High Performance Magnet Producers in the USA

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Types of Permanent Magnets

- Ferrite Magnets
  - Barium Ferrite
  - Strontium Ferrite
  - Alnico Magnets
    - SmCo 1:5
    - SmCo 2:17

- Metal Magnets
- RE Magnets
- Nd-Fe-B Magnets
- Bonded Ferrite Magnets
- Bonded RE Magnets

- Bonded Magnets (Rubber/Plastic)
- Other Magnets
Magnet Sales Worldwide

- Market is growing due to automotive & more uses, miniaturization
- Chinese are main beneficiaries of growth
- China will increase share & dominance

Data courtesy of Webmagnetics.com
“There is oil in the Middle East. There are rare earths in China. We must take full advantage of this resource.”

Deng Xiaoping, 1992
China Dominates Magnet Materials


NdFeB magnets 75% (22% Japan)

Rare Earth Oxide Ore production 94% (50% WW reserves)

Rare Earth pure Metals nearly 100%

Hard ferrites 85+ %

Japan, US, European producers close plants, move production

Over ½ WW Alnico & SmCo production

CHINA
China Rare Earth Metals Price Manipulation

- China overcapacity drives out all other producers
- Unique dominance by one country in metals
- High risk for other producers to invest on added capacity
- Inability to purchase Nd metals reported
- Rare earth metal buybacks from customers mandated at sub market level
- China views downstream user implications of price increases having positive effects
- Neodymium metal Price History
  - 1989 $42/kg
  - 2003 $8/kg
  - 2006 $28/kg
  - 2007 $52/kg
  - 2008 $40/kg

Source: US Geological Survey
Recent Trade Issues - DUMPING

**Commerce Finds China Receiving Subsidies In Raw Flexible Magnets**

**Preliminary Ruling**

The Commerce Department Feb. 20 preliminarily found Chinese producers/exporters of flexible raw magnets have received net countervailable subsidies of 70.41 percent *(Raw Flexible Magnets from China, ITC).*

**COMMERCE FINDS UNFAIR DUMPING OF MAGNETS FROM CHINA AND TAIWAN**

WASHINGTON – The U.S. Department of Commerce today (April 21, 2008) announced… *The preliminary rate for China is 185.28 percent and 38.03 percent for Taiwan.*

(Press release 5/21/08, International Trade Administration, US Dept. of Commerce)
Chinese Rare Earth Actions

- Government sets production caps (86,520 mT/yr REO currently, reduced from 105,000 MT in 2006)
- Price minimums established through industry collusion
- Export quotas traded among producers thereby adding to export price
- China producers established $100/ton fine for violations to price minimums (14 July 2005)
- Jan 1, 2008 Export taxes increase to 25% from 10% (US Import duty is 5%)
- Number of authorized seller of Rare Earths reduced in 2008 to 23 companies from over 40
- Massive Rare Earth Technology Center (1.6 million sq foot)
- Rare earth metal buybacks from Chinese customers mandated at sub market level
- China views downstream user implications of price increases having positive effects of reduced competition of magnet companies and forcing China’s products up the value chain
RE Implications Outside China

- Price spikes, uncertainty, supply chain disruptions
- Higher raw material prices for rare earth magnet producers
- Puts Chinese home markets at structural competitive advantage over export markets
- Incentivizes Chinese to move up value chain more quickly, competing more with developed nations products
- Adds revenue and profit to Chinese enterprises, increases industry consolidation and ability to compete
- All consumers will pay more where rare earths are used
- China as critical to supply chain
- Loss of knowledge base to innovate
China Rare Earth Trade Questions

- How does China justify Export Quotas? -25%
- Why hasn’t China notified WTO of need for export quotas?
- Why does China have export duties on rare earths?
China Trade Questions

- Transparency of Trade Reporting- Ministry of Commerce- MOFCOM Gazette – Info not captured –
- Disclosure process for Anti Dumping Calculations is inadequate
- Currency Valuations
- Intellectual Property Enforcement (NdFeB)
  - 9 valid licensees, over 100 producers
- State Owned Enterprises (SOE’s)
Why do we need Domestic Production?

- **Vietnam War**
  - Sony withheld cameras used to guide tactical missiles
- **1983**
  - Socialists in the Japanese Diet blocked the sale of ceramic packaging used in U.S. cruise missiles
    - 002
    - Hellfire Missile production stopped during West Coast dock strike
      - critical parts sourced in Japan were awaiting off-loading
- **2003**
  - JDAM bomb production stopped during Iraq war because Swatch Group refused to ship critical part
    - disagreed w/ Bush Administration policy
US Magnet Industry in the 1990’s

- US magnetic material producers employ 6000
- Robust Industry Association
- 5 Alnico magnet producers
- 5 Samarium Cobalt magnet producer
- 4 Neodymium Iron Boron magnet producers
- 2 Grain Oriented Electrical Steel (GOES) producers
- 1 Rare earth oxides or rare earth metals production
- non-captive Ferrite producers
U.S. Magnet Producers in 1990s

**Alnico Magnets**
- Arnold
- Hitachi
- Crucible Magnetics
- T&S
- Permanent Magnet Company

**SmCo Magnets**
- Arnold
- Crucible (1-5)
- EEC
- Hitachi (GE)
- IG Technologies (Ugimag)

**Sintered Ferrite Magnets**
- Arnold
- Hitachi (Edmore, China Grove)
- TDK
- Crucible Magnetics
- General Magnetic
- Sumitok
- Kane (Stackpole)

**NdFeB (dense) Magnets**
- Ugimag (IG Tech.)
- Hitachi
- Crucible
- Magnequench (GM)
Recent Decline of US Magnet Industry

- 2002 Mountain Pass, CA rare earth mine suspends operations
  - world’s richest rare earth reserves
  - only one in US
- 2003 Magnequench closes plant and moves equipment to China
  - former GM subsidiary
- 2003 VAC closes Elizabethtown, KY operations
- 2004 China National Offshore Oil Corp attempts to purchase Unocal
  - owner of Molycorp and Mountain Pass rare earth mine
- 2005 Hitachi closes its Edmore, MI production facility
  - acquired from GE in 1990’s
Who remains in US Magnet Industry?

- Remaining US magnetic material producers employ 500
- No unique industry association (SMMA)- statistics
- 3 Alnico magnet producers
- 1 Samarium Cobalt magnet producer
- 0 Neodymium Iron Boron magnet producers
- 2 Grain Oriented Electrical Steel (GOES) producers
- 0 Rare earth oxides or rare earth metals production
- 1 non captured Ferrite producer
Current US Magnet Production

Remaining US permanent magnet producers:

**Alnico Magnets**
- Thomas & Skinner
  - Indianapolis, IN
  - 170 employees
- Permanent Magnet Corporation
  - Indianapolis, IN
  - 50 employees

**Samarium Cobalt**
- Electron Energy Corporation,
  - Landisville, PA
  - 114 employees

**Hard Ferrites**
- Arnold Magnetic Technologies
  - Marengo, IL
  - 140 employees
- Hitachi China Grove (captured)
- TDK (captured)
- Hoosier Magnetics, Inc. (ferrite powder)
  - Ogdensburg, NY
  - 50 employees
DOD Applications

- Inertial Guidance
- Electronic Warfare
- Microwave Communications, RADAR (ship-shore, ground-space, space-ground)
- Motors (hydraulic systems, motion control)
- Generators (power for aircraft, ships)
- Space (actuators, electric propulsion)
- Nuclear reactors (pumps, control rod actuators)
DOD Platforms

- Missiles
  - Trident, Minuteman IV, Patriot, PAC III,
  - AIM 120 AMRAAM, Tomahawk

- Navy
  - Aegis destroyer radar, Virginia Submarines,
  - support “all electric ship” technologies

ALQ 131 Jamming Pod – F15
SM-3 (SM3)
USS Lake Erie
DOD Platforms

- **Army**
  - M1A1 tanks, Bradley A3 and FIST, Paladin Howitzer,
  - AH-64 Apache, Stryker, Humvee
- **Air Force**
  - F-15, F-16, F-18, B-52, towed decoys, Joint Strike Fighter
  - Predator, Unmanned Aerial Vehicles
Strategic Materials Provision Applicability to Permanent Magnet Materials

**Hard (Permanent) Magnets**
- Three general types:
  - Alnico
  - Rare Earth
    - SmCo
    - NdFeB
  - Hard Ferrites

**Soft Magnetic Materials**
- Multiple types, including:
  - Powdered iron
  - Electrical steel
  - Soft Ferrites

Materials covered by 10 U.S.C. 2533b
US Production is Vital

- *Develop unique materials for mission specific DOD & US market needs AND commercialize*
- *Interest and ability to work with high performance, small production runs*
- *Otherwise, China could become a critical US defense supplier.*
Magnet Family Positioning

[Graph showing different magnet families and their positions on a graph with axes labeled 'Maximum Operating Temperature (°C)' and 'Maximum Energy Product at 25 °C, (BH)_{max} (MGOe)'. The graph includes regions labeled 'Alnico 1930s', 'EEC SmCo (1.5, 2.17) 1990s', 'NdFeB 1980s', and 'Ferrite 1950s'. There are clusters of points in each region labeled 'USA', 'USA & Japan', and 'Mete & Nanomaterials (Future)'.]
SUMMARY

- US Magnet Materials Industry IS ALIVE
- 10 U.S.C. 2553b Applies to US magnet Industry
- Permanent Magnets are critical to Military Hardware and weapons systems
- US Defense needs domestic advanced, specialized magnet technology capabilities for unique mission needs
- Innovation Key to Future
EEC Summary Info

- Landisville, PA – 40,000 sq ft State of the Art Facility
- 114 employees
- One Modern Manufacturing Site
- Material compliance with DOD Domestic Preferences of Specialty Metals (DFARS 225.252-7014 Alt 1 Deviation)
- Products
  - Sintered Samarium Cobalt production
  - Rare Earth Magnet Assemblies and Systems
  - Design Services
  - Contract R&D
- Fully integrated production of SmCo
- Capabilities
  - Alloy Powder Production
  - Alloy Melting and Manufacturing
  - Magnet Pressing
  - Sintering and Curing Equipment
  - Magnetization and Test
  - Full magnetic properties characterization
  - Machining
  - Magnet Assemblies
  - Magnet Circuit Design
  - Research laboratories for materials and systems development
Points of Contact

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