Assessing Regional Shelter Quality

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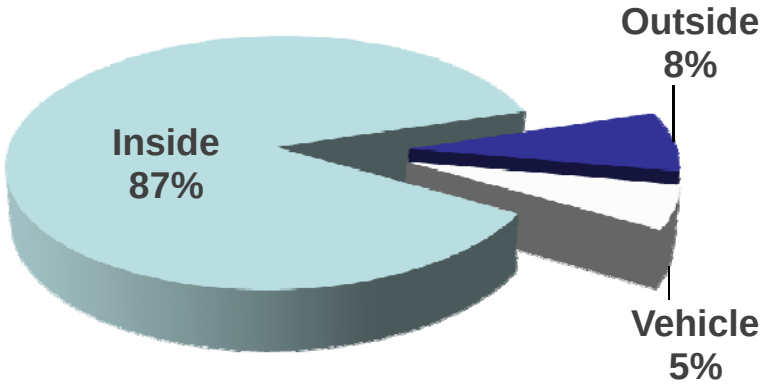
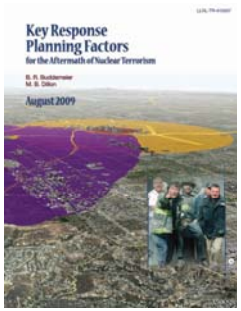
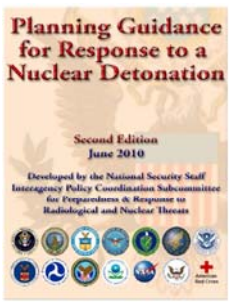
Knowing Buildings Matters…

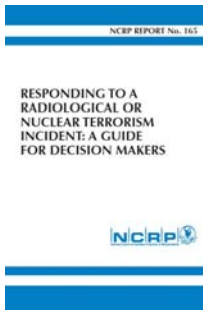
People are usually inside,



Sheltering is a classic response strategy,

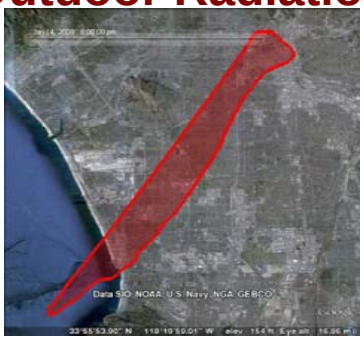






And being inside makes a difference…

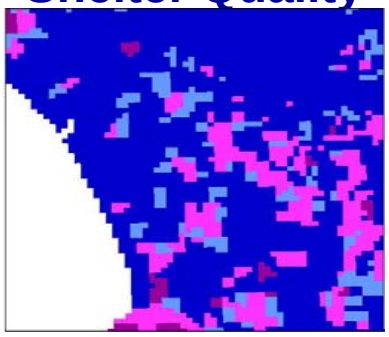
Outdoor Radiation



Potential 100 R Gamma Exposure

×

Shelter Quality



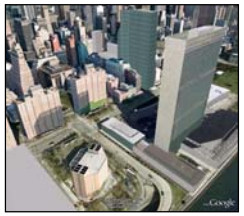
Local Shelter

Indoor Radiation

Potential 100 R Gamma Exposure

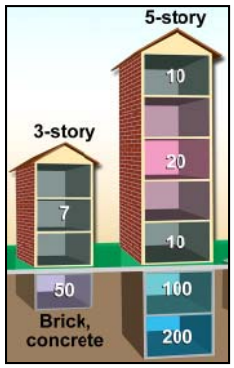
This effort focuses on nuclear fallout (external gamma radiation).

Radiation Shielding – A General Approach



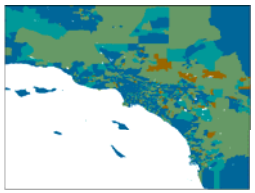
Sort the regional buildings into common types

- *Categorize by: Construction, Basements, Building Height*
- *Identify how many of these building types exist in a given region*



For each building type, determine the protection provided. Protection determined by:

- *Radiation shielding, which depends on construction material (e.g. concrete, wood)*
- *Distance to fallout, which depends on building height and geometry*

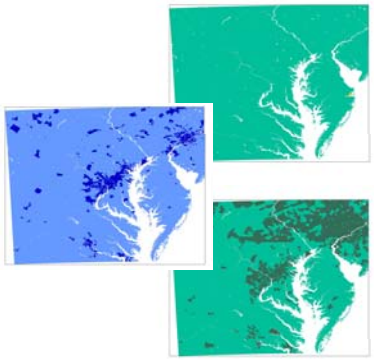


Determine the Regional Shelter Quality

- *Assess the shelter quality in a region by combining building protection with the regional building stock*

Products of the prototype capability

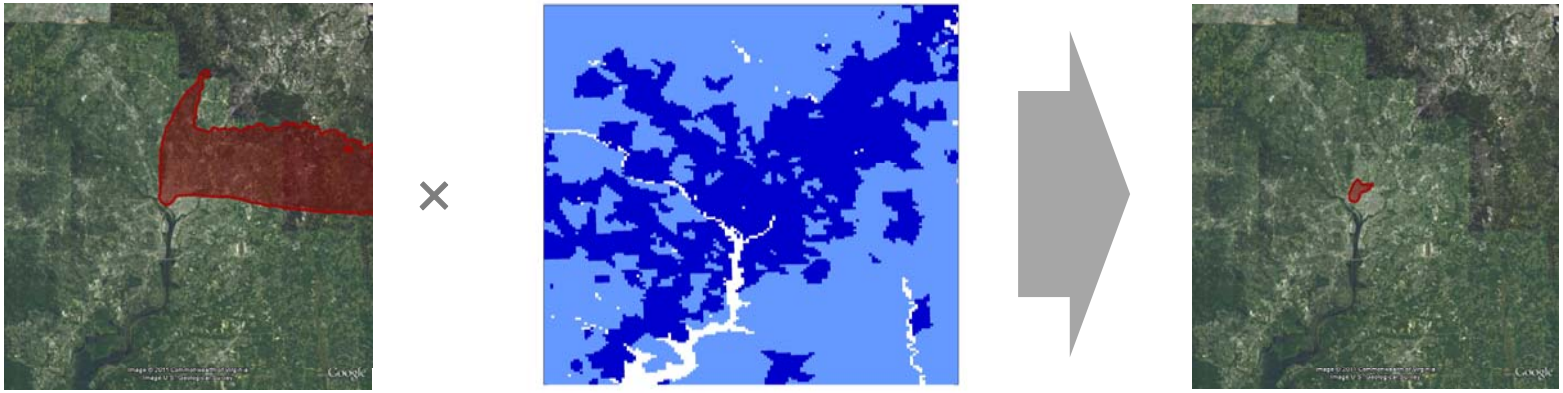
- **Maps of Regional Shelter Quality**
  - Local Shelter (best nearby shelter)
  - Shelter in Place (best shelter within a building)
  - No Response (people stay put)



- **Maps of Indoor Radiation**

  Combine regional shelter quality with outdoor radiation estimates

Outdoor Radiation × **Regional Shelter Quality** → **Indoor Radiation**



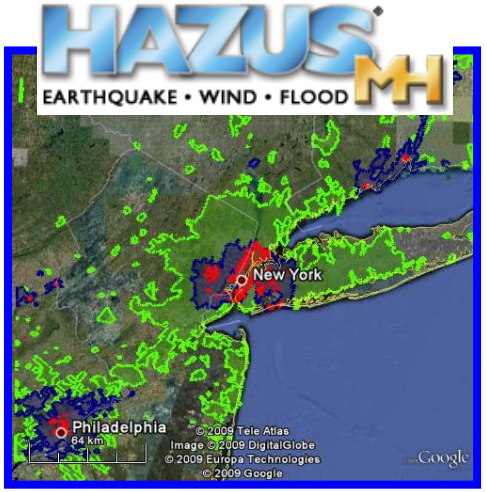
Potential 10 R Gamma Exposure | *Local Shelter* | *Potential 10 R Gamma Exposure*

Images for illustrative purposes only.
For visualization purposes, surface water locations have been rendered white.

Building information

National-level information exists and is useful for national planning.

- DHS FEMA HAZUS program
- National Geospatial-Intelligence Agency (data used under the auspices of the DHS IMAAC and DOE NARAC programs).
- DOE Residential Energy Consumption Survey



But national (and local) planning also requires local information

- Tax assessor data
- Population surveys
- Zoning and building codes

Two approaches are needed…

Svalin – a "tops down" approach

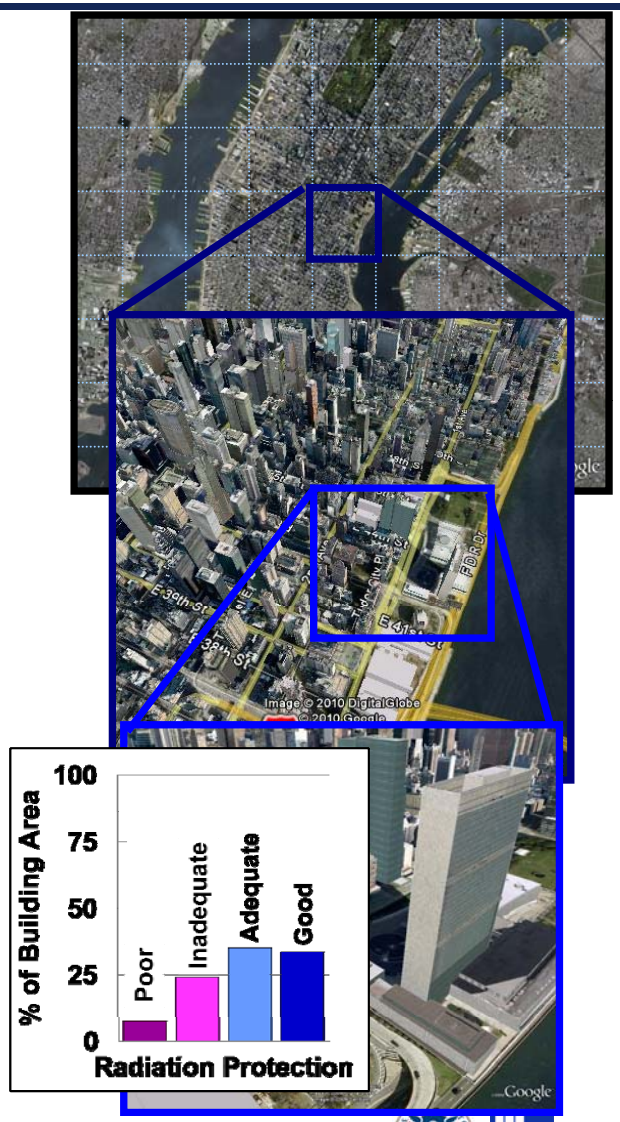
Uses nationally representative data to estimate regional and national shelter quality.

PFscreen – a "bottoms-up" approach

Uses local building data to estimate building and neighborhood shelter quality.

These are complementary capabilities:

- National data fills in missing local data.
- Local data and analyses are used to update nationally representative data.
- Local shelter quality results provide a check on the national results.



Images are illustrative and do not represent an assessment of the specific building shown.

Estimating building protection

Extensive Historical Work

- U.S. Civil Defense Program
- Environmental remediation of nuclear accidents

Structure	Dose transmission factor
Three feet underground	0.0002
Frame house	0.3–0.6
Basement	0.05–0.1
Multistory building (apartment type):	
Upper stories	0.01
Lower stories	0.1
Concrete blockhouse shelter:	
9-in. walls	0.007–0.09
12-in. walls	0.001–0.03
24-in. walls	0.0001–0.002
Shelter, partly above grade:	
With 2 ft earth cover	0.005–0.02
With 3 ft earth cover	0.001–0.005

But how do modern U.S. buildings perform?

Our Approach

- Initial estimates using historical work
- Identify key building parameters
- Develop fast-running screening tool
- Assess modern construction

Table from: Glasstone and Dolan, The Effects of Nuclear Weapons, 3rd Edition, 1977

PFscreen – A building protection screening model

- *Simple*

  Input limited to small number of key building characteristics

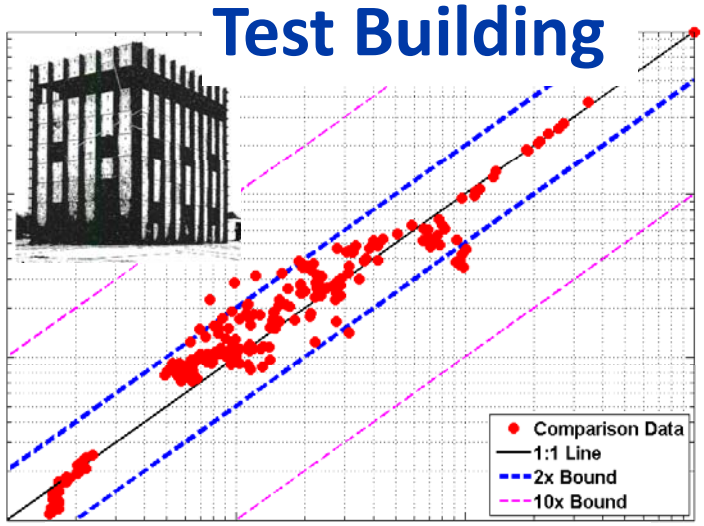
- *Fast*

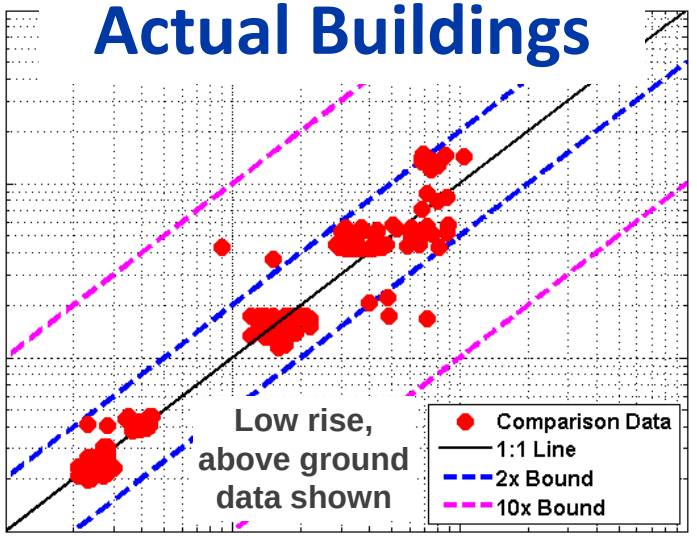
  Individual building analysis in 10's of seconds on laptop

- *Tested*

  Output agrees with measurements within a factor of 2 for simple buildings

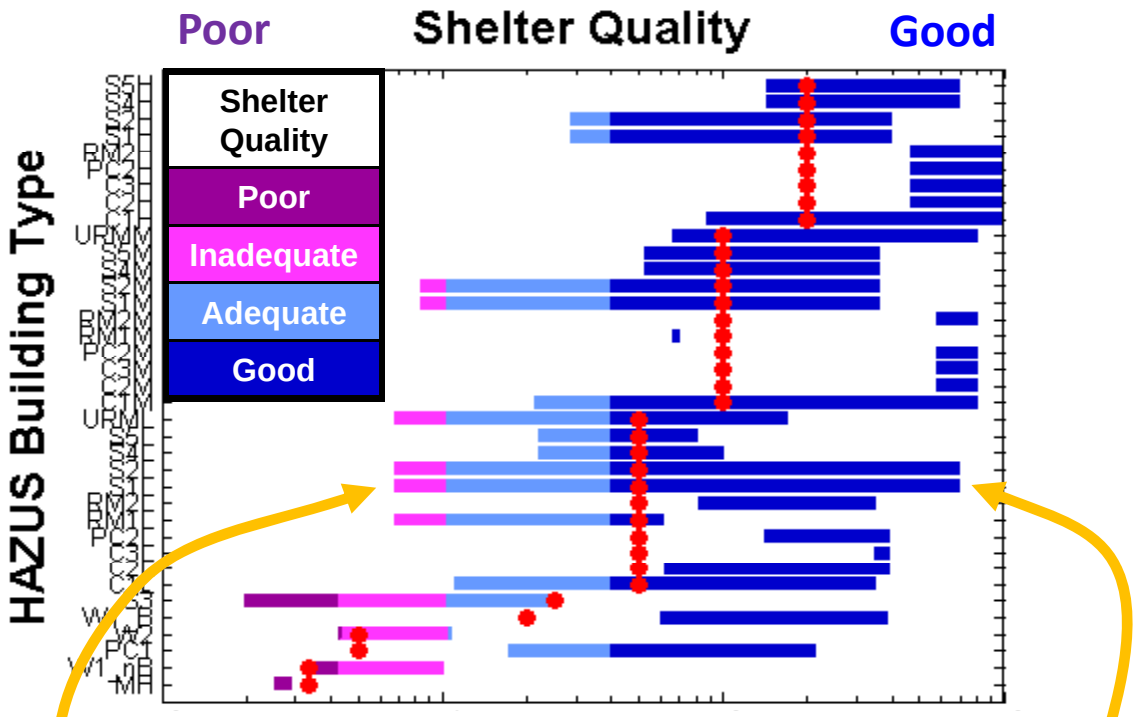
  Further upgrades and testing in progress





Current model is a prototype. Model upgrading, verification, and validation is on-going. Model is not appropriate for all buildings.

Revisiting HAZUS buildings – preliminary results



HAZUS S1L buildings range from:

Poor Protection

- Glass Exterior
- Built-up roof
- Open office

Good Protection

- Concrete exterior
- Concrete roof
- Closed offices

Shelter quality depends on construction details

Red dots indicate shelter quality estimates used in the original analysis

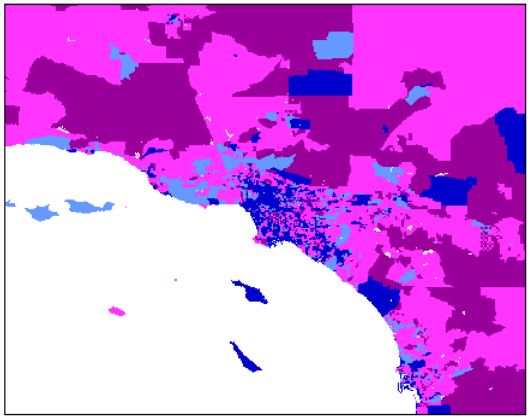
Colored bars indicates an updated range (estimated with PFscreen) to be used in the revised analysis.

Figure depicts work in progress and should not be used for decision making purposes.

Updating national regional shelter analyses

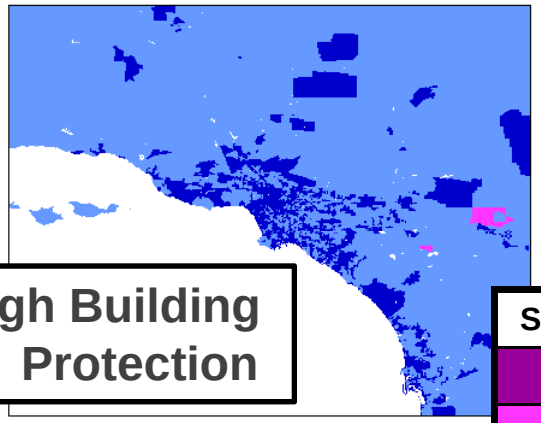
Original Analysis

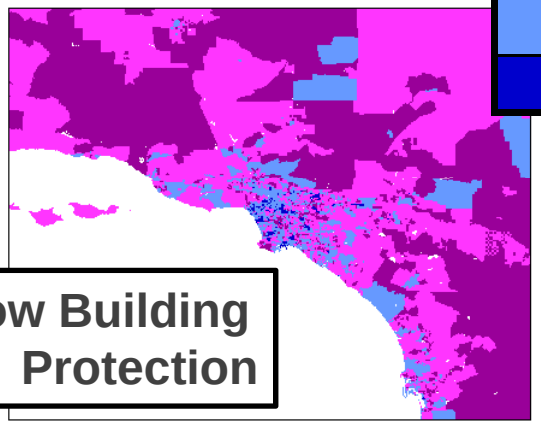
(red dots on prior slide)

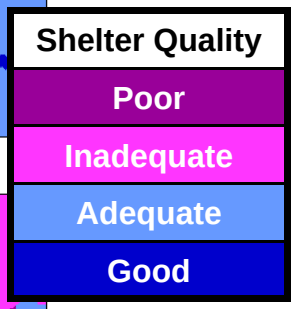


Updated

(a range of results)







Using local building information, we can narrow this range…

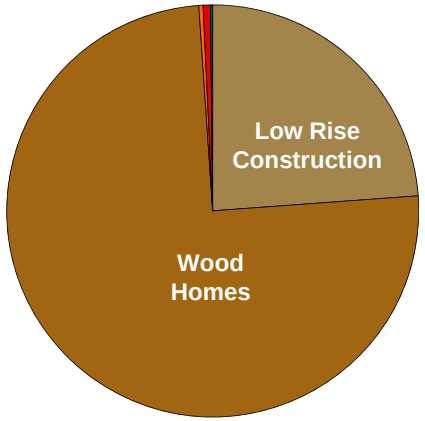
Figure depicts work in progress and should not be used for decision making purposes.

And one more thing - time of day can matter…

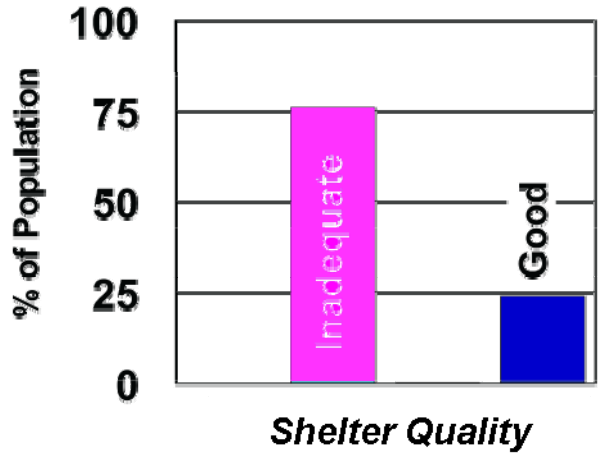
Nighttime:

- **Most people are in wood houses which provide inadequate protection.**

Shelter in Place may provide mostly inadequate protection



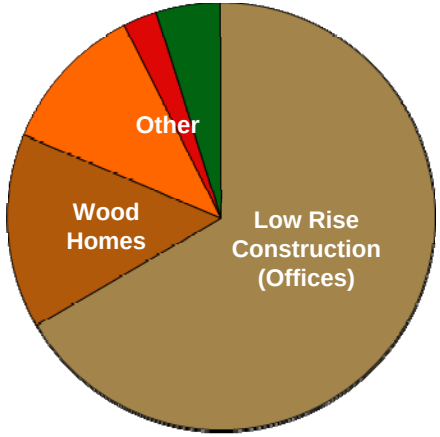
Population Distribution



Workday:

- **Most people are in office buildings which provide adequate shelter.**

Shelter in Place may provide mostly good protection



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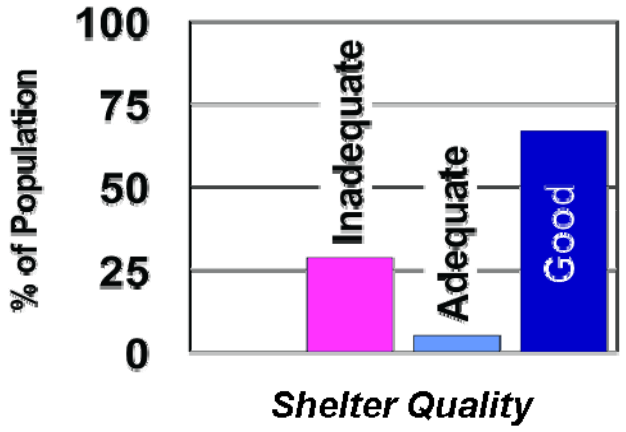


Illustrative calculation: Data from a Northeast U.S. census tract. Wood homes do not have basements. Building categories and protection factors for discussion purposes only.

Project Status – Work in Progress

At the local level, we're working with Clark County and National Capital Region officials to determine:

- What building information is available.
- How local officials plan to use these results.

On the technical side, we are:

- Streamlining model inputs/outputs to:
  - Utilize available local data
  - Meet local planning needs
- Updating national shelter analyses.
- Upgrading and (partially) validating models.

Next Steps

Continuing working with national and local partners to:

- Acquire and interpret local data
- Support use of HAZUS data and shelter analysis results
- Refine requirements for local planning capability

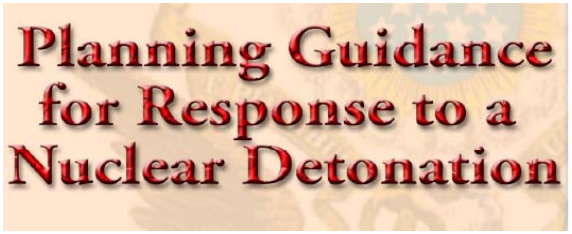
On the technical side:

- Continue capability development
  - Complete model upgrades
  - Simplify user interface
- Continue verification, validation, and peer review
- Develop end user and technical documentation

BACKUP SLIDES

What do we do with shelter quality estimates?

- **For Planners:**



"**Planners should consider areas where adequate shelter is not readily available** and develop options for protection of the public including information and awareness messaging, evacuation plans,. . . self-protection,. . . [and] a public shelter program"

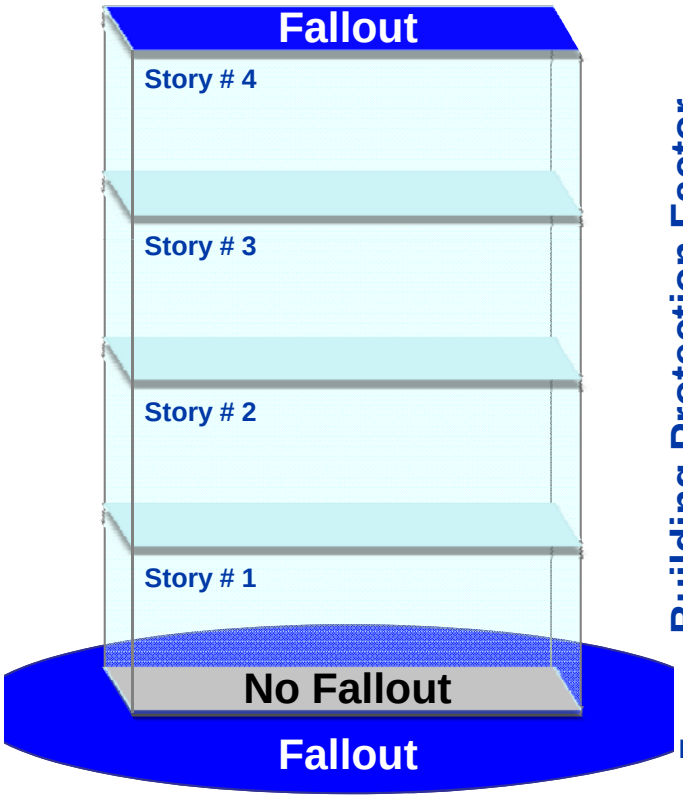
(PGfRND, p.56, emphasis added)

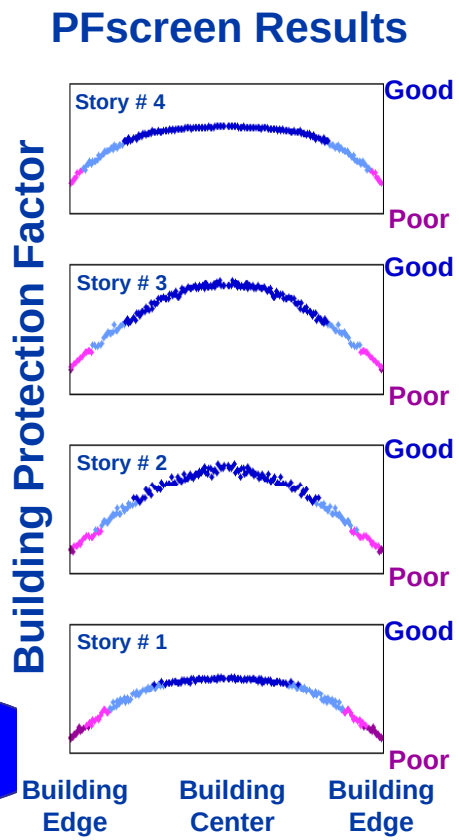
- **For Responders:**

"Rapidly defining populations or areas that need early evacuation is a high priority. . . **People occupying inadequate shelter may need to be selectively evacuated early** to avoid acute exposures and minimize overall dose"

(PGfRND, p.53, emphasis added)

PFscreen





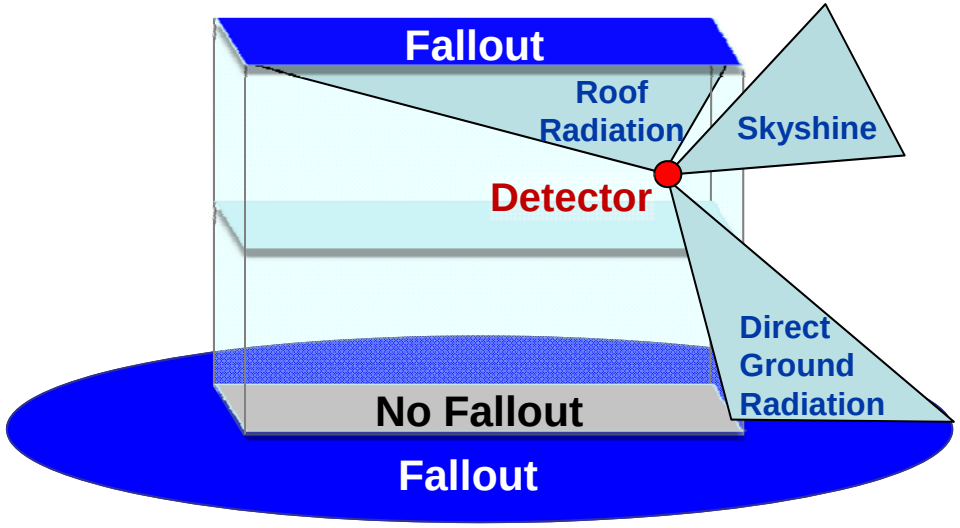
- *Simple*
  - Input limited to small number of key building characteristics
- *Fast*
  - Individual building analysis in 10's of seconds on laptop
- *Tested*
  - Output agrees with measurements within a factor of 2 for simple buildings

Current model is a prototype. Model verification and validation is on-going. Model is not appropriate for all buildings.

The PFscreen Model – Overview

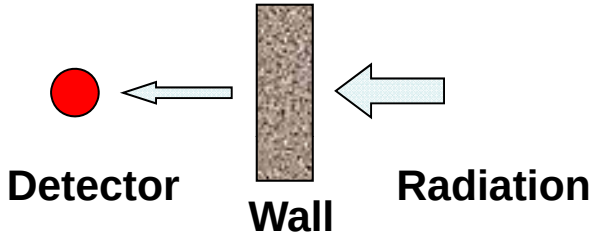
Radiation Sources

- Ground Contamination
  - Direct
  - Skyshine (scattered in the air)
- Roof Contamination



Building Shielding

- Loss of direct radiation



- Scattering (buildup)