Ground Motion Considerations

Developing GMRS, FIRS, and SSI Input Motion

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Scope of Presentation

- SSE and Siting Regulations
- Current Regulatory Guidance
- Fundamental Issues

SSE Requirements

- 10 CFR 50, Appendix S
  - SSE “must be characterized by free-field ground motion response spectra at the free ground surface.”
  - Horizontal component of SSE in free-field at foundation level “must be an appropriate response spectrum with a peak ground acceleration of at least 0.1g.”

Siting Criteria

- 10 CFR 100.23
  - Geological, seismological, and engineering characteristics of a site and its environs must be investigated in sufficient scope and detail to arrive at estimates of SSE
  - SSE for the site is characterized by both horizontal and vertical response spectra at the free ground surface

Ground Motion Definitions – CSDRS (RG 1.208)

- Certified Seismic Design Response
  - Site-independent seismic design response spectra that have been approved under Subpart B of 10 CFR Part 52 as the seismic design response spectra for an approved certified standard design nuclear power plant. The input or control location for the CSDRS is specified in the certified standard design.

Ground Motion Definitions – GMRS (RG 1.208)

- Ground Motion Response Spectra
  - Site-specific ground motion response spectra characterized by horizontal and vertical response spectra determined as free-field motions on the ground surface or as free-field outcrop motions on the uppermost in-situ competent material using performance-based procedures

Ground Motion Definitions – GMRS (cont.)

- When GMRS are determined as free-field outcrop motions on the uppermost in-situ competent material, only the effects of the materials below this elevation are included in the site-response analysis (RG 1.208)
- If non-competent material is present, any excavation and/or backfilling should not alter the development or location of the GMRS (SRP 3.7.1)

Ground Motion Definitions – FIRS (SRP 3.7.1)

- Foundation Input Response Spectra
  - When the site-specific GMRS and CSDRS are calculated at different elevations, the site-specific GMRS need to be transferred to the base elevations of each seismic Category I foundation. These site specific GMRS at the foundation levels in the free field are referred to as FIRS and are derived as free-field outcrop spectra.

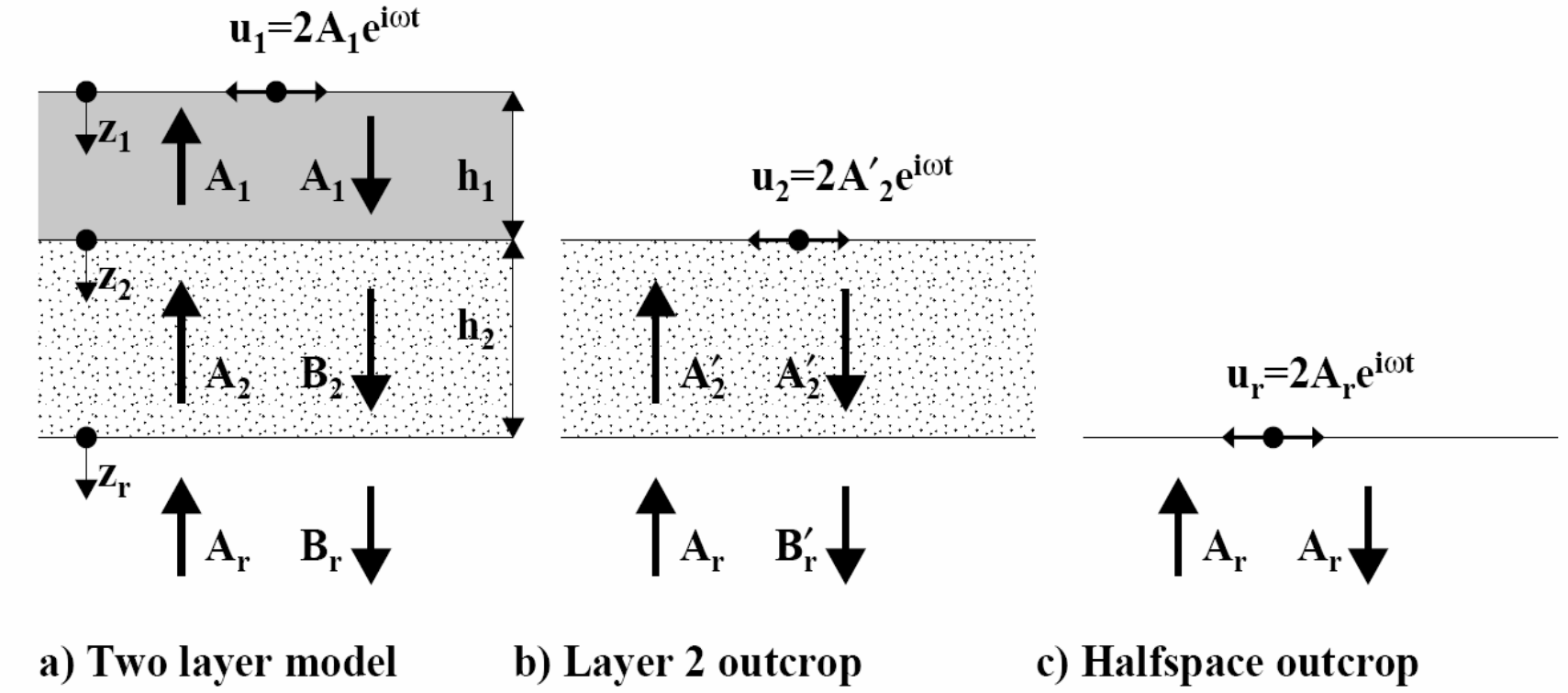
Ground Motion Definitions – FIRS (cont.)

- Further guidance related to FIRS (SRP 3.7.1)
  - Only the effects of materials below the base elevation of the seismic Category I structure are included in the site response analysis

Fundamental Issues – Developing GMRS

- Use of “SHAKE outcrop” rather than “geological outcrop” does not result in free surface motion
- Effect of weight of soil column above outcrop elevation needs to be included to ensure the correct overburden stress effects on the strain calculation

Outcropping Motion - GMRS



Fundamental Issues – Deriving FIRS from GMRS

- Whenever motions are computed at a given elevation, all soil layers below must be included
- Any transfer of ground motion from one elevation to another elevation needs to consider the entire soil column down to the effective uniform halfspace

Fundamental Issues – Deriving FIRS from GMRS

- Transfer of GMRS to individual foundation elevations should be consistent with the same process of randomization of soil properties and the site profile that was used to establish the GMRS
- Only the effects of materials below the base elevation of the seismic Category I structure are included in the site response analysis for FIRS

Fundamental Issues – Developing SSI Input Motion

- Transfer of FIRS or GMRS to SSI input motion must consider entire soil column
- Cannot simply convolve FIRS or GMRS up to ground surface considering the soil column above the foundation level alone
- Linear SASSI SSI analysis conducted without performing above step correctly results in an unconservative estimate of seismic demands

Ground Motion Considerations

THANK YOU