communications

KDI Precision Products, Inc.

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Development of Battery Automation Equipment

Lithium Reserve Battery for the M234/235 Self-Destruct Fuze

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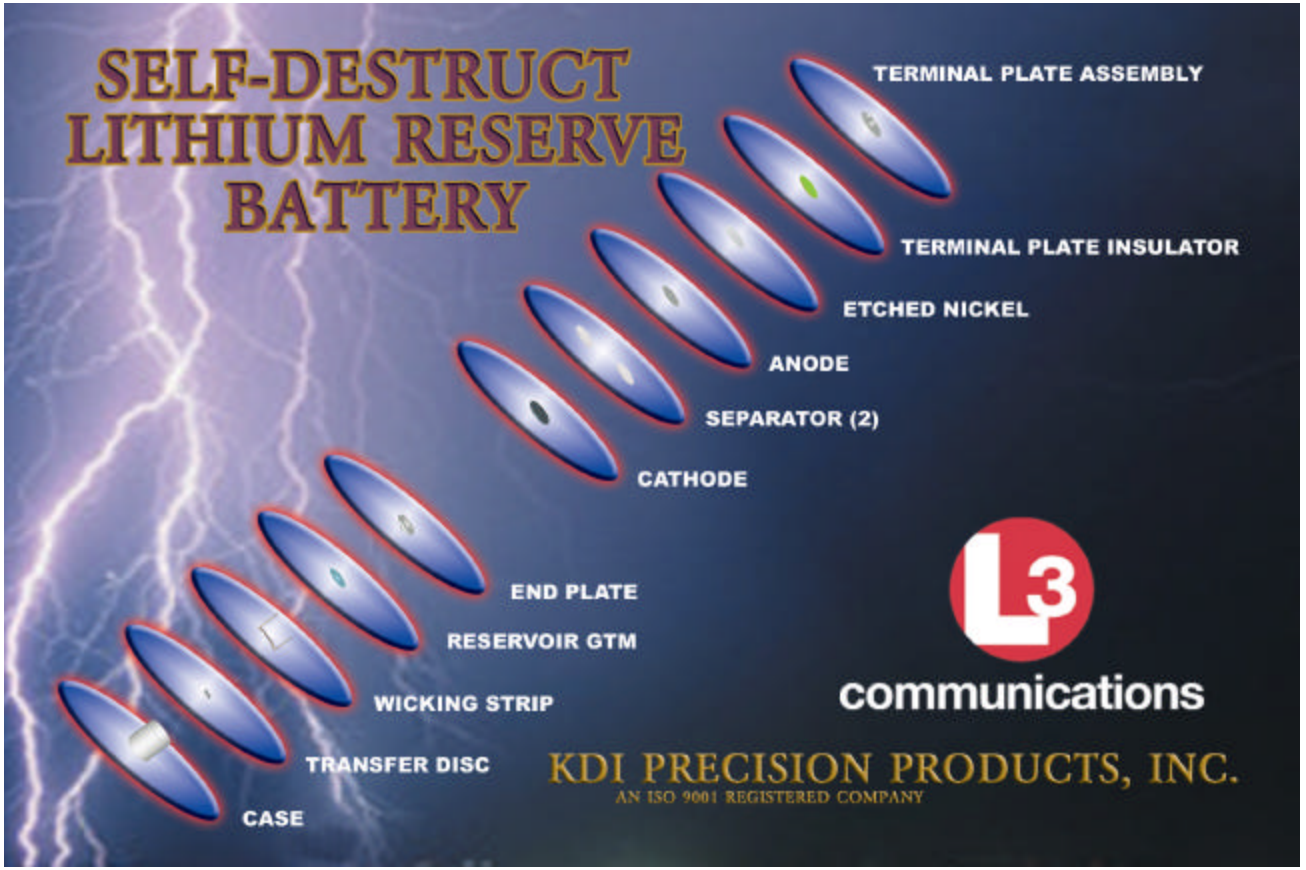
Director of Manufacturing Services

Development of Battery Automation Equipment

Program History

- ***Phase I***
  - Initial Concept of the Process
  - Selection of Qualified Vendors
- ***Phase II***
  - Conducted Risk Review of the Piece Parts and the Equipment
  - Conducted Preliminary Design Review of the Equipment
  - Conducted Critical Design Review of the Equipment
- ***Phase III***
  - Final Proveout of the Machines
- ***Current Status***

Development of Battery Automation Equipment



Development of Battery Automation Equipment

Program History

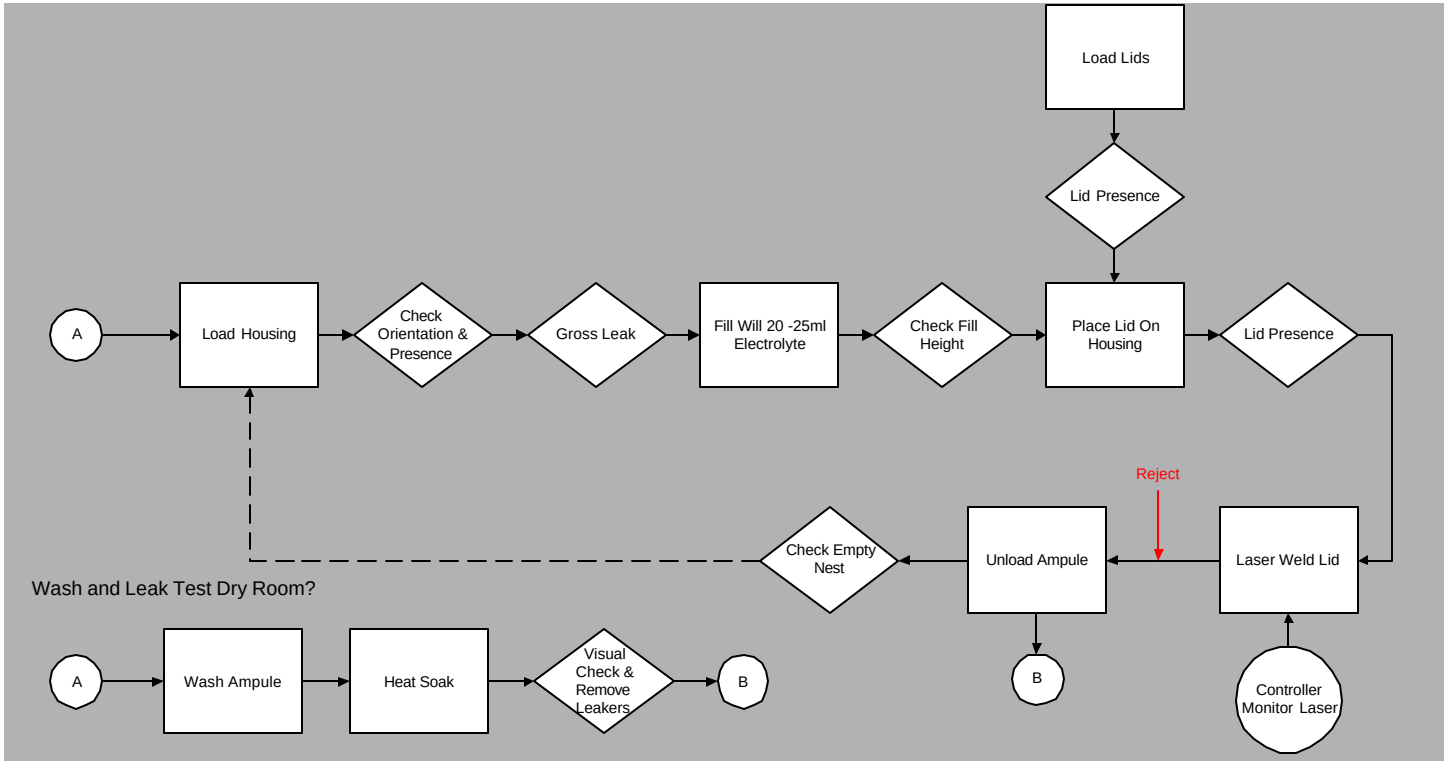
- The Automated Battery Line is part of a complete fuze assembly line contracted under the High Rate Equipment (HRE) contract, capable of delivering 190,000 fuzes/month on 1-8-5 shift basis.

- In 2000 an IPT Team was formed between KDI, ARDEC, and ARL to review the process and design requirements for the Self-Destruct Lithium Reserve Battery.

Development of Battery Automation Equipment

Phase I

- **Initial Concept of the Machines**
  - Developed a Process Flow of the Assembly Equipment with Specific Quality Checks (SOW)



Development of Battery Automation Equipment

Phase I

- **Selection of Qualified Vendors**
  - **Vendor Selection Rating Matrix**
    - Technical
    - Facilities/Personnel
    - Schedule
    - Financials
    - Intangibles
  - **Four Companies were reviewed**
- **RD Systems was the IPT's Final Selection**

Development of Battery Automation Equipment

Phase II

- **Conduct Risk Review of Piece Parts and Equipment**
  - **Risk Assessment Metrics**
    - Probability of Occurrence
    - Severity of Impact
    - Risk Leveling of Scoring Matrix
  - **Management Board Approval**

Risk Assessment Metrics

- **Probability of Occurrence**
  - ✓ **High** **(a 70% or Greater Chance That This Risk Will Occur)**
  - ✓ **Medium** **(a 30-69% Chance That This Risk Will Occur)**
  - ✓ **Low** **(a 10-29% Chance That This Risk Will Occur)**
  - ✓ **Very Low** **(a Less Than 10% Chance That This Risk Will Occur)**

Risk Assessment Metrics

- **Severity of Impact**

	RISK TYPES		SEVERITY OF IMPACT
COST	**SCHEDULE**	**PERFORMANCE**	
Increase of $500K or greater	Increase of 6 Months or greater	Customer-critical requirement will not be achieved; all margin has been exceeded	**High (Critical):** Will likely cause program failure and/or would not be able to meet primary requirements
Increase of at least $200K but less than $500K	Increase of at least 3 Months but less than 6 Months	Decrease in customer-critical performance eliminates all margin	**Medium (Serious):** Will cause major deviation from program plan and harm credibility with customer
Increase of at least $20K but less than $200K	Increase of at least 1 Months but less than 3	Customer-critical requirement will be achieved but all margin has been eliminated	**Low:** Will cause moderate deviation from program plan, but all key program requirements will be met
Increase of less than $20K	Increase of less than 1 Months	Customer requirements will be met with adequate margins	**Very Low:** Will cause only a small deviation from plan and all requirements will be met.

Risk Assessment Metrics

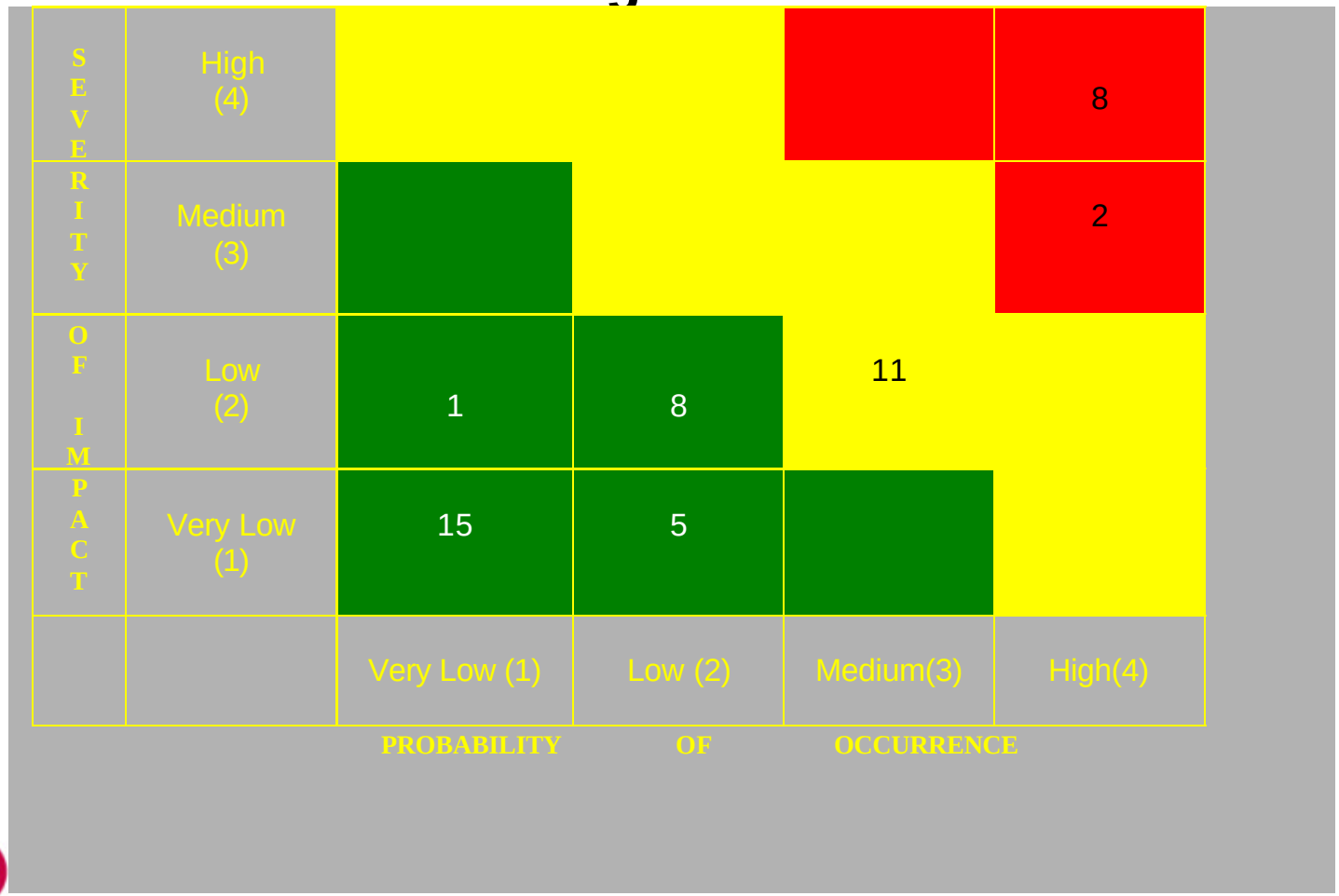
- **Risk Level of Scoring Matrix**

SEVERITY OF IMPACT					
	High (4)	Medium (5)*	Medium (6)*	High (7)*	High (8)*
	Medium (3)	Low (4)*	Medium (5)*	Medium (6)*	High (7)*
	Low (2)	Low (3)*	Low (4)*	Medium (5)*	Medium (6)*
	Very Low (1)	Very Low (2)*	Low (3)*	Low (4)*	Medium (5)*
		Very Low (1)	Low (2)	Medium(3)	High(4)

PROBABILITY OF OCCURRENCE

Risk Assessment Metrics

- **Risk Level of Scoring Matrix**



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- **Manufacturing Risk: (H8)**
  - Wicking of Electrolyte/Salt Build Up on Needle
  - Low / Over Fill of Ampule
  - Tight Tolerance (Needle to Hole)
  - Meeting rate / cycle time of Fill and Seal
  - Corrosion of Fill and Seal Equipment
  - Proper placement of Ball onto the Cover
  - Breaking of Ampule glass during the Ball press Operation
  - Obtain proper seal after the Ball is pressed into Cover
- **Manufacturing Risk: (H7)**
  - Cleaning and Etching of Terminal Pin
  - Lithium Punch Tool Build Up

Development of Battery Automation Equipment

- **Manufacturing Risk: (M5)**
  - Perpendicularity of Terminal Pin
  - Terminal Pin Tinning coverage (RD Prototyped a Process Developed by Ardec)
  - Solderability of Terminal Pins
  - Time between cleaning & tinning
  - Maintain Case flatness
  - Control the Welding Burrs on Case
  - Proper seating of Terminal Plate
  - Improper Terminal Plate Weld
  - Electrical Failure not detected
  - Gross Battery Leak not detected
  - Fine Battery Leak not detected

Development of Battery Automation Equipment

- **Manufacturing Risk**: **Wicking of Electrolyte/Salt Build Up**
- **Manufacturing Operation**: **Electrolyte Fill**
- **Probability of Occurrence:** **High (Inherent properties of electrolyte to wick)**
- **Severity of Impact:**
  - ✓ **Cost:** **High (may have to go to hand line $20-$60/battery)**
  - ✓ **Schedule:** **High (2 years to get new battery line)**
  - ✓ **Performance:** **Medium (heat soak/inspection will pick up low/over fills but chance of latent defect getting through)**
- **Risk Level:** **High (8)**
- **Risk Manager:** **Alex Hughes / Ben Lagasca**
- **SAVIT Producibility Study (parts completed - testing in progress)**
  - ✓ **No hole cover & projection weld**
  - ✓ **No hole slip fit cover & laser weld**

Development of Battery Automation Equipment

- **KDI Fill & Seal Investigation (Data Gathering)**
  - ✓ Use of Inert Atmosphere
  - ✓ Pull vacuum then fill
  - ✓ Effects on electrolyte temperature
  - ✓ Needle size/material effects
  - ✓ Pump size/stroke/speed/suck back features
  - ✓ Fill with cover and no cover
  - ✓ Pelletize salt then fill
- **RD Systems Fill & Seal Prototype (Chill electrolyte/parts, Fill open reservoir then laser weld cover)**
- **HIBAR Fill & Seal Prototype (Pull vacuum, Fill through hole, Inert gas purge, press ball)**
- **MANTECH Fill & Seal prototype (process yet to be defined)**

Development of Battery Automation Equipment

- **Utilize phased approach to build/design equipment**
  - ✓ **Build prototype and down select prior to final design of battery equipment**
- **Utilize Thales expertise/support**
  - ✓ **Hand build batteries - data gathering**
  - ✓ **Support production facility setup**
  - ✓ **Provide technical expertise**
- **Revised Probability of Occurrence: Low (several approaches but nothing proven yet)**
- **Revised Severity of Impact:**
  - ✓ **Cost: Medium**
  - ✓ **Schedule: Medium**
  - ✓ **Performance: Low**

Development of Battery Automation Equipment

- **Fill and Seal Results**
  - **Reduced Salting to a Manageable Level**
  - **Fill Volume (20-28 micro liters)***
    - ✓ **Stdev** **0.70**
    - ✓ **Average** **23.33**
    - ✓ **Max** **25.73**
    - ✓ **Min** **21.36**
    - ✓ **+ 3 Sig** **25.45**
    - ✓ **-3 Sig** **21.21**

    * **Samples taken over a 4 hour run**

Development of Battery Automation Equipment

Phase II

- **Lithium Laminate Assembly**
  - **Cutting the Lithium and Adhering the Lithium to the Nickel to Form the Anode**

Development of Battery Automation Equipment

Phase II

- Conducted Preliminary Design Review (PDR)
  - Reviewed the Initial Concept of the Machines at RD Systems

- Conducted Critical Design Review (CDR)
  - Reviewed the Detailed Drawings of the Assembly Equipment
  - Reviewed Exit Criteria for IPT's Technical Approval
    - All the Manufacturing Risk Points were resolved

Development of Battery Automation Equipment

Phase III

- Final Proveout of the Machines
  - Preliminary Production Review of Individual Machines
  - IPT Concurrence of Acceptance Test Plan (ATP)
    - Verify all Inspection Stations
    - Capability Studies of Each machine
    - Verify Throughput, First Pass Yield, and Uptime
  - Proveout of Assembly Line
    - Initial Proveout will be conducted at RD Systems
    - Final Proveout will be conducted at KDI

Development of Battery Automation Equipment

- **Current Status**
- **KDI's SD Fuze High Rate Equipment Complete**
- **Battery Automation Equipment**
  - **Phase I & II Complete**
  - **Phase III**
    - **PDR's & CDR's Complete**
    - **Began Proveout of individual work cells** **2/18/03**
    - **Proveout RD Systems** **June 03**
    - **Proveout KDI** **July 03**
    - **First Article Battery Testing** **September 03**
    - **First Article Fuze Testing** **November 03**