Defense Logistics Agency (DLA) & Navitas System’s Starlifter Lithium Forklift Trials @ DLA Susquehanna

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Director of Government Programs
Navitas Systems
Problem Statement

• Material-handling speed and efficiency is essential in keeping our Warfighters well-supplied
Problem Statement

- Susquehanna is DLA’s largest single worldwide site
  - 10 million square feet of storage space
  - Fundamental/pivotal role in supplying our warfighters
The First Military Transport Jet to Transcend The Propeller Age: Starlifter

Douglas C-133 Cargomaster

Lockheed C-141 Starlifter
The First Lithium Battery to Transcend The Lead Acid Forklift Age: Starlifter
Starlifter Product Overview

- **Counterweight Tray**
  - Weight and Footprint Replacement For Lead Acid battery packs
- **ESS Battery**
  - 24V, 36V, 48V, 80V Battery Packs
- **Navitas-Designed Custom Battery Management System**

**UIM (User Interface Module)**
- Visual and Audio Indicator of lithium battery pack information for truck operators
- Provides warnings for low state of charge and faults
- Diagnostics information display
Technical Approach

6 Lead Acid-Powered Crown vs 6 Starlifter Lithium-Powered Crown Forklifts

Fully-Instrumented One Year Trial Program @ DLA Susquehanna
Project Team Participants

• Defense Logistics Agency
  – DLA Headquarters – Ft. Belvoir, VA
  – DLA Distribution – Susquehanna, PA
• Navitas Systems
• National Center for Manufacturing Sciences (NCMS)
• Analytic Strategies LLC
Project Overview


Video Made by:
Overall Benefits

Lead Acid

Goes in Once; Never Leaves the Forklift

Driver Downtime

Spare Batteries, Change Eqt. & Personnel

Comes in/Goes out 3 Times/Day

Starlifter Lithium

Goes in Once; Never Leaves the Forklift
Overall Benefits

Lead Acid

Racks of Lead Acid Batteries & Chargers—8 Hours Charge + 8 Hours Cooldown

Starlifter Lithium

Starlifter In-Truck Opportunity Charging

8 Hours
Overall Benefits

Lead Acid

Constant Maintenance

Starlifter Lithium

No Sulfuric Acid/No Maintenance--Smart Battery Management System
Overall Benefits

Lead Acid

*Hazardous Sulfuric Acid*

Starlifter Lithium

Safe/Sealed Lithium Iron Phosphate + Onboard Battery Management System
Overall Benefits

Lead Acid

Starlifter Lithium

More Run-time in Cold Temps

40% more run time
Overall Benefits

Lead Acid

Starlifter Lithium

2-3X Cycle Life Improvement

Degraded Performance & Life
Overall Benefits

Weak vs Strong Voltage

A Lightbulb Analogy

Voltage Sag Leads to Slower Lifts as Height Increases and Time Elapses into Second Shift

Higher/Strong and Consistent Voltage Leads to Faster Lifts at Greater Heights and throughout the Shifts
The Starlifter Difference: Constant/Strong Lifting Speed --All the Way Up; And all the Way Through Each Shift

Even at Low State of Charge, the Starlifter Pulls Like a New 100%-charged Lead Acid Battery
Example Lift Test
@ Major Consumer Good Mfg.

See video at www.lithiumforkliftpower.com
Project Status

• Data Collection only recently commenced on 3/23/17
• Following charts show data collection at major NY food cold distribution warehouse from independent study of Lead Acid vs Starlifter Lithium forklifts funded by the state of New York (NYSERDA)
Starlifter and Old/New Lead Acid Batteries Lift Similarly Up to 100’
Past 100” Starlifter Lithium Lifts Both Faster and Consistently

- Starlifter lift speed remains faster/consistent throughout repeated cycling.
- Lead Acid lift speed is slower, and declines through repeated cycling.
Starlifter Lithium Power Equals Increase Productivity – Lithium Lifts Loads Both Faster and Consistently

Lift Duration with 1000 lb load

Lead Acid gets to 300” slower, and take longer throughout repeated cycling

Starlifter gets to 300” faster & consistently

Lifts to 300”

Lifts to 100”
Driver Opinions of Lead Acid vs Lithium

Answer the following question comparing Lead-acid battery against Lithium Ion powered forklifts using a scale of 1 to 3.

1 – Lead-acid batteries outperform Lithium Ion Batteries
2 – No difference
3 – Lithium Ion Batteries outperform Lead-acid batteries

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<th>Category</th>
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<td>Power</td>
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<td>Forklift Range</td>
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<td>Consistent speed</td>
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<td>Load Capacity</td>
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Comments/Observations:

Did you feel overall the lithium battery improved your productivity on the job? (circle your response)

1) No, it was worse  2) Hard to tell  3) Definitely

After your experience with Lithium batteries, given a choice between a lead acid powered truck and lithium truck, which one would you request? (circle your response)

a. Lead Acid
b. Lithium
Starlifter Lithium Power Means More Pallets Moved Per Hour

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<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
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<th>Week 4</th>
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<tr>
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<td>708</td>
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<td>avg #p/hr</td>
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<td>17</td>
<td>20</td>
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<th>Total</th>
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<tbody>
<tr>
<td>F102 - LIB pallets moved (#p)</td>
<td>921</td>
<td>730</td>
<td>711</td>
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<td>avg #p/hr</td>
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17% Increased Pallets Moved Per Hour

More Work Done in Less Time With Less Energy Consumed
Safety Testing
UL Safety Video

- Nail Penetration into side of Starlifter Lithium pack to penetrate cell & create a short-circuit
  - Starlifter Passed Short Circuit Test With Flying Colors
    - Minimum whiff of smoke @ 1 minute mark
    - No thermal runaway
    - Rest of Battery System behaved normally
What’s Ahead

• Expansion of Trial to DLA San Joaquin
  – 2nd Largest DLA Site
  – Cold Storage of Food and Use of Propane Forklifts
Out with the Old, In with the New!

www.liithiumforkliftpower.com
Navitas & The Gov’t & Military
Proud to Serve!

- Centurion Telecom Lithium System
  Providing Back up Power for FAA

- Centurion UPS Lithium System
  Providing Back up Power for NASA

- Safe High Energy Cell for Navy F18

- Lithium Sulfur Battery for F35

- Novel “Round Cell” For Tubular Applications

- Passed NAVSEA Testing

- Ultanium 6T Lithium Military Vehicle Battery

- Vehicle to Grid (V2G) System
  ESU + TVGM on skid in back of HMWV

- Navitas ESU

- United States Army

- NASA