Lessons Learned

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Lessons from Idaho

- Essential CSP elements includes
  - Understand and documenting the NCS risk
  - Mechanisms for controlling the risk

- However, at the program I inherited in Idaho
  - Criticality staff provided modeling and calculations.
    (My focus was improving the calculation capability)
  - Upset conditions largely provided by the Plant Safety Document staff.
  - Criticality staff developed numeric limits and controls.
Basic criticality control in first cycle extraction was chemical processes to limit the uranium concentration in vessels and pipes.

Controls were administrative (procedures)-aided by measurement devices.

A 1978 accident illustrated serious flaws in the hazard assessment and control system.

- Hazard Assessment -
  - Effect of the chemical dilution of scrub steam (direct cause) was documented but not the failure mode which caused the accident

- Control
  - Correct operational procedures not used.
  - One measurement device was inoperative.
  - A second device, on plant controlled drawings, had not been installed.
  - Operators did not notice or respond to abnormalities.
Program Upgrades Necessary

- **Hazard Assessment**
  - Use solvent extraction process chemical effects computer code to assess chemical risks
  - Use HAZOP method to define failure modes in the operations of chemical processes

- **Controls Development and Implementation**
  - Structured controls
    - Failure Limit, Safety Limit, Limiting Condition for Operations
      - Limits to provide basis to respond to non-conformance
    - Equipment relied on: classification/inspection criteria
  - Training for operators/tied to pay scale
  - Auditing for compliance improved
  - Configuration and Document control improved
Value of competent Criticality Safety Programs

- I knew about Personnel Protection
  - We attribute a high value to human life
- I learned the Mission and Financial Impact
  - Even non fatal criticality accidents will significantly effect our facility
  - 1978 Idaho accident shut down plant for two years (mission loss) and cost a large part of a billion dollars
More Idaho Lessons

- Fuel element pile found outside the unirradiated fuel storage building
  - We provided CSE for storage rack (Cd lined)
  - Also CSE for processing fuel elements
  - No CSE for transporting elements between facilities had been requested
  - Gaps need to be questioned
- During a fissile inventory, vials of Uranium Oxide removed from Cd lined racks and put by accountability staff in large garbage bag
  - Other groups than Operations need training and controls
Yet More Idaho Lessons

History

- A process campaign involving hundreds of kilograms ended, and an apparent discrepancy between input and output uranium mass values. The plant stopped.
- After several weeks of assessing the measurement data, statisticians determined the deviation was within measurement error and we could proceed with operations.
- Years later an unused and isolated cell was being prepared for demolition and measurement were made in large tanks.
- Measurement showed a uranium concentration about 12 g/l, (reported to me at 2:00 AM)
- We found the uranium discounted previously and an investigation found the path into the isolated cell.

Lesson

- Accountability controls oft concern with deviations of large numbers.
- NCS concerns with smaller amounts on large places.
- Accountability concerns not the same as NCS concerns.
More Idaho Lessons Yet

Pathfinder Fuel Bucket Event

- Routine NCS inspection of fuel storage basin noticed seven buckets, normally suspended two feet apart on rails, jackstrawed on basin floor.
- Safety basis assumption was a maximum of two in contact
Found Array of Fuel Buckets
How to respond?

- NCS developed calculations to support recovery.
- Fuel was cylindrical with a central core poisoned with B4C.
- Calculations, using the fuel Processing Contract information, showed an infinite number of fuel elements would not go critical. We reasoned that this was unlikely for a reactor.
- The fuel shipper had not retained records of fuel details - I tracked down the chief startup engineer who had retained fuel details in his basement.
Pathfinder continued

- The reprocessing contract listed the amount of B₄C in the core was substantially more than the reactor startup records.
- 77 of the fuel elements had the poisoned core removed.
- The minimum critical number of elements was a fraction of the pile observed.
- Strips of cadmium were hand inserted in each of the buckets and recovery was completed.

Lessons Learned

- Shipper’s attention to his waste stream does not receive attention paid to product stream.
- Events determined to be incredible, like seven jackstawed buckets, periodically happen.
More Idaho

1981 Decon Sink Event

- End of a production campaign which included converting uranium solution to UO$_3$ in a denitrator
- Process began to flush the plugged denitrator
  - Many nitric acid flushes
  - New supervisor removed bottom plenum and delivered it to the Decontamination Facility
- Item placed in large sink and filled with 200 l of Nitric acid
  - Technician noticed acid had become greenish yellow
  - Sample taken - 7.1 g/l U
Denitrator Room Layout
Response to Event

- I was called at midnight
  - Informed dissolving UO$_3$ was adding to the 7 g/l in the 200 l solution
  - Replied that some 20 g/l could result in a criticality
- Decon facility evacuated
- NCS worked all night and next day to gather info on plenum volume and UO$_3$ density
  - Sink modeled with 4 kg in solution in 4 M acid and max $k_{eff}$ was 0.86
  - Solution removed by entering facility and opening sink drain with long handled tool
Lessons Learned

- Decontamination facilities need more attention
  - Facility added as Criticality Control Area
  - Staff and supervision need NCS training
- Proper information needs to be supplied from sending group to receiving group
  - New Requirement: two assessments of fissile content need to accompany transfers.
Idaho Lessons-continued

Protecting the program

- The contractor suffering the 1978 accident supported all reforms of the criticality safety program
- The resulting program was strong and effective.
- However, the initial contractor lost the contract due to the accident
- Each subsequent contractor questioned program elements not seen elsewhere
- Eventually we needed to fully describe the whole program in a manual. It was reviewed and approved by senior management and delivered to each operational unit
- Practices deemed important need to be broadly agreed to and formalized.
Lessons from Colorado

Issues in late 1990s

- NCS program turmoil;
  - Persistent NCS manager and staff turnover
- NCS staff experienced hostility from Operations
  - Staff faced resistance getting information for evaluations
  - When evaluation about done, learned operation had changed
  - Evaluations considered a permissive to operate
  - Compliance with controls was faulty
- Competent Evaluations were problematic
Colorado Lessons continued

Core problem - Communication and cooperation

Action - Redefine the NCS program

Method - Develop a Program Manual

- Development team
  - Operations Management
  - NCS staff
  - Nuclear Safety staff

- Assessment team to critique result
  - Other operations groups
  - Union
  - Regulator
  - Outside independent NCS specialists
Manual Features

- Chapters on all features of a mature program
- Most helpful provision
  - Criticality Safety Officer
    - Reports to Operations manager
    - Sets priorities for NCS staff facility tasks
    - Provides information conduit for evaluation development
    - Approves the evaluation for Operations
    - Develops implementation plan for controls
    - Coordinates task specific operations NCS training
    - Manages non-conformance responses
CSO position results

Benefits
- Higher quality Evaluations
- More thoughtful control implementation
- Better understanding of Operators of control purpose and implementation methods
- Fewer non-compliances
- Less frustration of NCS staff and fewer turnovers

Other Responses
- Facility managers praised the concept and added additional CSOs
- Assessment teams took the concept elsewhere
Conclusion
Robust NCS Program

- Competent, involved NCS staff (low turnover)
- Good use of Hazard Assessment Methods
- Well defined and user friendly limits & controls
- Administrate the Evaluation assumptions also
- Assure Operations owns the NCS controls
- Strong Conduct of Operations program
- Operations staff with a questioning attitude
- Process to respond thoughtfully to non-conformances
- NCS group self critical culture
Further Conclusion

- All sites need to solve actual and local issues as well as comply with Industry and government regulations.
- Both Idaho and Colorado NCS programs, before reforms, believed they had implemented all industry and government regulations; however, they were not effective programs.