Title: **Evacuation Mode for Total Building Evacuation**

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EVACUATION MODE FOR TOTAL BUILDING EVACUATION

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ABSTRACT

The logic of a total evacuation mode of an elevator system includes user interfaces and system interface requirements during an emergency situation. High-level requirements for conventional group control and destination control systems are also significant issues.

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1 EVACUATION MODE LOGIC

The importance of emergency evacuation drills cannot be stressed enough. Even the most sophisticated equipment is useless if occupants and internal and external emergency management personnel are not knowledgeable about its use and intended purpose during an emergency situation. It is also worthwhile to bear in mind that emergency evacuation elevator systems comprise only one part of a building's egress routes and that mixed use of elevators and stairs is the most efficient way to empty a building. Maximizing ele-vator functionality cannot replace a building's emergency management systems and routines. The time it takes for the operator of an on-site security center's elevator monitoring system to detect an emergency, make an evacuation decision and approve elevator mode changes is dependent upon parameters and procedures distinct from those present in the elevator system.

That said, alterations to an elevator system's normal functionalities can optimize elevator handling capacity so that passenger transportation towards exit floors consumes as little time as possible. There is also a clear distinction between conventional elevator control systems and destination call systems.

Core requirements of an emergency-evacuation enabled elevator system concern the elevator controller functionality and the security center user interface of the elevator moni-toring system. The different elevator drive modes have different priorities depending upon the situation, with emer-gency drive modes overriding standard drive modes. The situation at hand dictates the appropriate mode.

Non-fire evacuation is more straightforward than a fire evacuation mode and could in principle be carried out with standard elevator systems. Non-fire total evacuation and its systems are under threat but not yet damaged, such as an electricity blackout in which auxiliary power systems are required in addition to "standard" elevator equipment.

During a fire evacuation, a building's fire system integra-tion and inputs from smoke, temperature and other sensors are required in order to ensure safe evacuation. Recom-mended requirements for protected elevators, which are mainly used for staged evacuations, are discussed in detail in the Council on Tall Buildings and Urban Habitat Emergency Evacuation: Elevator Systems Guideline (which also provides detailed recommendations for successful fractional evacuations, i.e. of occupants with temporary or permanent disabilities). If the elevator system is protected against events like explosions and toxic substances, the fire evacuation mode may be extended to include such extraordinary scenarios.

2 ELEVATOR CONTROLLER REQUIREMENTS

To maximize handling capacity, elevator hall calls are reg-istered only on evacuation floors. “Up” and “Down” hall calls are collected in the direction of emergency egress floors only, disregarding the direction of placed landing calls. Emergency egress floors are defined in the evacuation plan of the elevator controller. The evacuation plan is stored in the group controller.

In total evacuation mode, the evacuation plan is for all floors to be emptied and passengers taken to the emergency egress floors. Emergency egress exit floors can be defined via the elevator monitoring system if a deviation from the default floors is necessary. Once evacuation floors and emergency evacuation elevator groups have been defined, the emergency evacuation elevator group control operates automatically according to its up-peak and down-peak algorithms.

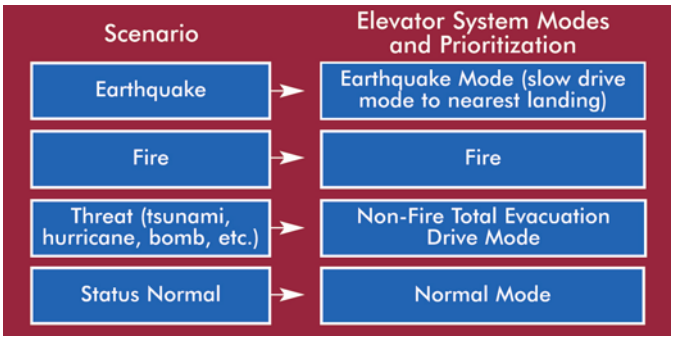

Figure 1. Threat scenarios and elevator system modes

3 DESTINATION CALL ALLOCATION REQUIREMENTS

In an evacuation mode, personalized destination floor calls are disregarded and the emergency exit floor is regarded as the destination floor. Elevator calls are transformed into ordinary floor calls to the floor where the call is placed. The elevator collects the transformed calls towards the emer-gency egress exit floor.

4 PASSENGER AND SECURITY CENTER PERSONNEL USER INTERFACE REQUIREMENTS

To minimize stress and confusion, total evacuation scenar-ios do not allow for special user interfaces placed behind locked panels or key switches. This is a practical as well as an emergency issue. The goal is for passengers to be able to use elevators in exactly the same way as during normal mode except that the elevator controller registers placed calls differently.

As previously noted, configuration and updating of default evacuation plans is performed through the elevator monitoring system’s user interface in the security center, and it is possible to activate and deactivate the evacuation mode from the monitoring system user interface by security center personnel.

5 MACHINE-TO-MACHINE INTERFACE REQUIREMENTS

Building management system interface specifications require cooperation between specialist planners so that safe waiting lobbies, building automation input, power supply redundancy and integration into building-in-use processes are provided. If the emergency evacuation elevator system is intended for use during fire scenarios, firefighter drive mode activated from fire or other alarm system inputs must be disabled in evacua-tion modes (most fire evacuations take place early during a fire scenario, in which event firefighter use of elevators takes place after evacuation and the security center operator acti-vates and deactivates the evacuation mode).

During evacuation operation, fire, smoke and in some cases gas warning system inputs monitor whether the smoke/gas and temperature level in the exit floor lobby, hoistway or elevator car compromise tenability or elevator system functionality. Detailed specifications are needed to define what are acceptable conditions in elevator lobbies to allow the elevators to stop at any given floor during fire, explosion, etc.

6 TIME-CRITICALITY REQUIREMENTS

The evacuation of high-rise structures has traditionally been performed through staged evacuations, but new threat sce-narios call for standardized building evacuation procedures which allow full building evacuations to be performed in an orderly manner in as short a time as possible. Participants in the ongoing research and discussions about evacuation have suggested different time criteria, but in well planned office buildings viable elevator-only evacuation time is estimated at approximately 30 minutes and evacuation using both elevators and stairs is estimated at under 20 minutes, independent of the number of floors in the building. Following are some considerations for maximizing elevator traffic-handling capacity.

- Elevators' efficient dispatching algorithms must be utilized in order to maximize traffic-handling capacity— manual dispatching can never compete with the efficiency of automatic dispatching.
- The emergency evacuation elevator should always take as full a load as possible during each stop with a minimum number of stops in one round trip.
- Every started trip should be completed disregarding failure of noncritical components.
- The emergency evacuation elevator system should start to close the doors with a full load, configurable from the elevator control system.
- The emergency evacuation elevator system evaluates occupied floor space. This prevents the emergency evacuation elevator from

stopping at other floors even if the elevator is not loaded to its full mass capacity.

BIOGRAPHICAL DETAILS

Kim Bärlund is KONE Corporation Major Projects Unit Manager of High-Rise Products and served as Chair of a 16-member Council on Tall Buildings and Urban Habitat task force that developed a report on evacuation by elevators.

Marjukka Mäkelä is an industrial designer in KONE Corporation's Global Research and Development Unit in Hyvinkää, Finland, and focuses on user interface and product design related to elevators.

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Marja-Liisa Siikonen is Director–People Flow for KONE Corporation's Major Projects Unit, has published numerous articles and patents in the field of elevator control systems, and is a member of the Finnish Operations Research Society and the European Physical Society.