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HIGH PERFORMANCE DIELECTRIC MATERIALS DEVELOPMENT

by

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Foster-Miller, Inc.
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FOSTER-MILLER, INC.

- 37 year old independent technology development company
- Located in the Boston area
- About 270 employees
- Primary areas of business
 - Advanced polymers
 - Robotics
 - Composites
 - Special machinery

POLYMER COMPOSITES MATERIALS TECHNOLOGY

- **Mission**
 - **Develop materials and processing technology to meet DoD and commercial needs**
- **Specific Areas of Research**
 - **High temperature dielectric materials**
 - **High performance dielectrics for capacitors**
 - **Electronics packaging**
 - **High performance structural materials**
 - **Micro-composite blends**
 - **NLO materials, devices**
 - **Smart processing**

HIGH PERFORMANCE CAPACITORS

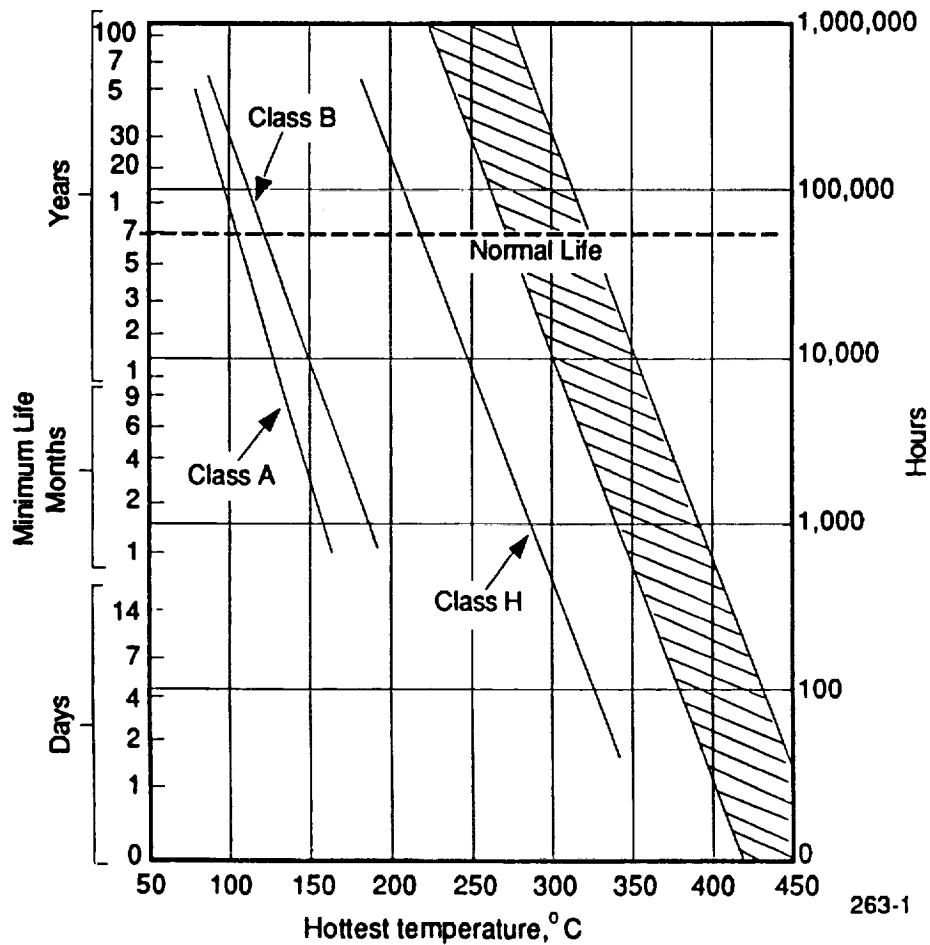
- **300°C Filter capacitor for aircraft power conditioning**
 - **Funded by the U.S. Air Force**
- **8 kJ/kg Repetition rated energy storage capacitor - SDIO**
- **High energy density dielectric film - U.S. Army**
- **Interpenetrated polymer network capacitor - SDIO (Scheduled to start September, 1991)**



HIGH TEMPERATURE AEROSPACE INSULATION

- Identify and develop new insulation materials that can operate reliably at 250°C+
- Phase I SBIR program started in July, 1991
- Funded by the U.S. Air Force
- Monitored by Mr. George Slenski, and Mr. Eddie White

TARGET FOR NEW INSULATION



WHY FOSTER-MILLER?

- **Extensive experience in the development of advanced materials for specific DoD applications**
 - **Thermotropic LCPs, Xydar, Vectra for PWBs**
 - **Lyotropic LCPs, e.g. PBZT, PBO for capacitors, light weight structures**
 - **High performance polyimides - electronic packaging**
 - **Blends of Vectra and LARC TPI**
 - **Blends of Matramid and PES**
 - **Interpenetrating networks of PBO, PBZT and polyimide resins, epoxies**

- **Foster-Miller is not a material vendor**
- **Design and synthesize novel materials**
- **Develop techniques to process difficult materials into films for major material producers**

- **Close working relationship with**
 - **Resin vendors**
 - **Cable and wire vendors**
 - **System houses**
 - **Airframe companies**
 - **and leading experts**

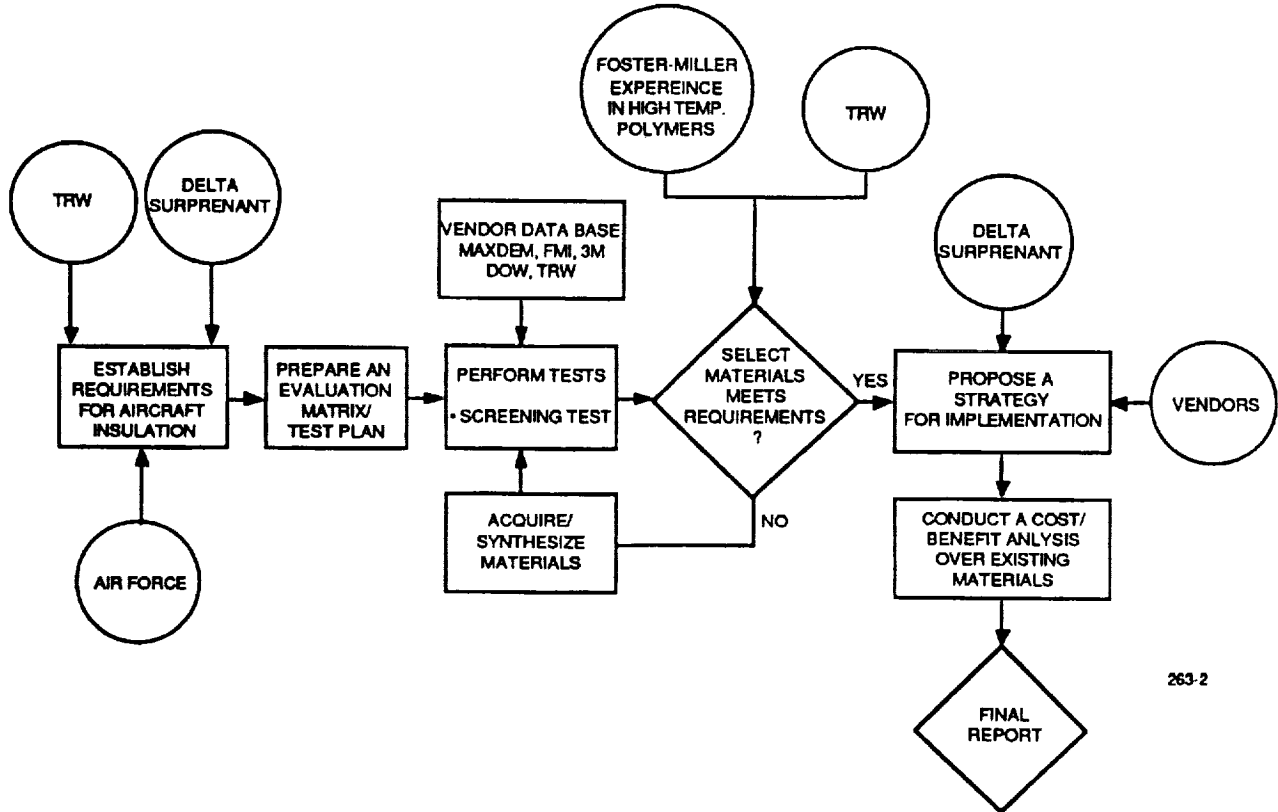
- **Related experience in**
 - **High temperature dielectrics for capacitors**
 - **Insulation for electromagnetic launchers**

APPROACH

- **Phase I**
 - **Identify key performance parameters and requirements for high temperature insulation materials**
 - **Prepare an evaluation matrix consisting of appropriate weighted coefficients for each performance parameter**
 - **Characterize each candidate material with a composite relative merit index (performance index) using the evaluation matrix**
 - **Select a small number of candidates that meet or exceed all requirements for further investigation**

- **Phase II**
 - **Thoroughly characterize selected materials**
 - **Develop methods to fabricate round and flat wire constructions**
 - **Evaluate materials in finished wire constructions**
 - **Pick one for incorporation into an airframe**

PHASE I PROGRAM PLAN



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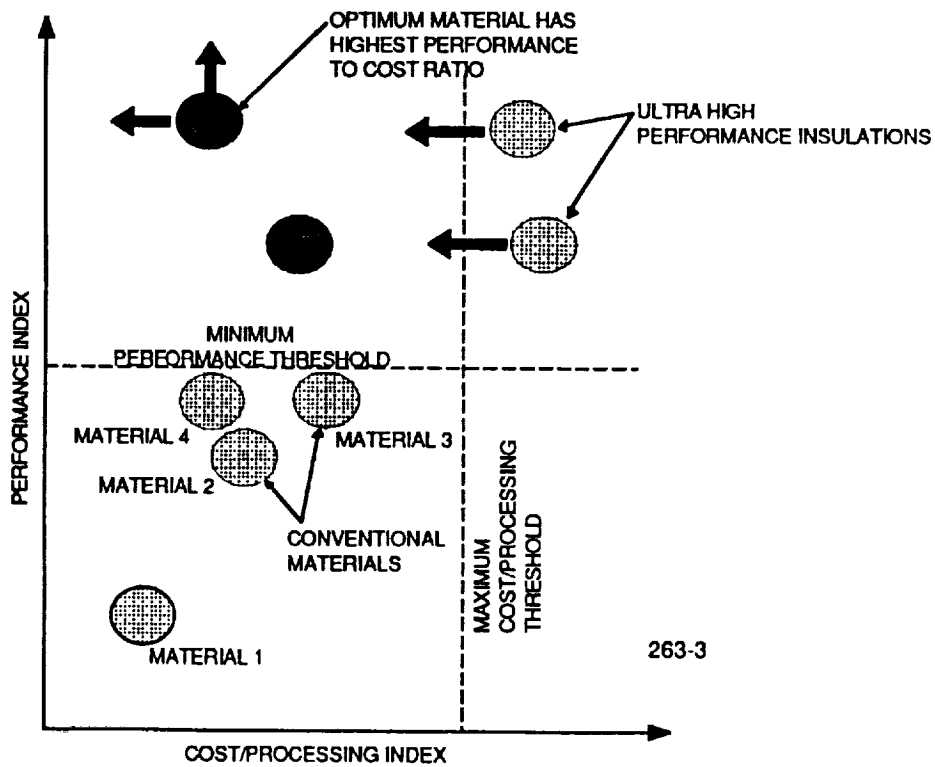
REQUIREMENTS/EVALUATION PARAMETERS

- **250°C+ temperature rating**
 - Thermal index
- **Dry arc resistance**
- **Voltage withstand, insulation resistance, flammability**
- **Toxicity, smoke quantity, . . .**
- **Retention of properties**
 - Abrasion, flex life . . .

MATERIALS UNDER CONSIDERATION

Material	Source	Advantages and Properties
Fluorinated PBO-PI	Hoechst Celanese	Combines processibility of polyimides with high temperature properties of LCPs
Thermoplastic PBO with hexafluorinated moieties	Material Lab, WRDC	Thermally processible, high temperature stability, $T_g > 380^\circ\text{C}$
Difluoro-PBZT, tetrafluoro-PBZT	Foster-Miller	High temperature stability, low dielectric constant
PQ-100 polyquinolines	Maxdem	Thermally processible, available in a number of configurations, high purity
PBO-fluorinated IPN	Foster-Miller	High temperature stability combined with resistance to flashover
PBO	Foster-Miller, Dow	Ultra high thermal stability $300 - 350^\circ\text{C}$ significantly exceeds the performance of Kapton and Tefzel
FPE proprietary aromatic polyester	3M	Readily available high quality aromatic films useful up to 250°C
Fluorinated polyimides	Hoescht-Celanese Ube/ICI DuPont	Readily available, from Ube/ICI, DuPont thermal stability exceeds Kapton and Tefzel
Polysiloxaneimides	McGrath, VPI	Resistant to ionizing radiation, high thermal stability
Fluorocarbon-hydrocarbon polymers	Tefzel, DuPont	Readily available, high quality films, moderate thermal stability
Organo-ceramic hybrid nano composites	Garth Wilkes, VPI	Resistant to ionizing radiation, high thermal stability, greater than 200°C
Polysilsequioxane	David Sarnoff Labs	Good electrical properties up to 250°C superior to Kapton and Tefzel, can dip or spray coat

ADVANCED INSULATION MUST MEET MINIMUM PERFORMANCE INCREASES OVER CURRENT MATERIALS AND BE AMENABLE TO LARGE-SCALE PROCESSING AT ACCEPTABLE COSTS



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