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Design and Protection of High-Rise Building ER&R Systems for Explosive Event

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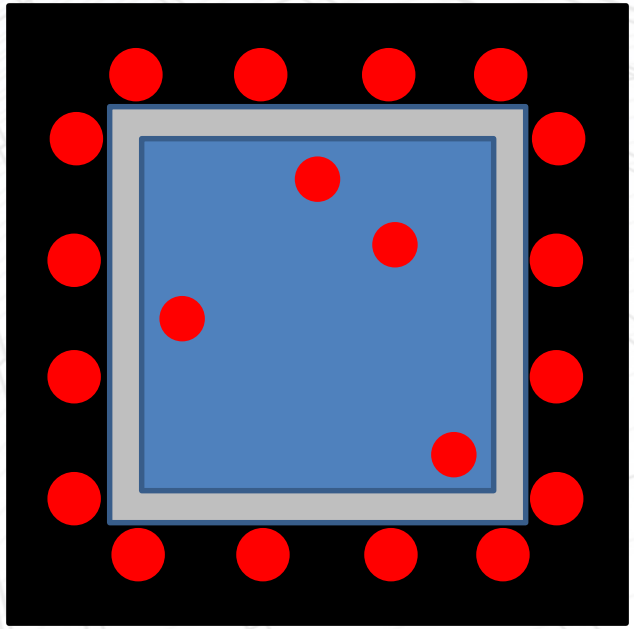
Presentation Outline

- Blast Load Primer
- Introduction to ER&R Systems
- Best Practices for ER&R System Layout
- Hardening Strategies

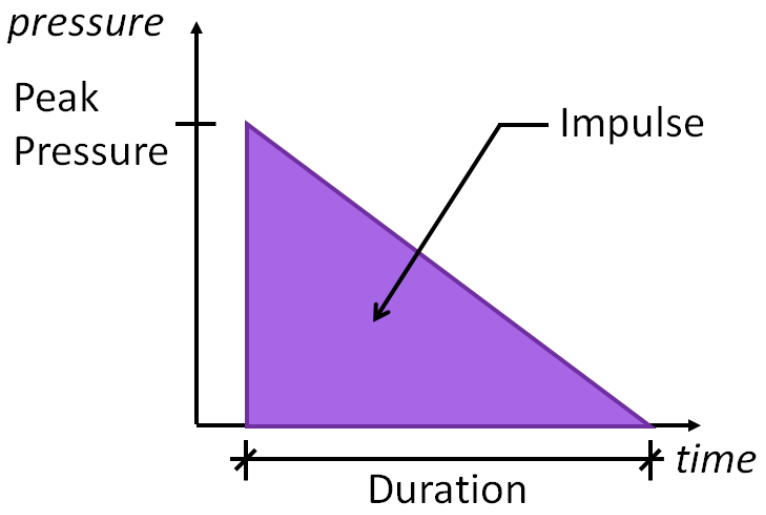
Explosive Event

- Size and location of DBTs determined from TARA or similar risk assessment.
  - DBTs often around building perimeter where a VBIED can be located.
  - Smaller DBTs can be located inside the building.
  - Other site-specific locations are possible.



Blast Load Parameters

- Loading functions are typically:
  - Dynamically applied;
  - Have an instantaneous rise to a peak pressure;
  - Have a small duration (on order of msec).
- Impulse (area under curve) is important.
- Other Factors



Exterior Explosions

- Pressure and impulse generally decrease as:
  - DBT size decreases;
  - standoff distance increases;
  - angle of incidence increases (normal = 0°).
- For exterior DBTs, urban environments provide relatively small standoffs.
  - Very high loads at first few floors close to DBT.
  - Load dissipates going up/around the building.
  - Canyon effects.
- **Note that interior components are subject to effects from exterior explosions.**

Interior Explosions

- Interior DBTs would generally be significantly smaller than exterior DBTs.
  - PBIED or screened VBIED vs. unscreened VBIED
  - Public areas vs. screened areas
- However, blast loads may still be high for interior DBTs due to:
  - Small standoffs;
  - Potential for multiple reflections (impulse increases);
  - Potential for gas build-up (impulse increases).

Introduction to ER&R Systems

- ER&R = Emergency, Response, and Rescue
  - Definition may vary.
- In case of an emergency evacuation, these systems allow for:
  - Building tenant egress;
  - First responder access.
- Primary concern is life safety, not continuity of operations.
- **Note that protection of these systems is not necessarily required by typical building codes.**

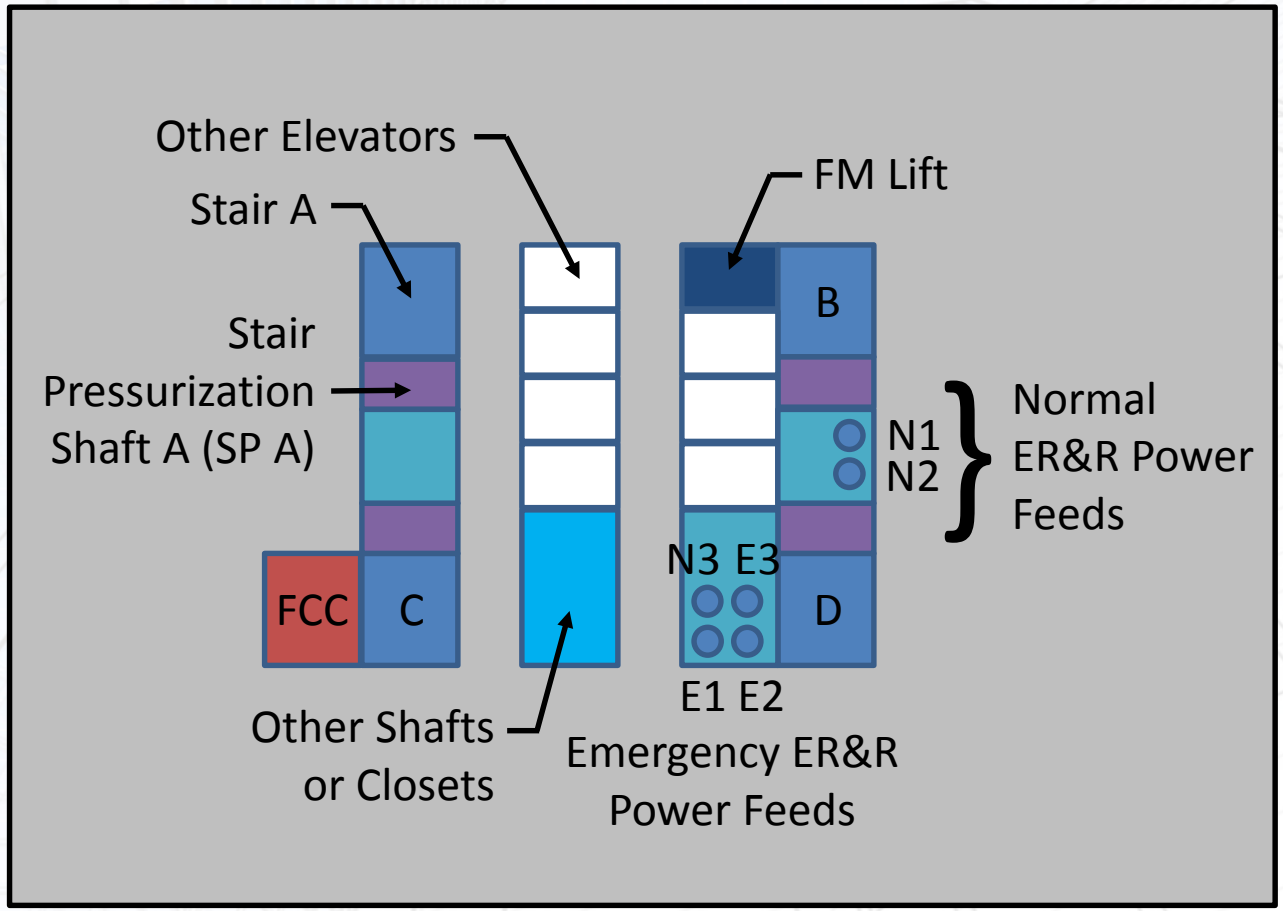
ER&R Systems

- Fire Alarm System
- Emergency Voice Communication System
- Vertical Transportation Utilized for ER&R
  - Stairwells
  - Fireman's Elevator
- Stair and Exit Emergency Lighting
- Stair Pressurization System
- Fire Suppression System
- Additional Supporting Components

ER&R System Notes

- ER&R systems generally maintained with conduits running up height of building.
  - Normal power feeds;
  - Emergency power feeds via generator.
- Some systems may use a panel to control function on a set number of floors.
- Stair Pressurization System also relies on ductwork being functional.
- Tenants may have their own specific area(s) of concerns.
- Ultimately want to implement measures that are not cost-prohibitive.

Representative ER&R System Layout



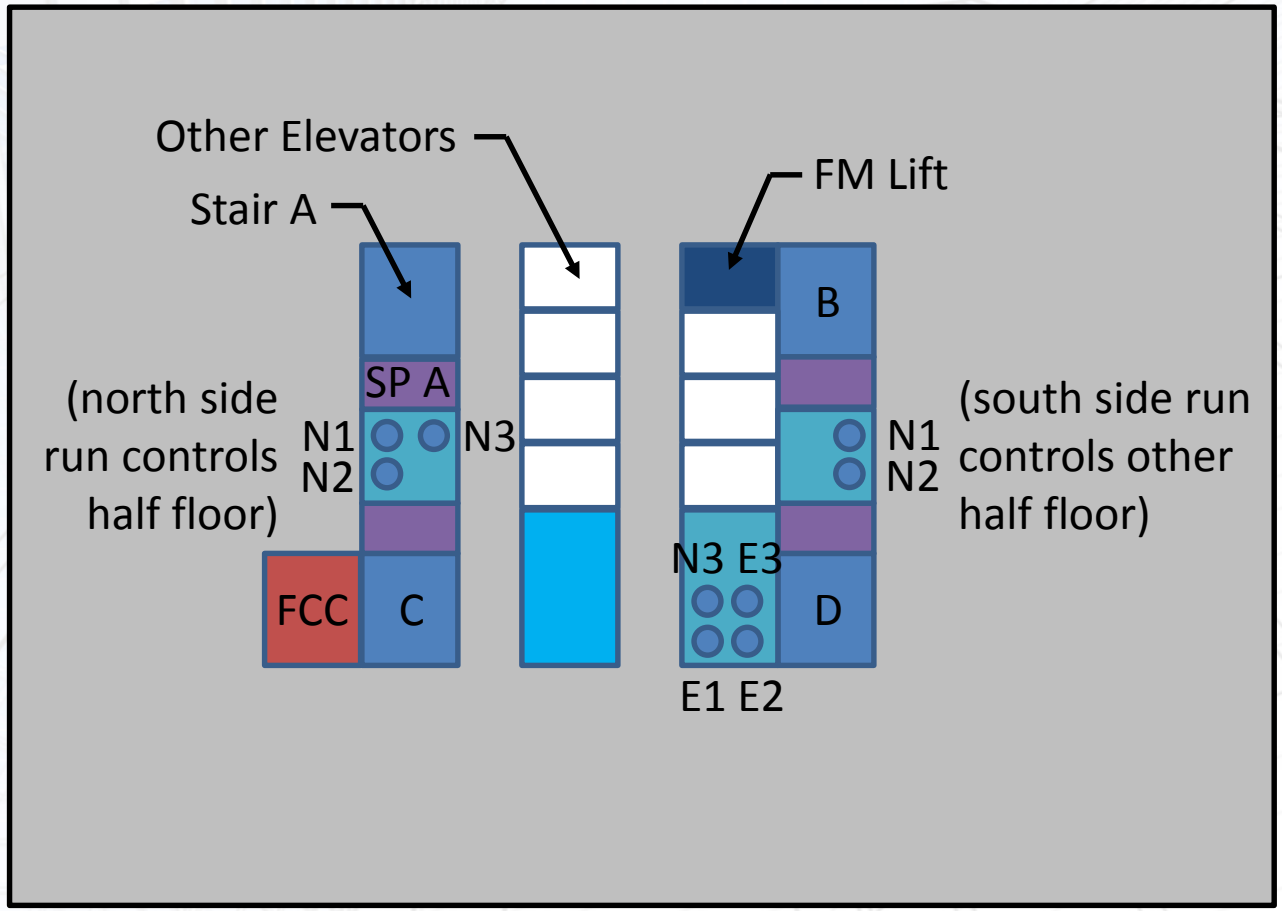
Best Practices for ER&R System Layout

- Goals for larger exterior DBTs:
  - Full building evacuation may be required.
  - Maintain functionality of at least XX% of ER&R systems.
- Goals for smaller interior DBTs:
  - Full building evacuation likely not required.
  - Lose no more than XX floors of ER&R systems.
- Consider loss scenarios early in design process.
  - Coordinate as needed with different disciplines.
  - Each discipline may have different objectives.
  - Make layout that works for everybody.
- Be conscious of expected egress times.

Best Practices for ER&R System Layout

- Restrict/Control Access
  - Particularly to mechanical floors and critical equipment rooms on non-mechanical floors.
  - Screening by itself may not be adequate to limit DBT size.
- Diversification and Multiple Pathways
  - Locate and route ER&R systems such that a loss of a portion of the system will not result in a disproportionate loss of that system.
  - Example: If one run serves north side and another serves south side, potentially lose one run, but not both.
  - Increase stairwell widths if feasible.

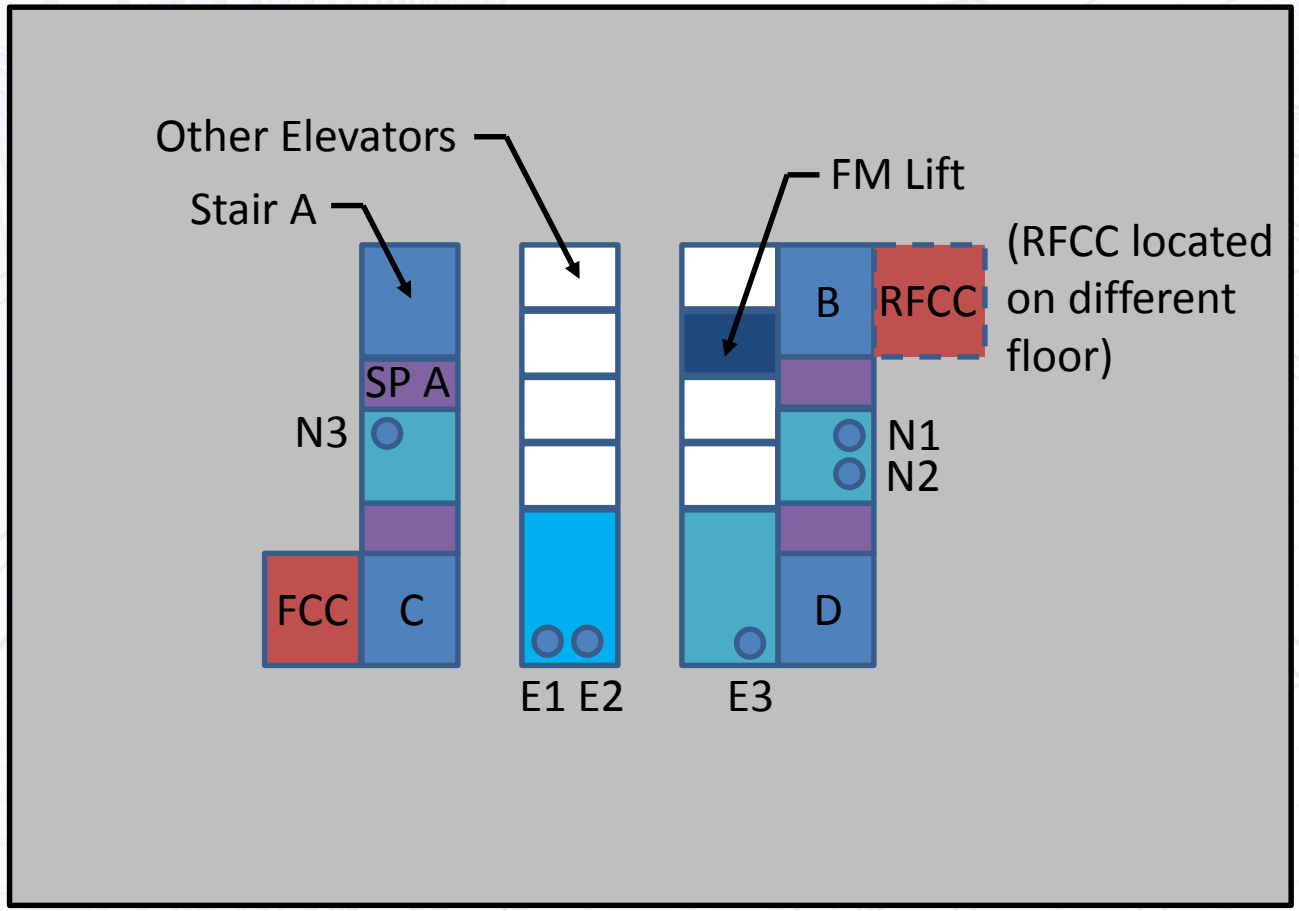
Diversification and Multiple Pathways



Best Practices for ER&R System Layout

- Add Distance (on top of diversification)
  - Do not locate normal and emergency power feed for any given ER&R system within same closet/shaft or otherwise proximately to one another if possible.
  - This ensures one event will not take out an entire ER&R system.
  - Keep stairwells as far apart as possible.
  - Locate generator on higher floors if possible.
- Redundancy
  - Consider providing a redundant power feed for any system that cannot otherwise meet goals.
  - Consider incorporating a redundant FCC.
    - Coordinate with local first responders.

Adding Distance & Redundancy



Hardening Strategies

- Generally only use hardening when other strategies are impractical or insufficient.
- Locate ER&R system components within concrete core whenever possible.
  - May not apply to all buildings.
- Hardened walls for high load cases.
  - Provide adequate connections.
- Minimize use of blast doors, if possible.
  - Harden shaft housing normal or emergency power feed to meet goals vs. harden an electrical closet.
  - Shaft construction issues may control.

Conclusions

- Coordinate ER&R protection items with different disciplines early in design to avoid issues down the road.
  - Ensure everyone on design team understands ER&R protection goals.
- Separate systems whenever possible.
- Make use of concrete core when available.
- Use a combination of strategies as needed to economically meet design objectives.

Acknowledgments

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