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.

1978 Accident

- 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 B_4C 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.

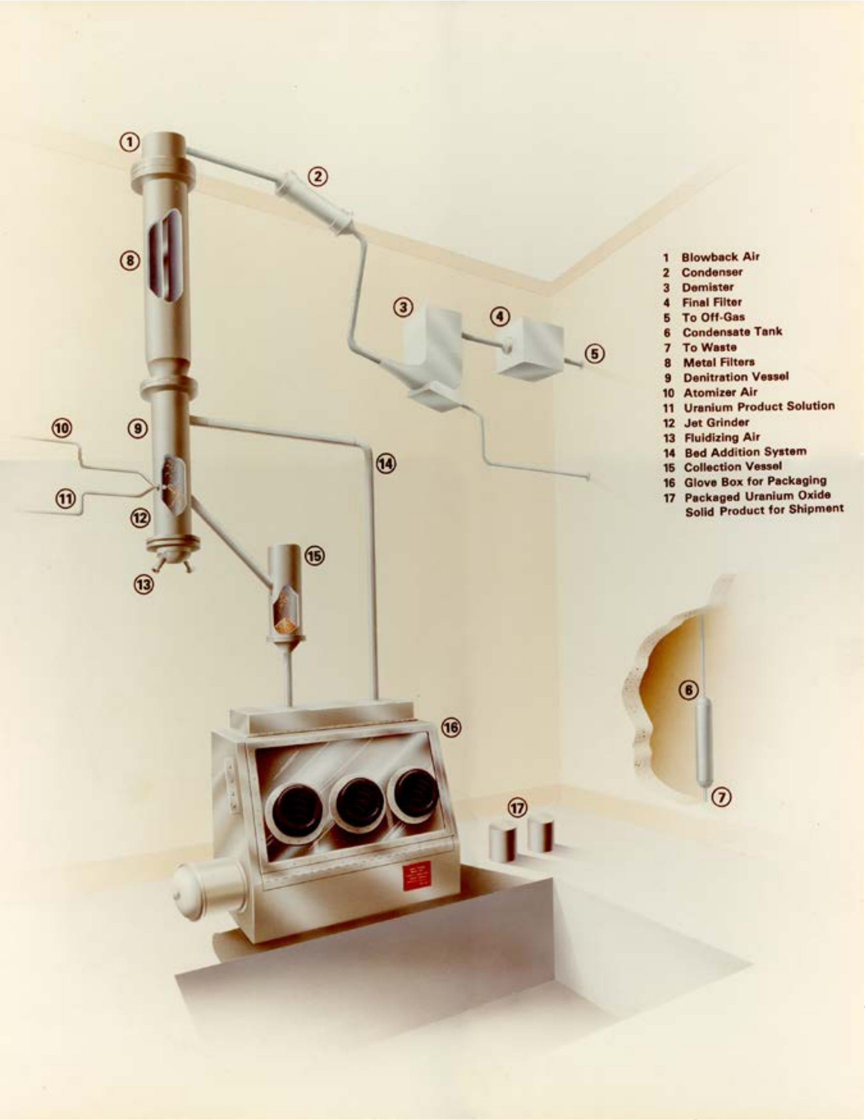
- Lessons Learned
  - Shipper's attention to his waste stream does not receive attention paid to product stream.
  - Events determined to be incredible, like seven jackstawed buckets, periodically happen

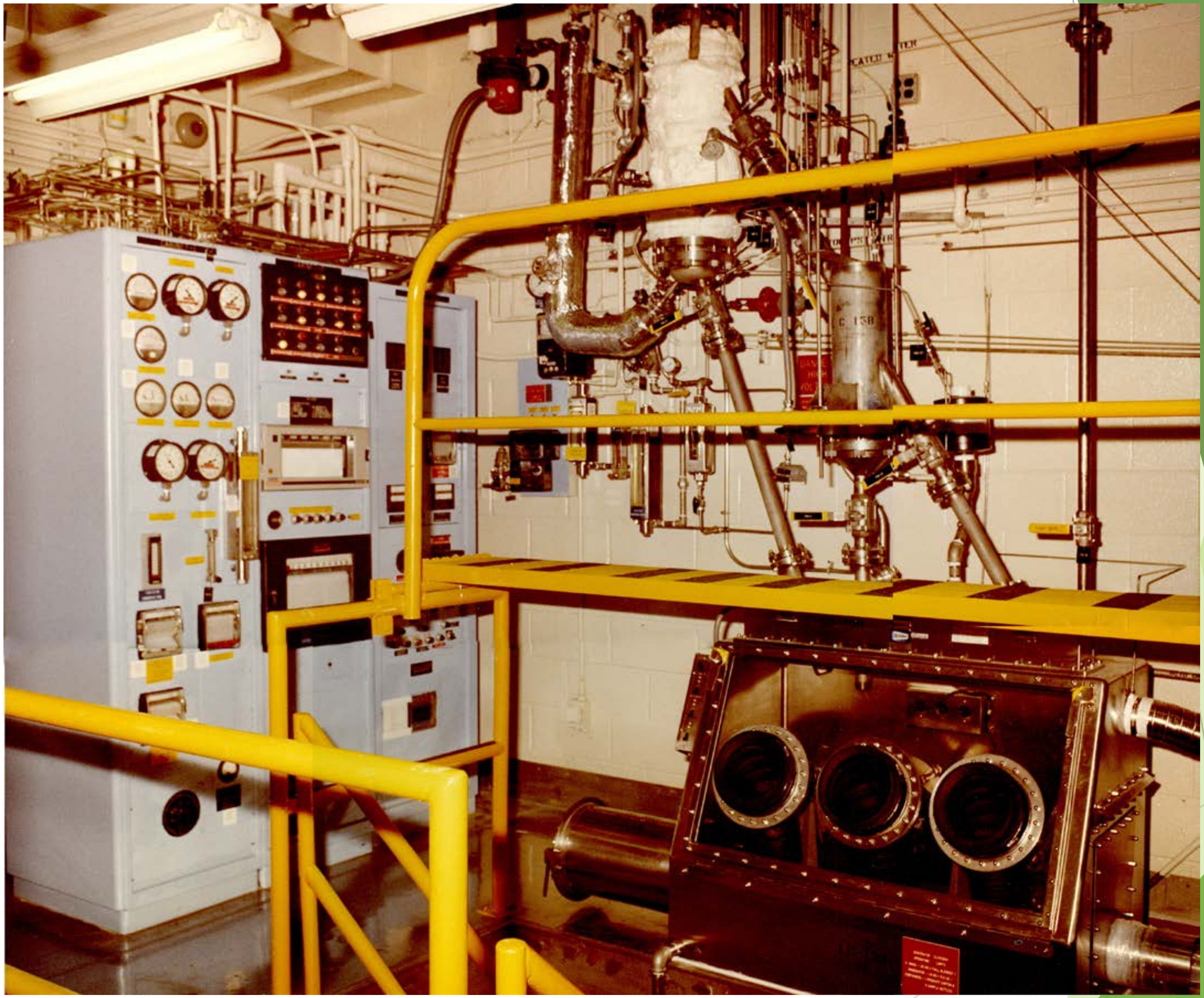
More Idaho

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.