Error Prevention Process Overview

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Error Prevention Lead,
United Launch Alliance (ULA) December 2010

Presented at:

The United States Air Force Space Safety Council, United States Air Force Academy, Colorado Springs, Colorado, December 6-10, 2010

Error Prevention Process

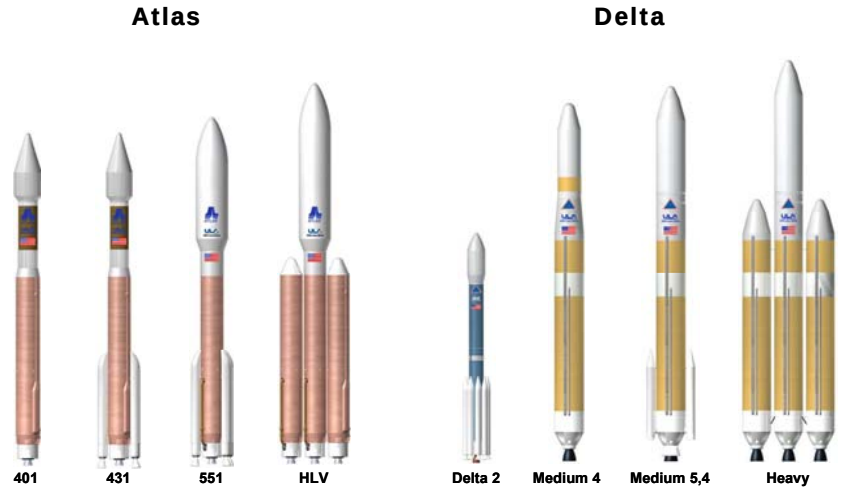
- Objective
  - Share ULA's Error Prevention Process & Experience
    - ULA & Error Prevention Background/History
    - Error Prevention Specific Definitions
    - ULA Error Prevention Process Overview
    - ULA Error Prevention Publications
    - More Lessons Learned
  - Questions are Always Welcome

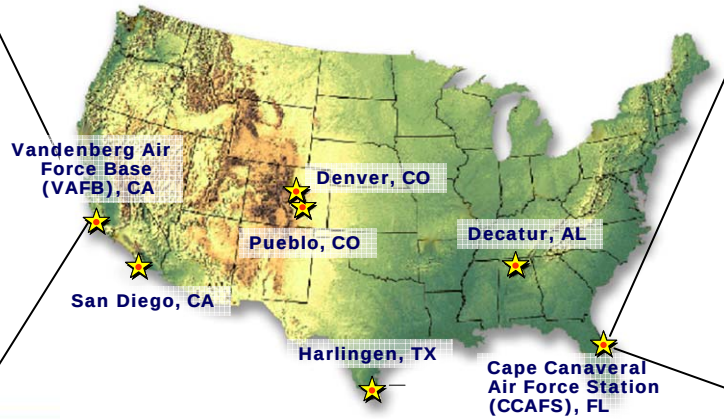
Background: Who / What is ULA?

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

ULA Launch Vehicles





Great News!

Errors CAN Be Prevented

Identify the Hazards

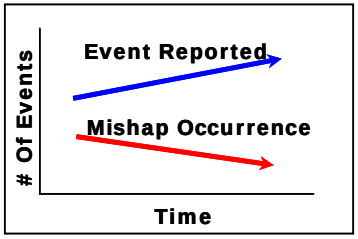
Recognizing When Others are Taking a Risk is Easy

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

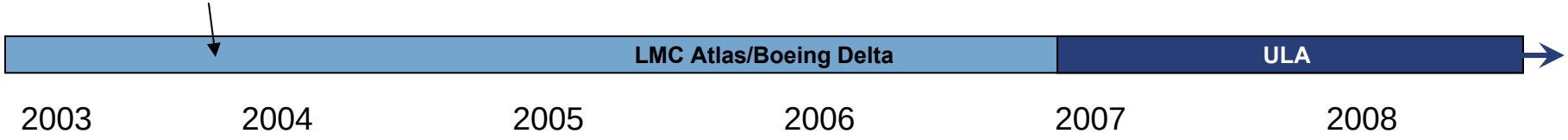
STOP & THINK Before You Act

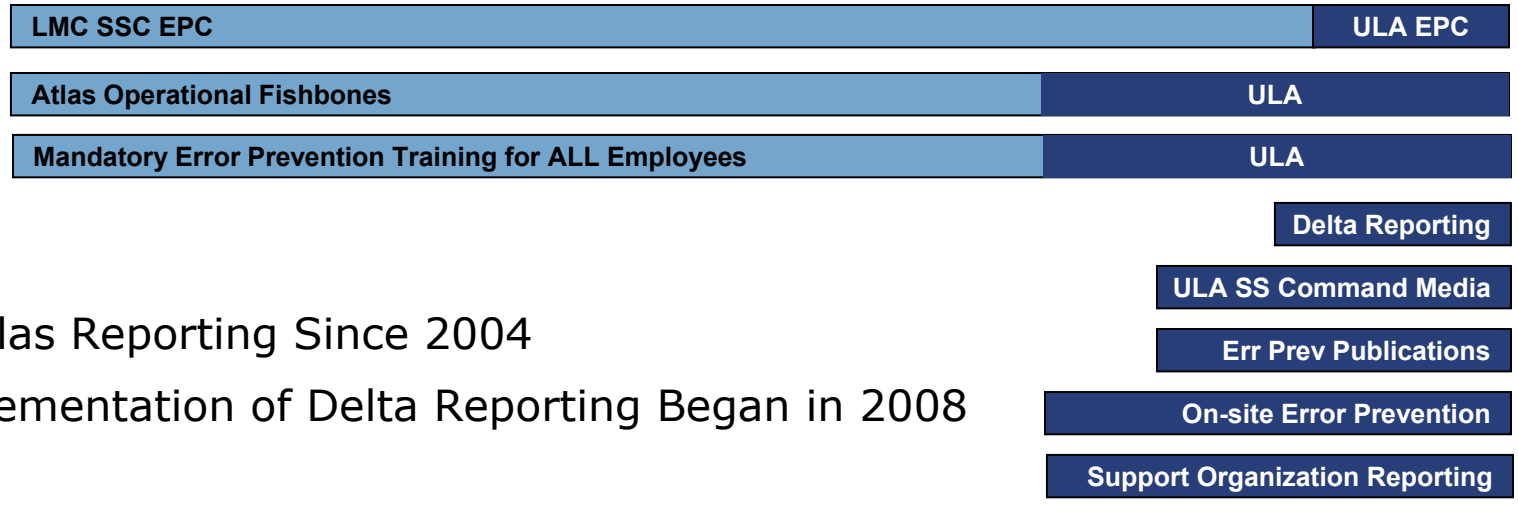
STOP When Risks / Hazards Exist

ULA Error Prevention History



TIROS Satellite Incident





- 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.

EVENT

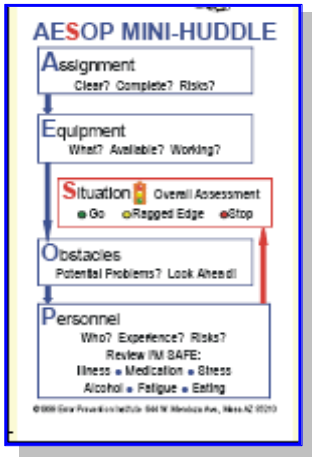
MISHAP

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.



Definitions

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.

Error Prevention Process Principles

- Achieve excellence in everything we do
- Continuously improve every process & product
- Develop a world-class work environment
- Deliver program success

ULA's Error Prevention Program is Founded on ULA's Perfect Product Delivery Ethic

ULA Error Prevention Process Technical Paper Available:

Learning from Mistakes: ULA's Error Prevention Program

by James E. Allison

Presented at the International System Safety Conference 2009

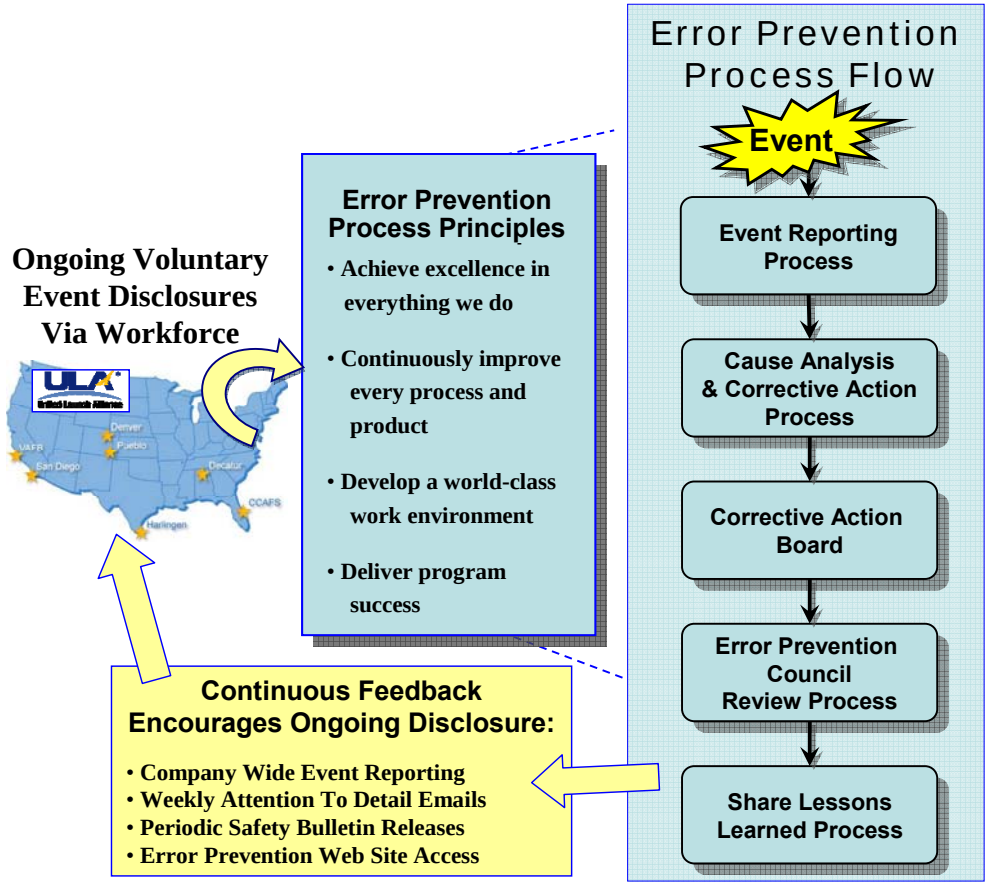
"The successful man will profit from his mistakes and try again in a different way." –Dale Carnegie

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)

The ULA Error Prevention Process Flow is Fed by Ongoing Voluntary Event Disclosure



Published Copy Available

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

Error Prevention Process + Recent Expansion

Perfect Product Delivery

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

Flow

Event

Event Reporting Process

Cause Analysis & Corrective Action Process

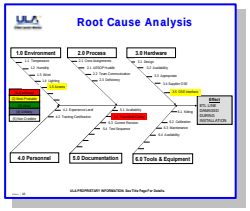
Corrective Action Board

Error Prevention Council Review Process

Share Lessons Learned Process

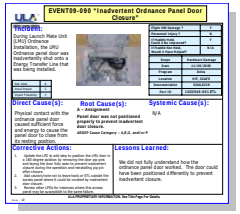
Flash

RCA



CAB

EPC



Share

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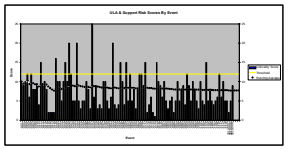
Recent (2010) Addition

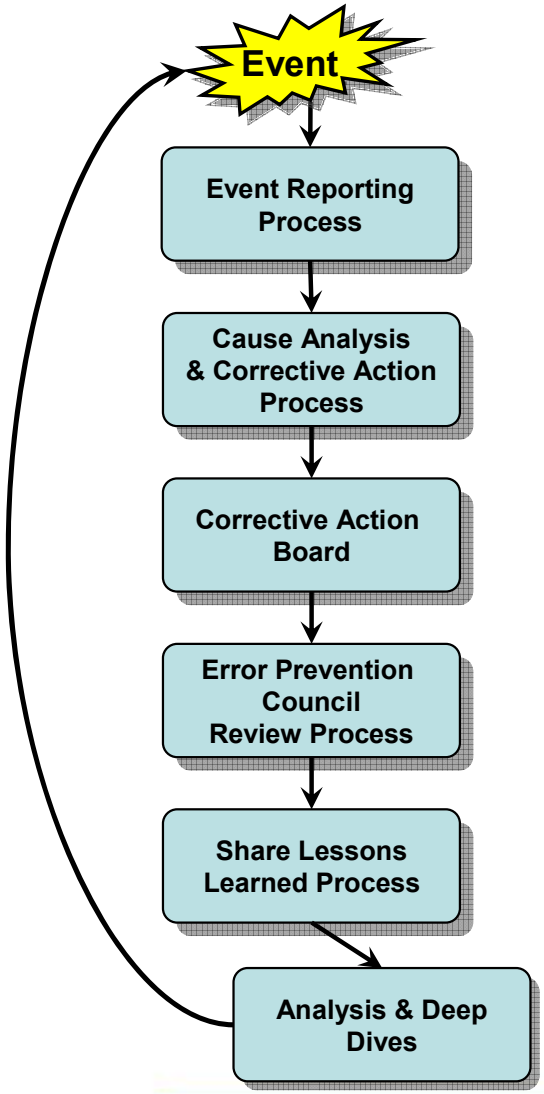
Analysis & Deep Dives

Metrics/ Reports



The EP Process is Designed to Share Lessons Learned from Mishaps/Events Across the ULA Enterprise

Error Prevention Process
A Few Key Concepts:



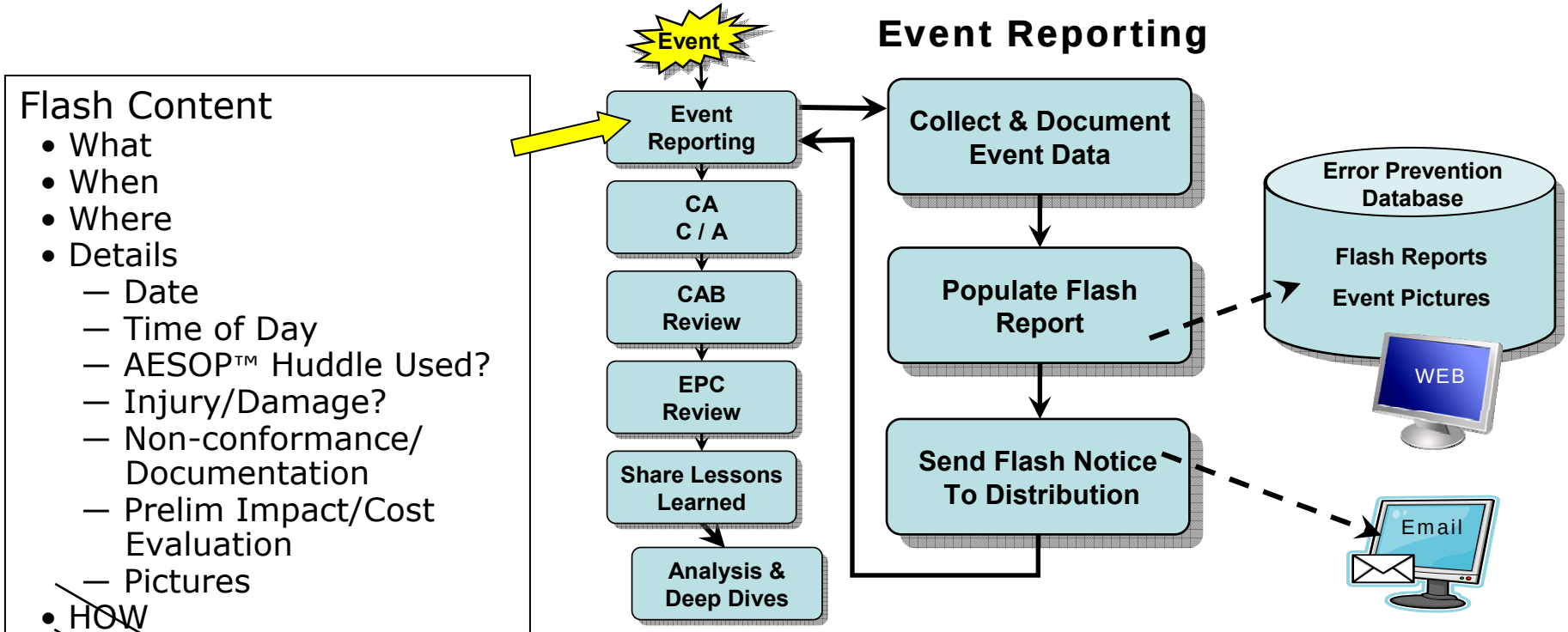
Prerequisites:

- 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



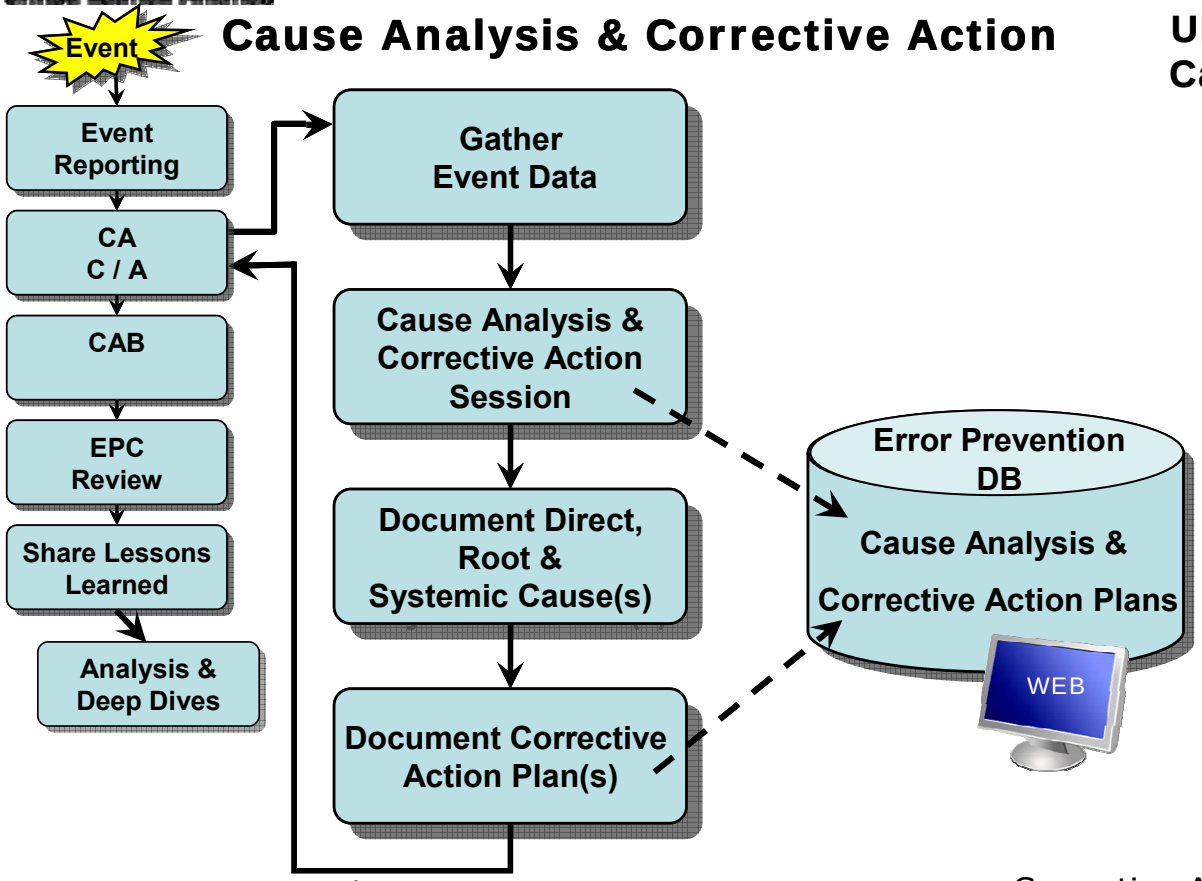
Flash Content
- What
- When
- Where
- Details
  - Date
  - Time of Day
  - AESOP™ Huddle Used?
  - Injury/Damage?
  - Non-conformance/ Documentation
  - Prelim Impact/Cost Evaluation
  - Pictures
- ~~HOW~~
- ~~WHO~~

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

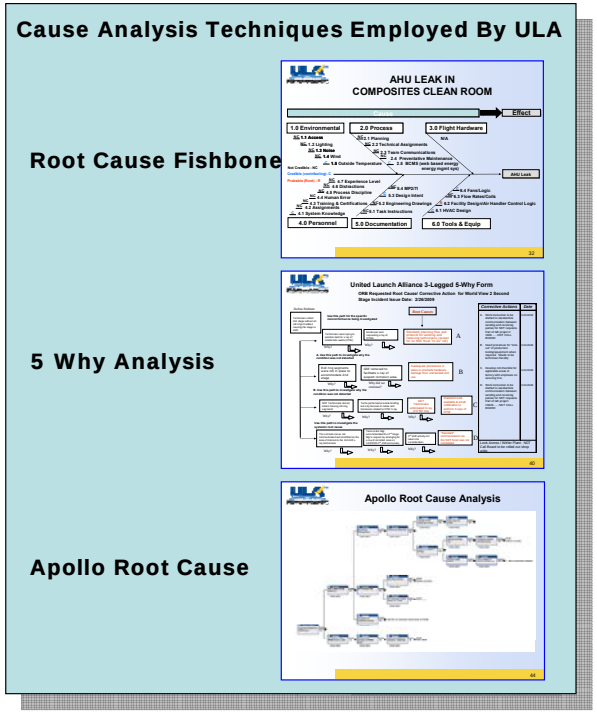
The Event Reporting Process is Triggered Each Time an Event Occurs

Cause Analysis and Corrective Action Process

Cause Analysis & Corrective Action



ULA Employs a Variety of Root Cause Analysis Techniques



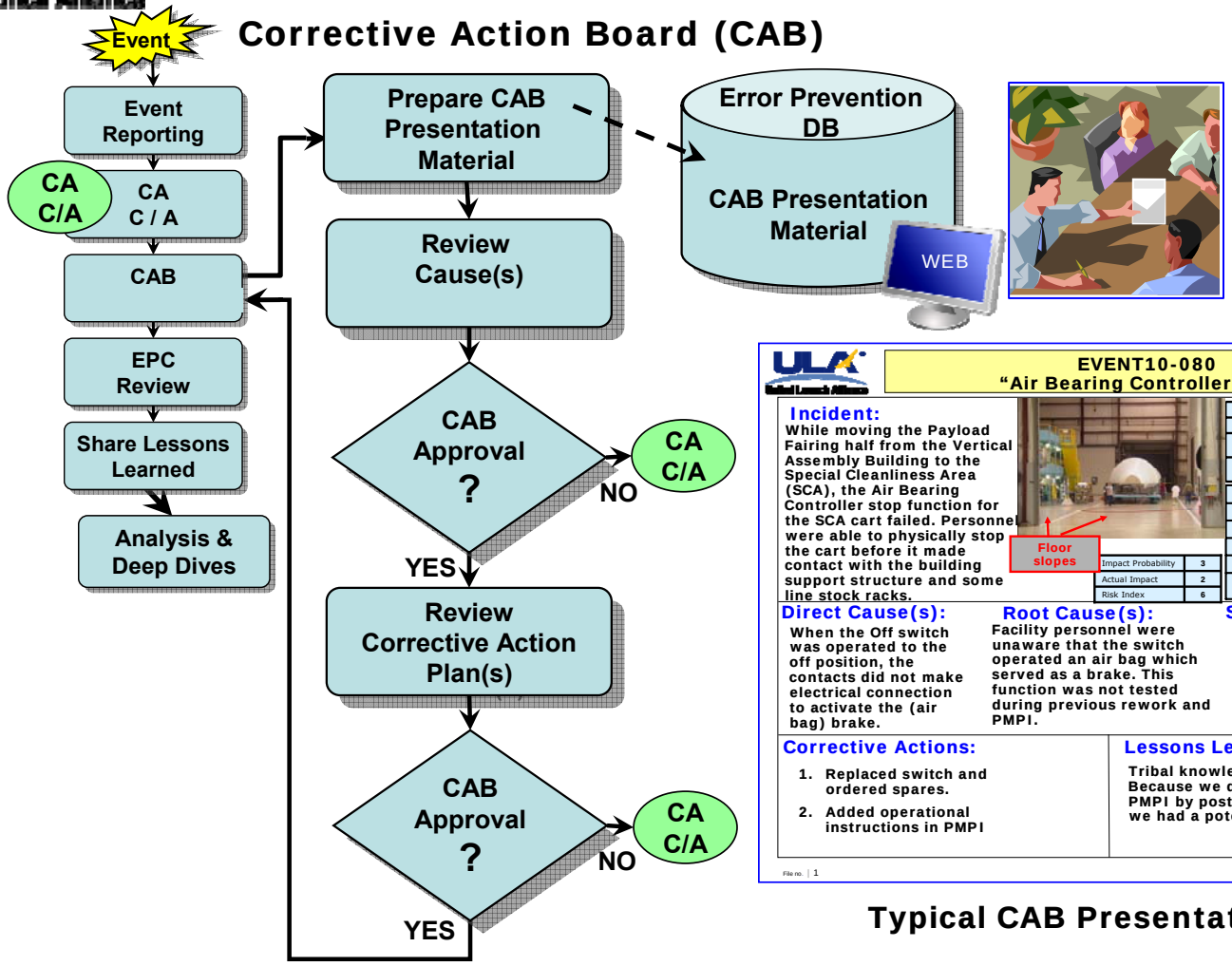
Cause Analysis
- Performed at Site of Occurrence
- Performed by an Investigation Team
- Formal Causal Analysis Method
- Documented Results
- Identify Direct, Root & Systemic Causes

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

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

Corrective Action Board Process

Corrective Action Board (CAB)

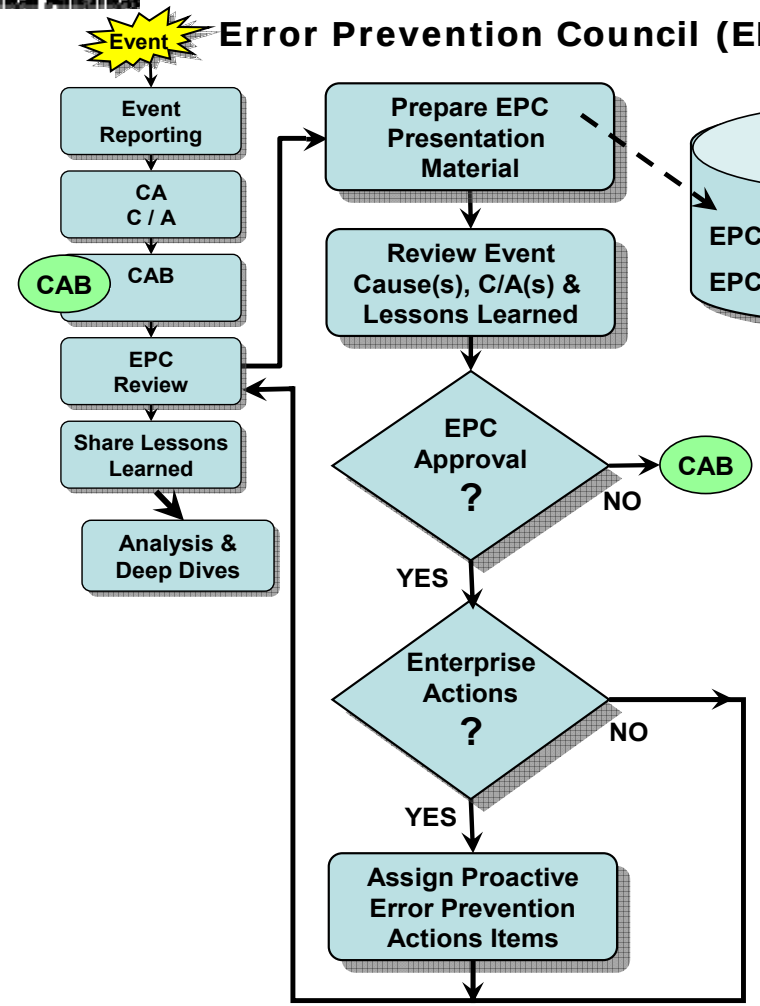


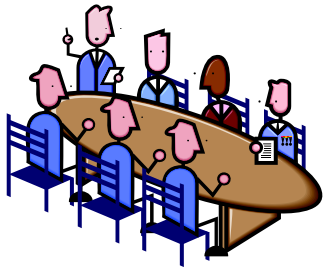
Typical CAB Presentation Format

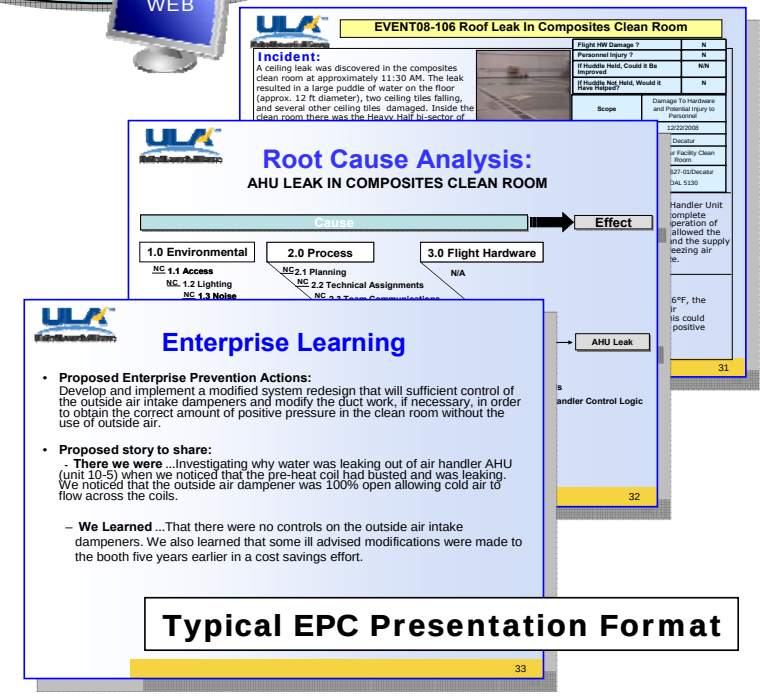
CABs are Executed to Verify an Event's Cause(s) & Corrective Action(s) are Accurate & Appropriate

Error Prevention Council Process

Error Prevention Council (EPC)



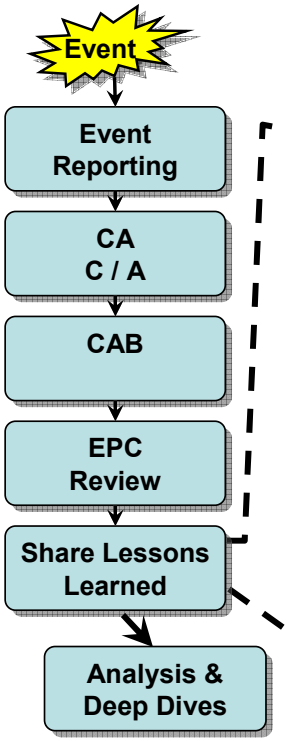




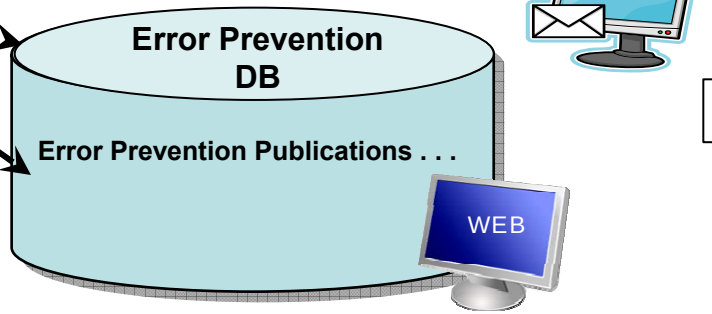
Typical EPC Presentation Format

The EPC Meets Monthly to Ensure Lessons Learned & Improved Practices are Applied Across the ULA Enterprise

Share Lessons Learned Process



Error Prevention Publications	
Publication	**Distributed to**
Safety Bulletins	Specific ULA Departments Based on Subject
Perfect Product Delivery Attention to Detail Topics	All ULA Management & Interested ULA Employees
There We Were Stories	Often Attached to Perfect Product Delivery Attention to Detail Topics
Success Stories	Often Attached to Perfect Product Delivery Attention to Detail Topics



Publication Examples Follow

The Share Lessons Learned Process Generates & Distributes a Variety of Error Prevention Data & Products

Analysis and Deep Dive Process

Event

Event Reporting

CA C / A

CAB

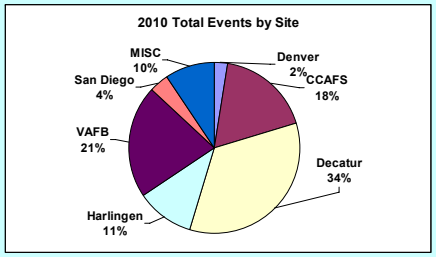
EPC Review

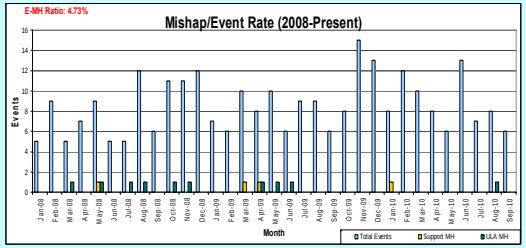
Share Lessons Learned

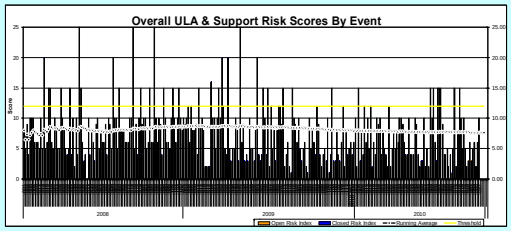
Analysis & Deep Dives

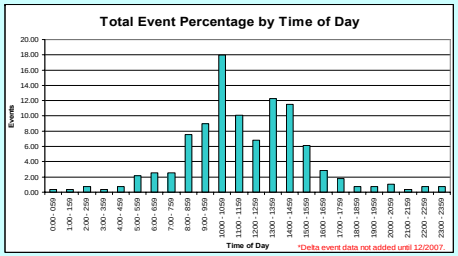
Analysis Tasks Look for Trends

Monthly





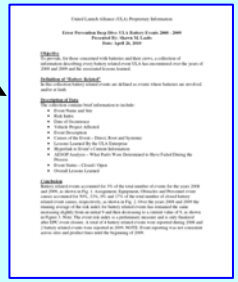


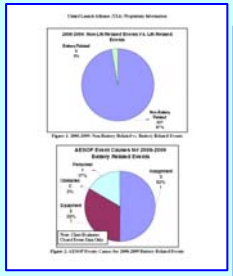


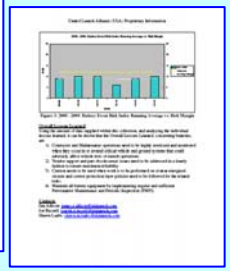
Many More

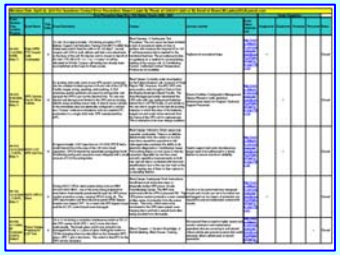
Deep Dive Tasks Document Observed Trends

Ongoing









Many More

The Analysis & Deep Dive Process Looks for & Documents Event / Mishap Trends via Historical Data Analysis

Metrics Demonstrate Error Prevention Process is Working

Perfect Product Delivery

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

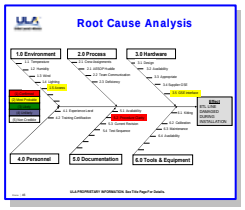
Flow

Event

- Event Reporting Process
- Cause Analysis & Corrective Action Process
- Corrective Action Board
- Error Prevention Council Review Process
- Share Lessons Learned Process

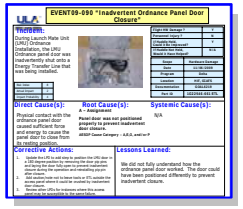
Flash

RCA



CAB

EPC



Share

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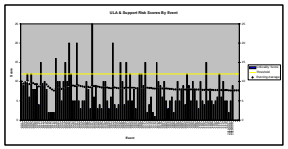
Continuous Feedback Encourages Ongoing Disclosure:

- Company Wide Event Reporting
- Weekly Attention To Detail Emails
- Periodic Safety Bulletin Releases
- Error Prevention Web Site Access

Recent (2010) Addition

Analysis & Deep Dives

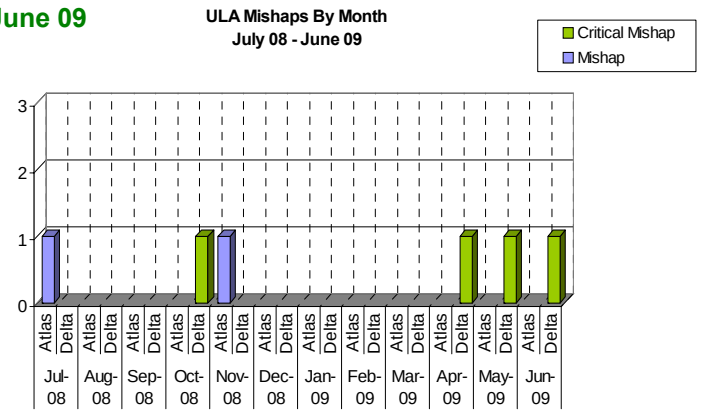
Metrics/ Reports



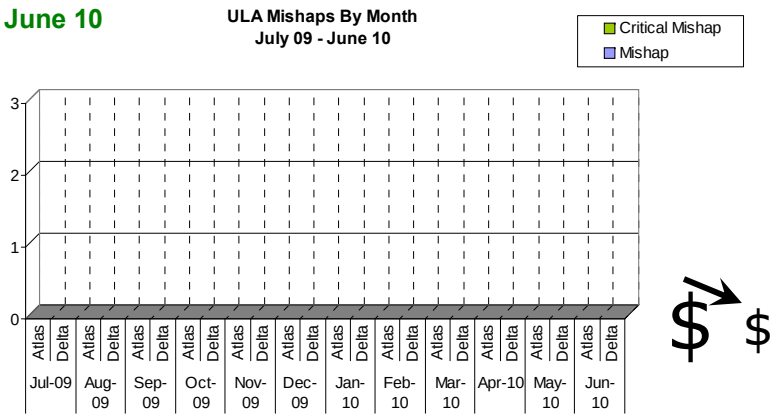
Metrics Demonstrate a Measurable Reduction in Mishap Frequency & Severity

Error Prevention Metrics – Mishap-free Time Span Increasing

July 08 – June 09



July 09 – June 10



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Mishap ≥$20K Hardware Damage

Critical Mishap ≥$100K Hardware Damage

- 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)

First 12 Month Period with No ULA Mishaps!

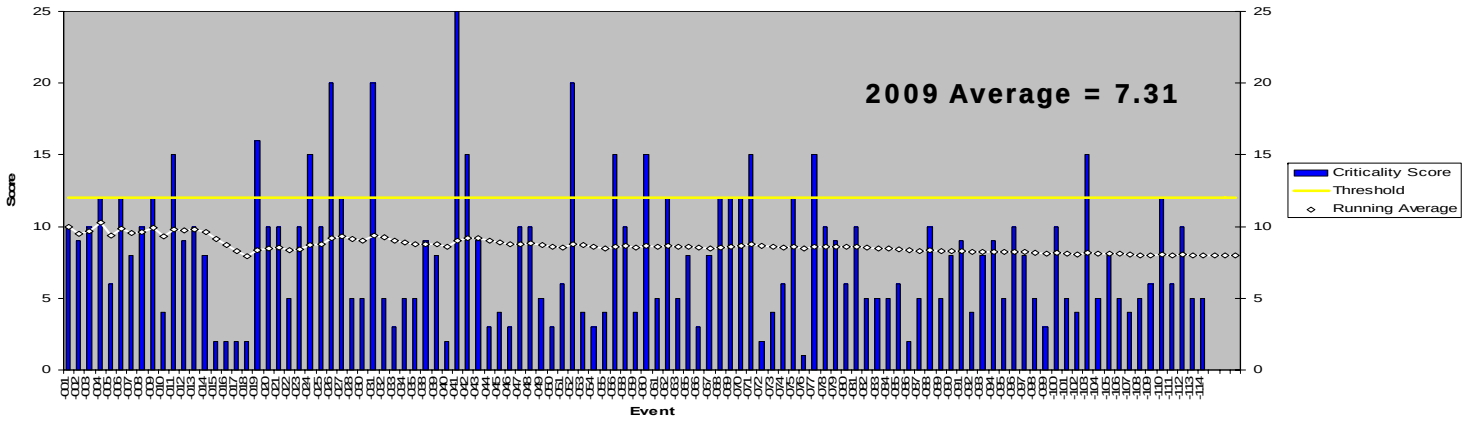
***(Last Mishap: 4 June 2009)**

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



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".

Probability for Damage: A subjective value representing a reasonable estimate of the highest level of damage, or disruption an event could have made had circumstances favored the worst possible outcome.

Probability for Damage		Event Risk Index Scores				
5	Damage Reasonably Expected	5	10	15	20	25
4	Damage Between Credible and Reasonable	4	8	12	16	20
3	Damage Credible	3	6	9	12	15
2	Damage Likely	2	4	6	8	10
1	Damage Unlikely	1	2	3	4	5
		Minor Impact	Small Impact	Moderate Impact	High Impact	Significant Impact
		1	2	3	4	5
		Actual Impact				

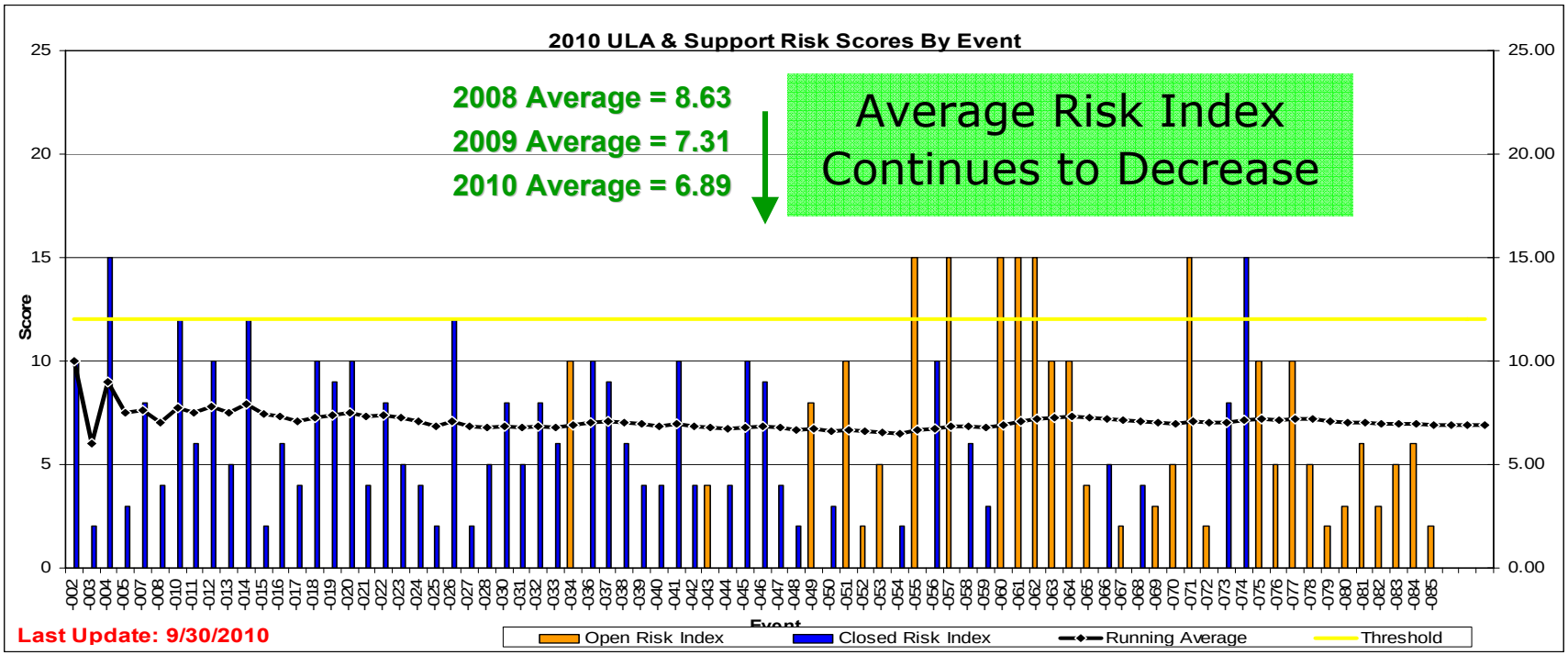
Actual Impact: An event's actual impact on ULA operations.

- **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

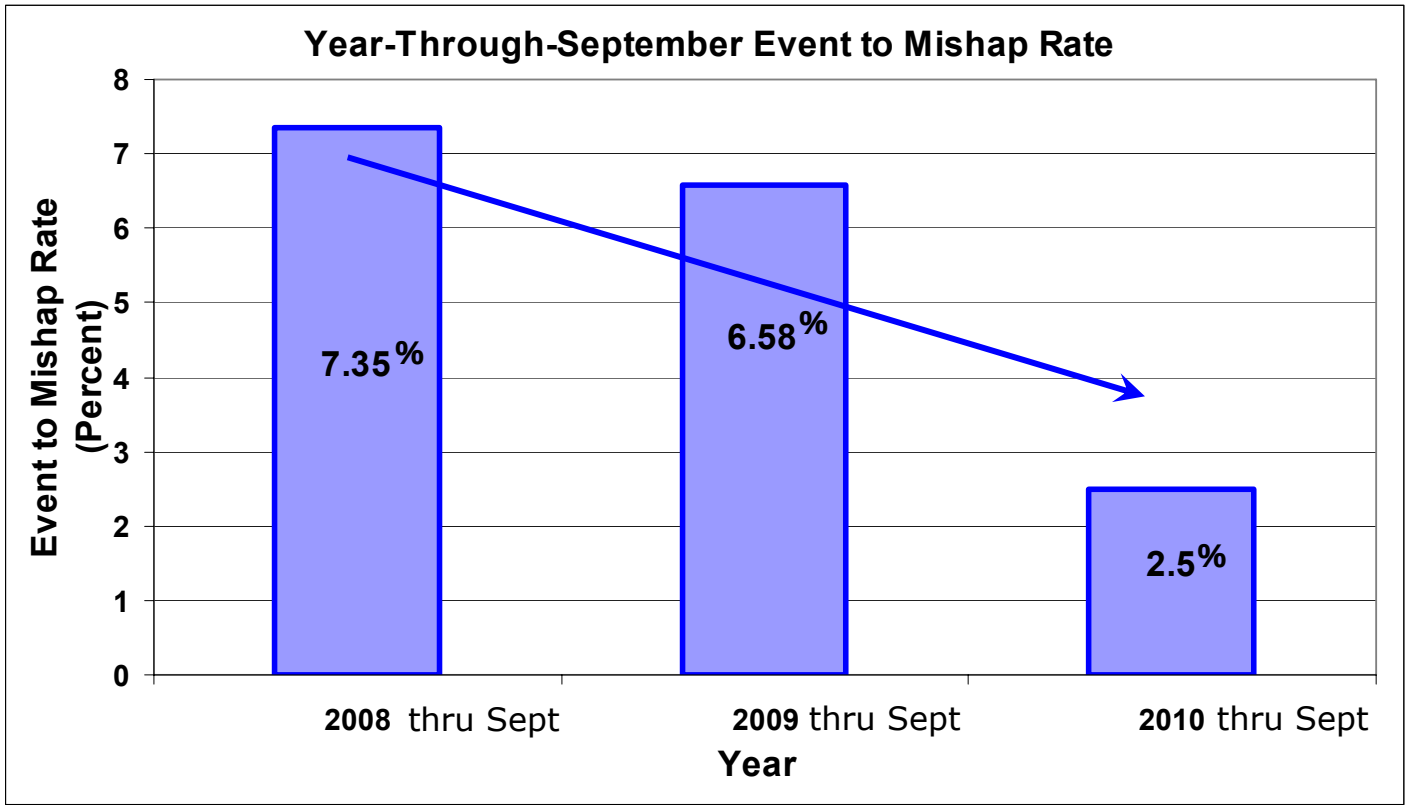
- Event/Mishap Ratio Continues to Show We are Learning & Improving
- Overall Risk Index for 2010 Continues to Decrease
- 18 Deep Dive Packages Developed & Available as ULA Resource
  - Several Enterprise Actions In-work and/or Improvement Projects Identified
- Error Prevention Team Supporting Level-1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



ULA's Average Risk Index is Decreasing

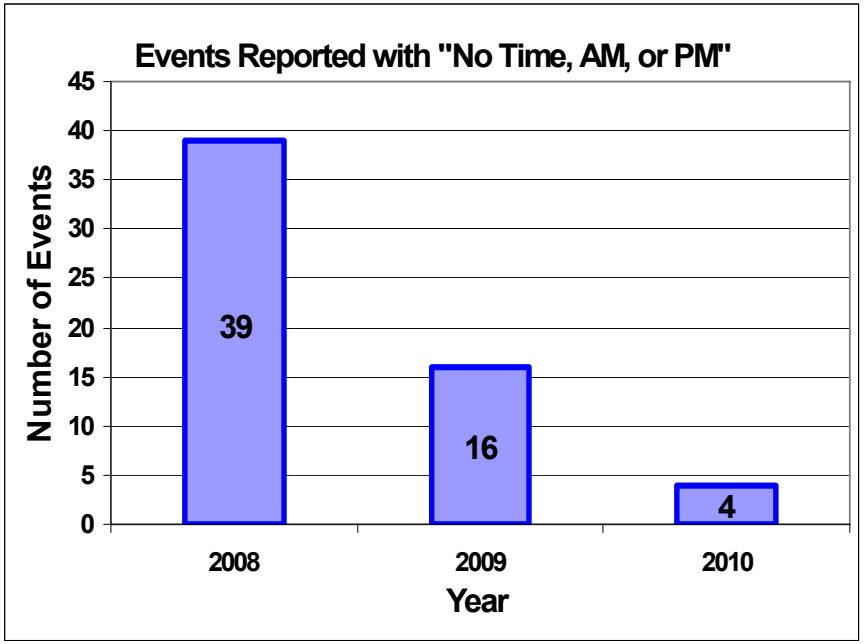
Error Prevention Metrics – Event to Mishap Ratio

Mishap Ratio = # of Mishaps/Total # of Events (for a Given Period of Time)
Reduction in Mishap Ratio Indicates Error Prevention Process Health



1 ULA's Mishap Ratio is Decreasing

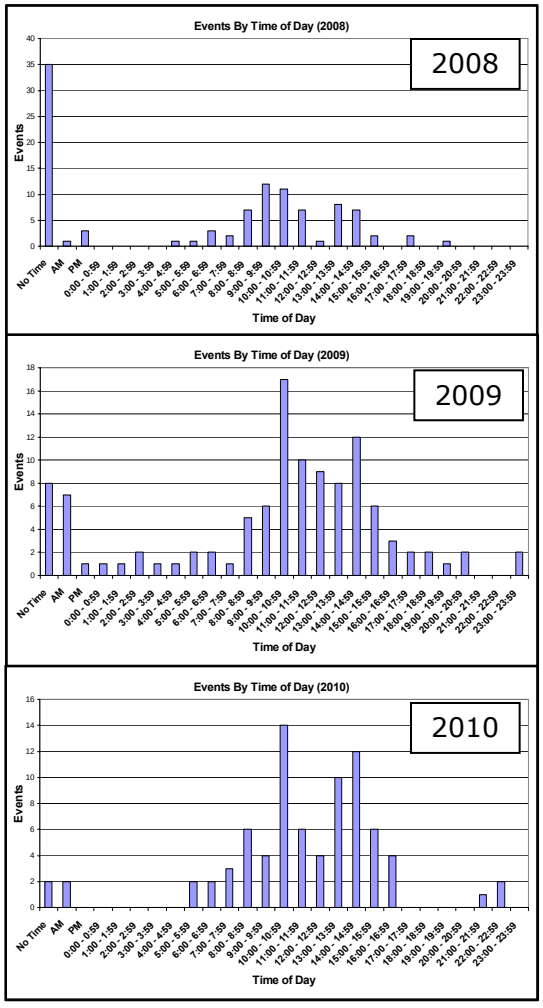
Error Prevention Metrics – Increased Reporting Detail



2008-2010 Flash Notice Data Has Been Increasingly More Detailed/Specific

EX: 10:33 AM vs AM

Greater Detail = Greater Insight & Understanding



Improving Fidelity

Improved Reporting Detail/Specificity Yields Higher Fidelity Metrics

Error Prevention Metrics – Increased Reporting Detail

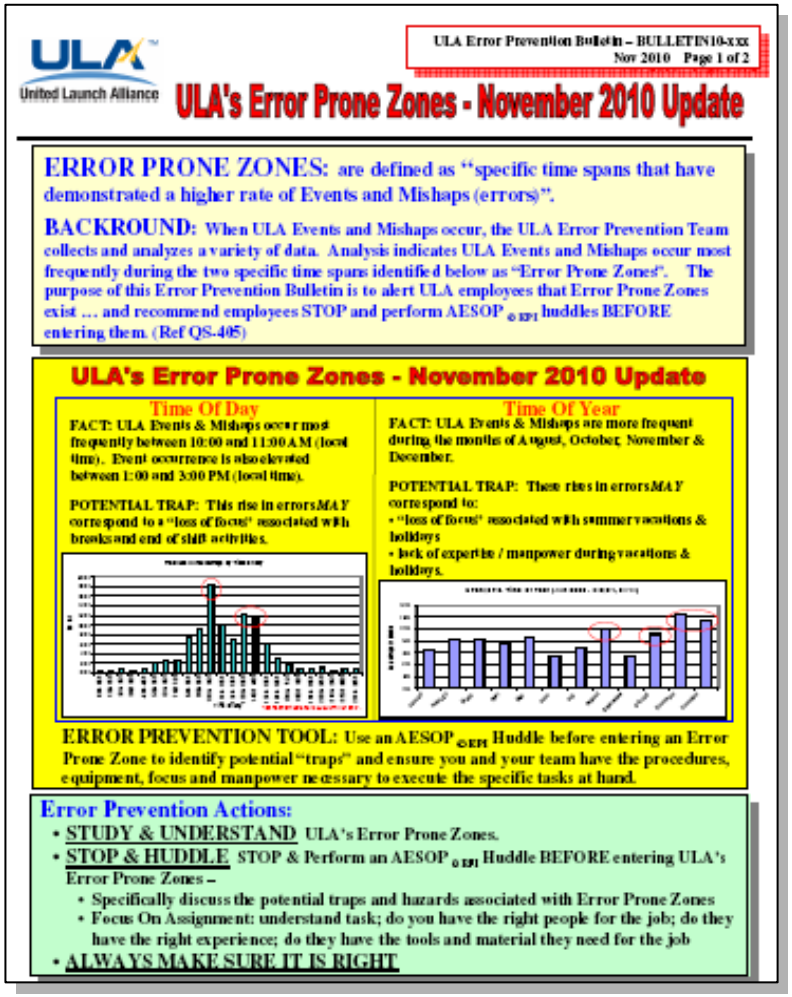
Example:

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



ULA Error Prevention Bulletin – BULLETIN10-xxx
Nov 2010 Page 1 of 2

United Launch Alliance

ULA's Error Prone Zones - November 2010 Update

ERROR PRONE ZONES: are defined as "specific time spans that have demonstrated a higher rate of Events and Mishaps (errors)".

BACKROUND: When ULA Events and Mishaps occur, the ULA Error Prevention Team collects and analyzes a variety of data. Analysis indicates ULA Events and Mishaps occur most frequently during the two specific time spans identified below as "Error Prone Zones". The purpose of this Error Prevention Bulletin is to alert ULA employees that Error Prone Zones exist … and recommend employees STOP and perform AESOP © EPI huddles BEFORE entering them. (Ref QS-405)

ULA's Error Prone Zones - November 2010 Update

Time Of Day

FACT: ULA Events & Mishaps occur most frequently between 10:00 and 11:00 AM (local time). Event occurrence is also elevated between 1:00 and 3:00 PM (local time).

POTENTIAL TRAP: This rise in errors *MAY* correspond to a "loss of focus" associated with breaks and end of shift activities.

Time Of Year

FACT: ULA Events & Mishaps are more frequent during the months of August, October, November & December.

POTENTIAL TRAP: These rises in errors *MAY* correspond to:
- "loss of focus" associated with summer vacations & holidays
- lack of expertise / manpower during vacations & holidays.

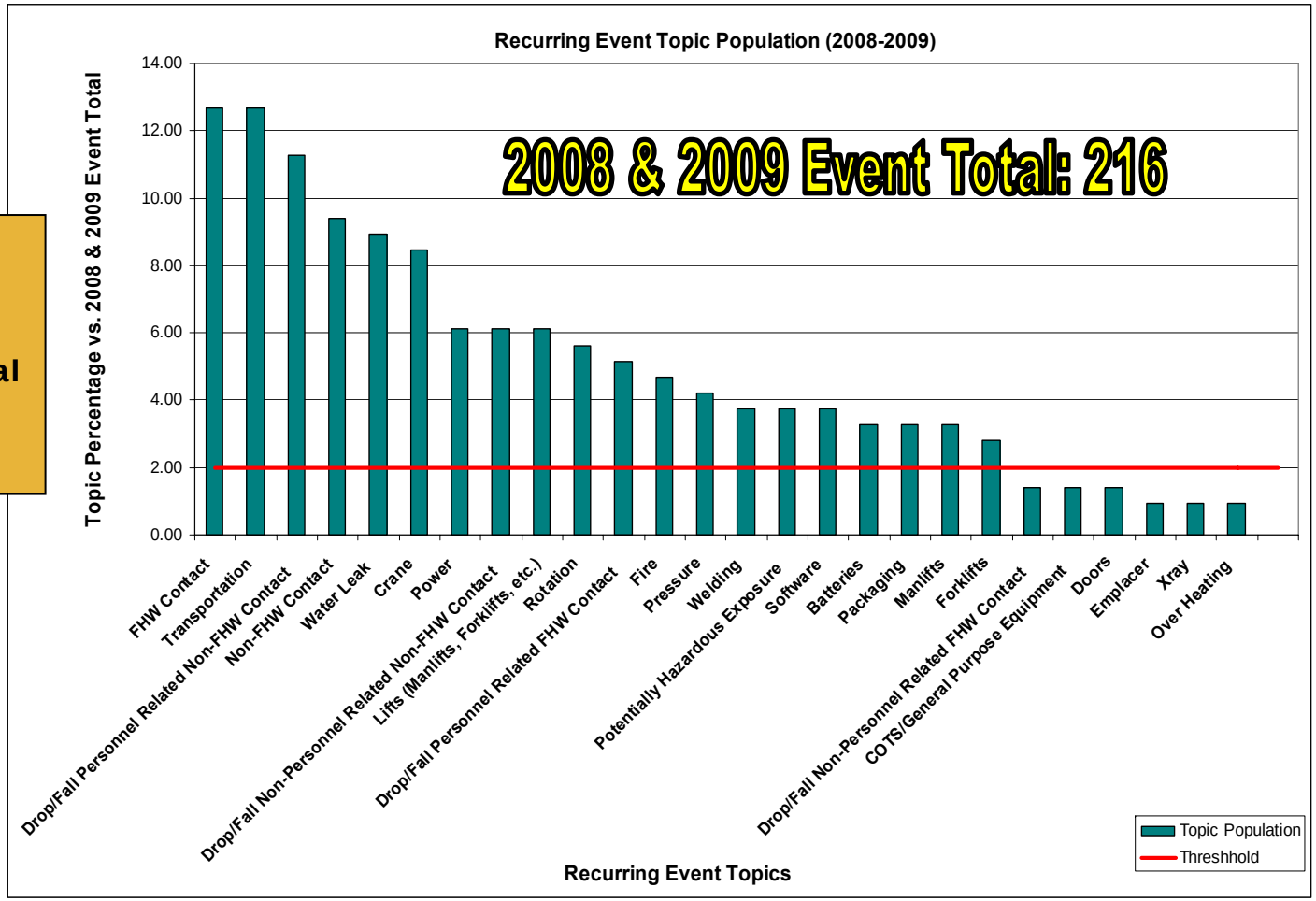
ERROR PREVENTION TOOL: Use an AESOP © EPI Huddle before entering an Error Prone Zone to identify potential "traps" and ensure you and your team have the procedures, equipment, focus and manpower necessary to execute the specific tasks at hand.

Error Prevention Actions:
- STUDY & UNDERSTAND ULA's Error Prone Zones.
- STOP & HUDDLE STOP & Perform an AESOP © EPI Huddle BEFORE entering ULA's Error Prone Zones –
  - Specifically discuss the potential traps and hazards associated with Error Prone Zones
  - Focus On Assignment: understand task; do you have the right people for the job; do they have the right experience; do they have the tools and material they need for the job
- ALWAYS MAKE SURE IT IS RIGHT

Error Prevention Bulletins Communicate Specific Hazards

Error Prevention Metrics –
Event Topic Tracking Feeds Deep Dive Analysis

Deep Dives Allow ULA Employees & Contractors to Access Historical Incident Data Based on Topic/Task



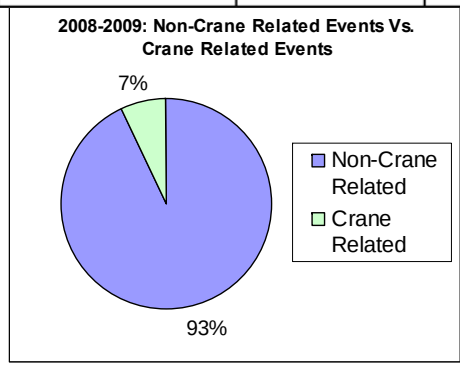
Note: Events May Be Categorized in to More Than One Topic; Lessons Learned May Be Common Over Topics

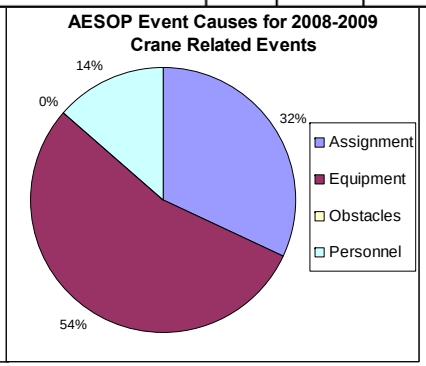
Deep Dive Analysis Identifies & Documents Common Hazards & Lessons Learned

Error Prevention Metrics – Deep Dive Example

Error Prevention Deep Dive
ULA Crane Events 2008-2009

Error Prevention Deep Dive: ULA Crane Events 2008 - 2009						Cause Categories				
Event Number, Date, Location, Project	Event Name	Event Description	Causes	Lessons Learned	Event Status Database Link	Assignment	Equipment	Obstacles	Personnel	Status
2008-001, 1/8/2008, Harlingen, Atlas	Lifting Tool for Payload Fairing Cylinder Strikes Transport Cart	The PLF cylinder half was removed from assembly tool and was in the process of being loaded on the transport cart when its lifting tool struck a metalic support on the transport cart. The process requires two cranes and manual adjustment to properly load on the cart. Each process should have been done in seperate sequences but they occurred at the same time. The effort from the manual adjustment was countering one of the crane's movement until the cylinder was released. This allowed the cylinder to swing thus the end of the tool struck the carts supporting bracket. Travel was under 20 inches and with light force.	**Root Causes:** 1) Person In Charge lost control. 2) Manual guides required on all 4 corners. 3) Required sequenced processes was lost.	In the AESOP Huddle held prior to the process the Person In Charge (PIC) needs to specifically state, "I am in charge, all comments are to be directed to me."	http://inside.ulalaunch.com/org/oqass/ep/Lists/Event%20Status/DispForm.aspx?ID=122	0.5			0.5	Closed





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

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

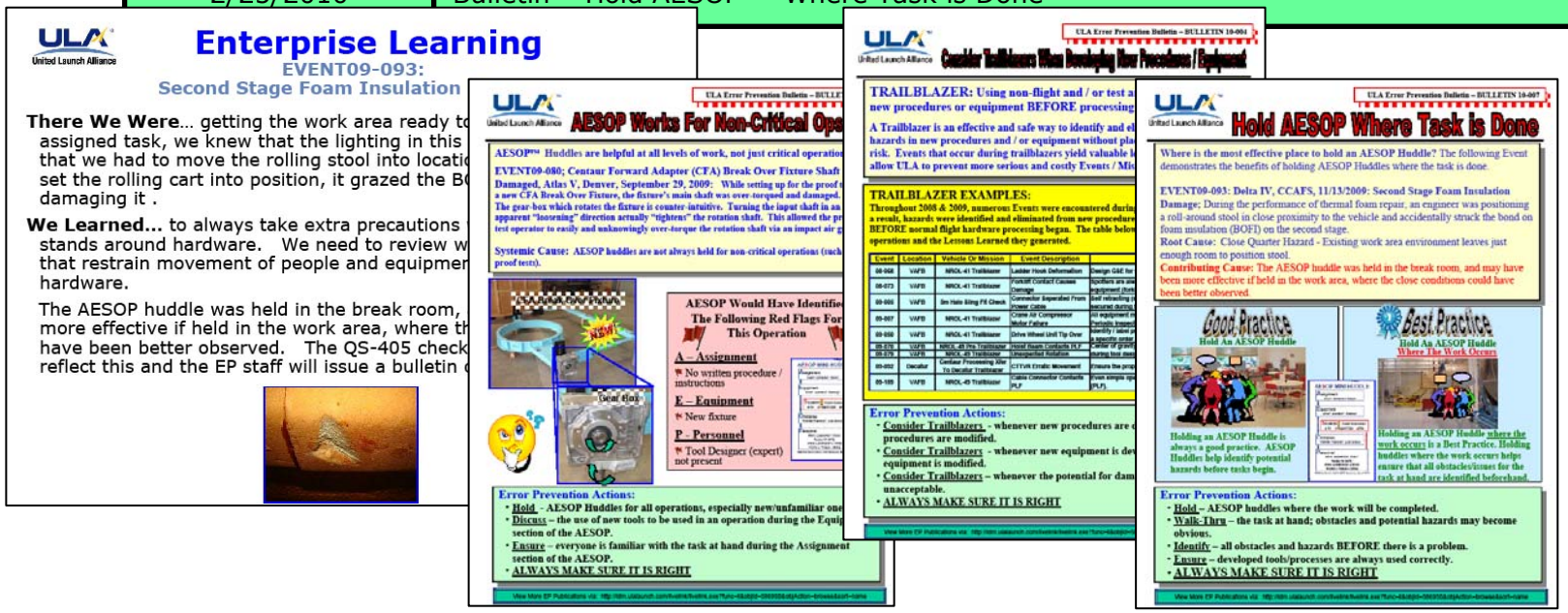
Error Prevention Publication	Publication Frequency	# Published Yearly	# Published Since Inception
Perfect Product Delivery, Attention To Detail Emails	Weekly	50	170 +
Picture Of The Week	Weekly	50	40 +
Safety Bulletins	As Directed By The EPC	30 (so far in 2010)	80
There We Were Stories	Monthly	100 +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

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

Release Date	Email Topic
2/4/2010	There We Were – EVENT09-093 2nd Stage Foam Damage
2/11/2010	AESOP ™ Huddles Work for Non-Critical Ops Too
2/18/2010	Bulletin – Consider Trailblazers When Developing New Procedures Equipment
2/25/2010	Bulletin – Hold AESOP ™ Where Task is Done



Error Prevention Publications: EP PIC of the Week

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

ULA Error Prevention Hazardous Pic Of The Week

ERROR PREVENTION

How many hazards can you identify in this picture ?

Recognizing when others are taking a risk is easy.

Recognizing when you are about to take a risk requires both effort and practice.

Use AESOP huddles to identify and address risks BEFORE you start a task.

For more information on the AESOP Huddle Process, see QS-405 in the command media library at the following link:
http://inside.ulalaunch.com/org/oig/cmi/published%20library/qs-405.pdf

Please Address Comments / Questions to:
james.e.allison@ulalaunch.com

8/26/2010

Error Prevention Publications: Error Prevention Bulletins

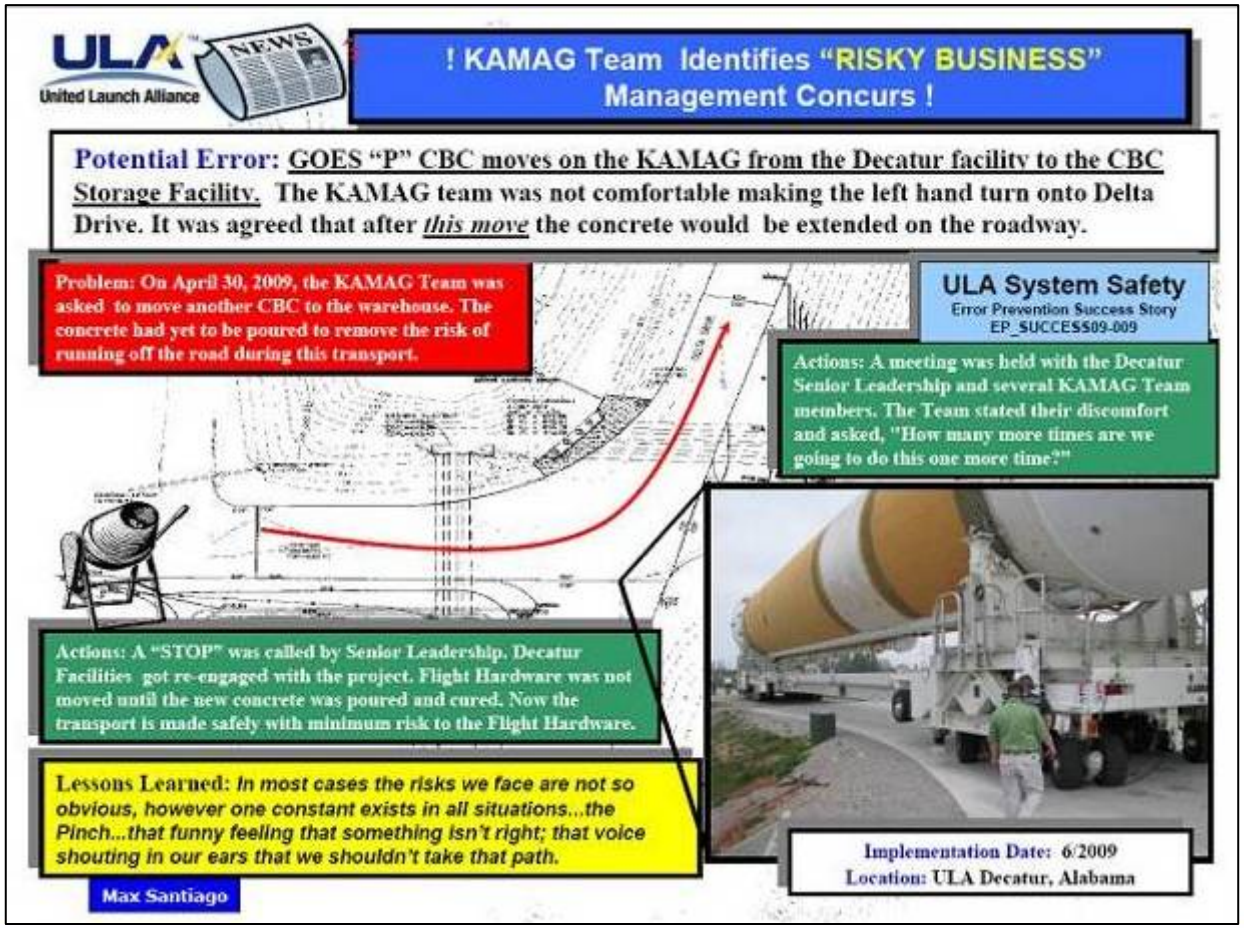
Objective: Document/Share Identified ULA Hazards
Document/Share Suggested EP Practices

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

Note: May Require Closed-loop Distribution

Error Prevention Publications: Success Stories

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



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

Error Prevention 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

Error Prevention Deep Dive: ULA Crane Events 2008 - 2009						Cause Categories				
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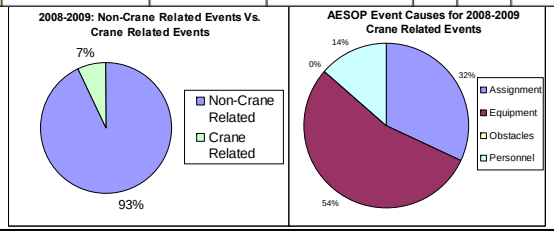


Identify the Hazards

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

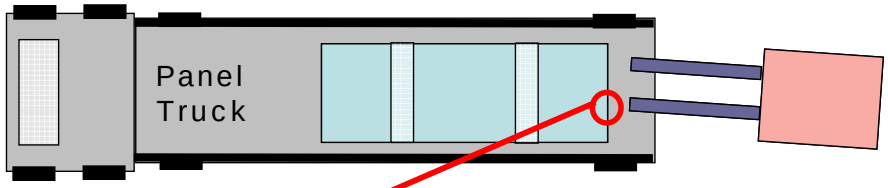
STOP When Risks / Hazards Exist

ULA Error Prevention Lessons Learned
Collected Examples

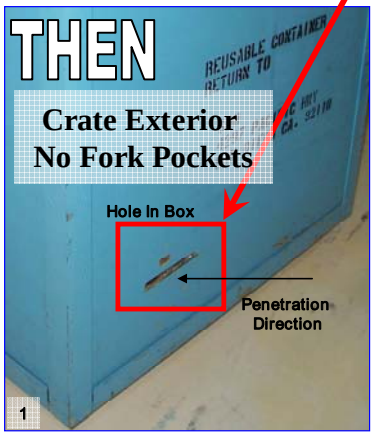
ATLAS System Safety
Error Prevention Success Story

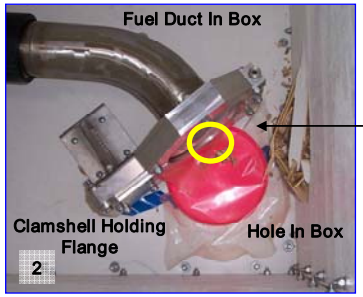
Potential Error: Fork Lift Pierces Crate & Damages Flight HW

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



Mistake Proofed Crate Allows Fork Lift Access From All Sides





Crate Interior – HW Damage

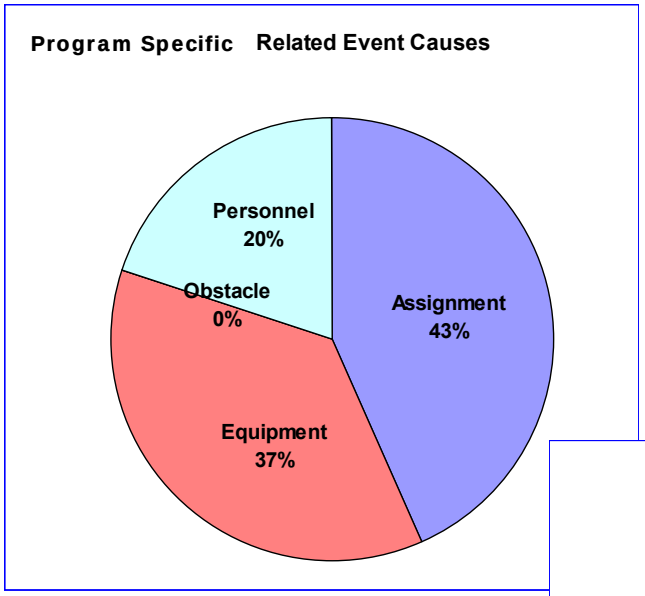
Error Prevention Action:

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.

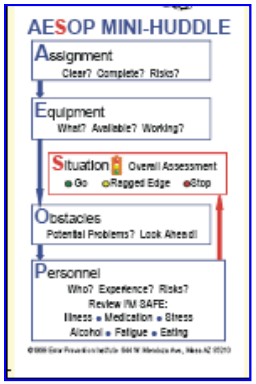
Implementation Date: Nov 2007
Location: SDO

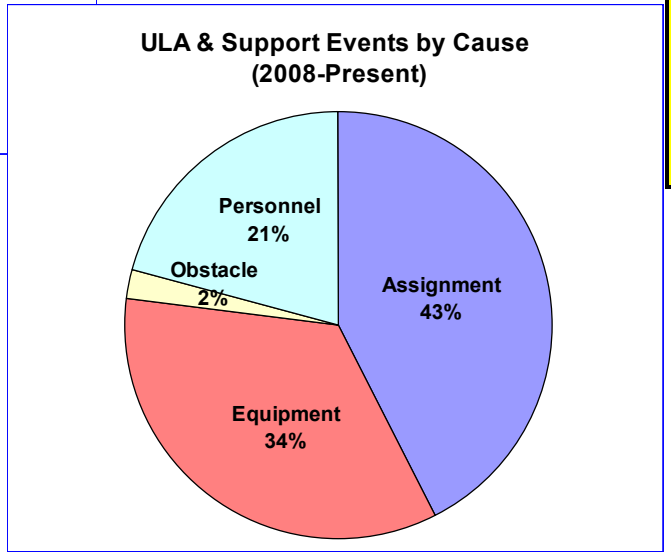
Program Specific Metric Focus Example: Event Causes Study -



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

Data shows > Not Really …





Causes	Examples	Avoid / Eliminate Via AESOP Huddle Focus
A - Assignment	Procedure lacks detail	Assignment Clear?, Complete?, Risks? © Error Prevention Institute
E – Equipment	Equipment / Tooling broken, inadequate	Equipment What?, Available?, Working? © Error Prevention Institute
O – Obstacle	Mother Nature – Hurricane, Rain	Obstacles Potential Problems?, Look Ahead? © Error Prevention Institute
P – Personnel	Intentionally not following procedure	Personnel Who?, Experienced?, Risks? Review I'm SAFE: Illness, Medication, Stress, Alcohol, Fatigue, Eating © Error Prevention Institute

Program Specific Related Event Cause "Signature" Matches the Overall ULA 2008-2009 Event Cause Signature

Error Prevention Opportunity: EP-OPP09-008
Spotter Assignment / Task Not Clearly or Consistently Described

United Launch Alliance

Opportunity:

Program: Atlas/Delta
Location: All ULA
Date Identified: 11/3/2009
Identified By: EPC

POTENTIAL FOR:	
Flight HW Damage ?	Y
Personnel Injury ?	Y
Support HW Damage ?	Y
Schedule Delay ?	Y

Causes:

- Spotter Assignments not well defined
- Spotter Tasks not clearly or consistently described
- Spotters not aware of the importance of their task

HAZARD:

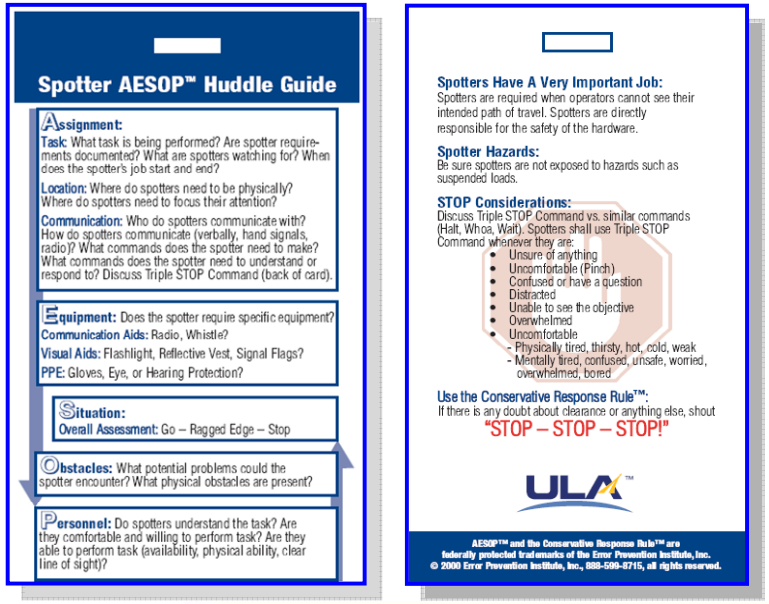
Numerous ULA Events are attributed to spotters and spotter related operations.
Spotters do not always STOP operations appropriately to prevent Events.

Support Provided:

- Badges Cost about $2000

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

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- ULA Error Prevention Bulletin – BULLETIN 09-005

United Launch Alliance

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 strike a composite x-brace and then fall to the factory floor. Fortunately, no personnel or hardware was damaged.

EVENT08-089

EVENT08-096

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**

United Launch Alliance

- ULA Error Prevention Bulletin – BULLETIN 09-012

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.

EVENT08-103 –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.

Photos courtesy of RSA Network Inc.

Error Prevention Actions:

- Recognize the types of transportation height poles your department uses.
- Replace out of date poles that do no 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

United Launch Alliance

- ULA Error Prevention Bulletin – BULLETIN 09-014

Understand & Identify Hand Force Only Requirements

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.

EVENT09-013 Schrader Valve

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**

- ULA Error Prevention Bulletin – BULLETIN 09-009

United Launch Alliance

Floor Hazards

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

- Floors that slope
- Floors that are uneven or not smooth due to bumps, cracks, holes,
- Floor seams that do not match up
- Floors with damaged surfaces (i.e. pitting, peeling or loose floor coverings)
- Floor mounted features (i.e. electrical outlets or drains)
- Raised and open floors
- Wet or slippery floors

Error Prevention Actions:

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

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- ULA Error Prevention Bulletin – BULLETIN 09-008

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 into, onto and or near flight hardware.

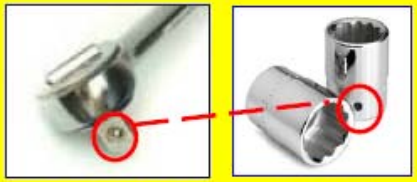
EVENT08-095 - In December 2008, a crows foot socket wrench attachment separated from a torque wrench and fell 10 feet in Decatur's production facility. During the fall, the crows foot struck the Delta IV vehicle's structure and caused minor damage.

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 socked 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.



Wrench Tip Lock Feature Must Engage Socket Lock Feature To Stay Secure

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

United Launch Alliance

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:

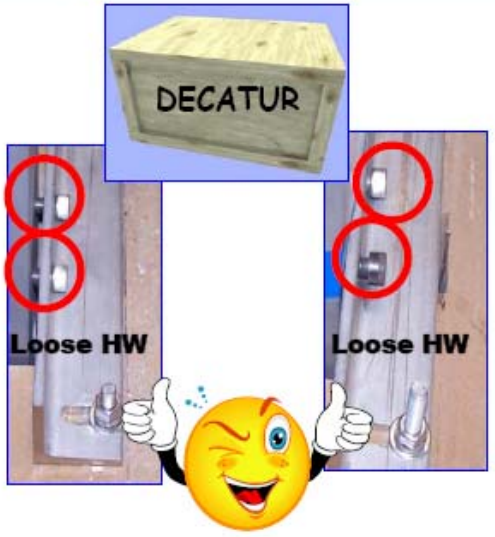
- Hardware contamination via Foreign Object (FO) exposure
- Hardware contact / impact hazards

Harlingen Techs Discover Mold & Loose HW Inside Shipping Container

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

Harlingen Techs Write & Submit A FLASH Which Is 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.



3 Days Later … Decatur Techs Read FLASH & Discover Similar Hazards BEFORE Processing HW

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

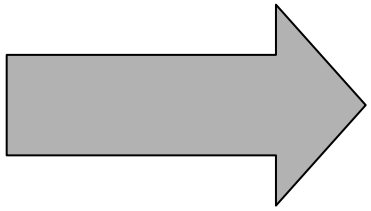
Great News!

Errors CAN Be Prevented

ULA has an EP Process in Place …
& Statistics to Prove it Works

Questions

Backup Slides Follow

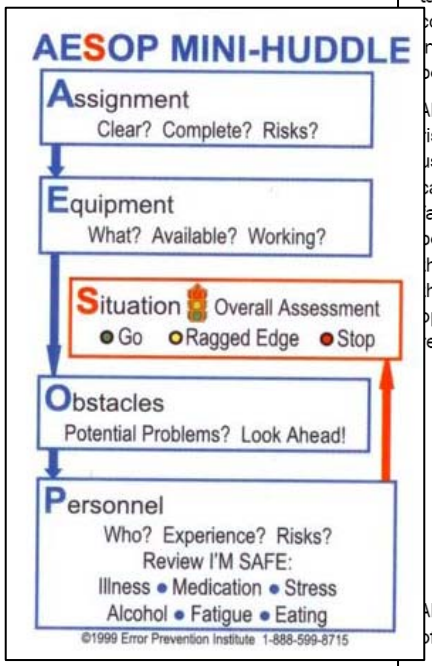


AESOP™ Huddle

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

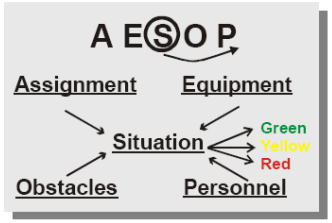


AESOP...What does it stand for?

Everyone is very busy these days. Corporate downsizing and restructuring have left the typical employee wearing many hats. Even smaller organizations are trying to do more with less.

This pressure to do more with less time and resources can lead to errors and accidents as we rush from one task to another. We don't pause for a moment to make sure we aren't missing something. Written procedures and multiple checklists may give the appearance of being in control, but often our minds are not on the current task. Additionally, a lack of communication between the individuals involved may result in critical problems being overlooked.

AESOP is a tool we can use to identify all risks prior to making a decision. It helps us to fully understand the problem causing potential of combined risk factors. It is a powerful tool to break people's tunnel vision lock on whatever they are doing so they can make sure all the bases are covered. It is also a final opportunity for anyone who has reservations to speak up.



AESOP reminds us to look at all aspects of the big picture.

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.)

Why Do We STOP ?

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

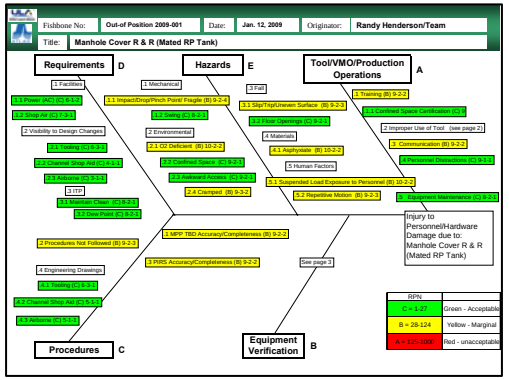
STOP Command

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

Operational Fishbone Process

Inputs

Procedure

Review Procedure with Team

Walkdown Equipment & React Process

Interview the Equipment Users

Fishbone Analysis (Brainstorming)

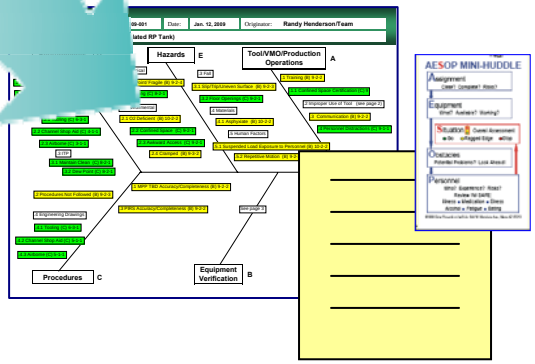
Outputs

Procedure

Procedure Updates

Equipment Update Request

- Mistake-Proofing
- Fix Problems
- Process Improvements
- Maintenance Procedure Update



Summary Sheet

Iterate!