Introduction to Seismic Mitigating Strategies Assessment (MSA) for BDBEE

周鼎
研究員兼審查召集人
核能研究所 核管技支中心
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清華大學 後福島改善研討會--FLEX

簡報大綱

- 前言/範圍與目的

  --NEI 12-06 App. H: Mitigating Strategies Assessment for New Seismic Hazard Information
- Seismic MSA: the process of establishing a plant's mitigating strategies to maintain or restore core cooling, containment, and SFP cooling capabilities in response to the mitigating strategies seismic hazard information.
- 美國DCPP實施現況
- 結論與心得

前言

- 2012.3: NRC NTTF 4.2, 及Order EA-12-049要求業主提出因應BDBEE策略的 OIP(Overall Integrated Plan)
- 2012.8: NEI 提出因應BDBEE的指引: FLEX(Diverse and Flexible Coping Strategies) Implementation Guide) NEI 12-06
- 2012.8.29: NRC JLD-ISG-2012-01 endorse NEI 12-06
- 2015.12: NEI 12-06 Rev2, 增加了App. H內容

FLEX的本質

- Site/plant specific

  --Site specific extreme hazards and applicability

  --Plant specific coping strategy

- Seismic induced challenges

  --protection of FLEX equipment,

  --deployment of FLEX equipment,

  --procedural interfaces, and

  --considerations in utilizing off-site resources.

Seismic protection of FLEX equipment

5.3.1 Protection of FLEX Equipment

1. FLEX equipment should be stored in one or more of following three configurations such that no one external event can reasonably fail the site FLEX capability (N):
    a. In a structure that meets the plant's design basis for the Safe Shutdown Earthquake (SSE)(e.g., existing safety-related structure).
    b. In a structure designed to or evaluated equivalent to ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
    c. Outside a structure and evaluated for seismic interactions to ensure equipment is not damaged by non-seismically robust components or structures.
2. Large FLEX equipment such as pumps and power supplies should be secured as appropriate to protect them during a seismic event (i.e., Safe Shutdown Earthquake (SSE) level).
3. Stored equipment and structures should be evaluated and protected from seismic interactions to ensure that unsecured and/or non-seismic components do not damage the equipment.

Deployment of FLEX equipment

- 詳如NEI 12-06 5.3.2
- deployment route should be reviewed for soil liquefaction following a severe seismic event.
- If FLEX strategy relies on a non-seismic robust water source, accessing this water should be addressed.
- Additional power supply should be provided if it is needed to move/deploy the FLEX equipment.

Procedural interfaces

- 詳如NEI 12-06 5.3.3
- Seismically qualified electrical equipment can be affected by BDB seismic events. Each plant should compile a reference source that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy.
- Consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems).
- For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.

considerations in utilizing off-site resources

- 詳如NEI 12-06 5.3.4
- Severe seismic events can have far-reaching effects on the roads/bridges in and around a plant. Obtaining off-site resources may require use of alternative transportation (such as air-lift capability).
- So, the FLEX strategies will need to assess the best means to obtain resources from off-site following a seismic event.

Seismic walkdown

- The FLEX strategies assumed BDBEs caused the ELAP and LUHS but otherwise were based on the existing design bases.
- Therefore, seismic walkdown provides the basis for the capability of the plant to successfully respond to design basis seismic events, which is a foundation for the FLEX strategies. (NTTF 2.3)

Check for Liquefaction potential

- The FLEX staging routes and deployment paths are not subjected to liquefaction hazards

Seismic mitigating strategies assessment (seismic MSA)

- NEI 12-06 App. H
- Newly developed(2015.12) in NEI 12-06 Rev. 2

MSSHI

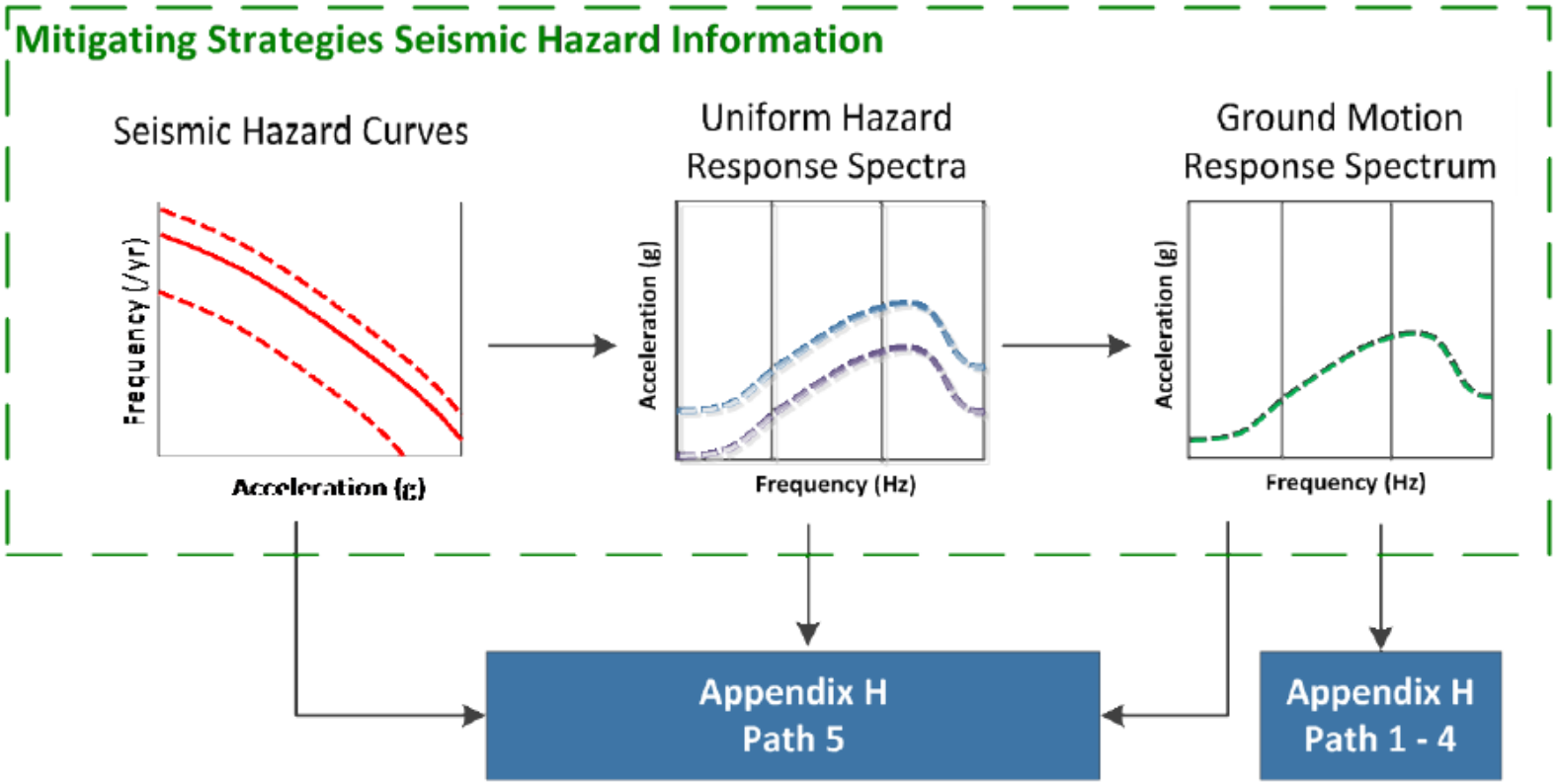


Figure H.1: MSSHI Use for Appendix H Paths

Seismic MSA

The MSA is performed in order to determine if the FLEX strategies developed and implemented per this guidance can be implemented considering the impacts of the MSSHI.

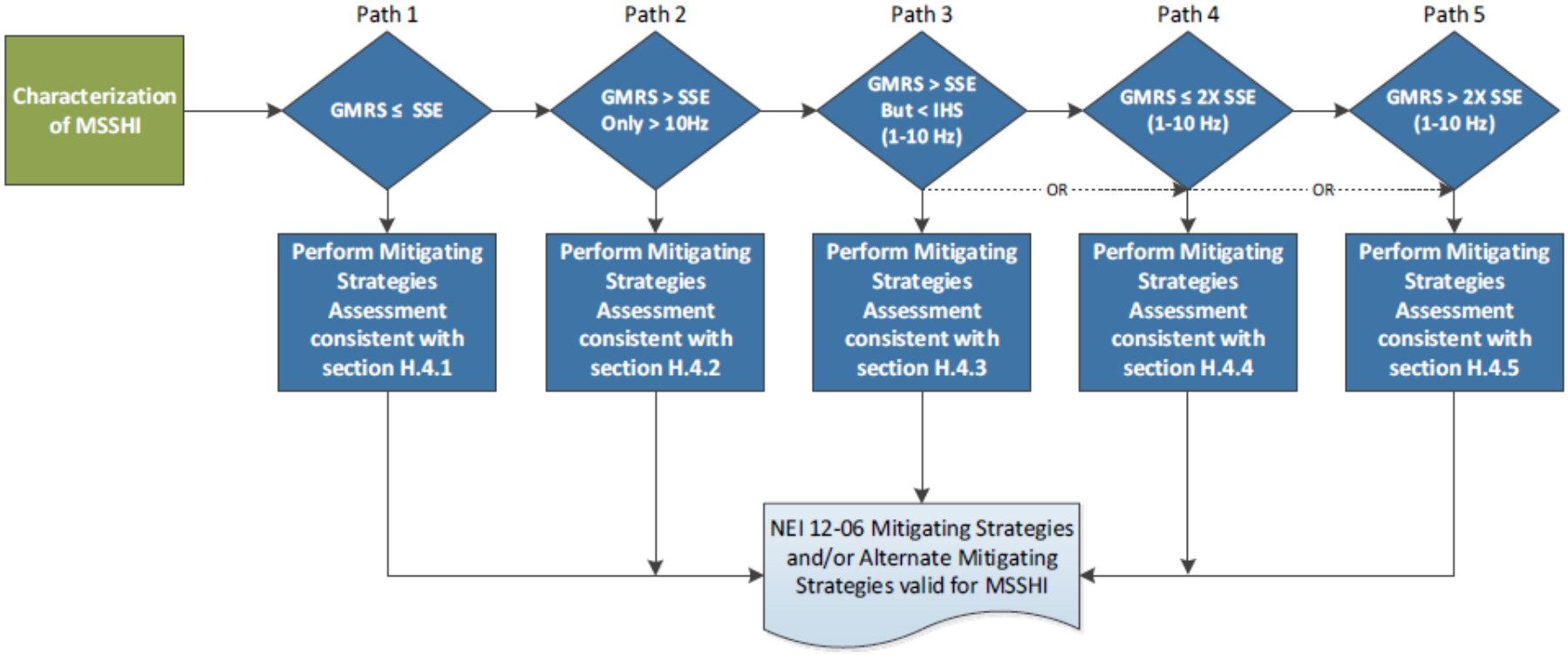


Figure H.2: Mitigating Strategies Assessment Process for the MSSHI

notes

- Path 2: Need high frequency evaluation per EPRI 3002004396
- Path 3: give previous IPEEE's credit for IHS, but check for indefinite coping is needed
- Path 4: case where GMRS< 2 SSE, give previous ESEP credit for 2 SSE evaluation.
- Path 5: very high GMRS, verify plant's $C_{10\%}$ > GMRS (use SPRA, $C_{10\%}$)

Performance Target for Mitigating Strategy (calculation of Figure H.4)

- The use of the C10% capacity criteria.
- To perform this C10% assessment, point estimates of the Annual Frequency of Unacceptable Performance (AFUP) were developed.
- The AFUP estimates were developed based on:
  - --the most recent seismic hazards for the US NPPs submitted to the NRC,
  - --assume the plant level C10% is equivalent to the minimum SSC C10% ,
  - --a plant fragility function using this C10% and a generic Beta value,
  - --the seismic hazard with the plant level fragility to calculate an AFUP,
  - --βC were varied in conformance to the values in the EPRI SPID,
  - --The AFUP were computed from 6 frequency seismic hazard estimates.

Bases for choosing $C_{10\%}$ as seismic performance goal

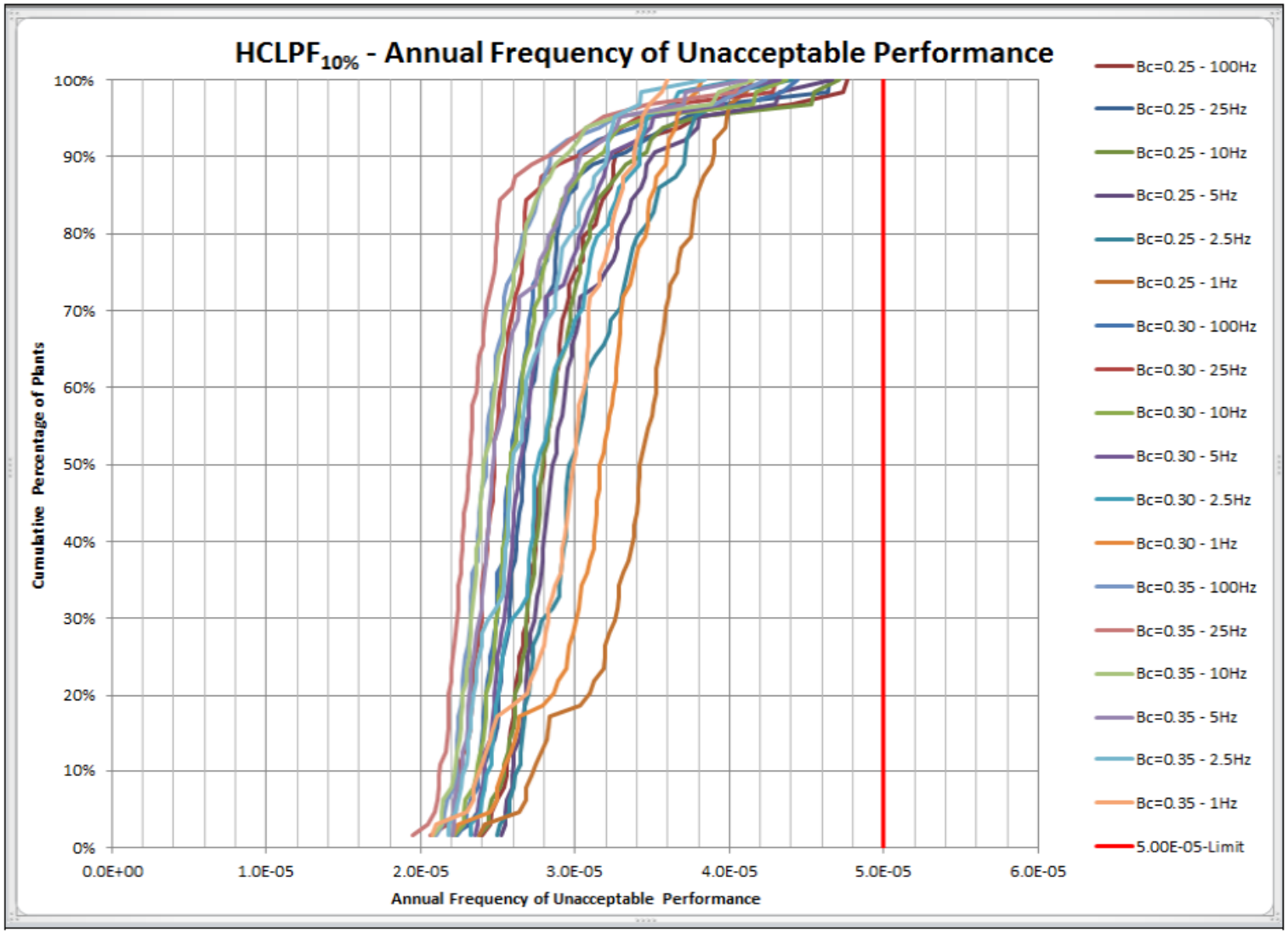


Figure H.4: US Nuclear Plant Fleet Mitigating Strategy Risk Cumulative Distribution

$C_{10\%}$ (defined by ASCE 43-05)

- $C_{10\%}$:10% probability of unacceptable performance under a BDBE
- ASCE/SEI 43-05 Sec.1.3 defines a 10% probability of unacceptable performance (C10%) which is reviewed against the beyond design-basis seismic event (150% of the DBE ground motion for the ASCE/SEI 43-05 case).
- ASCE 43-05 takes advantage of known seismic margin in the seismic designs (e.g. ductility, negligible effects of small displacements, conservative damping, etc.) to justify that the overall risks of unacceptable performance are acceptably low when using the C10% evaluation criteria.
- Use $C_{10\%}$ value as seismic capacity

Table H.1: Recommended β's and C10% Values Determination

Type SSC	Composite β_C	Random β_R	Uncertainty β_U	$C_{50\%}/C_{1\%}$	$C_{10\%}/C_{1\%}$
Structures & Major Passive Mechanical Components Mounted on Ground or at Low Elevation Within Structures	0.35	0.24	0.26	2.26	1.44
Active Components Mounted at High Elevation in Structures	0.45	0.24	0.38	2.85	1.60
Realistic Lower Bound Case[23]	0.30	0.24	0.18	2.00	1.36
Other SSCs	0.40	0.24	0.32	2.54	1.52

DCPP OIP

- Submit on 2013.2.27
- 78 pages
- Two FLEX storage locations(Area 10 and Lot 11) will be provided for the storage of the related FLEX equipment.
- The FLEX equipment will be protected in accordance with NEI 12-06, Section 5.3.1
- milestone date:

  --storage facilities: 12/31/2014;

  --implementation complete :10/30/2015 and 05/31/2016

DCPP FLEX Storage and Deployment Routes (Lot 11)

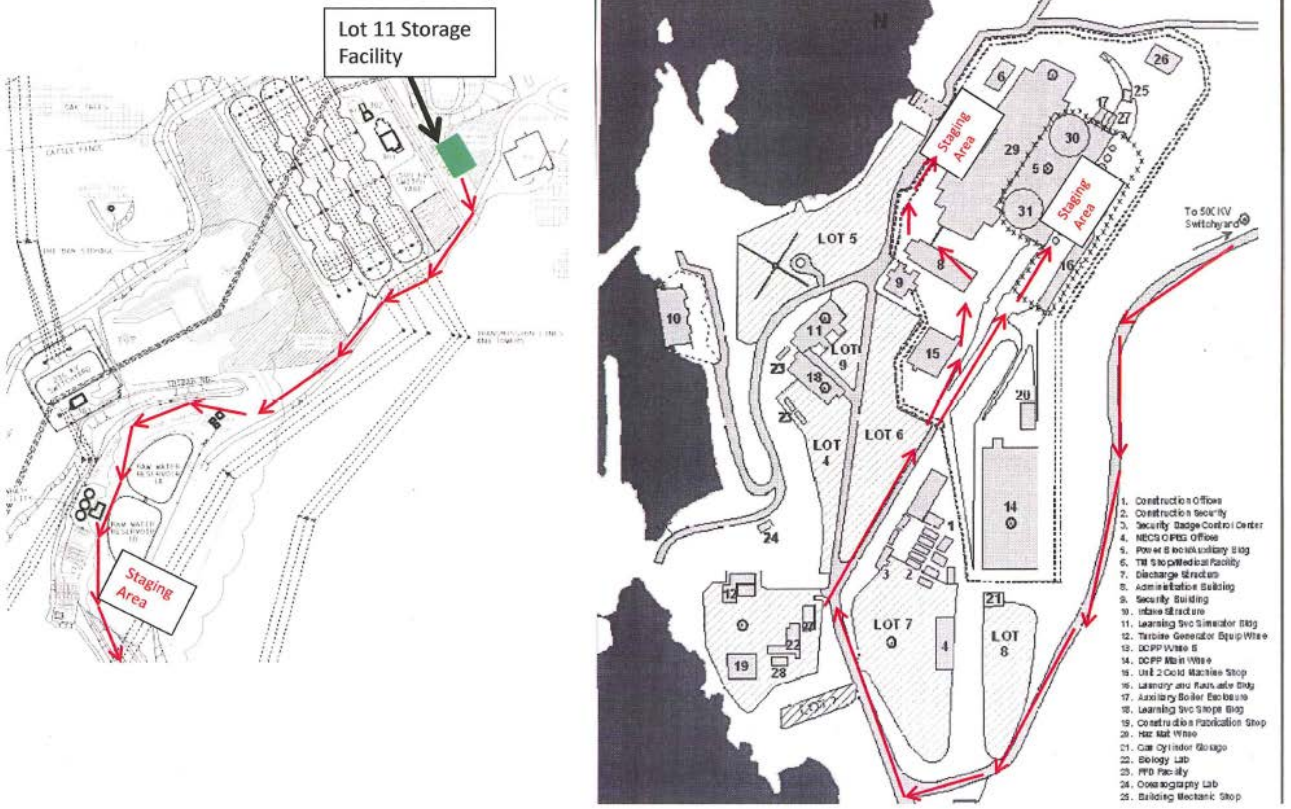
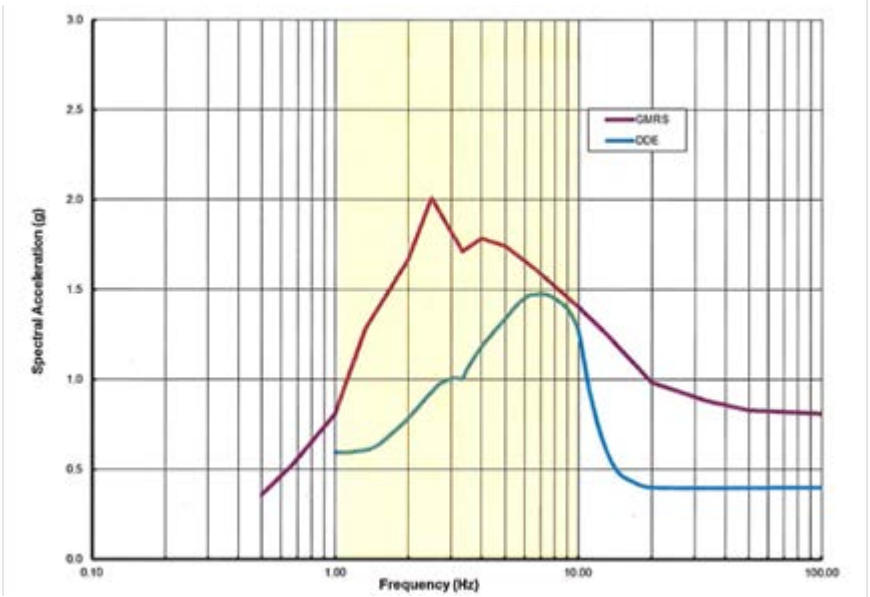
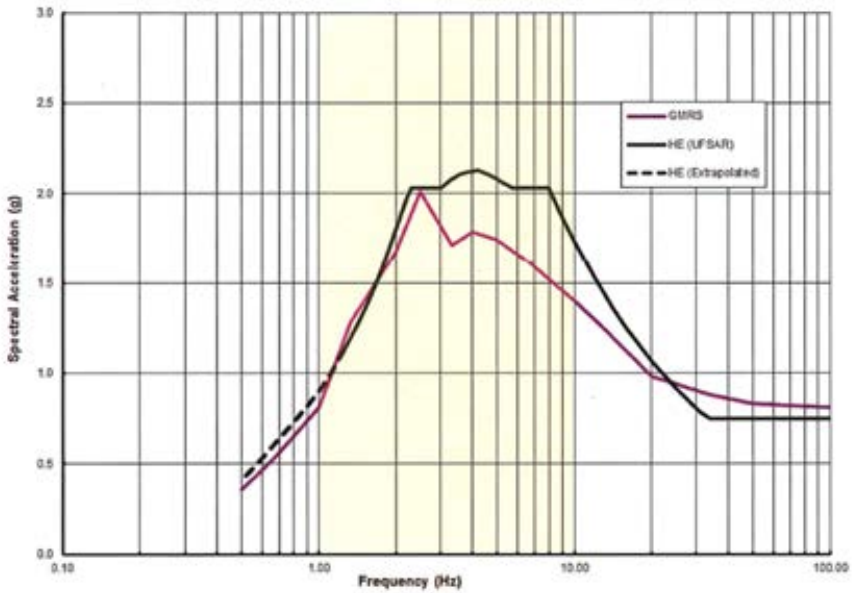


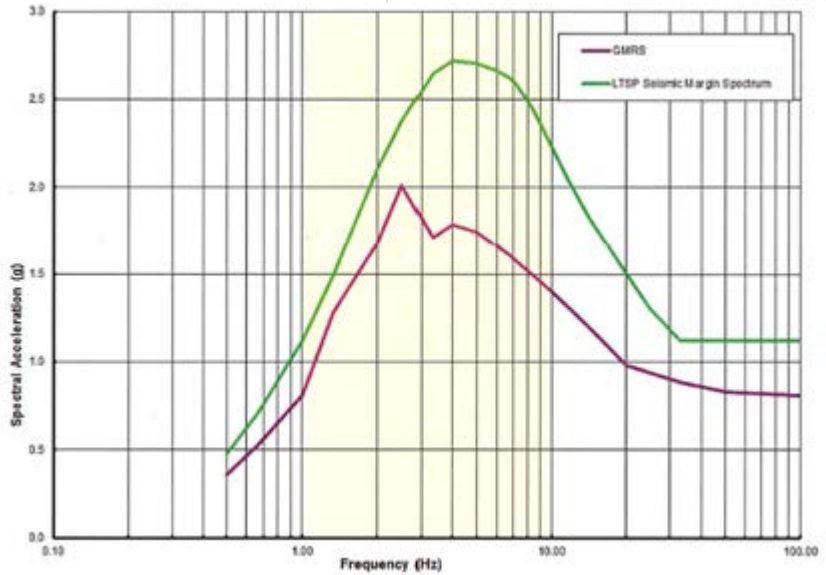
Figure 2
Deployment Routes
Lot 11 Storage Facility

DCPP GMRS

(DCPP SSHAC-3 PSHA係於2011年8月開始，完成於2015年3月)







DCPP 6-month status report

- As of 2015.8.26
- 5th status report
- Storage facilities (ASCE 7-10 upgraded warehouse) completed on 2015.9.30
- Storage facilities (ASCE 7-10 upgraded warehouse) completed on 2015.10.27

結論與心得

- 本報告focus在NEI12-06有關FLEX的耐震方面要求, 屬於導讀性的介紹
- BDBEE指的是R.G 1.208所得GMRS
- 儲存建物結構耐震起碼要求: SSE(既有), ASCE7-10(新建)
- 主要issue還是在如何確保FLEX在BDBEE的有效性. 在這方面, 之前的成果(如IPEEE IHS, or SPRA SMA, ESEP)給了很大的credit.
- 對於GMRS>>SSE的NPP, 用C10%為capacity index
- NEI12-06 App. H 相關搭配技術報告可參考EPRI ESEP文件