

Flywheel Safety and Containment Program

Project Objective

The objective of this project was to gain a fundamental understanding of composite flywheel failures leading to guidelines for safe design practices. To accomplish this objective, we conducted a combined experimental and theoretical program on flywheel failure, devised a basic methodology for design of containment structures and systems, and performed flywheel durability testing to assess both safety and performance issues over its rated service life.

Team Members

- University of Texas at Austin Center for Electromechanics
- Test Devices, Inc.
- AFS Trinity Power Systems,
- US Flywheel System
- Satcon/Beacon Power System
- Lawrence Livermore National Laboratory
- Oak Ridge National Laboratory
- Argonne National Laboratory
- Center for Transportation and the Environment (CTE)



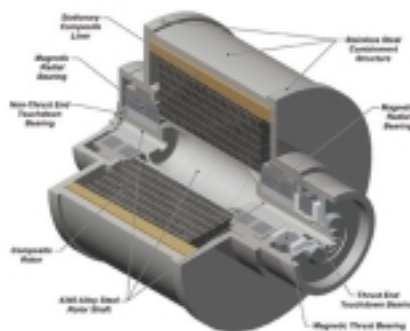
project overview

The Flywheel Safety Program has:

1. developed an understanding of flywheel failure phenomena,
2. developed rotor burst and instrumentation technology,
3. conducted flywheel failure tests,
4. developed an understanding of loads exerted on containment structures during flywheel bursts,
5. developed lightweight containment concepts,
6. tested containment structures, and
7. conducted cyclic testing to understand basic flywheel durability issues.

Attainment of this level of understanding of safety related issues has bolstered each participant's ability to pursue:

- Beta-site field testing of their flywheel systems
- Near-term flywheel system production programs
- Development of next generation flywheel.



Project Description

Flywheel energy storage systems, commonly known as flywheel batteries, are being developed for a number of power averaging applications in the utility, transportation, and space industries. Modern designs incorporate rotors made from composite materials for which operating experience is limited and little failure data is available. Given the large amount of energy stored in these devices, an engineering data base is needed to design adequate containment structures to insure safe operation in the event of flywheel failure. The Flywheel Safety Program provided needed design data.

This collaborative program combined the talents of a major commercial U.S. flywheel spin-test facility with researchers from a university, three national laboratories and two commercial flywheel developers. The group pooled resources and knowledge of various successful flywheel designs to develop an approach for design of composite flywheel containment systems. As a result of this program, lightweight containment structures are now available to allow safe field demonstrations of flywheels on hybrid electric vehicles.

Project Results

Among the research results are

- Accumulated published information on flywheel designs and containment approaches. The results of this investigation are available on the CTE website
- Conducted more than 45 flywheel tests, including spinning flywheels to failure to verify maximum operating speed, identify failure modes and structural margins, and evaluate safe operating design points
- Correlated analytical models with measured loads resulting from flywheel burst; Key information needed for the successful development of containment systems for vehicular applications.
- Tested candidate containment designs for several different flywheel designs
- One flywheel system, with light-weight containment, has been installed on a hybrid electric transit bus for Houston Metro Transit Authority
- Other flywheel systems, with development assistance under this program, are in commercial use for the UPS markets
- Demonstrated life of more than 100,000 cycles with a 50% DOD
- Developed general flywheel and containment design guidelines for safe operation.

The program activities resulted in flywheel systems with known lifetimes and known margins of safety at the end of their specified lifetimes. This information provides a solid technical basis for emerging flywheel applications for transportation and for space.

Next Steps

While this project provides the technical basis for the safe design of a flywheel system, there is also a need for appropriate standards. The standards are needed to assure the user that a system was constructed using the best technical information. So the near-term efforts are focused on the development of the technical standards.

