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Drill and Blast Safety

Austin Powder Company Mid-Atlantic

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Drill Safety

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Slips, Trips and Fall Hazards

- Can occur anywhere on the bench
- 21% of all non-fatal incidents
- Are not limited to on bench activities
  - Shop area (repair/maintenance)
  - Magazines (load/unload)
  - Transportation (vehicle hazards)

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Slips, Trips and Fall Hazards

- Condition of boot soles (provide friction between foot and ground)
- Loss of balance (uneven surface, loose rocks)
- Wet, muddy conditions (loss of friction)
- Emulsion hose
- Powder poles
- Shovels
- Measuring tapes

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In the shop

- Grease and oil spills
- Loose tools
- Parts on floor
- Hoses and electrical lines
- Drains

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Prior to Drilling….

- Observe drilling area from **below** to identify geologic concerns
- On the bench, check for ground stability issues, excessive cracking of the rock, shear planes or other potential rock failures.
  - Document potential issues
  - Communicate issues with blaster or site manager
- Ensure fall protection markers at face have been placed and are observable from drill
- Ensure proper PPE including dust protection and noise protection
- Do not wear loose fitting clothing

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Prior to drilling….

- Driller should thoroughly inspect his equipment
  - Condition of drill string
  - Condition of hammer and bit
  - Correct bit size
  - Proper operation of dust control system
  - Guards on moving parts
  - Condition of hydraulic hoses

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Summing it up

- Be aware of slips, trips and fall hazards
- Fully inspect equipment
- Communicate any geologic anomaly prior to drilling
- Be sure to set up buddy check system if drilling alone
- Never override safety systems or bypasses

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Blasting Safety

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Blasting Safety

- Explosives are commonly used to excavate rock for mining and construction
- Explosives are designed to be safe to transport and handle
- It is important to remember, even though these products are designed with safety as the priority, they are designed to release tremendous amounts of energy and must be treated with respect at all times

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Blasting Operations

- Blasting requires the distribution of energy in the rock mass
- Holes are drilled to a specified depth
- Holes are drilled a specified distance apart (burden and spacing)
- Detonators are placed into boosters and lowered into each hole
- Primary explosive/blasting agent is pumped into each hole to a specified depth
- Crushed stone or drill cuttings are used to fill the remainder of the hole to limit rock ejection and control rock throw outside the blast area

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Blasting Operations

- When the blast has been loaded and the blaster confirms ready to fire…
  - Blast Clearance zone must be evacuated by all personnel on site
  - Any roads or approaches to clearance zone must be guarded
  - Any road guard must have method to communicate unauthorized entry to area
  - Warning siren will be sounded
  - Blast will be detonated
  - Clearance zone must be maintained until an All Clear is sounded by blaster

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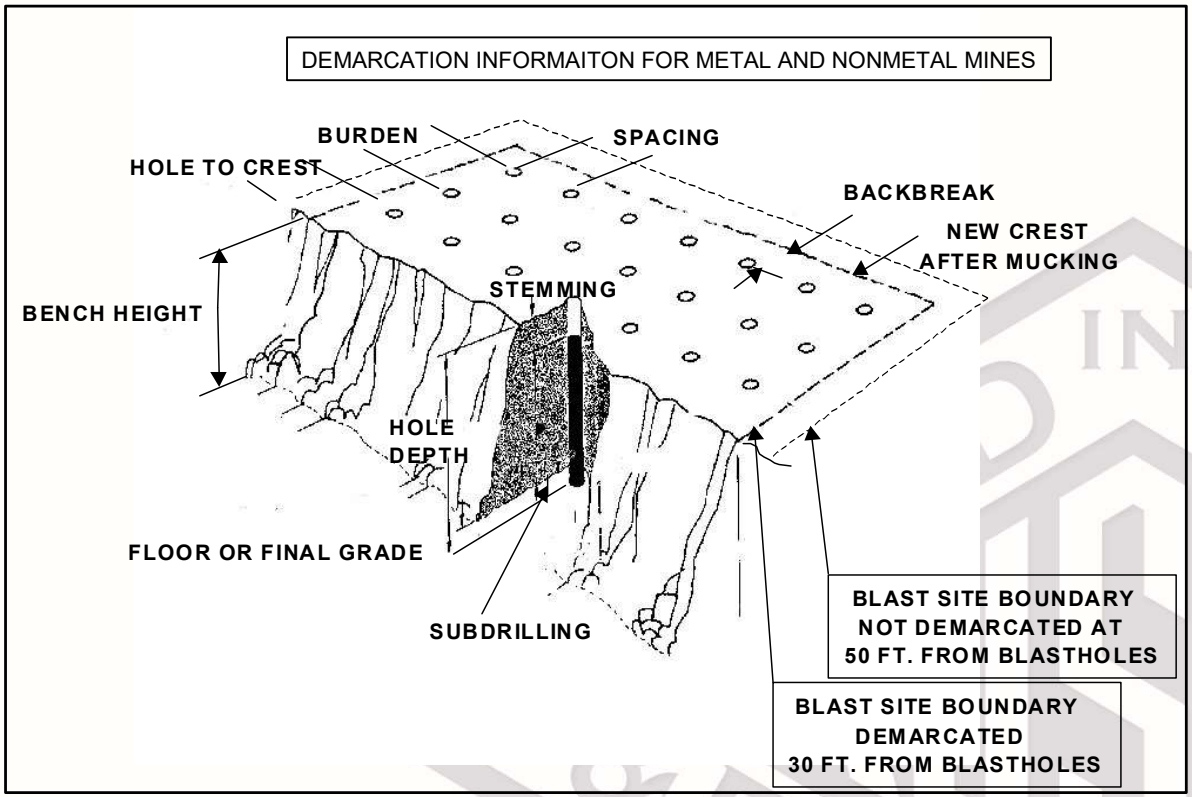
Blasting Terminology



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Blasting Safety

- Blasting can result in damage to equipment or structures, injuries and even death
- Most blast-related injuries and fatalities involve flyrock, or rock ejected from the blast into the air.
- The primary causes of blasting accidents are due to
  - Poor blast design
  - Breached security zone
  - Improper security zone

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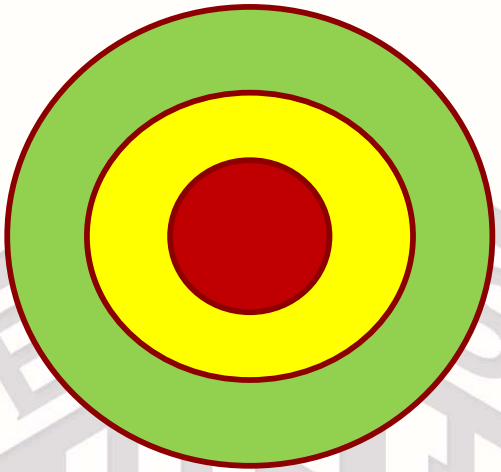
Blast Zones

- **Blast Site**
  - Area containing loaded holes
  - BIC must approve entrance to this area
  - Area must be evacuated in presence of lightning regardless of detonator type



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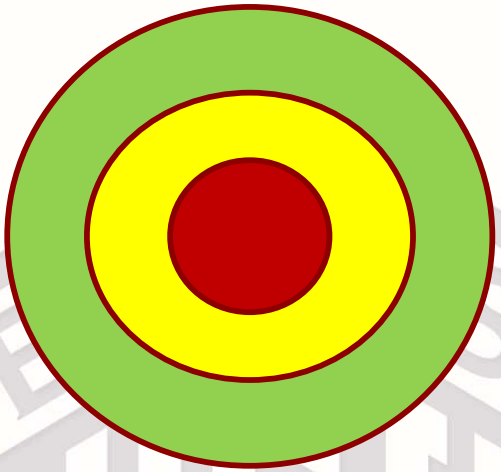
Blast Zones

- **Blast Area**
  - Area where flyrock, concussive shock waves and NOx may result from the blast event
  - Damage to equipment, injuries or fatalities may occur here even with well designed blasts



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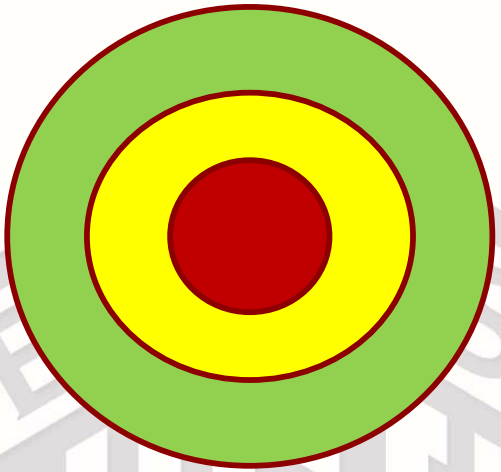
Blast Zones

- **Blast Clearance Area**
  - Safety factor to be added to insure no possibility of damage, injury or fatalities as a result of the blast
  - Persons within this area must have approved blasting shelter to protect against flyrock
    - Heavy equipment
    - Loader bucket
    - IME approved shelter



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Blasting Safety

- Only the Blaster In Charge (BIC) can approve someone to enter the blast site
- The blast area and clearance zones should be modified based on blast conditions
  - Misfire reshoot
  - Geology
  - Location in pit
  - Holes blocked and not able to be properly loaded or stemmed

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Blasting Safety

- If anyone is required to be in safety zone, they must have adequate protection.

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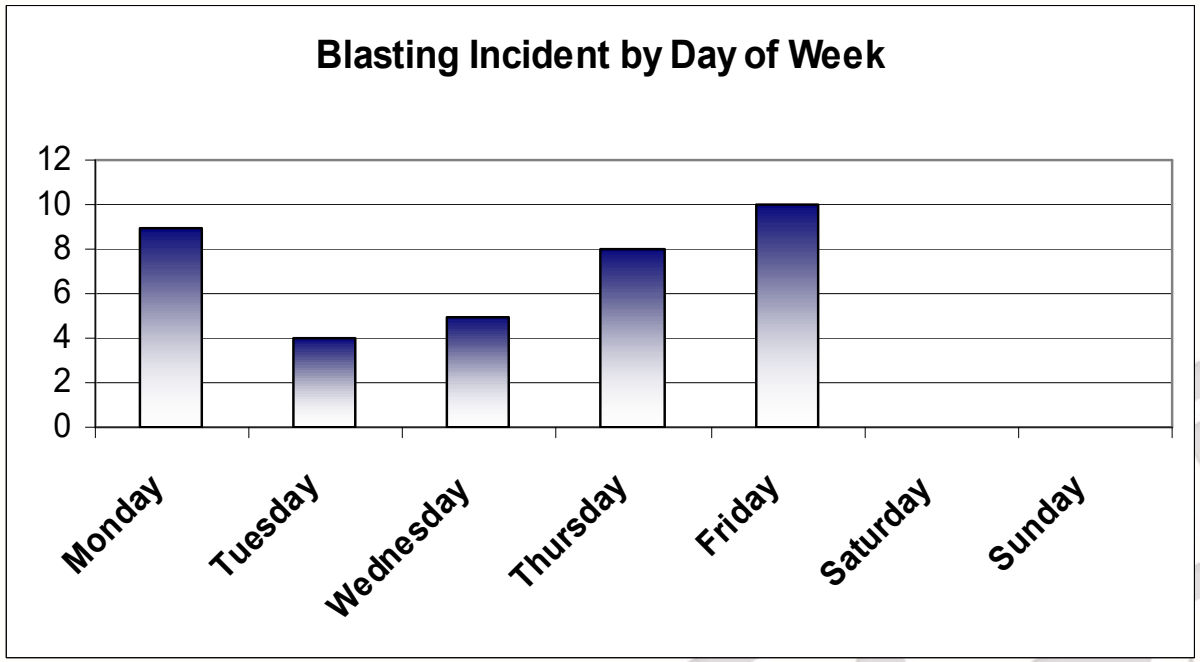
Blasting Safety



- Fatigue can also lead to taking short cuts, forgetting what you are doing and ultimately causing an incident

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Blasting Safety

- Every aspect of potential for risk must be evaluated by the blaster. Even water can prove an unnecessary risk

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Blasting Safety

- Flyrock, poor ground condition and carelessness can all lead to damage, injury and fatalities

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Blasting Safety

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Blasting Safety

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Proper Handling of Products

- A blast consists of several different products used to break the rock
  - Detonator
  - Booster
  - Blasting agent/Explosive
  - Stemming/Inert Material
- All play a role in ensuring a safe blast event and desired results
- Anyone working in blasting area should be able to identify these products

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Detonators

- Detonators provide the initial energy to start the detonation process in each hole
- Detonators have a “delay” element that allows the blaster to sequence the blast to fire holes at separate times to provide the desired result
- Delays in detonators are manufactured/programmed in millisecond intervals
- There are 2 primary types of detonators used in blasting today
  - Non-Electric (pyrotechnic)
  - Electronic

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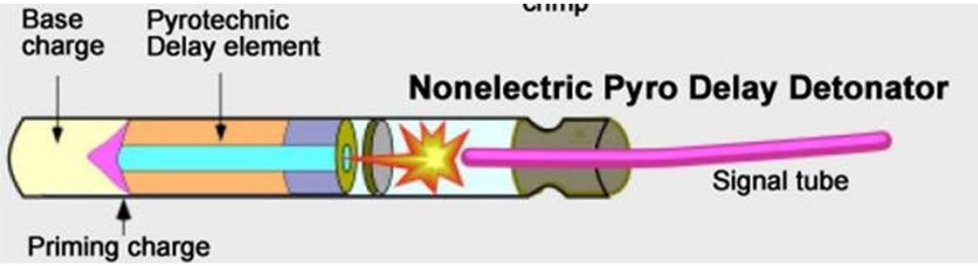
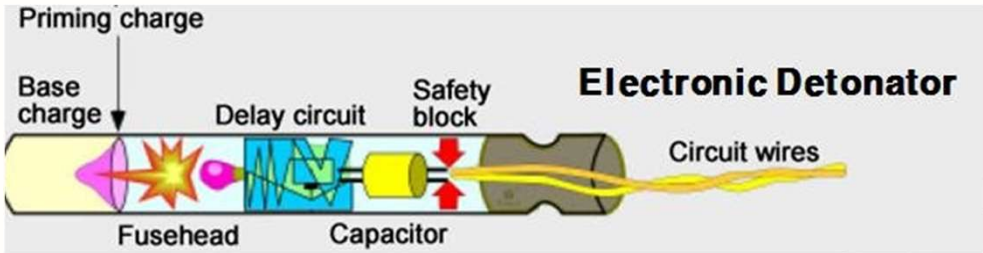
Detonators





- Pyrotechnic
  - Creates delay by precise fuse powder elements
  - Robust, less accurate than electronic dets.
- Electronics
  - Programmable, precise delays
  - More sensitive to shock

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Detonators

- Proper detonation times are vital for shot performance
  - Direction of rock movement
  - Vibration
  - Muckpile development
  - Fragmentation
  - Safety
- Some wire or tube may be found in muckpile after shot. If the metal detonator shell is observed, stop work and notify your supervisor.

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Detonators

Electronic

Non-Electric

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Boosters

- Use energy released by detonator to provide added energy needed to initiate primary explosive column
- Often the most energetic, sensitive product in the shot
- If you see a booster in any condition, in the shot muckpile or outside the blast area stop immediately and contact supervisor
- **Never** handle these products without direct permission of the Blaster in Charge
- **Never** insert detonator into booster until ready to load into the hole
- **Never** force a detonator into the booster cap well

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Boosters

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Primary Charge

- The primary charge in a hole can be rated an Explosive or a Blasting Agent
  - Products have differing sensitivity to detonation
  - All products, regardless of classification release large amounts of energy
    - Cause flyrock
    - Cause direct injury or death

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Primary Charge

- The primary explosive column can be a packaged product, or a bulk product pumped or poured into a hole
- The primer (detonator and booster) provides the required energy to initiate the explosive column
- If primary product or packaging is observed in muckpile, isolate the area, stop work and immediately contact your supervisor

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Primary Charge

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Stemming

- Material inserted on top or primary charge to confine gasses and stemming material when deonated
- Assists in controlling rock from ejecting out of top of the hole and potentially leaving blast security area (flyrock)
- Reduces overpressure and noise generated by blast event
- Desired material for stemming is clean crushed stone
- Drill cuttings can be used but are less effective in controlling flyrock
- Drill cuttings/dirt are ineffective stemming materials when wet

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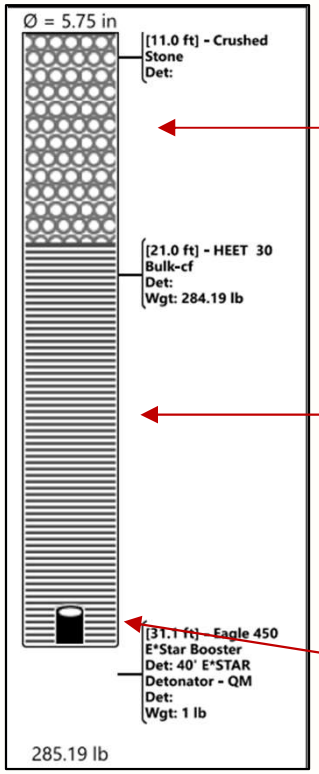
Typical Blast Hole



Stemming Material

Primary Blasting Agent (Emulsion)

Detonator and Booster

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Blast Design/Timing

- Proper design and sequencing of blast holes critical to insure controlled outcome
- Incorrect timing can result in out of sequence initiation of holes
  - Poor performance
  - Excessive confinement, resulting in stemming ejection/flyrock
  - Excessive vibration

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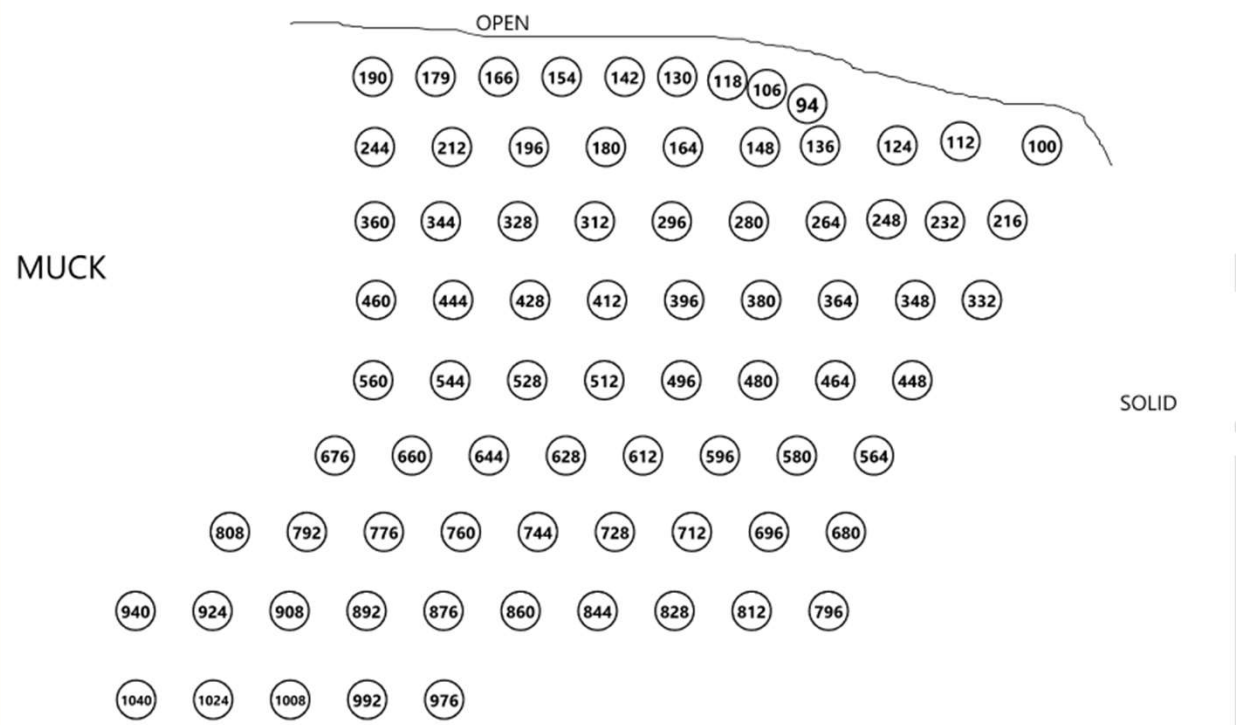
Typical Blast Patten With Delay Sequence in Milliseconds



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Summary

- Do not enter blast area unless cleared by BIC
- Always look out for blast products in muckpile
- Report any products found in muckpile with exception of loose wire or tube
- Blasting products can be detonated by lightning, report onset of storm to your supervisor. Close approach may require isolating blast area till storm passes
- If asked to assist on the blast site, ALWAYS ask questions if unsure what to do or what you see….

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Normalization of Deviance

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Normalization of Deviance

- Often drill/blast accidents are caused by negligence or taking shortcuts
- This can be caused by improper training, fatigue or simple carelessness
- When shortcuts do not result in accidents, they can become accepted procedures. There is a name for this type of behavior – Normalization of Deviance
- This can happen anywhere, to anyone, no matter how informed or technically advanced…..

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Safety……

- **NORMALIZATION OF DEVIANCE**
  - Disregarding or ignoring accepted standards and processes
  - Observing non-standard conditions regarding a process or action
    - **No adverse or ill effect resulting from actions**

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Space Shuttle

- NASA Space Shuttle
- SRB (Solid Rocket Booster)
  - 83% of Shuttles thrust at take-off
  - ½ inch thick steel casings
  - 4 sections
  - Sealed together with O-rings

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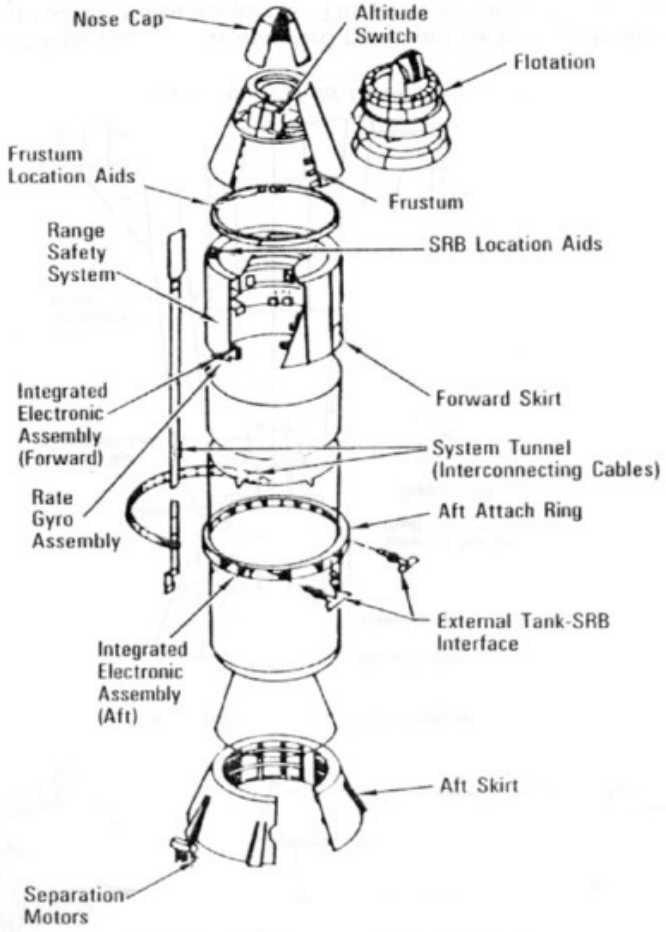

Solid Rocket Booster—Exploded View

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First Shuttle Launch

April 12, 1981

2 crewman

Uneventful

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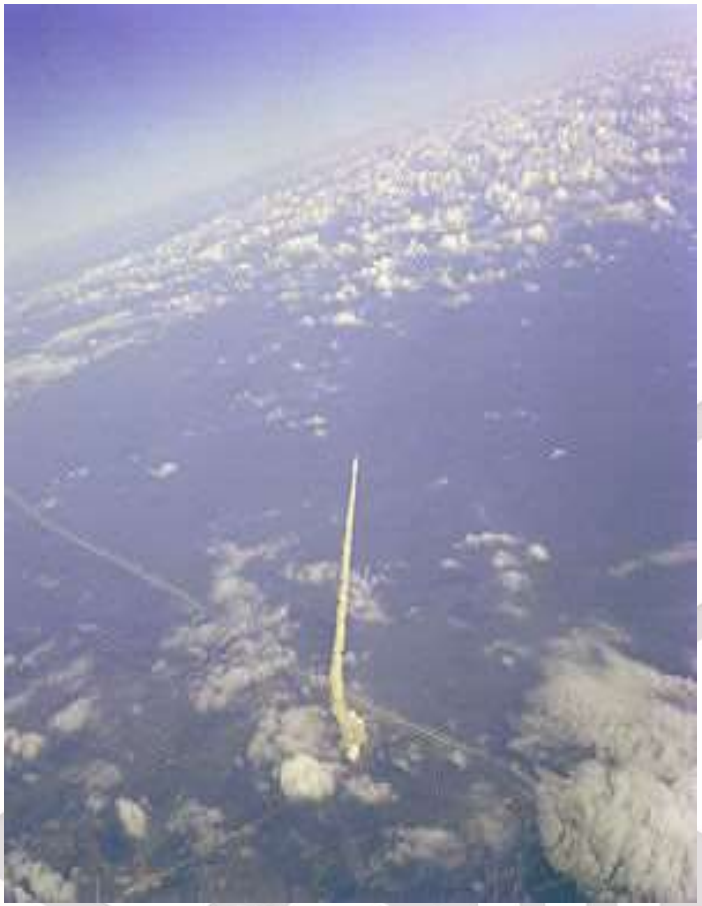
Second Shuttle Launch

November 12, 1981

2 Crewman

Post flight inspection of SRB's shows erosion of O-rings sealing each section of booster



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O-Ring Erosion

- Damaged O-rings tested
- Even though “damaged” they performed well
- Flight status for shuttle missions back online
- Shuttle SOP requires “stand down” for anything that deviates from expected results or conditions
- This was ignored

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New Shuttle Missions

- Between November 1981 and January 1986, O-Ring erosion was found on SRB's of 14 additional shuttle flights…….



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Safety……

- **NORMALIZATION OF DEVIANCE**
  - Disregarding or ignoring accepted standards and processes
  - Observing non-standard conditions with regard to a process or action
    - No adverse or ill effect resulting from actions
  - **Since no adverse effect is observed, nonstandard behavior or actions become viewed as accepted or now “Standard”**

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Safety……

- **NORMALIZATION OF DEVIANCE**
  - Disregarding or ignoring accepted standards and processes
  - Observing non-standard conditions with regard to a process or action
    - No adverse or ill effect resulting from actions
  - Since no adverse effect is observed, nonstandard behavior or actions become viewed as accepted or now “Standard”
  - **New accepted behavior continues until…….**

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STS 51 - Challenger

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January 28, 1986

Extreme cold makes O-rings less flexible, harder to seal.

SRB engineers ask for flight cancellation due to weather

The engineers were overruled; the flight allowed to proceed…..

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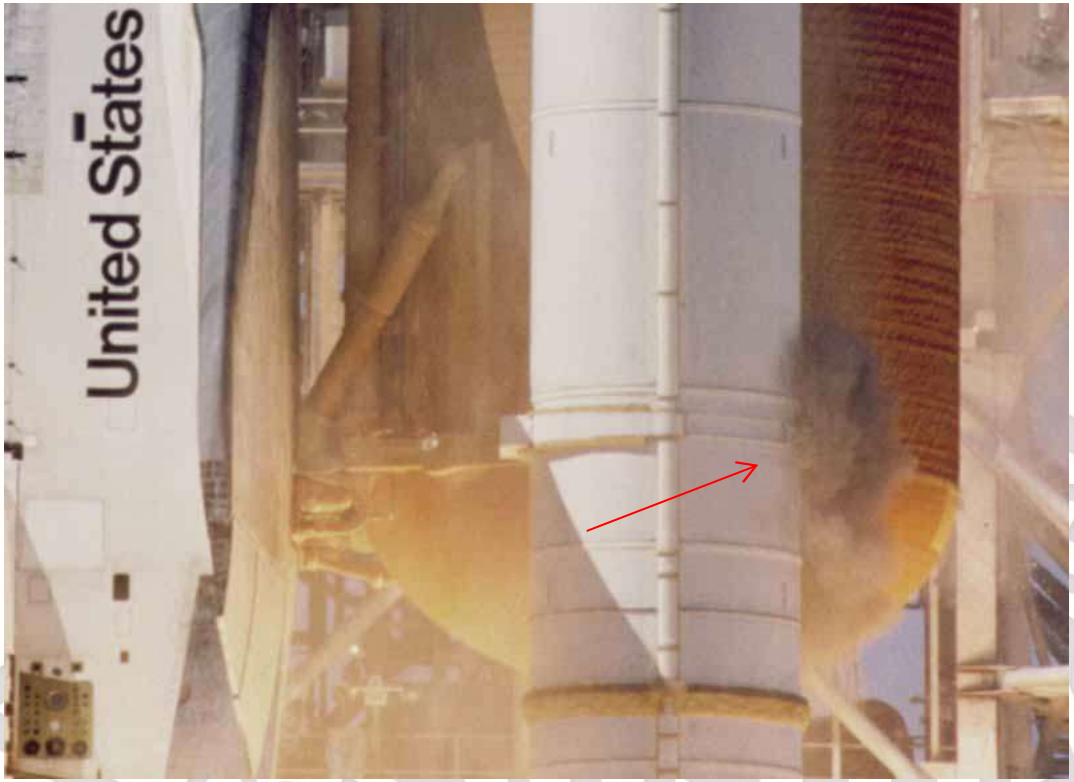
Challenger Launch

Smoke from SRB propellant visible venting from unsealed O-ring joint



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58 seconds after launch

Burning propellant reaches exterior of booster

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64 Seconds after launch

SRB strut fails

Booster starts to separate from vehicle

Booster strikes external fuel tank

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68 seconds after launch

External tank is vented

External tank explodes

Challenger breaks into multiple pieces

Crew cabin remains intact

Evidence astronauts may have been alive till impact with ocean

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“We need to stay vigilant and recognize that even the smallest potential flaw can become a big problem. Even small problems can serve as major failures.”

- NASA administrator

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Remember why we have SOP's

- "Accidents are like the lottery. The odds are long, but eventually somebody always wins…" - Navy F-18 pilot

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Summary

- There are multiple things that can go wrong on a blast
- We have responsibility to coworkers, customers and the public to do it right every time
- Our customers are on record asking us to not be intimidated if we see an unsafe situation and need to stop what we are doing
- If you are not comfortable discussing with customer, call your manager or tech manager for help
- There is no excuse for failure

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Let's be careful out there…….