

# Energy Absorption and Vibration Isolation Components for Rotorcraft



# ROTORCRAFT COMPONENTS

At ITT we have an extensive list of equipment and testing services that offer us the flexibility to meet demanding application requirements for various rotorcraft designs. From custom elastomers to rate control and energy absorption devices we specialize in bringing the highest quality engineered components to market on time and under budget.

**We partner with you to solve your most demanding rotorcraft application requirements.**

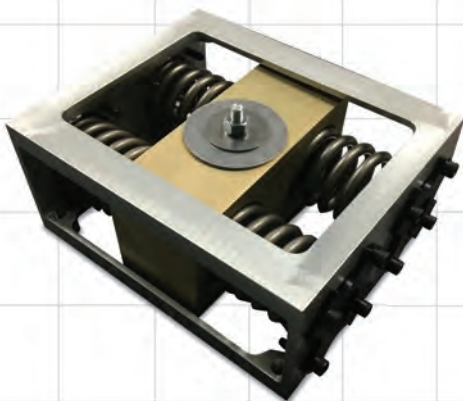
## High Capacity Laminated (HCL) Bearings



ITT Enidine's high-capacity laminated elastomeric bearings are needed in transmissions and rotor systems. These devices are used to support loads in-flight critical assemblies as well as transmit loads and motion to the blades of the helicopter. These HCL bearings provide a high stiffness in one or combined directions to take loads, while lowering stiffness in other directions allowing for motion.

- Reduce in-flight vibration — Stiffness and damping are engineered for each application
- Longer life than traditional bearings — Resistant to dust, debris and fluids
- Improve the reliability of other aircraft systems
- Easy inspection — Visual inspection indicates approaching end of life
- Utilized for flapping and blade retention on the tail rotor
- Reduced maintenance — Require no lubrication

## Frahm Damper



A Frahm is a dynamically tuned vibration absorber, used on helicopter airframes and rotors to reduce the vibration for pilots and passengers. Used on helicopters for vibration reduction for over 50 years, consist of:

- **Mass** – Typically designed from high density metals to optimize design space, such as tungsten
- **Springs** – Designed and selected to match the n/rev frequency in conjunction with the mass
- **Enclosure** – Used to house components and fasten the Frahm to the aircraft structure
- **Bushings** – Center springs in mass and enclosure
- **Tuning Washers** – allow for tuning the Frahm to precisely match the required frequency. Frahm mass resonates at a particular (tuned) frequency that is undesirable for a structure. This force of the resonating mass counteracts the undesired vibratory forces on a structure to reduce these forces ( $\square F=ma$ )



## Interior and Equipment Isolators

ITT Enidine has designed an advanced interior panel isolator that is a drop-in replacement of standard interior panel isolators.

- Support equipment and interior panels from the aircraft frame/skins
- Dynamic isolation in all degrees of freedom extending the lifespan of isolated equipment
- Provide structureborne noise attenuation such that the cabin noise objectives are reached
- Integrated washer with large mounting face and a taller stem to eliminate misalignment during installation
- Fail-safe torque resistance



## Strut Integrated Isolator

ITT Enidine has developed a patented, strut-integrated isolator that offers weight, performance and system integration benefits when compared to traditional isolation systems for engines, APUs and sub-systems.

- Multiple systems delivered
- Engine and APU installation and tests have confirmed exceptional performance
- Certification approved, production delivered
- Stiffness reduced no more than 6% for a total of 2 endurance lives
- Linear load vs. deflection curve, leading to better vibration isolation and noise attenuation performance compared to traditional configurations
- Fail-safe design and construction



## Hydraulic Control Dampers

ITT Enidine is globally recognized as the preferred source for energy absorption and hydraulic motion control products. Our experience designing, developing and manufacturing an array of products allows us to utilize that experience into a variety of markets. We have over 5 decades of experience with military and commercial aerospace shock and vibration isolation in the hydraulic market. Many standard designs are capable of >1 million operating cycles without the loss of fluid or performance due to sealing technology and experience.

- Mitigate bio-mechanical feedback of helicopter collective controls
- Provide pilots with precise resistance for controls
- Prevents jamming or high-stiffness in pilot controls with fail-safe design
- Hydraulic dampers are custom designed per application requirements for opening or closing actuation or rate control of cowl and doors

## Engineering Capabilities

ITT Enidine uses NEi Nastran software with Femap for dynamic non-linear, 6-DOF system analyses in conjunction with FEA analyses on complex 3D parts, assemblies and systems.

In addition, we have developed proprietary closed form analytical programs to predict the non-linear performance of our products.

ITT Enidine developed system equations in MatLab® and Mathcad® to simulate non-linear performance and predictive analysis.

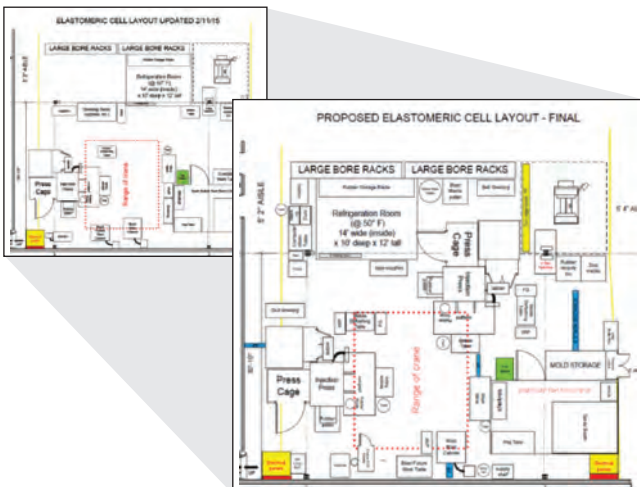


## Manufacturing Capabilities

ITT Enidine has an in-house molding facility for rapid prototype development and manufacturing. This provides the ability to move quickly through the process development and evaluation phase of a project.

- High Pressure Dual Ram Transfer Presses
- High Volume Injection Presses
- High Force Injection Presses
- Custom ITT Compound Formulations
- Contained Adhesive Spray Booths and Metal Prep

ITT Enidine is doubling the production capacity dedicated to elastomers and associated technology.

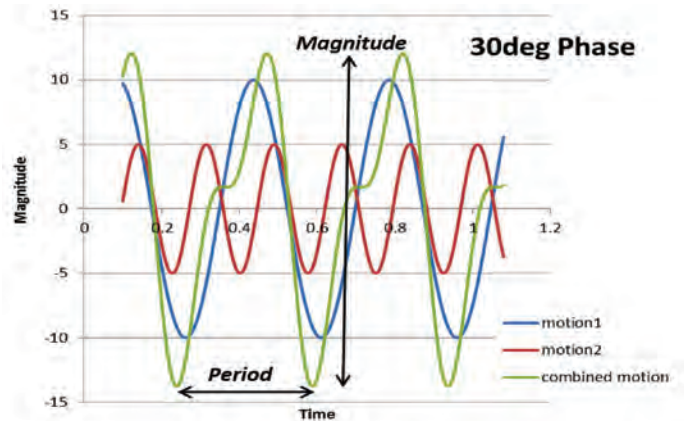


## FUTURE TECHNOLOGIES

### Lead Lag Dampers



The current technologies for lead-lag dampers are pure orifice or shearing hydraulic dampers, visco-elastic (molded silicone elastomer), and hybrid (both elastomeric and hydraulic components in a damping system). The type of technology used for lead lag dampers is a function of the rotor system design. One of the nuances of dual frequency, harmonic motion is that the combined motion can vary substantially with the relative phase of the in-plane and out-plane rotor motions. The elastomer damping characteristic responds to the frequency and magnitude of combined motion.



### Investment in Lead Lag Technology

ITT Enidine has invested in a specialized test machine for these dampers:

200 Hz, 5.5 kip, MTS tester.  
Two transverse axis with dual frequency and phase control.



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