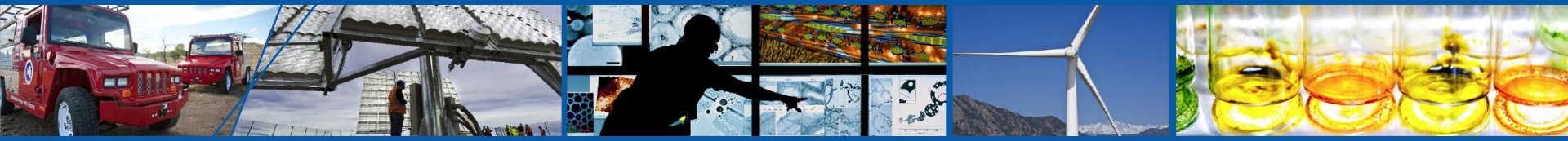
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Lessons Learned: Thermochemical Process Development Unit (TCPDU) Drum Explosion



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Ron Hill, MSPH (Environmental Sciences & Engineering), CIH, CSP
EHS Programs Manager
National Renewable Energy Laboratory

DOE/EFCOG Enforcement Coordination Working Group Spring 2014 Meeting
Las Vegas, Nevada

Agenda

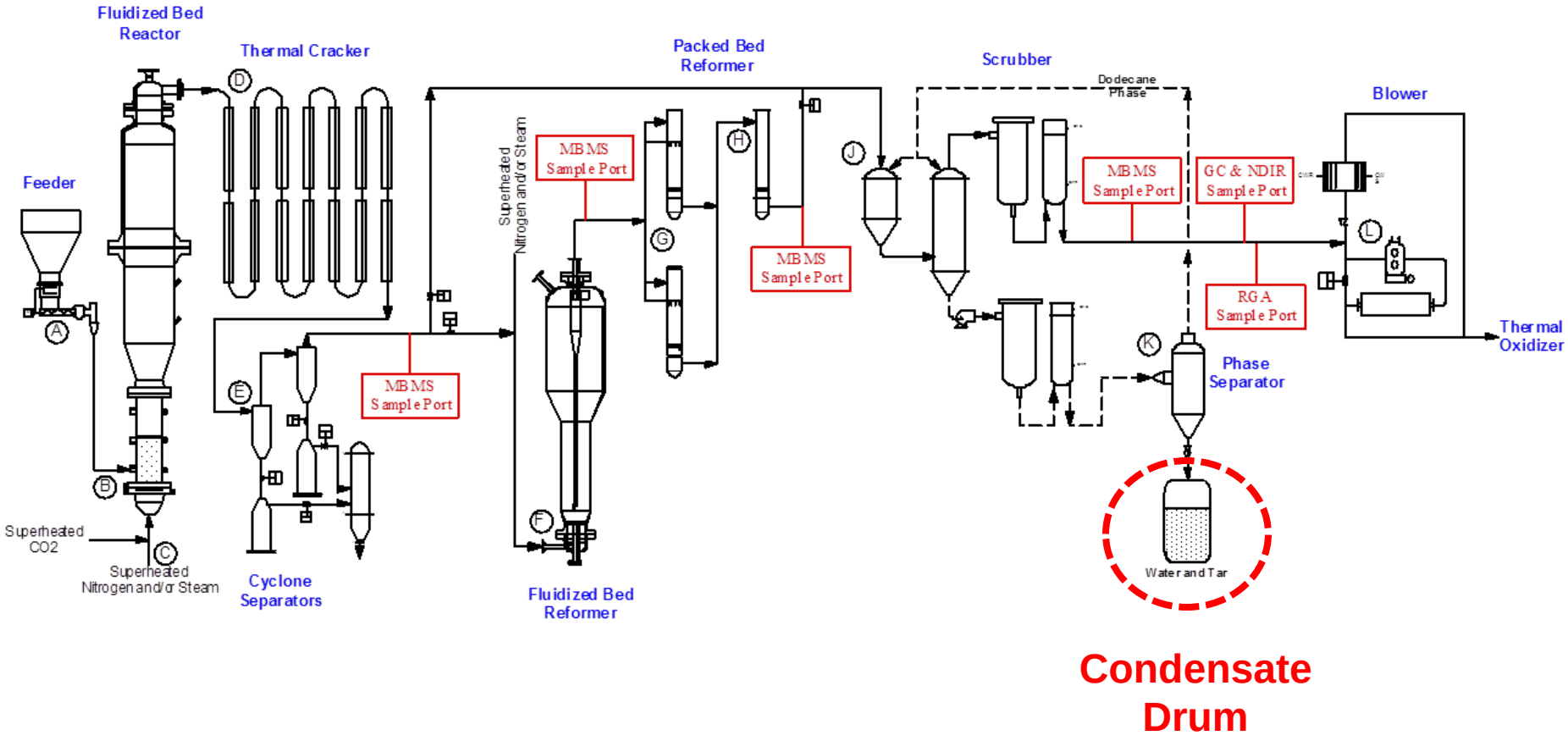
- Event Overview
    - Event Summary
    - Event Response
    - Event Teams
    - Causal Factors
- Extent of Condition (EoC) Review
- Lessons Learned
- DOE Enforcement Letter
    - Response
    - Impact
- Path Forward
- Questions/Discussion

Event Overview

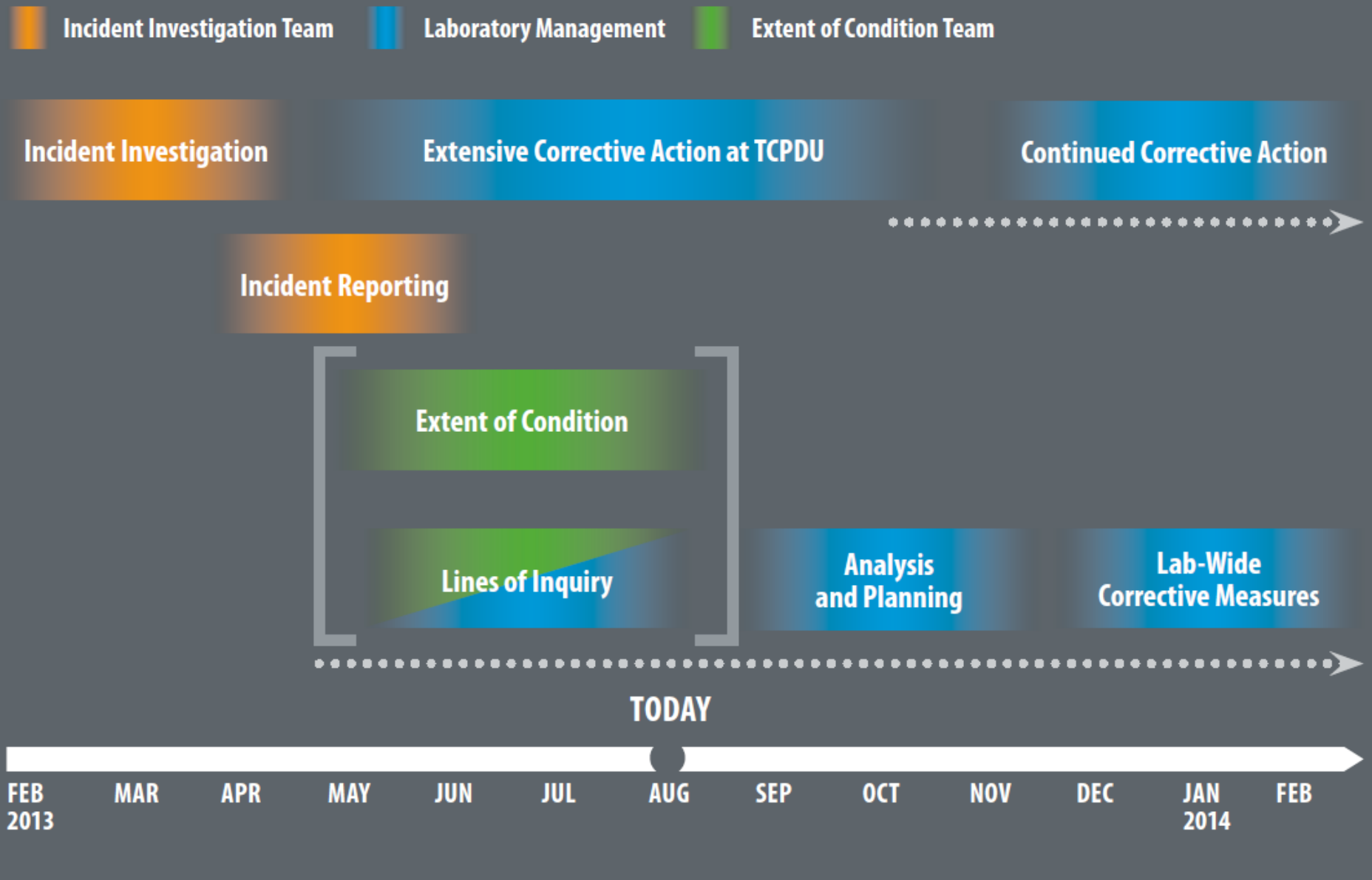
- Friday, February 8, 2013
- 3:13 AM – 55-gallon polyethylene condensate collection drum flashed & exploded
- ~30 kilograms of water, tars, and char violently released
- Equipment damage
- No injuries

TCPDU Schematic Diagram

TCPDU product is a flammable, synthetic gas



Full Response to TCPDU Drum Explosion



Event Teams

- Incident Investigation Team
  - 97 page investigation report
- CAPA Development Team
- Extent of Condition (EoC) Site-Wide review Team

Drum Event Causal Factors

Direct cause:

- Ignition of flammable mixture by electrostatic discharge

Drum Event Causal Factors

Contributing cause(s):

- TCPDU hazard analyses not current to reflect changes made
  - Sticky residue on one-way check valve

Contributing Cause: Mixed-use Drum

- The drum was a “used drum”
  - It already contained some liquid waste
- Post-event analysis found acetone
- As little as 50 mL of liquid acetone can create a flammable headspace

Drum Event Causal Factors

Contributing cause(s):

- Ineffective management of change (MoC)
- Ineffective corrective action management

Drum Event Causal Factors

Root cause:

- Insufficient identification and control of hazards

Lessons Learned: Initiate Extent of Condition Review

After the drum event, NREL Management Team recognized the need to initiate a lab-wide EoC

- On 12 Dec 2012 an Electrical Safety Enforcement Letter directed NREL to conduct an EOC
  - “A thorough extent-of-condition review would promote effective improvements….”

Extent of Condition (EoC) Conclusions

- Some similarities to TCPDU causes & conditions found to partially exist in other lab organizations:
  - Hazard analyses not current with configuration
  - Inadequate management of change processes
  - Ineffective corrective action management
  - Certain latent conditions (e.g., management turnover and increased stress due to time pressures or workload)
- Similar causes & conditions at TCPDU event not found across the Lab whereby another event was likely

Lessons Learned – Funding the Investigation

- Quickly engage site Business & Contracts specialists
  - Contracts for external experts had to be in place in <5 days
- The drum investigation was funded from EHS budget, not research

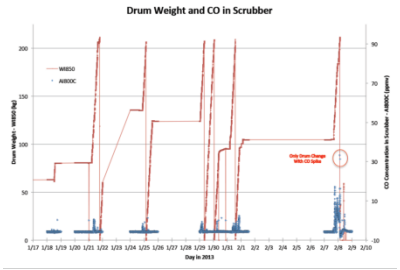
Lessons Learned: Event Investigation & EoC Review

- Long work weeks for investigation team, EoC team, and TCPDU workers / group
- A significant, but necessary, undertaking even before receiving the TCPDU enforcement letter
- Demonstrated to HSS NREL's commitment to identifying and eliminating similar hazards across the site
- Positive reaction and extensive engagement from line managers, up to and including CDs
- NREL currently developing Lab-level procedure on EoCs

Lessons Learned – Investigation

- Engaged external experts from other national labs and private industry
  - ➢ Investigation
    - PNNL
    - LANL
    - Fire / explosion engineer
    - ORNL & DOE Complex-experienced consultant
  - ➢ Validation of corrective actions (electrostatic discharge elimination system)

Lessons Learned: Retrospective Exposure Assessment



- DOE required a retrospective exposure assessment in advance of enforcement letter
- NREL used fixed air monitors & chemical process data to retrospectively assess worker exposure
  - Exposure results were well below Occupational Exposure Limits
  - Report submitted to HSS
  - NREL modified our IH Procedure to do this in a future release

Lessons Learned: Need to Improve Work Control

NREL initiated Research & Operations Safety Enhancement (ROSE) program

- Assigned 11 Facility Managers for major facilities
- Expanded MoC processes in research facilities
  - Started Facility Management Council
  - Started Engineering Council
- Progressing in subcontract for HAR development
- Improving Subcontractor work control
- Improving manager and worker on-boarding
- Hired independent oversight staff

DOE Feedback

- DOE Field Office pleased with NREL's response to TCPDU drum event
- DOE HSS very interested throughout the investigation, EoC, and corrective actions
  - Multiple video-conferences
  - Multiple information requests from HSS (phone, email)

Enforcement Letter – Summary

- Received November 27, 2013
- No $ fines
- No response required
- Letter issued to: *"ensure management awareness of the regulatory issues associated with this event and to provide positive feedback on the measures that Alliance has taken to prevent recurrence."*

Enforcement Letter – Conclusion

HSS noted Alliance's:

- "Thorough and appropriately self-critical evaluation of the causal factors and related program deficiencies associated with this event"
- Use of this and other recent events "as opportunities to objectively assess needed improvements to implementation of NREL's worker safety and health program"

NREL's Enforcement Letter Response to OEO

- Submitted general response letter to OEO
  - "Alliance is committed to continued transparency and open communication."
  - "Will continue to keep you apprised of our progress in implementing improvements."

Group Discussion/Feedback

Any Questions?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