Error Prevention Process

Objective

- Share ULA’s Error Prevention Process & Experience
  - ULA & Error Prevention Background/History
  - Error Prevention Specific Definitions
  - ULA Error Prevention Process Overview
  - ULA Error Prevention Publications
  - More Lessons Learned
- Questions are Always Welcome
United Launch Alliance

- Formed in 2006 as a 50-50 Joint Venture Between Lockheed Martin & Boeing
- Provides Two World Class Launch Systems Operating as a Single Provider to the U.S. Government
  - Atlas V Product Line
  - Delta IV Product Line
  - Delta II Product Line
- Employs More Than 3500 Employees
- More Than a Century of Combined Experience in Expendable Launch System Production & Operation Providing Assured Access to Space
- Pooled Experience of Nearly 1300 Launches
- Legacy Reaching Back to 1950s
Great News!

Errors CAN Be Prevented

[No symbol for errors]
Identify the Hazards

Recognizing When Others are Taking a Risk is Easy

Recognizing When You are About to Take a Risk Requires Both Effort & Practice

STOP & THINK Before You Act

STOP When Risks/Hazards Exist
ULA Error Prevention History

- Active Atlas Reporting Since 2004
- Full Implementation of Delta Reporting Began in 2008
Definitions

**Event:** An incident that has a negative impact on production or launch operations. An EVENT is considered a potential MISHAP warning.

**Mishap:** An EVENT resulting in incurred costs over $20K or consequences with high or significant impact.

**Critical Mishap:** A Mishap resulting in incurred costs over $100K.

**Support Organization Event:** An EVENT that occurs as a result of a Support Organization’s action.
**Definitions**

**AESOP™ Huddle:** An Error Prevention technique used to ensure that all personnel associated with an operation are familiar with & understand their roles & responsibilities in the operation & that risks of failure are identified & mitigated.

**Flash Notice:** A preliminary notice to Executive Management & other personnel that a Mishap or Event has occurred.

**Corrective Action Board (CAB):** A board to ensure effective corrective action processes are implemented & closed. CAB evaluates issues/problems/products/processes & approves or directs corrective actions as necessary to remedy critical problems in a timely manner.
Perfect Product Delivery Ethic:

- Relentless pursuit of perfection to achieve excellence in everything we do;
- Applies our passion for Mission Success to continuously improve every process and product, to completely meet the needs of every customer; and
- Inspires and empowers all employees to dedicate our innovative talents to deliver program success and develop a world-class work environment.

ULA’s Error Prevention Program is Founded on ULA’s Perfect Product Delivery Ethic
"The successful man will profit from his mistakes and try again in a different way. ” –Dale Carnegie

This Paper Describes How United Launch Alliance’s (ULAs) Error Prevention Program Applies This Concept to Rocket Production, Test & Launch Operations

ULAs Error Prevention Program
• Recognizes Errors as Learning Opportunities
• Encourages Error Reporting Instead of Punishing Employees When Errors Occur
• Extracts & Shares Lessons Learned Company Wide
• Issues Action Items to Reduce Error Occurrence Company Wide

Each Reported Error is Tracked Through Resolution as Follows
• Root Cause Analysis
• Corrective Action Review Boards (CABs)
• Executive Management Review (Called an Error Prevention Council or EPC)

Published Copy Available
Identify the Hazards

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STOP & THINK Before You Act

STOP When Risks/ Hazards Exist

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Ongoing Voluntary Event Disclosures Via Workforce

Continuous Feedback Encourages Ongoing Disclosure:
- Company Wide Event Reporting
- Weekly Attention To Detail Emails
- Periodic Safety Bulletin Releases
- Error Prevention Web Site Access

Recent (2010) Addition

The EP Process is Designed to Share Lessons Learned from Mishaps/Events Across the ULA Enterprise
Error Prevention Process
A Few Key Concepts:

Prerequisites:

**Error Prevention** is a Cultural Change

ALL ULA Employees Attend a 4-hour “Human Error Prevention” Course Followed by an Annual ½-hour Refresher Course

ALL Critical ULA Processes Require an Operational Fishbone (to Identify & Eliminate or Mitigate Hazards)

ANY ULA Process Can Be STOPPED at Any Time by Any Process Participant

Basic Rules:

ULA’s Error Prevention Process is Executed for Every Event

Events are Recognized as Learning Opportunities

Events & Mishaps are Pursued with Equal Intensity
Event Reporting Process

Flash Content
- What
- When
- Where
- Details
  - Date
  - Time of Day
  - AESOP™ Huddle Used?
  - Injury/Damage?
  - Non-conformance/Documentation
  - Prelim Impact/Cost Evaluation
  - Pictures
- HOW
- WHO

Note: ULA’s Goal is to Issue Flash Notices within One Business Day of Event Occurrence; ULA has learned that WHO & HOW Data Points are generally premature at that Time; WHO & HOW Details are specifically edited out of Flash Notices.

The Event Reporting Process is Triggered Each Time an Event Occurs.
Cause Analysis and Corrective Action Process

The Cause Analysis & Corrective Action Process Determines Cause(s) & Develops Appropriate Corrective Action Plans

Cause Analysis
- Performed at Site of Occurrence
- Performed by an Investigation Team
- Formal Causal Analysis Method
- Documented Results
- Identify Direct, Root & Systemic Causes

Corrective Action
- Goal = Mistake-proof
- Address Multiple Causes
- Target Systemic Causes

Event

Event Reporting
- CA C / A
- CAB
- EPC Review
- Share Lessons Learned
- Analysis & Deep Dives

Gather Event Data

Cause Analysis & Corrective Action Session

Document Direct, Root & Systemic Cause(s)

Document Corrective Action Plan(s)

Error Prevention DB

Cause Analysis Techniques Employed By ULA
- Root Cause Fishbone
- 5 Why Analysis
- Apollo Root Cause

Root & Cause Analysis Techniques

Corrective Action Plans

ULA Employs a Variety of Root Cause Analysis Techniques
Corrective Action Board Process

Event Reporting → Prepare CAB Presentation Material → Review Cause(s) → CAB Approval

- Analysis & Deep Dives
- EPC Review
- Share Lessons Learned
- Error Prevention DB

CABs are Executed to Verify an Event’s Cause(s) & Corrective Action(s) are Accurate & Appropriate

**Typical CAB Presentation Format**

**EVENT10-080**

"Air Bearing Controller Fails"

**Incident:**
While moving the Payload Fairing half from the Vertical Assembly Building to the Special Cleanliness Area (SCA), the Air Bearing Controller stop function for the SCA cart failed. Personnel were able to physically stop the cart before it made contact with the building support structure and some line stock racks.

**Direct Cause(s):**
When the Off switch was operated to the off position, the contacts did not make electrical connection to activate the (air bag) brake.

**Root Cause(s):**
Facility personnel were unaware that the switch operated an air bag which served as a brake. This function was not tested during previous rework and PMPI.

**Systemic Cause(s):**
Errors; Verbal instructions passed down by previous personnel that had accepted the product and no designated area for Operation Manuals.

**Corrective Actions:**
1. Replaced switch and ordered spares.
2. Added operational instructions in PMPI

**Lessons Learned:**
Tribal knowledge strikes again. Because we did not formalize the PMPI by posting detail instructions, we had a potential for a mishap.

**WEB**

**ULAB PROPRIETARY INFORMATION. See Title Page For Details.**
The EPC Meets Monthly to Ensure Lessons Learned & Improved Practices are Applied Across the ULA Enterprise
Share Lessons Learned Process

### Error Prevention Publications

<table>
<thead>
<tr>
<th>Publication</th>
<th>Distributed to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Bulletins</td>
<td>Specific ULA Departments Based on Subject</td>
</tr>
<tr>
<td>Perfect Product Delivery</td>
<td>All ULA Management &amp; Interested ULA Employees</td>
</tr>
<tr>
<td>Attention to Detail Topics</td>
<td></td>
</tr>
<tr>
<td>There We Were Stories</td>
<td>Often Attached to Perfect Product Delivery Attention to Detail Topics</td>
</tr>
<tr>
<td>Success Stories</td>
<td>Often Attached to Perfect Product Delivery Attention to Detail Topics</td>
</tr>
</tbody>
</table>

The Share Lessons Learned Process Generates & Distributes a Variety of Error Prevention Data & Products
Analysis and Deep Dive Process

Analysis Tasks Look for Trends

Deep Dive Tasks Document Observed Trends

The Analysis & Deep Dive Process Looks for & Documents Event/Mishap Trends via Historical Data Analysis
Metrics Demonstrate
Error Prevention Process is Working

Ongoing Voluntary Event Disclosures Via Workforce

Error Prevention Process Principles
- Achieve excellence in everything we do
- Continuously improve every process and product
- Develop a world-class work environment
- Deliver program success

Continuous Feedback Encourages Ongoing Disclosure:
- Company Wide Event Reporting
- Weekly Attention To Detail Emails
- Periodic Safety Bulletin Releases
- Error Prevention Web Site Access

Recent (2010) Addition

Analysis & Deep Dives

Metrics Demonstrate a Measurable Reduction in Mishap Frequency & Severity
**Error Prevention Metrics – Mishap-free Time Span Increasing**

**First 12 Month Period with No ULA Mishaps!** *(Last Mishap: 4 June 2009)*

- Events = Process Improvement & Learning Opportunities (Valuable Resource)
- Common/Consolidated Atlas, Delta Metrics & Evaluation Criteria
- Decatur Stand Down & Restart Activities (Including Implementation of 5S)
- Fishbone Evaluations of Processes & Procedures, Deep-dive Analyses
- AESOP™ Huddles (Assignment, Equipment, Situation, Obstacles, Personnel)
- Work Package Reviews of Denver Hardware Moves/Relocation to Decatur
- CAB Reviews (Local) & Error Prevention Council (Enterprise Level)
- Risk Index Metric helps Prioritize, Assess & Focus Follow-up Evaluations
- Weekly Error Prevention Awareness & Perfect Product Delivery Discussion Topics (LL & Successes)

**ULA’s Error Prevention Program is Working – Maintain Focus!**

* 1 Sep Update – Event 10-071 (3 Aug 2010, Decatur Off-site Warehouse) COPV Fell from Transport Pallet Upgraded to Mishap Status
Error Prevention Metrics – Risk Index

ULA & Support Organization Risk Index Scores – 2009

2009 Average = 7.31

Event Risk Index is useful in understanding and communicating the relationship between an event’s actual impact and probability for damage.

Event Risk Index is defined as the product of an Event’s “Actual Impact” and an Event’s “Probability for Damage”.

- Over-reporting of minor events encouraged
  - Root Cause analysis and systemic preventive action over time eliminates program risk
  - Eliminates future opportunities for minor events becoming more serious

- Each Event scored for both Actual and Potential Damage

- Risk scoring allows focus on areas of higher potential (unrealized) risk

- Risk Index approach similar to Mishap Risk Index defined in MIL STD-882C, ULA SSPP, and ULA QS-453

Risk-based Assessments Enhance ULA’s Error Prevention Metrics
Error Prevention Metrics – Risk Index

- Event/Mishap Ratio Continues to Show We are Learning & Improving
- Overall Risk Index for 2010 Continues to Decrease
- 18 Deep Dive Packages Developed & Available as ULA Resource
  - Several Enterprise Actions In-work and/or Improvement Projects Identified
- Error Prevention Team Supporting Level-1 CABs for Events with Risk Index 12 or Greater as Added Resource for Causal Analysis Process

![2010 ULA & Support Risk Scores By Event](chart)

**Average Risk Index Continues to Decrease**

ULA’s Average Risk Index is Decreasing
Mishap Ratio = # of Mishaps/Total # of Events (for a Given Period of Time)
Reduction in Mishap Ratio Indicates Error Prevention Process Health

**Year-Through-September Event to Mishap Rate**

- **2008 thru Sept**: 7.35%
- **2009 thru Sept**: 6.58%
- **2010 thru Sept**: 2.5%

**1 ULA’s Mishap Ratio is Decreasing**
Error Prevention Metrics – Increased Reporting Detail

2008-2010 Flash Notice Data Has Been Increasingly More Detailed/Specific
EX: 10:33 AM vs AM

Greater Detail = Greater Insight & Understanding

Improved Reporting Detail/Specificity Yields Higher Fidelity Metrics
Error Prevention Metrics – Increased Reporting Detail

Example:
Increased Reporting Detail Helped the Error Prevention Team Identify “Error Prone Zones …”

Error Prone Zone: “Specific Time Spans That Have Demonstrated a Higher Rate of Events & Mishaps (Errors)”

The Error Prevention Team Regularly Releases Bulletins Alerting the Work-force That Error Prone Zone Hazards Exist

Error Prevention Bulletins Communicate Specific Hazards
Deep Dives Allow ULA Employees & Contractors to Access Historical Incident Data Based on Topic/Task

Deep Dive Analysis Identifies & Documents Common Hazards & Lessons Learned
Error Prevention Metrics – Deep Dive Example

**Error Prevention Deep Dive**
**ULA Crane Events 2008-2009**

<table>
<thead>
<tr>
<th>Event Number, Date, Location, Project</th>
<th>Event Name</th>
<th>Event Description</th>
<th>Causes</th>
<th>Lessons Learned</th>
<th>Event Database Link</th>
<th>Cause Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-001, 1/4/2008, Hattingen, Altes</td>
<td>Lifting Tool for Payload</td>
<td>Payload striking transport cart</td>
<td>1) Person in charge lost control; 2) Manual guides required on all 4 corners; 3) Required sequenced processes was not.</td>
<td>93%</td>
<td>Non-Crane Related Events vs. Crane Related Events</td>
<td></td>
</tr>
</tbody>
</table>

**2008-2009: Non-Crane Related Events Vs. Crane Related Events**

- Non-Crane Related: 7%
- Crane Related: 93%

**AESOP Event Causes for 2008-2009**

- Assignment: 32%
- Equipment: 54%
- Obstacles: 0%
- Personnel: 14%

Deep Dives Document Historical Incident Data Based on Topic/Task
Identify the Hazards

Recognizing When Others are Taking a Risk is Easy

Recognizing When You are About to Take a Risk Requires Both Effort & Practice

STOP & THINK Before You Act

STOP When Risks/Hazards Exist
ULA Error Prevention Publications
Overview
ULA’s Error Prevention Process Generates & Shares More Than 200 Error Prevention Specific Publications Yearly

ULA’s Error Prevention Process Has Generated More Than 650 Error Prevention Specific Publications to Date

Error Prevention Publications

- Stimulate Ongoing Error Prevention Related Conversation, Awareness & Change
- Are a Constant Reminder of ULA’s Error Prevention Principals
- Are Based on Actual Events/Accomplishments/Lessons Learned

<table>
<thead>
<tr>
<th>Error Prevention Publication</th>
<th>Publication Frequency</th>
<th># Published Yearly</th>
<th># Published Since Inception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect Product Delivery, Attention To Detail Emails</td>
<td>Weekly</td>
<td>50</td>
<td>170 +</td>
</tr>
<tr>
<td>Picture Of The Week</td>
<td>Weekly</td>
<td>50</td>
<td>40 +</td>
</tr>
<tr>
<td>Safety Bulletins</td>
<td>As Directed By The EPC</td>
<td>30 (so far in 2010)</td>
<td>80</td>
</tr>
<tr>
<td>There We Were Stories</td>
<td>Monthly</td>
<td>100 +</td>
<td>300 +</td>
</tr>
<tr>
<td>Success Stories</td>
<td>Monthly</td>
<td>20 +</td>
<td>60 +</td>
</tr>
<tr>
<td>Deep Dives</td>
<td>As Appropriate</td>
<td>Based On Observed Event Causes / Topics</td>
<td>20 +</td>
</tr>
</tbody>
</table>

Various Error Prevention Publications Drive & Support the Ongoing Cultural Change Necessary for Error Prevention Success
## Error Prevention Publications: Perfect Product Delivery, Attention to Detail Emails

### Objective: Provide ULA Managers with Weekly Error Prevention Discussion Topics

<table>
<thead>
<tr>
<th>Release Date</th>
<th>Email Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/4/2010</td>
<td>There We Were – EVENT09-093 2nd Stage Foam Damage</td>
</tr>
<tr>
<td>2/11/2010</td>
<td>AESOP™ Huddles Work for Non-Critical Ops Too</td>
</tr>
<tr>
<td>2/25/2010</td>
<td>Bulletin – Hold AESOP™ Where Task is Done</td>
</tr>
</tbody>
</table>

---

### AESOP™ Works For Non-Critical Ops

**There We Were**

Getting the work area ready to assigned task, we knew that the lighting in this that we had to move the rolling stool into located the rolling cart into position, it grazed the By damaging it.

**We Learned...** to always take extra precautions stands around hardware. We need to review that restrain movement of people and equipment hardware.

The AESOP huddle was held in the break room, more effective if held in the work area, where it have been better observed. The QS-405 check reflect this and the EP staff will issue a bulletin with.

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Error Prevention Publications:
EP PIC of the Week

Hazardous Picture Of The Week - Sept 2010
## Error Prevention Publications: Error Prevention Bulletins

**Objective:** Document/Share Identified ULA Hazards  

<table>
<thead>
<tr>
<th>Bulletin</th>
<th>Release Date</th>
<th>Bulletin Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULLETIN10-002</td>
<td>2/4/2010</td>
<td>Rotating Tool Hazards</td>
</tr>
<tr>
<td>BULLETIN10-003</td>
<td>2/10/2010</td>
<td>AESOP™ – Not Just For Critical Ops</td>
</tr>
<tr>
<td>BULLETIN10-004</td>
<td>2/10/2010</td>
<td>Consider Trailblazers</td>
</tr>
<tr>
<td>BULLETIN10-005</td>
<td>2/10/2010</td>
<td>Torque Lift Points</td>
</tr>
<tr>
<td>BULLETIN10-006</td>
<td>2/10/2010</td>
<td>OOP Hazards</td>
</tr>
<tr>
<td>BULLETIN10-007</td>
<td>2/18/2010</td>
<td>Hold AESOP™ Where Work Occurs</td>
</tr>
<tr>
<td>BULLETIN10-008</td>
<td>2/18/2010</td>
<td>Modifications Can Introduce Hazards</td>
</tr>
<tr>
<td>BULLETIN10-009</td>
<td>2/19/2010</td>
<td>Crane Hazard Identified</td>
</tr>
</tbody>
</table>

*Note: May Require Closed-loop Distribution*
Error Prevention Publications: Success Stories

Objective: Identify & Share EP Successes
Demonstrate That the EP Process Works

Potential Error: GOES “P” CBC moves on the KAMAG from the Decatur facility to the CBC Storage Facility. The KAMAG team was not comfortable making the left hand turn onto Delta Drive. It was agreed that after this move the concrete would be extended on the roadway.

Problem: On April 30, 2009, the KAMAG Team was asked to move another CBC to the warehouse. The concrete had yet to be poured to remove the risk of running off the road during this transport.

Actions: A “STOP” was called by Senior Leadership. Decatur Facilities got re-engaged with the project. Flight Hardware was not moved until the new concrete was poured and cured. Now the transport is made safely with minimum risk to the Flight Hardware.

 Lessons Learned: In most cases the risks we face are not so obvious, however one constant exists in all situations… the Pinch… that funny feeling that something isn’t right; that voice shouting in our ears that we shouldn’t take that path.

Max Santiago

Implementation Date: 6/2009
Location: ULA Decatur, Alabama
Error Prevention Publications: There We Were Stories AKA: Closed-Loop Reporting

Objective: Document & Share Each Event’s Story & Lesson Learned Distributed Monthly to EP Distribution List

Enterprise Learning
EVENT09-113
Support: Semi Truck Bumps Tool Dolly

- There we were... walking down the aisle in the Skin Ring and Dome area when I noticed a semi tractor trailer trying to maneuver in what appeared to be a tight space to work in. I also notice that there were no spotters in the front of the vehicle as it was moving forward towards a ring sitting on a dolly. I witnessed the tractor bump the dolly lightly however, the contractors were unaware of the contact. Now I’m not a Rocket Scientist by trade but I know that’s not how we treat flight hardware here, so I immediately informed security about what I had just witnessed.

- We learned... while spotter use is common across ULA, no specific or uniform instructions or guidelines existed for spotter tasks, but there are now (ref QS-408 appendix C and Appendix B, Obstacles 10). Decatur updated D-206 to identify job specific duties and responsibilities of Decatur ULA and ULA Contractor Badged Escort/Spotters. An action was assigned to the EP staff to review ULA procedures for consistent spotter requirements.
**Error Prevention Publications: Deep Dives**

- **Topic:** Error Prevention Deep Dives
- **Focus:** To create and maintain concise event information in which common groupings of events are presented together.
  - Equipment (Cranes, Forklifts, etc.)
  - Process (Transportation, Packaging, etc.)
- **Reason:** Allows ULA employees and contractors, based on interest or task, to access a brief summary of event groupings.
- **Summarizes:**
  - Event Details, Description and Causes
  - Individual Lessons Learned
  - Overall Lessons Learned

---

**Error Prevention Deep Dive**

**ULA Crane Events 2008-2009**

<table>
<thead>
<tr>
<th>Year</th>
<th>Crane-Related Events</th>
<th>Equipment-Related Events</th>
<th>O&amp;M</th>
<th>Overall Lessons Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>32%</td>
<td>54%</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>2009</td>
<td>5%</td>
<td>4%</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*In the AESOP Manual held prior to engagement the "Proof to the Program (PC)" needs to specifically state, "Use in change, all comments to be directed to x.x.x."

---

**2008-2009: Non-Crane Related Events**

- Non-Crane Related: 6%
- Crane Related: 93%

---

**Types of Event Causes for 2008-2009**

- Equipment
- Environment
- Obstacles
- Personnel
Identify the Hazards

Recognizing When Others are Taking a Risk is Easy

Recognizing When You are About to Take a Risk Requires Both Effort & Practice

STOP & THINK Before You Act

STOP When Risks/ Hazards Exist

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ULA Error Prevention Lessons Learned
Collected Examples
Potential Error: Fork Lift Pierces Crate & Damages Flight HW

NM07-009, 1/31/2007: A fuel duct flange was damaged when a fork lift penetrated a transportation crate.

Error Prevention Action:

Root Cause Analysis identified the problem was due to poor crate design NOT fork lift operator negligence. The operator was unloading the crate from a panel truck and the crate had no fork pockets at the accessible location. The fork lift operator tried to move the crate with the forks & accidentally pierced the crate and damaged flight HW.

Corrective Action: The crate was redesigned to accommodate appropriate access.
Program Specific Metric Focus Example: Event Causes Study -

Program X Experienced What Seemed Like An Unusual Amount Of Events ... Is Something Wrong With The Program?

Data shows > Not Really ...

ULA & Support Events by Cause (2008-Present)

Program Specific Related Event Cause “Signature” Matches the Overall ULA 2008-2009 Event Cause Signature
HAZARD: Numerous ULA Events are attributed to spotters and spotter related operations. Spotters do not always STOP operations appropriately to prevent Events.

Solution – Implemented (3/2010):

**Spotter AESOP™ Huddle Guide Badge**

**Implementation Plan:**
- Badge Drafts Reviewed and Approved by each site
- 1000 badges printed & distributed
- Badge Availability Announced In PPD Attention To Detail Weekly Email (3/11/2010)
- Spotter Training topic included in Vendor Access Training at Decatur

**Note:** EPI Reviewed and Approved This Concept
Protective Covers Can Become Drop Hazards

Each Mishap & Event provides an opportunity for ULA to learn lessons that help prevent future mishaps. The following two events demonstrate how protective covers (designed to prevent fragile components from impacts and contact damage) can become drop hazards that may damage other components. These events also demonstrate velcro fasteners are subject to wear and fatigue.

Background: Protective Covers Can Become Drop Hazards - EVENT08-089: Protective Cover Drop, Delta IV, CCAFS, November 10, 2008:
While opening the Port Common Booster Core Engine Section to perform daily work, we discovered the bottom half of the lower hydraulic accumulator protective non-flight cover (P/N: 1C86442) had came lose from its velcro fasteners and fallen approximately 8 feet into the main engine blanket below. The 2.2 lb cover half is made of aluminum. Fortunately, no personnel or hardware was damaged.

EVENT08-096: Protective Cover Drop, Delta IV, Decatur, December 3, 2008:
While rotating a Delta IV 2nd Stage during production, velcro fasteners on a COPV protective cover gave way allowing the cover half to fall and striking a composite x-brace and then fall to the factory floor. Fortunately, no personnel or hardware was damaged.

Error Prevention Actions:
- Recognize protective covers as potential drop hazards.
- Realize velcro can and does wear out and weaken with use.
- Add velcro attach point inspection steps to protective cover related procedures.
- Replace worn velcro with new material or more robust fasteners.
- Design protective covers with mechanical fasteners / attach points.
- ALWAYS MAKE SURE IT IS RIGHT
transportation height poles hazard

Each mishap & event provides an opportunity for ula to learn lessons that help prevent future mishaps. this bulletin identifies an event where the height poles used in transporting over roads failed and caused contact with an overpass.

event 08-103— A rs-68 engine was being transported from decatur to stennis space center by one of our vendors, r.j. langley. during transport, the height pole on the lead car slipped. the lead car pulled off the road and the pole went under the overpass, but when the truck went under, the engine’s trailer contacted the overpass.

the height pole used a “grip” or compression hold to keep the pole in place. as time goes on, age and wear lessen the effectiveness of this hold.

the solution to this problem is to switch to a height pole that employs bolts to lock the pole in place to ensure no height change during transportation.

this has been instituted in po-885 “over the road transportation requirements for oversized loads.”

4.5.1 pole extensions

a) Use standard pole equipment for all pilot cars. verify pole height prior to transport.

verify height pole is pinned and secure in order to prevent slippage during transit.

error prevention actions:

• Recognize the types of transportation height poles your department uses.
• Replace out of date poles that do not have positive pin locking features
• Verify that the locking mechanisms used on these poles are in good condition every time they are used.
• ALWAYS MAKE SURE IT IS RIGHT
**Background:** The following event demonstrates how the use of tools on equipment intended for “Hand Force Only” can result in damaged hardware and could result in personnel injury.

**EVENT09-013:** February 2009, VAFB Delta IV, Test Valve Adapter Damage:
Following a Hydraulic Spin Start Accumulator operation at the VAFB Delta IV launch table, a valve in a pressurized nitrogen system needed to be secured (closed). The small Schrader hand valve requires three turns to close. The valve was sticking so the technician placed a wrench on the valve to add leverage. The extra torque broke the valve’s handle and stem. Since the system was under pressure the valve handle and stem shot across the room. Fortunately no personnel or adjacent flight hardware was struck and injured by the valve pieces.

**Error Prevention Actions:**
- **IDENTIFY** “Hand Force Only” operations as potentially hazardous via WARNING statements in associated procedures.
- **DISCUSS** the presence of “Hand Force Only” parts and their associated hazards during pre-operation AESOP huddles.
- **LABEL** “Hand Force Only” parts with appropriate WARNING labels.
- **STOP And ASK** when uncertain if parts are appropriate to manipulate via tools.
- **ALWAYS MAKE SURE IT IS RIGHT**
Each Mishap & Event provides an opportunity for ULA to learn lessons that help prevent future Mishaps. The following two Events demonstrate how floor conditions can create hazards or risks that may cause personnel injury or flight hardware damage.

**EVENT08-067** - In September 2008, one of Harlingen’s wheel mounted work platforms moved unexpectedly during use and contacted an adjacent work stand. Analysis indicated uneven / sloping floors and lack of brake use as root causes and wheel chocks were chosen as a corrective action.

**EVENT08-081** - In October 2008, the work platform moved again during use and came into contact with an adjacent work stand. Analysis indicated that wheel chocks alone were not sufficient to stabilize the platform on the uneven floors, and new floor interfaces were developed as a corrective action. This time, corrective actions were tested and verified before the work platform was returned to use.

*NOTE: Every ULA facility has a floor – all floors may feature hazards.*

### Typical Floor Hazards

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floors that slope</td>
<td>Rough</td>
</tr>
<tr>
<td>Floors that are uneven or not smooth due to bumps, cracks, holes</td>
<td>Uneven</td>
</tr>
<tr>
<td>Floor seams that do not match up</td>
<td>Knobs</td>
</tr>
<tr>
<td>Floors with damaged surfaces (i.e. pitting, peeling or loose floor coverings)</td>
<td>Cracked</td>
</tr>
<tr>
<td>Floor mounted features (i.e. electrical outlets or drains)</td>
<td>Cables</td>
</tr>
<tr>
<td>Raised and open floors</td>
<td>Drain</td>
</tr>
<tr>
<td>Wet or slippery floors</td>
<td>Outlet</td>
</tr>
</tbody>
</table>

### Error Prevention Actions:

- Be Aware there are many floor hazards
- Verify floors are clear and safe before conducting operations
- Post Warnings in areas where floor hazards exist
- Notify management / facilities when floors need repair
- ALWAYS MAKE SURE IT IS RIGHT
Socket Wrench Drop Hazards

Each Mishap & Event provides an opportunity for ULA to learn lessons that help prevent future Mishaps. This Bulletin identifies several events where socket tips disengaged from wrench handles and fell onto, onto and or near flight hardware.

EVENT05-095 - In December 2008, a crows foot socket wrench attachment separated from a torque wrench and fell 10 feet in Decatur’s production facility. During the fall, the crows foot struck the Delta IV vehicle’s structure and caused minor damage.

Previous Events - In February of 2003 (NM03-04), a socket tip disengaged from a tethered socket wrench in the Atlas VIF at CCAFS and fell 30 feet coming to rest in the Atlas vehicle raceway.

In November of 2005 (NM05-148) a socket tip disengaged from a socket wrench during Atlas Centaur processing and fell thru an opening in the CCAFS VIF deck coming to rest on a lower deck level. This socket did not contact flight hardware.

Root Cause Analysis determined socket tips are not always compatible with the positive locking features present on the associated wrench handles.

Sockets and wrenches from dissimilar manufacturers (i.e. Craftsman and Snap On) may not have compatible locking features.

Error Prevention Actions:
- **Be Aware** socket tips represent a drop hazard that has affected both Atlas and Delta programs in the recent past.
- **Verify** socket tips lock firmly onto associated socket wrenches prior to use above or near flight hardware and/or personnel.
- **Secure** sockets via tape or other means to guarantee they will not disengage.
- **ALWAYS MAKE SURE IT IS RIGHT**
**Flash Notice Focuses Attention On Potential Hazards**

**Potential Error:** Damage to Flight Hardware Due To Loose Hardware and Loose Fasteners In Shipping Container

**System Safety**
Error Prevention Success Story
EP-SUCCESS10-010

**EVENT10-034:** Loose hardware and mold was discovered inside inbound Carbon Overwrapped Pressure Vessel (COPV) shipping containers at ULA’s Harlingen facility. Mold and loose hardware represent the following hazards:
- Hardware contamination via Foreign Object (FO) exposure
- Hardware contact / impact hazards

**ERROR PREVENTION ACTION:** Harlingen personnel documented incident via a FLASH - FLASH distributed enterprise wide.

**SUCCESS:** Decatur Technicians read the Flash and carefully examined two recently received COPV crates. Loose fasteners in both crates were discovered BEFORE the COPV’s were unpacked.

**Lessons Learned:** FLASH Notices are effective mechanisms for communicating hazards across the ULA Enterprise.

**Implementation Date:** March, 2010
**Location:** ULA Enterprise Wide
Identify the Hazards

Recognizing When Others are Taking a Risk is Easy

Recognizing When You are About to Take a Risk Requires Both Effort & Practice

STOP & THINK Before You Act

STOP When Risks/ Hazards Exist
Great News!

Errors CAN Be Prevented

ULA has an EP Process in Place ... & Statistics to Prove it Works
Questions
Backup Slides Follow
AESOP™ Defined... An Error Prevention technique used to ensure that all personnel associated with an operation are familiar with & understand their roles & responsibilities in the operation & that risks of failure are identified & mitigated.

AESOP™ Key Points
- A Structured Pause BEFORE a Task to Verify
  - Assignment
  - Equipment
  - Obstacles
  - Personnel
  - Situation
- May Be a Built-in Procedure Step
- Gets Everyone Focused on the Task
- Allows Individuals to Consider the Potential for Problems & Speak Up
- Used Daily at ULA
- All ULA Employees Receive AESOP™ Training

AESOP™...What does it stand for?

- ASSIGNMENT
  - What is the true goal we are pursuing?
  - What are we supposed to accomplish?
  - Do we need more information?
  - Have we been sidetracked by other problems?
  - Has our focus been diverted?
- EQUIPMENT
  - What do we need to do the job?
  - Is it available?
  - Is it appropriate for the task?
  - Is it working properly?
- SITUATION
  - What is the overall situation based on all the other parameters?
  - Green = Good to Go
  - Yellow = Proceed with caution
  - Red = Stop until risk can be reduced
  - A problem may not seem to add much risk, but combined with other risk factors, it may be the straw that broke the camel’s back.
- OBSTACLES
  - Are there any obstacles to completing this task with what we have available?
  - Are there any other problems we haven’t addressed?
- PERSONNEL
  - Who do we need?
  - Who is assigned to this task?
  - What is their experience level?
  - Is each person properly trained?
  - Ask each person to use the I’M SAFE checklist to assess if they are ready to take on this task. (More detail on I’M SAFE checklist in a future huddle.)

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Why Do We STOP?

- Obstacle Encountered
- Unsure of Assignment
- Uncomfortable with Situation
- Confused
- Distracted
- Overwhelmed
- Address Needs
- Tired
- . . .
STOP Command

Any ULA Process Can Be STOPPED at Any Time
At ULA … STOP is Always an Option

A STOP Command May Be Issued by Any Process Participant (e.g., Defense Contract Management Agency, Supplier, or ULA Employee)

When the Stop Command is Issued, All Associated Work Must Stop Until Authority to Proceed is Provided by the Person in Charge
Operational Fishbones

What is an Operational Fishbone?
- A Cause & Effect Analysis Tool
- Proven Method for Identifying & Documenting Risk Items within a Process
- Reliable Method for Developing & Documenting Risk Elimination or Risk Mitigation Actions
- A Tool Discussed in AESOP™ Huddles to Highlight Risks & Hazards
- A “Living Document” – It Will Be Maintained & Updated Forever

When is an Operational Fishbone Used?
- Developed for Each Critical Process
- Used Every Time Prior to Executing a Critical Process (in the AESOP™ Huddle)
- Operational Fishbones are Updated Whenever:
  - The Associated Process, Flight Hardware Design, or Associated Tooling Changes
  - When an Event (Flash Notice) Occurs

Why are we Conducting a Fishbone?
- You are Associated with a Critical Process

Who Owns the Fishbone?
- The Fishbone is Developed by the Process Stakeholders (Technicians, Supervisors, Production Engineer, Quality Engineer, Certified Responsible Engineers, Other)
- The Production Manager for the Workcenter is Responsible for Ensuring Risks are Mitigated
- The Fishbone is Maintained by the Cognizant Production Engineer for the Process

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