Use of SmCo T550 Magnetic Materials on Weapon Applications at High Temperature

Presented by

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Outline

- **Who** is involved?
  - **Why** are we doing this?
    - **What** are we doing?
      - **How** are we doing this?
        - **What else** can we do?

Who and Why?

WHO?

- Office of Naval Research

- ARDEC

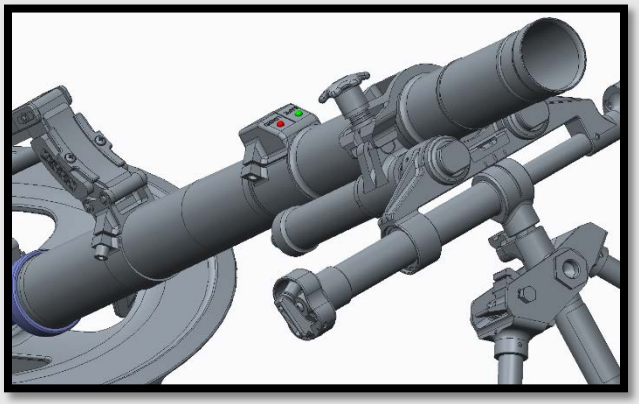
WHY?

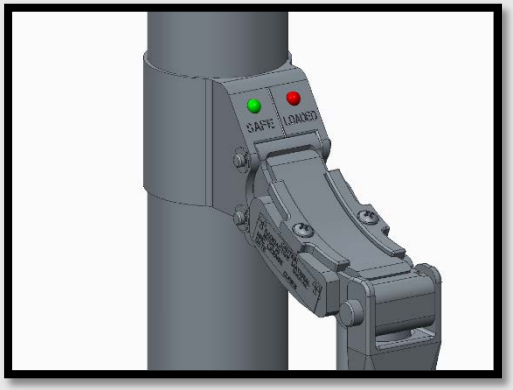
- "Double Load"
- Hawthorne Incident
  (March 18th, 2013)
- Need for Load Indicator

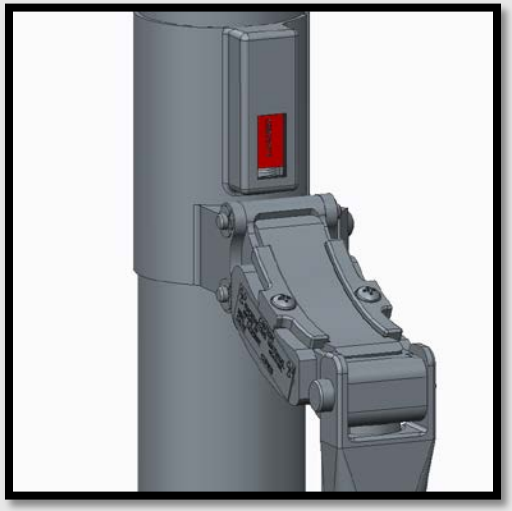
US ARMY RDECOM

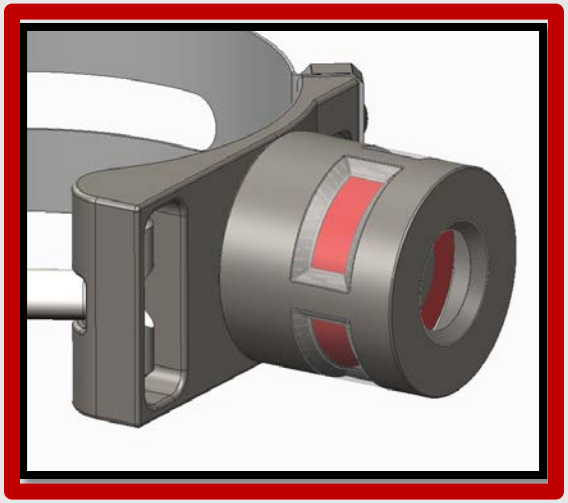
What Are We Doing?

Proposals for Load Indicator









Malcolm Baldrige National Quality Award 2007 Award Recipient

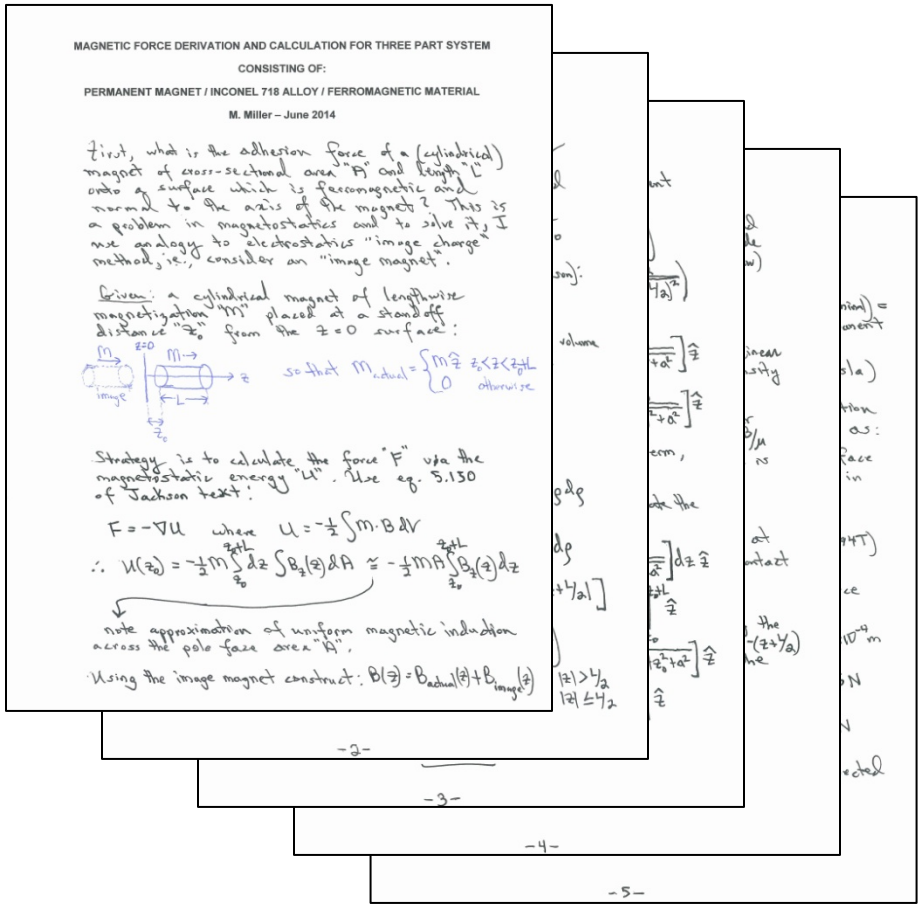
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

How Are We Doing This?

- Findings
  - Ultra-High Temperature
  - SmCo (Samarium Cobalt) Material
  - 550° C (1022° F) max operating
  - 1,450° F curie temp

- Sm_2Co_{17} T550

Preliminary Material Study



MAGNETIC FORCE DERIVATION AND CALCULATION FOR THREE PART SYSTEM

CONSISTING OF:

PERMANENT MAGNET / INCONEL 718 ALLOY / FERROMAGNETIC MATERIAL

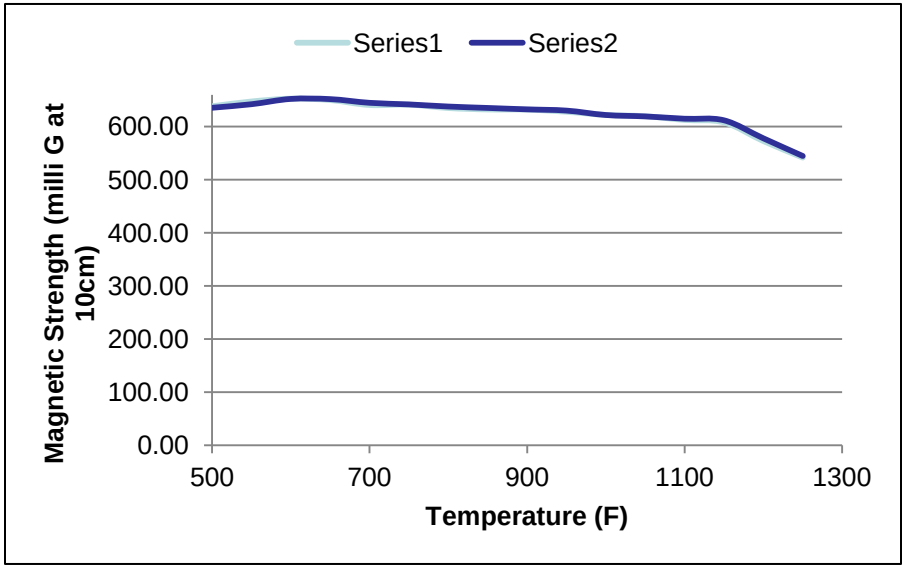
M. Miller – June 2014

First, what is the adhesion force of a (cylindrical) magnet of cross-sectional area "A" and length "L" onto a surface which is ferromagnetic and normal to the axis of the magnet? This is a problem in magnetostatics and to solve it, I use an analogy to electrostatics "image charge" method, i.e., consider an "image magnet".

Given: a cylindrical magnet of lengthwise magnetization "M" placed at a stand-off distance "z_0" from the z=0 surface:

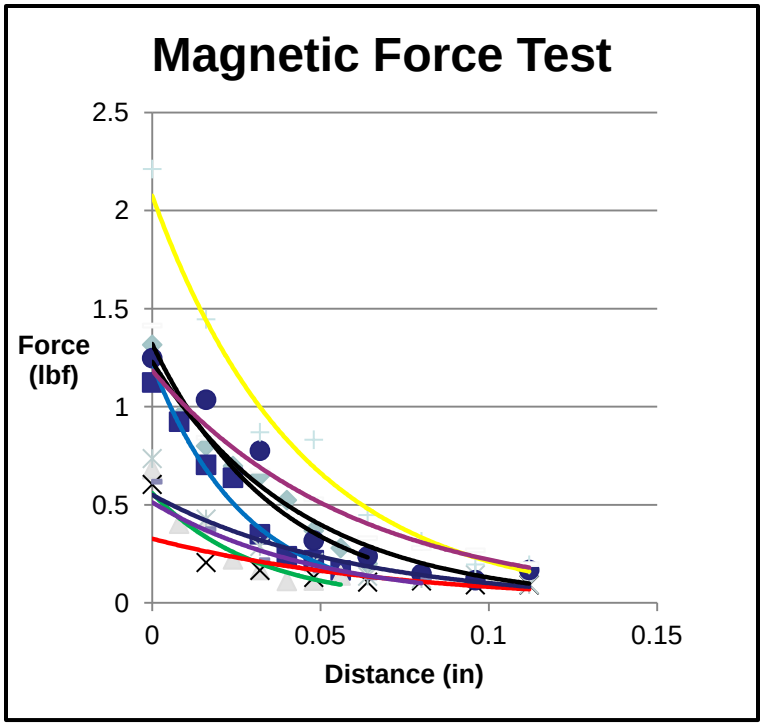
Magnetic Stability

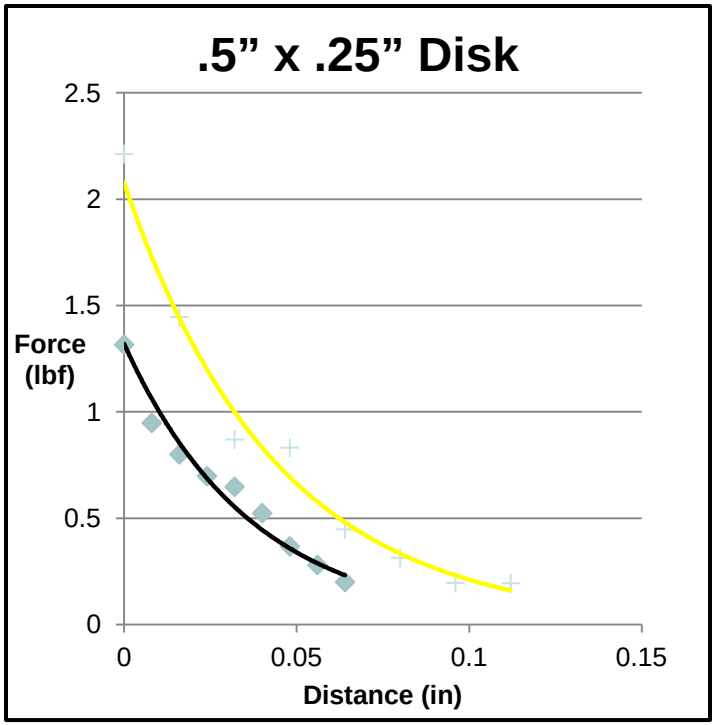
- Sm_2Co_{17} T550
- Tested up to 1250° F
- ~10% degradation
- High temperature will not be a factor



Pull Strength Study

- SmCo T550
  - Multiple form factors
  - Diameter has most effect of strength
  - Height ≥ Diameter for survivability





Sample Materials

Future Testing and Studies

- High Temperature Shock testing
  Spring 2016
- Live fire testing
  Summer 2016
- Full survivability study
- Further Warfighter Workshops

What Else Can We Do?

- Load Indicator
  - Help fulfill requirement to indicate weapon status
- Hall effect sensors/ magnetometers
  - Use with sensors for tracking data across the tube
- Power generation
  - Generation of power from shock
- High temp acoustics
  - Microphones to sense weapon operation.

Thoughts…

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Thank You

Abstract

Title: Use of SmCo T550 Magnetic Materials on Weapon Applications at High Temperature

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Abstract:
The use of permanent magnets incorporated into weapon platforms can add features and capabilities for the War Fighter. This can be an issue if the application is in a high temperature environment as most permanent magnetic materials will lose their magnetic strength at higher temperatures. This paper reviewed testing conducted on SmCo T550 permanent magnetic material in relation to temperatures seen on mortar weapon platforms. A review of magnetic materials will be presented and the high temperature test findings of the study. Further the applications in fire control that the testing was conducted for will also be presented. Overall attendees should gain an understanding of which permanent magnetic materials can be utilized on weapon platforms and in Fire Control applications.

References

"Effect of the Internet-of-Things on Fire Control and Weapon Systems" *R. Tillinghast (80%) et all, Proceedings: NDIA Armaments Systems Forum, April 2015 [Paper]*

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"Study to Evaluate Loss of Magnetic Strength at Elevated Temperatures in SmCo T550 Permanent Magnets", S. Vanweele & R. Tillinghast, DTIC Report, 2015