[redacted]

Homework #8

1.) **Mortar does not fire**

Severity
Hazardous-without warning (10)

The deployment of a parachute is a very time-critical operation. Should the mortar not fire, there would be no warning, and the pilot chute(s) would not deploy. The main parachute could not be deployed without the pilot chute extracting it. Consequently, the spacecraft would not be decelerated and would impact the surface at an extremely high velocity, resulting in loss of spacecraft, mission and/or crew.

Occurrence
Low: Relatively few failures (2)

The likelihood of a failure due to a mortar not firing is very difficult to ascertain. However, because the mortar is a single fault tolerant system, extensive ground and flight testing would have occurred. Additionally, myriad heritage programs exist from which to draw lessons learned. Due to this, the likelihood that the mortar would not fire is low, with relatively few failures.

Detection
High (3)

It is relatively simple to detect visually the failure of a mortar because the pilot/drogue chute would not deploy and the vehicle would not be stabilized/decelerated as expected. A sensor could tell whether or not a mortar fired or if power was supplied to the mortar-firing device.

2.) **Asynchronous inflation of parachute clusters**

Severity
Moderate (6)

The severity of an asynchronous inflation depends on the timing. If the cluster of parachutes opens slightly asynchronously, there would be minimal effect on the vehicle operation. However, if the inflation is highly asynchronous, the results could be much more severe, resulting in other separate failure modes. For a three-parachute cluster, if one chute opens well before the other two, the aerodynamic loads could exceed maximum designed load of the chute. Consequently, the spacecraft would descend with only two chutes fully operational. However, due to current engineering design, the result of an asynchronous inflation should not cause loss of life or mission.

Occurrence
High (7)

Due to the complex aerodynamics surrounding a re-entering vehicle, it probably is difficult to inflate all parachutes in a cluster at exactly the same time. Because of this, there is a high likelihood that the parachutes would not inflate synchronously. However, there is a much lower risk that there would be a highly asynchronous inflation than a slightly asynchronous one.

Detection
Very Remote (9)

If all the preventative measures are taken, there is no way to determine the cause of the failure. Visual inspection can be used to see that an asynchronous inflation occurred but the cause may never be known.

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Causes/ Mechanism(s) Failure	Occurrence
Mortar a deployment device used to eject a packed parachute from the payload	Mortar does not fire	Parachute does not deploy resulting in loss of spacecraft, data, and/or crew	10	Malfunction of mortar trigger Misfire of cartridges Parachute deployment switches installed incorrectly Power system failure	2
Parachute Cluster group of parachutes which once deployed are together designed to stabilize and slow the spacecraft down to a safe landing velocity	Asynchronous inflation of parachute clusters	Destabilization of spacecraft Parachute failure Not enough drag to slow spacecraft down sufficiently	6	Cross-winds Speed of deployment Spacecraft instability too great for proper inflation Suspension lines entangled Deployment bag not fully separated from canopy Improper parachute packing Perforation in canopy	7

Current Design Controls					
Prevention	Detection	Detection	RPN	Recommended Action(s)	Responsibility & Target Completion Date
Designing for multiple cartridges Design for redundancy mortar Design for multiple mortar-fired parachutes Multiple checks/tests of mortar system hardware	Electrical system failure warnings Redundancy mortar fires	3	60	Increase design verification procedures (check the hardware) Install additional redundancy mortars	Lead Systems Engineer Parachute Packer Mortar Production Facility
Proper parachute packing Inspection of parachute canopy for perforations Reef inflation of parachutes to ensure slow inflation	Visual detection	9	378	Inspect packed parachute for proper packing Design redundancy parachute system Slower reefing process	Lead Systems Engineer Parachute Packer

since winds may be a cause, you might consider the landing conditions & any adjustments to the conops.

Would be helpful if write-up was not so abbreviated: what does "design red..." mean? You are already assuming there are multiple chutes. How does this action relate to your "design controls"