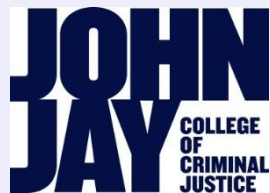# A Simple Decision Model for Managing the Movement of Building Occupants during Fire Emergencies
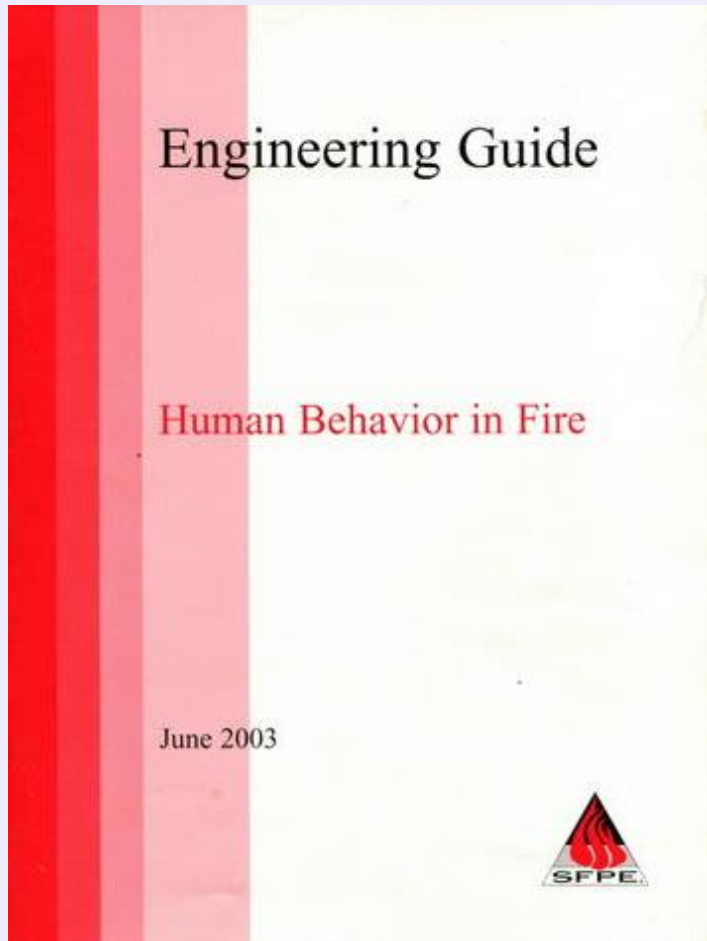
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CUNY The City University of New York

RACERS
The Christian Regenhard Center for Emergency Response Studies

New Chapter in the SFPE Engineering Guide to Human Behavior in Fire

Engineering Guide

Human Behavior in Fire

June 2003

SFPE

Missing from the literature

How to actually plan people movement during fire emergency that is tailored to specific buildings and scenarios

A decision model to decide who goes where, when

- For operational managers: guidance on emergency occupant movement planning, both before and during a fire emergency

- Operational managers include both fire safety/EAP directors and first responders.

NYC requires that: "The Emergency Action Plan shall set forth the circumstances and procedures for the sheltering in place, in-building relocation, partial evacuation and/or evacuation of building occupants in response to an emergency."

But the requirements are silent about how to accomplish this requirement.

Standard strategies are too general

- sheltering in place

- in-building relocation

- partial evacuation

- evacuation of building

Which "standard strategies" apply to which occupants depends on the scenario

Instead, model divides occupants into groups using the following scenario-specific information

- Locations of building occupants

- Anticipated growth and mitigation of hazards

- Separations between hazards and groups of occupants both while stationary and moving to safer locations.

- Limitations in abilities of building occupants to move to new locations

- The availability of assistance to compensate for those limitations.
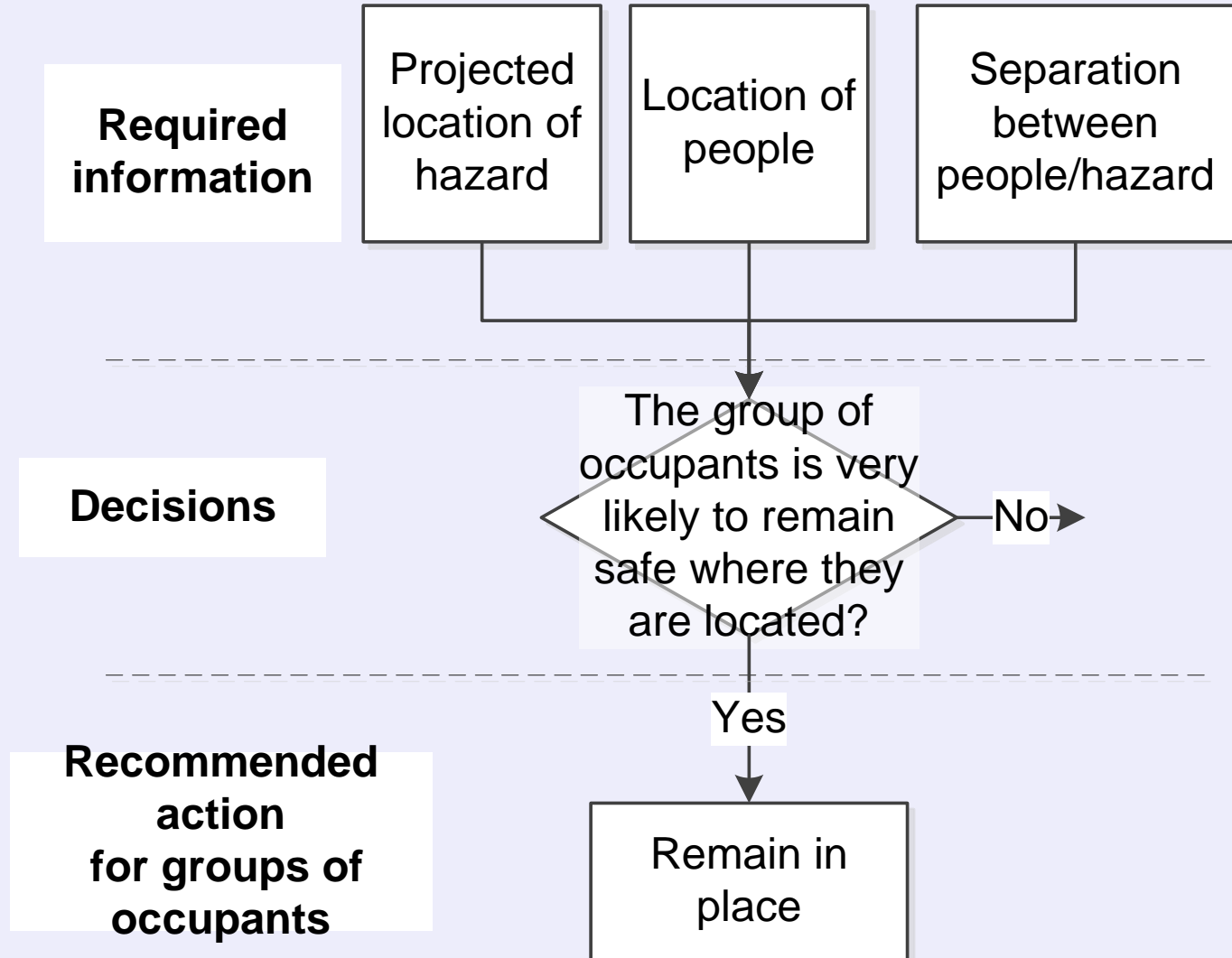
Managing the Movement of Building Occupants *during* Emergencies
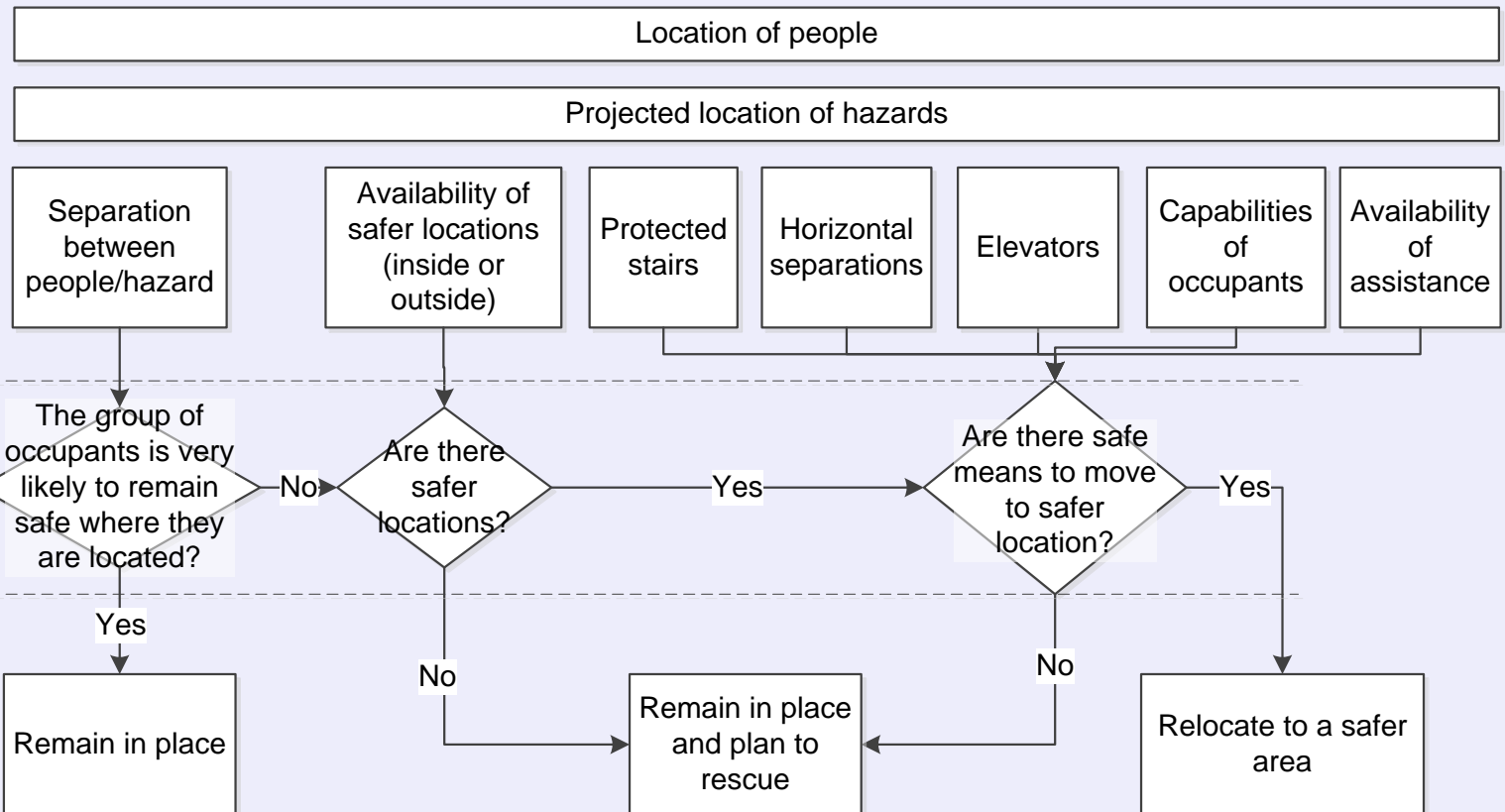
Model can be used for any situation where occupants must be kept separate from hazards

In addition to fires, the model can be applied any "incident involving an explosion, a biological, chemical, radiological, nuclear or other chemical incident or release, natural disaster, or the threat thereof…" [§6-02 (b)]

Decision 1: Which groups of occupants will not be in danger where they are already located?

Required information

Projected location of hazard	Location of people	Separation between people/hazard

Decisions

The group of occupants is very likely to remain safe where they are located? → No →

Yes

Recommended action for groups of occupants

Remain in place

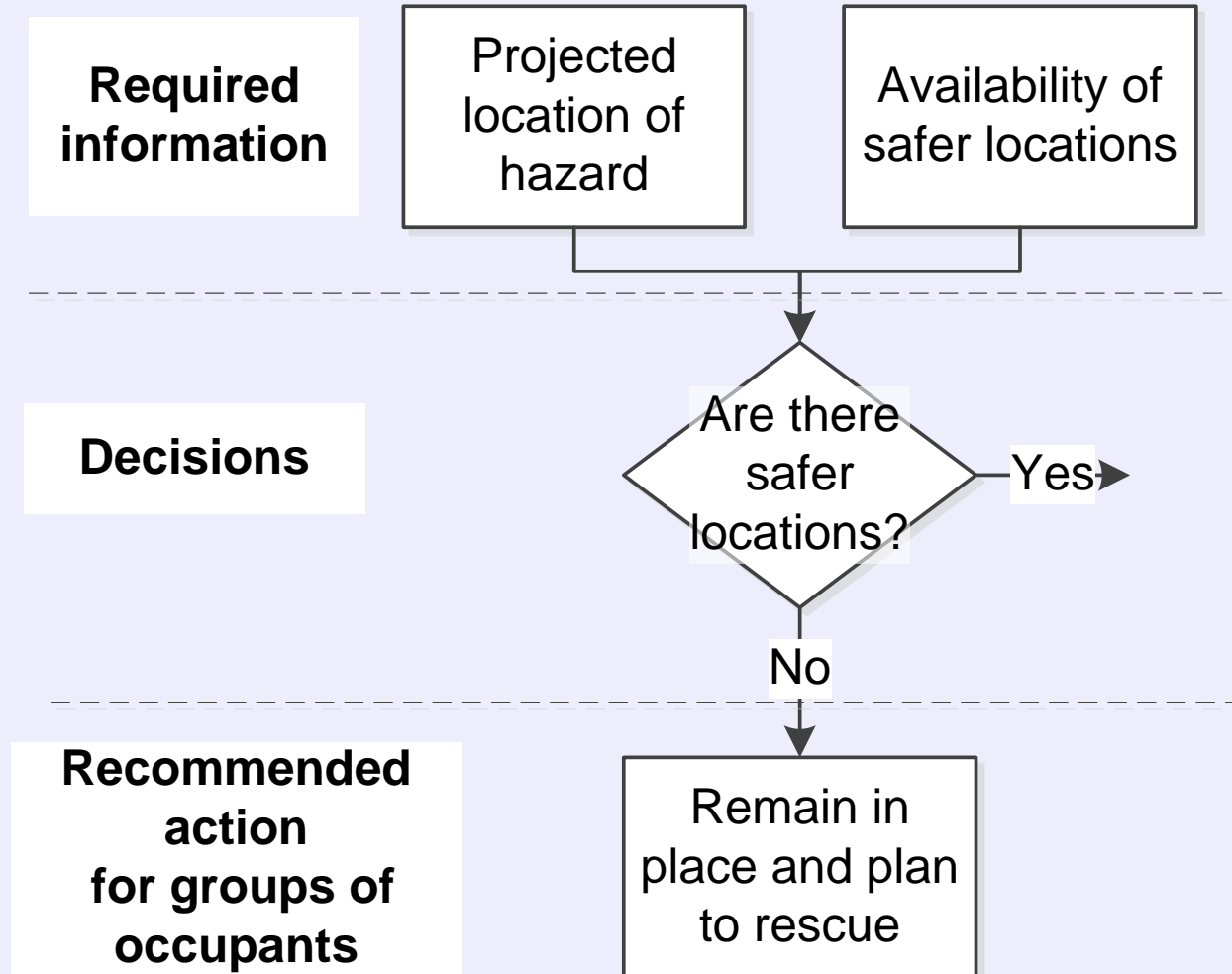# Example of informational inputs:

Building features that limit the projected locations of fire hazards

- Compartmentation
    - Vertical
    - Horizontal
- Automatic suppression
- Smoke control

The communicate recommend actions even when people are not asked to move

- People may be motivated to leave a safe area when they
    - Observe cues (e.g., smell smoke)
    - See emergency responders (e.g., arriving fire fighters)
    - Communicate with others (e.g., cell phones, social media).
- Tell them *why* they are safe

Decision number two:
Are there safer locations?

Required information

Projected location of hazard

Availability of safer locations

Decisions

Are there safer locations? → Yes →

No

Recommended action for groups of occupants

Remain in place and plan to rescue
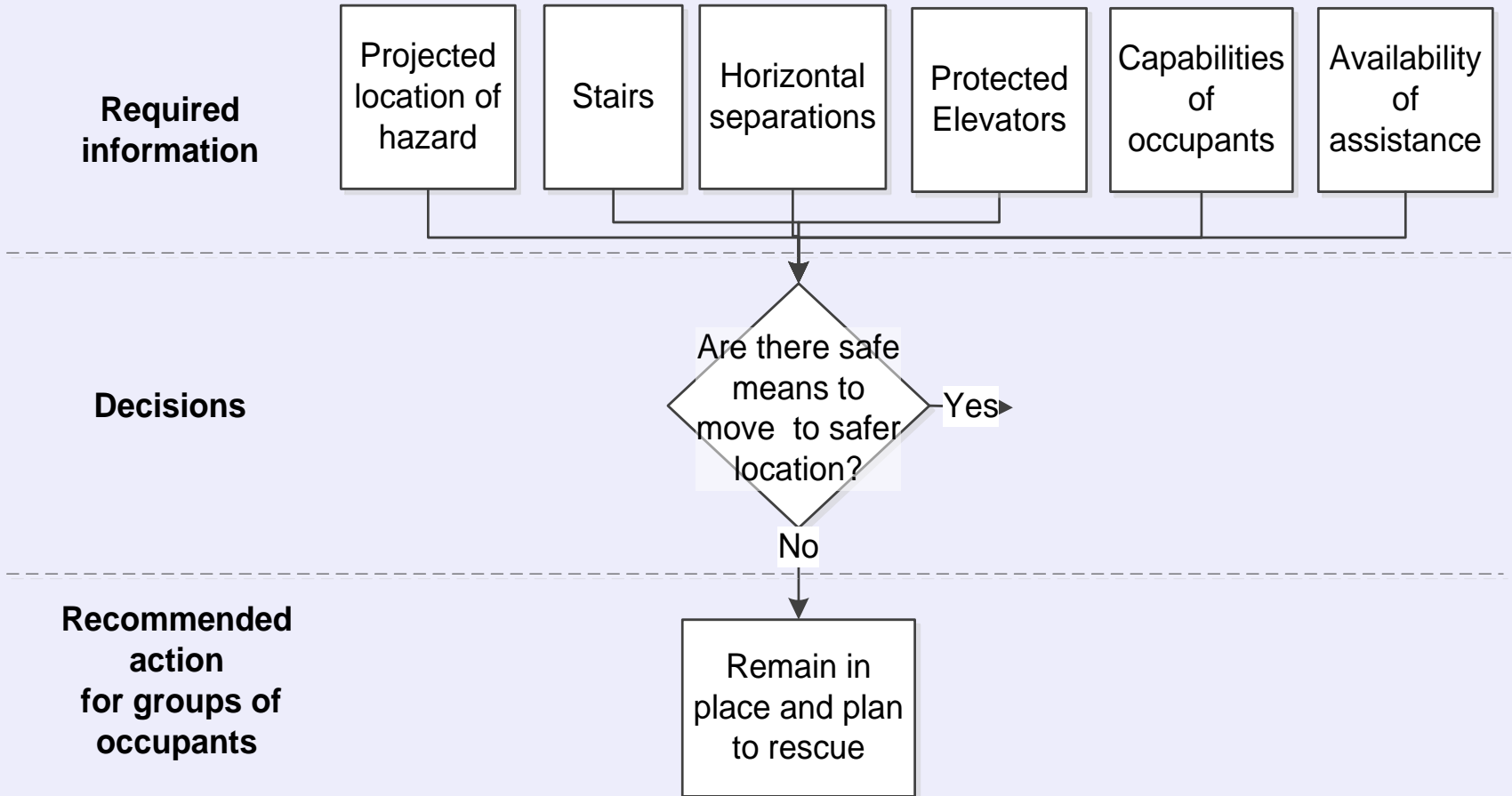
"Are there safer locations?"
Should always happen, but operational managers can inherit a building that has problems

- *Scenarios have not been considered during the design phase*
- *Building protection features fail because of retrofits*
- *Organization fails (e.g., training not supported)*
- *No assessments building occupants capabilities*
- *The building was designed using code provisions that do not meet current standards.*

Hazards sometimes evolve in ways that cannot be anticipated

- *The hazard is more severe than anticipated*

- *Fire protection features fail*

- *Organization fails (e.g., wardens not replaced or untrained*

- *Building occupants capabilities are unknown*

- *Complex systems interact with their environments in ways that cannot always be anticipated*

Decision 3: Are there safe means to move to a safer location?

Required information

| Projected location of hazard | Stairs | Horizontal separations | Protected Elevators | Capabilities of occupants | Availability of assistance |

Decisions

Are there safe means to move to safer location? → Yes

No

Recommended action for groups of occupants

Remain in place and plan to rescue

Example of information inputs for fire scenarios

Building features and equipment for vertical movement

- Stairs

- "Protected" elevators

- Areas of rescue assistance and rest

Information inputs movement performance of occupants

- ## Mobility impairments

  - Hidden disabilities

  - Temporary impairments

- ## Sensory disabilities

  - Sight

  - Hearing

- ## Cognitive impairments\

  - Age-related

  - Drugs and alcohol

  - Sleep

Informational inputs
availability of assistance

- Building emergency response teams

- Communication systems

  - Public address systems

  - Signage

- Controlled descent devices

Informational inputs
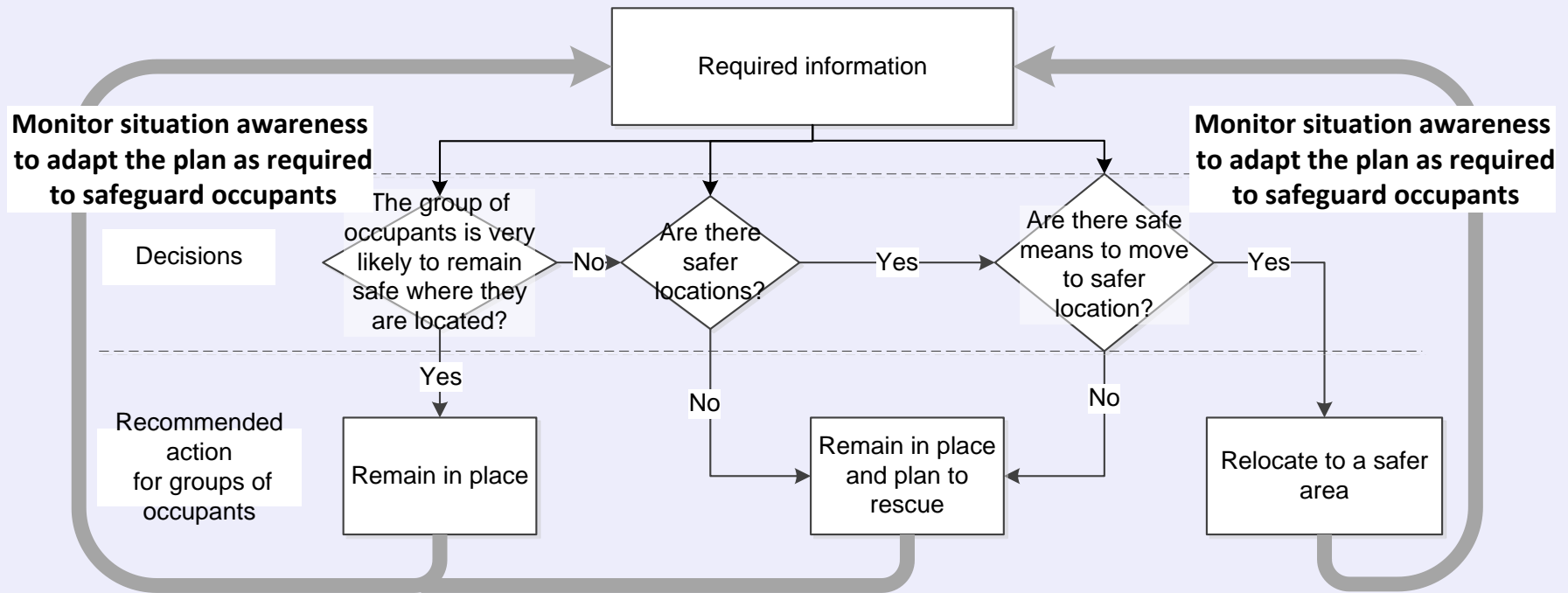# Delayed movement for persons with critical functions

- Building emergency response team members
- Persons who secure tenant infrastructure
- Persons who shut down building infrastructure
- Persons who remove a roster of occupants
- Persons who maintain access control

Using the occupant movement model to adapt occupant movement strategies as an emergency develops

- ## Backup strategies

  > Remain in place and plan to rescue

- ## Maintaining good situation awareness

  - Interpersonal communications

  - Sensors and annunciators

  - CCTV

Feedback loop for adapting the model as an emergency develops

Required information

Monitor situation awareness to adapt the plan as required to safeguard occupants

Monitor situation awareness to adapt the plan as required to safeguard occupants

Decisions

The group of occupants is very likely to remain safe where they are located? — No → Are there safer locations? — Yes → Are there safe means to move to safer location? — Yes

Yes ↓   No ↓   No ↓   ↓

Recommended action for groups of occupants

Remain in place

Remain in place and plan to rescue

Relocate to a safer area

Examples of scenarios from the audience

- Which groups are safe where already located?

- For any "unsafe" group, are there safer areas?

- Are there safe means to move them to a safer area?

CONCLUSION: USING THE MODEL

- The models are simple and intuitive
- For designers
  - ✓ Communicate with design team
  - ✓ Provide a "users' manual"
  - ✓ Incorporate features that improve situation awareness
- For operational managers
  - ✓ Plan and organize planning workshops
  - ✓ train/educate to occupants
  - ✓ Collaborate on EAPs (planning and response)
  - ✓ Argue for upgrades
  - ✓ Use to document the rationale for plans

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