NHA OPERATIONAL EXCELLENCE PROGRAM

OpEx Case Studies: Human Performance Events - Best Practices and Lessons Learned

Hydraulic Power Committee Fall Retreat

October 25, 2016

Outline

NHA OPERATIONAL EXCELLENCE PROGRAM

- Introduction
- OpEx Results-To-Date
- Human Performance Defined
- Human Performance Case Studies
- Audience Discussion
- Summary

Introduction

NHA OPERATIONAL EXCELLENCE PROGRAM

Panelists:

Raymond Chow, Duke Energy

Alex Mosley, Tennessee Valley Authority

Scott Thoren, U.S. Army Corps of Engineers

Co-Moderators:

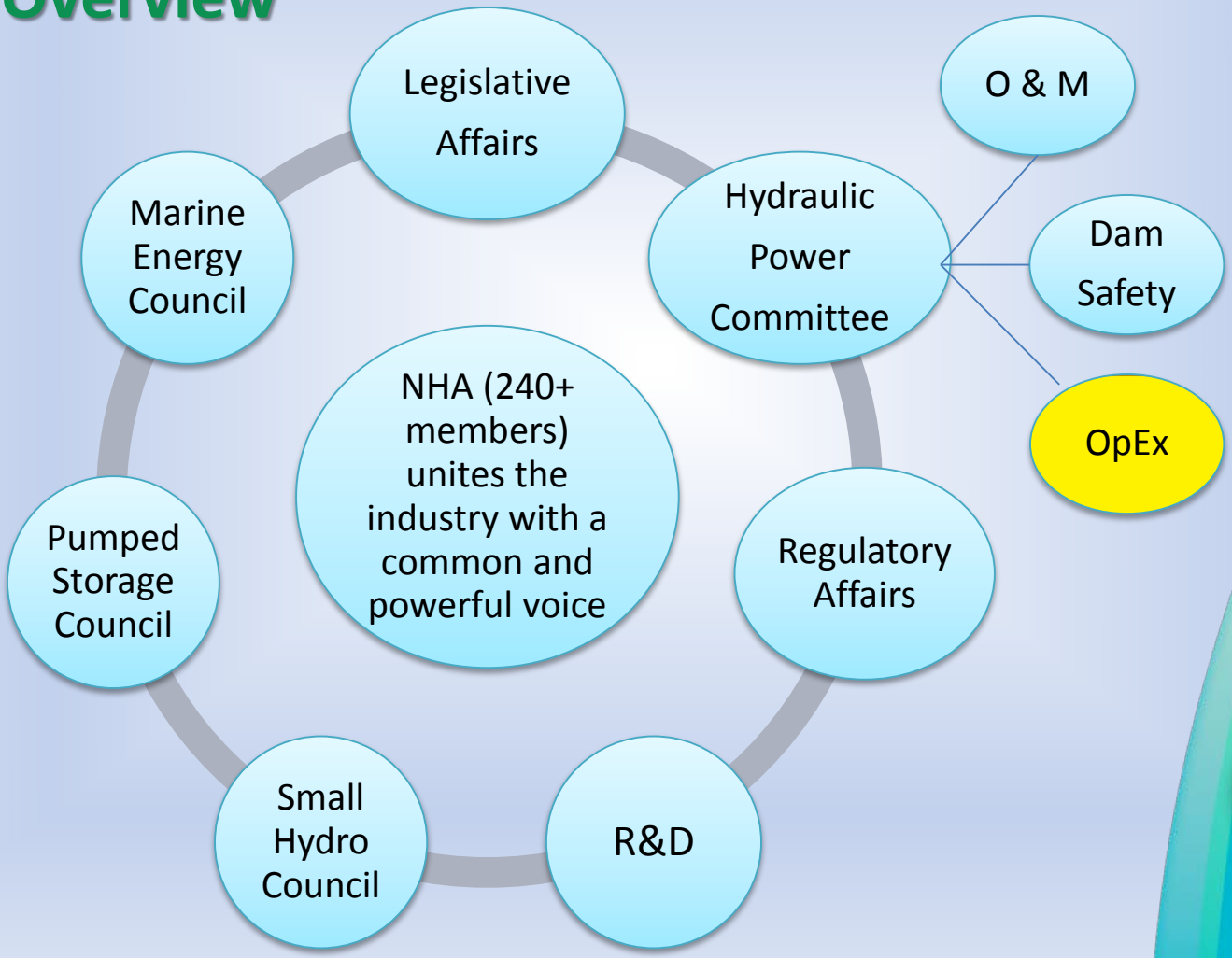
Dave Zayas, National Hydropower Association

Jim Miller, Signal Hydropower Consultants

Introduction

OPEX
NHA OPERATIONAL EXCELLENCE PROGRAM

NHA Overview



Introduction

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OpEx Is:

- Voluntary sharing of critical information (Event Reports), best practices, lessons learned, and near-misses, in a secure and private forum
- A tool for managing aging assets in order to raise the industry's standard of performance
- Educational resource for a workforce in transition
- ***The only Event Reporting program and database available to the hydro industry***

OpEx Scope:

- Event Reports, Best Practices, and Lessons Learned in the areas of:
  - Operations
  - Maintenance
  - Safety – Dam, Employee, and Public
  - Environmental Performance
- ***OpEx is not policy, legislative or regulatory in nature***

Introduction

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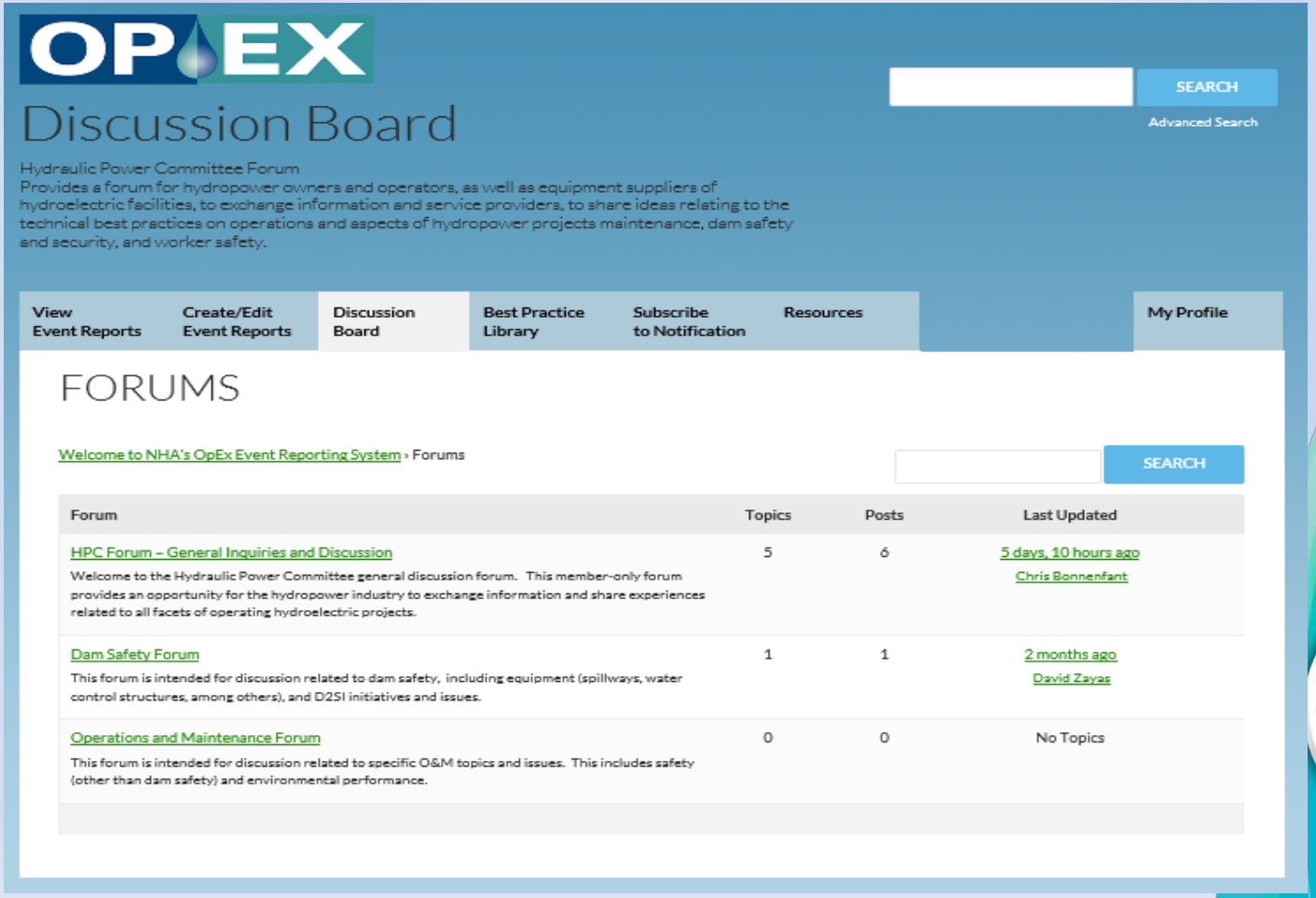
Launched new discussion board in 2016, replacing Basecamp as the HPC forum.



Results-To-Date

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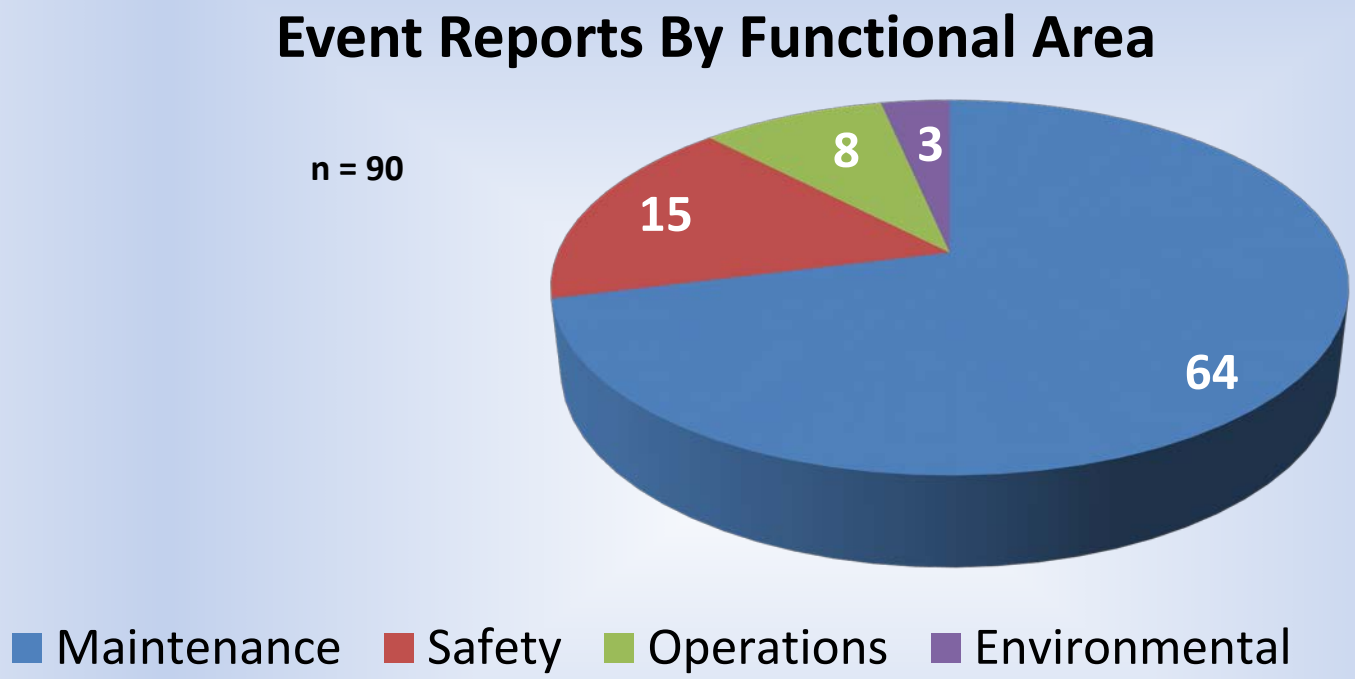
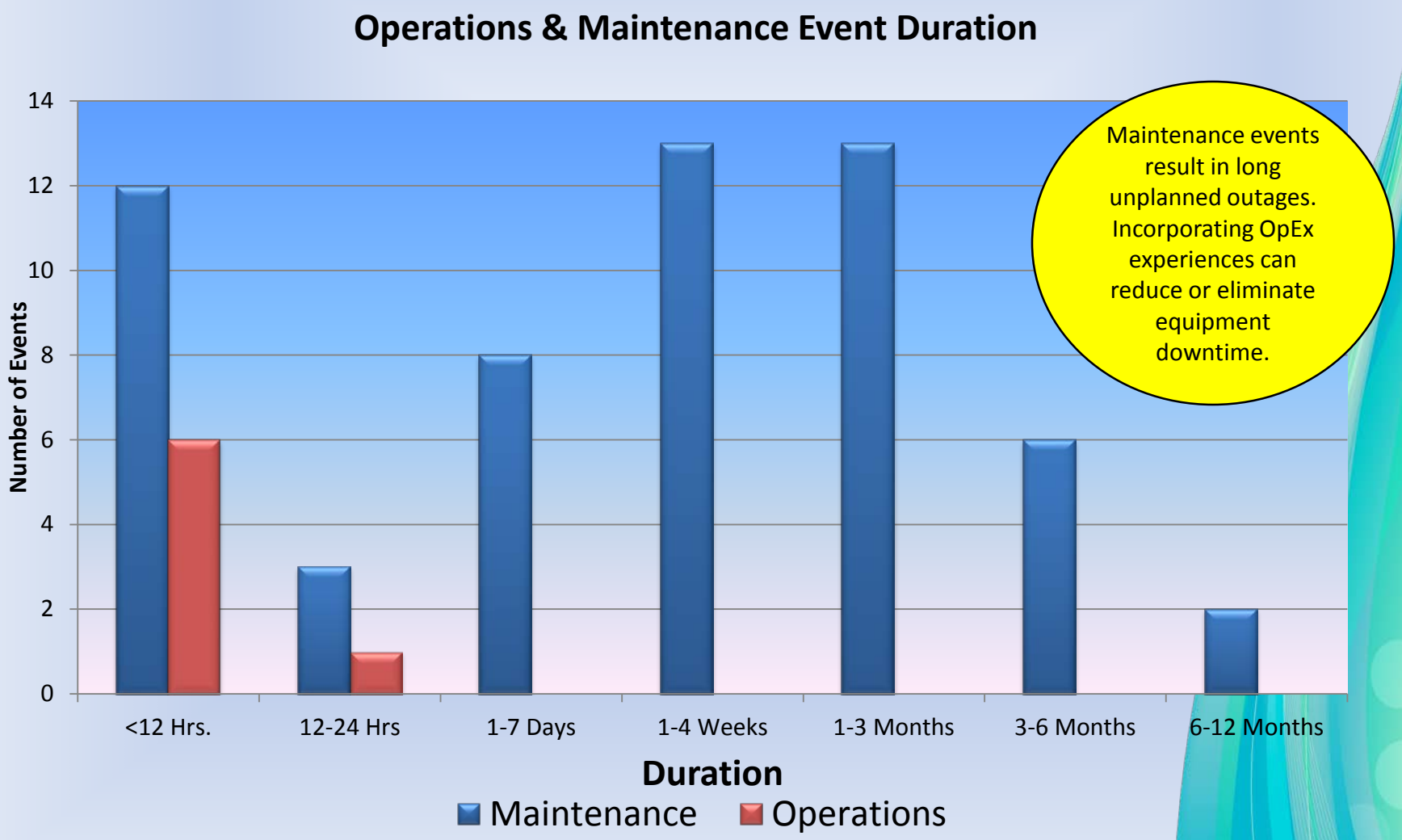


These Event Reports contain *over 405* lessons learned and corrective actions

Severity: Significant (46), Severe (22), Minor (22)

Results to Date



Results to Date

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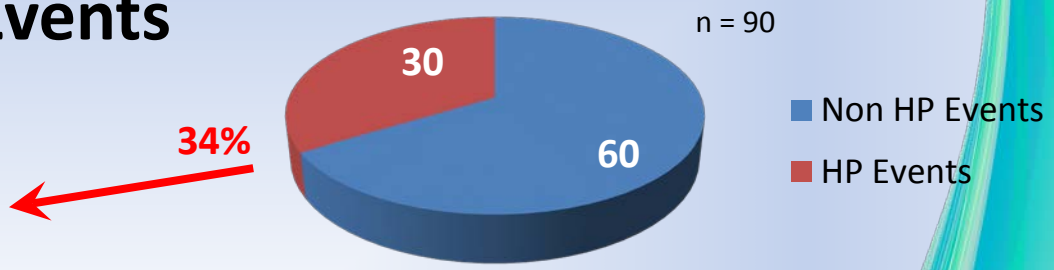
Human Performance Events



Functional Category

15 – Maintenance
10 - Safety
4 – Operations
1- Environmental

Impact

19 – Significant
6 - Minor
5– Severe

Common Inappropriate Actions

- Not verifying operation before initiation
- Inattention to task
- Not utilizing a check list

Human Performance (HP) events often result in significant impacts and can be prevented.

Human Performance Defined

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Human Performance (HP) is a series of behaviors carried out to accomplish specific task objectives (results).

Behavior is what people do and say—it is a means to an end. Behaviors are observable acts that can be seen and heard

Human error is caused not only by normal human fallibility, but also by incompatible management and leadership practices and organizational weaknesses in work processes and values.

Acknowledgment: Human Performance Material from Department of Energy, Human Performance Improvement Handbook, Volumes 1 & 2 , June 2009

Human Performance Defined

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5 Principles of Human Performance

1. Humans are fallible and even the best people make mistakes.
2. Error-likely situations are predictable, manageable and preventable.
3. Individual behavior is influenced by Organizational processes and values.
4. People achieve high levels of performance due largely on the encouragement and reinforcement received from leaders, peers, and subordinates.
5. Events can be avoided by understanding the reason mistakes occur...

Human Performance Defined

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Top Ten Drivers of Human Error

- High Workload
- Time Pressure
- First Time Evolution
- Distractive Work
- Environment
- First day Working After Day Off
- Vague or Incorrect Guidance
- Imprecise Communications
- End of Shift Activities
- Over Confidence
- Work Stress

Human Performance Defined

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Examples from the News

COVER STORY

Why planes take off with too little fuel

About this report

USA TODAY airline reporter Julie Schmit spent two months reporting today's Cover Story and the related stories and graphics on page 2B.

Schmit set out to answer a question many fliers perhaps never ask: How often do aircraft take off without enough fuel?

To get her story, Schmit studied safety reports and other documents obtained from the Federal Aviation Administration under the Freedom of Information Act. She obtained pilot reports filed voluntarily with the Aviation Safety Reporting System, an arm of NASA. And she interviewed more than 30 pilots, airline managers, FAA officials and safety experts.

The documents had their limitations. Some of the FAA records were too sketchy to use. The pilot reports obtained from NASA did not include names of pilots or airlines. The office deletes that information to preserve confidentiality. Sometimes other facts — routes, types of planes, number of passengers, specific dates — were missing.

But despite their shortcomings, the reports reveal how dangerous mistakes occur on U.S. airlines.

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see COVER STORY next page ▶

USA Today 22 Jan 94

'Human performance' gets the blame for Amtrak crash

By Peter Eisler
Gannett News Service

An ill-trained towboat pilot, lost in a foggy night when he rammed a barge into an unlighted Alabama railroad bridge last September, got the official blame Tuesday for Amtrak's deadliest train wreck.

The National Transportation Safety Board recommended tougher training, licensing and equipment requirements for towboat pilots.

"In this case, a human performance issue led directly to the most tragic accident in Amtrak history," board member John Lauber said of the crash that claimed 47 lives.

Lauber echoed other board members in blaming towboat pilot Willie Odom's mistakes partly to his employer, Warrior and Gulf Navigation, for instruction that was "informal, unstructured and relied mostly on on-the-job training."

But board members were unable to determine the extent of the firm's responsibility or the degree to which the accident reflects a more sweeping problem in the training and oversight of barge pilots.

Part of the problem, they said, was an incomplete investigation; part of it was the lack of barge accident records.

NTSB investigators said Odom, failing to properly use his radar or tie up when he got lost in the fog, never even knew he was near the 7-foot-high railroad bridge. He thought he'd hit a sandbar.

The barges knocked the span 38 inches off kilter, pushing a steel girder into the tracks. Minutes later, the first of three engines pulling Amtrak's Sunset Limited at 70 mph from Los Angeles to Miami hit the girder, tore the bridge apart, and flew more than 70 feet into the water. The lead engine spiked 45 feet deep into the bottom, spewing diesel fuel that burst into flames.

WASHINGTON AND THE WORLD

Report lays 'friendly fire' blame

Multiple errors in chopper downings

By Steve Komarow
USA TODAY

The "friendly fire" shooting down of U.S. helicopters over Iraq in April resulted from multiple human errors, Defense Secretary William Perry will report Wednesday.

The two Army Black Hawk helicopters were ferrying international observers to Kurdish villages in the no-fly zone over northern Iraq when they were hit by missiles from a pair of F-15 fighter jets. All 26 aboard the helicopters, including 15 Americans, were killed.

Investigators have confirmed suspicions that were voiced soon after the incident: that the F-15 pilots mistook the Black Hawks for Iraqi Hind helicopters.

Although the exact details of the report won't be revealed until Wednesday, Army and Air Force officials say it includes these major findings:

▶ The F-15 pilots were never briefed about the helicopters in the region, a precaution that should have been routine.

▶ The most effective backup, an electronic signal between the helicopters and the jets, the "Identify Friend or Foe" system, was ineffective at least in part because of improper frequency settings.

▶ There was confusion aboard the airborne air traffic control center that was directing both sets of aircraft.

USA TODAY

AWACS controllers failed to talk among themselves. If they had, the F-15s would have been warned they were targetting U.S. helicopters.

"This incident clearly shows us that technology, no matter how advanced, can't solve all of our problems," says Robert Gaskin, a former Air Force pilot, now vice president of Business Executives for National Security. "Ultimately, it comes down to human beings having to make crucial decisions."

Perry has promised repeatedly to lower the chances of such accidents.

Immediately after the tragedy, he ordered an end to "hair-trigger" firing at targets in the no-fly zone. That type of firing contributed to the accident. He has promised additional "corrective action."

Joining Perry will be Gen. John Shalikashvili, the chairman of the Joint Chiefs of Staff who once headed the Iraq operation, and Maj. Gen. James Andrus, the chief investigator.

Still under debate: whether to release TV cockpit tapes of the helicopter downings.

Apparently, Perry won't announce what punishment will be meted out to those responsible. Under military procedures, once the accident report is accepted, commanding officers use that as a basis for punishment, which could range from none to a court-martial.

Human Performance Defined

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Error or Violation?

- **Error** = an action taken that <u>un</u>intentionally departs from an expected behavior
- **Violation** = deliberate deviation from expected behavior

Human Performance Defined

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Two Kinds of Error:

- **Active Error** = an error that triggers an immediate undesired consequence.
- **Latent Error** = an error that results in an undetected organization-related weakness or equipment flaw that lies dormant.

Human Performance Defined

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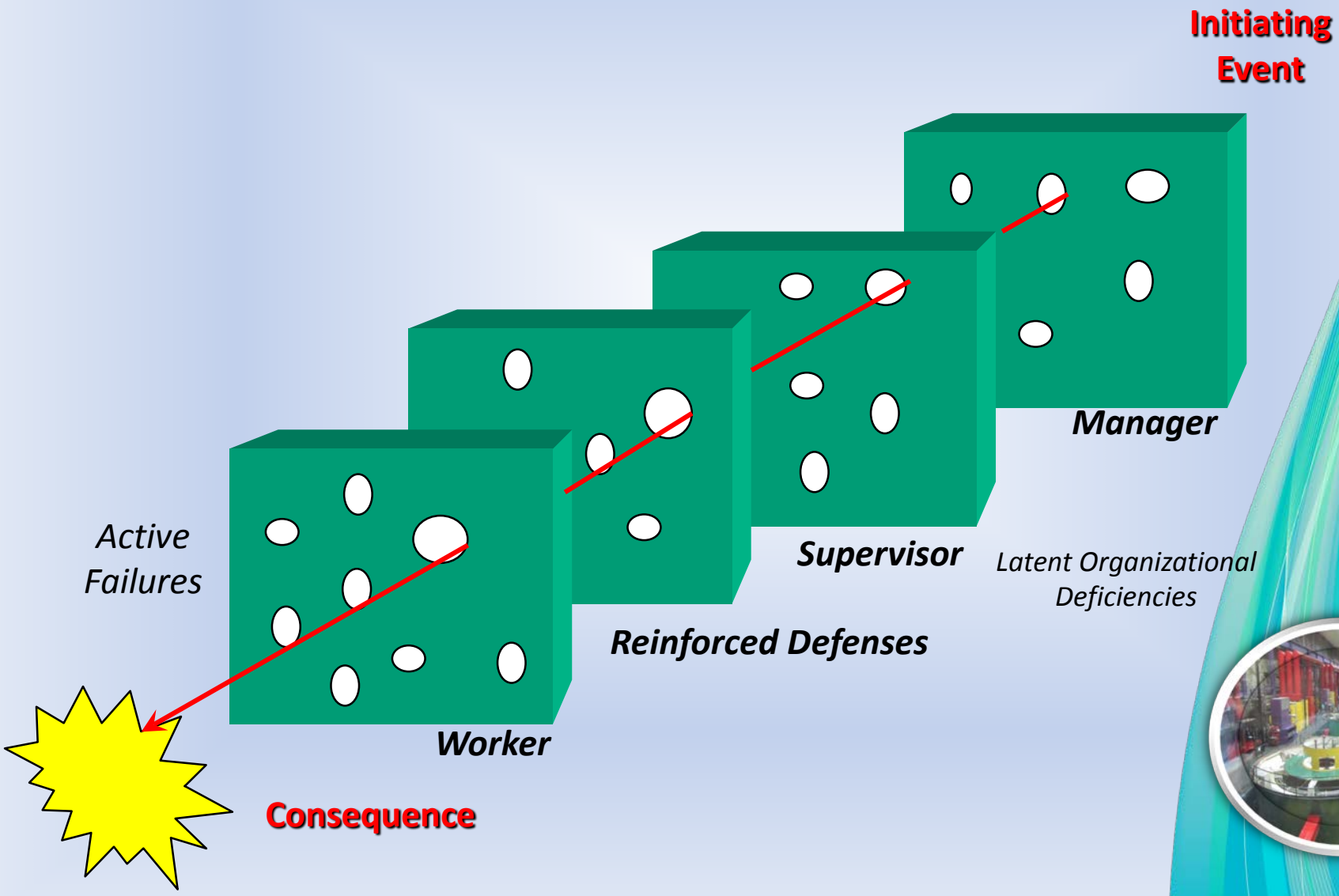

Human Performance Defined

The consistent and effective use of HPI error-reduction tools when performing work reduces the probability that an active error may cause an accident or serious event. Error-reduction tools include among others:

- Self-checking
- Questioning attitude
- Stop when unsure
- Effective communication
- Procedure use and adherence
- Peer-checking
- Correct Component Verification
- Job Specific Pre-Job Briefing

Panel Presentation

Ray Chow, PE

Performance Excellence Coordinator

Regulated Renewables

Duke Energy

Panel Presentation

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Event Description

Cowans Ford Station Black Line Trip
February 10, 2016

- Performing Generator Back Charge Test
- Working from Procedure
- Question a Step in Procedure
- Started Troubleshooting
- Working Outside of Procedure
- Inadvertently Tripped Station Black Line Breaker in Switchyard
- Station Looses All Auxiliary Power

HP Tool

Procedure Use and Adherence or 2-Minute Drill

Panel Presentation

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Event Description

Bad Creek Inadvertent Spherical Valve Closure
June 18, 2016

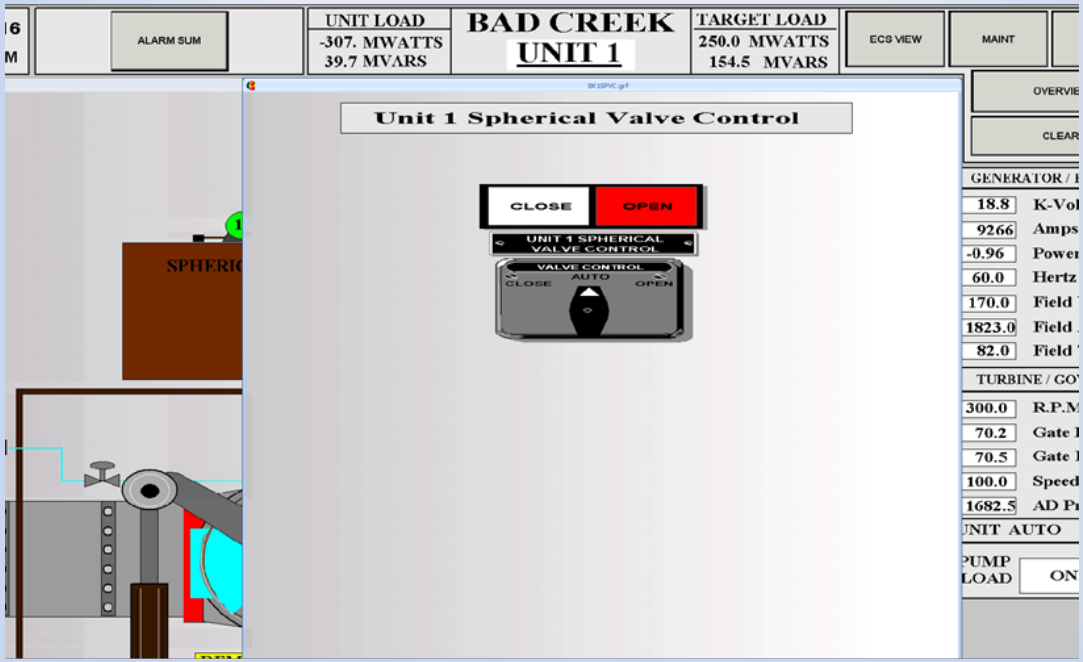
- Unit Failed to Startup Normally
- Station Personnel Repaired Problem
- Returned to Control Room to Reset Unit for Startup
- Working Through Checklist
- Actually on an Operating Unit
- Closed Spherical Valve on Operating Unit
- Tripped Operating Unit Offline

Panel Presentation

NHA OPERATIONAL EXCELLENCE PROGRAM

Event Description

Bad Creek Inadvertent Spherical Valve Closure



HP Tool

STAR or Correct Component Verification (CCV)

Panel Presentation

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Event Description

Cowans Ford Station Contractor Slip Injury
July 26, 2016

- Task to Replace Light Bulbs in the Wheel Pit
- Personnel Recognized Floor to be Slippery
- No Mitigation Strategy Identified
- Slipped on Floor
- Personnel Injured

Panel Presentation

NHA OPERATIONAL EXCELLENCE PROGRAM

Event Description

Cowans Ford Station Contractor Slip Injury

HP Tool

Job Specific Pre-Job Brief or 2-Minute Drill

Panel Presentation

Alex D. Mosley

Hydro Generation General Manager

Tennessee Valley Authority

Panel Presentation

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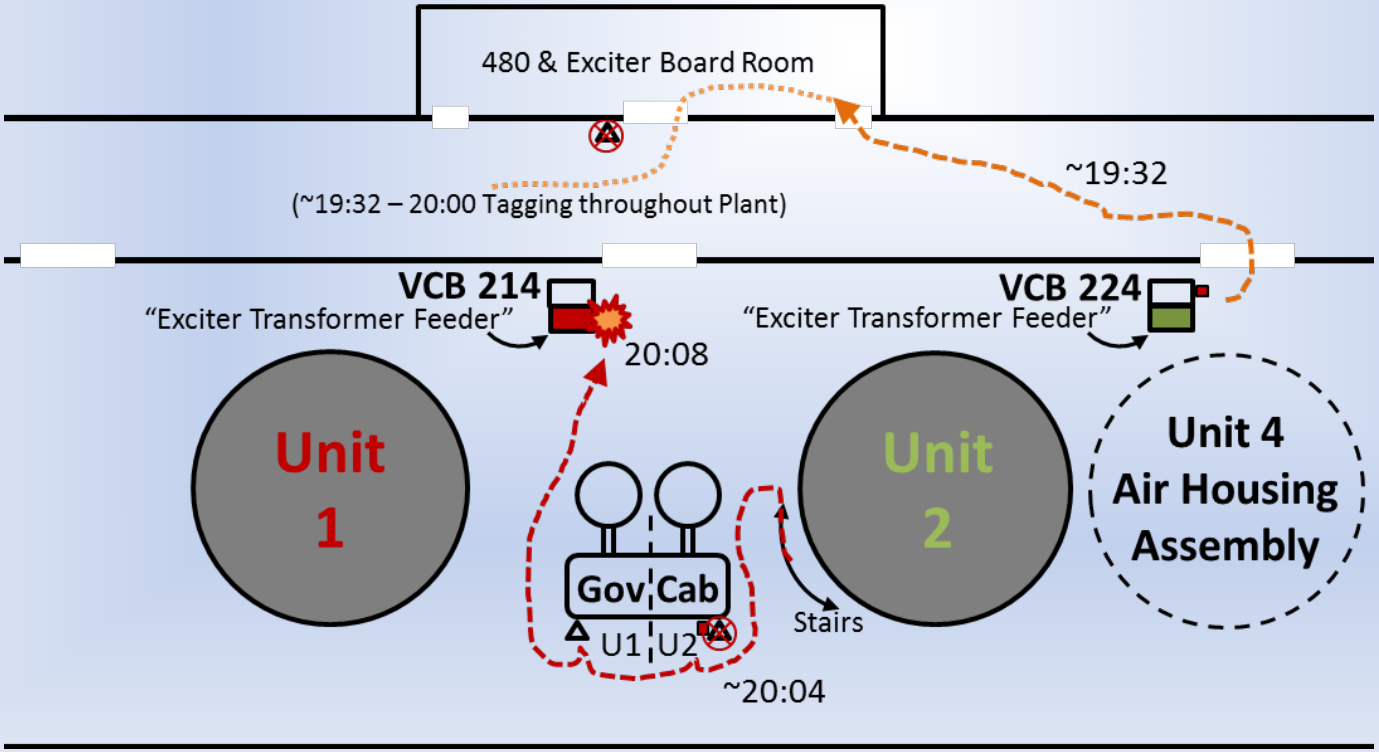
Event Description

Pickwick Hydro, July 2016 - During clearance tagging of Unit 2, personnel inadvertently opened the exciter transformer feeder fuse draw on the adjacent unit, Unit 1, which was energized resulting in an arc flash, personnel injury, and equipment damage.



Panel Presentation

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Unit 2 Generator Breaker Cabinet -
Correct location on unit to be tagged out per the clearance instruction

Unit 1 Generator Breaker Cabinet -
Incorrect location, showing opened exciter transformer feeder fuse drawer

Panel Presentation

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Human Performance Role in Event

Successful HU Tool Use

- Peer Check – During clearance creation
- Pre-Job Brief – Prior to tagging out equipment
- Stop When Unsure – Called control room to verify smudged tag

Upon receiving verification of tag, personnel returned to the clearance instruction on the wrong unit.

Failed HU Tool Use

- Self Check – Failed to verify correct location and equipment
- Peer Check – Failed to verify correct location and equipment

Smudged tag in question for Unit 2 Exciter Transformer Feeder Fuse Drawer

Panel Presentation

Scott Thoren

Hydropower Business Line Manager

US Army Corps of Engineers, Northwestern Division

scott.d.thoren@usace.army.mil

Panel Presentation

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Plant Trip with Damage During Upgrades and Maintenance

Capital Investment work ongoing

- Battery replacement and DC system upgrades in progress.
- Battery chargers used to supply DC power while battery was removed.
- Temporary battery not used; diesel generator to mitigate potential events.

Panel Presentation

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Plant Trip with Damage During Upgrades and Maintenance

Maintenance Activities

- Preferred AC inverter maintenance to troubleshoot intermittent ground.
- Restoration of equipment caused high in-rush current, chargers could not maintain voltage and tripped offline.

Plant Trip

- Loss of DC power caused capacitive trip circuits to open station service breakers and generator output breakers (except for units 2 and 3).
- Units 2 and 3 started the shutdown sequence, but motored for ~3 minutes until the output breakers were tripped manually.
- High field currents caused damage to the respective exciters.

Panel Presentation

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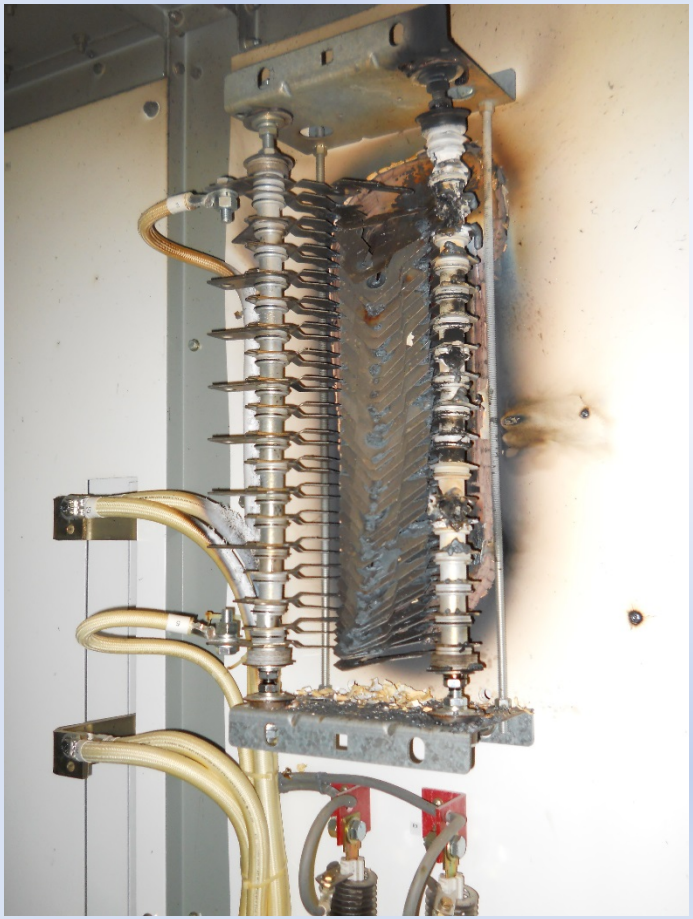
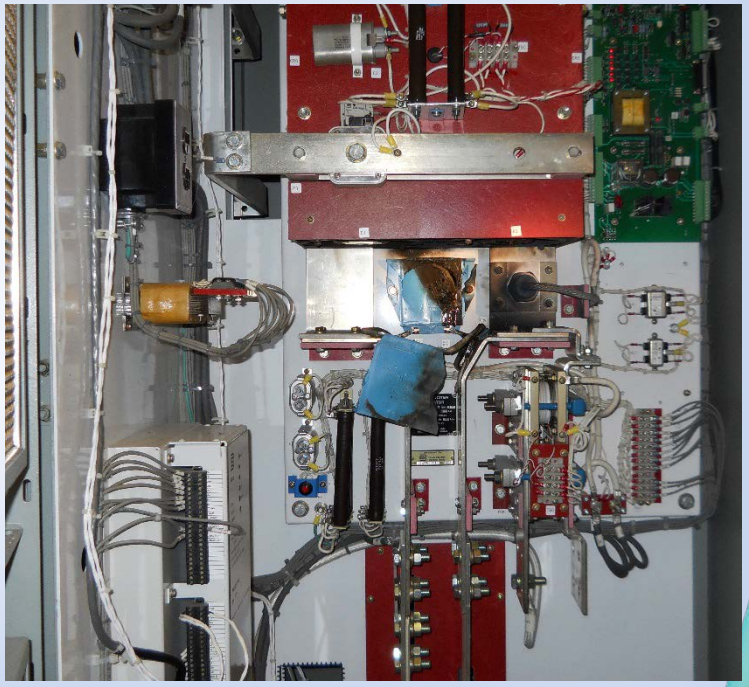
Plant Trip with Damage During Upgrades and Maintenance





Panel Presentation

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Human Performance Role in Event

Decision to perform maintenance on inverter with no battery in place

- No contingency plans, minimal coordination with other work, timing of work was questionable.
- Maintenance activities were not considered during the battery replacement work.
- In-rush current to the inverter was not recognized by maintenance staff.

Capacitive trip circuit failed during loss of DC power

- Testing of capacitive trips not required in preventative maintenance work plan.

Station Service transformer breaker capacitive trip active

- Lack of proper design control during breaker replacement 10 years ago. Original scheme did not have capacitive trip on station service transformer breakers.

Summary

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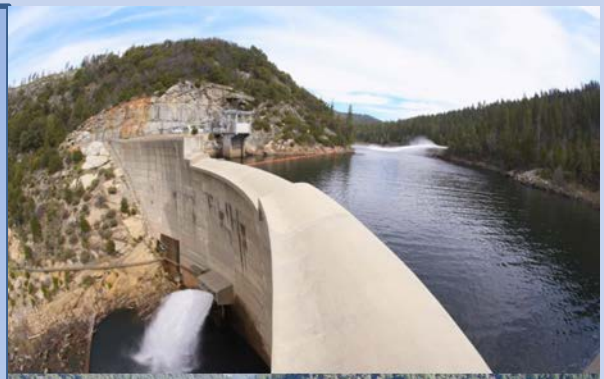
Human performance events can be prevented.

Errors can result in equipment damage, employee injuries, and loss of production, among others

NHA's OpEx program, with nearly 40% of ERs in the database identified as HP, can help you improve and maintain a high-level of performance.



Summary

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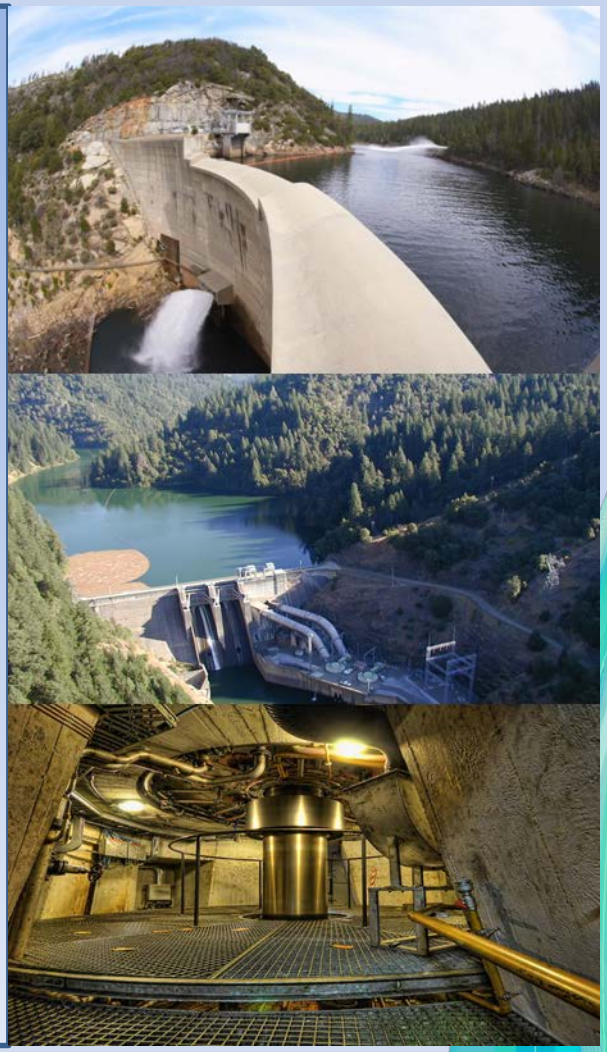
As the industry contends with aging assets and an aging workforce, OpEx and the event reporting system provides a trusted and reliable database of historical and current operational issues and serves as an educational and training resource for future personnel.



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