Agenda

- **Overview of the F-22A Gun System**
- **Comparison to Legacy Gun Systems**
- **Application of Composite Materials**
- **Lightweight Composite Conveyor Element**
Background Information

- Developed for Lockheed Martin during the mid-1990s.
  - Low weight and tight envelope requirements
  - High stiffness requirement – container supported at the ends
- Incorporated new technologies
  - Extensive use of composite materials
  - Semi-flexible recoil track; single conveyor stores & transfers ammunition to/from the gun
  - Lightweight composite conveyor element
M61A2 20mm Gun and F-22A Lightweight Linear Linkless Ammunition Handling System

- M61A2 Gun
- Ammunition Transfer Unit
- Recoil Track Assembly
- Linear Linkless Ammunition Container
LLAHS Overall Size

- Length: 99.8” (2,534.9mm)
- Height: 73.1” (1,856.7mm)
- Width: 44” (1,117.6mm)
- Width: 9.1” (232.2mm)
- Width: 9.3” (236.7mm)
F-15E, F-16, and F/A-18 E/F Gun Systems

F-15E
Linear Linkless, Closed Loop Ammunition Handling System
Mainly Metallic Construction

F-16 & F/A-18 E/F
Rotary Linkless, Closed Loop Ammunition Handling System
Mainly Metallic Construction
## Specifications and Weight Comparisons of 20mm Aircraft Gun Systems

<table>
<thead>
<tr>
<th>SYSTEM DESIGNATION:</th>
<th>F-22A</th>
<th>F-15E</th>
<th>F-16</th>
<th>F/A-18 E/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed System Type (closed loop)</td>
<td>Linear</td>
<td>Linear</td>
<td>Rotary</td>
<td>Rotary</td>
</tr>
<tr>
<td>Ammunition Capacity</td>
<td>480</td>
<td>500</td>
<td>511</td>
<td>412</td>
</tr>
<tr>
<td>Gun Type</td>
<td>M61A2</td>
<td>M61A1</td>
<td>M61A1</td>
<td>M61A2</td>
</tr>
<tr>
<td>Firing Rate (shots/minute)</td>
<td>6000</td>
<td>4000/6000</td>
<td>6000</td>
<td>4000/6000</td>
</tr>
<tr>
<td>Empty System Weight (pounds)</td>
<td>378</td>
<td>484</td>
<td>506</td>
<td>451</td>
</tr>
<tr>
<td>Gun Weight</td>
<td>202</td>
<td>248</td>
<td>248</td>
<td>202</td>
</tr>
<tr>
<td>Feed System Weight (pounds)</td>
<td>176</td>
<td>236</td>
<td>258</td>
<td>249</td>
</tr>
<tr>
<td>Feed System Weight Delta from F-15E (pounds)</td>
<td><strong>-60</strong></td>
<td>0</td>
<td>+22</td>
<td>+13</td>
</tr>
<tr>
<td>System Specific Capacity (lbs/rd)</td>
<td><strong>0.79</strong></td>
<td>0.97</td>
<td>0.99</td>
<td>1.09</td>
</tr>
</tbody>
</table>
F-22A Ammunition Container Assembly Line Replaceable Unit (LRU) Makes Extensive Use of Composites

- Compression Molded Lytex™ 4149 Turnaround Guides and Edge Closeouts Bonded to Panels
- Semi-Flexible Recoil Track Assembly Allows Conveyor Belt to Recoil with the Gun
- Top and Bottom Covers and Side Panels Constructed of Glass/Carbon/Epoxy Face Sheets with Aluminum Honeycomb Core
Hydraulic Drive, Container Drive Shaft, and Transfer Unit LRUs

These LRUs Use Conventional Metal Construction

Hydraulic Drive Assembly

Transfer Unit Assembly

Container Drive Shaft
Compression molded Lytex™ 4149 Edge Closeouts Form Panel Perimeter

Glass/Carbon/Epoxy face sheets are pre-cured and secondarily bonded to edge closeouts and honeycomb core
View Inside Showing Ammunition Container Side Panel with Serpentine Path

Compression Molded Lytex™ 4149 Turnaround Guide is Bonded to a Composite Track Panel

Lytex™ 4149 Edge Closeout

Glass/Graphite/Epoxy Track Panel

Glass/Graphite/Epoxy Face Sheets

Lytex™ 4149 Edge Closeout

CROSS SECTION OF TRACK PANEL

Aluminum Honeycomb Core
Ammunition Storage and Transfer Schematic

- A continuous conveyor belt with 473 conveyor elements transfers ammunition to the gun and transfers fired cases back to the ammunition container.

- The recoil track allows the conveyor belt to recoil with the gun during firing and permits container installation & removal.
Recoil Track Collapses onto Container to allow Installation and Removal
Injection Molded Conveyor Elements
PEEK™ with 30% Carbon Reinforcement
View of top row of conveyor belt in ammunition container with cartridges
Key Suppliers of Composite Components

- Quantum Composites – Bay City, MI
  - Supplier of Lytex™ 4149 material
- Parkway Products Inc. – Erlanger, KY
  - Lytex™ 4149 compression molded parts
- Midwest Plastic Components – Minneapolis, MN
  - PEEK™ with 30% carbon fiber injection molded conveyor elements
- Neptune Precision Composites – Jacksonville, FLA
  - Fabrication of composite panel assemblies
- GDATP – Saco, ME
  - Structural and final assembly