



DOE Energy Storage Systems Research Annual Peer Review

ETO Switch Testing

***Patrick J. McGinnis P.E.
Naval Surface Warfare Center***

***November 19, 2002
11:20 am – 12:00 pm
Washington, DC***

[←Home](#)

[←Agenda](#)



PROJECT OVERVIEW



Regional Electric Power Technology Integration & Leveraging Enterprise



Assess & Develop Innovative Electric Technologies for Navy & Commercial Applications

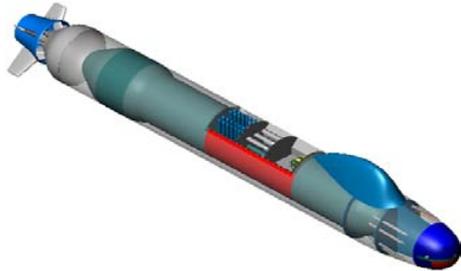
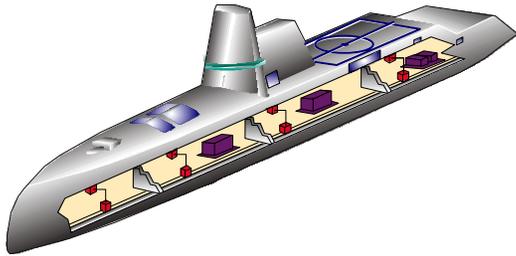


American Competitiveness Institute



Assess ETO For Potential Power Conversion Applications

NAVY TRANSFORMATION ALL ELECTRIC FORCE



- **Propulsion**
- **Control & Actuation**
- **Weapons Systems**
- **Aircraft Launch & Recovery**
- **Survivability Systems**
- **Storage and Distribution**
- **Alternative Sources**
- **Signature Reduction**

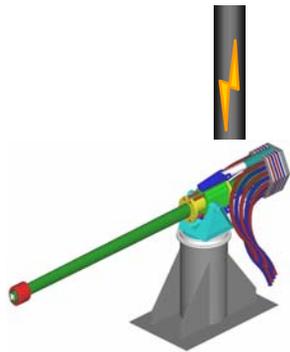
INTEGRATED POWER SYSTEM ARCHITECTURE



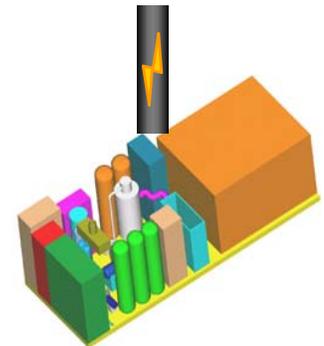
Conversion - Conditioning - Control



Mission Loads



Ship Service Power



Alternative Energy Sources

INTEGRATED POWER SYSTEM CONVERSION & LOADS

MAIN BUS

4160 VAC or 6.6 KVAC or 13.8 KVAC @ 60 hz

PROPULSION LOAD

**Main Bus to DC to 0-2000 VAC @ 0-60 hz
20 - 70 Mw**

**Main Bus
15000 VDC
and/or
450 VAC @ 400 hz
15 - 25 Mw**

Mission Loads

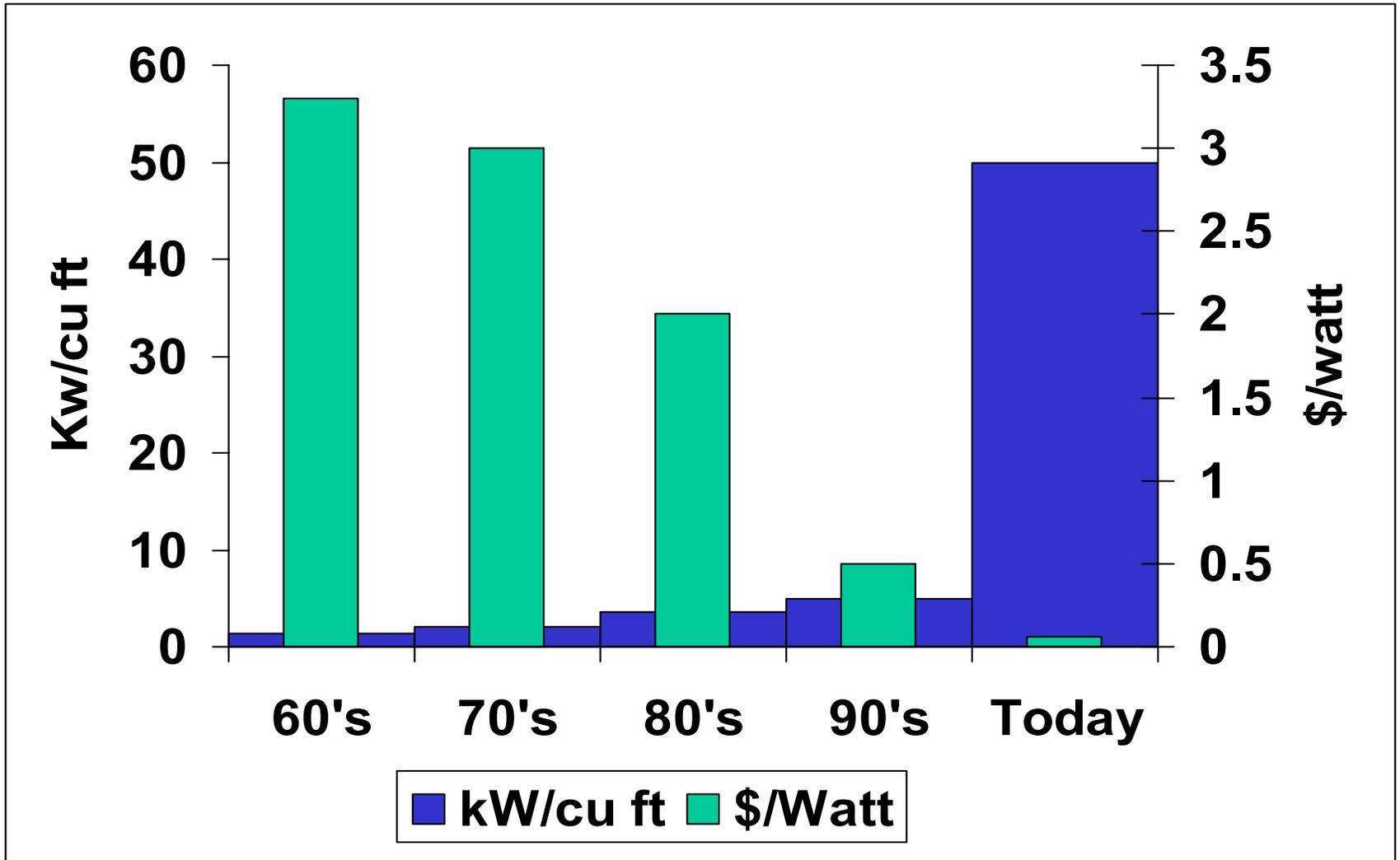
**Main Bus
1100 VDC
450 VAC @ 60 hz
10 Mw**

Ship Service Power

**Main Bus
4160 VAC @ 60 hz
0-450 VDC
20 Mw
(Scaleable)**

***Alternative
Energy Sources***

NAVY POWER SUPPLY PERFORMANCE OBJECTIVES



POWER SEMICONDUCTOR PERFORMANCE BASELINE

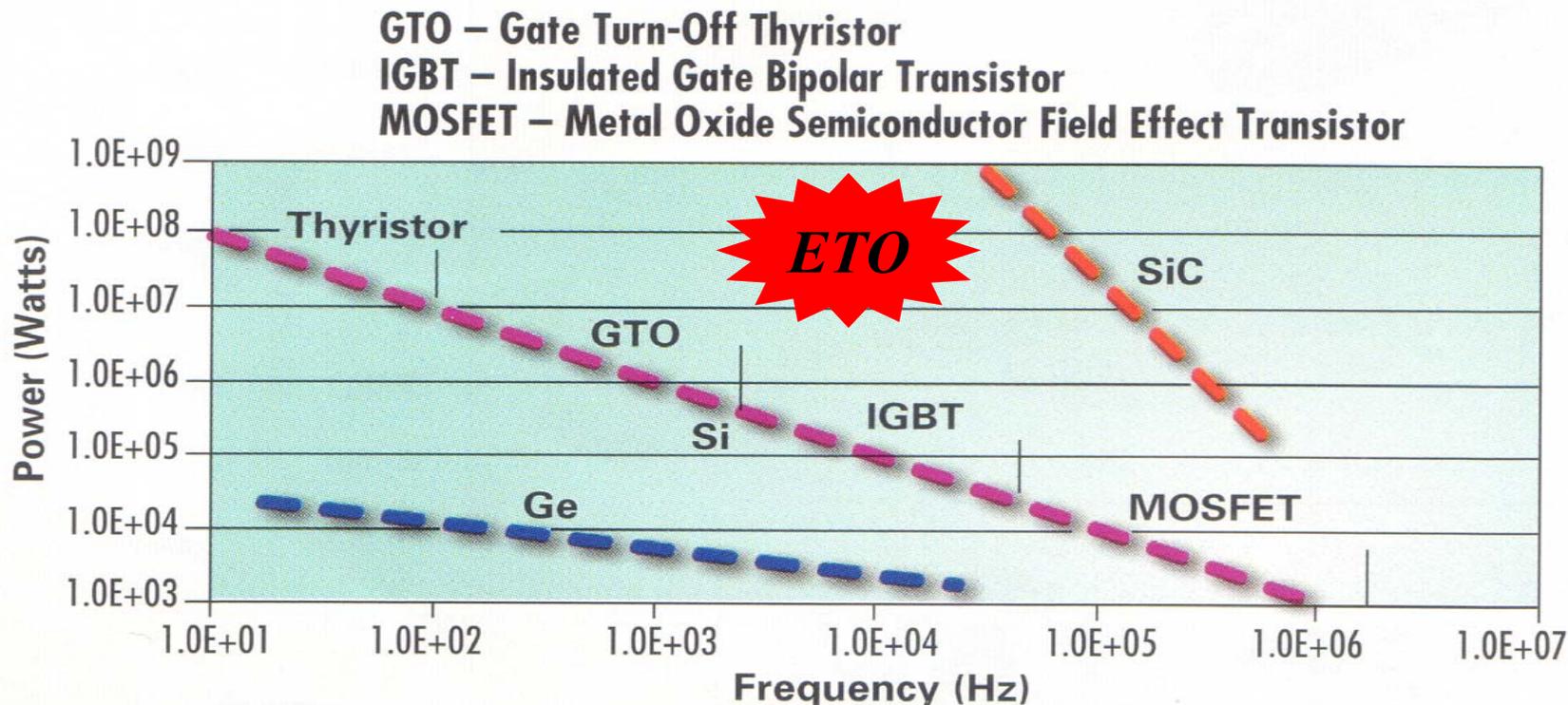


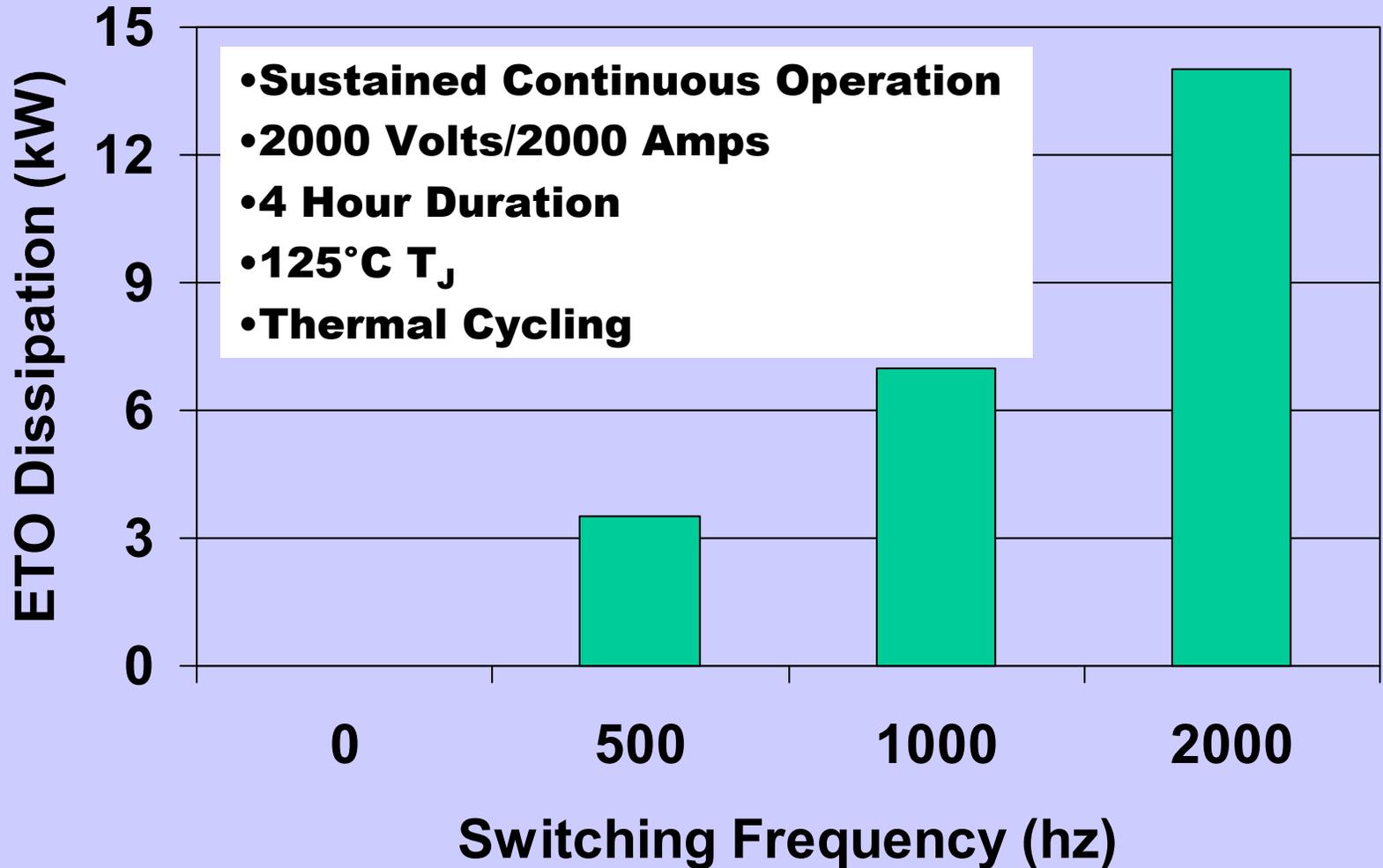
Fig. 3: Schematic diagram showing the power and frequency ranges for silicon-based power semiconductor devices.

From: R.M. Anklekar, M.T. Lanagan, and J-J Pan, "Trends and Developments in Capacitor Technologies for Power Electronics Applications," Passive Component Industry, July/August 2001, pp. 16-27

ETO TEST HISTORY & OBJECTIVES-Virginia Tech

- **Pulse testing**
 - 2000 Amps
 - 3000 Volts
 - 125°C Junction temp
- **Objectives**
 - Validate operation
 - Characterize waveforms
 - Measure state conditions (on/off)
 - Calculate power losses

PROPOSED TEST REGIME NCWCCD





- **Test Regime**
 - **Functional Test**
 - **Thermal Cycle**
 - **Functional Test**
- **Test Profile (IPC-9701 & IPC-SM-785)**
 - **-25° C to 125° C**
 - **5° C/min Ramp Rate**
 - **15 minute Plateau**
 - **500 Cycles or 63% failure (~ 35 days)**
- **Full Failure Analysis of Any Test Failure**

DEVELOPMENTAL TEST PLAN

- **ETO Device Level**
 - Higher Frequencies
 - Higher Power via 727 volt/3450 amp power supply
- **Subsystem Level**
 - Linear Motor Controller
 - 3-phase Converter

SUMMARY

- Navy Electric Initiative Requires High Power/High Speed Switches
- Cooperative Effort to Evaluate ETO For Commercial & Military Use
- Device Level Performance Testing Leading to Subsystem Development