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Issues and Challenges of Becoming a Domestic Source for Military Batteries

NAATBatt 2020 Annual Conference • Pasadena, CA

February 11, 2020

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History: Wanxiang Wants A123 Acquisition

June 2012

MIT Technology Review

ENERGY NEWS

19 COMMENTS

A123's China Deal Is the Latest Energy Controversy

Some observers are alarmed that the federally backed battery maker A123 Systems could soon be owned by the Chinese. But did the company have a choice?

By Martin LaMonica on August 13,

The cash-strapped battery maker, which last month said it had only enough money to last through October, reached an agreement with the auto parts division of Wanxiang that would give the Chinese company a controlling interest. The deal, which the companies hope to close by the end of the year, is structured to provide A123 Systems with much-needed cash for operations in the months ahead and then give Wanxiang the ability to buy warrants that would be converted into stock. If the Chinese and U.S. governments approve the deal, it would give Wanxiang about 80 percent ownership for a $450 million investment.

History: US Gov't Stops Sale

THE HILL

December 07, 2012, 09:15 pm

Review of A123 sale critical to national interest

On the military front, A123 Systems' contracts with the Defense Department provide automotive batteries and durable energy supplies for deployed U.S. combat troops. For example, A123 Systems' equipment and technology are used in unmanned aerial and underwater vehicles and portable energy grid systems at forward operating bases. Already a group of former senior U.S. military leaders and industry experts, the Strategic Materials Advisory Council, has expressed grave concerns about the security risks of an acquisition by Wanxiang. As the United States re-balances its global force posture and increases its focus on the Asia Pacific region, it would be the height of folly to allow a Chinese company – and potentially the Chinese military – to gain insight into, and access to, critical U.S.energy-related capabilities.

History:
Navitas Keeps Top Battery Scientists Under US Roof

denverpost.com

Navitas Systems acquires A123's government, research side

Melissa Burden / The Detroit News

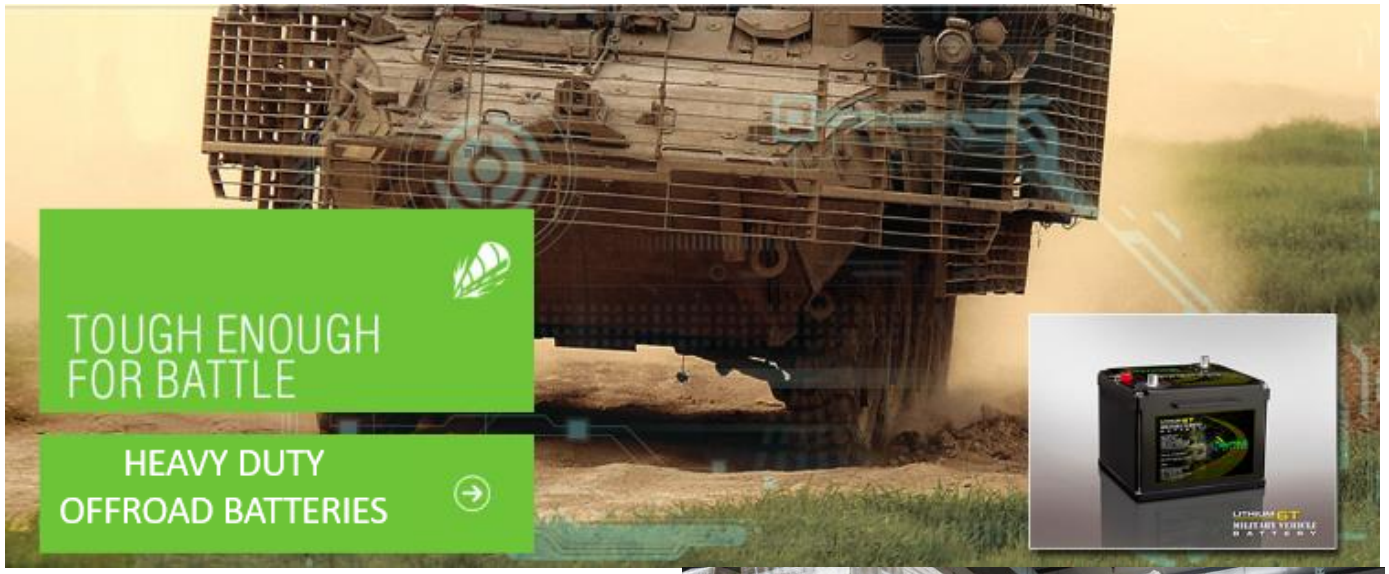
POSTED: 01/29/2013 02:54:07 PM MST

Ann Arbor - Navitas Systems LLC plans to bring on board about 40 A123 Systems Inc. employees in southeast Michigan, following its $2.3 million acquisition of the government and research side of the battery maker's business.

Woodbridge, Ill.-based Navitas Systems' was the winning bidder in a December U.S. Bankruptcy Court auction for the government side of A123 Systems' operations. Wanxiang America Corp., a Chinese company, won the majority of A123 Systems' business, including its automotive lithium-ion battery business.

On Tuesday, the Obama administration approved the A123 Systems' sale to Wanxiang, and the companies closed their deals late Tuesday.

Our Passion: Make Tough Batteries for Critical Niches



TOUGH ENOUGH FOR YOUR APPLICATION

Our Businesses

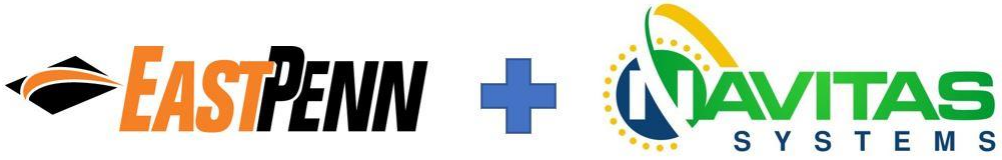
Navitas is comprised of three business lines.

Commercial	Government		Advanced R&D
			
Lithium Forklift Batteries STAR LIFTER	Lithium Heavy Duty Vehicle Batteries	Advanced Lithium Cell Manufacturing	Research Contracts

Navitas Capabilities

	Cell and Advanced Chemistry R&D and Processing	Analytical and Testing	Custom Cell Development & Manufacturing	Battery Management Systems (BMS)	System Design and Assembly	Lithium Battery Solutions
Capability						
Scope	• Wet lab • Controlled atmosphere tube furnaces for synthesis • Custom anode, cathode, and electrolyte development • Battery materials and concepts evaluation • Advanced Chemical processing	• 500+ MACCOR test channels • Environmental control -70 to +200°C • Electrochemical Impedance Spectro-scopy • Scanning Electron Microscope with elemental mapping and inert gas sample transfer device • Analytical chemistry instrumentation • Cell deconstruction analysis	• Prismatic cells • 2x3 to 20x20 cm form factors • In house slot-die coating • 650 sq. ft. dry prototyping room • 10k sq. ft. dry room for midscale production • Various Li-ion chemistries developed • Extreme high power and high energy density chemistries available; 100-600 Wh/L	• Custom PCBA and wiring harness design and assembly • In-house SMT line for quick turn and low volume prototyping • Customized configurable software developed in house • Box builds	• Cell form factor and chemistry agnostic • >1kWh solutions • System mechanical and electrical design • Custom power electronics • Finite element analysis • Thermal modeling • Prototype and low-volume assembly in house	• Custom battery development, prototyping, and manufacturing • 24V NATO 6T Battery • Multi-kWh motive application batteries • PowerForce™ Idle Reduction Battery • Frontierion™ Photovoltaic Interface + Energy Storage • Mission-critical UPS Systems

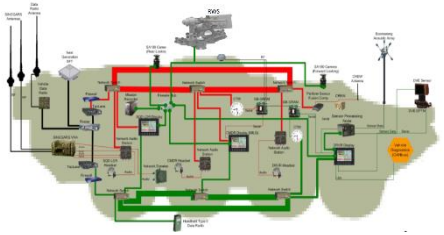
And Even More Capabilities…



- **East Penn is largest privately-held lead battery company in North America**
  - Leadership share in forklift and automotive batteries
- **Navitas Systems is a leader in specialized lithium**
  - Advanced lithium R&D, automated manufacturing, and leadership in lithium forklift and military batteries
- **Both companies announced acquisition by East Penn of majority interest of Navitas on August 16th 2019**
  - Navitas company structure/team stay fully intact

Challenges for Better/High Performance Batteries

- **Greater Power Demands Across DoD Branches**
  - **Sea**
    - Sonobuoys
    - Small Submarines
    - Directed Energy
    - Catapults
  - **Land**
    - Increased onboard electronics systems
    - Silent Watch
    - Soldier Portable
  - **Air**
    - Small UAVs
    - Lead and NiCAD battery replacement on helicopters/planes
    - Directed Energy
  - **Space**
    - LEOs
    - GEOs



White Space Performance List

- High Energy Density System (300 Wh/kg+)
  - Long run time/reduced weight
- Safe
- Fast Charging
- Wireless Charging
- Smart BMS/User Interface
- Meet MIL Stds.
- Compatible w/Existing Systems

Every ounce and every watt hour counts!

Need for Domestic Sources

- **Dependence on foreign sources presents problems[1]**
  - **Configuration control**
    - **Potential for materials not validated to military specs to enter the supply stream**
  - **Surge capacity**
    - **War-time battery demand can increase by over 20X that of peace-time demand**
    - **No guarantees that global commercial sources can be diverted in time to meet demand**
  - **Long lead times**
    - **Chinese Government pushing its Li Ion manufacturing base to grow from current 55% share of global market to 90% share**
    - **US based companies have been denied the ability to order material due to lack of available volumes**
    - **Disruptive future events (e.g. "Coronavirus")**

[1] Gietter, Marc D. "Viewpoint: Offshore Battery Production Poses Problems for Military". *National Defense*, 8 November, 2018. https://www.nationaldefensemagazine.org/articles/2018/11/8/offshore-battery-production-poses-problems-for-military

Enablers for Domestic Source Development

- **Recommendations for Government [2]**
  - **Increase investment in R&D to make state of the art technologies as affordable as possible**
    - **Result in increase in commercial interest and demand for these batteries**
  - **Support transition of these technologies into production**
    - **Bridge the "valley of death" between mid-TRL and production**
    - **Fund manufacturing technology development**
    - **Ensure the investment is utilized for specific DOD needs**
  - **Support and sustain the capacity once established**
    - **Reduce industry reluctance by awarding long term contracts**
  - **Specific college programs geared to energy storage engineering**

[2] Gietter, Marc D. "Viewpoint: Offshore Battery Production Poses Problems for Military". *National Defense*, 8 November, 2018. https://www.nationaldefensemagazine.org/articles/2018/11/8/offshore-battery-production-poses-problems-for-military

Enablers for Domestic Source Development

- Recommendations for domestic battery manufacturers
  - Understand the applications deeply
  - Understand which chemistries are best optimized for a particular application
  - Test test test before committing to locked-in design
  - Have the necessary infrastructure to scale-up with quality and cost in mind
    - Interaction between chemistry and the line
    - Design production line for safety
  - Maintain vertically integrated development capabilities
  - Strong domestic and friendly country supplier partnerships

Vertically Integrated Advanced Solution Development

Powder to Pack Capability is Key

Powder Development

- In -house mixing testing capability
- Development of Source Control Specifications
- High-volume, world-class, electrode coating partners

Cell Design and Assembly

- In house automated assembly
- Filling and formation
- Testing validation

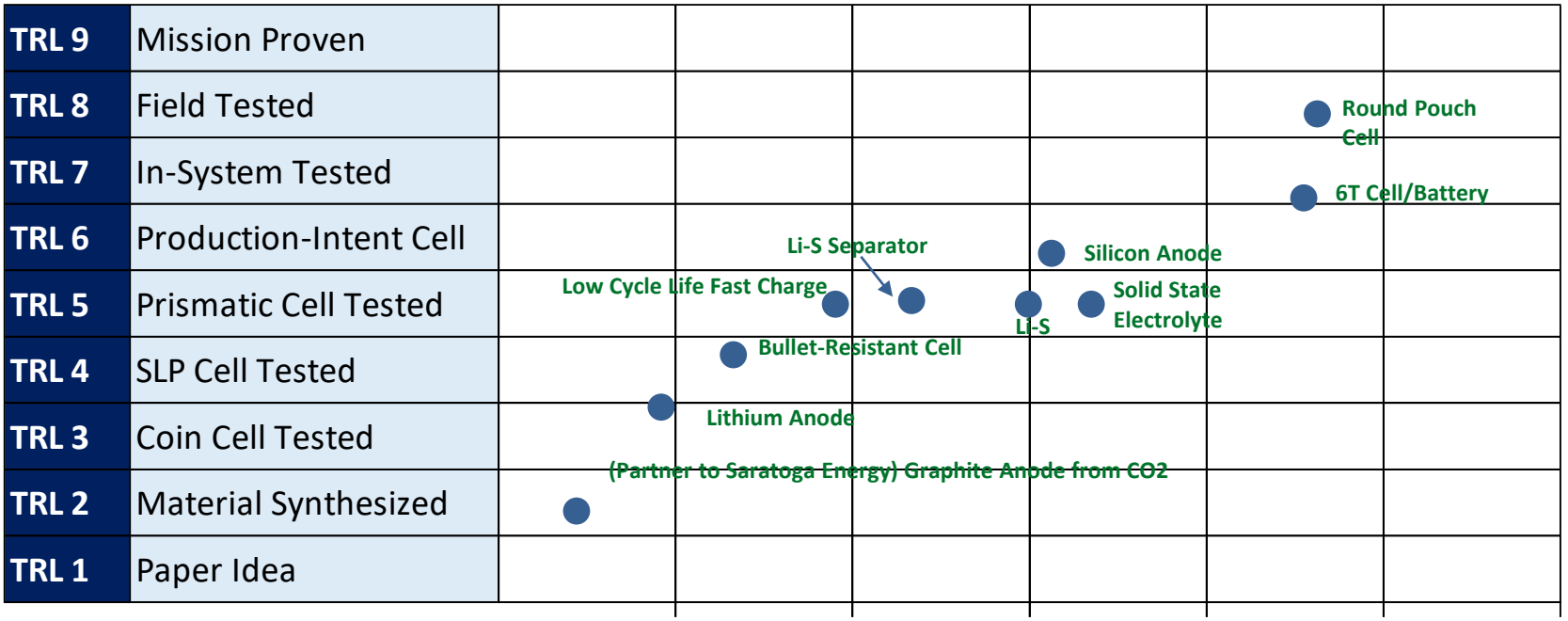
Module Design and Assembly

- Case and housing design and sourcing
- Tab Welding
- Stacking

Pack and BMS design and assembly

- State of the Art BMS designs
- Modular, configurable
- NAVSEA S9310 experience
- MIL-STD-810 test methods

Navitas Advanced/"Beyond Lithium" Tech Development in the White Spaces



What Can Be Produced?
Design Capabilities - “Horses are for Courses”

- Standard or custom sizes and form factors
- Turn key development, or build to customer specifications
- Prismatic and exotic geometry cells
- Pouch cells and metal can cells
- High speed assembly of pouch cells
- Non-commercial chemistries and designs for extreme applications

- Standard or Advanced lithium-ion cell chemistries:

Graphite, Silicon, LTO anodes

LFP, NMC, NCA, LCO, High V cathodes

- High power density to high energy density cells:

60 Wh/kg high power → 300+ Wh/kg high energy

Prismatic Pouch Cell

Round Pouch Cell

Cell Assembly

Custom Cell Assembly

Development and Prototyping

NEW!

Automated Assembly

Cell Assembly Summary

Navitas Systems' cell production line fills an important gap in the marketplace

- Defense customers who want to buy more than just standard battery sizes, form factors, and chemistries from large battery companies
- Defense contractors intrigued by new battery technology coming from small innovative battery companies who can't scale their innovation into meaningful production

Automated Lithium-Ion Cell Assembly

- Highly flexible in terms of size and shapes producible
- Current emplacement supports production of 500k cells/year
- Future expansion:
  - Add equipment to achieve 1.5M cells/year

Battery Pack Assembly

- BMS PCBA and control software design, validation and production
- Pack design, development and production
- Automated assembly line started up in 2019

Navitas Lithium-Ion Cell Assembly Line Overview

- High speed production equipment
- NATO member country source
- Highly flexible; rapid tool change over

- Initial production capacity:
  600,000 (4Ah) cells per year (9 MWh)
- Expandable to 1.5M cells per year (22 MWh)

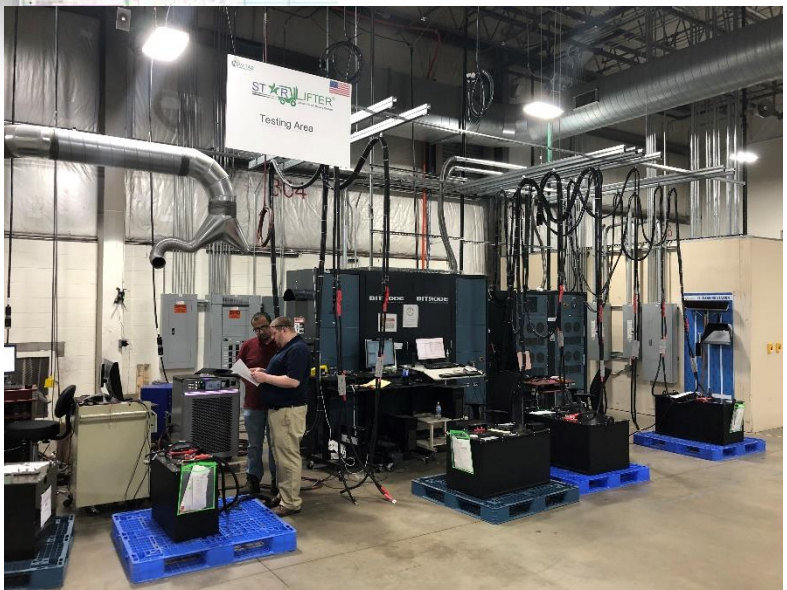
Navitas Lithium-Ion Cell Assembly Line Overview

- Size range: 20 x 30mm ↔ 200 x 200mm
- Form factor flexible: square, prismatic, notched, curved, or arbitrary-shape cells
- “3D” cells possible

- High volume electrode coating with partner
- ISO 9001:2015 registered
- ITAR-compliant, controlled access facility
- Expert development and support team

Serving Government Agencies; DOD Primes and Subcontractors; and Specialty Commercial, Medical, and Industrial Users

Vast Test Infrastructure



Designing to Meet MIL Standards

Example: Over 125 Tests of 6T!

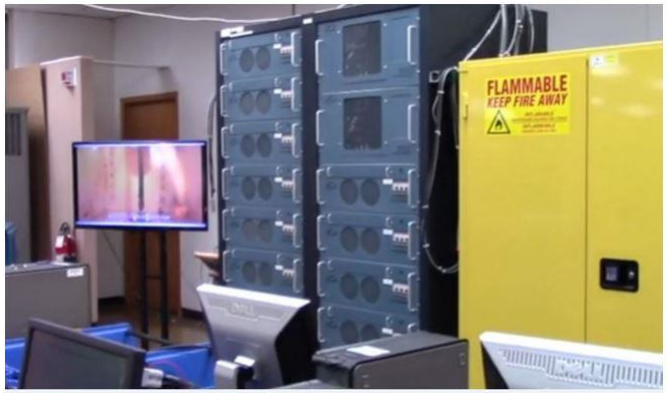
NAVITAS SYSTEMS

MY 2019 Applications: MGV

Item No.	Procedure or Standard	Test Description
11	MIL-PRF 32565A 3.3.4.1	Cell Protective Covering
12	MIL-PRF 32565A 3.3.4.2	Cell Leakage
116	MIL-PRF 32565A 3.11.1.1	Cell Safety Abuse Test
117	MIL-PRF 32565A 3.11.1.1.1	Cell Over-charge
118	MIL-PRF 32565A 3.11.1.1.2	Cell Short Circuit
119	MIL-PRF 32565A 3.11.1.1.3	Cell Over-Discharge
120	MIL-PRF 32565A 3.11.1.1.4	Cell Penetration
121	MIL-PRF 32565A 3.11.1.1.5	Cell Crush
122	MIL-PRF 32565A 3.11.1.2	Cell Leakage

...

137	MIL-PRF 32565A 3.13	Charger Compatibility
138	MIL-PRF 32565A 3.14	Workmanship
139	MIL-PRF 32565A 3.15.1	Paint, Protective Finishes, & Coatings
140	MIL-PRF 32565A 3.15.2	Corrosion Resistance
141	MIL-PRF 32565A 3.15.3	Electronic Assemblies
142	MIL-PRF 32565A 3.15.4	Hazardous Materials
143	MIL-PRF 32565A 3.15.5	Chemical, Biological, Radiological, & Nuclear (CBRN)
144	MIL-PRF 32565A 3.16	Defects



Navitas On-site Abuse Testing

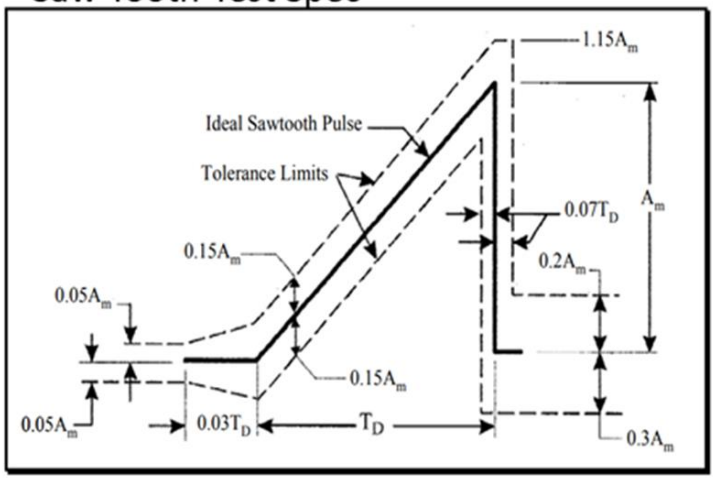
Schedule: QPL Testing start target late Q4 CY2020

Validation Requirements Require Upfront Analysis

- **MIL-STD-810 Test methods**

Shock

Saw Tooth Test Spec



Vibration

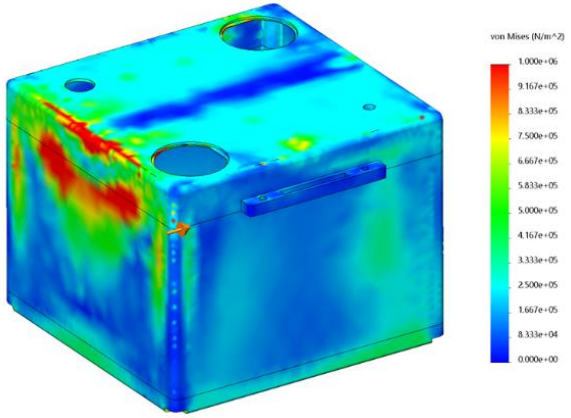
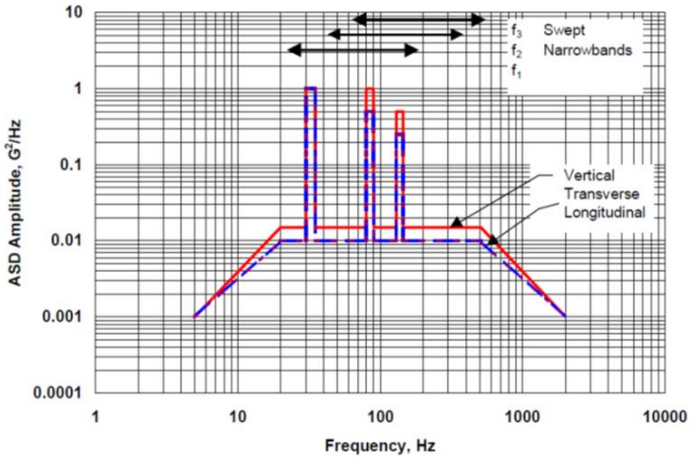
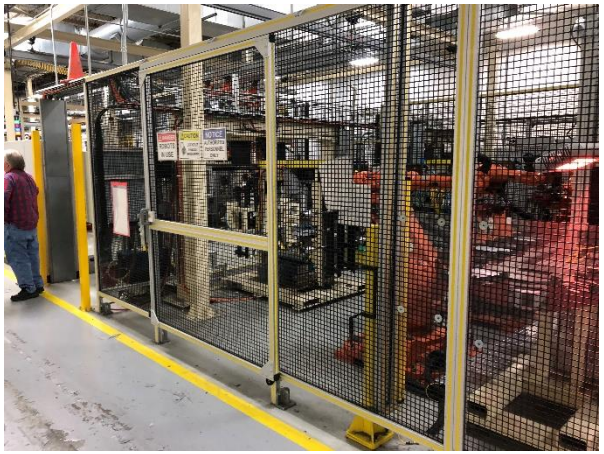
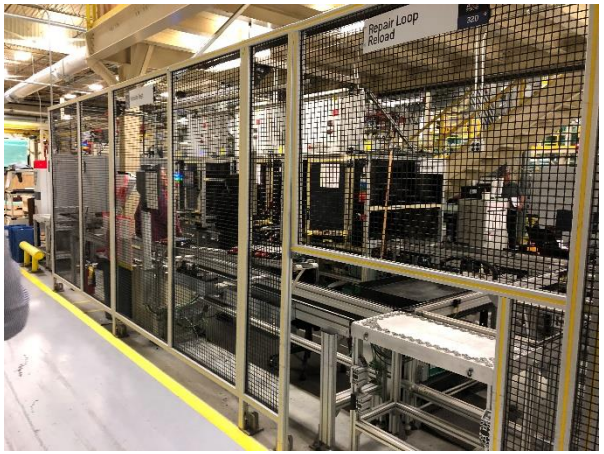


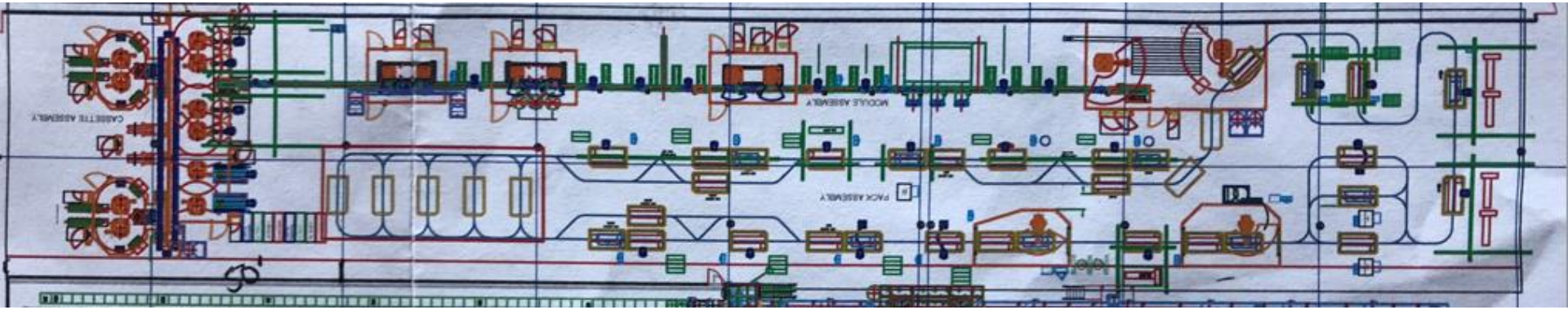
FIGURE B-4 LIGHT VEHICLE – MATERIEL ON SPONSON OR INSTALLED IN HULL



Module Line







Summary

- **Primary driver for battery development and manufacturing is consumer/commercial**
  - Supplied mainly by Asia
- **US Government is increasingly recognizing the need for advanced battery manufacturing in the US for military apps**
- **Navitas “at the tip of the spear” in serving the stringent and varied requirements of the military**

Summary

- US Government needs to weigh procurement cost (Asia = cheap) vs supporting higher-cost US supply base
- US Government should consider investing in surge manufacturing capacity and large advanced purchases for stockpiling/volume production efficiencies

Our Warfighters are Counting on Us

Thank You!