

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA24FA026

MATERIALS LABORATORY

Factual Report 24-033

May 24, 2024

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A. ACCIDENT INFORMATION

Location: Marion, OH
Date: 10/31/2023
Vehicle: Piper PA-32-300 N44601
Investigator: Daniel Boggs, AS-ERA

B. COMPONENTS EXAMINED

Oil screen and cap with various particles to be examined.

C. EXAMINATION PARTICIPANTS

Technician Edward Komarnicki
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

An image of the as-received oil screen, cap and particles is shown in figure 1. The particles, along with loose particles on the paper towel; were collected onto glassine paper and imaged as a group using a digital microscope shown in figure 2. The particles were then separated magnetically into two groups of magnetic and non-magnetic particles as shown in figures 3 and 4 respectively.

Representative particles from each group were not cleaned but were placed on a beryllium (Be) stub within the Scanning Electron Microscope (SEM) for subsequent identification using Energy Dispersive Spectroscopy (EDS). Representative particles were given arbitrary numbers are shown on Be stubs in figure 5. The red asterisks in the image denote particles that were later cleaned ultrasonically in acetone and re-analyzed for identification. An image of these cleaned particles on a Be stub are shown in figure 6.

Table 1 lists the elements detected from the six magnetic particles analyzed. All particles revealed a significant carbon component as well as a significant ferromagnetic component in the form of iron or nickel along with trace or minor concentrations of suspected environmental contamination.

Table 1 - Magnetic Particles

	1	2	3	4*	5*	6
Carbon (C)	minor	major	major	major	major	major
Nitrogen (N)				minor		
Oxygen (O)	trace	trace	minor	minor	minor	trace
Aluminum (Al)	trace		trace	minor	minor	
Silicon (Si)		trace	trace	minor		
Phosphorus (P)					minor	
Sulfur (S)				trace		
Chrome (Cr)				trace		
Manganese (Mn)		trace		trace	minor	
Iron (Fe)		major	major	major	major	minor
Nickel (Ni)	major			minor		major
Copper (Cu)				minor		
Molybdenum (Mo)				trace		
Lead (Pb)				trace	major	

Blank = none detected

* these particles were later cleaned

In Table 2, the non-magnetic particles numbered 1, 2, and 3 appear to be pieces of an O-ring, gasket, or other plastic-type organic material. The EDS results reveal that the rest of the particles (4 - 9) are aluminum particles with trace or minor concentrations of environmental contamination.

Table 2 - Non-magnetic Particles

	1	2	3	4*	5*	6	7*	8*	9
Carbon (C)	major	major	major	major	major	major	major	major	major
Oxygen (O)	major	major	major	trace	minor	minor	minor	minor	trace
Sodium (Na)			trace						
Magnesium (Mg)				trace	trace	trace	trace		
Aluminum (Al)	minor	minor	minor	major	major	major	major	major	major
Silicon (Si)	major			minor	minor	minor	trace	trace	trace
Sulfur (S)					trace			trace	
Chlorine (Cl)								trace	
Chrome (Cr)							minor		
Manganese (Mn)					minor				
Iron (Fe)				trace	major			minor	
Nickel (Ni)				trace					
Copper (Cu)					trace	trace			trace
Cadmium (Cd)			major						
Lead (Pb)	minor	major	major		minor	minor	major	minor	trace

Blank = none detected

* these particles were later cleaned

Trace, minor and even major concentrations of lead was found in several of the particles in both groups. Upon removing the particles from the Be stubs, a liquid residue; thought to be oil from the oil screen remained on the stub. This liquid was analyzed and compared with a clean area on the stub. EDS results revealed a major carbon peak along with trace aluminum, silicon, sulfur and lead.

Particles 4 and 5 from the magnetic group and particles 4, 5, 7 and 8 from the non-magnetic group were cleaned ultrasonically while submersed in acetone for 30 minutes. The particles were allowed to dry then placed on a clean Be stub for further analysis. Table 3 lists the elements revealed after cleaning. With a minor amount of chrome and trace nickel detected, particle 4 is most likely a ferritic stainless steel while particle 5 resembles plain steel. EDS analyses confirmed that all the cleaned non-magnetic particles are aluminum as the amounts of carbon, oxygen and other contaminants decreased significantly or were not detected due to the cleaning process.

Table 3 - Magnetic and Non-magnetic Particles After Cleaning

magnetic particles (after cleaning)				non-magnetic particles (after cleaning)			
	4	5		4	5	7	8
Carbon (C)	minor	minor		minor	minor	major	minor
Nitrogen (N)	trace						
Oxygen (O)	trace	trace		trace	minor	minor	trace
Magnesium (Mg)				trace	trace		trace
Aluminum (Al)	trace	trace		major	major	major	major
Silicon (Si)	trace	minor		minor	trace	minor	trace
Sulfur (S)					trace		
Chrome (Cr)	minor					trace	
Manganese (Mn)	trace	trace					
Iron (Fe)	major	major		trace			
Nickel (Ni)	trace			trace			
Copper (Cu)					minor		trace
Molybdenum (Mo)	trace						
Lead (Pb)					trace		

Blank = none detected

Submitted by:

Edward Komarnicki
Engineering Technician



Figure 1. As-received oil screen, cap, copper washer and particles.



Figure 2. All as-received particles.

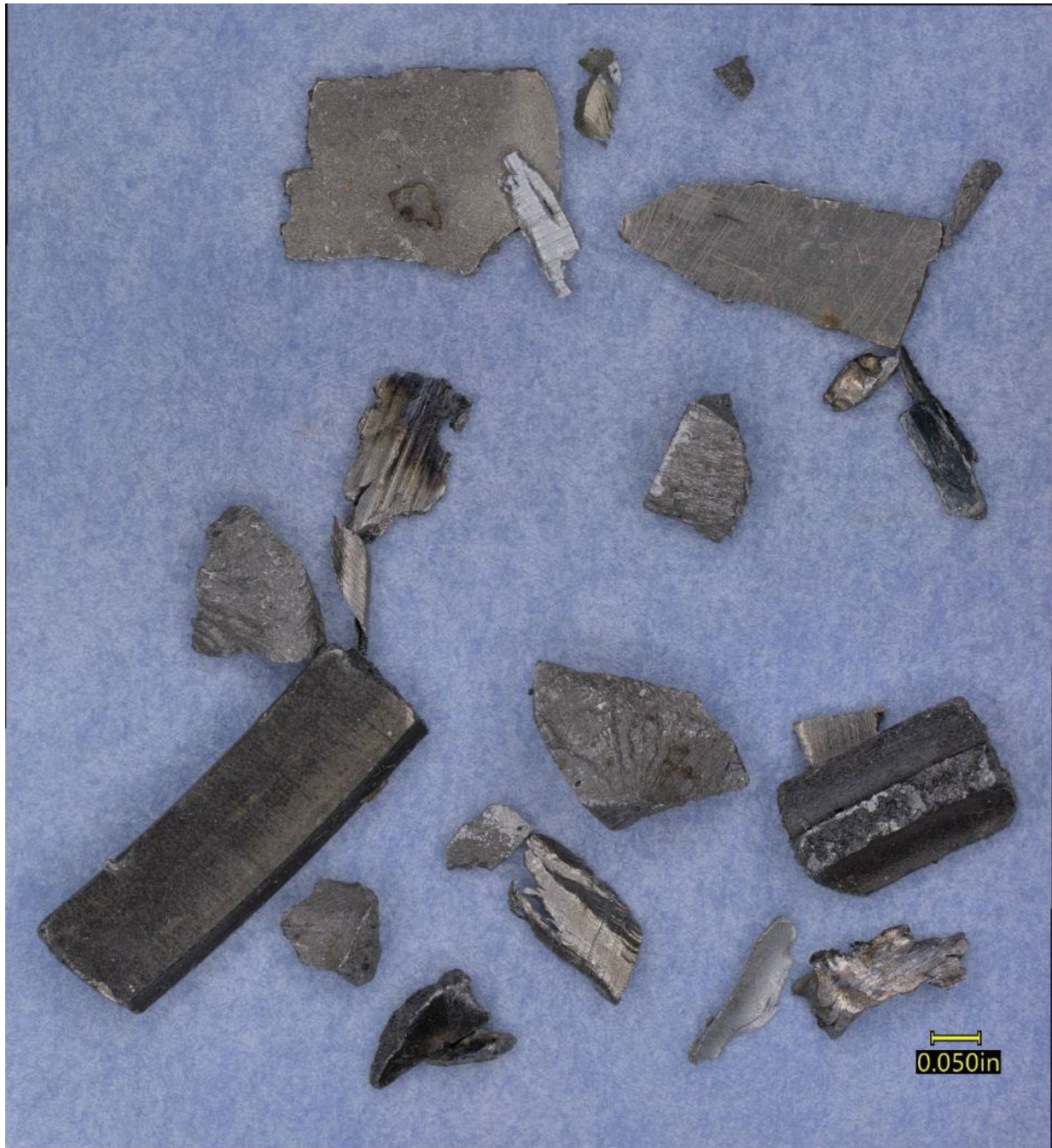


Figure 3. As-received magnetic particles.



Figure 4. As-received non-magnetic particles.

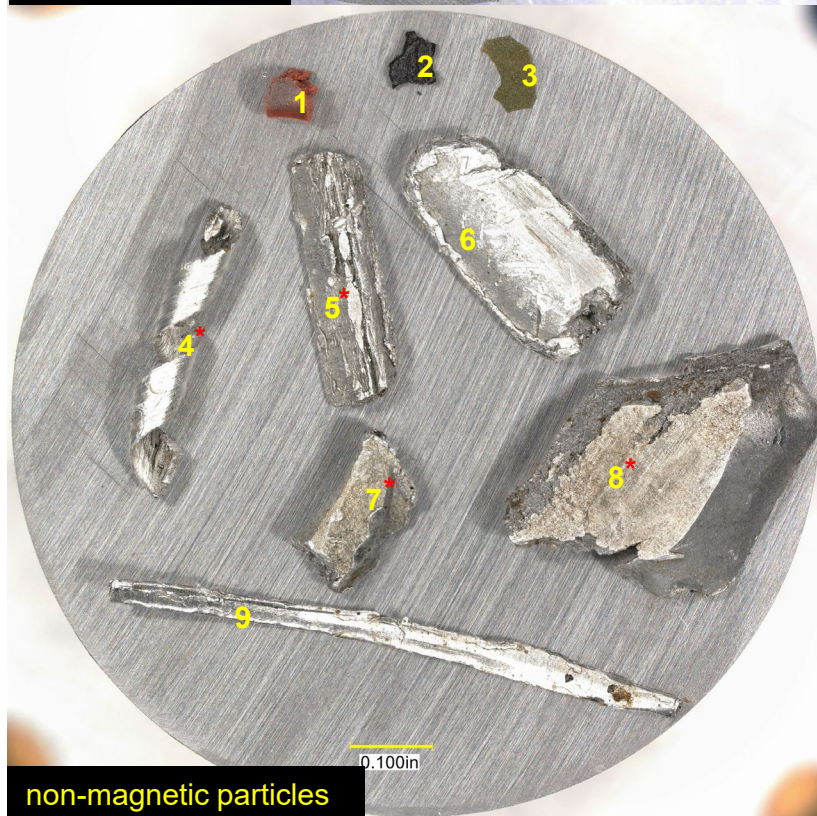
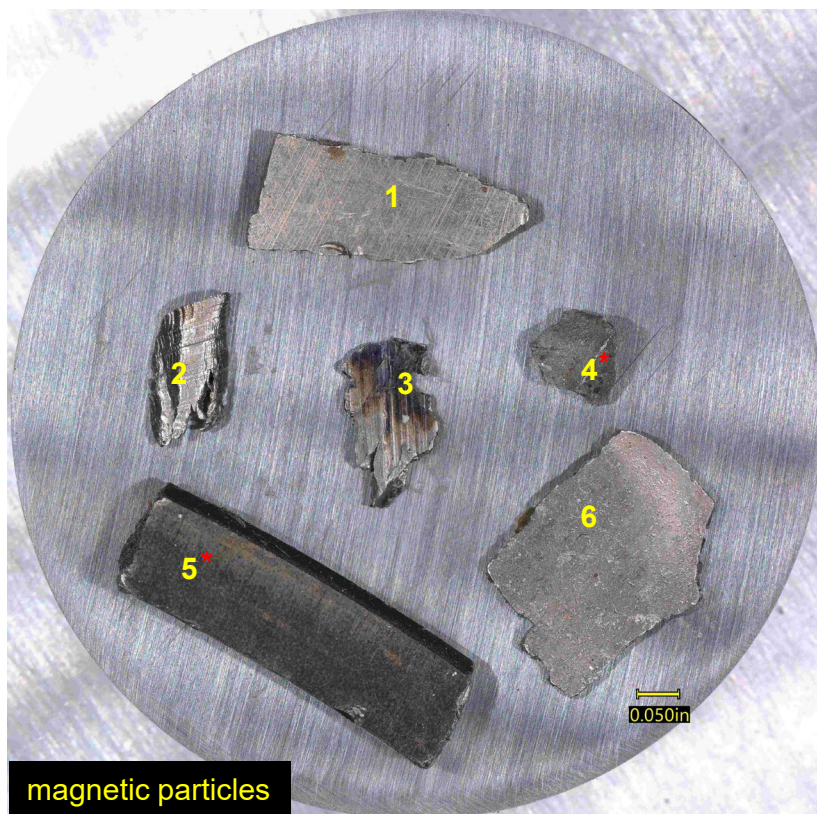


Figure 5. Grouped particles place on separate Be stubs. The red asterisk denotes particles later cleaned and re-analyzed.

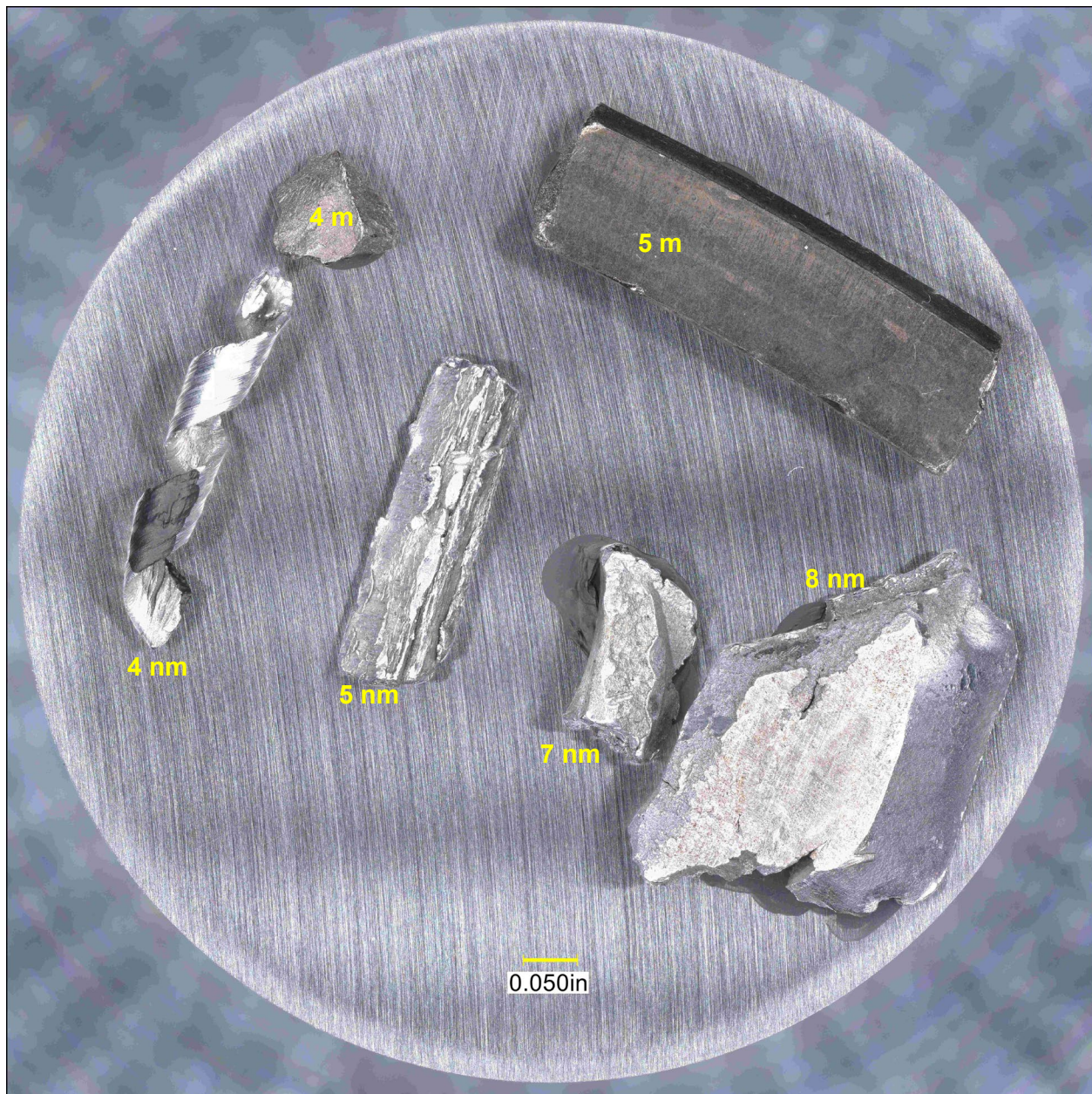


Figure 6. Cleaned particles on Be stub where 'm' denotes magnetic particles while 'nm' denotes non-magnetic particles.