



Topical NERC Lessons Learned

Donnie Bielak
Manager, Reliability Engineering



Root Cause Analysis Tools – Barrier Analysis



General Processes



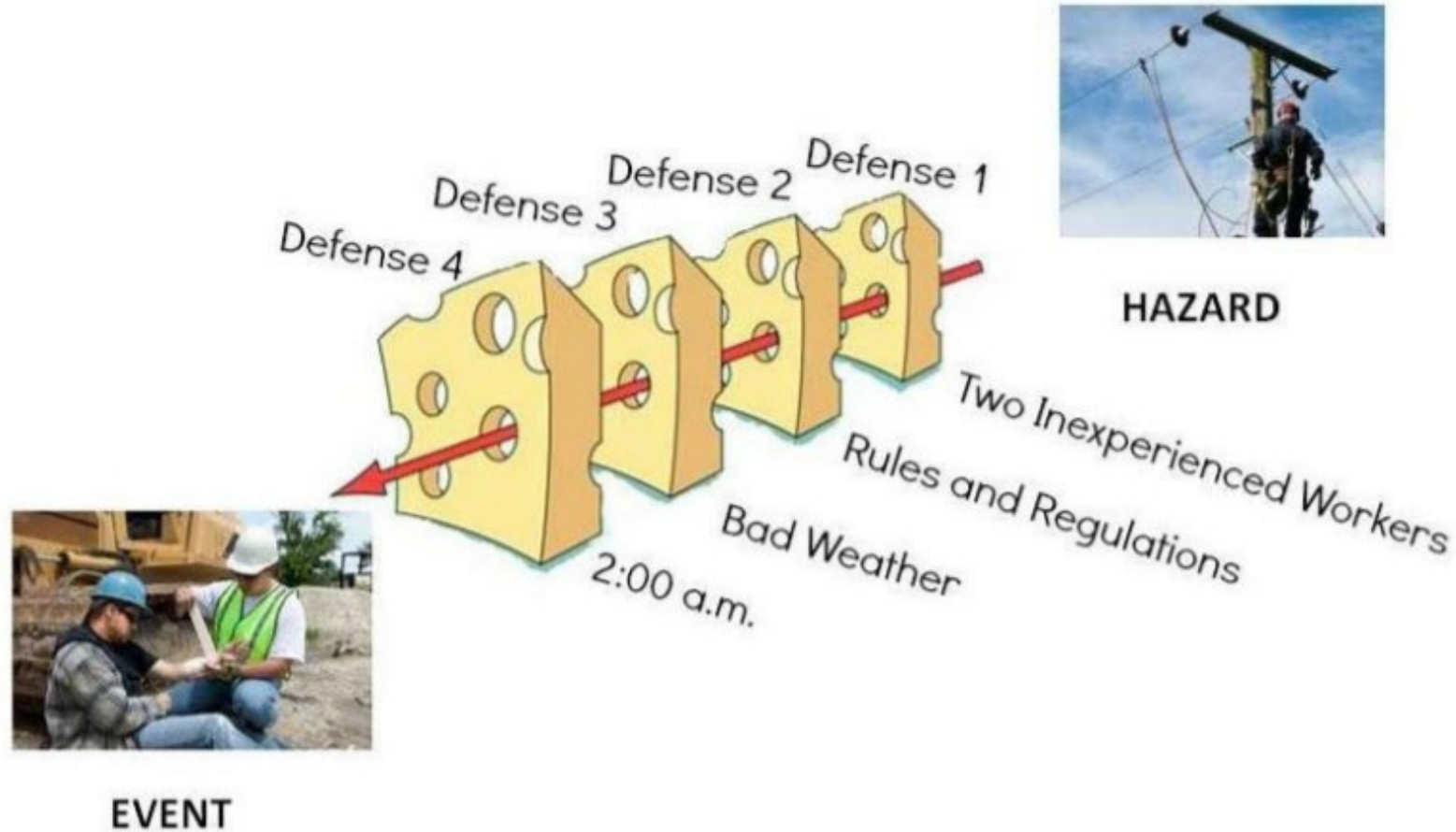
February 10, 2021

- Barrier Analysis for Root Cause Analysis
- Example:
 - Entity had several CIP-006 violations during construction work while adding source backup power to primary system operating center
 - People and materials were moving in and out of critical infrastructure protection controlled areas while contractors installed equipment and route cable
 - Contract construction workers had been trained on access procedure
 - Several access violations were noted that resulted a “work stand down”

Table 1: Barrier Analysis Chart				
Identify the Hazard: Unauthorized/untracked access to the system operating center (SOC)			Identify the Target: CIP-006 compliance	
What are the barriers?	How did the barrier perform?	Why did the barrier fail?	How did the barrier affect the adverse event?	What could make this better? (Improved Barriers)
SOC side door lock	It was 'worked around'	Workers thought they had free access to the equipment spaces around the SOC once they signed in for the day. After workers found the door to be a shortcut, they opened it from the inside for each other	It was not effective at preventing access	Require a key to unlock and open the door from inside Rejected by Safety - exit must be available without key
SOC side door lock	It was 'worked around'	Workers thought they had free access to the equipment spaces around the SOC once they signed in for the day. After workers found the door to be a shortcut, they opened it from the inside for each other	It was not effective at preventing access	Alarm the door when opened

Figure 1: Barrier Analysis Chart

- Used shortcuts to bypass path and barriers that could have prevented this were ineffective
- In result, a controlled access path for construction work was laid out and barriers to enforce path were installed
- Created simpler procedures improving log in/log out form
- Construction contractors were trained regarding new changes



The “Swiss Cheese” Model (adapted from Reason, 1990). Under the wrong set of circumstances, the holes in the defense line up and result in an unwanted event.

Figure 2: Swiss Cheese Model

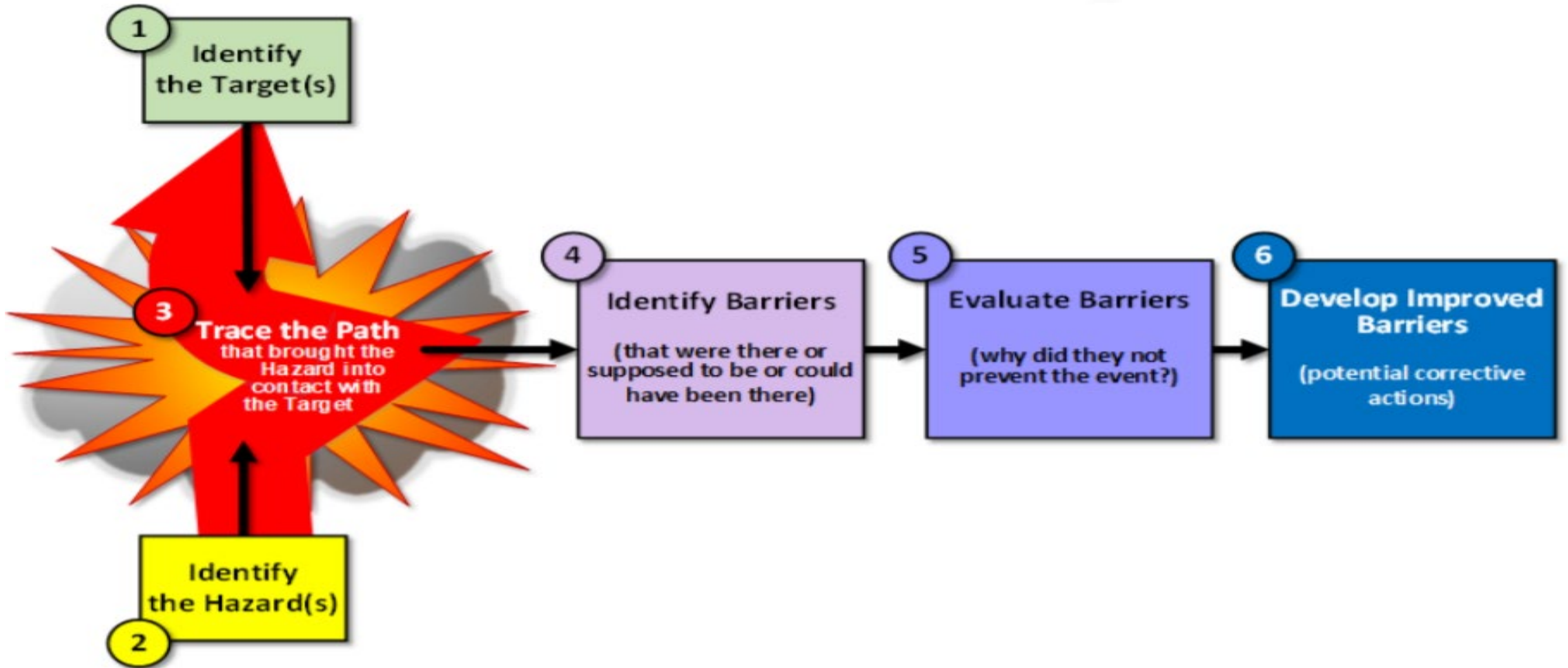


Figure 3: Department of Energy Barrier Analysis Method

- Quality of brief reports submitted and the success of an entity's corrective action depend on root cause analysis
- Barrier Analysis is simple, effective and quick tool
- Useful in human error cases, safety issues, and improving procedures



Root Cause Analysis Tools – Change Analysis



General Processes



February 10, 2021

- Transformer catastrophically failed after approximately 20 years of service
- One of two nearly identical transformers operating in parallel to feed a large community
- Protective relays responded appropriately, opening the station's 138 kV and 13.8 kV breakers (one each) to isolate the fault

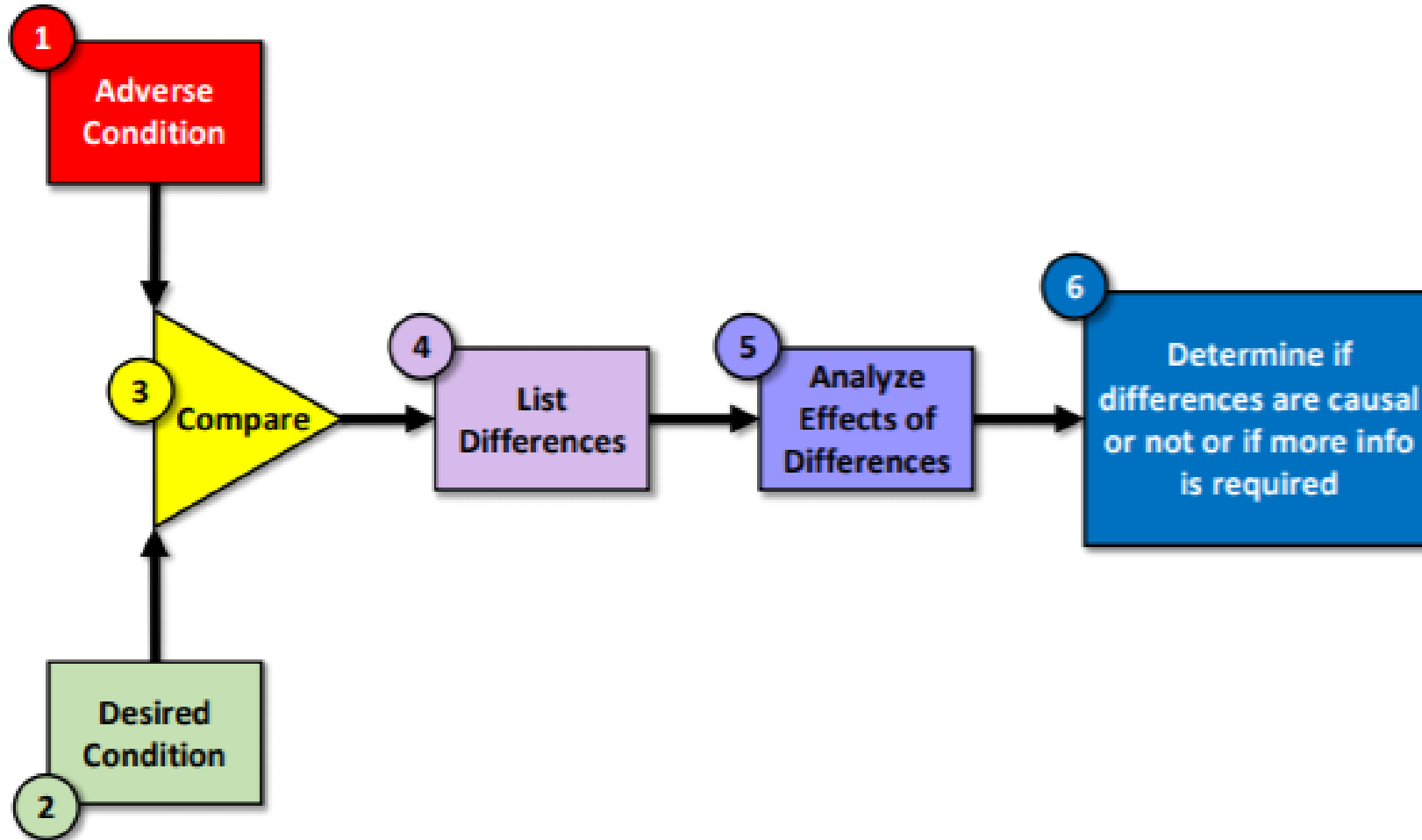


Figure 4: Change Analysis Diagram

- Change Analysis used to find the root cause of the failure
- Different loading of the transformers; the transformer with the lower impedance failed
- Difference was not monitored
- Prolonged overload heating causing thermal embrittlement and eventual failure of the winding insulation paper, resulting in a turn-to-turn short

- A spare transformer was installed to restore service
- Station was redesigned with two larger transformers with separate load paths and separate metering
- Change Analysis is a simple, effective, quick tool to find the cause of problems
- Used where the causes are obscure or involve failed equipment