



Qualification Testing

SOUTHWEST RESEARCH INSTITUTE®

Cheuk Ng, P.E., Manager (cng@swri.org)

Marine Hi-Power Battery Workshop

Washington, DC.



ENGINE, EMISSIONS & VEHICLE RESEARCH

Introduction



Deep Sea to Deep Space

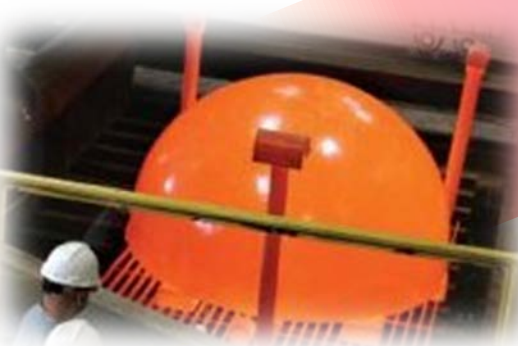
Southwest Research Institute (SwRI®)

Independent.
Advanced Science.
Applied Technology.
From *Deep Sea*
To *Deep Space*.

- **New Horizons**
 - **Mission to Pluto**

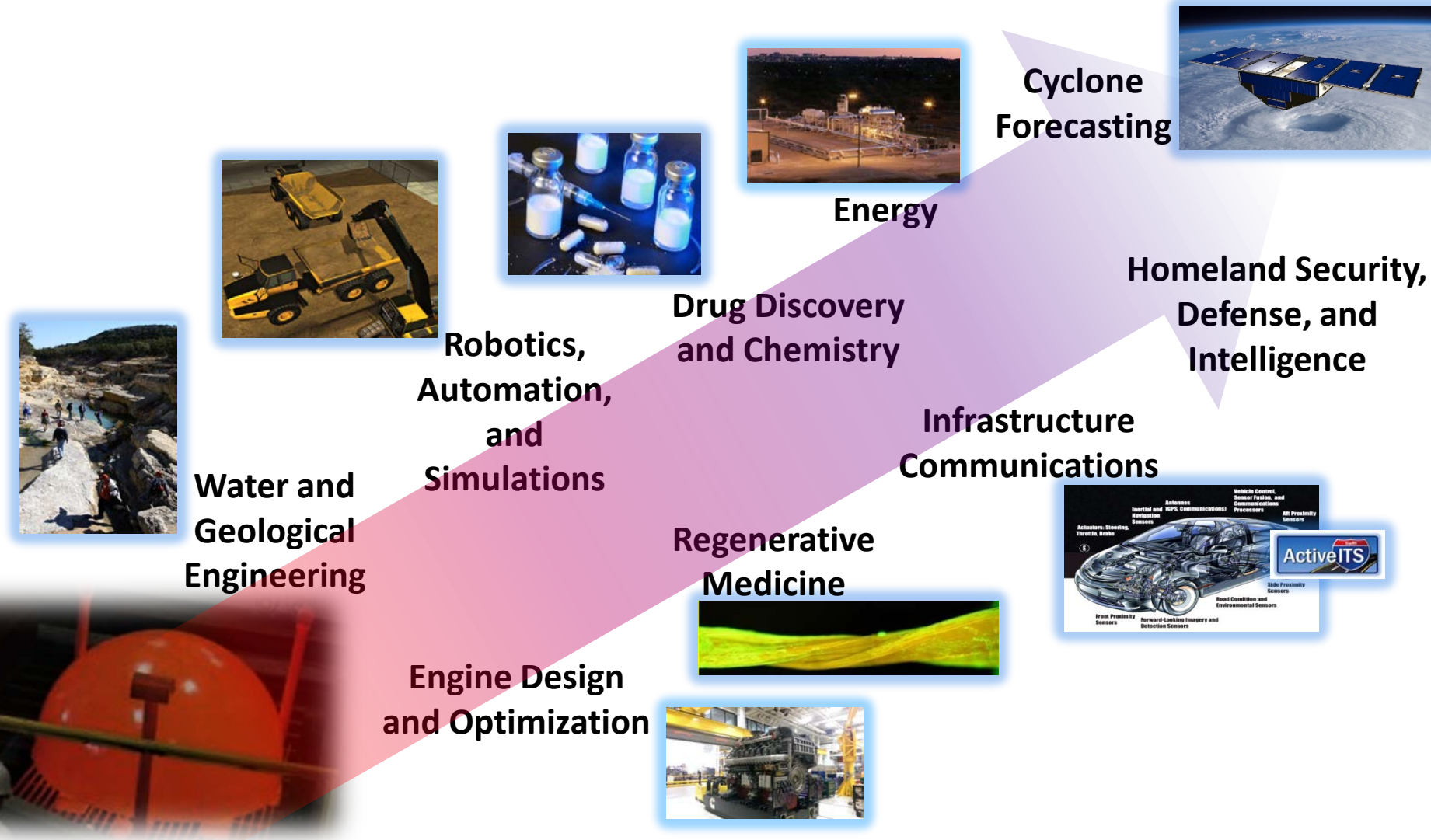


- **Alvin**
 - **Alvin (3' titanium sphere) capable of > 21,000 ft.**

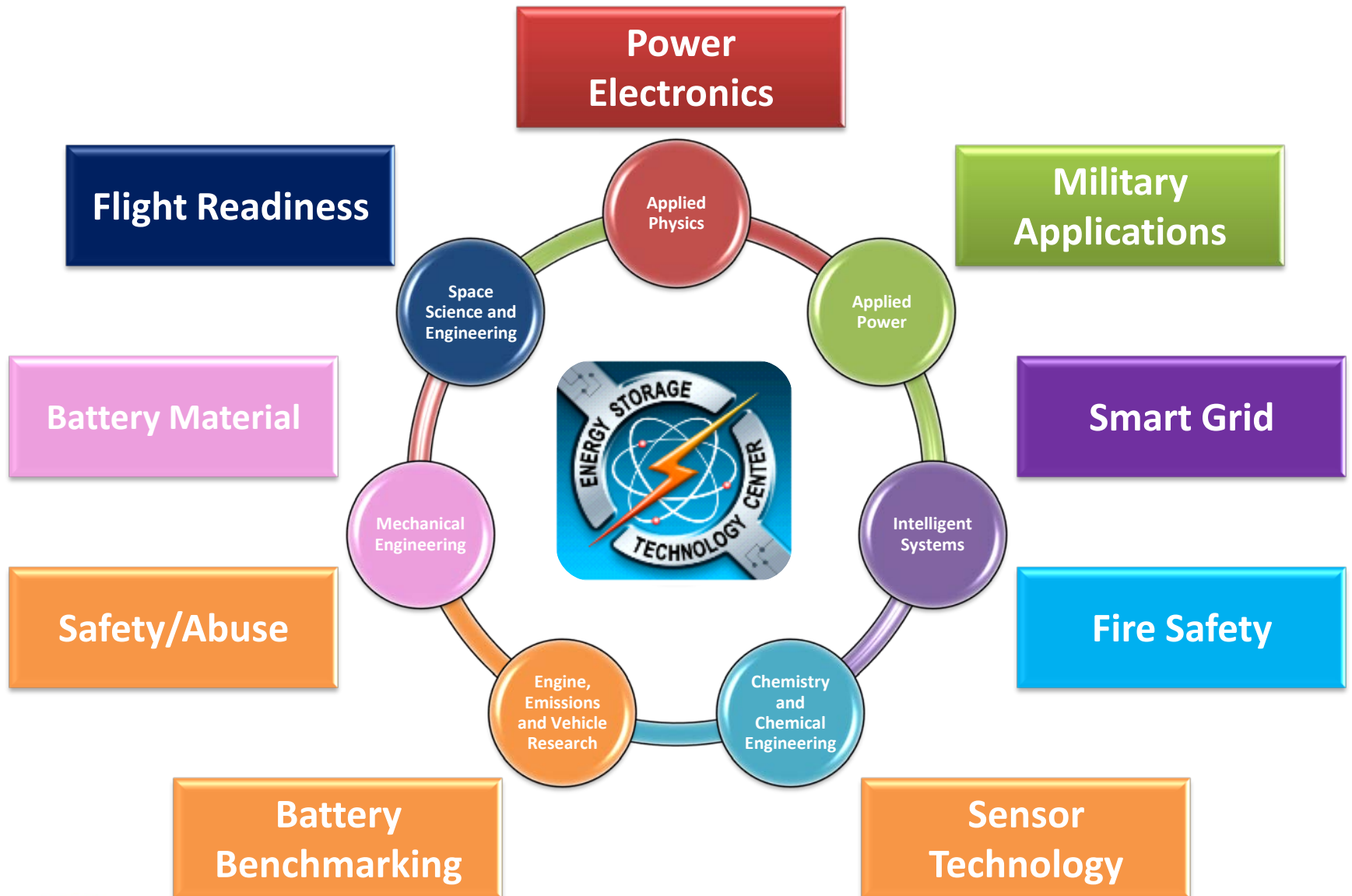


Deep Sea to Deep Space

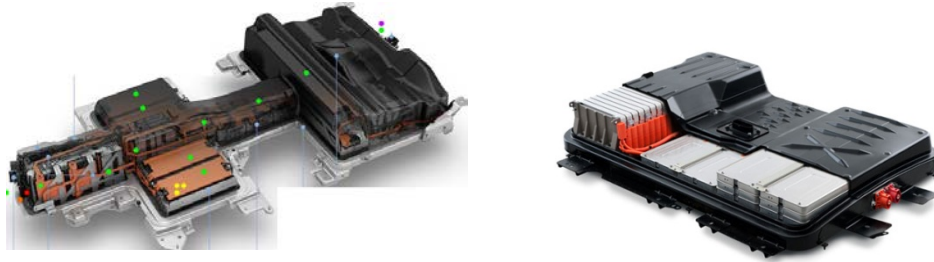
And Everything Between



Energy Storage Technology Center at SwRI



SwRI Leads Industry Consortia and Benchmarks Batteries

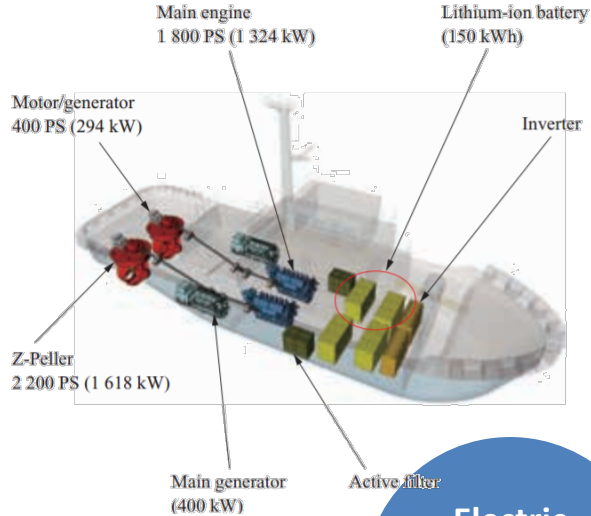


+Es|s|Es- 
Energy Storage System Evaluation
and Safety Consortium II

Qualification Testing



Marine Vessel Electrification



Tug Boats

Electric Allows Autonomous Boats

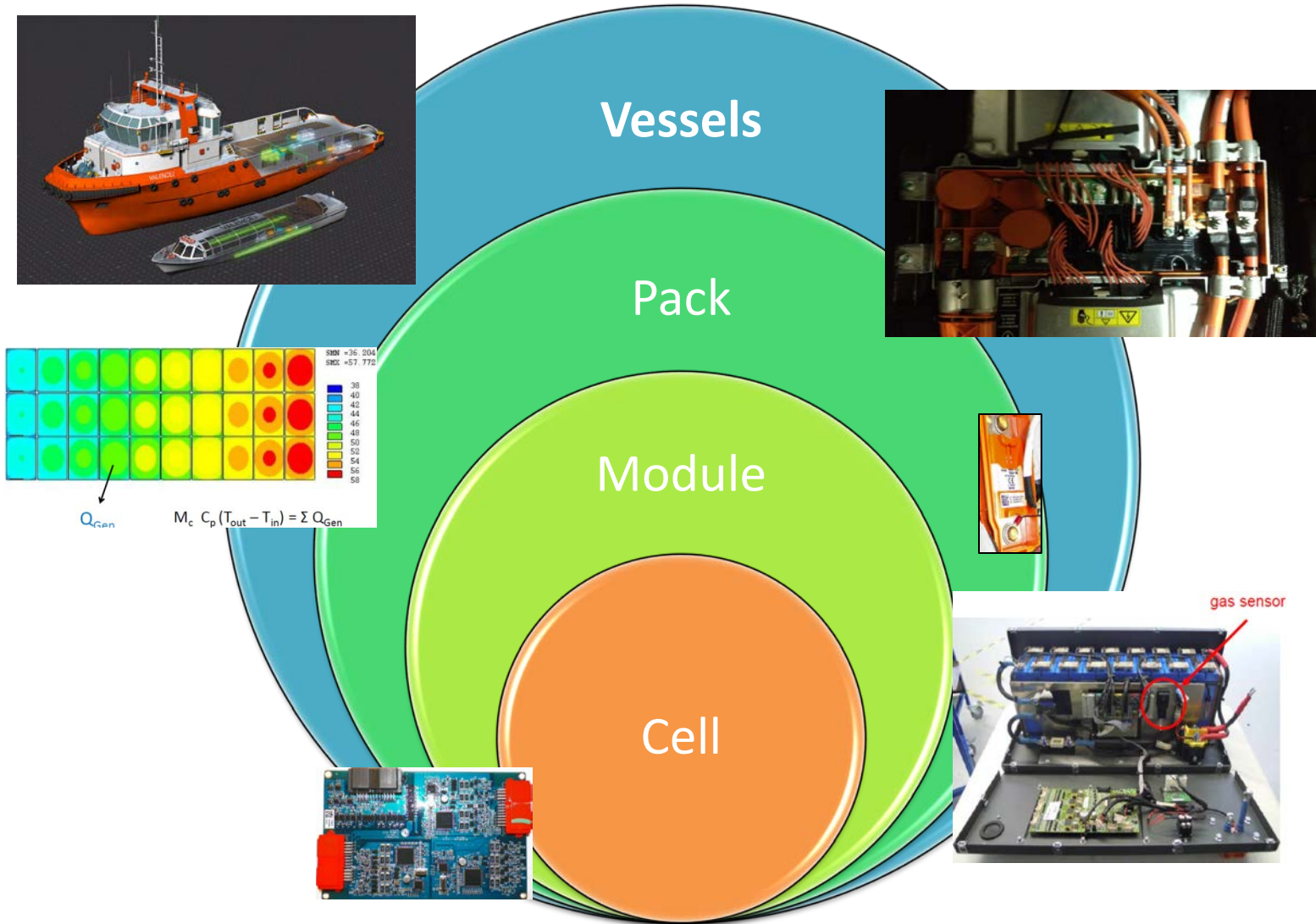
Marine

Silent Luxury Catamarans

Cargo Ship Fuel Savings Reduce Emission



Engineering Safety from Cell to Vessels

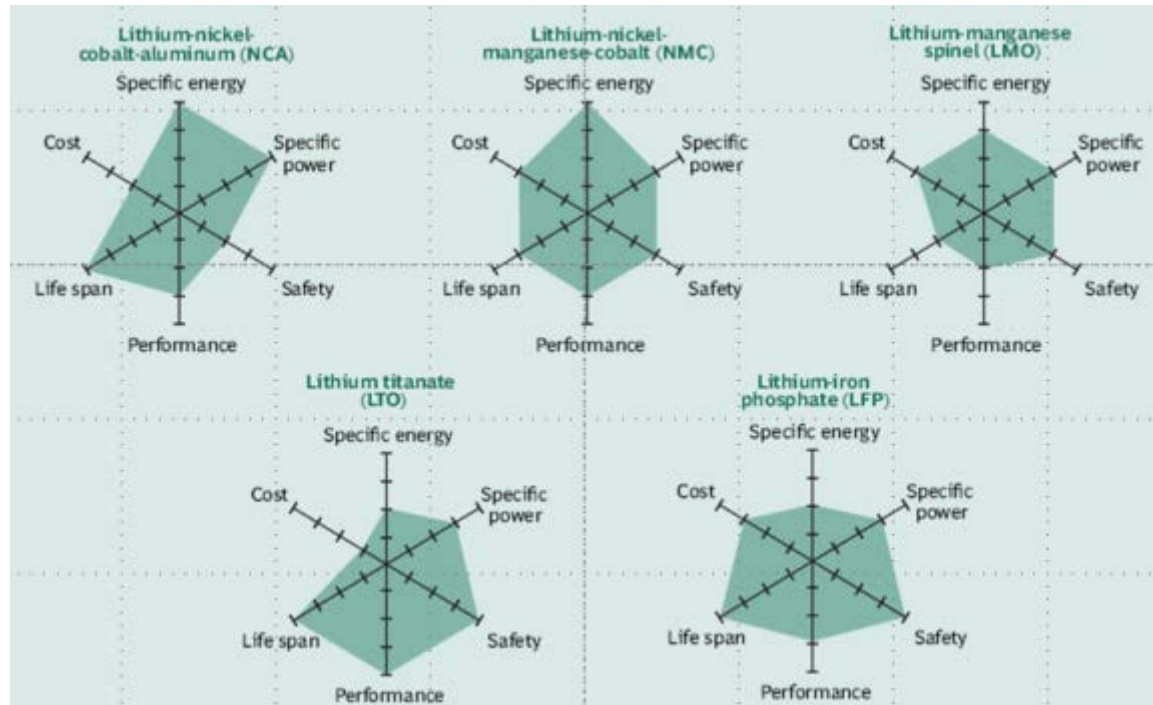


Safety Test Standards

- SwRI can conduct testing to a variety of test standards and excels in custom and modified procedures.
 - UN ECE100-02
 - UN 38.3
 - KMVSS
 - SAE-J2464
 - SAE-J2929
 - Flight Readiness
 - ISO-12405-3
 - IEC-62660
 - DO-311
 - MIL-STD-810G
 - GB/T 31467.3
 - NAVSEA S9310

Cell Selection

- There are many chemistry, size and format, price and safety differences
- There will be no clear 'winner' but rather a best match for a particular application



Source : AABC 2010, Pasadena, California and Boston Consulting Group

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Cell Evaluation

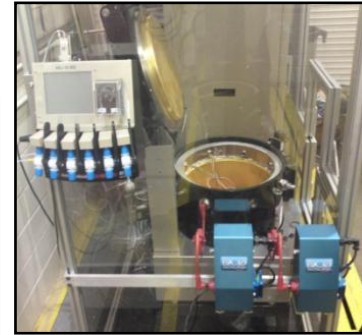


Manufacturing

- DC Resistance
- Impedance
- Open Circuit Voltage

Safety/Abuse

- Nail Penetration
- Overcharge
- Thermal Stability



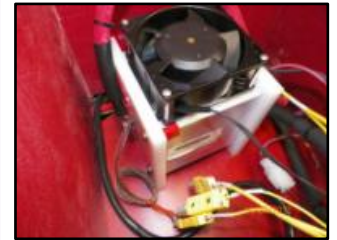
Cell Evaluation

Characterization

- Static Capacity
- Dynamic Pulse Power
- Energy Efficiency

Aging

- Cycle Life
- Calendar Life



Module and Pack Level Safety



- SwRI has conducted ESS testing across a variety of industries.
 - Automotive
 - Transportation
 - Space
 - Grid Storage
 - Telecommunications

Mechanical Safety



Penetration

Crush



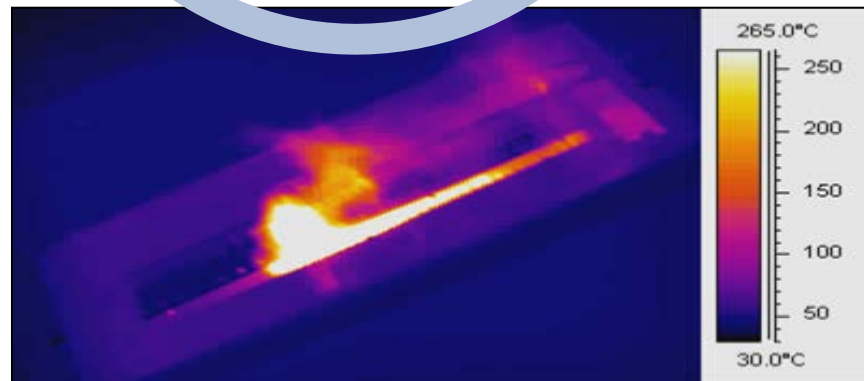
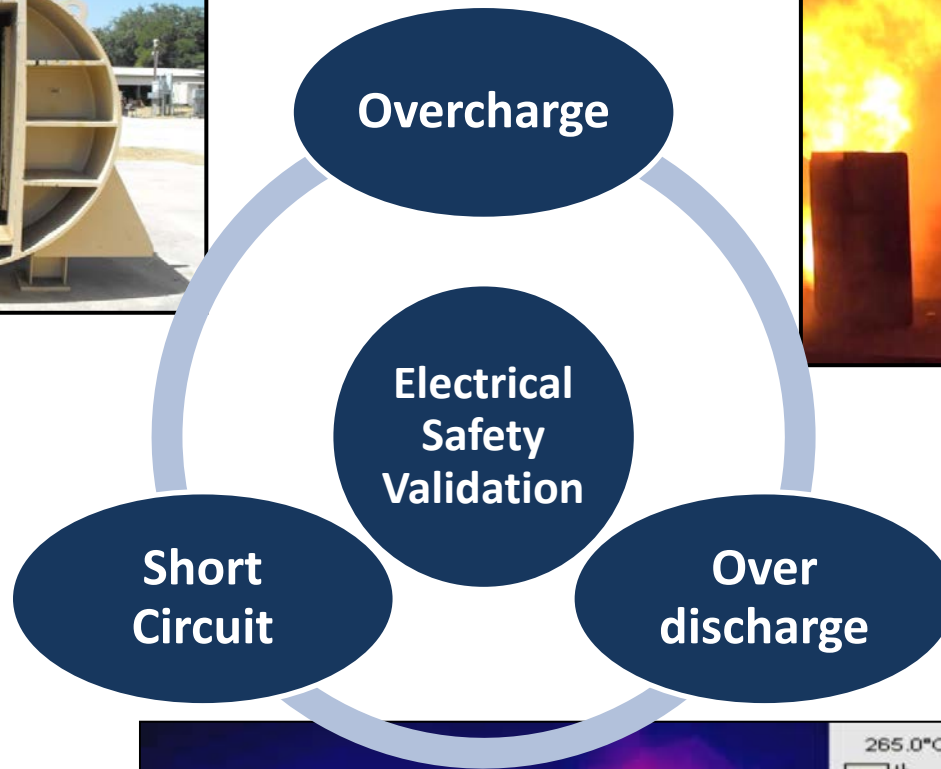
**Mechanical
Safety
Validation**

Vibration

**Shock,
Impact,
Drop**



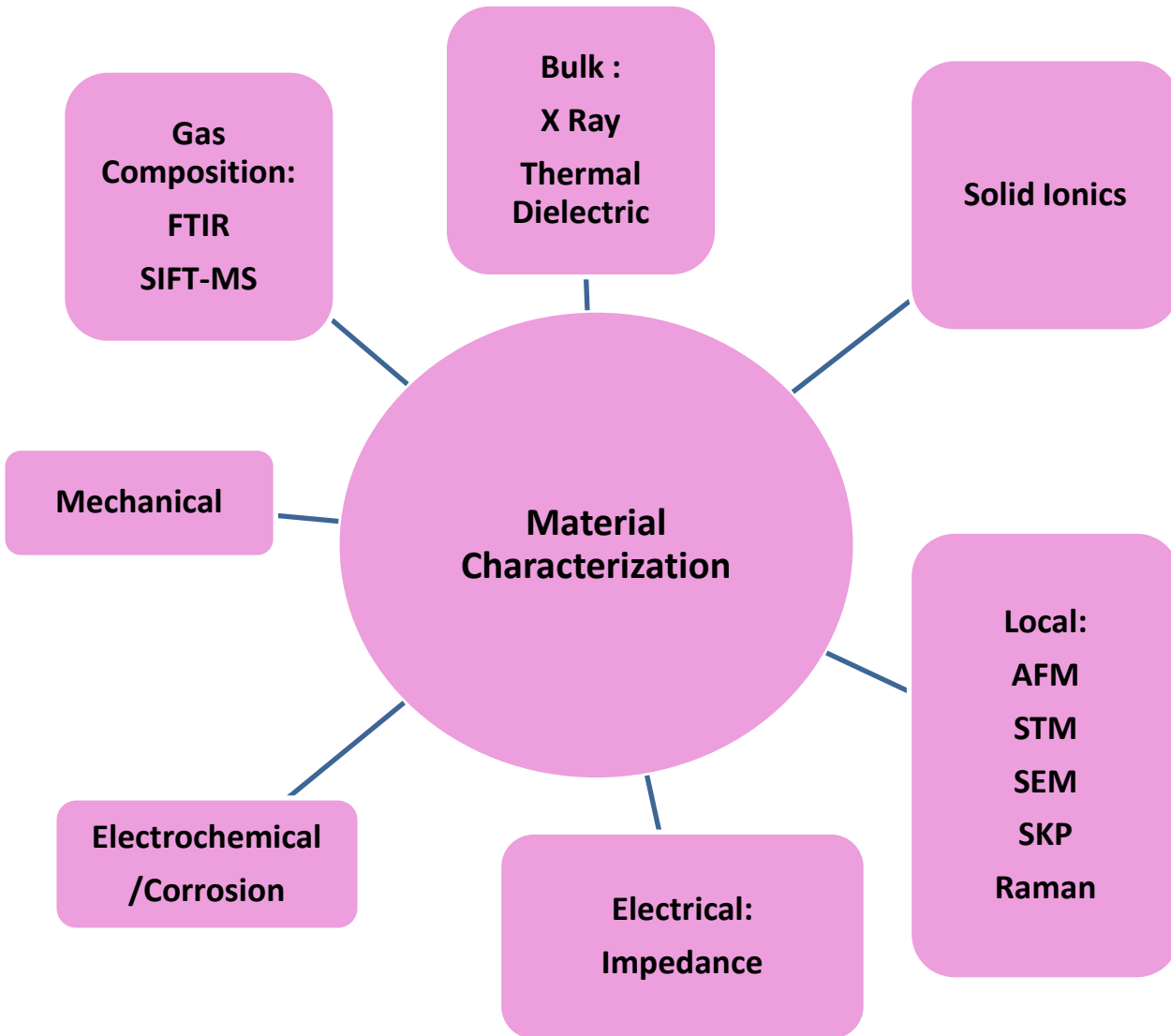
Electrical Safety



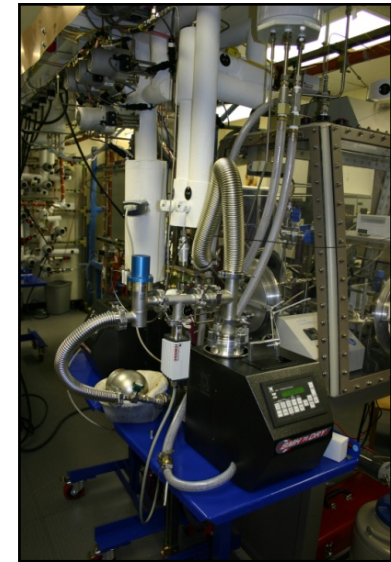
Environmental Safety



Post Test and Material Analysis



North Star CT Scanning System



Argon Glove Box

Thank You!

