



PAVEMENT CAUSED FOD TO AIRCRAFT ENGINES

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Objective Of Study



- **Determine what percentage of “Foreign Object Debris” (FOD) damaged aircraft engines were caused by pavement material:**
 - AC fragments
 - PCC fragments
 - Joint Seals
- **This information will assist in determining if the critical PCI thresholds being used by the Navy should be tightened to a higher level to reduce FOD probabilities.**

PCI - Defined



- **PCI – *Pavement Condition Index***
- **Quantitative Measure of Pavement Condition**
Range: 100 – 85 (Excellent) -----> 10 – 0 (Failed)
- **Obtained by ASTM Standard Test Method D5340-03 for Airport Pavement Condition Surveys. This method identifies/measures pavement distress:**

Type
Quantity
Severity

- **Critical PCI values for Navy and Marine Corps airfield pavements:**

Runways 70
Taxiways 60
Aprons 60
Helipads 60

FOD Data Sources



- **Engine FOD Incident Reports**
 - Required by OPNAVINST 4790.2H for each damaged engine
- **Reports Reviewed: 843**
- **Report Sources:**
 - Commander, Naval Air Force, Atlantic Fleet
 - Commander, Naval Air Force, Pacific Fleet
 - Commander, Strike Fighter Wing, Pacific Fleet
 - Commander, Strike Fighter Wing, Atlantic Fleet
 - Commander, Third Marine Air Wing

Engine FOD Incident Reports



- **Contents of reports:**

- **Aircraft – Type, model, series**
- **Engine – Type, model, series, serial number, installed position**
- **Julian Date engine damaged by FOD**
- **Julian Dates and type of last maintenance**
- **Aircraft Location when damaged by FOD**
- **Engine Repair/Replacement Cost Data**
- **Damage Investigation Results**
 - **Evidence**
 - **Analysis of evidence**
 - **FOD identification, or suspected object and material if identification not possible**
- **Corrective action to prevent recurrence**
- **Commanding Officer's comments**

FOD Identification



- Done visually by aircraft operators
- Degree of Difficulty in assigning cause in this study:
 - Simple - Actual object recovered or good evidence of actual object
 - Intermediate - Suspected objects missing forward of engine intake or evidence at damaged site (e.g., rubber, metal, glass)
 - Unknown – Evidence/description of cause lacking in report

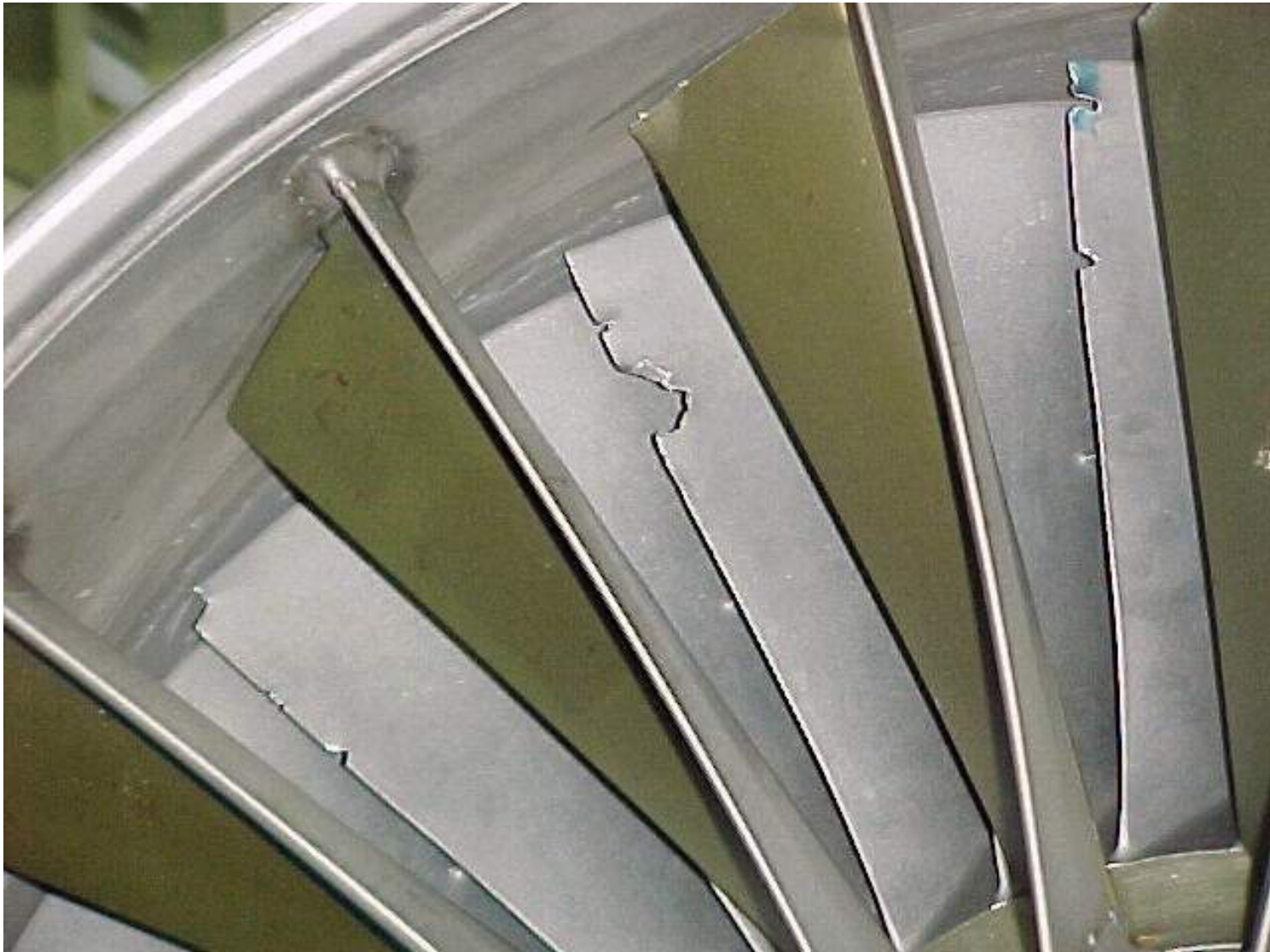
Damage Caused By Fastener

(Photo Courtesy of Failure Analysis Service Technology)



Damage Caused By Concrete

(Photo Courtesy of Failure Analysis Service Technology)



Damage Caused By a Tool

(Photo Courtesy of Failure Analysis Service Technology)



Damage Caused by Hard Ice

(Photo Courtesy of Failure Analysis Service Technology)

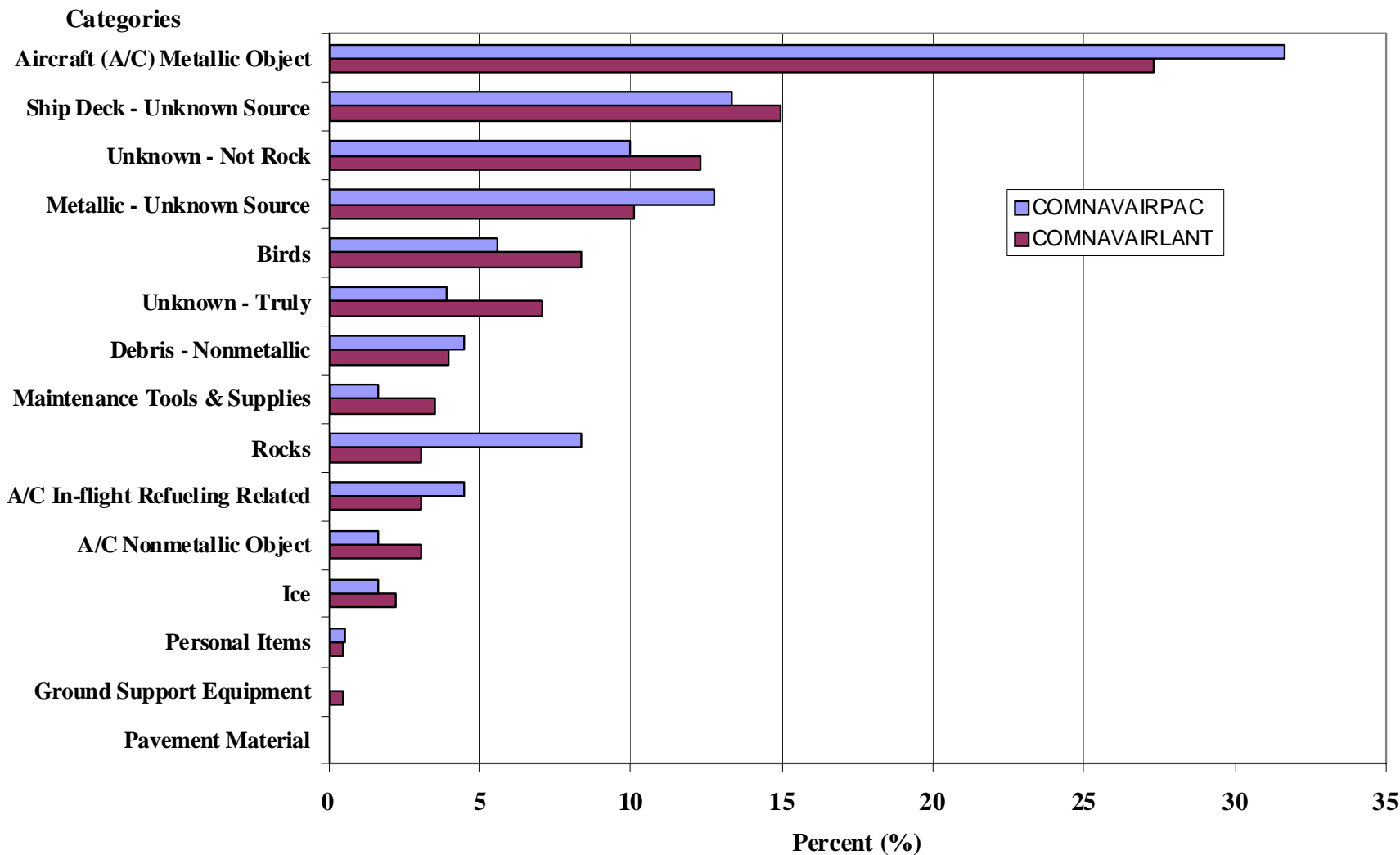


FOD Incidents – January 2002 through March 2003



Cause	Total Incidents	Percent
Aircraft Metallic Object	119	29.2
Ship Deck – Unknown Source	58	14.3
Metallic – Unknown Source	46	11.3
Unknown – Not Rock	46	11.3
Birds	29	7.1
Unknown – Truly	23	5.7
Rocks	22	5.4
Debris – Nonmetallic	17	4.2
Aircraft In-flight Refueling Related	15	3.7
Maintenance Tools and Supplies	11	2.7
Aircraft Nonmetallic Object	10	2.5
Ice	8	2.0
Personal Items	2	0.5
Ground Support Equipment	1	0.2
Pavement Material	0	0.0
Totals:	407	100.0

COMNAVAIRLANT & COMNAVAIRPAC FOD Incidents (January 2002 – March 2003)

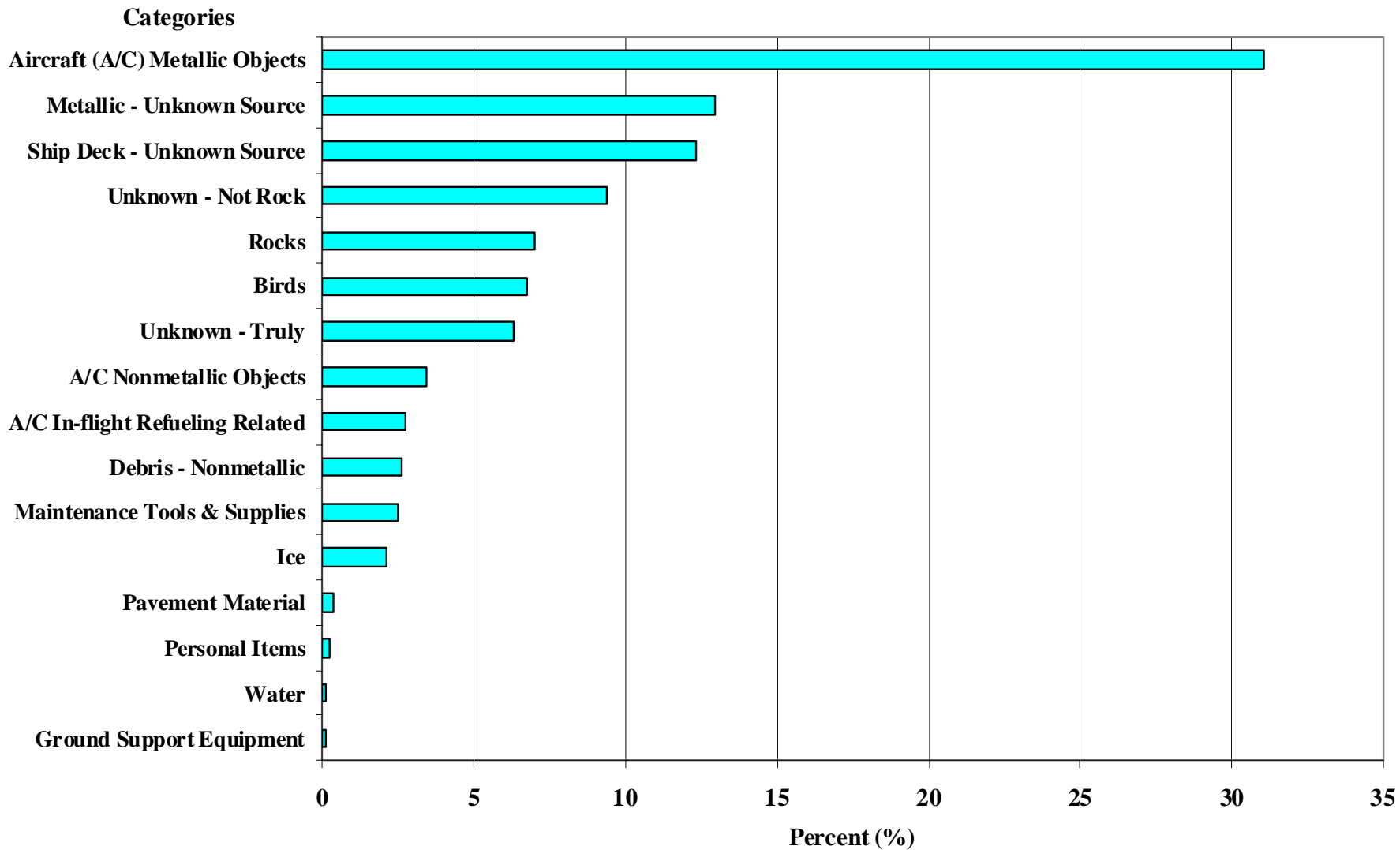


FOD Incidents – All Collected Data



Cause	Total Incidents	Percent
Aircraft Metallic Object	262	31.1
Metallic – Unknown Source	109	12.9
Ship Deck – Unknown Source	104	12.3
Unknown – Not Rock	79	9.4
Rocks	59	7.0
Birds	57	6.8
Unknown – Truly	53	6.3
Aircraft Nonmetallic Object	29	3.4
Aircraft In-flight Refueling Related	23	2.7
Debris – Nonmetallic	22	2.6
Maintenance Tools and Supplies	21	2.5
Ice	18	2.1
Pavement Material	3	0.4
Personal Items	2	0.2
Ground Support Equipment	1	0.1
Water	1	0.1
Totals:	843	100

FOD Incidents – All Collected Data



Rock and Pavement FOD



FOD Material	Number Incidences	Standard Cost (\$)
Rocks	59	8,015,000
Pavement	3	226,000

Findings



- **For period Jan 02 thru Mar 03 for COMNAVAIRLANT & COMNAVAIRPAC:**
 - Majority of engine damaged were caused by objects from:
 - Aircraft itself
 - Ship deck
 - In-flight refueling equipment
 - Unknown sources (metallic, not rock or truly unknown)
 - Rock FOD 22 (5.4%)
 - **Pavement FOD 0 (0%)**

- **For all 843 collected data:**
 - Majority of engine damaged were caused by: (same as above)
 - Rock FOD 59 (7.0%)
 - **Pavement FOD 3 (0.4%)**
 - Rock caused damage is more prevalent at Air Stations in arid western United States
 - Insufficient data to determine existence of correlation between engine height and FOD caused engine damage

Conclusion



- **Based on findings from this study, the critical PCI threshold levels should remain unchanged for Navy and Marine Corps airfield pavements.**