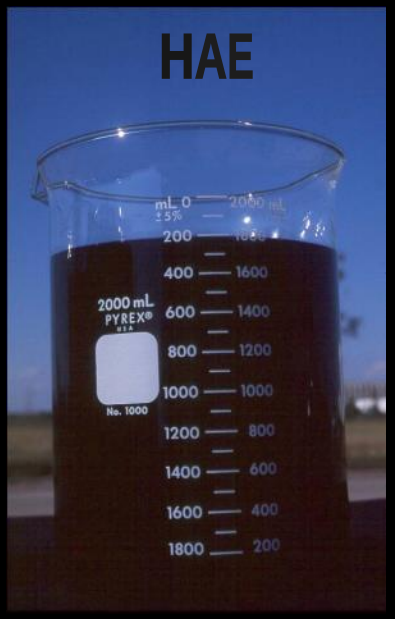
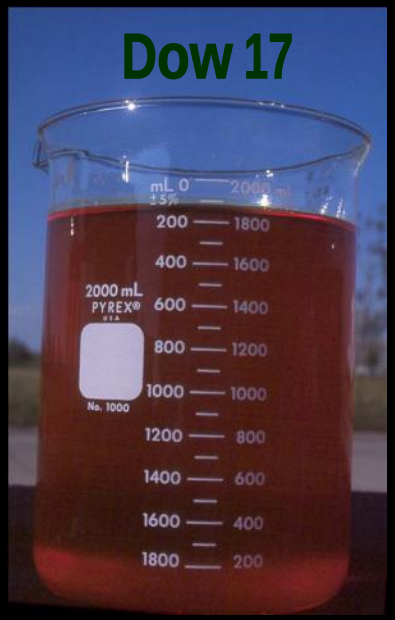
Chemical Composition as a Percentage of Water

5% * chemical concentration



25%* chemical concentration

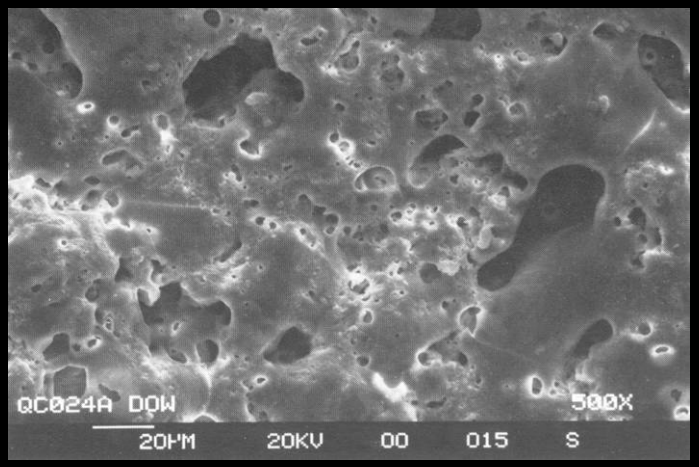


56% * chemical concentration

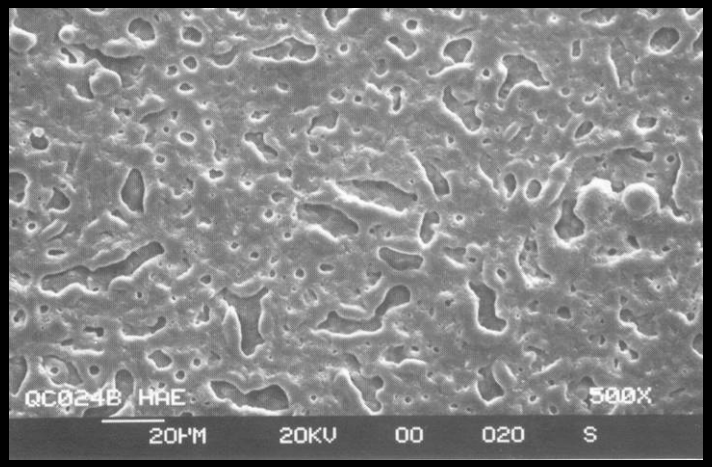
HAE contains heavy metals; Dow 17 contains heavy metals and chromium

*Approximations

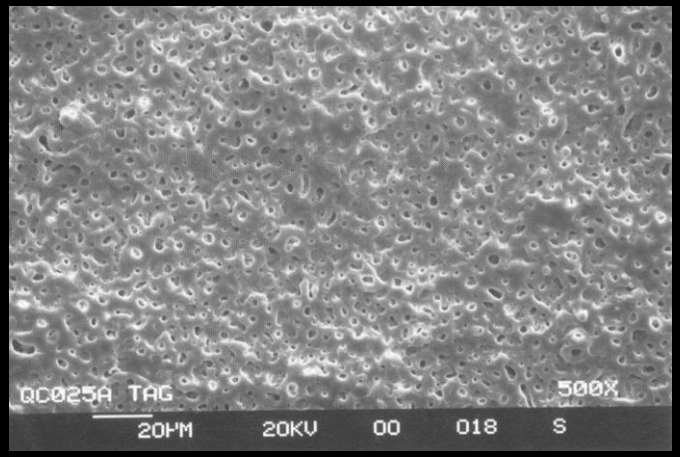
Coating Morphology



Dow 17



HAE



TAGNITE®

All photos shown at 500x magnification.

Corrosion Testing

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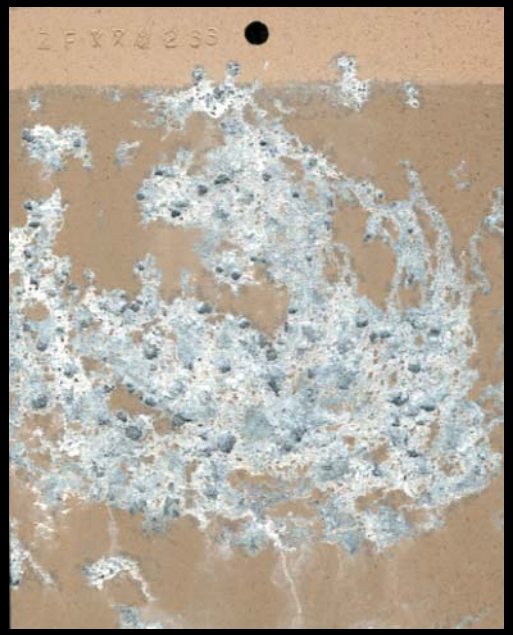
Superior Corrosion Resistance

TAGNITE®



HAE

DOW 17

TAGNITE®, HAE & Dow 17 (Type I) on magnesium alloy ZE41 after 168 hours in salt spray

Only Tagnite Provides Inherent Corrosion Resistance

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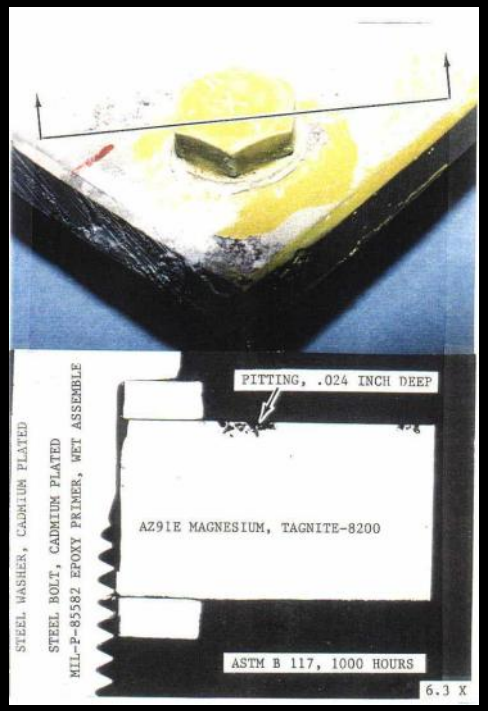
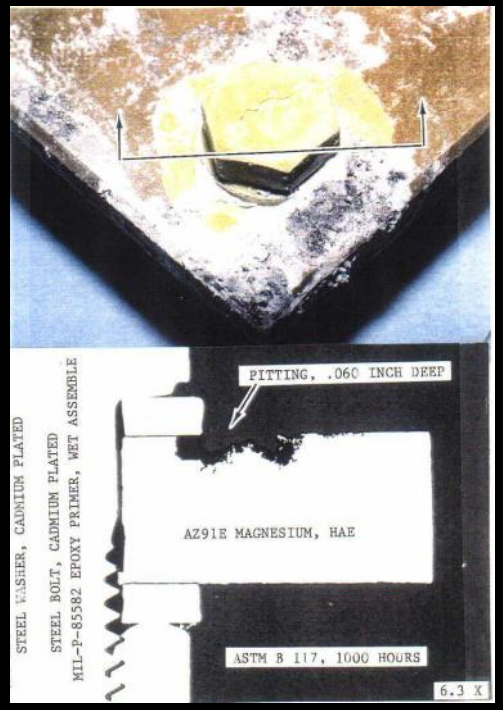
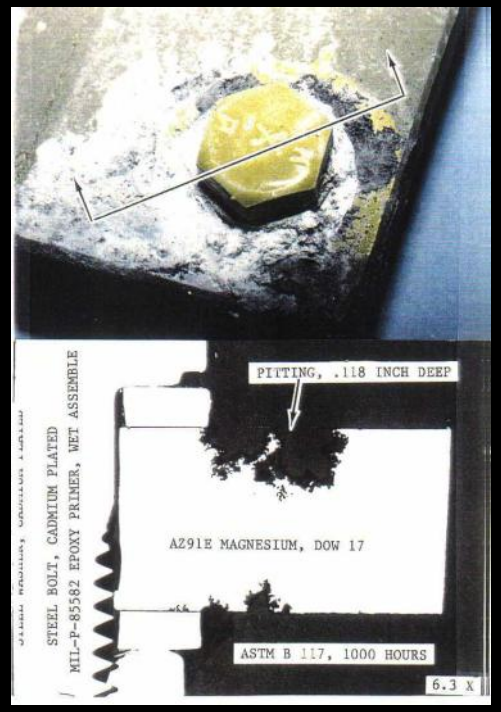
Superior Galvanic Corrosion Resistance



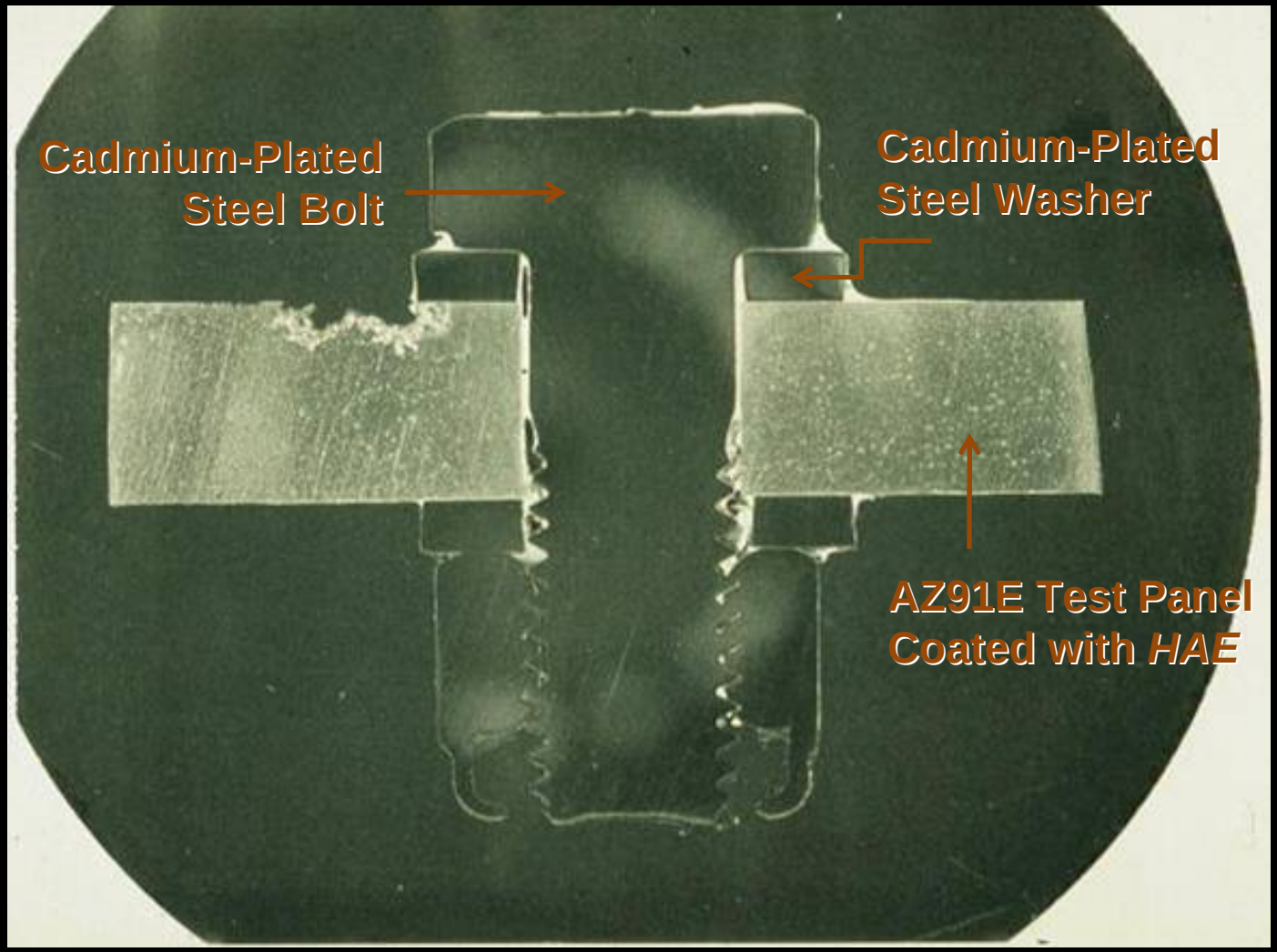




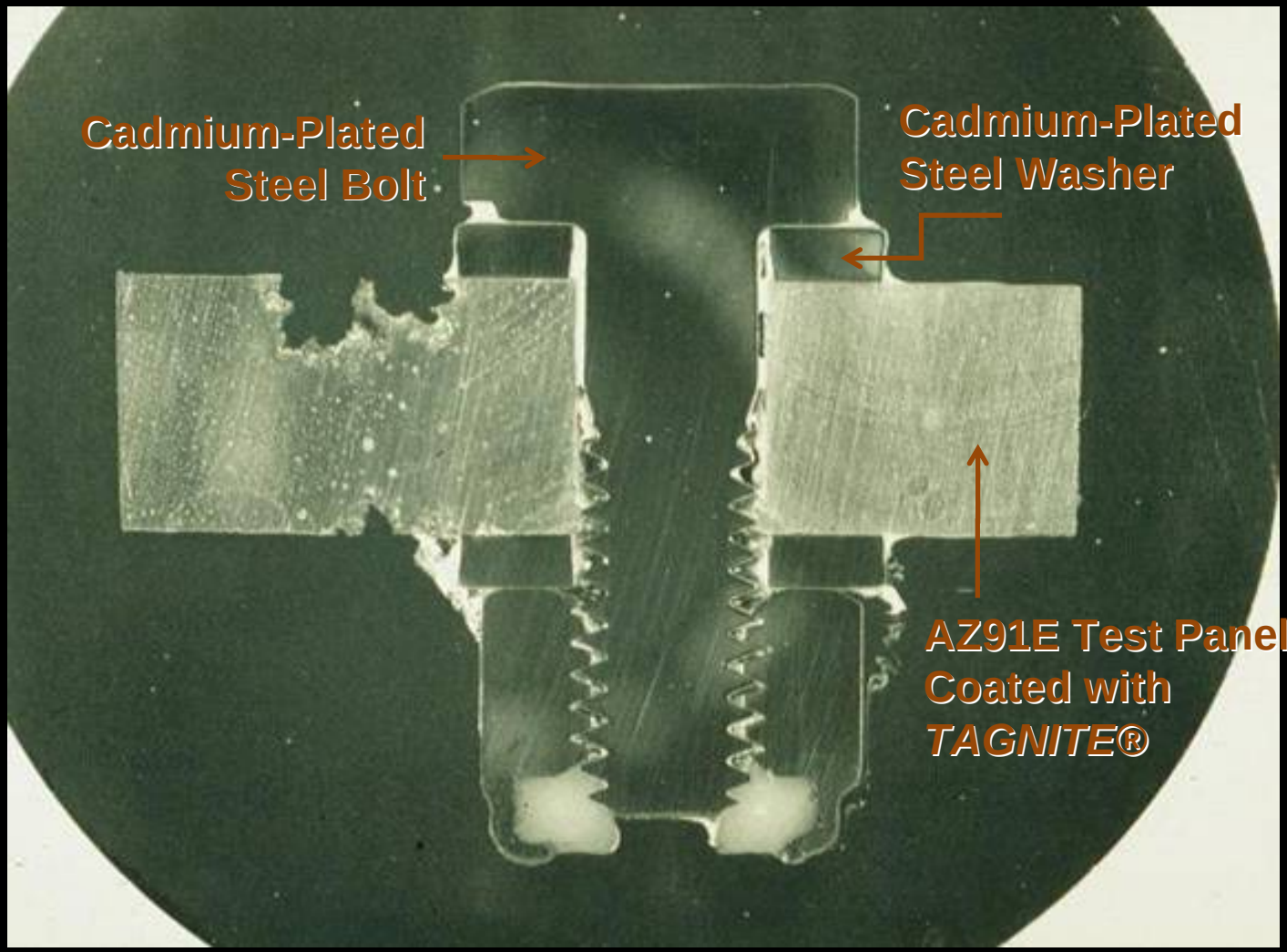
TAGNITE® 8200 **HAE** **DOW 17**

AZ91E sand cast magnesium test plates assembled using cadmium plated steel bolt/washer & placed in salt spray (ASTM B117) for 1000 hours.

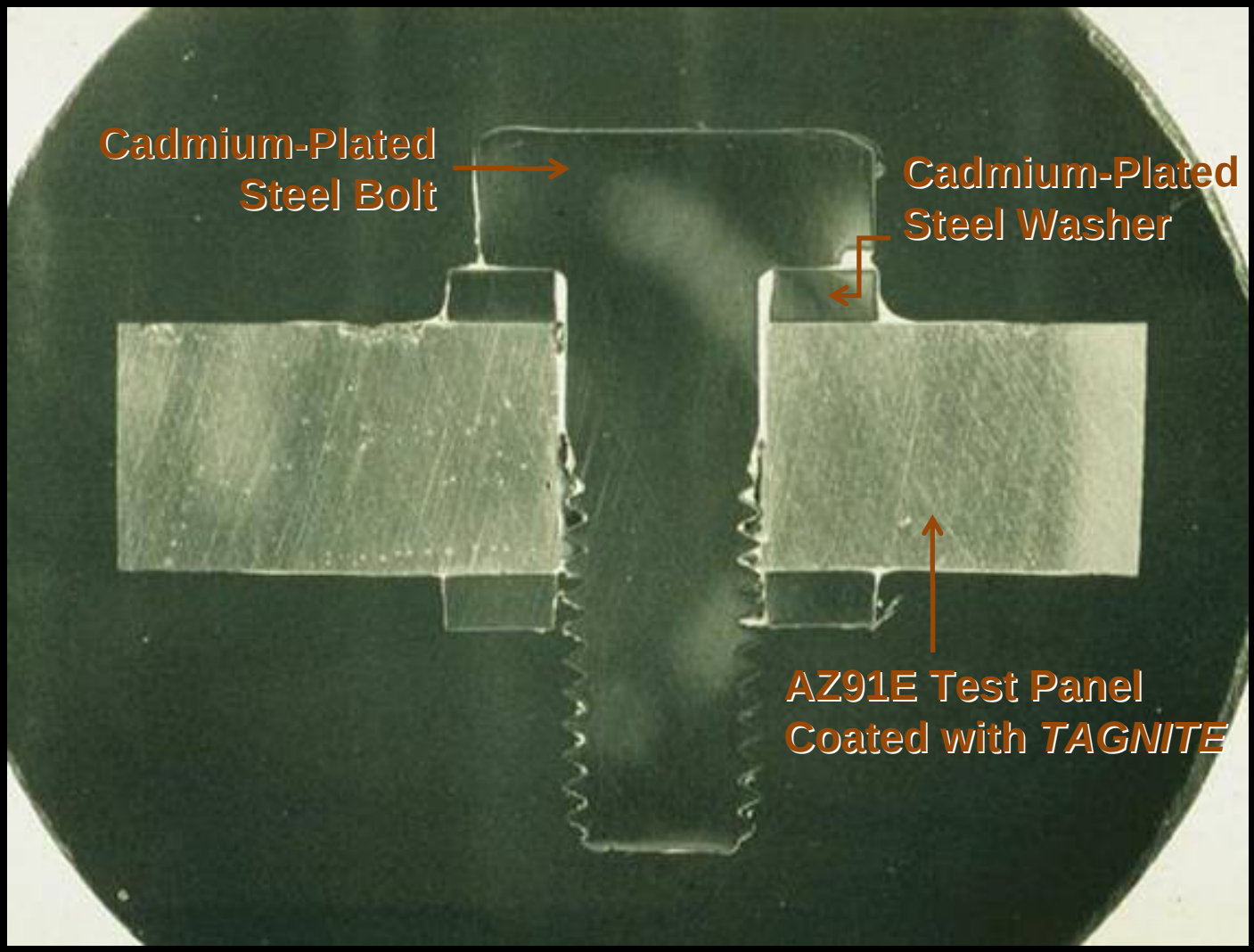
Galvanic Corrosion - HAE



Galvanic Corrosion – Dow 17



Galvanic Corrosion – TAGNITE



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Environmentally Clean

Tagnite has been carefully studied and reviewed and by the EPA's Design for the Environment Program and has been granted the status of Partner Formulator

Tagnite Contains

- No Chromium(VI)
- No Heavy Metals
- No Sulfuric Acid
- No Nitric Acid
- No Hydrofluoric Acid

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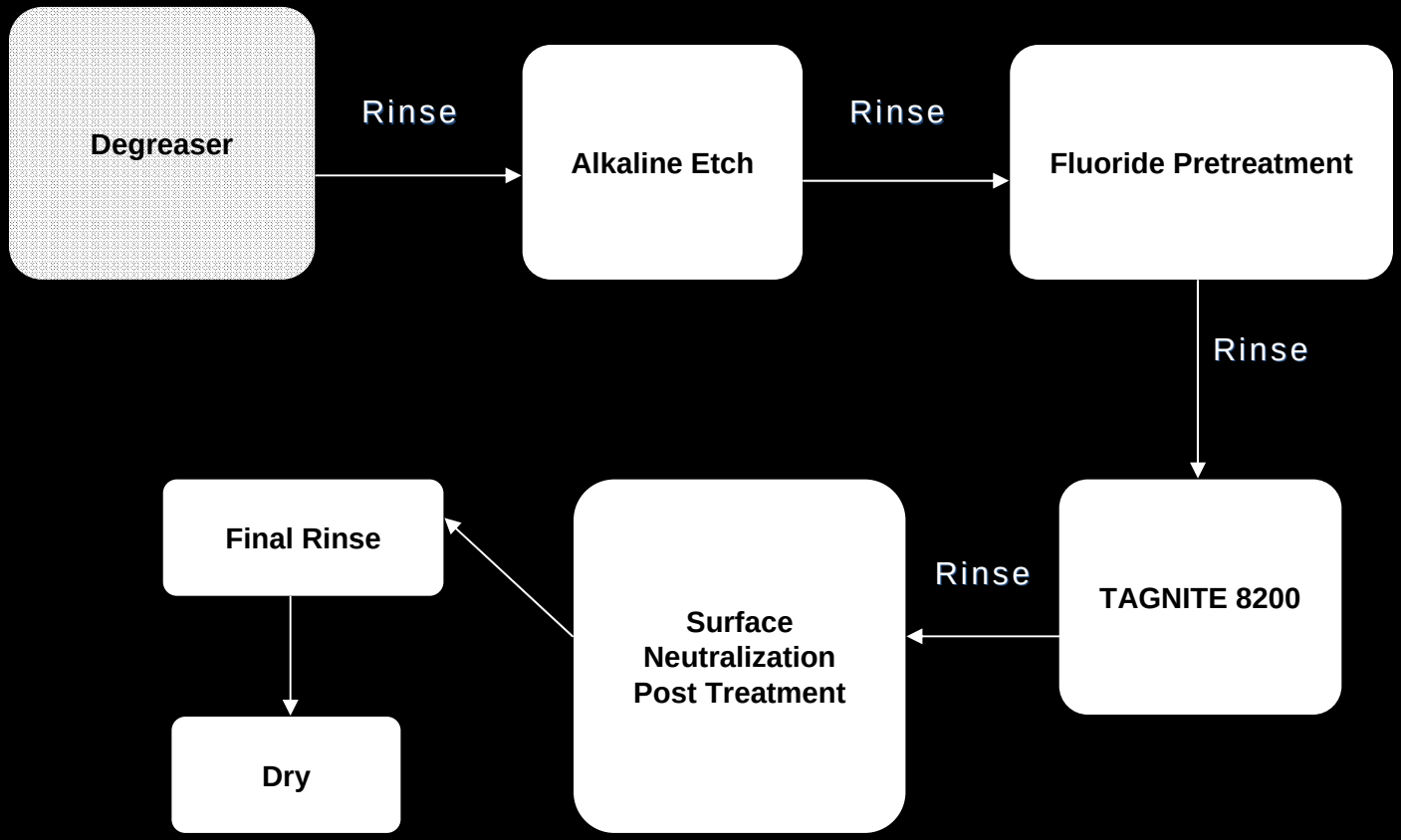
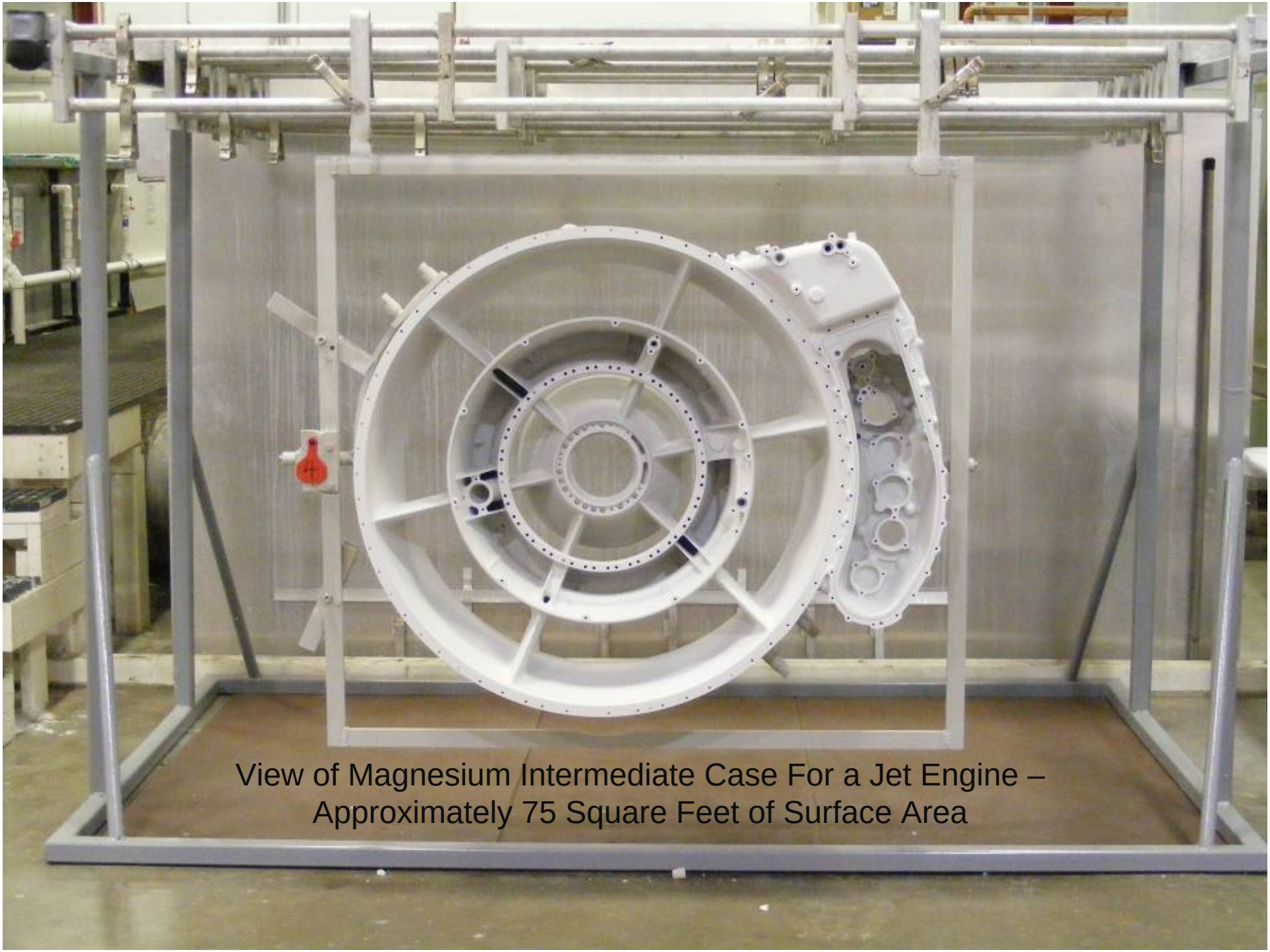
Tagnite Process Overview



Approximately 120 Minutes From Entering Degrease Station to Entering Drying Station



View of Magnesium Intermediate Case For a Jet Engine –
Approximately 75 Square Feet of Surface Area

CH-53

AH-6

F-35 Fighter

F-22 Fighter

PROTECTED BY TAGNITE

MD 500/600

USMC EFV

Widely Specified

AH-64 Apache

KC-135 Tanker

B-52 Bomber

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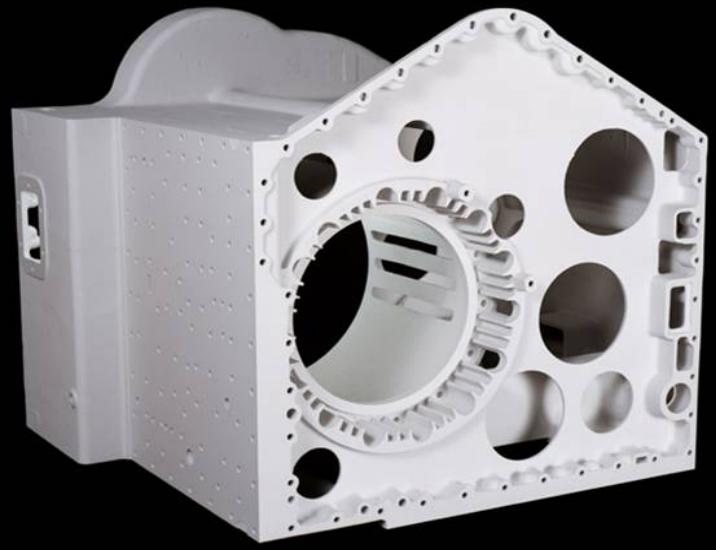
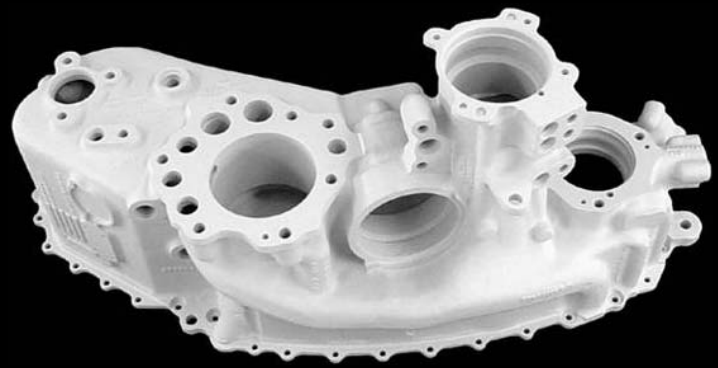


Magnesium Transmission Housing

Magnesium Oil Pan

Magnesium Gearbox



Magnesium Jet Engine Gearbox

- Last B-52 was built in 1962
- Air Force wants to keep them going until 2040
- The B-52 utilizes many magnesium components including several in the pilot yoke/Steering column
- These 48 year old castings still look good, and show few signs of corrosion
- By today's standards, the magnesium alloys used on the B-52 corrode at a very high rate
- Tagnite is on average 10 times more corrosion resistant than what was first used to protect these 48 year old castings

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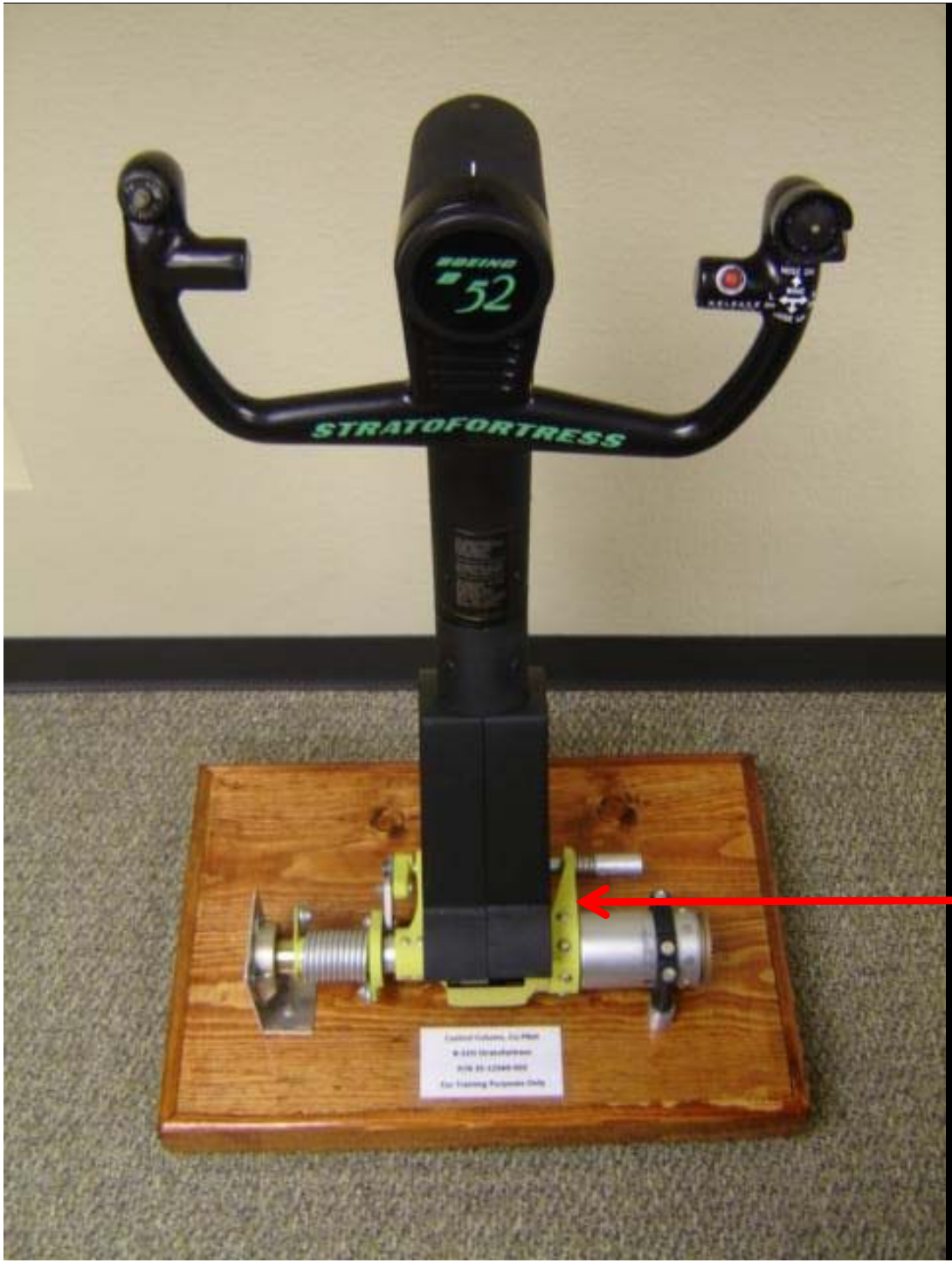
Tagnite is regularly applied to used magnesium castings on the B-52



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48 Year Old+ Magnesium Castings

Corrosion Has Not Taken Them Out of Service

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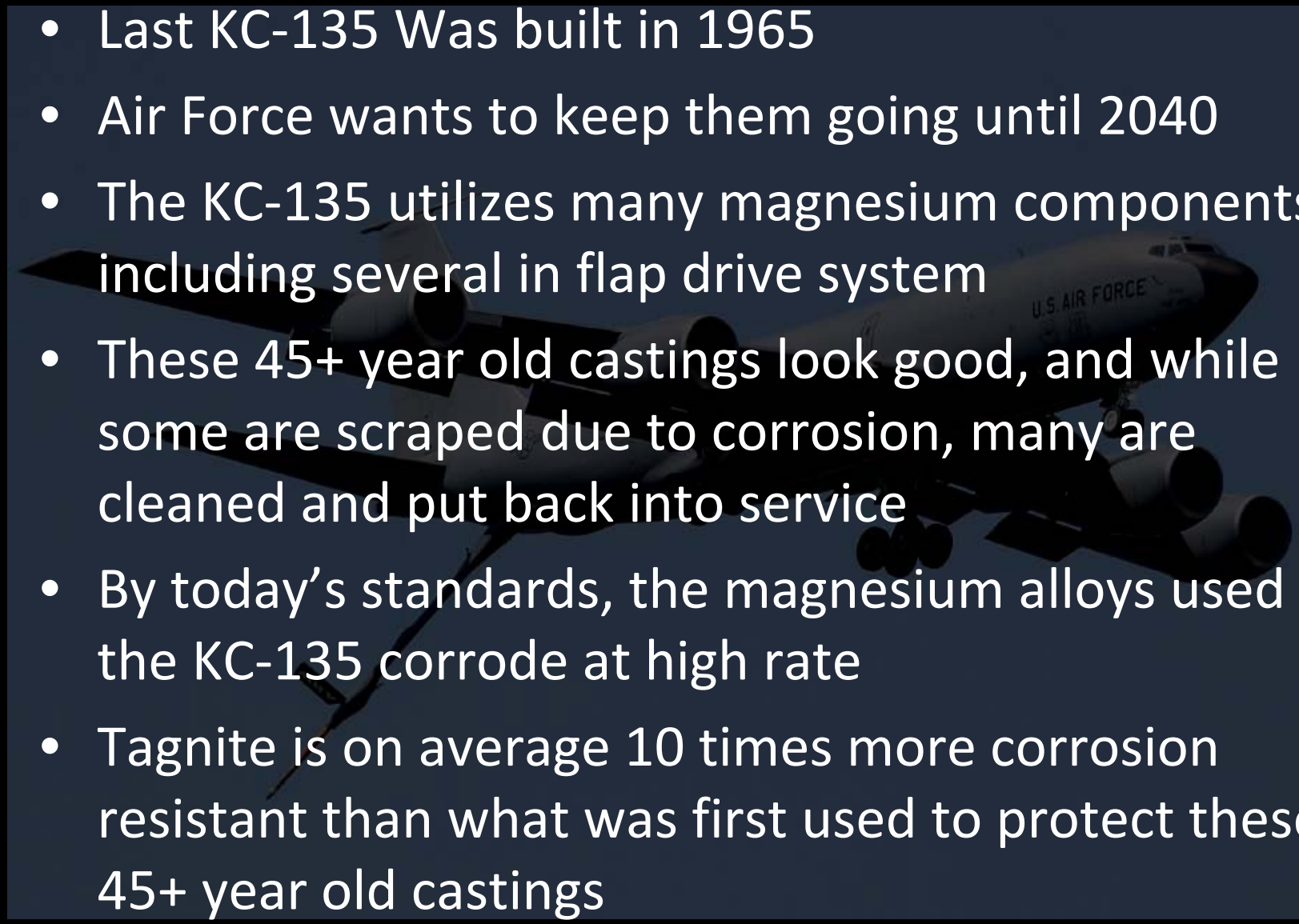

- Last KC-135 Was built in 1965
- Air Force wants to keep them going until 2040
- The KC-135 utilizes many magnesium components including several in flap drive system
- These 45+ year old castings look good, and while some are scraped due to corrosion, many are cleaned and put back into service
- By today's standards, the magnesium alloys used on the KC-135 corrode at high rate
- Tagnite is on average 10 times more corrosion resistant than what was first used to protect these 45+ year old castings

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Magnesium Housings
Used For Flap Drive Gearboxes

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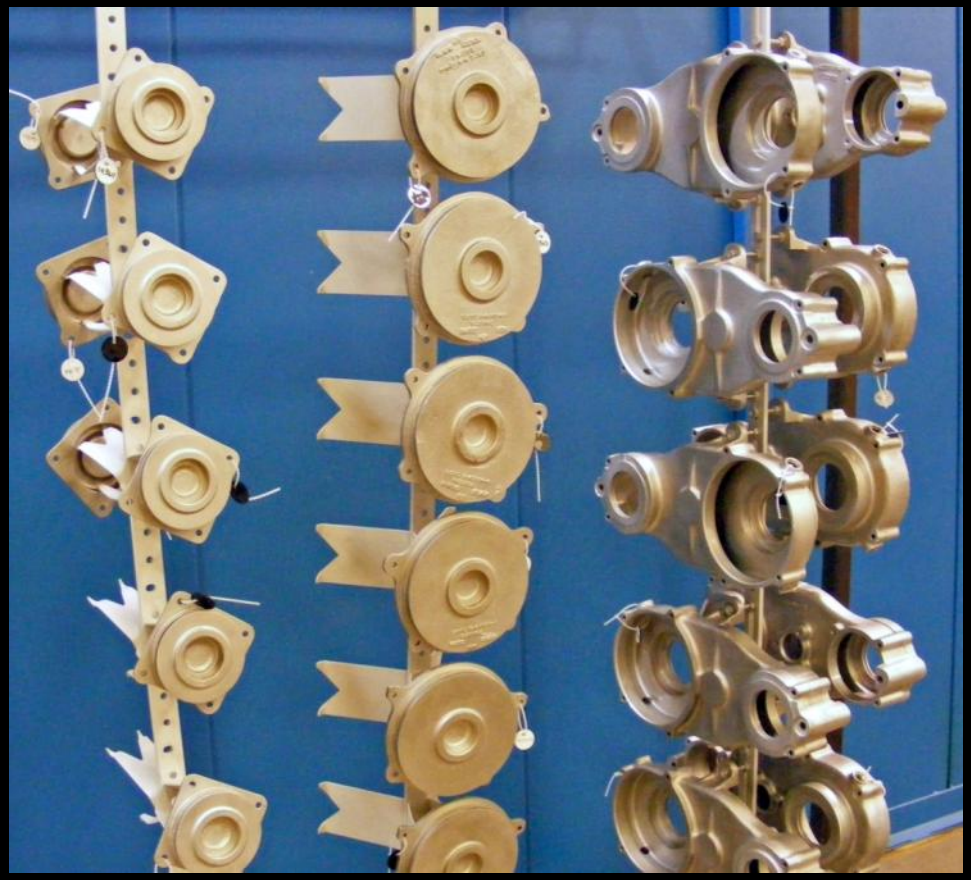

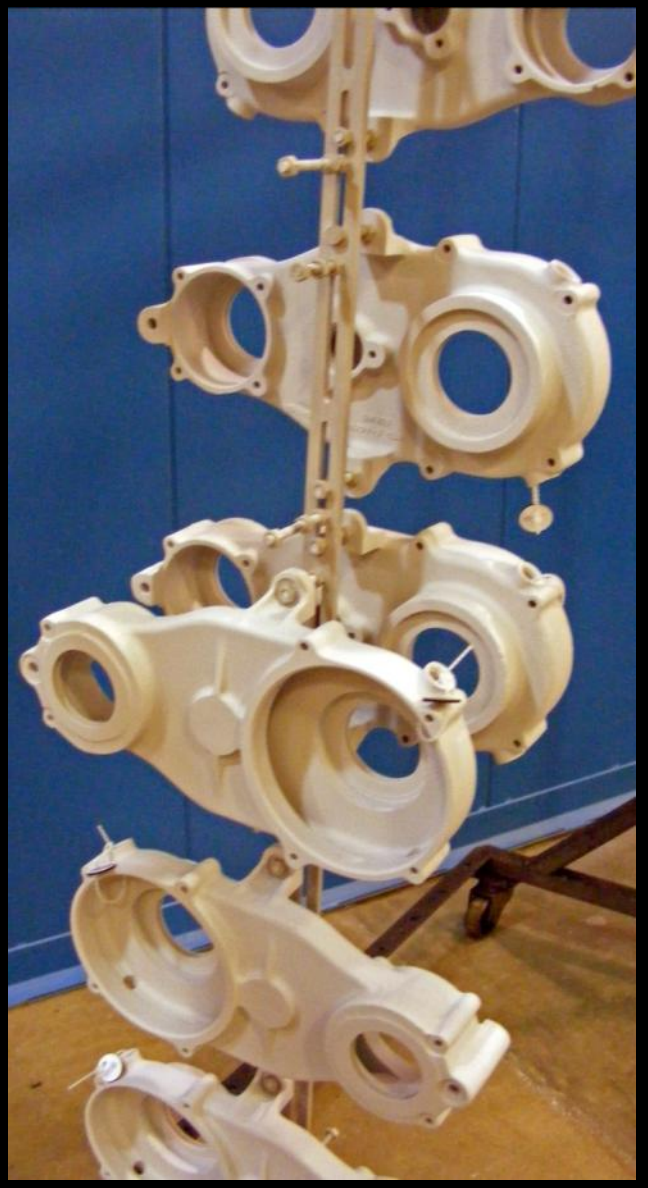

Do these look like 49 year old magnesium castings?

Old magnesium castings cleaned and then Tagnite anodized.

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45 Year Old+ Magnesium Castings Corrosion Has Not Taken Them Out of Service

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45 Year Old+ Magnesium Castings Ready to Return to Service

Lockheed P-2V Neptune
1945 - 1962

Neptune Aviation has a fleet of P-2V's which they use as Fire Bombers. The aircraft's magnesium wheels are scheduled to be replaced in 2011.

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There is a Long History of Successful Use of Magnesium in Aviation

- Properly protected, magnesium can provide years of trouble free service
- Today's magnesium alloys have a much lower corrosion rate than many of magnesium components that are presently in service
- Today's coatings prevent magnesium corrosion far better than what has historically been used

The Bottom Line: You Can Use Strong, Lightweight Magnesium With Confidence

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