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DEVELOPMENT OF DESIGN DATA FOR PROPULSION PMR-15 COMPOSITES

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The continuing development of PMR-15 composite materials and their associated design properties is pacing the implementation of this technology on commercial aircraft.

The guidelines that the FAA has issued regarding the certification of advanced composite structures are very significant with respect to future PMR-15 research and development activities.

FAA GUIDELINES

The FAA has issued an advisory circular dated 1-5-83 concerning guidelines for composite aircraft structures. Of particular significance to PMR-15 technology development is the reliance on combined environmental exposure and component testing, coupled with the stipulation that reliance on previous experience be limited to where common structures and materials have been used for a similar function.

Critical environmental exposures for commercial propulsion structures include 50 000 cycle service life, exposure to skydrol, moisture and other fluids, and nacelle fire conditions.

The structures currently being considered for PMR-15 are shown in figure 1.

DESIGN DATA DEVELOPMENT

Boeing is in the process of investigating PMR-15 composite characteristics of greatest significance to propulsion structures including:

- Damage tolerance
- Thermo-mechanical durability
- Fire exposure performance

Figure 2 describes the results of a "through penetration" impact test on a B-3000/PMR-15 panel. Figure 3 demonstrates the "Post Impact Compression" strain capability of C-3000/PMR-15 under several conditions of temperature and fluid exposure.

Also under evaluation is the structural load carrying capability of Gr/PMR-15 panels damaged by fire. This information will allow the optimization of fire zone containment structures. The test fixture being used for the coincident application of fire and facesheet compression loads on a long beam bending sandwich specimen is shown in figure 4. Thermo-mechanical and thermo-oxidative durability and the effect of coatings and sizings has been addressed by C. Sheppard in a separate paper.

Given the guidelines recommended by the FAA, little of the large amount of information that is being, or has been generated regarding PMR-15 composites is of significance towards the certification of PMR-15 propulsion structures. The principal reasons for this are:

(1) Variability of PMR-15 composites

(2) Incomplete understanding of effect of resin chemistry and cure cycle on Thermo-mechanical stability of composites.

(3) No capability to predict change in composite properties with service conditions.

(4) Lack of service experience with representation structure and materials.

CONCLUSION

PMR-15 composites continue to show promise for application to commercial aircraft structure. However, at present PMR-15 structures are being built with considerable variety in specifications and procedure, the affect of which is not fully understood with respect to long term durability. Thus, this interpretation of the FAA guidelines implies that great expenses will be incurred by the industry in certifying these structures.

Critical needs for the efficient and effective implementation of PMR-15 composites to commercial aircraft include:

(1) Establishment of an industry standard regarding:

  (a) The control imposed by the materials and processing specifications on fibers, sizing, resin, and quality control.

  (b) The methods used to generate long term durability and damage tolerance data for high temperature composites.

  (c) The methods used to generate high temperature mechanical properties of high temperature composites.

(2) Compilation of an industry wide database for the principle PMR-15 resins and cure cycles in use.

(3) Development of capability to predict PMR-15 composite mechanical property responses to long term exposure to cyclic thermal environment, particularly with regard to damage and durability.

(4) Gain in flight service experience with representative structures.

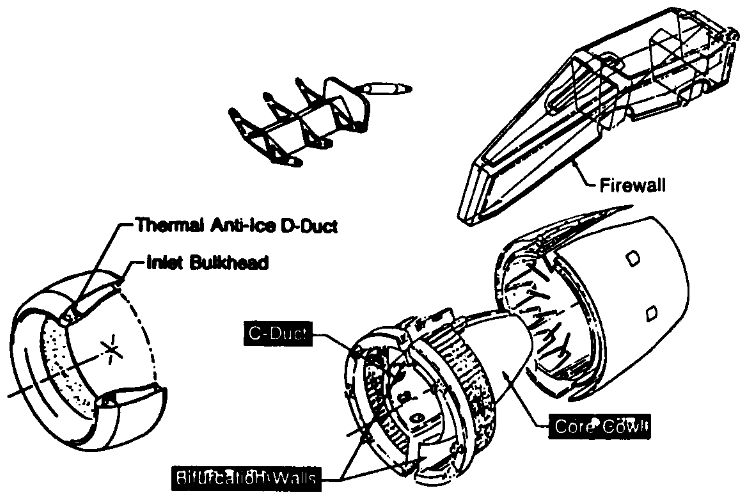

Figure 1. - PMR-15 applications.

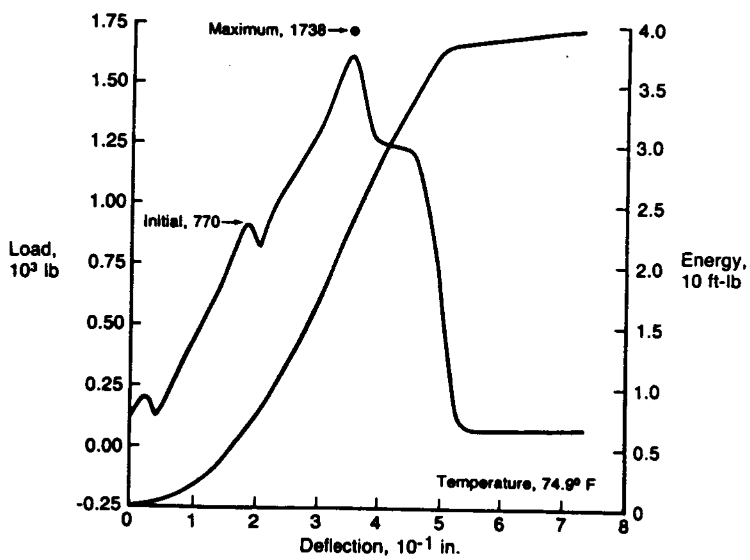

Figure 2. - Through penetration impact test.

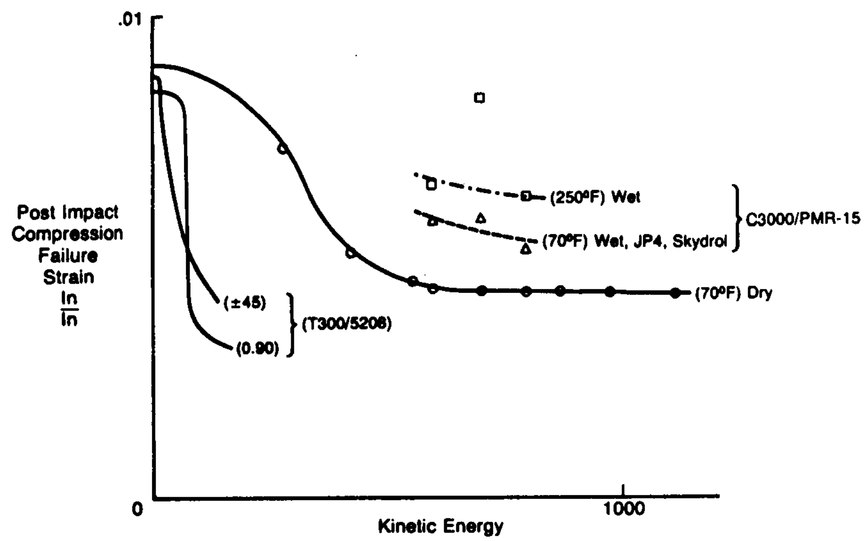

Figure 3. - Damage tolerance.

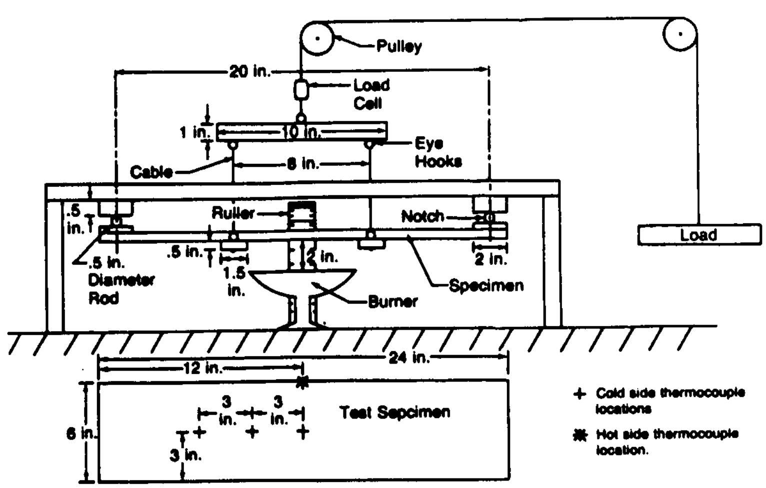

Figure 4. - Subcomponent hot side compression test rig. (900°F-2600°F.)