Titanium for Ground Combat Vehicles
Supporting Our Forces At War
BAE Systems Land and Armaments
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Outline

- Concern about availability
- Effect on future vehicle material selection
- Availability of small R&D quantities
- Price
- Fabrication
- Recommendations/Summary
Welcome to BAE Systems
Over 100,000 combat vehicles designed and built in all weight classes

- Bradley A3
- Bradley FIST
- C2V
- Thunderbolt
- AAV
- M88A2
- MLRS
- NLOS-C SD
- M109A6
- FAASV
- VLS
- M113 A3
- M9 ACE
- Mk 45
- MGV-W
- MGV-T

🌟 In service with the U.S. Army and/or USMC in Operation Iraqi Freedom
🌟 Advanced prototypes
🌟 In service with the U.S. Navy in Operation Iraqi Freedom
Future Combat System Program

- **BAE Systems providing**
  - Manned Ground Vehicle systems
    - NLOS-C howitzer
    - Infantry Combat Vehicle
    - Medical and Evacuation Vehicle
    - Maintenance and Recovery Vehicle
  - Common systems
    - Armor, Active Protection
    - Hybrid Electric Drive
    - Software
  - Armed Robotic Vehicle
  - Slated for full rate production 2012
  - Prototype development to start 2006
    - Trade studies underway to select hull materials
Delivery and Availability

- **Long lead time**
  - Affects R&D testing for future systems
  - Lack of ready availability for R&D testing

- **Current force vehicle production planning**
  - Need to account for delivery delays

- **Future vehicle production**
  - Delivery time can be built into schedule
Future program impact on capacity

- Future Combat System
  - Production begins in 2012
  - Possibility of several million pounds required per year

- What proportion of domestic production?
  - Effect on
    - Price
    - Delivery
  - What new technologies will be on line in 2012?
  - What are industry plans to increase capacity?

- Combined with external forces
  - Ferrotilanium demand
  - Energy costs
  - ……
- Ground vehicle buyers very sensitive to price
  - Traditionally use “cheap” steel and aluminum
  - Paradigm of initial acquisition, not life cycle cost
  - No tradition of $X per pound of weight saved
  - (Use of $100/lb ceramics planned for armor)
DoD Cost Reduction Efforts

- Armor MIL-Spec
  - MIL-PRF-46077
  - Performance based
  - Single melt
  - Looser chemistry compared to aerospace grade
  - Alternate chemistries to Ti64

- Non-Kroll reduction efforts
  - DARPA initiative
  - Industry initiatives

Have not observed any impact due to small quantity of armor grade produced
Fabrication costs

- Machining
- Welding
- High buy to fly ratio
- Near net shape processes desired
  - Castings
  - Forgings
  - SPF-DB
  - ....

Compounding raw material cost is high cost of fabrication
Welding for Combat Vehicles

- Not considered as critical as aerospace
- Yet requires maximum ballistic shock resistance
  - Impact and mine blast resistance
- AWS committee developing structural weld code
  - Includes ballistic shock test for “armor” applications
  - Test criteria/methodology being defined
Are current market conditions an aberration?
- Long lead time affecting future application of titanium on combat vehicles
- Price trends having similar effect
- Will promised new technology ever come to the market?
- Ti industry efforts to increase capacity welcome
  - Should include all manufacturing steps
  - Bottleneck analysis
- Army efforts to increase availability of titanium for armor applications is also welcome
- Let’s get suppliers and consumers together to plan for future
  - Long term corporate/program commitments needed
  - Macroeconomic assessment of titanium market over next decade