3 Design of Structures, Systems, Components, and Equipment

3.0 Design of Structures, Systems, Components, and Equipment

3.1 Conformance with NRC General Design Criteria

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.1.4.16.1 Discussion

Replace the third, fourth, and fifth sentences of the first paragraph in DCD Subsection 3.1.4.16.1 with the following.

STD COL 3.1(1)

These components have suitable inspection capability enhanced with appropriate layout features, as discussed in Section 9.2. The essential service water system (ESWS) and component cooling water system (CCWS) piping is arranged to permit access for inspection. Manholes, handholes, or inspection ports are provided for periodic inspection of system components. The integrity of underground piping is demonstrated by pressure and functional tests.

3.1.6.4.1 Discussion

Add the following at the end of the section.

NAPS SUP 3.1(1)

Area radiation monitoring is provided in the IRSF for personnel protection and general surveillance. These area monitors alarm locally and in the MCR.

See Chapter 11, Appendix 11AA for details.

3.1.6.5.1 Discussion

Add the following at the end of the section.

NAPS SUP 3.1(2)

The IRSF atmosphere is continuously monitored during normal operations and in the event of an accidental spill, using the IRSF Exhaust Fan Airborne Radiation monitor.

Portable radiation detection instruments are available to periodically monitor radiation levels in the IRSF spaces that contain stored radioactive wastes.

See Chapter 11, Appendix 11AA for details.

3.1.7 Combined License Information

Replace the content of DCD Subsection 3.1.7 with the following.

STD COL 3.1(1)

3.1(1) ***Design provisions for inspections***

This Combined License (COL) item is addressed in Subsection 3.1.4.16.1.

3.2 Classification of Structures, Systems and Components

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.2.1.2 Classifications

NAPS COL 3.2(4)

Replace last sentence of first paragraph in DCD Subsection 3.2.1.2 with the following.

The site-specific, safety-related systems and components that are designed to withstand the effects of earthquakes without loss of capability to perform their safety function are identified in Tables 3.2-2R and 3.2-201. The industry codes and standards applicable to those components are listed in Table 3.2-203.

3.2.1.3 Classification of Building Structures

NAPS SUP 3.2(1)

Add the following at the end of the section.

Table 3.2-202 provides the designated seismic category for site-specific structures.

3.2.2 System Quality Group Classification

NAPS COL 3.2(5)

Replace the last sentence of the eleventh paragraph in DCD Subsection 3.2.2 with the following.

The equipment class and seismic category of the site-specific safety-related and nonsafety-related fluid systems, components (including pressure retaining), and equipment as well as the applicable industry codes and standards are provided in Tables 3.2-2R and 3.2-201.

3.2.2.5 Other Equipment Classes

NAPS COL 3.2(6)

Replace the third paragraph in DCD Subsection 3.2.2.5 with the following.

DCD methods of equipment classification and seismic categorization of risk-significant, nonsafety-related SSCs based on their safety role assumed in the PRA and treatment by the design reliability assurance program (D-RAP) described in Chapter 17 will be applied to SSCs identified in Tables 3.2-2R and 3.2-201.

3.2.3 Combined License Information

Replace the content of DCD Subsection 3.2.3 with the following.

3.2(1) ***Deleted from the DCD.***

3.2(2) ***Deleted from the DCD.***

3.2(3) ***Deleted from the DCD.***

NAPS COL 3.2(4)

3.2(4) ***Site-specific safety-related systems and components designed to withstand earthquakes***

This COL item is addressed in Subsection 3.2.1.2 and Tables 3.2-2R, 3.2-201 and 3.2-203.

NAPS COL 3.2(5)

3.2(5) ***Equipment class and seismic category***

This COL item is addressed in Subsection 3.2.2 and Tables 3.2-2R and 3.2-201.

NAPS COL 3.2(6)

3.2(6) ***Equipment class and seismic category of risk-significant, non-safety related SSCs***

This COL item is addressed in Subsection 3.2.2.5 and Tables 3.2-2R and 3.2-201.

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 5 of 56)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
Reactor coolant system piping and valves related to pressurizer relief tank excluding containment isolation valves and piping between valves	4	PCCV R/B	D	N/A	4	NS	
Following containment isolation valves and piping between valves: RCS-AOV-147, 148 RCS-AOV-132, RCS-VLV-133 RCS-AOV-138, RCS-VLV-139, 140	2	PCCV R/B	B	YES	2	I	
3. Chemical and Volume Control System							
Charging pumps	3	R/B	C	YES	3	I	
Boric acid transfer pumps	4	A/B	D	N/A	4	NS	
NAPS DEP 9.2(1) ~~Boric acid evaporator feed pumps~~ Holdup tank pumps	8	A/B	D	N/A	4	NS	
Volume control tank	4	R/B	D	N/A	4	II	
Holdup tanks	8	A/B	D	N/A	4	NS	
Boric acid batching tank	8	A/B	D	N/A	4	NS	
Boric acid tanks	4	A/B	D	N/A	4	NS	
Resin fill tank	8	A/B	D	N/A	4	NS	
Chemical mixing tank	8	R/B	D	N/A	4	NS	
Reactor coolant pump purge water head tank	8	PCCV	D	N/A	4	NS	
Regenerative heat exchanger	3	PCCV	C	YES	3	I	
Letdown heat exchanger – tube side	3	PCCV	C	YES	3	I	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 5 of 56) *(continued)*

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
Letdown heat exchanger – component cooling water side	2	PCCV	B	YES	2	I	
Seal water heat exchanger – tube side	8	R/B	D	N/A	4	NS	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 6 of 56)

	System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
	Seal water heat exchanger – component cooling water side	4	R/B	D	N/A	4	II	
	Excess letdown heat exchanger	3	PCCV	C	YES	3	I	
	Excess letdown heat exchanger – component cooling water side	2	PCCV	B	YES	2	I	
	Reactor coolant filters	8	A/B	D	N/A	4	NS	
	Seal water injection filters	8	A/B	D	N/A	4	NS	
	Boric acid filter	4	A/B	D	N/A	4	NS	
NAPS DEP 9.2(1)	~~Boric aid evaporator feed demineralizer filter~~ Degasifier feed filter	8	A/B	D	N/A	4	NS	
	Mixed bed demineralizer inlet filters	8	A/B	D	N/A	4	NS	
	Seal water return strainer	8	R/B	D	N/A	4	NS	
	Mixed bed demineralizers	8	A/B	D	N/A	4	NS	
	Cation bed demineralizer	8	A/B	D	N/A	4	NS	
NAPS DEP 9.2(1)	~~Boric acid evaporator feed demineralizer~~ Degasifier feed demineralizer	8	A/B	D	N/A	4	NS	
	Deborating demineralizers	8	A/B	D	N/A	4	NS	
	Letdown orifices	3	PCCV	C	YES	3	I	
	Charging pump minimum flow orifices	3	R/B	C	YES	3	I	
	Boric acid transfer pump minimum flow orifices	4	A/B	D	N/A	4	NS	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 6 of 56) *(continued)*

	System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
NAPS DEP 9.2(1)	~~Boric acid evaporator feed pumps minimum flow orifices~~ Holdup tank pump minimum flow orifices	8	A/B	D	N/A	4	NS	
	Charging flow control orifice	3	R/B	C	YES	3	I	
	Seal water flow control orifice	3	R/B	C	YES	3	I	
	Chemical mixing tank orifice	8	R/B	D	N/A	4	NS	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 7 of 56)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
NAPS DEP 9.2(1) ~~Boric acid evaporator~~ Degasifier	8	A/B	D	N/A	4	NS	
Boric acid blender	8	R/B	D	N/A	4	NS	
Letdown line and valves from reactor coolant system to and including valve CVS-LCV-362 prior to regenerative heat exchanger.	1	PCCV	A	YES	1	I	
Letdown line piping and valves from and excluding the valve CVS-LCV-362 prior to regenerative heat exchanger to the following valves: Letdown line drain valve CVS-VLV-602 (including the valve) Residual Heat Removal System valves (2 each) (excluding the valves) RHS-AOV-024B,C Containment isolation valve (excluding the valve) CVS-AOV-005 Letdown line relief valve CVS-SRV-002 (including the valve) Letdown heat exchanger tube side drain valve CVS-VLV-606 (including the valve)	3	PCCV	C	YES	3	I	
Chemical and volume control system containment isolation valves and piping between the valves.	2	PCCV R/B	B	YES	2	I	
Excess letdown piping and valves from reactor coolant system to and including valve CVS-AOV-222 just prior to excess letdown heat exchanger.	1	PCCV	A	YES	1	I	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 12 of 56)

NAPS DEP 9.2(1)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards [3]	Seismic Category [4]	Notes
Chemical and volume control system piping and valves related to the boric acid tanks excluding valve CVS-VLV-557, up to and including valves CVS-VLV-542, 547, CVS-AOV-549A, B, through boric acid transfer pump A, B, boric acid filter and including the downstream piping from and including valve CVS-VLV-525	4	A/B	D	N/A	4	NS	
Chemical and volume control system piping and valves related to the boric acid batching tank to and excluding valve CVS-VLV-525	8	A/B	D	N/A	4	NS	
(Deleted)							
Chemical and volume control system piping and valves related to the boric acid pump minimum flow piping up to boric acid tank, through transfer pump minimum flow orifice and valve CVS-VLV531A,B	4	A/B	D	N/A	4	NS	
Chemical and volume control system piping and valves related to the boric acid tanks up to and including valves CVS-SRV-509A,B, CVS-VLV-511A,B, CVS-VLV508A,B	4	A/B	D	N/A	4	NS	
Chemical and volume control system piping and valves related to the boric acid tanks excluding foregoing piping and valves	8	A/B	D	N/A	4	NS	
Chemical and volume control system piping and valves related to the holdup tanks and the ~~boric acid evaporator feed pumps~~ holdup tank pumps	8	A/B	D	N/A	4	NS	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 13 of 56)

	System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
NAPS DEP 9.2(1)	Chemical and volume control system piping and valves related to the ~~boric acid evaporator and the boric acid evaporator feed demineralizer~~ degasifier and the degasifier feed demineralizer.	8	A/B	D	N/A	4	NS	
	Chemical and volume control system piping and valves related to the primary makeup water supply isolation CVS-FCV-133A, 129, 128, and CVS-VLV-581	3	R/B	C	YES	3	I	
	4. Safety Injection System							
	Safety injection pumps	2	R/B	B	YES	2	I	
	Safety injection piping and valves between the System penetration and including the second check valve SIS-VLV-012A, B, C, D upstream of the direct Vessel Injection penetration	1	PCCV	A	YES	1	I	
	Safety injection piping and valves upstream of and excluding the second check valve SIS-VLV-012A, B, C, D upstream of the direct Vessel Injection penetration	2	PCCV R/B	B	YES	2	I	
	Hot leg injection piping downstream of and including the motor operated valves SIS-MOV-014A, B, C, D	1	PCCV	A	YES	1	I	
	Hot leg injection piping upstream of but excluding the motor operated valves SIS-MOV-014A, B, C, D	2	PCCV	B	YES	2	I	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-2R Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 13 of 56) *(continued)*

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards (3)	Seismic Category (4)	Notes
Accumulator	2	PCCV	B	YES	1	I	
Accumulator piping and valves on the reactor coolant system side of and including the second check valves SIS-VLV-102A, B, C, D	1	PCCV	A	YES	1	1	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-201 Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

Systems and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Code and Standards	Seismic Category	Notes
1. ESWS							
Blowdown line piping from ESW supply piping up to isolation valves EWS-VLV-543A, B, C, D including blowdown CVs EWS-HCV-010, 011, 012, 013 and blowdown control bypass valves EWS-VLV-544A, B, C, D	3	ultimate heat sink related structures (UHSRS)	C	YES	3	I	
ESWP discharge strainer backwash line downstream of valves EWS-MOV-573A, B, C, D and EWS-MOV-574A, B, C, D to the UHS basin	3	UHSRS	C	YES	3	I	
ESW supply line piping connected to the fire protection system (FPS) in the UHSRS, and valves from and excluding ESW supply header piping up to the following isolation valves: EWS-VLV-551A, B, C, D	3	UHSRS	C	YES	3	I	
ESW supply line piping connected to the FPS in the R/B, and valves from and excluding ESW supply header piping up to the following isolation valves: EWS-VLV-552A, B, C, D	3	R/B	C	YES	3	I	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-201 Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

Systems and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Code and Standards	Seismic Category	Notes
2. UHS							
UHS transfer pumps	3	UHSRS	C	YES	3	I	
UHS cooling tower fans	3	UHSRS	C	YES	5	I	
UHS basins	3	UHSRS	C	YES	3	I	
Transfer line piping and valves from UHS transfer pumps to basins	3	UHSRS	C	YES	3	I	
ESW return line piping and valves	3	UHSRS ESWPT	C	YES	3	I	
UHS basin makeup piping and valves	9	UHSRS	N/A	N/A	5	NS	
3. UHS ESW pump house ventilation system							
ESW pump room exhaust fans	3	UHSRS	C	YES	5	I	
UHS transfer pump room exhaust fans	3	UHSRS	C	YES	5	I	
UHS ESW pump house supply and exhaust backdraft dampers	3	UHSRS	C	YES	5	I	
ESW pump room unit heaters	3	UHSRS	C	YES	5	I	
UHS transfer pump room unit heaters	3	UHSRS	C	YES	5	I	

NAPS COL 3.2(4)
NAPS COL 3.2(5)
NAPS COL 3.2(6)

Table 3.2-201 Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

Systems and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Code and Standards	Seismic Category	Notes
4. Startup steam generator (SG) blowdown system							
System components, piping and valves	6	turbine building (T/B), A/B, outdoors	N/A	N/A	6	Note 1	

Notes:

1. Seismic category meeting RG 1.143 (Reference 3.2-10) is applied.
2. Not used.
3. Identification number for “Code and Standards”
   (1) American Society of Mechanical Engineers (ASME) Code, Section III, Class 1 (Reference 3.2-14)
   (2) ASME Code, Section III, Class 2 (Reference 3.2-14)
   (3) ASME Code, Section III, Class 3 (Reference 3.2-14)
   (4) RG 1.26 (Reference 3.2-13), Table 1, Quality Standards
   (5) Codes and standards as defined in design bases
   (6) Codes and standards, and guidelines provided in RG 1.143 (Reference 3.2-10), for design of SSCs for Radwaste Facility
4. Not used

NAPS SUP 3.2(1)

Table 3.2-202 Seismic Classification of Site-Specific Buildings and Structures[1]

Structure	Acronym	Seismic Category[2]
Interim Radwaste Storage Facility	IRSF	NS
Concrete under Seismic Category I structures[3]	-	I

Notes:

1. Other non-standard plant building structures, such as minor NS buildings and structures in the plant yard, are not listed in this table and are not considered part of the Nuclear Island.
2. Seismic Category I (I)
   Seismic Category II (II)
   Non-Seismic (NS)
3. Fill concrete beneath the Seismic Category I structures is safety related.

NAPS COL 3.2(4)

Table 3.2-203 Codes and Standard Applicable to Site-Specific Mechanical and Fluid Systems, Components, and Equipment [5]

Safety-Related Piping, Valves, Pumps [1]
ASME Section II, 2001 Edition with 2003 Addendum Section III, 2001 Edition with 2003 Addendum Section V, 2001 Edition with 2003 Addendum Section IX, 2001 Edition with 2003 Addendum Section XI, 2001 Edition with 2003 Addendum
Non-Safety-Related Piping, Valves, and Pumps [2]
ASME B31.1-2004 "Power Piping"
Heating, Ventilation, and Air Conditioning Equipment [3]
ASME AG-1-2003 "Code on Nuclear Air and Gas Treatment"
Air Movement and Control Association 200-1995 "Air Systems" 201-2002 "Fans and Systems"
Underwriters Laboratory 1278-2000 "Safety Movable and Wall- or Ceiling-Hung Electric Room Heaters" 1996-2009 "Safety Electric Duct Heaters" 2021-1997 "Safety Fixed and Location-Dedicated Electric Room Heaters"
Class 1E Components [4]
Institute of Electrical and Electronic Engineers (IEEE) 323-1974 "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" 323-2003 "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" 344-2004 as modified by NRC RG 1.100, Rev. 3 dated September 2009, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants" 384-1992 "Standard Criteria for Independence of Class 1E Equipment and Circuits" 603-1998 "Standard Criteria for Safety Systems for Nuclear Power Generating Stations"

Notes:

1. These codes and standard are applied to the UHS and ESW safety-related SSCs identified in Table 3.2-201.
2. These codes and standards are applied to the SG blowdown system identified in Table 3.2-201.
3. These codes and standards are applied to the heating, ventilation, and air conditioning equipment identified in Table 3.2-201.
4. These codes and standards are applied to Class 1E equipment identified in Table 3.2-201.
5. This table identifies the current revision of documents. Later editions that are current as of procurement or manufacture date may be used.

3.3 Wind and Tornado Loadings

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.3.1.1 Design Wind Velocity and Recurrence Interval

NAPS COL 3.3(1)

Replace the last sentence of the second paragraph in DCD Subsection 3.3.1.1 with the following.

The site-specific basic wind speed of 96 mph corresponds to a 3-second gust at 33 ft. above ground for exposure category C, with the same recurrence interval as described above, and is therefore enveloped by the basic wind speed used for the design of the standard plant. Site-specific structures, systems, and components (SSCs) are designed using the site-specific basic wind speed of 96 mph, or higher.

3.3.1.2 Determination of Applied Forces

NAPS COL 3.3(4)

Replace the last paragraph in DCD Subsection 3.3.1.2 with the following.

Specific descriptions of wind load design method and importance factor for US-APWR site-specific plant structures are as follows:

- The UHSRS (seismic category I) are analyzed using method 2 of American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) 7-05 (Reference 3.3-1) and an importance factor of 1.15. Figures 2.1-201 and 2.5-255 show that the site does possess natural features such as escarpments or hills near the UHSRS that may promote channeling effects or the creation of wakes, but not to the extent that special consideration is warranted. Method 2 of ASCE/SEI 7-05 provides a topographic factor, K_{zt}, in Section 6.5.7 "Topographic Effects," to address this issue when calculating the design wind loading. Also, the other buildings on the site are not of the height, plan dimension, or location relative to the UHSRS such that channeling effects or the creation of wakes or other non-standard wind effects are produced that extend beyond the provisions of the ASCE/SEI 7-05 method 2 procedure. COLA Part 11, Table 3.0-4, states that the minimum natural frequency of the UHSRS is 7.28 Hz for the plant east-west direction, which is the lowest fundamental frequency in any orthogonal direction for any of the soil conditions considered. This means that the UHSRS are rigid with respect to wind loading. As shown in Figures 3.8-206 through 3.8-211, the UHSRS complex is comprised of relatively low-rise, nearly rectangular structures that do not include any unusual or irregular geometric shapes and are constructed of reinforced concrete walls, floors, and roofs. Therefore, based on the configuration and properties of the UHSRS complex, method 2 of ASCE/SEI 7-05 is an appropriate method of wind load design.

- The exposed portions of the ESWPT (seismic category I) and PSFSVs (seismic category I) are analyzed using method 1 of ASCE/SEI 7-05 (Reference 3.3-1) and an importance factor of 1.15.

There are no site-specific seismic category II buildings and structures.

3.3.2.2.2 Tornado Atmospheric Forces

STD* COL 3.3(5)

Replace the last paragraph in DCD Subsection 3.3.2.2.2 with the following.

Site-specific seismic category I structures are the UHSRS, ESWPT, and the PSFSVs.

The UHSRS, including the pump houses and transfer pump rooms, are configured with large openings and/or vents. The UHS basins and cooling tower enclosures are designed as vented with respect to tornado atmospheric differential pressure loading. Venting of the pump houses and transfer pump rooms is anticipated during a tornado event, however, for the purpose of structural design, the external walls, internal walls, and slabs of the pump houses and transfer pumps rooms are conservatively designed as unvented and the full tornado atmospheric differential pressure loading is applied. Since the full pressure differential for the structural elements is considered, a depressurization model is not used for the structural design.

The ESWPT and PSFSV structures are designed as unvented because they do not have openings that permit depressurization during a tornado.

3.3.2.2.4 Combined Tornado Effects

NAPS COL 3.3(2)

Replace the first and second sentences of the last paragraph in DCD Subsection 3.3.2.2.4 with the following.

Site-specific seismic category I structures, i.e., the UHSRS and exposed portions of the ESWPT and PSFSVs, are designed for the site-specific tornado loadings and combined tornado effects using the same methods for qualification described for standard plant SSCs.

3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado Loads

STD COL 3.3(3)

Replace the last paragraph of DCD Subsection 3.3.2.3 with the following.

Other miscellaneous NS buildings and structures in the plant yard are located and/or anchored such that their failure will neither jeopardize safety-related SSCs nor generate missiles not bounded by those discussed in Subsection 3.5.1.4. Further, any site-specific or field routed safety-related SSCs in the plant yard are evaluated prior to their installation to determine if structural reinforcement and/or missile barriers are required to ensure their function and integrity.

3.3.3 Combined License Information

Replace the content of DCD Subsection 3.3.3 with the following.

NAPS COL 3.3(1)

3.3(1) ***Wind speed requirements***

This COL item is addressed in Subsection 3.3.1.1.

NAPS COL 3.3(2)

3.3(2) ***Tornado loadings and combined tornado effects***

This COL item is addressed in Subsection 3.3.2.2.4.

STD COL 3.3(3)

3.3(3) ***Structures not designed for tornado loads***

This COL item is addressed in Subsection 3.3.2.3.

NAPS COL 3.3(4)

3.3(4) ***Wind load design methods and importance factors***

This COL item is addressed in Subsection 3.3.1.2.

STD* COL 3.3(5)

3.3(5) ***Vented and unvented requirements for site-specific buildings and structures***

This COL item is addressed in Subsection 3.3.2.2.2.

3.4 Water Level (Flood) Design

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.4.1.2 Flood Protection from External Sources

STD COL 3.4(1)

Replace the first sentence of the third paragraph in DCD Subsection 3.4.1.2 with the following.

Entrances to all safety-related structures are above the design-basis flooding level (DBFL) listed in Section 2.4, and adequate sloped site grading and drainage prevents flooding caused by probable maximum precipitation (PMP) or postulated failure of non safety-related, non seismic storage tanks on site.

NAPS COL 3.4(5)

Replace the fourth paragraph in DCD Subsection 3.4.1.2 with the following.

No site-specific flood protection measures such as levees, seawalls, floodwalls, site bulkheads, revetments, or breakwaters are applicable at Unit 3, since the plant is built above the DBFL and has adequate site grading. As described in Section 2.4.12.4, based on the maximum groundwater elevations used in seismic and stability analyses, a permanent dewatering system is not required.

NAPS COL 3.4(4)

Replace the seventh paragraph in DCD Subsection 3.4.1.2 with the following.

All Seismic Category 1 buildings and structures below grade are protected against the effects of flooding. This is achieved by providing a water barrier on all exterior concrete members subjected to ground water. The water barrier consists of waterstops at all below grade construction joints in the perimeter walls and slabs exposed to outside environment; and a water proofing system consisting of membrane waterproofing material at all below grade perimeter walls. The foundation slab water barrier system consists of crystalline waterproofing compound applied between the basemat and fill concrete/mudmat. The compound will either be spray applied or dry shake to the fill concrete/mudmat. In addition, crystalline waterproofing compound cementitious membrane waterproofing is provided on the inside face of the UHSRS basin walls and foundation slab, including the UHS sump pits, to prevent water migration from the UHS basin into the subgrade.

STD COL 3.4(3)

Replace the last sentence in the ninth paragraph in DCD Subsection 3.4.1.2 with the following.

Site-specific potential sources of external flooding such as the cooling tower, service water piping, or circulating water piping are not located near structures containing safety-related SSCs, with the exception of piping entering plant structures. The CWS enters only within the T/B, and any postulated pipe break is prevented from back-flowing into the safety-related R/B by watertight separation. Postulated pipe breaks near structures are prevented from entering the structures by adequate sloped site grading and drainage.

3.4.1.3 Flood Protection from Internal Sources

STD COL 3.4(7)

Replace the last sentence in the last paragraph of DCD Subsection 3.4.1.3 with the following.

Three site-specific safety-related structures have been evaluated for internal flooding concerns: the UHSRS, the ESWPT, and the PSFSV. Other site-specific buildings and structures in the plant yard are designated as nonsafety related. By definition, their postulated failure due to internal flooding or other postulated events do not adversely affect safety-related SSCs or required safety functions.

Each of these three structures is configured with independent compartments, divisionally separated. Internal flooding of any one compartment and corresponding division will not prevent the system from performing required safety-related functions. Postulated flooding events such as those caused by moderate energy line break (MELB) or fire suppression system activation within one division will affect that respective division only. Flooding affecting one compartment will not affect adjacent areas.

3.4.1.4 Evaluation of External Flooding

STD COL 3.4(2)

Replace the last sentence in the last paragraph of DCD Subsection 3.4.1.4 with the following.

As discussed in Section 2.4, the site-specific DBFL does not exceed the maximum flood level for the standard plant design. Therefore, there are no static and/or dynamic flooding forces beyond those considered in the standard plant design.

3.4.2 Analysis Procedures

STD COL 3.4(6)

Replace the last paragraph of DCD Subsection 3.4.2 with the following.

No site-specific physical models are used to predict prototype performance of hydraulic structures and systems, since there are no unusual design or configuration or design or operating bases involving thermal and erosion problems.

3.4.3 Combined License Information

Replace the content of DCD Subsection 3.4.3 with the following.

STD COL 3.4(1)

3.4(1) ***Site-specific design of plant grading and drainage***

This COL item is addressed in Subsection 3.4.1.2.

STD COL 3.4(2)

3.4(2) ***DBFL applicability to site***

This COL item is addressed in Subsection 3.4.1.4.

STD COL 3.4(3)

3.4(3) ***Site-specific flooding hazards from engineered features***

This COL item is addressed in Subsection 3.4.1.2.

NAPS COL 3.4(4)

3.4(4) ***Additional ground water protection***

This COL item is addressed in Subsection 3.4.1.2.

NAPS COL 3.4(5)

3.4(5) ***DBFL and site-specific conditions***

This COL item is addressed in Subsection 3.4.1.2.

STD COL 3.4(6)

3.4(6) ***Physical models for performance of hydraulic structures and systems***

This COL item is addressed in Subsection 3.4.2.

STD COL 3.4(7)

*3.4(7) **Protection from internal flooding***

This COL item is addressed in Subsection 3.4.1.3.

3.5 Missile Protection

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.5.1.1.2 High-Speed Rotating Equipment

STD* SUP 3.5(2) After the fifth paragraph of DCD Subsection 3.5.1.1.2, add the following.

Potential sources of internal missiles from high-speed rotating equipment are assessed for the UHS ESW pump house. Internally generated missiles from ventilation fans, pumps and cooling tower fans are not considered credible. Design considerations that apply include:

- Rotating elements are contained within the casing, and the induction motors are designed to withstand an over-speed.
- The fan blades of the unit heaters are contained inside the unit heater housing. The unit heater housing are designed to prevent the fan blades from penetrating it.
- The exhaust fans are mounted on the wall with steel shrouds placed around each fan. These fans are not in line with the motors so that a fan blade would not strike the motor.
- Rotation of the UHS cooling tower exhaust fans is such that if a fan blade leaves the hub it will tend to travel down since it is forcing air up. Beneath the fans, there is a substantial steel and concrete structure to restrain the blade. The fan blades are shrouded on the sides by a concrete wall that prevents the blades from leaving the shrouded area in a horizontal direction. The concrete slabs above the fans, placed there for external missile protection, also prevent any broken blades from leaving the fan room in the upward direction. The fan room itself is enclosed by concrete walls and partial roof that prevents any broken fan blade pieces from leaving the room.
- The ESW pumps and pump motors are all enclosed within concrete walls capable of preventing a generated missile from leaving the pump compartment. The transfer pump motor is enclosed within a concrete wall enclosure that isolates it from the ESW pump motor so that failure of one does not affect operation of the other. Failure of a pump impeller by fracture of the impeller blade does not affect the

other pump in the same basin as the broken blade is confined within the pump casing and falls to the basin bottom when the energy is expended.

3.5.1.1.4 Gravitational Missiles

STD COL 3.5(1)

Replace the paragraph of DCD Subsection 3.5.1.1.4 with the following.

Procedures will be issued prior to fuel load in accordance with Subsection 13.5.2.2 to require unsecured equipment including portable pressurized gas cylinders, located inside or outside containment for maintenance or undergoing maintenance to be removed from containment prior to operation, moved to a location where it is not a potential hazard to SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

3.5.1.3.1 Geometry

NAPS DEP 3.5(1)

Replace the second sentence of the second paragraph of DCD Subsection 3.5.1.3.1 with the following:

In this orientation, the R/B, PCCV, PS/B, and SSCs defined by the guidance and examples in RG 1.117 (except the two PSFSVs) are located outside the high-velocity, low-trajectory missile strike zone as defined by RG 1.115. For the PSFSVs, redundancy and separation of the SSCs contained within the PSFSVs are provided by locating the two PSFSVs on opposite sides of the turbine axis. Although the PSFSVs are located within the low-trajectory missile strike zone, the Unit 3 turbine has a favorable orientation as defined in NUREG-0800 Standard Review Plan (SRP) Section 3.5.1.3 because almost all safety-related SSCs outside containment are excluded from the high-velocity, low-trajectory hazard zone.

NAPS COL 3.5(6)

Replace the third paragraph of DCD Subsection 3.5.1.3.1.

The site Plan (Figure 1.2-1R) reflects the placement of Unit 3 in relation to existing Units 1 and 2. The location and favorable orientation of Unit 3 relative to the Units 1 and 2 turbine generators as defined in SRP Section 3.5.1.3 and RG 1.115 (Reference 3.5-6) are such that Unit 3 is outside the low-trajectory turbine missile strike zone inclined at 25 degrees to the low-pressure turbines (LPTs), and therefore no postulated low-trajectory turbine missiles from Units 1 and 2 affect Unit 3 safety-related SSCs.

3.5.1.3.2 Evaluation

NAPS DEP 3.5(1)

Replace the first sentence of the first paragraph of DCD Section 3.5.1.3.2 with the following:

Protection against damage from turbine missiles to safety-related SSCs is provided by the orientation of the T/G (except for the PSFSVs), by the robust turbine rotors, and by the redundant and fail-safe turbine design control system as described in Section 10.2.

NAPS COL 3.5(2)

Replace the third paragraph of DCD Subsection 3.5.1.3.2.

NAPS DEP 3.5(1)
NAPS DEP 10.2(1)

Mathematically, $P_4 = P_1 \times P_2 \times P_3$, where RG 1.115 considers an acceptable risk rate for P_4 as less than 10^{-7} per year. For favorably oriented T/Gs, which is the case for Unit 3, SRP Section 3.5.1.3 estimates the product of P_2 and P_3 as 10^{-3} per year. The determination of P_1 is strongly influenced by the program for periodic testing and inspection. To maintain an acceptably low P_1, Technical Reports MUAP-10005-NP, "Probability of Missile Generation From Low Pressure Turbines for Model L54" (Reference 3.5-17R), and MUAP-07029-NP, "Probabilistic Evaluation of Turbine Valve Test Frequency" (Reference 3.5-18), are used to establish the procedures and criteria for preservice inspection (PSI), inservice inspection (ISI) intervals, and turbine valve test frequencies. Additionally, procedures implement the applicable operating criteria specified in SRP 3.5.1.3, Table 3.5.1.3-1. These actions maintain the probability of turbine failure resulting in the ejection of turbine rotor (or internal structure) fragments through the turbine casing, P_1, at less than 10^{-5} per year. The acceptable risk rate $P_4 = P_1 \times P_2 \times P_3$ is therefore maintained at 10^{-8}, an order of magnitude less than 10^{-7} per year.

3.5.1.4 Missiles Generated by Tornadoes and Extreme Winds

NAPS SUP 3.5(1)

Add the following at the end of DCD Subsection 3.5.1.4.

The design basis spectrum of tornado missiles for Unit 3 site-specific Seismic Category I structures conforms to the spectrum of missiles defined in Table 2 of "Design-Basis Tornado and Tornado Missiles for

Nuclear Power Plants," RG 1.76, Rev. 1 (DCD Reference 3.5-8) for a Region II tornado. The spectrum of tornado missiles is as follows:

- A 4,000 pound automobile, 16.4 ft by 6.6 ft by 4.3 ft, impacting the structure at normal incidence with a horizontal velocity of 112 ft/s or a vertical velocity of 75 ft/s.
- A 6.625 inch diameter by 15 ft long schedule 40 pipe, weighing 287 pounds, impacting the structure end-on at normal incidence with a horizontal velocity of 112 ft/s or a vertical velocity of 75 ft/s.
- A one inch diameter solid steel sphere assumed to impinge upon barrier openings in the most damaging direction with a horizontal velocity of 23 ft/s or a vertical velocity of 15.4 ft/s.

Due to the robustness of the exterior wall design, the Unit 3 site-specific Seismic Category I structures exposed to tornado missiles are capable of withstanding the impact of each identified tornado missile at any elevation, including the potential impact of a 4,000 pound automobile greater than 30 feet above grade.

3.5.1.5 Site Proximity Missiles (Except Aircraft)

NAPS COL 3.5(3) Replace the paragraph of DCD Subsection 3.5.1.5 with the following.

Externally initiated missiles considered for design are based on tornado missiles as described in DCD Subsection 3.5.1.4 and Section 3.5.1.4. As described in Section 2.2, no potential site-proximity missile hazards are identified except aircraft, which are evaluated in Section 3.5.1.6.

NAPS COL 3.5(4)

3.5.1.6 Aircraft Hazards

Replace the paragraph of DCD Subsection 3.5.1.6 with the following.

The second and subsequent paragraphs of SSAR Section 2.2.3.2.2 are supplemented as follows with information on effective plant areas for Unit 3 and the evaluation results.

The R/B, PCCV, UHSRS, PS/B, and the PSFSV were evaluated.

For flights in the civilian airway, a total effective plant area of 0.069 square miles was used in the evaluation.

For flights in the military airways, a total effective plant area of 0.077 square miles was used in the evaluation.

For civil airway V223, the Unit 3 result is:

$$P_{FA} = 2.59 \times 10^{-7}$$

For military routes, IR714, IR760/VR1754, IR720, and VR1755, the Unit 3 result is:

$$P_{FA} = 1.07 \times 10^{-8}$$

The total of these two accident probabilities meets the NUREG-0800, Section 3.5.1.6 guideline and is of an order of magnitude of 10^{-7} per year.

3.5.2 Structures, Systems, and Components to be Protected from Externally Generated Missiles

NAPS COL 3.5(5)

Replace the second sentence in the second paragraph of DCD Subsection 3.5.2 with the following.

No site-specific hazards for external events are shown to produce missiles more energetic than tornado missiles identified for Unit 3 site-specific Seismic Category I structure design. The design basis for externally generated missiles is therefore bounded by the design criteria for tornado-generated missiles in Section 3.5.1.4.

3.5.4 Combined License Information

Replace the content of DCD Subsection 3.5.4 with the following.

STD COL 3.5(1)

3.5(1) ***Prevent unsecured equipment from becoming potential hazard***

This COL item is addressed in Subsection 3.5.1.1.4.

NAPS COL 3.5(2)

3.5(2) ***Maintain P_1 within acceptable limit***

This COL item is addressed in Subsection 3.5.1.3.2.

NAPS COL 3.5(3)

3.5(3) ***Presence of potential hazards and effects in vicinity of site, except aircraft***

This COL item is addressed in Subsection 3.5.1.5.

NAPS COL 3.5(4)

3.5(4) ***Site interface parameters for aircraft crashes and air transportation accidents***

This COL item is addressed in Subsection 3.5.1.6.

NAPS COL 3.5(5)

3.5(5) ***Other potential site-specific missiles***

This COL item is addressed in Subsection 3.5.2.

NAPS COL 3.5(6)

3.5(6) ***Orientation of T/G of other unit(s)***

This COL item is addressed in Subsection 3.5.1.3.1.

3.5.5 References

Replace the following reference in DCD Subsection 3.5.5.

3.5-17R Probability of Missile Generation From Low Pressure Turbines for Model L54, MUAP-10005-P, Rev. 1 (Proprietary) and MUAP-10005-NP, Rev. 1 (Non-Proprietary), Mitsubishi Heavy Industries, Ltd., Tokyo, Japan, July 2011.

3.6 Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.6.1.3 Postulated Failures Associated with Site-Specific Piping

STD COL 3.6(1)

Replace the paragraph in DCD Subsection 3.6.1.3 with the following.

The site-specific systems or components that are safety-related or required for safe shutdown are limited to the essential service water system (ESWS) and the ultimate heat sink (UHS) system. There is no site-specific high-energy piping within the protective walls of the ESWPT and UHSRSs, and therefore, high-energy pipe breaks are not postulated for site-specific piping within these protective walls. The site-specific moderate-energy piping systems are the ESWS and the fire protection water supply system (FSS).

A qualitative evaluation of site-specific moderate-energy piping systems to assess environmental and flooding impacts is provided below.

The ESWS and the UHS consist of four independent trains with each train providing fifty percent (50%) of the cooling capacity required for a design basis accident and subsequent placement of the plant in the safe shutdown condition. Each train of the ESWS in the ESWPT is physically separated from the other trains by concrete walls and floors, and piping penetrations to other buildings are sealed. The failure in the piping of one ESWS train will not affect the other trains of the ESWS from an environmental and flooding perspective. Therefore, the consequences of failures in site-specific ESWS piping does not affect the ability to safely shut down the plant.

The failure in the FSS piping will not affect the safety function of the ESWS and the UHS from an environmental perspective because the FSS water temperature is approximately room temperature. From a flooding perspective, the ESWS is safe from a FSS pipe failure because FSS piping does not exist in the ESWPT, and the ESWPT piping penetrations prevent intrusion from any postulated FSS spillage in other buildings. Therefore, the consequences of the failure in site-specific FSS piping does not affect the ability to safely shut down the plant.

3.6.2.1 Criteria used to Define Break and Crack Location and Configuration

STD COL 3.6(4)

Replace the second paragraph in DCD Subsection 3.6.2.1 with the following.

As noted in Section 3.6.1.3, there is no site-specific high-energy piping within the protective walls of the ESWPT and UHSRSs. The site-specific moderate-energy piping systems are the ESWS and the FSS. A crack in the moderate-energy piping ESWS and FSS does not affect the safety function of the ESWS and the UHS that are required for a design basis accident and for safe shutdown, as described in Section 3.6.1.3.

STD COL 3.6(10)

3.6.3.3.1 Water Hammer

Replace the fourth paragraph in DCD Subsection 3.6.3.3.1 with the following.

Generally, water hammer is not experienced in reactor coolant loop (RCL) branch piping, and the piping is designed to preclude the voiding condition according to operation at a pressure greater than the saturation pressure of the coolant. No valve that requires immediate action, such as pressurizer safety valve or relief valve, is present in the piping. Operating and maintenance procedures regarding water hammer are included in system operating procedures in Subsection 13.5.2.1. A milestones schedule for implementation of the procedures is also included in Subsection 13.5.2.1. The procedures are to address plant operating and maintenance requirements to provide adequate measures to prevent water hammer due to a voided line condition.

3.6.4 Combined License Information

Replace the content of DCD Subsection 3.6.4 with the following.

STD COL 3.6(1) *3.6(1)* ***Postulated failures associated with site-specific piping***

This COL item is addressed in Subsection 3.6.1.3.

3.6(2) ***Deleted from the DCD.***

3.6(3) ***Deleted from the DCD.***

STD COL 3.6(4) *3.6(4)* ***Criteria used to define break and crack location and configuration for site-specific piping.***

This COL item is addressed in Subsection 3.6.2.1.

3.6(5) ***Deleted from the DCD.***

3.6(6) ***Deleted from the DCD.***

3.6(7) ***Deleted from the DCD.***

3.6(8) ***Deleted from the DCD.***

3.6(9) ***Deleted from the DCD.***

STD COL 3.6(10) *3.6(10)* ***Operating and maintenance procedures for water hammer prevention***

This COL item is addressed in Subsection 3.6.3.3.1.

3.7 Seismic Design

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

NAPS COL 3.7(20)
NAPS COL 3.7(6)
NAPS COL 3.7(5)

Replace the third paragraph in DCD Section 3.7 with the following.

The validity of the site-independent seismic design of the standard plant structures for the site-specific seismic conditions is addressed in this Section 3.7 and in Appendix 3NN. FIRS, presented in Appendix 3OO and Section 3.7.1.1, are developed for the site-specific US-APWR plant configuration. SSI Input motions are developed considering both the minimum response spectra that are defined in Subsection 3.7.1.1 and the response spectra obtained from the site-specific SSE ground motion response analyses. The FIRS are derived by an analysis methodology which accounts for the upward propagation of the SSE ground motion. The site-dependent (also referred to herein as site-specific) GMRS, defined as a free-field hypothetical outcrop at Elevation 250 ft NAVD88 (250.86 ft NGVD29) corresponding to Zone III-IV rock with a shear wave velocity of 4250 ft/s as discussed in Section 2.5.2, is developed following the intent of RG 1.165 and RG 1.208. The site-specific design SSE motions are defined in Subsection 3.7.1.1.

NAPS COL 3.7(21)
NAPS DEP 3.7(5)

Replace the fourth paragraph in DCD Section 3.7 with the following.

For the site-specific seismic design of seismic category I and seismic category II SSCs that are not part of the US-APWR standard plant, FIRS included in Appendix 3OO are derived from the site-specific SSE ground motion in the same manner as the site-specific FIRS used for validation of the standard plant structures. The FIRS are developed following the requirements of RG 1.165 (Reference 3.7-203), and represent the envelope of the minimum response spectra as described in Subsection 3.7.1.1.

NAPS COL 3.7(1)
NAPS COL 3.7(6)

Replace the fifth paragraph in DCD Section 3.7 with the following.

The PGA and spectral shapes of the site-specific FIRS are not enveloped by the US-APWR standard plant CSDRS. Exceedances of the CSDRS are present in the mid- to HF range. To confirm the suitability of the US-APWR standard plant seismic designs for the site, validation analyses compare the standard plant seismic design to the site-specific seismic responses. The site-specific seismic responses are derived from site-specific soil-structure interaction (SSI) analyses which use the site-specific soil properties and SSI Input motions. The analyses results demonstrate that the standard plant seismic design of structural components envelopes the responses from the site-specific seismic analyses. The analyses are discussed further in Section 3.7.2.4.1.

NAPS COL 3.7(23) The site-specific SSI analyses show that the broadened in-structure response spectra (ISRS) derived from the site-specific input motion are not enveloped by the US-APWR standard plant ISRS. The evaluation approach for the spectral exceedances in the mid- to HF range is discussed further in Sections 3.7.2.4.1 and 3.7.2.5, and Sections 3.10 and 3.12.

3.7.1 Seismic Design Parameters

3.7.1.1 Design Ground Motion

NAPS SUP 3.7(1) Add the following before the first paragraph in DCD Subsection 3.7.1.1.

The site-specific seismic design ground motions are developed, as described in detail in Appendix 3OO, for the following seismic category I structures:

- Reactor Building Complex (R/B Complex); this includes the R/B, the PCCV and the containment internal structure (CIS), which all rest on a common basemat.
- East and West PS/Bs
- East and West PSFSVs
- Ultimate Heat Sink Related Structures (UHSRS) A, B, C and D; each of the four are composed of a basin, pump house cooling tower and pipe room. The UHSRS Pipe Chase extends between UHSRS B and C
- East and West ESWPTs

Note that while the R/B Complex and PS/B are included in the US-APWR standard plant design, the PSFSV, UHSRS and ESWPT are site-specific structures.

NAPS COL 3.7(1)
NAPS DEP 3.7(1)

Replace the second sentence of the first paragraph in DCD Subsection 3.7.1.1 with the following.

The applicable site-specific PGA is greater than 0.3g for the horizontal and vertical directions (refer to Figure 3.7-201 through Figure 3.7-208).

NAPS COL 3.7(22)

Replace the last sentence of the third paragraph in DCD Subsection 3.7.1.1 "CSDRS" with the following.

Unit 3 seismic category I structures are founded on rock or concrete fill on rock, and the ground motion at Unit 3 is characterized by a high frequency content. The site-specific seismic GMRS and FIRS demonstrate that there are high frequency exceedances of the CSDRS. Site-specific seismic analyses, including SSI analyses, which consider seismic wave transmission incoherence are described in Section 3.7.2. The site-specific SSI analyses determine if HF exceedances of the CSDRS could be transmitted to SSCs in the plant superstructure with potentially damaging effects.

NAPS DEP 3.7(5)

Replace the second sentence of the second paragraph in DCD Subsection 3.7.1.1 "Site-Specific GMRS" with the following.

A probabilistic seismic hazard analysis considering horizontal ground motion models for central and eastern US generic hard rock (shear wave velocity of at least 9,200 ft/s) is performed based on the reference probabilistic approach conforming to guidance in RG 1.165 (Reference 3.7-203).

NAPS DEP 3.7(2)

Replace the last two sentences of the first paragraph in DCD Subsection 3.7.1.1 "FIRS" with the following.

Free-field outcrop spectra of site-specific horizontal ground motions are derived from the hard rock SSE spectra consistent with the horizontal GMRS using site response analyses that consider the wave propagation effects in the materials representing the Unit 3 site-specific conditions. The methodology is described in detail in Appendix 3OO.

NAPS COL 3.7(5)

Replace the last two sentences of the second paragraph in DCD Subsection 3.7.1.1 “FIRS” with the following.

The horizontal FIRS defining the site-specific SSE ground motions at the bottom of each basemat are obtained from the seismic site response analysis, presented in detail in Appendix 3OO. The site response analysis is performed using the computer program P-SHAKE as discussed in Appendix 3OO. The seismic category I structures are listed in Table 3OO-201, along with the SSI analysis approach for each structure (embedded, surface founded, or both). For structures analyzed as embedded, the FIRS are calculated as full-column outcrop motions and compared to the CSDRS scaled at 0.1g, representing the minimum design response spectra required by 10 CFR 50, Appendix S, as shown in Figure 3.7-201 for the horizontal direction and Figure 3.7-202 for the vertical direction. For structures analyzed as surface-founded, the FIRS are calculated as geologic outcrop motions (also referred to as Truncated Soil Column Response (TSCR)) and compared to the minimum response spectra required by 10 CFR 50, Appendix S, as shown in Figure 3.7-203 for the horizontal direction and Figure 3.7-204 for the vertical direction. The comparison shows that the minimum design response spectra requirements are not satisfied by the FIRS for any of these structures for either SSI analysis approach. The SSI input motions were computed using FIRS in accordance with Interim Staff Guidance, as described in Appendix 3OO. In addition, where applicable, the FIRS are augmented by the CSDRS scaled to a PGA of 0.1g (see Section 3OO.1.4) to satisfy the minimum design ground motion requirements of Appendix S to 10 CFR Part 50. The resulting ARS are smoothed and are labeled “SSI Input” motions.

NAPS COL 3.7(2)
NAPS DEP 3.7(1)

Replace the third paragraph in DCD Subsection 3.7.1.1 “FIRS” with the following.

The site-specific FIRS at the basemat level control point of the CSDRS are compared to the site-independent CSDRS for the US-APWR standard plant seismic category I design structures, namely the R/B Complex and the PS/B. The comparison is shown in Figure 3.7-201 and Figure 3.7-202 for the full-column outcrop FIRS in the horizontal and vertical directions, respectively, and in Figure 3.7-203 and Figure 3.7-204 for the geologic outcrop FIRS and the GMRS in the horizontal and vertical directions, respectively. The comparisons show that the site-dependent GMRS and FIRS exceed the CSDRS in all cases in the high frequency range of the spectrum. Note that the FIRS for the site-specific seismic category I structures are also shown in Figure 3.7-201 and Figure 3.7-202 for full-column outcrop motions, and in Figure 3.7-203 and Figure 3.7-204 for the geologic outcrop motions.

A site-specific verification analysis of US-APWR standard plant seismic category I structures is performed considering SSI effects, as described in Section 3.7.2, and using the site-specific SSI Input motions, based on the site-specific FIRS, which are described in detail in Appendix 3OO. One set of full-column outcrop SSI Input motions (horizontal and vertical) is developed for each of the R/B Complex, and the PS/B (based on the envelope FIRS for the East and West units) for their analysis with embedded foundations. The full-column outcrop SSI Input motions are presented in Figure 3.7-205 and Figure 3.7-206 in the horizontal and vertical directions, respectively. A second set for each of the R/B Complex and the PS/B (based on the envelope FIRS for the East and West units) is shown in Figure 3.7-207 and Figure 3.7-208 for the geologic outcrop SSI Input motion in the horizontal and vertical directions, respectively. The geologic outcrop SSI input motions are used for the SSI analysis of the structures with surface foundations. Note that, since the design of the R/B Complex and PS/B is covered by the standard plant design, the minimum design response spectra required by 10 CFR 50, Appendix S, are not included in these motions, and are considered in a separate SSI analysis, as described in Section 3.7.2.

NAPS SUP 3.7(2)
NAPS ESP VAR 2.0-4

Add the following before the first paragraph in DCD Subsection 3.7.1.1 “OBE.”

For the design of seismic category I SSCs that are not part of the US-APWR standard plant, the site-specific SSI Input motions, including minimum requirements, are developed based on the site-specific FIRS for the ESWPT and UHSRS. Figure 3.7-209 and Figure 3.7-210 present the SSI Input motions in the horizontal and vertical directions, respectively. Note that the site-specific SSI Input motions for the PS/B are adopted for the SSI analysis of the PSFSV, due to their proximity and similar site conditions. As described in Appendix 3LL and Reference 3.7-47R, the minimum design response spectra required by 10 CFR 50, Appendix S for PSFSV is satisfied through SSI analysis of these buildings for two separate spectra (site-specific FIRS and minimum required spectra).

The free-field site-dependent design ground motions at plant grade are developed at multiple locations at the Unit 3 site, corresponding to the locations of seismic category I structures. To develop the site-dependent SSE free-field ground motion at grade, the design response spectra at finished grade on top of backfill at the locations of the following structures are considered:

- R/B Complex
- PS/B (also applicable to PSFSV)
- UHSRS (A, B, C and D)
- ESWPT (East and West)

Figure 3.7-211 presents the aforementioned spectra at finished grade, in addition to the US-APWR CSDRS anchored at 0.1g, which satisfies the minimum requirements for design ground motions as described in Appendix S to 10 CFR Part 50. Note that all the considered site conditions consist of backfill material in the upper soil layers. Figure 3.7-212 presents the corresponding vertical spectra. As shown in Figure 3.7-211, the envelope of the aforementioned spectra at finished grade, in addition to the CSDRS scaled to 0.1g PGA, defines the site-dependent SSE free-field design ground motion at grade in the horizontal direction. The same definition is applied for the vertical spectra, as presented in Figure 3.7-212.

NAPS COL 3.7(13) Replace the second paragraph in DCD Subsection 3.7.1.1 “OBE” with the following.

For the purpose of defining the free-field OBE ground motion, a “Minimum SSE at grade” is defined by the following two spectra, as shown in Figure 3.7-211 and Figure 3.7-212 for the horizontal and vertical directions, respectively:

a) Minimum acceleration response spectrum from the aforementioned design response spectra at finished grade, where this is greater than (b) and,

b) US-APWR CSDRS scaled to 0.1g PGA, representing the minimum requirements of Appendix S to 10 CFR Part 50 where this is greater than (a).

The "Site-dependent OBE at grade" is defined as 1/3 of the "Minimum SSE at grade".

Figure 3.7-213 and Table 3.7-201 present the horizontal "Site-dependent SSE at grade", "Minimum SSE at grade", and "Site-dependent OBE at grade", while Figure 3.7-214 and Table 3.7-202 present the corresponding vertical spectra. The site-independent SSE (CSDRS with a PGA of 0.3g) and one third of that (CSDRS scaled to a PGA of 0.1g) are also shown for comparison.

NAPS DEP 3.7(4)

Replace the first sentence of the first paragraph in DCD Subsection 3.7.1.1 "Design Ground Motion Time History" with the following.

As described in Technical Report MUAP-10001 (Reference 3.7-47R), one set of three statistically independent time histories of seismic motion is synthesized from seed recorded earthquake ground motions for use as the input motion in the earthquake response analysis of the US-APWR standard plant including the R/B, PCCV, CIS, and PS/Bs.

Replace the second paragraph in DCD Subsection 3.7.1.1 "Duration of Motion" with the following.

For the linear structural analyses, which are based on synthesized time histories presented in Technical Report MUAP-10001 (Reference 3.7-47R) that are used to design US-APWR standard plant seismic category I buildings and structures, the total duration of the ground motion time histories has been demonstrated to be long enough such that adequate representation of the Fourier components at LF is included in the time history.

NAPS COL 3.7(24)

Replace the first sentence of the fifth paragraph in DCD Subsection 3.7.1.1 "Duration of Motion" with the following.

The site-specific ratios V/A and AD/V^2 (A, V, D, are PGA, ground velocity, and ground displacement, respectively) are reported in Section 3OO.3. The site-specific ratios are discussed and are consistent with values characteristic for the magnitude and distance of the appropriate controlling events defining the site-specific uniform hazard response spectra.

NAPS COL 3.7(30) Replace the sixth paragraph in DCD Subsection 3.7.1.1 "Duration of Motion" with the following.

For each set of horizontal and vertical site-dependent SSI Input motion spectra (Figure 3.7-205 through Figure 3.7-210), one set of three statistically independent acceleration time histories of motions (two horizontal and one vertical component) is developed. The seed time histories are modified to be spectrum compatible following Option 1, Approach 2 of NUREG 0800, SRP 3.7.1, using the computer program RSPM as discussed in Appendix 3OO. The matching procedure is implemented in accordance with NUREG/CR-6728 (Reference 3.7-14) and is described in detail in Appendix 3OO (Section 3OO.3), including the selection of the seed acceleration time histories and the matching criteria.

Figure 3.7-215 presents the acceleration, velocity and displacement time histories for the first horizontal direction (H1) spectrally matched to the site-specific SSI Input motion for the R/B Complex analyzed as surface foundation with a duration of 59 seconds. Figure 3.7-216 and Figure 3.7-217 present the corresponding plots for the second horizontal direction (H2), and the vertical direction (UP), respectively.

Figure 3.7-218 through Figure 3.7-220 present the corresponding set of time histories spectrally matched to the site-specific SSI Input motion for the R/B Complex analyzed as embedded foundation. The input time histories needed for SSI analysis of the R/B Complex with embedded foundation are within (in-column) motions corresponding to each of the SSI soil profiles. As such, each of the outcrop acceleration time histories (2 horizontal and 1 vertical), is used as input, using the computer program SHAKE2000 (as discussed in Appendix 3OO) at the foundation level of the R/B Complex to a soil column model of the SSI soil profiles (LB, BE and UB); and their corresponding within time histories are obtained at the same horizon. The resulting acceleration time histories are described in Section 3OO.3 for the R/B Complex, as well as for all seismic category I structures.

3.7.1.2 Percentage of Critical Damping Values

NAPS COL 3.7(4)

Replace the last three sentences of the second paragraph in DCD Subsection 3.7.1.2 with the following.

The SSE level damping values in DCD Table 3.7.3-1(a) are used, both for calculation of seismic structural demands and for computation of the ISRS. The damping values are based on RG 1.61 and ASCE Standard 4-98 (Reference 3.7-9). A plant-specific technical basis for use of these damping values is provided in Section 3.7.2.4.1.

The damping values in Table 3.7.3-1(a) and Table 3.7.3-1(b) are applicable to all modes of vibration of a structure constructed of the same material. Tier 2 3.7-10 Revision 2 The damping values for systems that include two or more substructures, such as a concrete and steel composite structure, can be obtained using the strain energy method. The strain energy dependent modal damping values are computed based on Reference 3.7-18, which is the same as the stiffness weighted composite modal damping method, and acceptable to SRP 3.7.2 (Reference 3.7-16).

3.7.1.3 Supporting Media for Seismic Category I Structures

NAPS COL 3.7(28)

Replace the last sentence of the first paragraph in DCD Subsection 3.7.1.3 with the following.

The overall basemat dimensions, basemat embedment depths, and maximum height of the US-APWR R/B, PCCV, and CIS (referred to as the R/B Complex) on their common basemat, as well as for the PS/B and site-specific seismic category I structures are given in Table 3.7.1-3R.

NAPS COL 3.7(7)

Replace the last two sentences of the second paragraph in DCD Subsection 3.7.1.3 with the following.

The allowable static and dynamic bearing capacities are determined based on site conditions, including the properties of concrete fill, as described in Section 2.5.4.10 and Table 2.5-214. The dynamic bearing loads for seismic category I structure basemats are determined based on a site-specific seismic analysis. The ratios of the allowable bearing capacity versus the applied bearing pressures are presented in Table 2.5-215.

NAPS DEP 3.7(4) Replace the fifth paragraph in DCD Subsection 3.7.1.3 with the following.

The resulting generic layered supporting media provide a wide variation of properties to address potential ranges in dynamic soil properties. The development of the supporting soil media profiles are described further in Sections 4.2 and 5.2 of Technical Report MUAP-10001 (Reference 3.7-47R).

NAPS SUP 3.7(3) Add the following after the last paragraph in DCD Subsection 3.7.1.3.

The site-specific soil property profiles are developed in Appendix 3OO to represent the site conditions associated with seismic category I structures. The developed soil properties are strain-compatible with the site-specific FIRS, and represent the variability in the site conditions by including a set of LB, BE and upper bound soil property profiles for each structure.

3.7.2 Seismic System Analysis

3.7.2.1 Seismic Analysis Methods

NAPS COL 3.7(29) Replace the last sentence of the first paragraph in DCD Subsection 3.7.2.1 with the following.

The methods used for the seismic analysis of the US-APWR seismic category I systems conform to the requirements of SRP Subsections 3.7.1 (Reference 3.7-10) and 3.7.2 (Reference 3.7-16). Table 3.7.2-1R presents a summary of dynamic analysis and combination techniques including types of models and computer programs used, seismic analysis methods, and method of combination for the three directional components for the seismic analysis of the US-APWR standard and site-specific seismic category I buildings and structures.

The dynamic analyses used for the site-specific validation analyses of the standard plant include SSI analyses of surface and embedded conditions as described in Appendix 3NN. The surface and embedded conditions considered in the dynamic analyses of the site-specific seismic category I structures are described in Appendix 3LL.

3.7.2.2 Natural Frequencies and Responses

NAPS DEP 3.7(4)

Replace the third sentence of the first paragraph in DCD Subsection 3.7.2.2 with the following.

The dynamic model is discussed further below in Subsection 3.7.2.3 and in Technical Report MUAP-10001 (Reference 3.7-47R).

NAPS COL 3.7(20)
NAPS DEP 3.7(4)

Add the following at the end of the last paragraph in DCD Subsection 3.7.2.2.

Section 3.7.2.5 and Section 3NN.5 of Appendix 3NN discuss development of ISRS based on the results of the site-specific seismic analyses. Appendix 3NN compares the seismic responses and 5% damping ISRS obtained from the site-specific analyses of the R/B complex and the PS/Bs to the seismic responses and 5% damping ISRS obtained from site-independent analyses documented in MUAP-10006 (Reference 3.7-48R).

3.7.2.3.1 General Discussion of Analytical Models

NAPS COL 3.7(3)

Replace the sixth paragraph (including bullets) in DCD Subsection 3.7.2.3.1 with the following.

Analytical models are developed on a site-specific basis and used for the seismic analyses of non-standard plant buildings and structures discussed in Appendix 3LL.

- UHSRS (seismic category I). Three-dimensional site-specific SASSI (Reference 3.7-17) FE models are used for seismic analysis.
- ESWPT (seismic category I). Three-dimensional site-specific SASSI (Reference 3.7-17) FE models are used for seismic analysis.
- PSFSVs (seismic category I). A three-dimensional site-specific SASSI (Reference 3.7-17) finite element (FE) model is used for seismic analysis.

Replace the last sentence in the last paragraph in DCD Subsection 3.7.2.3.1 with the following.

However, the ANSYS FE models are also used for validation of the dynamic models, as discussed later in this section.

3.7.2.3.2 R/B, PCCV, and Containment Internal Structure Lumped Mass Stick Models

NAPS DEP 3.7(4)

Replace the third sentence of the first paragraph in DCD Subsection 3.7.2.3.2 with the following.

The methodology initially used to develop the stick models and the stick model properties is presented in Technical Report MUAP-08005 (Reference 3.7-204), and in the following Subsections 3.7.2.3.4 through 3.7.2.3.9.

Replace the last sentence of the first paragraph of DCD Subsection 3.7.2.3.2 with the following.

Technical Report MUAP-10001(Reference 3.7-47R) presents the methodology used for these enhancements and describes the overall enhanced R/B complex model in further detail.

3.7.2.3.3 East and West PS/Bs Models

NAPS DEP 3.7(4)

Replace the last sentence of the second paragraph in DCD Subsection 3.7.2.3.3 with the following.

The PS/B seismic model and the seismic analysis results are discussed in further detail in Technical Reports MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R, respectively).

3.7.2.3.4 Subsystem Coupling Requirements

NAPS DEP 3.7(4)

Replace the last sentence of the second paragraph in Subsection 3.7.2.3.4 with the following.

This is the approach used for including the RCL seismic subsystem in the coupled RCL-R/B-PCCV-CIS lumped mass stick model discussed in Technical Report MUAP-08005 (Reference 3.7-204).

3.7.2.3.6.1 Mass Points and Associated Weights (*W*)

NAPS DEP 3.7(4)

Replace the last paragraph in DCD Subsection 3.7.2.3.6.1 with the following.

Vertical amplification effects on the masses of floor slab systems due to out-of-plane flexibility are addressed as part of Technical Reports

MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R, respectively).

3.7.2.4 Soil-Structure Interaction

NAPS DEP 3.7(4)

Replace the last sentence of the second paragraph in DCD Subsection 3.7.2.4 with the following.

Approaches and methods used for the SSI analyses are discussed further in Technical Report MUAP-10001 (Reference 3.7-47R).

3.7.2.4.1 Requirements for Site-Specific SSI Analysis of US-APWR Standard Plant

NAPS COL 3.7(25)
NAPS DEP 3.7(1)

Replace the first paragraph in DCD Subsection 3.7.2.4.1 with the following.

The site-specific SSI analyses for the R/B-PCCV-CIS and PS/Bs are performed using the program ACS SASSI (Reference 3.7-17). Sets of analyses are performed on the R/B-PCCV-CIS and PS/Bs to evaluate the effects of site-specific seismological and geotechnical conditions and the incoherence of the input ground motion. As discussed earlier in Section 3.7, the analyses utilize site-specific SSI Input motion documented in Section 3.7.1 and Appendix 3OO for evaluation of the standard design against the spectral exceedances of the standard plant CSDRS. The modeling and site-specific SSI analyses of the R/B-PCCV-CIS (also referred to herein as the R/B complex) and PS/Bs are addressed in Appendix 3NN.

NAPS COL 3.7(26)

Replace the second paragraph in DCD Subsection 3.7.2.4.1 with the following.

The site-specific SSI analyses of the UHSRS, ESWPT, and PSFSVs are also performed using the computer program ACS SASSI (Reference 3.7-17). The SASSI analyses for these structures are performed using the same methodology as the site-specific SASSI analyses of the R/B complex and PS/Bs, except that the appropriate site-specific SSI Input motion for each structure is used and the incoherency of the input motion is not considered. The SSI analyses and results for the UHSRS, ESWPT, and PSFSVs are addressed in further detail in Appendix 3LL.

NAPS COL 3.7(20)

Site-specific SSI analyses are required to confirm that the seismic designs of the A/B and T/B are suitable for the site-specific seismic input motion and the range of site-specific subgrade conditions, in accordance with the guidance given in SRP 3.7.2.

NAPS COL 3.7(25)

Replace the first sentence of the third paragraph in DCD Subsection 3.7.2.4.1 with the following.

The site-specific seismic response analyses address factors that affect the response of the combined soil-structure dynamic system that include, but are not limited to, the following.

Replace the last two sentences of the fifth paragraph in DCD Subsection 3.7.2.4.1 with the following.

The value of C_V used to determine bounding values for all subgrade and backfill shear moduli in the SSI analyses is at least 0.5, corresponding to a well investigated site.

NAPS COL 3.7(8)
NAPS COL 3.7(25)
NAPS COL 3.7(26)
NAPS DEP 3.7(1)
NAPS DEP 3.7(2)

Replace the sixth, seventh, and eighth paragraphs in DCD Subsection 3.7.2.4.1 with the following.

The SSI analyses use stiffness and damping properties of the subgrade materials that are compatible with the strains generated by the site-specific design earthquake which is based on the FIRS discussed in Section 3.7.1.1. In accordance with guidance of SRP 3.7.2, the soil material damping considered in Appendices 3OO and 3NN does not exceed 15%.

All standard plant and site-specific seismic category I and II buildings and structures are founded on rock or on a layer of fill concrete placed on the rock as described in Section 2.5.4. The R/B complex, the PSFSVs, and the PS/Bs are founded completely on bedrock or on fill concrete placed on bedrock as described in Section 2.5.4.

The fill concrete has a minimum design compressive strength of 2,500 psi as stated in Section 2.5.4 and a BE shear wave velocity of 7,000 ft/s as stated in Appendix 3OO. The fill concrete is installed as a leveling layer and to fill the space between the basemat and the top of competent rock. Fill concrete may be used as “dental” fill in any areas where additional removal of materials below the anticipated bottom of excavation is required in order to reach competent rock. To ensure that the effects of the fill concrete on the seismic response are adequately captured, the fill concrete is included in analyses to develop the SSI Input motions, except for the ESWPT and UHSRS pipe chase, as discussed further in Appendix 3OO.

Section 2.5.4 discusses the dynamic properties of the rock subgrade. The dynamic properties of the Zone III-IV slightly to moderately weathered rock and underlying Zone IV parent bedrock are strain independent. The Zone III rock exhibits reduction of shear modulus due to strain. The reduction in shear modulus is taken into account for the soil/rock column amplification/attenuation analyses used to develop the FIRS and SSI Input motions in Appendix 3OO, and is used in the modeling of the subgrade in the SASSI analyses. Figures 3NN-1 through 3NN-6 in Appendix 3NN present the sets of site-specific S-wave, P-Wave, and damping profiles used in the SASSI validation analyses for the R-B and PS/Bs.

As previously mentioned in DCD Subsection 3.7.2.4, the seismic design of the standard plant buildings does not rely on the backfill present on the sides of the building to derive lateral or structural support. Further, the seismic designs of the site-specific seismic category I structures, including the UHSRS, ESWPT, and PSFSVs, also do not rely on backfill for lateral or structural support. The designs of exterior below-grade walls do consider applicable earth pressures generated by the design earthquake.

For purposes of site-specific seismic analysis, the water table for each structure is considered based on groundwater levels reported in Section 2.4.12. The P-wave velocities of the saturated fill concrete and rock layers exceed the P-wave velocity of the water (5,000 ft/s). Therefore, the water table elevation does not affect the P-wave velocities of these materials as used in the SSI analyses. To account for the presence of groundwater, the Poisson's ratio for backfill materials is adjusted as discussed in Appendix 3OO, Section 3OO.2, to obtain the corresponding values for the strain-compatible backfill P-wave velocities used in the validation analyses documented in Appendix 3NN.

The same dynamic models used for the standard plant analyses are used for the site-specific SSI validation analyses. The properties of the ACS SASSI (Reference 3.7-17) seismic models have been verified by SSI analyses of the buildings resting on the surface of a hard rock subgrade that simulates fixed base conditions. The results of the SASSI analyses match the results from the time history analyses of fixed base models.

NAPS COL 3.7(23)
NAPS DEP 3.7(1)
NAPS DEP 3.7(4)

Replace the last sentence of the ninth paragraph in DCD Subsection 3.7.2.4.1 with the following.

The results of the site-specific SSI analysis documented in Appendix 3NN demonstrate that the standard plant seismic design of structural members envelopes the site-specific seismic responses (demands) for the R/B complex and the PS/Bs. Tables 3NN-20A, 3NN-20B, 3NN-20C, 3NN-20D, and 3NN-20E demonstrate that the standard plant seismic design loading for the R/B complex envelopes the responses (demands) obtained from the site-specific seismic analyses of the R/B complex. Tables 3NN-21A and 3NN-21B demonstrate that the standard plant seismic design loading for the PS/Bs envelopes the seismic responses (demands) obtained from the site-specific seismic analyses of the PS/Bs. Figure 3NN-22 demonstrates that the total (static and dynamic) site-specific lateral earth pressures on basement walls are enveloped by the US-APWR standard design.

Broadened ISRS are developed for the R/B complex and PS/Bs as described in Section 3.7.2.5. The standard plant and site-specific 5% damping broadened ISRS for the R/B complex are presented in Figure 3NN-23. The standard plant and site-specific 5% damping broadened ISRS for the PS/Bs are presented in Figure 3NN-21. The standard plant broadened ISRS do not envelope all of the corresponding site-specific broadened ISRS at all frequencies.

The seismic designs of standard plant subsystems affected by site-specific exceedances of the standard plant input motion are required to be evaluated to confirm suitability of the designs in accordance with SRP 3.7.3. To evaluate the exceedances of the standard plant broadened ISRS, the seismic design of each standard plant subsystem is required to be reviewed against the seismic responses corresponding to the site-specific broadened ISRS and obtained from the site-specific input motion. At locations where envelopment of the applicable site-specific broadened ISRS does not occur, the suitability of the standard design is to be confirmed by re-analysis using site-specific input motion. Where the standard plant subsystem design envelopes the applicable site-specific responses, the design is considered valid for the site and no further review is performed. Where suitability of the subsystem seismic design cannot be confirmed, design modifications are to be made as necessary to accommodate the site-specific conditions.

Suppliers of seismically qualified equipment and components are required to assure that their design and qualification utilizes appropriate spectra. Suppliers of equipment and components may perform seismic qualification based on generic spectra, standard plant broadened ISRS, and/or site-specific broadened ISRS. Where standard plant equipment and components seismic qualification has been performed based on the standard plant broadened ISRS, the qualification is required to be reviewed, and re-performed if appropriate, considering the effects of any exceedances identified by the site-specific SSI analyses. Refer to Section 3.10 for further discussion of equipment and component seismic qualification.

NAPS COL 3.7(4)

Replace the first sentence of the 11th paragraph in DCD Subsection 3.7.2.4.1 with the following.

SSE damping values in DCD Table 3.7.3-1(a) are assigned as shown in Appendix 3NN, Tables 3NN-9 and 3NN-10, to the standard plant structural models for development of site-specific ISRS and development of site-specific seismic responses (demands) on structural members. This is considered to conform to the guidance in Section 1.2 of RG 1.61. The technical basis is that the site-specific SSE Input motion produces seismic responses and demands (as shown in Tables 3NN-20 and 3NN-21 in Appendix 3NN) that result in stress levels that justify the use of SSE damping levels to account for the dissipation of energy due to structural material damping. SSE damping values are assigned to the SASSI models for site-specific structures as discussed in Appendix 3LL for development of ISRS.

3.7.2.5 Development of Floor Response Spectra

NAPS DEP 3.7(4)

Replace the third sentence of the first paragraph in DCD Subsection 3.7.2.5 with the following.

Note that the dynamic properties of the stick model portions of the R/B complex seismic model presented in Appendix 3H and Technical Report MUAP-08005 (Reference 3.7-204) are modified to account for the effects of cracking for accuracy in the seismic design and development of the ISRS.

Replace the last sentence in the second paragraph in DCD Subsection 3.7.2.5 with the following.

The local analyses of floor slab systems with respect to out-of-plane flexibility and effects on the ISRS are addressed in Technical Reports MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R).

Replace the second, third, fourth, and fifth sentences in the fifth paragraph in DCD Subsection 3.7.2.5 with the following.

The ISRS envelope the spectra obtained from the site-independent analyses for all generic subgrade conditions described in Section 3.7.1.3. 5% critical damping ISRS developed from the site-independent seismic analyses of the R/B complex and PS/Bs, which are used for design and validation by comparison to site-specific 5% critical damping ISRS, are provided in Appendix 3I. The process for developing enveloped ISRS is described in detail in Section 3.5 of Technical Report MUAP-10006 (Reference 3.7-48R) and is summarized as follows:

NAPS COL 3.7(23)

Add the following paragraphs after the 5th paragraph in DCD Subsection 3.7.2.5.

Consistent with the methodology of the standard plant, the site-specific broadened ISRS are developed following the guidance of RG 1.122 for frequencies up to 100 Hz. The site-specific SASSI time history analyses provide results for each site soil profile considered in the design, and for each of the three orthogonal directions where the input motion has been applied separately in each direction. The SRSS method is then used to combine the ARS results to obtain the ARS of the response of the structure in each orthogonal direction.

ISRS are developed for R/B complex and PS/B by grouping and combining the SRSS ARS results at different locations and then by broadening the peaks of the combined ARS by 15% in accordance with RG 1.122. The methodology used to combine and broaden the ARS results is identical to that utilized in the standard plant design to develop ISRS for design of subsystems. The results of the SSI analyses of the individual site-specific soil profiles are enveloped. The site-specific broadened ISRS used for R/B complex and PS/B subsystem analyses and/or design are developed as the envelope of the site-specific response considering the incoherency of the input design motion.

3.7.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures

NAPS COL 3.7(10)

Replace the last sentence of the fifth paragraph in DCD Subsection 3.7.2.8 with the following.

Structure-to-structure interactions, which could potentially influence the seismic response levels, will not occur because all seismic category I and II structures are founded on rock or on fill concrete placed on the rock as described in Section 2.5.4. Seismic Category I and II structures are also separated by expansion joints which prevent seismic interaction.

Site-specific conditions do not result in structure-to-structure interaction effects or exceedances of the assumed pressure distributions used for the US-APWR standard plant design. As stated in FSAR Subsection 3.7.2.4.1, Figure 3NN-22 of Appendix 3NN demonstrates that the total (static and dynamic) site-specific lateral earth pressures on basement walls are enveloped by the US-APWR standard design.

STD COL 3.7(9)

Replace the seventh paragraph in DCD Subsection 3.7.2.8 with the following.

The site-specific category I SSCs are the UHSRS, the ESWPT, and the PSFSVs. The layout design of the site-specific seismic Category I SSCs ensures that there are no adjacent non-seismic Category I structures which may adversely affect these structures, to protect them from structural failure of non-seismic Category I structures.

3.7.2.8.6 PS/Bs

NAPS DEP 3.7(4)

Replace the first sentence in the first paragraph in DCD Subsection 3.7.2.8.6 with the following.

The US-APWR standard plant PS/Bs are Seismic Category I structures and their seismic modeling and analyses are described in Technical Reports MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R, respectively).

3.7.2.13 Methods for Seismic Analysis of Dams

NAPS COL 3.7(27)

Replace the paragraph in DCD Subsection 3.7.2.13 with the following.

Neither the US-APWR standard plant design nor the Unit 3 plant design includes the use of dams.

3.7.3.8 Methods for Seismic Analysis of Category I Concrete Dams

NAPS COL 3.7(27)

Replace the paragraph in DCD Subsection 3.7.3.8 with the following.

Neither the US-APWR standard plant design nor the Unit 3 plant design includes the use of dams.

3.7.3.9 Methods for Seismic Analysis of Aboveground Tanks

NAPS COL 3.7(12)

Replace the first paragraph in DCD Subsection 3.7.3.9 with the following.

The seismic category I fuel oil storage tanks are metal tanks which are enclosed by tornado missile protecting concrete vaults (that is, the seismic category I PSFSVs). Since the PSFSVs are partially embedded structures, the fuel oil storage tanks are not above-ground tanks. However, the tanks and their mountings are seismically analyzed consistent with the discussion of hydrodynamic loads for above-ground tanks given further below. The tanks' seismic analyses are based on the ISRS which are derived from site-specific SSI and response spectra analyses of the PSFSVs as documented in Appendix 3LL. Flexibility of the tank shell and tank shell damping effects are considered in estimating the fundamental frequency and spectral accelerations of the tank including its impulsive fluid weight.

3.7.4.1 Comparison with Regulatory Guide 1.12

NAPS COL 3.7(16)
NAPS DEP 3.7(1)

Replace all sentences between the first and last sentences of the second paragraph in DCD Subsection 3.7.4.1 with the following.

The 5% damping site-specific OBE at grade meets or exceeds the 5% damping standard plant OBE. For purposes of defining the plant shutdown criteria, this exceedance is addressed by adopting the site-specific OBE, which is defined as 1/3 of the minimum site-dependent SSE at grade, as discussed in Section 3.7.1.1. OBE motion is measured at plant grade with seismic instrumentation located in the free field.

Acceleration and velocity spectra are computed for comparison evaluation against the measured seismic responses in accordance with RG 1.166. The OBE spectra are computed by scaling from site response analysis which uses as input the site-specific SSE ground motion and properties of the supporting media that are strain-compatible to the site-specific SSE ground motion. The computed site-specific free-field OBE spectra are presented in Figures 3.7-213 and 3.7-214, and Tables 3.7-201 and 3.7-202. The comparison evaluation is to be performed within 4 hours of the earthquake using data obtained from the three components of the earthquake motion as defined by the three orthogonal axes of the plant (two horizontal and one vertical) on the uncorrected earthquake records.

Replace the third paragraph in DCD Subsection 3.7.4.1 with the following.

The locations of seismic monitors for the plant are provided in Section 3.7.4.2. Using the site-specific values of OBE input motion, acceleration and velocity spectra for 5% critical damping are developed for the free-field instrumentation located in the plant yard for purposes of shutdown consideration. Using site-specific values of OBE input motion, acceleration and velocity spectra for 5% critical damping are also developed for the seismic instrumentation located at the two foundation basemat locations in the R/B and east PS/B. Following the guidance of RG 1.12 and RG 1.166, the basemat instrumentation locations are used for shutdown consideration only in the event that the free-field instrumentation is inoperable. The other three instrument locations in the plant superstructure described in Section 3.7.4.2 serve as data sources for long-term evaluation for start-up and as back-up data sources in the unlikely event that both the free-field and the foundation instruments are inoperable during an earthquake, as these instrument locations are not required by RG 1.12 to be used for shutdown determination.

Replace the first sentence of the fifth paragraph in DCD Subsection 3.7.4.1 with the following.

Because free-field instrumentation alone is used (not in combination with instrumentation mounted on the plant superstructure or building foundations), the site-specific OBE is considered to be exceeded and plant shutdown is required in accordance with the criteria of RG 1.166, only if the first of the following three conditions in combination with either the second or third conditions are met:

Replace the sixth paragraph in DCD Subsection 3.7.4.1 with the following.

In the event that the free-field instrumentation is inoperable, or both the free-field and foundation-level instrumentation are inoperable, then the guidance of RG 1.166 Appendix A is applicable.

3.7.4.2 Location and Description of Instrumentation

NAPS COL 3.7(16)

Replace the sixth bullet in the second paragraph of DCD Subsection 3.7.4.2 with the following.

- In the vicinity of the power block area at surface grade, on top of backfill material, and sufficiently far away from structures in order to appropriately measure free-field ground motion.

3.7.4.3 Control Room Operator Notification

NAPS COL 3.7(14)

Replace the paragraph in DCD Subsection 3.7.4.3 with the following.

The US-APWR at Unit 3 is configured such that triggering of the free-field or foundation-level instrumentation is annunciated in the MCR of the plant.

3.7.4.4 Comparison with Regulatory Guide 1.166

STD* COL 3.7(16)

Replace the second sentence of the first paragraph of DCD Subsection 3.7.4.4 with the following.

As previously discussed in Subsection 3.7.4.1, the seismic instrumentation and OBE exceedance checks can be performed using only uncorrected earthquake data for the three orthogonal plant directions (two horizontal and one vertical) obtained from seismic instrumentation installed in the free fields as described in Subsection 3.7.4.2.

3.7.4.6 Program Implementation

NAPS COL 3.7(19) Replace the paragraph in DCD Subsection 3.7.4.6 with the following.

The seismic monitoring program, including the necessary test and operating procedures, will be implemented prior to receipt of fuel on site.

3.7.5 Combined License Information

Replace the content of DCD Subsection 3.7.5 with the following.

NAPS COL 3.7(1) *3.7(1)* ***Site-specific PGA***

This COL item is addressed in Subsection 3.7.1.1.

NAPS COL 3.7(2) *3.7(2)* ***Analysis of Site-specific FIRS and Site-independent CSDRS***

This COL item is addressed in Subsection 3.7.1.1.

NAPS COL 3.7(3) *3.7(3)* ***Analytical models for site-specific buildings and structures***

This COL item is addressed in Subsection 3.7.2.3.1 and Appendix 3LL.

NAPS COL 3.7(4) *3.7(4)* ***Damping values for site-specific ISRS***

This COL item is addressed in Subsections 3.7.1.2 and 3.7.2.4.1.

NAPS COL 3.7(5) *3.7(5)* ***Horizontal FIRS, Vertical FIRS, and Minimum Response Spectra***

This COL item is addressed in Subsections 3.7 and 3.7.1.1, and Appendix 3OO.

NAPS COL 3.7(6) *3.7(6)* ***Site-specific GMRS and FIRS***

This COL item is addressed in Sections 2.5.2, 3.7, 3.7.1.1, and Appendix 3OO.

NAPS COL 3.7(7) *3.7(7)* ***Allowable static and dynamic bearing capacities***

This COL item is addressed in Subsections 3.7.1.3, 2.5.4.10, and Table 3.8-202.

NAPS COL 3.7(8) *3.7(8)* ***Strain-dependent variation of material dynamic properties***

This COL item is addressed in Subsection 3.7.2.4.1.

STD COL 3.7(9)

3.7(9) ***Failure or collapse of non-seismic category I structures***

This COL item is addressed in Subsection 3.7.2.8.

NAPS COL 3.7(10)

3.7(10) ***Structure-to-structure interaction***

This COL item is addressed in Subsection 3.7.2.8.

3.7(11) ***Deleted from the DCD***

NAPS COL 3.7(12)

3.7(12) ***Liquid-retaining metal tanks***

This COL item is addressed in Subsection 3.7.3.9 and Appendix 3LL.

NAPS COL 3.7(13)

3.7(13) ***Value of OBE to define criteria for shutdown***

This COL item is addressed in Subsection 3.7.1.1.

NAPS COL 3.7(14)

3.7(14) ***Seismic instrumentation at multiple-unit site***

This COL item is addressed in Subsection 3.7.4.3.

3.7(15) ***Deleted from the DCD***

STD* COL 3.7(16)
NAPS COL 3.7(16)

3.7(16) ***Free-field seismic instrumentation***

This COL item is addressed in Subsections 3.7.4.1, 3.7.4.2 and 3.7.4.4.

3.7(17) ***Deleted from the DCD.***

3.7(18) ***Deleted from the DCD.***

NAPS COL 3.7(19)

3.7(19) ***Site-specific details of seismic instrumentation implementation plan***

This COL item is addressed in Subsection 3.7.4.6.

NAPS COL 3.7(20)

3.7(20) ***Standard plant for site-specific conditions***

This COL item is addressed inSections 2.5.2, 3.7, 3.7.2.2, 3.7.2.4.1, Appendix 3NN, and Appendix 3OO.

NAPS COL 3.7(21)

3.7(21) ***Seismic design of non-standard plant SSCs***

This COL item is addressed in Subsection 3.7 and Appendix 3LL.

NAPS COL 3.7(22)

3.7(22) ***High seismic areas***

This COL item is addressed in Subsections 3.7, 3.7.2.4.1 and 3.7.2.5, and Appendix 3NN.

NAPS COL 3.7(23) *3.7(23) **Broadened ISRS and lateral soil pressure***

This COL item is addressed in Subsection 3.7.2.4.1 and Appendix 3NN.

NAPS COL 3.7(24) *3.7(24) **Site-specific uniform hazard response spectra***

This COL item is addressed in Subsection 3.7.1.1.

NAPS COL 3.7(25) *3.7(25) **SSI analysis of R/B-PCCV-containment internal structure and PS/B model***

This COL item is addressed in Subsection 3.7.2.4.1 and Appendix 3NN.

NAPS COL 3.7(26) *3.7(26) **SSI effects for non-standard plant structures***

This COL item is addressed in Subsection 3.7.2.4.1 and Appendix 3LL.

NAPS COL 3.7(27) *3.7(27) **Seismic analysis of dams***

This COL item is addressed in Subsections 3.7.2.13 and 3.7.3.8.

NAPS COL 3.7(28) *3.7(28) **Overall site-specific building dimensions***

This COL item is addressed in Subsection 3.7.1.3 and Table 3.7.1-3R.

NAPS COL 3.7(29) *3.7(29) **Summary of dynamic analysis and combination techniques***

This COL item is addressed in Subsection 3.7.2.1 and Table 3.7.2-1R.

NAPS COL 3.7(30) *3.7(30) **Site-specific design ground motion time histories and duration***

This COL item is addressed in Subsection 3.7.1.1 and Appendix 3OO.

3.7.6 References

Replace the following references in DCD Subsection 3.7.6:

3.7-33 Deleted.

NAPS DEP 3.7(4) 3.7-47R Seismic Design Bases of the US-APWR Standard Plant, MUAP-10001, Revision 1, Mitsubishi Heavy Industries, Ltd., May 2010.

NAPS DEP 3.7(4) 3.7-48R Soil-Structure Interaction Analyses and Results for the US-APWR Standard Plant, MUAP-10006, Revision 0, Mitsubishi Heavy Industries, Ltd., April 2010.

Add the following references in DCD Subsection 3.7.6:

3.7-201 Not used.

3.7-202 Not used.

3.7-203 Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion, Regulatory Guide 1.165, U.S. Nuclear Regulatory Commission.

NAPS DEP 3.7(4) 3.7-204 Dynamic Analysis of the Coupled RCL-R/B-PCCV-Containment Internal Structure Lumped Mass Stick Model, MUAP-08005 Rev. 0, April 2008.

NAPS COL 3.7(28)

Table 3.7.1-3R Major Dimensions of Seismic Category I Structures(1)

Structure	Basemat Embedment Depth Below Grade (ft)	Basemat Width and Length (ft)	Max. Structure Height
R/B	38'-10"	210' x 309'(3)	190'-9"
PCCV	See note 2.	See note 2.	268'-3"
Containment Internal Structure	See note 2.	See note 2.	175'-9" (top of pressurizer compartment)
PS/B	38'-10"	66'-0" x 111'-6"(3)	87'-4"
PSFSV(4),(8)	34'-5"	86' x 108'	55'-8"
UHSRS(5),(8)	25'/13'	135'-6" x 159'(6)	116'-0"
UHSRS pipe chase	4'	28' x 60' (nominal)	12'-8"
ESWPT(7),(8)	30'-11" (typical)	26' (typical)/ 32'-2" (maximum) x length varies for each ESWPT segment	18'-8" (typical) 26'-7" (maximum)

Notes:

1) The dimensions shown are approximate and are based on the general arrangement drawings in Section 1.2.

2) The R/B, PCCV, and containment internal structure rest on a common basemat as shown on the general arrangement drawings in Section 1.2.

3) Width and length are the distances between column lines of exterior walls.

4) The maximum structure height, basemat embedment, and basemat length dimensions include portions of the ESWPT which are integrally attached to the PSFSV. The maximum structure height is from the bottom of mat to top of structure, and includes the height of the parapet at the high point on the PSFSV roof slab.

5) The basemat embedment depth dimensions are for the bottom of the mat in the pump house area and bottom of mat in the main pool area, respectively. The basemat length dimension includes portions of the ESWPT which are integrally attached to the UHSRS. The maximum structure height is from the bottom of mat in the pump house area to top of structure.

6) Each mat foundation supports one UHS basin with one pool.

7) Dimensions are shown for those ESWPT segments that are independent structures and not integrally attached to another structure.

8) The PSFSV, UHSRS, and ESWPT dimensions are based on the structural arrangements presented in Figures 3.8-201 through 3.8-214. The width and length dimensions are the distances between exterior surfaces (not column lines).

Table 3.7.1-4R [Deleted]

Table 3.7.1-5R [Deleted]

NAPS COL 3.7(29)
NAPS DEP 3.7(4)

Table 3.7.2-1R Summary of Dynamic Analysis and Combination Techniques

Model	Analysis Method	Program	Three Components Combination (for Purposes of Dynamic Analysis)	Modal Combination
Three-dimensional R/B-PCCV-containment internal structure SSI model(1)	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
Three-dimensional RCL-R/B-PCCV-containment internal structure FE Model(2)	Time History Analysis in Frequency Domain	ANSYS	N/A(2)	N/A
Three-dimensional PS/B SSI model(3)	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
Three-dimensional PS/B FE models(2)	Time History Analysis in Frequency Domain	ANSYS	N/A(2)	N/A
Three-dimensional UHSRS FE model(4)	Response Spectra Analysis	ANSYS	SRSS	Lindley-Yow method
Three-dimensional UHSRS SSI model	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
Three-dimensional ESWPT FE models(4)	Response Spectra Analysis	ANSYS	SRSS	Lindley-Yow method

NAPS COL 3.7(29)
NAPS DEP 3.7(4)

Table 3.7.2-1R Summary of Dynamic Analysis and Combination Techniques *(continued)*

Model	Analysis Method	Program	Three Components Combination (for Purposes of Dynamic Analysis)	Modal Combination
Three-dimensional ESWPT FE models	Modal Analysis	ANSYS	N/A(5)	N/A
Three-dimensional ESWPT SSI models	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
Three-dimensional PSFSV FE model(4)	Response Spectra Analysis	ANSYS	SRSS	Lindley-Yow method
Three-dimensional PSFSV SSI model	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A

1. The three-dimensional RCL-R/B-PCCV-containment internal structure SSI model is addressed in Technical Reports MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R).
2. The FE models for the RCL-R/B-PCCV-containment internal structure on their common basemat and the PS/Bs are used only for validation of the seismic models and for static analysis for design of structural members and components as addressed in Section 3.8.
3. The three-dimensional PS/B model is addressed in Technical Reports MUAP-10001 and MUAP-10006 (References 3.7-47R and 3.7-48R).
4. Response spectra analyses are performed to obtain responses under seismic design loads for the UHSRS, PSFSVs, and ESWPT as described further in Appendix 3LL. The SASSI analyses are used to develop ISRS and to confirm the seismic responses obtained from response spectra analyses that are used for the structural design.
5. The modal analyses performed on the ANSYS FE models of the ESWPT are used only for the validation of SASSI models.

NAPS COL 3.7(13)

Table 3.7-201 Free-Field SSE and OBE 5% Damping ARS and OBE Velocity Response Spectra (VRS) at Grade - Horizontal

Frequency [Hz]	ARS for Site-dependent SSE at grade [9]	ARS for Minimum SSE at grade [9]	ARS for Site-dependent OBE at grade [9]	VRS for Site-dependent OBE at grade [in/sec]
0.1	7.467E-03	7.467E-03	2.489E-03	1.531E+00
0.125	1.167E-02	1.167E-02	3.889E-03	1.913E+00
0.15	1.680E-02	1.680E-02	5.599E-03	2.295E+00
0.2	2.987E-02	2.987E-02	9.958E-03	3.062E+00
0.3	5.426E-02	5.426E-02	1.809E-02	3.708E+00
0.4	6.884E-02	6.884E-02	2.295E-02	3.528E+00
0.5	8.279E-02	8.279E-02	2.760E-02	3.394E+00
0.6	9.626E-02	9.626E-02	3.209E-02	3.289E+00
0.7	1.094E-01	1.094E-01	3.645E-02	3.202E+00
0.8	1.221E-01	1.221E-01	4.071 E-02	3.129E+00
0.9	1.346E-01	1.346E-01	4.487E-02	3.066E+00
1	1.469E-01	1.469E-01	4.896E-02	3.011E+00
1.25	1.766E-01	1.766E-01	5.888E-02	2.897E+00
1.5	2.054E-01	2.054E-01	6.846E-02	2.807E+00
2	2.605E-01	2.605E-01	8.685E-02	2.671E+00
2.5	3.605E-01	3.114E-01	1.038E-01	2.553E+00
3	4.658E-01	3.067E-01	1.022E-01	2.095E+00
4	6.708E-01	4.296E-01	1.432E-01	2.202E+00
5	9.255E-01	6.510E-01	2.170E-01	2.669E+00
6	1.207E+00	8.461 E-01	2.820E-01	2.891E+00
7	1.432E+00	1.011E+00	3.369E-01	2.959E+00
8	1.598E+00	1.053E+00	3.510E-01	2.698E+00
9	1.664E+00	1.114E+00	3.715E-01	2.538E+00
10	1.691E+00	1.161 E+00	3.870E-01	2.380E+00
12.5	1.882E+00	1.278E+00	4.259E-01	2.096E+00
15	2.115E+00	1.432E+00	4.773E-01	1.957E+00
20	2.292E+00	1.519E+00	5.065E-01	1.557E+00
25	2.319E+00	1.405E+00	4.684E-01	1.152E+00
30	2.100E+00	1.269E+00	4.232E-01	8.674E-01
35	1.882E+00	1.113E+00	3.711 E-01	6.521E-01

NAPS COL 3.7(13)

Table 3.7-201 Free-Field SSE and OBE 5% Damping ARS and OBE Velocity Response Spectra (VRS) at Grade - Horizontal

Frequency [Hz]	ARS for Site-dependent SSE at grade [9]	ARS for Minimum SSE at grade [9]	ARS for Site-dependent OBE at grade [9]	VRS for Site-dependent OBE at grade [in/sec]
40	1.694E+00	1.027E+00	3.423E-01	5.262E-01
45	1.550E+00	9.554E-01	3.185E-01	4.352E-01
50	1.451E+00	8.991E-01	2.997E-01	3.686E-01
60	1.240E+00	7.697E-01	2.566E-01	2.630E-01
70	1.104E+00	6.939E-01	2.313E-01	2.032E-01
80	1.019E+00	6.518E-01	2.173E-01	1.670E-01
90	9.602E-01	6.291 E-01	2.097E-01	1.433E-01
100	9.209E-01	6.158E-01	2.053E-01	1.262E-01

NAPS COL 3.7(13)

Table 3.7-202 Free-Field SSE and OBE 5% Damping ARS and OBE Velocity Response Spectra (VRS) at Grade - Vertical

Frequency [Hz]	ARS for Site-dependent SSE at grade [9]	ARS for Minimum SSE at grade [9]	ARS for Site-dependent OBE at grade [9]	VRS for Site-dependent OBE at grade [in/sec]
0.1	5.013E-03	5.013E-03	1.671E-03	1.028E+00
0.125	7.834E-03	7.834E-03	2.611E-03	1.285E+00
0.15	1.128E-02	1.128E-02	3.759E-03	1.541E+00
0.2	2.006E-02	2.006E-02	6.686E-03	2.056E+00
0.3	3.663E-02	3.663E-02	1.221 E-02	2.503E+00
0.4	4.688E-02	4.688E-02	1.563E-02	2.403E+00
0.5	5.677E-02	5.677E-02	1.892E-02	2.327E+00
0.6	6.637E-02	6.637E-02	2.212E-02	2.268E+00
0.7	7.576E-02	7.576E-02	2.525E-02	2.218E+00
0.8	8.494E-02	8.494E-02	2.831E-02	2.177E+00
0.9	9.396E-02	9.396E-02	3.132E-02	2.140E+00
1	1.029E-01	1.029E-01	3.428E-02	2.108E+00
1.25	1.245E-01	1.245E-01	4.151E-02	2.042E+00
1.5	1.456E-01	1.456E-01	4.854E-02	1.990E+00
2	1.907E-01	1.863E-01	6.211E-02	1.910E+00
2.5	2.703E-01	2.256E-01	7.521 E-02	1.850E+00
3	3.494E-01	2.638E-01	8.793E-02	1.803E+00
4	5.031E-01	3.222E-01	1.074E-01	1.651 E+00
5	6.941E-01	4.882E-01	1.627E-01	2.002E+00
6	9.050E-01	6.346E-01	2.115E-01	2.168E+00
7	1.074E+00	7.580E-01	2.527E-01	2.220E+00
8	1.198E+00	7.898E-01	2.633E-01	2.024E+00
9	1.248E+00	8.359E-01	2.786E-01	1.904E+00
10	1.268E+00	8.708E-01	2.903E-01	1.785E+00
12.5	1.450E+00	9.849E-01	3.283E-01	1.615E+00
15	1.667E+00	1.129E+00	3.762E-01	1.542E+00
20	1.893E+00	1.254E+00	4.182E-01	1.286E+00
25	2.041E+00	1.237E+00	4.123E-01	1.014E+00
30	1.967E+00	1.189E+00	3.964E-01	8.126E-01
35	1.846E+00	1.092E+00	3.640E-01	6.396E-01

NAPS COL 3.7(13)

Table 3.7-202 Free-Field SSE and OBE 5% Damping ARS and OBE Velocity Response Spectra (VRS) at Grade - Vertical

Frequency [Hz]	ARS for Site-dependent SSE at grade [9]	ARS for Minimum SSE at grade [9]	ARS for Site-dependent OBE at grade [9]	VRS for Site-dependent OBE at grade [in/sec]
40	1.765E+00	1.070E+00	3.567E-01	5.485E-01
45	1.709E+00	1.053E+00	3.511 E-01	4.798E-01
50	1.632E+00	1.011 E+00	3.370E-01	4.145E-01
60	1.410E+00	8.753E-01	2.918E-01	2.991E-01
70	1.244E+00	7.824E-01	2.608E-01	2.291 E-01
80	1.111E+00	7.105E-01	2.368E-01	1.821 E-01
90	9.963E-01	6.527E-01	2.176E-01	1.487E-01
100	9.209E-01	6.158E-01	2.053E-01	1.262E-01

Table 3.7-203 [Deleted]

Figure 3.7.1-3R [Deleted]

Figure 3.7.1-4R [Deleted]

Figure 3.7.1-5R [Deleted]

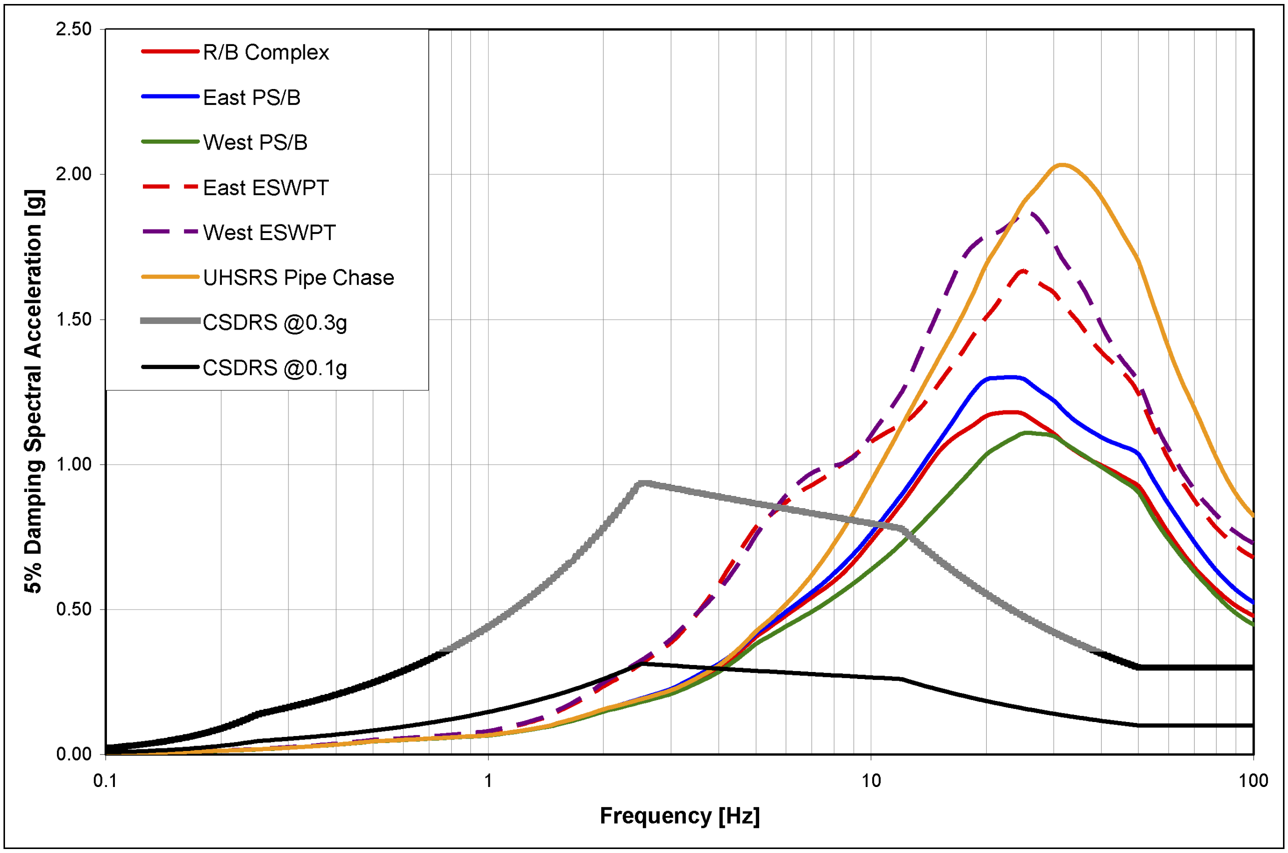
Figure 3.7.1-6R [Deleted]

Figure 3.7.1-7R [Deleted]

Figure 3.7.1-8R [Deleted]

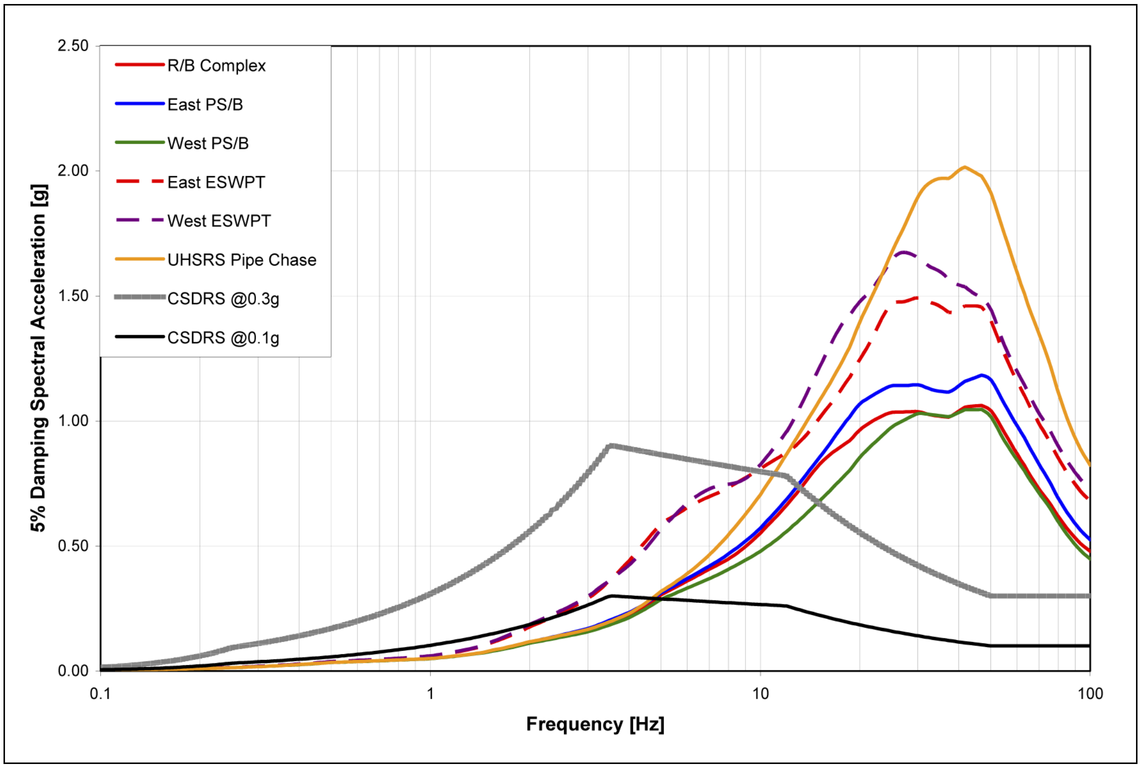
NAPS COL 3.7(2)
NAPS COL 3.7(5)
NAPS DEP 3.7(1)

Figure 3.7-201 Full Column Outcrop FIRS at Bottom of Basemat - Horizontal



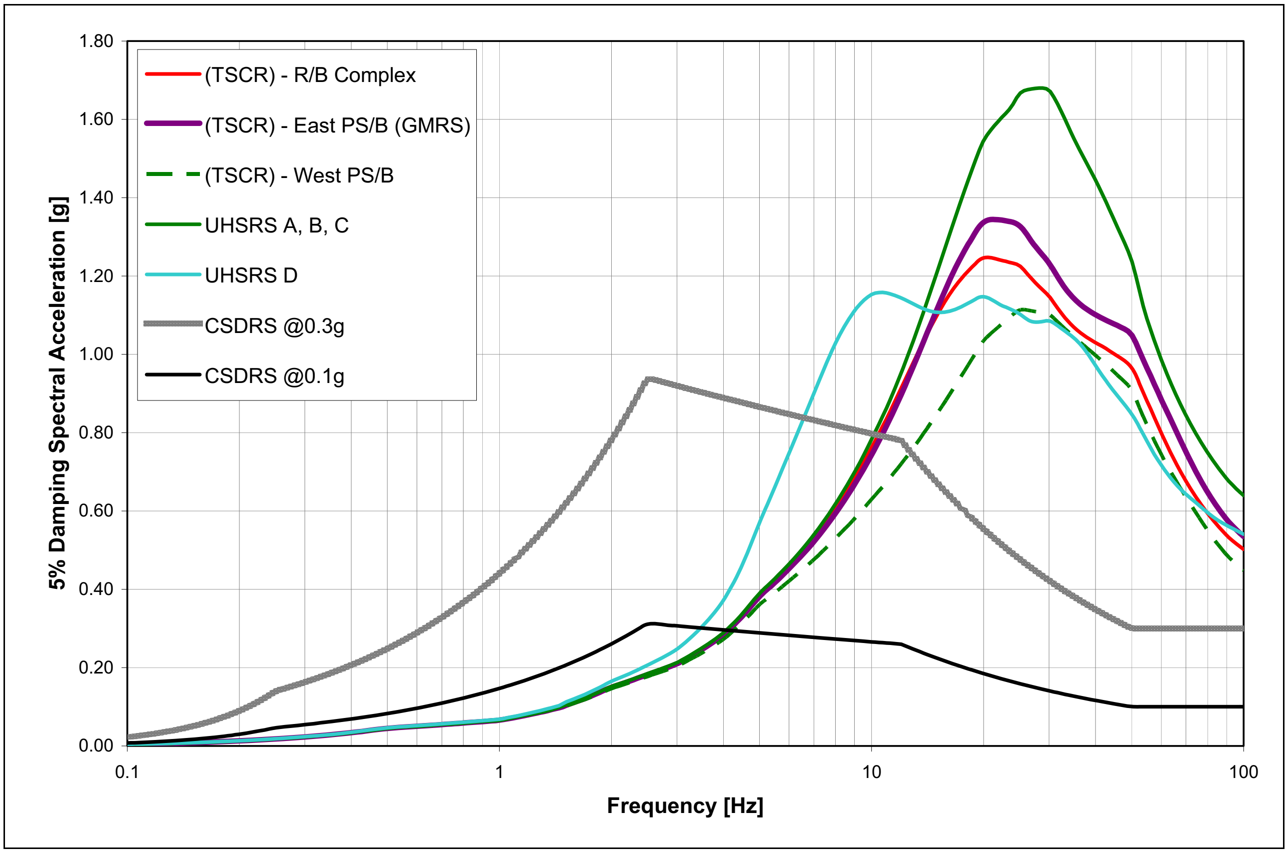
NAPS COL 3.7(2)
NAPS COL 3.7(5)
NAPS DEP 3.7(1)

Figure 3.7-202 Full Column Outcrop FIRS at Bottom of Basemat - Vertical



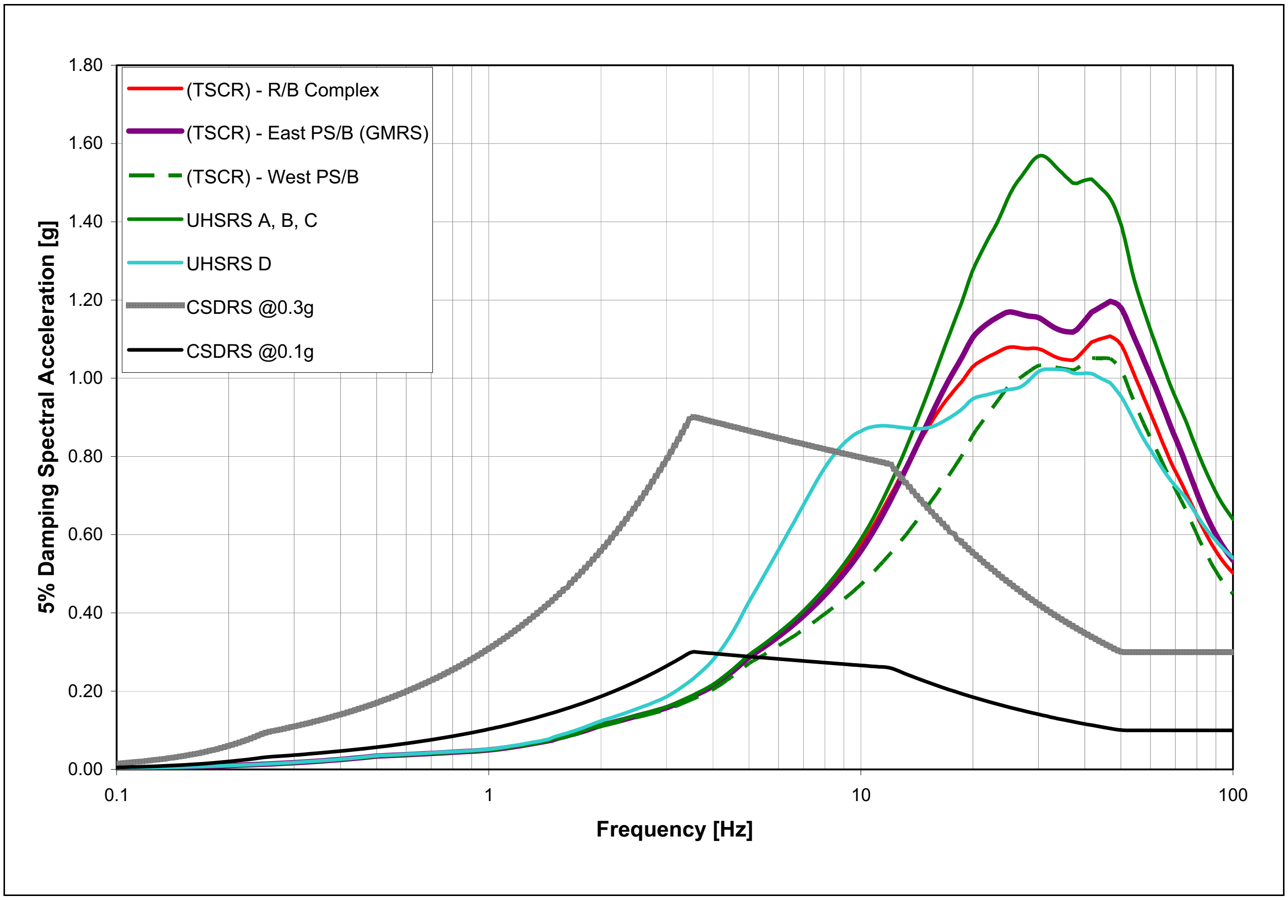
NAPS COL 3.7(2)
NAPS COL 3.7(5)
NAPS DEP 3.7(1)

Figure 3.7-203 GMRS and Geologic Outcrop FIRS at Bottom of Basemat - Horizontal

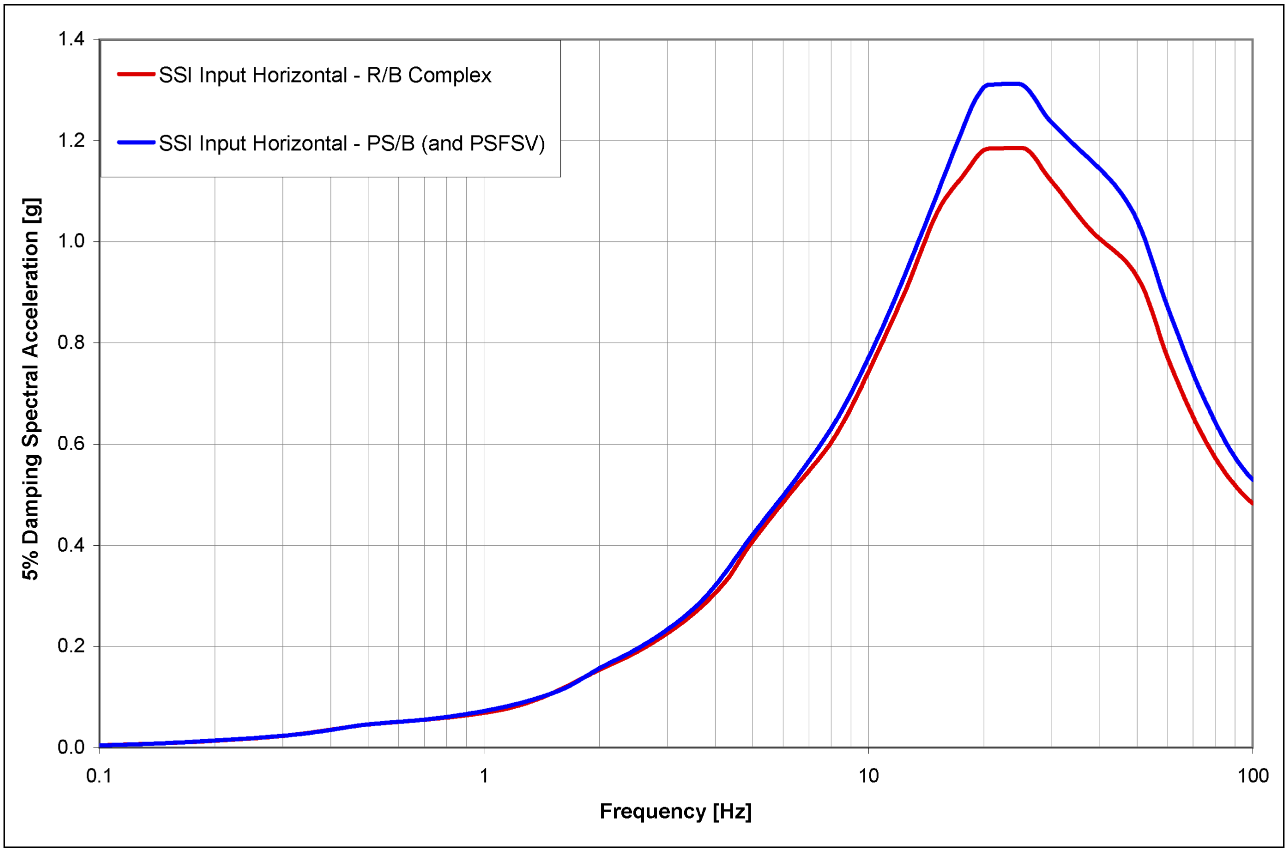


NAPS COL 3.7(2)
NAPS COL 3.7(5)
NAPS DEP 3.7(1)

Figure 3.7-204 GMRS and Geologic Outcrop FIRS at Bottom of Basemat - Vertical

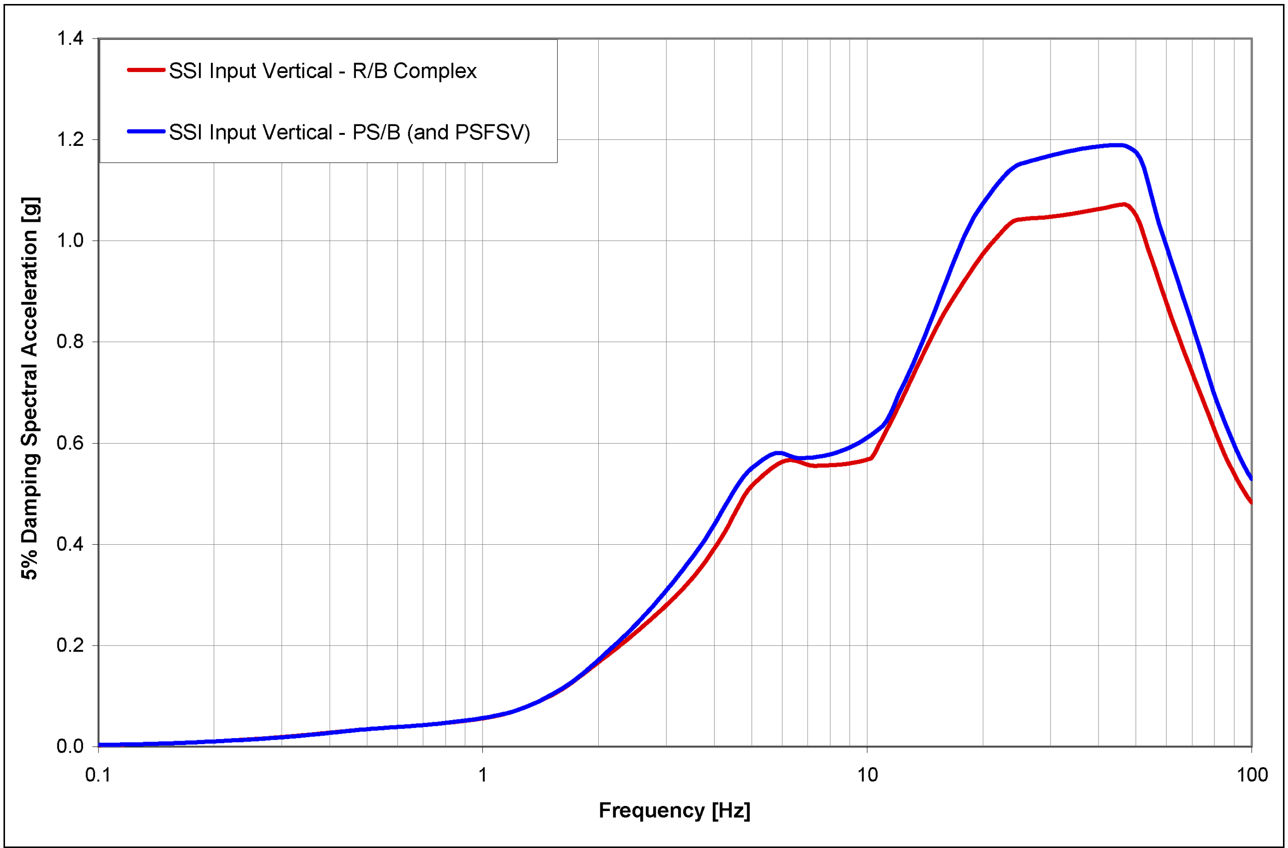


NAPS COL 3.7(2) **Figure 3.7-205 Full Column Outcrop SSI Input Motions for R/B Complex, PS/B and PSFSV - Horizontal**



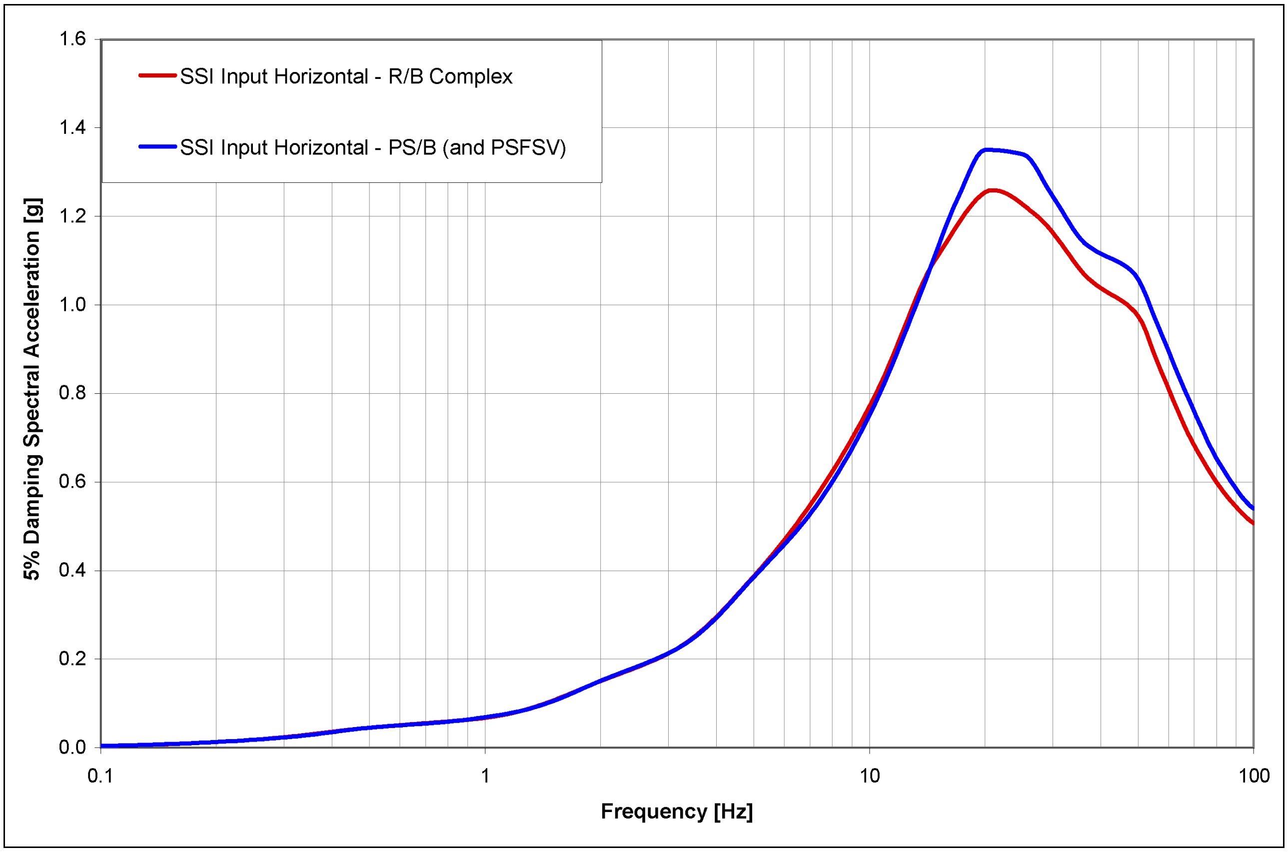
NAPS COL 3.7(2)

Figure 3.7-206 Full Column Outcrop SSI Input Motions for R/B Complex, PS/B and PSFSV - Vertical



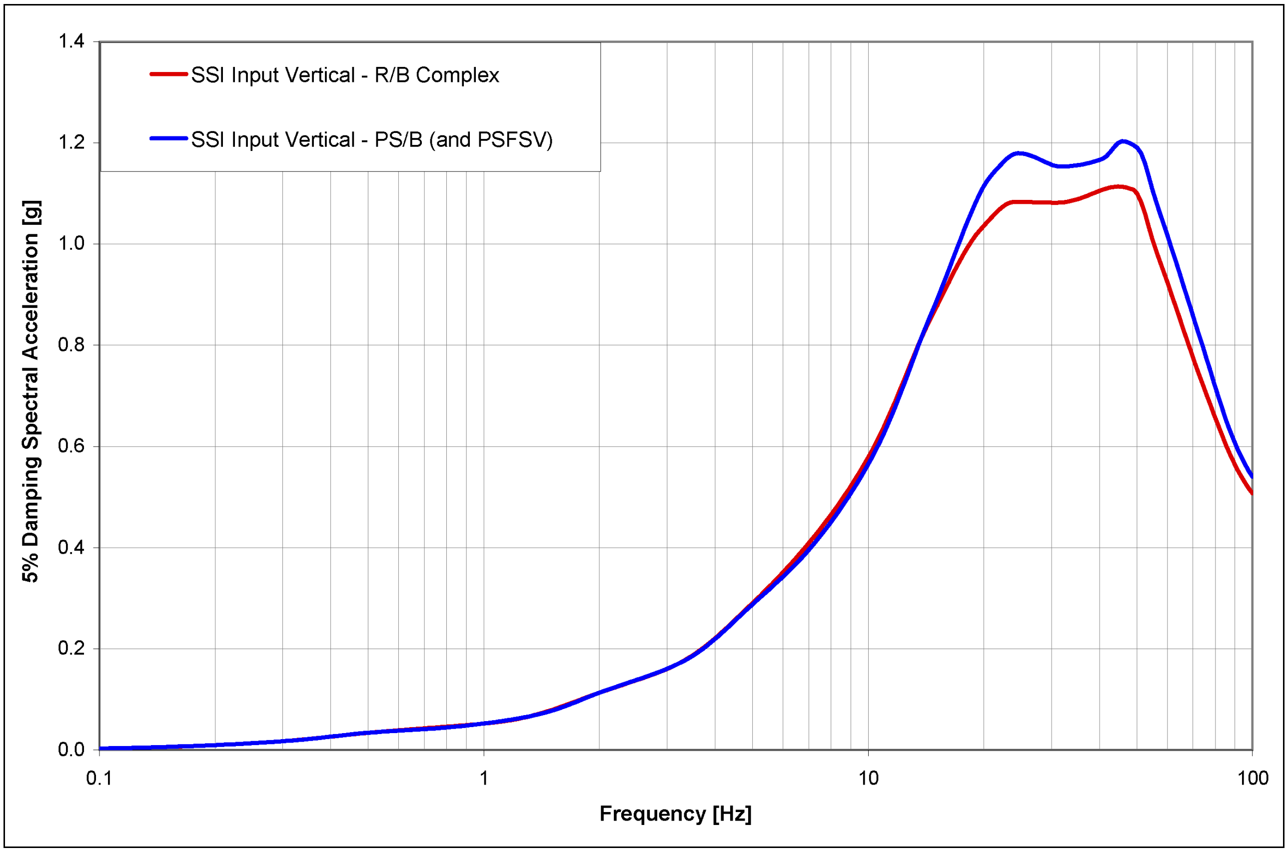
NAPS COL 3.7(2)

Figure 3.7-207 Geologic Outcrop SSI Input Motions for R/B Complex, PS/B (and PSFSV) - Horizontal

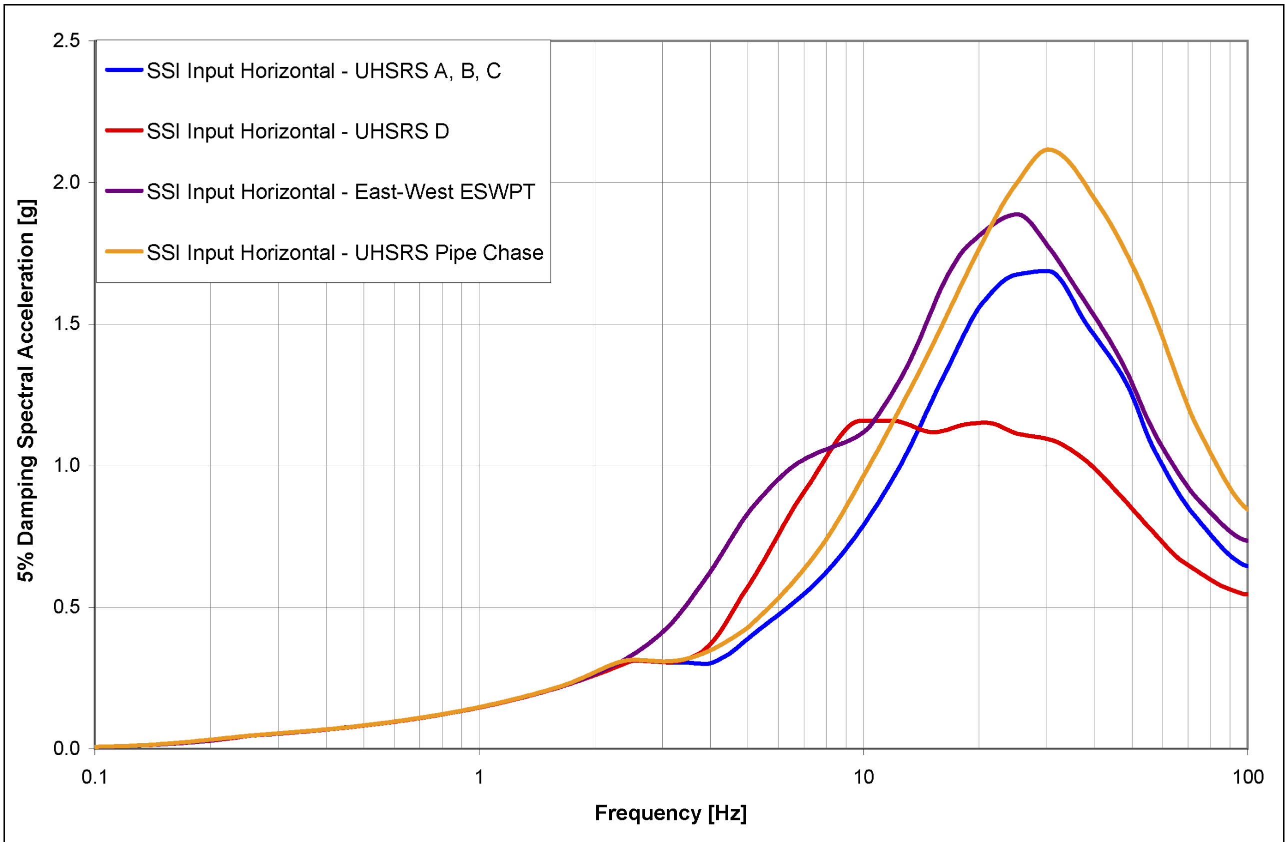


NAPS COL 3.7(2)

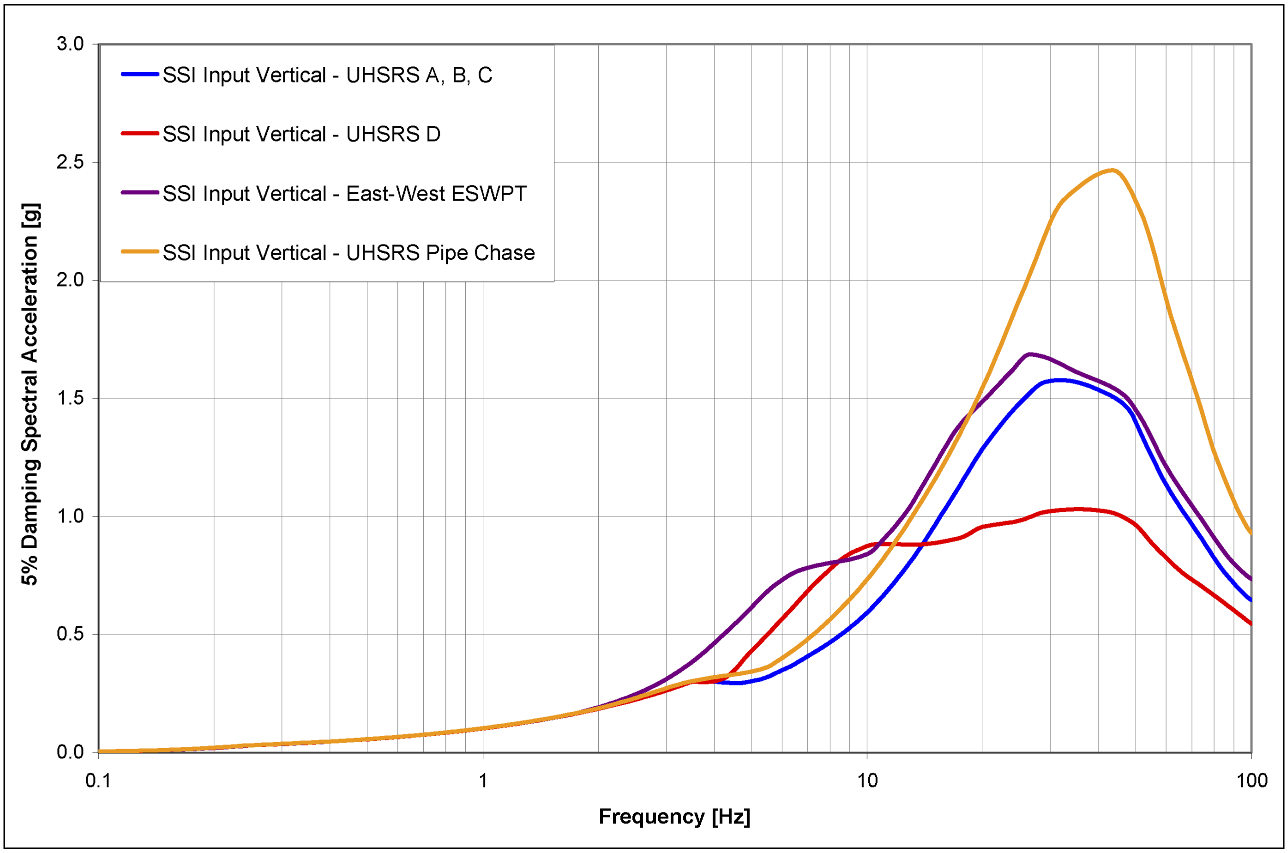
Figure 3.7-208 Geologic Outcrop SSI Input Motions for R/B Complex, PS/B (and PSFSV) - Vertical



NAPS SUP 3.7(2) **Figure 3.7-209 SSI Input Motions for UHSRS and ESWPT - Horizontal**

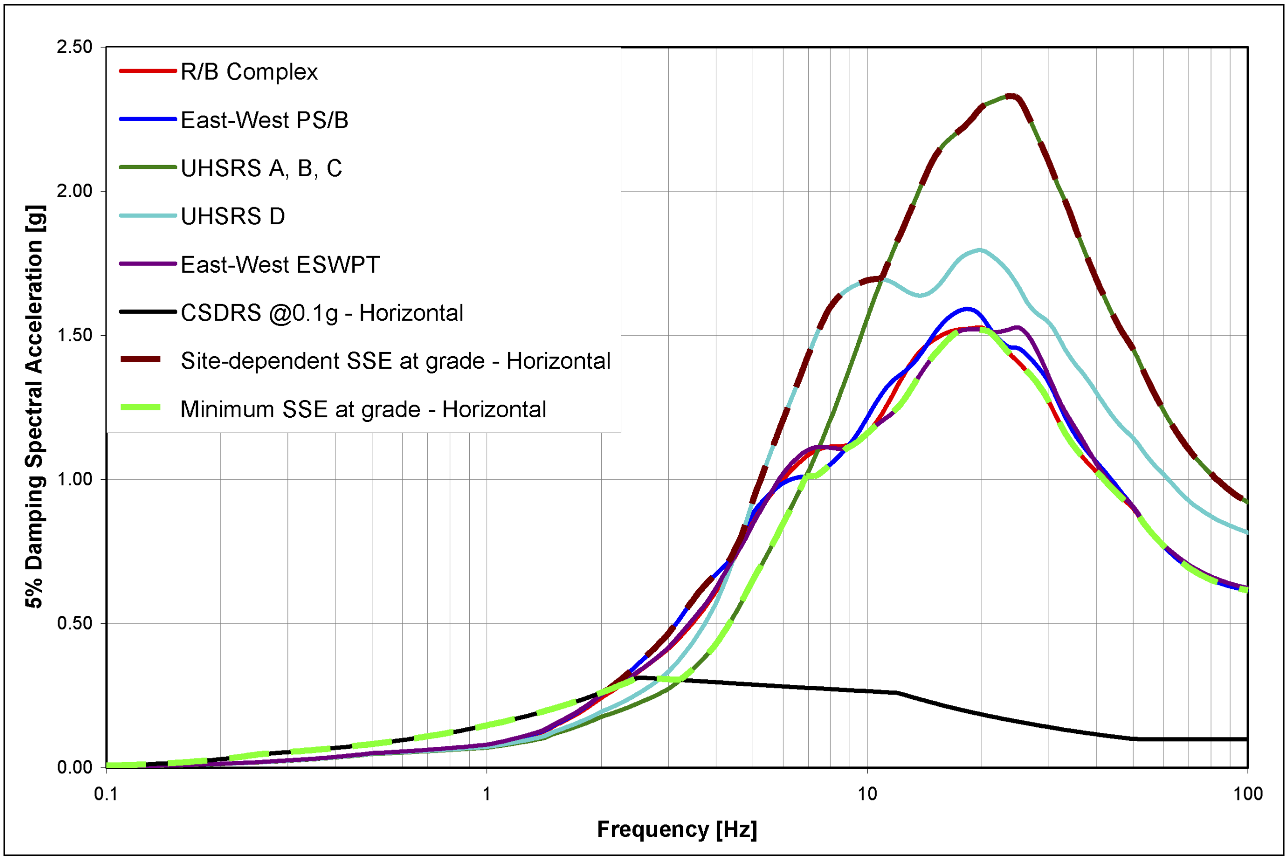


NAPS SUP 3.7(2) **Figure 3.7-210 SSI Input Motions for UHSRS and ESWPT - Vertical**



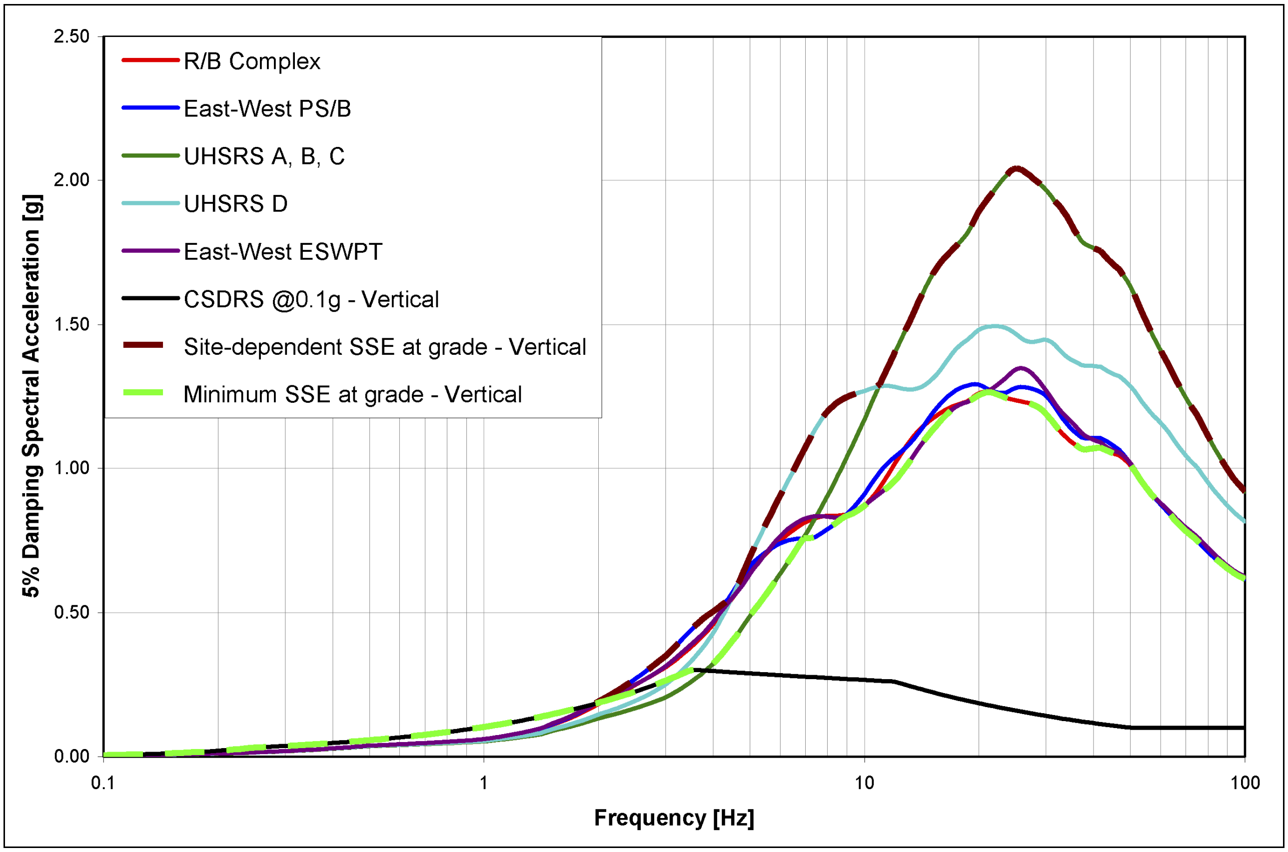
NAPS COL 3.7(13)
NAPS SUP 3.7(2)

Figure 3.7-211 Design Ground Motions at Grade - Horizontal



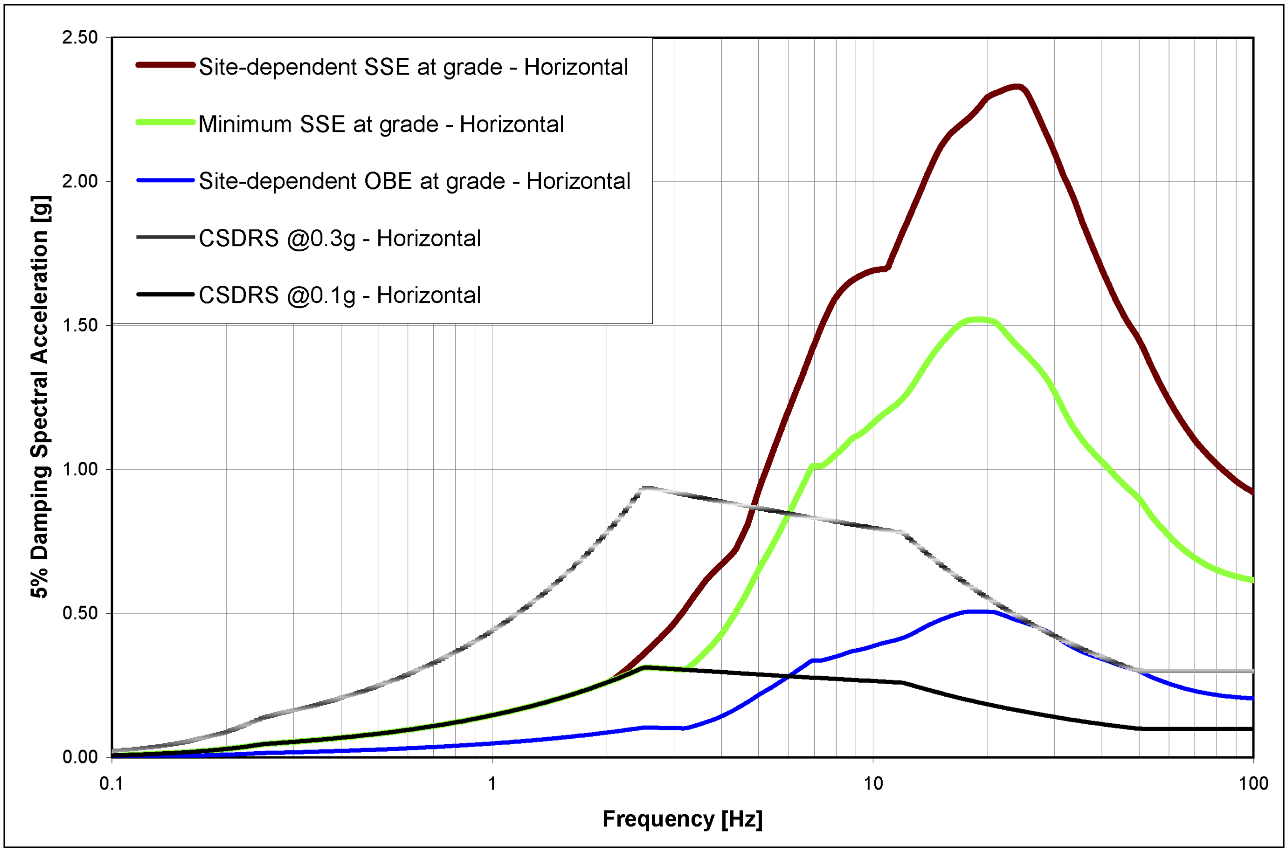
NAPS COL 3.7(13)
NAPS SUP 3.7(2)

Figure 3.7-212 Design Ground Motions at Grade - Vertical



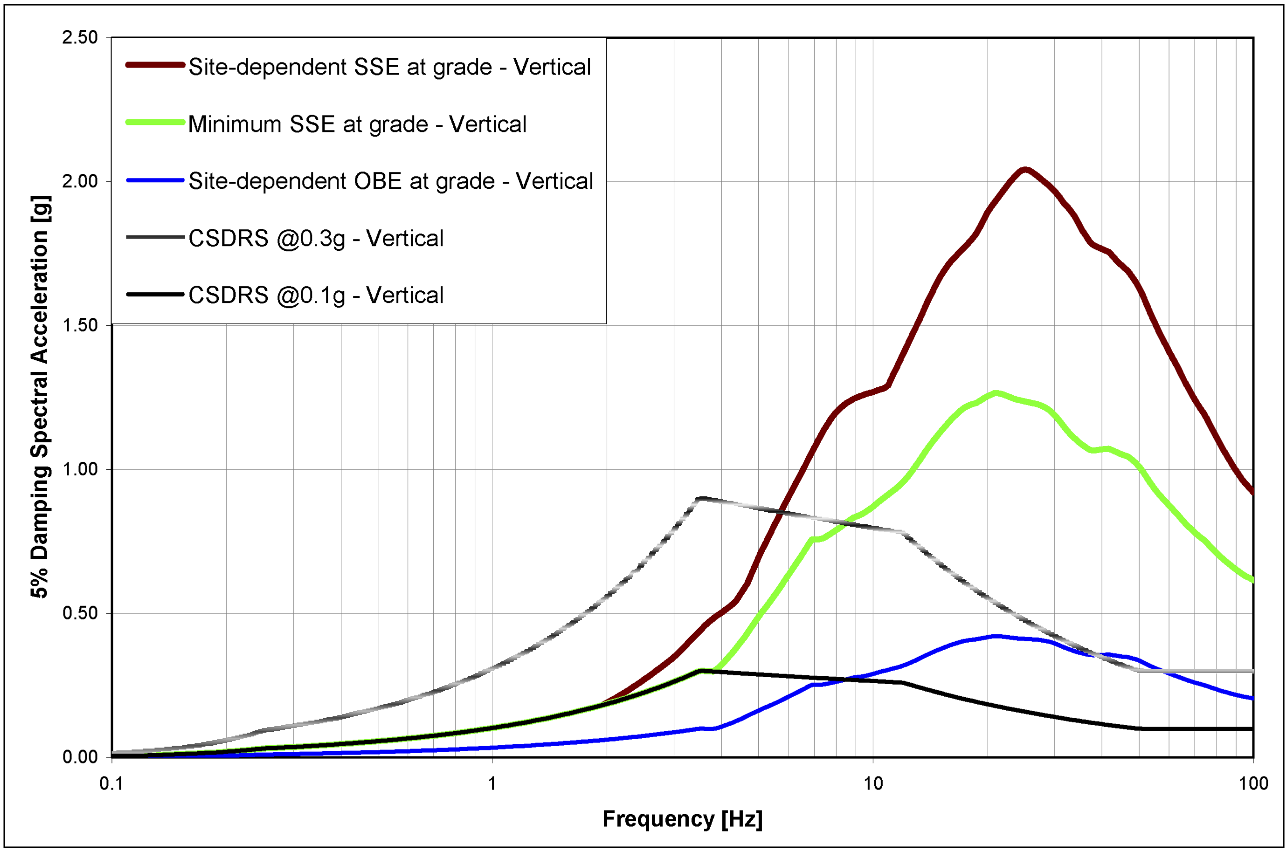
NAPS COL 3.7(2)
NAPS COL 3.7(13)

Figure 3.7-213 SSE and OBE at Grade - Horizontal

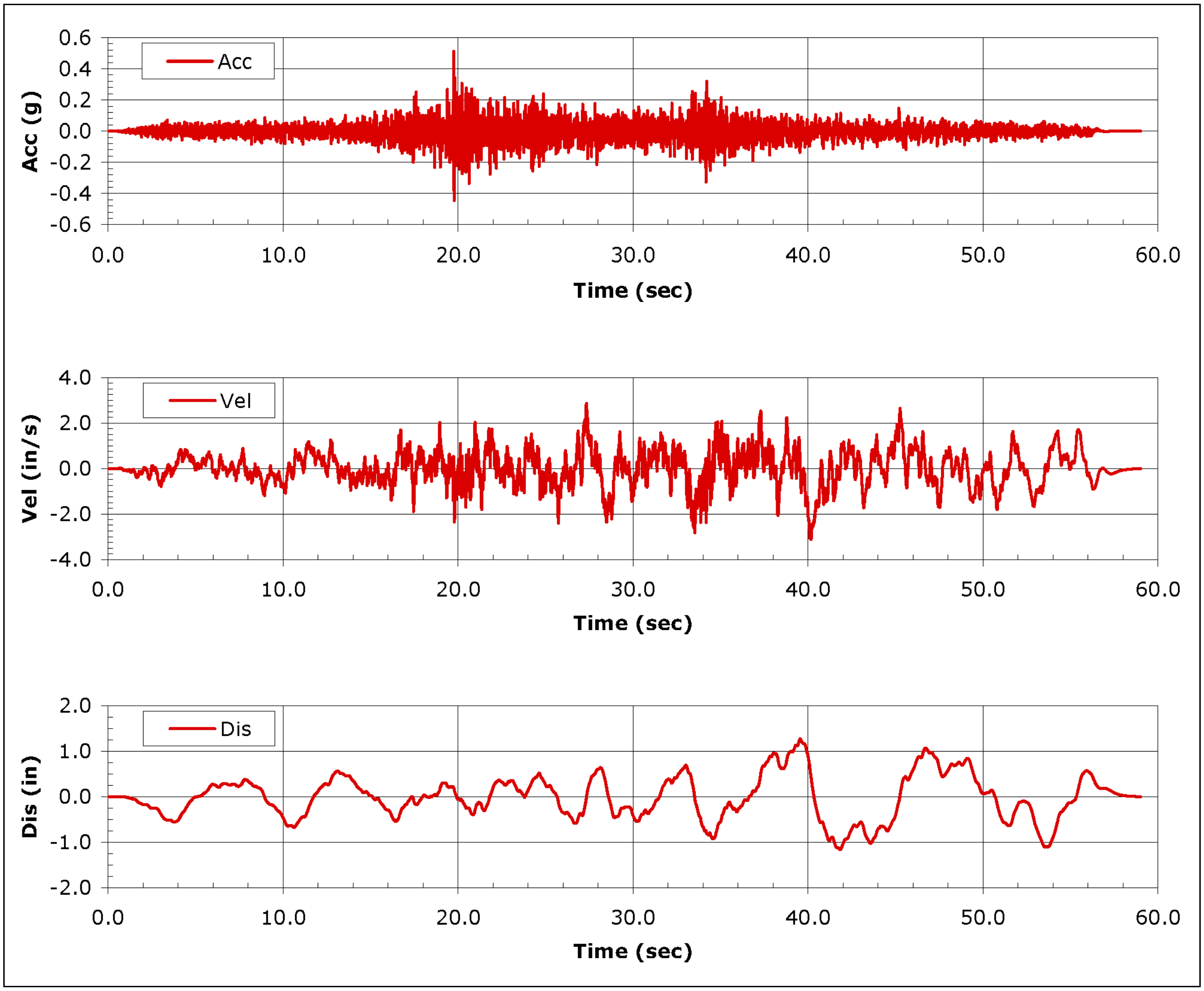


NAPS COL 3.7(2)
NAPS COL 3.7(13)

Figure 3.7-214 SSE and OBE at Grade - Vertical

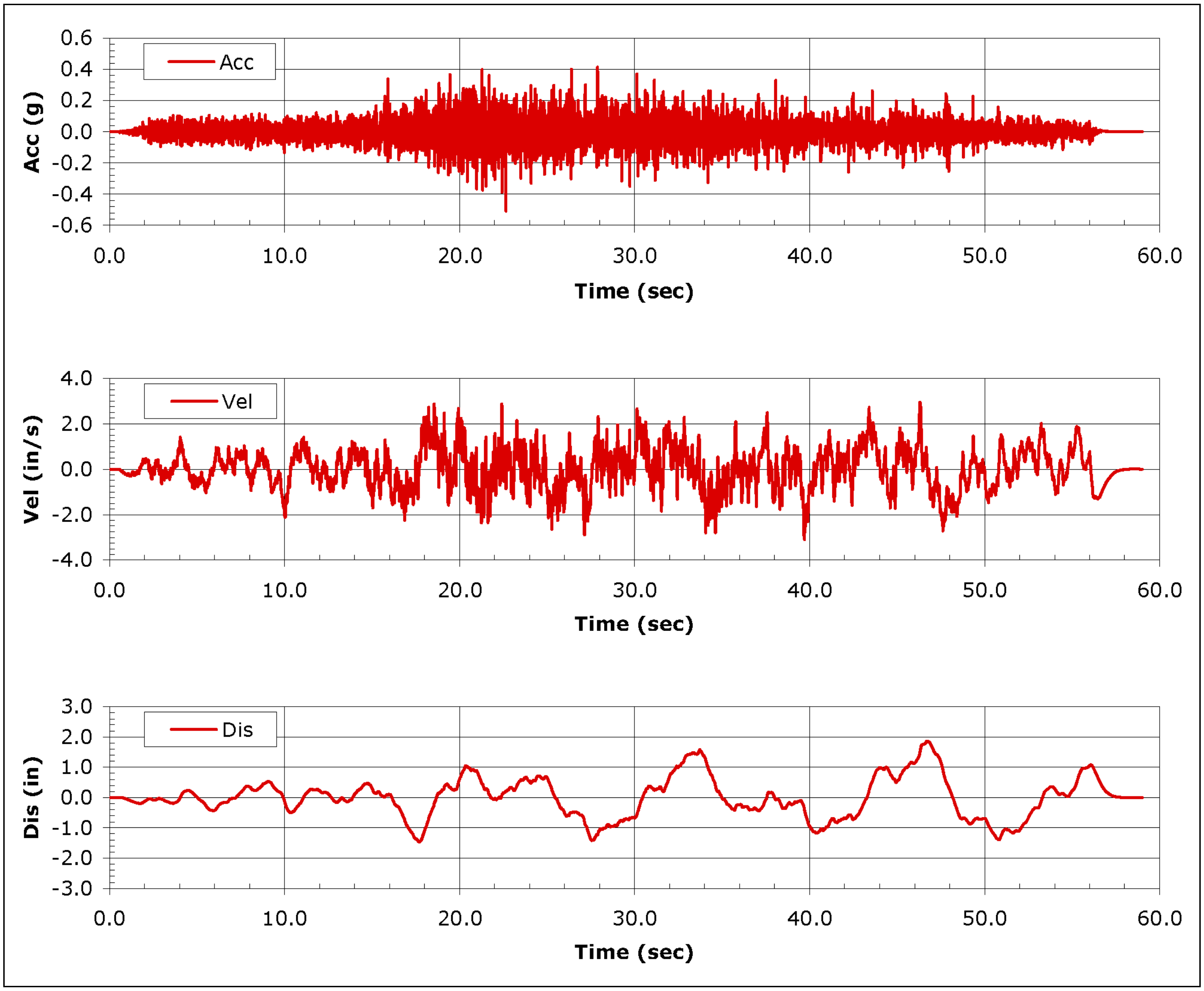


NAPS COL 3.7(30) **Figure 3.7-215 Site-Specific Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex Analyzed with Surface Foundation - H1 direction**

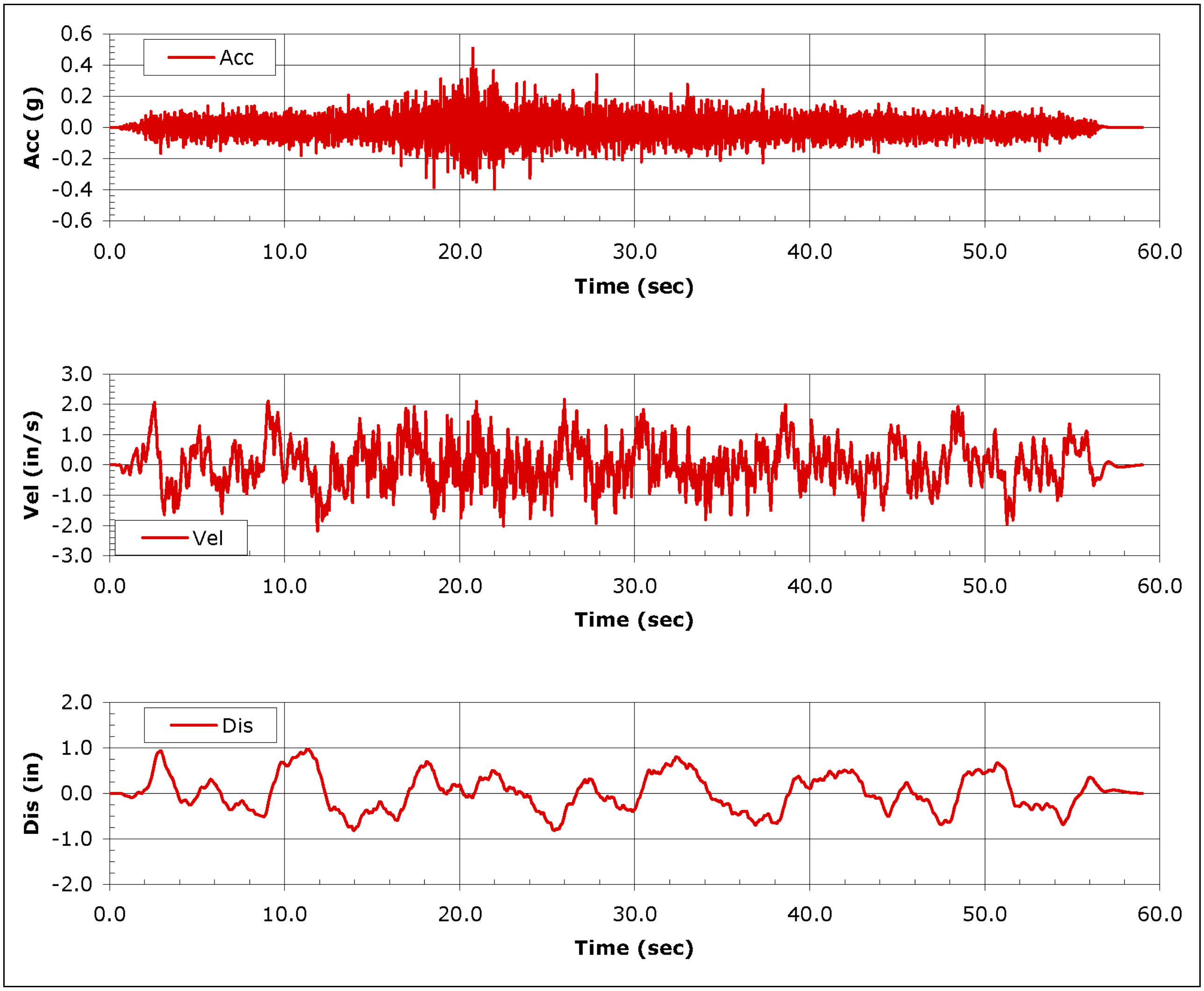


NAPS COL 3.7(30)

Figure 3.7-216 Site-Specific Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex Analyzed with Surface Foundation - H2 direction

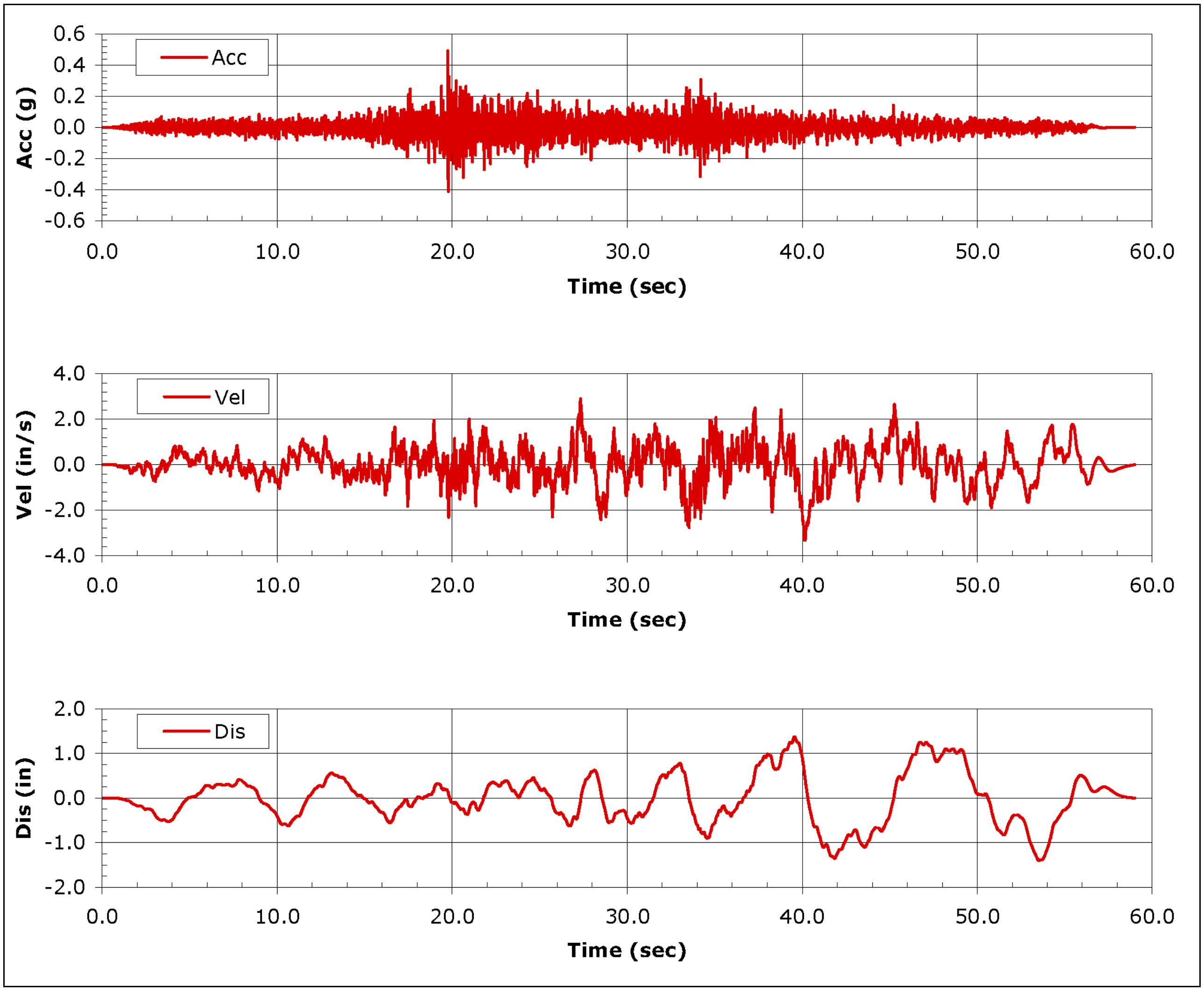


NAPS COL 3.7(30) **Figure 3.7-217 Site-Specific Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex Analyzed with Surface Foundation - UP direction**



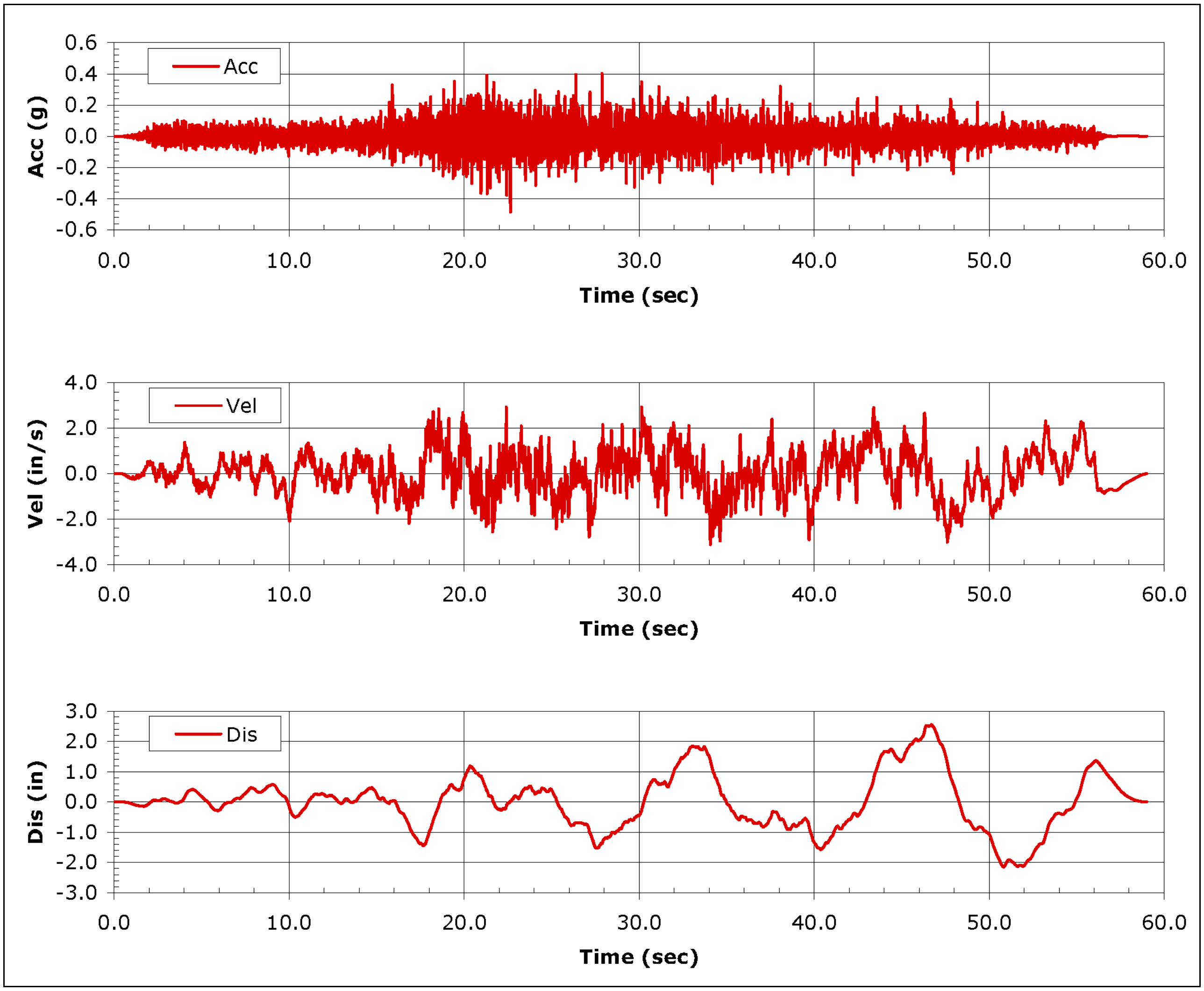
NAPS COL 3.7(30)

Figure 3.7-218 Site-Specific Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex Analyzed with Embedded Foundation - H1 direction

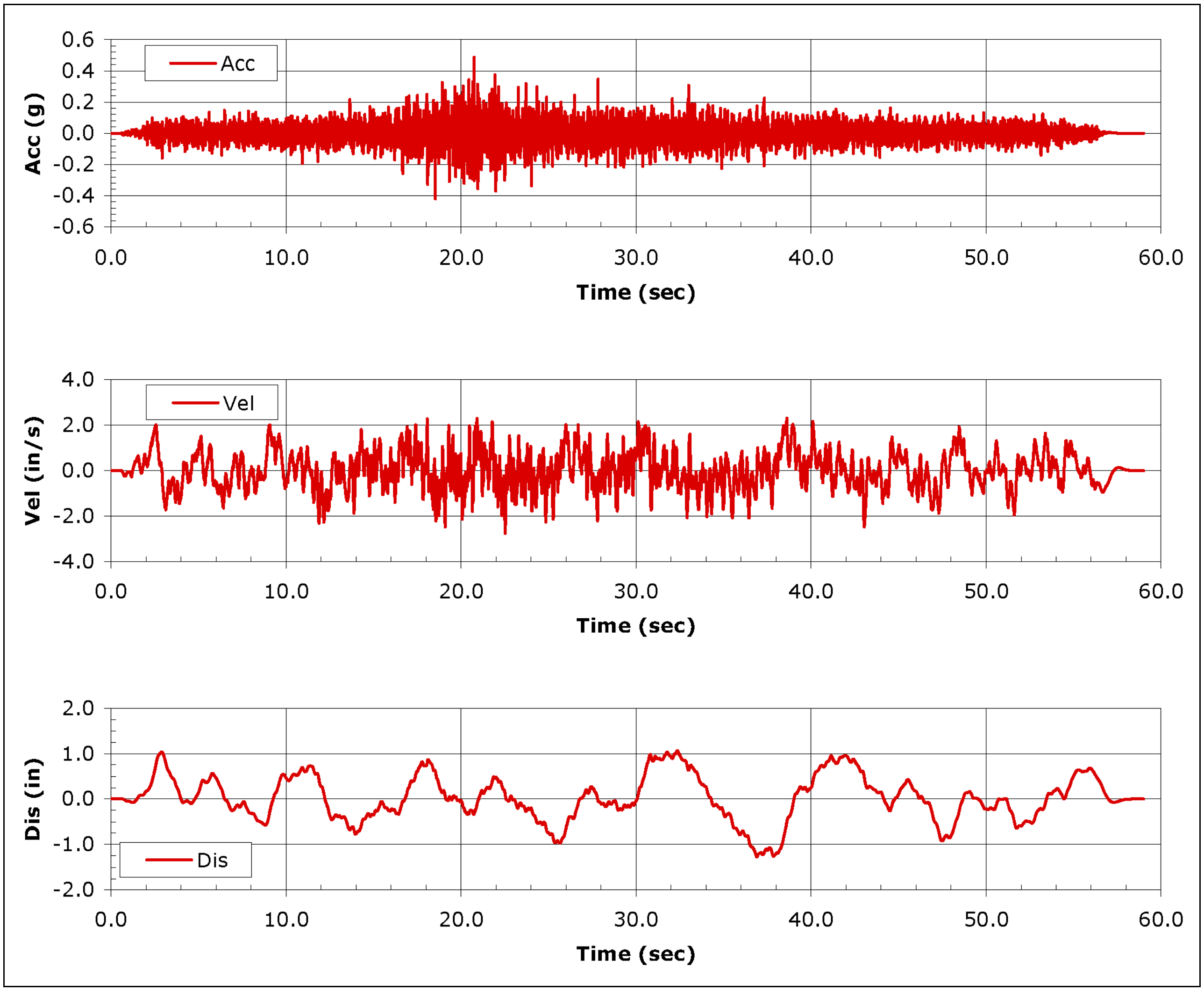


NAPS COL 3.7(30)

Figure 3.7-219 Site-Specific Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex Analyzed with Embedded Foundation - H2 direction



NAPS COL 3.7(30) **Figure 3.7-220 Site-Specific Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex Analyzed with Embedded Foundation - UP direction**



3.8 Design of Category I Structures

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.8.1.6 Material, Quality Control, and Special Construction Techniques

STD COL 3.8(3)

Replace the second sentence of the first paragraph in DCD Subsection 3.8.1.6 with the following.

Any material changes to the site-specific materials for construction of the PCCV will meet the requirements specified in ASME Code, Section III (Reference 3.8-2), Article CC-2000, and supplementary requirements of RG 1.136 (Reference 3.8-3), as well as SRP 3.8.1 (Reference 3.8-7).

STD COL 3.8(7)

Replace the first sentence of the thirteenth paragraph in DCD Subsection 3.8.1.6 with the following.

Site-specific ground water/soil at the site is not aggressive, as discussed in Subsection 2.5.4. As part of inservice inspection programs discussed in Subsection 3.8.4.7, exposed portions of below-grade concrete of seismic category I structures, including the PCCV, will be examined for signs of degradation when below-grade concrete walls and basemats are excavated for any reason, and periodic site monitoring of ground water chemistry will be performed to confirm that the ground water/soil remains nonaggressive.

STD COL 3.8(10)

Replace the second and third sentences of the twenty-third paragraph in DCD Subsection 3.8.1.6 with the following.

The prestressing system is designed as a strand system.

3.8.1.7 Testing and Inservice Inspection Requirements

Replace the third paragraph in DCD Subsection 3.8.1.7 with the following.

STD COL 3.8(14)

A PSI program for the PCCV will be completed prior to initial plant startup. The PSI requirements will conform to the provisions of ASME Section XI Division 1 Articles IWA-2000, IWE-2000, and IWL-2000, and the PSI establishes the baseline for the subsequent ISI activities. ISI are performed during the initial and subsequent 10 year intervals as identified in Subsections IWE and IWL Article 2400. The PCCV PSI and ISI programs include preservice examination, testing and ISI requirements, and also address personnel qualification requirements and responsibilities. The PCCV ISI program also provides detailed inspection plans and surveillance schedules consistent with those of the integrated leak rate test (ILRT) program, which is discussed further below and in Section 6.2.6. ASME Code Section XI requirements incorporated by reference in 10 CFR 50.55a on the date 12 months prior to issuance of the operating license, and optional ASME code cases endorsed by the NRC via RG 1.147, establish the requirements for the ISI program. ISI conducted during successive inspection intervals complies with the requirements incorporated by reference (in 10 CFR 50.55a) 12 months before the start of the 120-month inspection interval, subject to the modifications and limitations listed in paragraph (b) of that section, or the optional ASME Code cases endorsed by the NRC via RG 1.147.

The PCCV ISI program surveillance requirements for periodic surveillance and inspection of the overall structure, as well as the liner and prestressing tendon systems, are in accordance with ASME Code Section XI (Reference 3.8-4) Subsections IWA, IWE, and IWL. Further, inservice inspection requirements for the tendons also follow the applicable guidelines of RG 1.35 (Reference 3.8-5) and 1.35.1 (Reference 3.8-6). The ISI of the PCCV includes the pertinent items in all examination categories identified in Tables IWE-2500-1 and IWL-2500-1 of ASME Section XI (Reference 3.8-4), summarized as follows:

- PCCV pressure retaining boundary, including all accessible interior and exterior surfaces of the liner, penetration liners, and class MC components, parts, and appurtenances.
- Containment structural and pressure retaining boundary welds and pressure-retaining bolted connections.
- Integral structural attachments and welds connecting the attachments to the liner.
- Wetted surfaces of submerged areas such as the refueling water storage pit (RWSP).
- Moisture barriers (where applicable).
- Areas at tendon end anchors, wherever accessible, to inspect for concrete cracking, corrosion protection material leakage, and/or tendon cap deformation.
- Examination of, sampling, and testing corrosion protection material.

- Examination of wires or strand and anchorage hardware for cracks, wear, and corrosion.
- Determination of tendon forces by measuring lift-off forces.
- Detensioning tendons and the removal of a wire or strand for inspection for corrosion and testing to measure strength and elongation.
- Establish acceptability and compare measured lift-off values with predictions and minimum requirements.
- General visual inspection of all accessible concrete surface areas to assess the general structural condition of the containment.

3.8.4 Other Seismic Category I Structures

NAPS COL 3.8(15)

Replace the fourth paragraph in DCD Subsection 3.8.4 with the following.

The ESWPT, UHSRS, and PSFSVs are site-specific Seismic Category I structures and are designed to the site-specific SSE. These structures are discussed in detail in Section 3.8.4.1.3. There are no site-specific Seismic Category II structures.

3.8.4.1.3 ESWPT, UHSRS, PSFSVs, and Other Site-Specific Structures

NAPS COL 3.8(19)

Replace the second paragraph in DCD Subsection 3.8.4.1.3 with the following.

The ESWPT, UHSRS, and PSFSVs are designed using SSI Input motion associated with the site-specific SSE, and are described in detail in Sections 3.8.4.1.3.1, 3.8.4.1.3.2, and 3.8.4.1.3.3, respectively. Figure 3.8-201 provides the general arrangement of ESWPT, UHSRS, and PSFSVs. Each of these structures is separated from other structures with expansion/isolation joints as shown in various views in Figures 3.8-201 through Figure 3.8-214. The performance specifications for the elastomeric joint or seal materials address requirements for critical characteristics such as bounding the allowable stress-strain properties, durability requirements, and associated material testing.

In lieu of expansion joints, the interfaces below grade may be left empty and waterproof joint sealant provided along the perimeter at grade. The sealant will be inspected periodically to maintain integrity.

3.8.4.1.3.1 **ESWPT**

The ESWPT is an underground reinforced concrete structure. Figure 3.8-203 shows the typical section of the ESWPT. The tunnel layout forms a “U” configuration, connecting at the east and west ends of UHS Basins, then runs plant south to the PSFSVs and continues plant east – west between the two PSFSVs underneath the north end of the T/B. The outside dimensions of the tunnel are shown in Figure 3.8-203. The tunnel is divided into two sections by an interior concrete wall to provide separation of piping trains. Each section contains both ESWS supply and return lines. End walls are also provided where required to maintain train separation. The top of the tunnel is approximately 12.25 ft below grade. Access to the tunnel is provided by reinforced concrete manholes.

For cross-sections of the ESWPT, see Figures 3.8-203 through 3.8-205.

The modeling and analysis of the ESWPT is described in Appendix 3LL.

The ESWPT is divided into two segments separated by expansion joints. A key plan showing the locations of the two segments is included in Figure 3.8-201. The segments are defined as follows:

- Tunnel Segment 1, as shown in Section D in Figure 3.8-203, is representative of the typical fully embedded tunnel segments to the plant east and plant west of the R/B. This segment is further subdivided into Segment 1a which includes straight portions of the tunnel, and Segment 1b, which includes the diagonal portions shown in Figure 3.8-201.
- Tunnel Segment 2, as shown in Section F in Figure 3.8-205 represents the portion of the ESWPT passing underneath the north end of the T/B.

Each segment has a somewhat different geometry and is designed separately. Segment 1 has a roof slab and mat slab thicknesses of 2'-0". Segment 2 has a roof slab thickness of 2'-0" and mat slab thickness of 9'-11".

All segments are designed for the same basic load conditions, but due to differing geometry and embedment conditions, the values of some of the loads (seismic, soil pressure, live loads, etc.) vary. The resulting moments and shears also vary. Segment 2 requires a thicker mat slab to resist additional loading from the supported portions of the T/B foundation. Segment 1 and Segment 2 are designed with reinforcement dowels and a shear key to prevent overturning and sliding, respectively. The dowels for Segment 1 extend down into fill concrete and the dowels for Segment 2 extend down into the bedrock. For Segment 1, the dowels and shear key are only present at the portion of the tunnel adjacent to the east PS/B.

Some portions of the reinforced concrete enclosure, which protects the ESW piping, are integrally attached to the structures they pass by or under. Each portion of the reinforced concrete enclosure passing by the PSFSVs is designed as part of the PSFSV structure and is integrally attached to it as shown in Figure 3.8-213. The reinforced concrete chase which protects the ESW piping as it passes by the UHSRS is designed as part of its respective UHS basin and is integrally attached to it as shown in Section F in Figure 3.8-202. The designs for those enclosures/chases integrally attached to structures are addressed as part of the design of that structure.

The interior surfaces of walls, mats, and slabs of the ESWPT, including pipe chases/enclosures which protect and support ESW piping, line up evenly. Interior dimensions of the structures are maintained, except the interface between the UHSRS pipe chase and the pipe chase that is constructed monolithically with the UHS basin south exterior wall where only the interior wall and roof slab surfaces line up. Any other differences in wall or slab thickness affect only the alignment of the outer surface of the structures.

3.8.4.1.3.2 **UHSRS**

The UHSRS consist of UHS basins including pipe chase, UHS ESW pump houses, and cooling tower enclosures. The UHSRS also include a UHSRS pipe chase between UHS B and C as shown in Figure 3.8-201. All UHSRS are reinforced concrete structures, described below.

UHS Basin - There are four basins and each reinforced concrete basin has one cooling tower with two cells. Each basin rests on a separate foundation, is square in shape, constructed of reinforced concrete, and separated from the adjacent basin by a minimum 4 inch expansion joint. A site-specific specification for the expansion/separation joint that provides material or system performance requirements will be prepared. Performance requirements for a elastomeric material include requirements bounding the allowable stress-strain properties, durability requirements, and specification for a material testing program. See Section 3.8.4.1.3 for alternate to expansion joints. Each basin serves as a reservoir for the ESWS. There is a cementitious membrane adhered to the interior faces of the reinforced concrete basin walls and foundation slab, including the UHS sump pit, which minimizes long-term seepage of water from the basin. See also Section 3.4.1.2 for description of waterproofing. An UHS ESW pump house is located at the plant south-west corner of each basin. Adjacent to the pump house on the east side of the basin are cooling tower enclosures supported by UHS basin walls. A reinforced concrete pipe chase protects and supports the ESW piping as it runs plant east-west along the plant south exterior wall of each UHS basin. The pipe chase is constructed monolithically with the UHS basin south exterior wall, as shown in Figures 3.8-202, 3.8-209, and 3.8-210.

See Figure 3.8-206 for general arrangement, layout, and dimensions of an UHS Basin. Each basin is divided into two parts, as shown on Figure 3.8-206. The larger section of the basin shares the pump house and one cooling tower cell enclosure. The other cooling tower cell enclosure is in the smaller segment of the basin. A reinforced concrete wall, running plant east-west, separates the cooling tower enclosure basin area from rest of the basin. This wall is provided with underwater slots to maintain the continuity of the reservoir.

UHS ESW pump house - The pump house is an integral part of the UHS basin supported by UHS basin exterior and interior walls. Each pump house contains one ESW pump and one UHS transfer pump with associated auxiliaries. The pump bay (lowest portion of the pump house required for the pump suction) is deeper than the rest of the UHS basin. A reinforced concrete wall, running plant east-west, divides the pump house basin from rest of the UHS basin. This wall is provided with slots for flow of water. Two baffle walls (running plant east-west) are provided inside the pump house basin, before the pump bay. These baffle walls are provided with slots to maintain the flow of water and are staggered to prevent trajectory of postulated direct or deflected design basis tornado missiles.

The operating floor of the pump house is a reinforced concrete slab spanning plant east-west and supported by UHS basin exterior and interior walls. The operating floor supports the ESWS pump, UHS transfer pump, and motors. The roof of the pump house is a reinforced concrete slab spanning plant north-south and supported by reinforced concrete beams. To allow access to the ESWS pump/motor, a removable reinforced concrete cover is provided in an opening in the roof of the pump house.

Tornado missile shields are provided to protect the air intake and air outlets of the UHS ESW pump house ventilation system from tornado missiles. The structural design considers tornado differential pressure loads as discussed in Section 3.3.2.2.2.

UHS cooling tower enclosures - Each UHS basin has one cooling tower with two cells. Each cell is enclosed by reinforced concrete structures that house the equipment required to cool the water for ESWS. The reinforced concrete wall running plant north-south separates the two cell enclosures. The enclosures are an integral part of the UHS basin supported by the basin interior and exterior walls on the basemat foundation. A reinforced concrete wall, running plant east-west, separates the cell enclosure portion of the basin from the rest of the UHS basin. An east-west wall is provided with openings at the basemat to maintain the continuity of the UHS basin. Air intakes are located at the plant north and plant south face of the cooling tower enclosure. The missile shields at the air intakes are configured to protect the safety-related substructures and components housed within the UHS structure from tornado missiles. Table 3.2-201 lists the site-specific equipment and components located in the UHSRS that are protected from tornado missiles. The north side air intake is an integral part of the cooling tower enclosure and the south side air intake is an integral part of a pipe chase that is constructed monolithically with the UHS south wall.

Each cooling tower cell enclosure is equipped with a fan and associated equipment to cool the water. Equipment includes header pipe, spray nozzles, and drift eliminators with associated reinforced concrete beams supported by the exterior walls of the enclosure. The fan and motor are supported by reinforced concrete deck above the drift eliminators. A circular opening is provided in the deck for the fan, and the deck is supported by enclosure walls and a deep upside circular concrete beam around the fan opening. The fan is supported by a north-south concrete beam at the center of enclosure. For air circulation and to protect the fan and motor from tornado missiles, a circular opening is provided at the roof of the enclosure (centered on the fan) with a reinforced concrete slab and heavy steel grating between the roof and the deck. The fans, motors and associated equipment are designed with consideration given to the effects of design basis tornado differential pressure.

UHSRS pipe chase - The UHSRS pipe chase running plant east-west between UHS B and C is partially embedded and is part of the UHSRS. This pipe chase has a roof and mat slab thickness of 2'-0" as shown in Figure 3.8-202. The pipe chase is constructed with reinforcement dowels extending into the fill concrete/rock and a shear key extending into the fill concrete/rock to prevent overturning and sliding, respectively.

All exposed parts of cooling tower enclosure, the UHS ESWS pump house, the UHS basin, and the UHSRS pipe chase between UHS B and C that could be impacted by a tornado missile are designed to prevent full penetration or structural failure by the spectrum of tornado missiles identified in Section 3.5.1.4.

For details see Figure 3.8-202 and Figures 3.8-206 through 3.8-211 for the UHS basin, UHS ESW pump house and cooling tower enclosures and the UHSRS pipe chase. Details of the UHSRS seismic analysis are provided in Appendix 3LL.

3.8.4.1.3.3 **PSFSVs**

The PSFSVs are partially embedded reinforced concrete structures required to house the safety-related and non safety-related fuel oil tanks. There is one vault for each PS/B. The vault contains two safety-related and one nonsafety-related oil tanks. Each tank is contained in a separate compartment. Compartments are separated by reinforced concrete walls. A common mat supports the tanks and the rest of the vault. The reinforced concrete enclosure, which protects the ESW piping passing adjacent to each PSFSV, as shown in Figures 3.8-204 and 3.8-213 is integrally attached with and designed as part of the PSFSV structure. Fuel/Pipe access tunnels, providing access from the PS/B to the PSFSVs are supported by the PSFSV as shown in Figures 3.8-204 and 3.8-212. The PSFSV roof slab is sloped to facilitate drainage. The highest point of the roof slab is approximately 20.5 ft. above grade.

Access to each vault is provided by a reinforced concrete tunnel from the applicable PS/B. Each tank compartment has a separate pipe/access tunnel, which is an integral part of the reinforced concrete enclosure which protects the ESW piping and PSFSV as shown on Figure 3.8-204.

For vault details see Figures 3.8-204 and 3.8-212 through 3.8-214. Each vault is designed with reinforcement dowels extending into the fill concrete to resist sliding. Details of the PSFSV seismic analysis are provided in Appendix 3LL.

3.8.4.1.3.4 Other Site-Specific Structures

There are no additional Seismic Category I structures other than the fill concrete, as identified in Table 3.2-202.

3.8.4.3 Loads and Load Combinations

NAPS COL 3.8(20) Replace the second paragraph in DCD Subsection 3.8.4.3 with the following.

Externally generated loads from the following postulated site-specific sources are evaluated in the following subsections:

- Subsection 2.4.2.3 concludes no loads induced by floods are applicable.
- Subsection 3.5.1.6 concludes no loads from non-terrorism related aircraft crashes are applicable.
- Subsection 2.2.3.1.1 concludes no explosive hazards in proximity to the site are applicable, and
- Subsection 3.5.1.6 concludes no projectiles and missiles generated from activities of nearby military installations are applicable.
- Subsection 3.7.1.1 provides the safe-shutdown earthquake input motion used in the site-specific seismic design.
- Subsection 3.3.1.1 provides the site-specific design wind speed.

3.8.4.3.4.2 Roof Snow Loads and Roof Live Loads

NAPS COL 3.8(25) Add the following paragraph as the last paragraph in DCD Subsection 3.8.4.3.4.2.

The roof live load used for design of site-specific Seismic Category I buildings and structures is 100 psf minimum. Twenty-five percent of the roof live load was used in the dynamic modeling of the site-specific Seismic Category I buildings and structures. This value exceeds

75 percent of the site-specific 100-year snow loading based on the ground snow loading given in Table 2.0-201.

3.8.4.3.7.1 Operating Thermal Loads (T_o)

STD COL 3.8(27)

Replace the second paragraph in DCD Subsection 3.8.4.3.7.1 with the following.

The UHSRS, PSFSVs, and ESWPT structures experience only small ranges of operating temperatures and loads which do not require explicit analysis. The designs of the UHSRS, PSFSVs and ESWPT accommodate normal operating thermal loads and environmental thermal gradients such as those identified in Table 3.8-201.

3.8.4.4.2 East and West PS/Bs

NAPS DEP 3.7(1)

Add the following sentence at the end of the first paragraph in DCD Subsection 3.8.4.4.2.

Shear rebar dowels are provided at the bottom of the basemat along the entire perimeter of the foundation to transfer the building lateral loads into the structural concrete fill/rock.

3.8.4.4.3 Other Seismic Category I Structures

NAPS COL 3.8(29)
NAPS COL 3.8(30)

Replace the last paragraph in DCD Subsection 3.8.4.4.3 with the following.

3.8.4.4.3.1 **ESWPT**

The ESWPT is designed to withstand the loads specified in Subsection 3.8.4.3. The structural analysis of the ESWPT is performed using the computer program ANSYS (Reference 3.8-14). The seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3LL.

The static analyses are performed on the ANSYS model placed on soil springs at the top of the concrete fill representing the stiffness of the support provided by the concrete fill and rock. The stiffness of each of the subgrade springs under different sections of the ESWPT is calculated using the methodology in ASCE 4-98 Section 3.3.4.2 (Reference 3.8-34), for vibration of a rectangular foundation resting on an elastic half space. The springs are included to provide localized flexibility at the base of the structure to calculate base slab demands. For structural design, no credit is taken for the ability of the side backfill stiffness to reduce forces and moments acting on the ESWPT. This results in the total seismic design load being transferred through the structure down to the base slab. Embedment effects are considered in the SSI analyses, and the seismic lateral soil pressures and inertia loads used as input for the structural design adequately envelope the loads obtained from the SSI analyses results. Since the support below the structure (fill concrete and rock) will not exhibit long-term settlement effects, the subgrade stiffness calculated from ASCE 4-98 Section 3.3.4.2 is used for analysis of both static and seismic loads. The equivalent shear modulus for the ASCE spring calculations is based on the equivalent shear wave velocity which is determined using the equivalent shear wave travel time method described in Appendix 3NN. The equivalent Poisson's ratio and density are based on the weighted average with respect to layer thickness. The springs are included in the model using three individual, uncoupled uni-directional spring elements that are attached to each node of the base mat. The sums of all nodal springs in each of the three orthogonal directions are equal to the corresponding generalized structure-foundation stiffness in the same direction calculated from ASCE 4-98. In the vertical direction, the smaller of the spring stiffnesses that match ASCE 4-98 vertical or rocking stiffness is used. Matching of the torsional stiffness is not considered since significant torsional response is not expected (or observed) in any of the structures.

Gravity loads on the tunnel roof include a design surcharge pressure as applicable, and are resisted by one-way slab action of the roof. These loads are distributed to the outer and interior walls, transferred through the walls down to the mat slab where they are distributed, and from the bottom of the mat slab to the concrete fill over the bedrock. Segment 2 is not subject to heavy haul route surcharge loads. A design surcharge pressure of 600 psf (from a cask transporter) is applied to tunnel Segment 1.

Lateral soil pressures on outer tunnel walls are typically resisted by one-way action of the outer walls. Forces from these pressures are transferred to the roof and mat slabs. Where axial force in the roof and mat slabs transverse to the tunnel axis are not balanced by an equal and opposite force from the other side of the tunnel, the roof and mat slabs work with the walls as a moment frame to resist the unbalanced lateral forces. Corner tunnel segments resist unbalanced lateral loads in part by moment frame action and in part by return walls located at an end of the segment (such as where the ESWPT changes direction).

Lateral forces that may not be balanced by an equal and opposite force on the other side of the tunnel are transferred to the concrete fill below the tunnel by friction and by lateral bearing of the exterior wall to the fill concrete. Lateral forces in the fill are then transferred to rock by friction.

For dynamic forces oriented parallel to the length of the tunnel segment, the roof slab acts as a diaphragm that transfers loads to the outer and interior walls. The walls act as shear walls that transfer the forces to the mat slab. For dynamic forces acting perpendicular to the length of the tunnel, the roof acts as a frame member that transfers loads to the interior and exterior walls. The tunnel walls, roof, and base slab act as a moment frame causing out-of-plane bending in these elements. The exterior walls are also designed for static and dynamic soil pressures. The static soil pressures are calculated using at-rest pressures with K_o = 0.36 for the structural fill and Zone IIB saprolite, and K_o = 0.5 for Zone IIA saprolite. The design also considers the load from the overburden pressure and the soil compaction pressure. The dynamic soil pressures are described in Appendix 3LL.

3.8.4.4.3.2 **UHSRS**

The UHSRS are designed to withstand the loads specified in Section 3.8.4.3. The structural analysis of the UHSRS is performed using the computer program ANSYS (Reference 3.8-14). The seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3LL.

The seismic responses for the design are calculated using a two step analysis method. Step 1 is the SSI analysis using the program SASSI (Reference 3.7-17), to calculate the response of the structure considering site-specific SSI effects, and to develop ISRS for design of subsystems. Step 2 is calculating the seismic demands for the design of the UHS using response spectra analysis and the program ANSYS as described below. The seismic lateral pressures and inertia loads obtained from a SSI analysis are compared with the seismic demands (loads) obtained from a response spectra analysis using an ANSYS model. This comparison demonstrates that the results of the SSI analysis are enveloped by the results of the ANSYS model, which is the basis for the structural design. Seismic lateral soil pressures used in the ANSYS analysis are based upon the dynamic soil pressure distribution given in ASCE 4-98 (Reference 3.8-34) Figure 3.5-1.

The SSI analysis from Step 1 provides ARS at the base of the UHS in the lateral and vertical directions. ANSYS response spectrum analyses are then performed with the nodes in the base mat restrained perforce in the direction of seismic excitation. A drawback to assuming that the nodes are fully restrained in the vertical direction is that no bending occurs in the base mat. In order to permit bending in the base mat during lateral excitation, uniform vertical springs are placed beneath the mat. Since lateral excitation is accompanied by rocking, the magnitude of these springs is calculated based upon an equivalence of overall rocking stiffness. The overall rocking stiffness is calculated in accordance with the methods of the theory of elasticity, assuming a rigid mat resting on a layered elastic half-space. The soil profiles used in the analysis are based upon strain-compatible BE properties for the four Unit 3 UHS structures. The minimum vertical spring value is used since the smallest value yields the largest bending in the base mat.

Vertical spectrum analysis requires that the vertical degrees of freedom of the base mat are restrained. Since this condition of restraint prevents bending in the mat, a secondary static analysis is performed with the mat supported by vertical springs. In this secondary static analysis an equivalent vertical acceleration is applied, equal to the total vertical reaction from the response spectrum analysis divided by the total mass of the structure. However, the magnitude of the vertical springs used in this analysis is based upon an equivalence of overall vertical stiffness, obtained in a manner similar to that described above for the rocking springs.

The UHS cooling tower, the air intake enclosures, and the ESWS pump house are designed for tornado wind and tornado generated missiles and in-plane and out-of-plane seismic forces. The walls are shear/bearing walls carrying the loads from the superstructure and transferring to the basemat. The UHS basin exterior walls are also designed for static and dynamic soil pressure, and hydrostatic and hydrodynamic fluid pressures. The static soil pressures are calculated using at-rest pressures with K_o = 0.36 for the structural fill and Zone IIB saprolite, and K_o = 0.5 for Zone IIA saprolite. The design also considers the load from soil compaction pressure. The dynamic soil pressures are determined in accordance with ASCE 4-98 (Reference 3.8-34) and the hydrodynamic fluid pressures are determined using “Fluid/Structure Interaction During Seismic Excitation” (Reference 3.8-201) and modeling procedures of ASCE 4-98 as described in Appendix 3LL. Below-grade walls loaded laterally by soil pressure on the outside, or hydrostatic pressure on the inside, act as two-way slabs, spanning horizontally to perpendicular shear walls, and cantilevering vertically from the mat slab (at the pump room, the walls span vertically between the mat slab and the pump room floor). For seismic loads, the shear walls are designed to resist 100% of the applied lateral load through in-plane shear. The shear walls transmit load to the mat slab. The shear in the mat slab is transferred to the fill concrete via friction, and direct bearing at the pump house sump. The shear in the fill concrete is transferred to the rock via friction and bearing at the pump hose sump. The coefficients of friction are 0.6 concrete against Zone III rock, 0.65 for concrete against Zone III-IV rock, and 0.7 for concrete against Zone IV rock and concrete fill. See Subsection 3.8.5.5.2 for additional discussion of sliding acceptance criteria.

Above grade walls loaded laterally by seismic forces as described in Appendix 3LL, or by wind or tornado wind, atmospheric and missile loads, act as two-way slabs, spanning horizontally to perpendicular shear walls and vertically to floor and roof slabs. These slabs act as horizontal diaphragms, and span horizontally to the perpendicular shear walls. The shear in the shear walls is transferred to rock as described above.

Vertical loads in the floor and roof slabs are due to dead load, live load, and wind or tornado missile loads. The floor and roof slabs act as two-way slabs, spanning to the walls or beams below in both directions. The vertical loads are transmitted to the mat slab, then into the fill concrete, and then into rock.

3.8.4.4.3.3 **PSFSVs**

The PSFSVs are designed to withstand the loads specified in Section 3.8.4.3. The structural analysis of the PSFSV is performed using the computer program ANSYS (Reference 3.8-14). Details of the seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3LL.

The seismic responses for the design are calculated using a two step analysis method. Step 1 is the SSI analysis using the program ACS

SASSI, to calculate the response of the structure considering site-specific SSI effects, and to develop ISRS for design of subsystems. Step 2 is calculating the seismic demands for the design of the UHS using response spectra analysis and the program ANSYS as described below. The seismic lateral pressures and inertia loads obtained from a SSI analysis are compared with the seismic demands (loads) obtained from a response spectra analysis using an ANSYS model. This comparison demonstrates that the results of the SSI analysis are enveloped by the results of the ANSYS model, which is the basis for the structural design. Seismic lateral soil pressures used in the ANSYS analysis are based upon the dynamic soil pressure distribution given in ASCE 4-98 (Reference 3.8-34) Figure 3.5-1.

The SSI analysis from Step 1 provides ARS at the base of the PSFSV in the lateral and vertical directions. ANSYS response spectrum analyses are then performed with the nodes in the base mat restrained in all three orthogonal directions of seismic excitation. A drawback to assuming that the nodes are fully restrained in the vertical direction is that no bending occurs in the base mat, except those that are induced by out-of-plane bending of the walls at the mat/wall intersection. The subgrade at the Vaults is based on the basis of the space between the elevation of the PS/B basemat and that of the Vault basemat will be filled with concrete fill. In all situations, the concrete fill is underlain by Rock III-IV. It is therefore reasonable to assume a value of 6,900 kcf for the modulus of subgrade reaction below Vault basemats. This modulus is extremely stiff and therefore the fixed base assumption is satisfactory. To capture bending in the base mat, a secondary static analysis is performed with the mat supported by vertical springs. In this secondary static analysis an equivalent vertical acceleration is applied, equal to the total vertical reaction from the response spectrum analysis divided by the total mass of the structure, using the given modulus of subgrade reaction.

Vertical loads present on the roof of the PSFSVs are carried by the perimeter and interior walls. The roof acts as a two-way slab based on its aspect ratio with a single span in the plant north-south direction and a 3-span continuous slab in the plant east-west direction. The vertical wall loads are transmitted to the mat slab and into the rock. The exterior walls are also designed for static and dynamic soil pressure. The static soil pressures are calculated using at-rest pressures with K_o = 0.36 for the structural fill and Zone IIB saprolite, and K_o = 0.5 for Zone IIA saprolite.

The design also considers the load from the surcharge pressure. Application of the dynamic soil pressure is described in Appendix 3LL. Walls loaded laterally by earth pressure act as two-way plate members, spreading load to the mat slab, roof, and perpendicular shear walls. For seismic load cases, the shear walls are designed to resist 100% of the applied lateral load in in-plane shear and are also designed for out-of-plane loading due to seismic inertia demands. This can be accomplished in the main vault structure. The shear walls transmit load to the foundation mat along their length. The load in the foundation mat is then transferred to the fill concrete and rock via friction. Seismic load is transmitted in the tunnel area in a similar manner as for the ESWPT, which is described in Section 3.8.4.4.3.1.

3.8.4.6.1.1 Concrete

NAPS COL 3.8(28)

Replace the third sentence of the first paragraph in DCD Subsection 3.8.4.6.1.1 with the following.

For ESWPT, UHSRS, and PSFSVs concrete compressive strength, f'_c = 5,000 psi is utilized. The compressive strength, f'_c, of the concrete fill under the ESWPT, UHSRS, and PSFSVs is at least 2,500 psi.

3.8.4.7 Testing and Inservice Inspection Requirements

STD COL 3.8(22)
STD COL 3.8(7)

Replace the second through last paragraph of DCD Subsection 3.8.4.7 with the following.

A site-specific program for monitoring and maintenance of Seismic Category I structures is performed in accordance with the requirements of NUMARC 93-01 (Reference 3.8-28) and 10 CFR 50.65 (Reference 3.8-29) as detailed in RG 1.160 (Reference 3.8-30). Monitoring of Seismic Category I structures includes base settlements and differential displacements.

Prior to completion of construction, site-specific programs are developed in accordance with RG 1.127 (Reference 3.8-47) for ISI of Seismic Category I water control structures, including the UHSRS and any associated safety and performance instrumentation.

The site-specific programs address in particular ISI of critical areas to assure plant safety through appropriate levels of monitoring and maintenance. Any special design provisions (such as providing sufficient physical access or providing alternative means for identification of conditions in inaccessible areas that can lead to degradation) to accommodate ISI are also required to be addressed in the ISI program.

Because the site exhibits nonaggressive ground water/soil (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1,500 ppm), the program for ISI of inaccessible, below-grade concrete walls and foundations of seismic Category I structures is less stringent than would be applied for sites with aggressive ground water/soil. The program is required to include requirements for (1) examination of the exposed portions of the below-grade concrete, when excavated for any reason, for signs of degradation; and (2) conducting periodic site monitoring of ground water chemistry, to confirm that the ground water remains nonaggressive.

3.8.5.1 Description of the Foundations

STD COL 3.8(23)

Replace the second sentence of the second paragraph in DCD Subsection 3.8.5.1 with the following.

The 4-ft. depth exceeds the maximum depth of frost penetration.

3.8.5.1.2 Power Source Buildings

NAPS SUP 3.8(1)

Replace the last sentence of the first paragraph in DCD Subsection 3.8.5.1.2 with the following.

The bottom of the basemat is at elevation -36 ft. 3 in. for the standard plant design or elevation 251 ft. 2 in. for Unit 3.

NAPS DEP 3.7(1)

Add the following at the end of the first paragraph in DCD Subsection 3.8.5.1.2.

Shear rebar dowels are provided at the bottom of the basemat. See Figure 3.8.5-13R for location and configuration of the shear rebar dowels, and Table 3.8.5-5R for size and spacing.

3.8.5.1.3 Site-Specific Structures

NAPS COL 3.8(24) Replace the paragraph in DCD Subsection 3.8.5.1.3 with the following new subsections.

3.8.5.1.3.1 ESWPT

The ESWPT is an underground structure supported by a monolithic reinforced concrete basemat. The basemat is a 2-ft. thick concrete slab in Segment 1 as shown in Figure 3.8-203, and is 9'-11" thick in Segment 2 as shown in Figure 3.8-205, with top and bottom reinforcement in each direction arranged in a rectangular grid. Unless otherwise noted, all elevations discussed herein are provided North America Vertical Datum of 1988 (NAVD88). Add 0.86 feet to the NAVD88 elevations to obtain the National Geodetic Vertical Datum of 1929 (NGVD29) elevations.

The bottom of the basemat is at elevation 259.08 ft. in Segment 1, and elevation 251.17 ft. in Segment 2 under the north end of the T/B, and is founded on structural concrete fill placed directly on rock. Portions of the reinforced concrete enclosure, which protects the ESW piping that are integrally attached with the UHSRS and PSFSVs are designed as parts of those structures.

3.8.5.1.3.2 UHSRS

The UHS basins, ESWS pump house, and the cooling towers are free-standing structures supported on a reinforced concrete basemat. Each basin, including its pump house and cooling towers, rests on a 5 ft. thick mat with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the UHS basemat is at elevation 277 ft., except the pump house sump mat is at elevation 265 ft as shown on Figure 3.8-208. The pump house basemat and the rest of the UHS mat are founded on structural concrete fill placed directly on Zone III material.

The UHSRS pipe chase between UHS B and C has a basemat thickness of 2'-0" with top and bottom reinforcement in each direction arranged in a rectangular grid. The bottom of the basemat is at elevation 286 ft. Refer to Section E-E of Figure 3.8-202.

3.8.5.1.3.3 PSFSVs

PSFSVs are structures supported by a monolithic reinforced concrete basemat. The basemat is a 5'-6" thick concrete slab with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the basemat is at elevation 272.25 ft., and is founded directly on structural concrete fill placed directly on rock. See Figures 3.8-213 and 3.8-214.

3.8.5.4.3 Boundary Conditions of Basemat

NAPS DEP 3.7(4) Replace the third and fourth sentences in DCD Subsection 3.8.5.4.3 with the following.

An SSI analysis is performed on the SASSI model of the R/B with the model resting on the surface of a half-space with hard-rock properties. This is to simulate the response of the structure under a fixed base condition.

To increase computational efficiency, the subgrade part of the FE model is condensed into a super-element. The properties of the subgrade layers used in the FE model of the subgrade are established based on several profiles selected from the generic layered soil profiles described in Technical Report MUAP-10001 (Reference 3.7-47R) to cover the entire range of soil/rock conditions at representative nuclear power plant sites within the central and eastern US.

3.8.5.4.4 Analyses of Settlement

STD COL 3.8(26) Replace the last sentence of the first paragraph in DCD Subsection 3.8.5.4.4 with the following.

As discussed in Section 2.5.4.10.2, maximum and differential settlements of all the seismic category I buildings and structures at the site, including R/B, PS/Bs, ESWPT, UHSRS, and PSFSVs are estimated to be less than ½ inch, including long-term settlements.

3.8.5.5 Structural Acceptance Criteria

NAPS COL 3.8(25)

Replace the second sentence of the first paragraph in DCD Subsection 3.8.5.5 with the following.

All Seismic Category I buildings and structures at the site, including R/B, PS/Bs, ESWPT, UHSRS, and PSFSVs, are founded either directly on a rock layer or structural concrete fill which is placed directly on the rock layer. Table 3.8-202 shows the actual bearing pressure during static and seismic load cases and the ratio of allowable bearing capacity to bearing pressure. Table 3.8-203 shows the load combinations and factors of safety against overturning, sliding, and flotation.

3.8.5.5.2 Sliding Acceptance Criteria

NAPS COL 3.8(30)

Replace the last paragraph in DCD Subsection 3.8.5.5.2 with the following.

In accordance with Table 2.5-212, a coefficient of friction of 0.7 for structural concrete founded on concrete fill is used in structural sliding stability evaluations; therefore, roughening of fill concrete is required.

3.8.6 Combined License Information

Replace the content of DCD Subsection 3.8.6 with the following.

3.8(1) ***Deleted from the DCD.***

3.8(2) ***Deleted from the DCD.***

STD COL 3.8(3)

3.8(3) ***Material changes for PCCV***

This COL item is addressed in Subsection 3.8.1.6.

3.8(4) ***Deleted from the DCD.***

3.8(5) ***Deleted from the DCD.***

3.8(6) ***Deleted from the DCD.***

STD COL 3.8(7)
NAPS COL 3.8(7)

3.8(7) ***Aggressivity of ground water/soil***

This COL item is addressed in Subsection 3.8.1.6 and 3.8.4.7.

3.8(8) ***Deleted from the DCD.***

3.8(9) ***Deleted from the DCD.***

STD COL 3.8(10) *3.8(10)* ***Alternate wire prestressing system***

This COL item is addressed in Subsection 3.8.1.6.

3.8(11) ***Deleted from the DCD.***

3.8(12) ***Deleted from the DCD.***

3.8(13) ***Deleted from the DCD.***

STD COL 3.8(14) *3.8(14)* ***PCCV testing and ISI***

This COL item is addressed in Subsection 3.8.1.7.

NAPS COL 3.8(15) *3.8(15)* ***Seismic design of SSCs not part of standard plant***

This COL item is addressed in Subsection 3.8.4.

3.8(16) ***Deleted from the DCD.***

3.8(17) ***Deleted from the DCD.***

3.8(18) ***Deleted from the DCD.***

NAPS COL 3.8(19) *3.8(19)* ***Design and analysis of ESWPT, UHSRS, PSFSVs, and other site-specific structures***

This COL item is addressed in Subsection 3.8.4.1.3, and Figures 3.8-201 through 3.8-214.

NAPS COL 3.8(20) *3.8(20)* ***Externally generated loads***

This COL item is addressed in Subsection 3.8.4.3.

3.8(21) ***Deleted from the DCD.***

STD COL 3.8(22) *3.8(22)* ***Monitoring of Seismic Category I structures***

This COL item is addressed in Subsection 3.8.4.7.

STD COL 3.8(23) *3.8(23)* ***Maximum frost penetration level***

This COL item is addressed in Subsection 3.8.5.1.

NAPS COL 3.8(24)

3.8(24) ***Design of other non-standard Seismic Category I buildings and structures***

This COL item is addressed in Subsection 3.8.5.1.3, and Figures 3.8-202, 3.8-213, and 3.8-214.

NAPS COL 3.8(25)

3.8(25) ***Site-specific conditions***

This COL item is addressed in Subsections 3.8.4.3.4.2 and 3.8.5.5 and Tables 3.8-202 and 3.8-203.

STD COL 3.8(26)

3.8(26) ***Subsidence and differential displacement***

This COL item is addressed in Subsection 3.8.5.4.4.

STD COL 3.8(27)
NAPS COL 3.8(27)

3.8(27) ***Normal operating thermal loads***

This COL item is addressed in Subsection 3.8.4.3.7.1, and Table 3.8-201.

NAPS COL 3.8(28)

3.8(28) ***Concrete strength in non-standard plant Seismic Category I structures***

This COL item is addressed in Subsection 3.8.4.6.1.1.

NAPS COL 3.8(29)

3.8(29) ***Design and analysis procedures for ESWPT, UHSRS, and PSFSVs***

This COL item is addressed in Subsection 3.8.4.4.3 and Appendix 3LL.

NAPS COL 3.8(30)

3.8(30) ***Coefficient of friction used in calculating sliding resistance***

This COL item is addressed in Subsections 3.8.4.4.3 and 3.8.5.5.2.

3.8.7 References

Add the following references to the end of DCD Subsection 3.8.7:

3.8-201 Fluid/Structure Interaction During Seismic Excitation, Committee on Seismic Analysis of the Committee on Nuclear Structures and Materials of the Structural Division, American Society of Civil Engineers, 1984.

3.8-202 Deleted.

3.8-203 Deleted.

3.8-204 Deleted.

NAPS DEP 3.7(1)

Table 3.8.5-5R Typical Reinforcement in PS/B Basemat

	Provided Reinforcement		
	NS-Dir.	EW-Dir.	Shear
Concrete Thickness 119 in.			
Control Load Combination Case	None[(1)] (Minimum Requirement)	None[(1)] (Minimum Requirement)	-
Top	#11@12"+#11@12"	#11@12"+#11@12"	-
Bottom	#11@12"+#11@12"	#11@12"+#11@12"	-
Dowels into Fill Concrete	#11@ 1'-9" (Arranged in 6 rows total, 3 along the east edge and 3 along the west edge of the basemat)	#11@ 1'-9" (Arranged in 6 rows total, 3 along the north edge and 3 along the south edge of the basemat)	-

Note: ~~( ) shows the reinforcement ratio.~~

1) The dowels into the fill concrete are required to maintain sliding stability.

NAPS COL 3.8(27)

Table 3.8-201 Environmental Temperature Gradients for the Exterior Walls and Roofs of UHSRS, PSFSV, and ESWPT

Normal air temperatures range from a maximum of 109°F to a minimum –21°F. The seasonal soil temperature gradient follows:

	Winter (minimum °F)	Summer (maximum °F)
Plant Grade	30	88
-10 ft.	38	80
-20 ft.	46	72
-30 ft.	54	64

NAPS COL 3.7(7)
NAPS COL 3.8(25)
NAPS DEP 3.7(1)

Table 3.8-202 Summary of Bearing Pressures and Ratios of Allowable Bearing Capacity to Bearing Pressure

	Bearing Pressures(6) (lb/ft^2)		Allowable Bearing Capacity(7) (lb/ft^2)		Ratio of Allowable Bearing Capacity to Bearing Pressure	
Building	Static Case	Seismic Case(1),(2)	Static Case	Seismic Case	Static Case	Seismic Case
R/B	13,050	30,120	80,000	214,000	6.1	7.1
PS/Bs	5,100	60,810	80,000	214,000	15.7	3.5
PSFSVs	5,110(3)	9,360(3)	80,000	214,000	15.7	22.9
UHSRS	7,270(4)	8,650(4)	20,000	29,000	2.8	3.4
ESWPT	3,170(5)	5,890*(5)	20,000	29,000	6.3	4.9

Notes:
1) All seismic case bearing pressures are based on the site-specific SSI input motion.
2) Seismic case bearing pressures shown above include static bearing pressures.
3) The pressure shown includes bearing pressure due to full fuel oil tanks.
4) The pressure shown includes bearing pressure due to full reservoirs. Maximum corner pressure is listed.
5) (*) denotes fully embedded sections at segments 1a and 1b.
6) Bearing pressures are based on site-specific groundwater levels.
7) Values obtained from Table 2.5-215.

NAPS COL 3.8(25)
NAPS DEP 3.7(1)

Table 3.8-203 Load Combinations and Factor of Safety for Buildings and Structures

Building/Structure[1]	Load Combination (per SRP 3.8.5)	Overturning[7] (FS_{ot})	Sliding[7] (FS_{sl})	Flotation (FS_{fl})
RB	D + H + W	149.0	46.2	N/A
	D + H + E_s	1.6	1.1	N/A
	D + H + W_t	72.4	32.9	N/A
	D + F_b	N/A	N/A	4.9
PS/B(East)	D + H + W	13.5	4.3	N/A
	D + H + E_s	1.2[4]	1.2[4]	N/A
	D + H + W_t	9.1	3.8	N/A
	D + F_b	N/A	N/A	1.9
PS/B(West)	D + H + W	13.2	4.2	N/A
	D + H + E_s	1.2[4]	1.2[4]	N/A
	D + H + W_t	8.8	3.7	N/A
	D + F_b	N/A	N/A	1.9
PSFSVs	D + H + W	10.7[1]	17.9[1]	N/A
	D + H + E_s	1.6	1.1[3]	N/A
	D + H + W_t	9.3[1]	15.6[1]	N/A
	D + F_b	N/A	N/A	2.5[1]
UHSRS	D + H + W	5.9[2]	22.1[2]	N/A
	D + H + E_s	1.5	1.2	N/A
	D + H + W_t	5.2[2]	13.4[2]	N/A
	D + F_b	N/A	N/A	4.2[2]
UHSRS Pipe Chase	D + H + W	47.68	91.08	N/A
	D + H + E_s	1.1	1.16	N/A
	D + H + W_t	12.1	23.67	N/A
	D + F_b	N/A	N/A	3.84

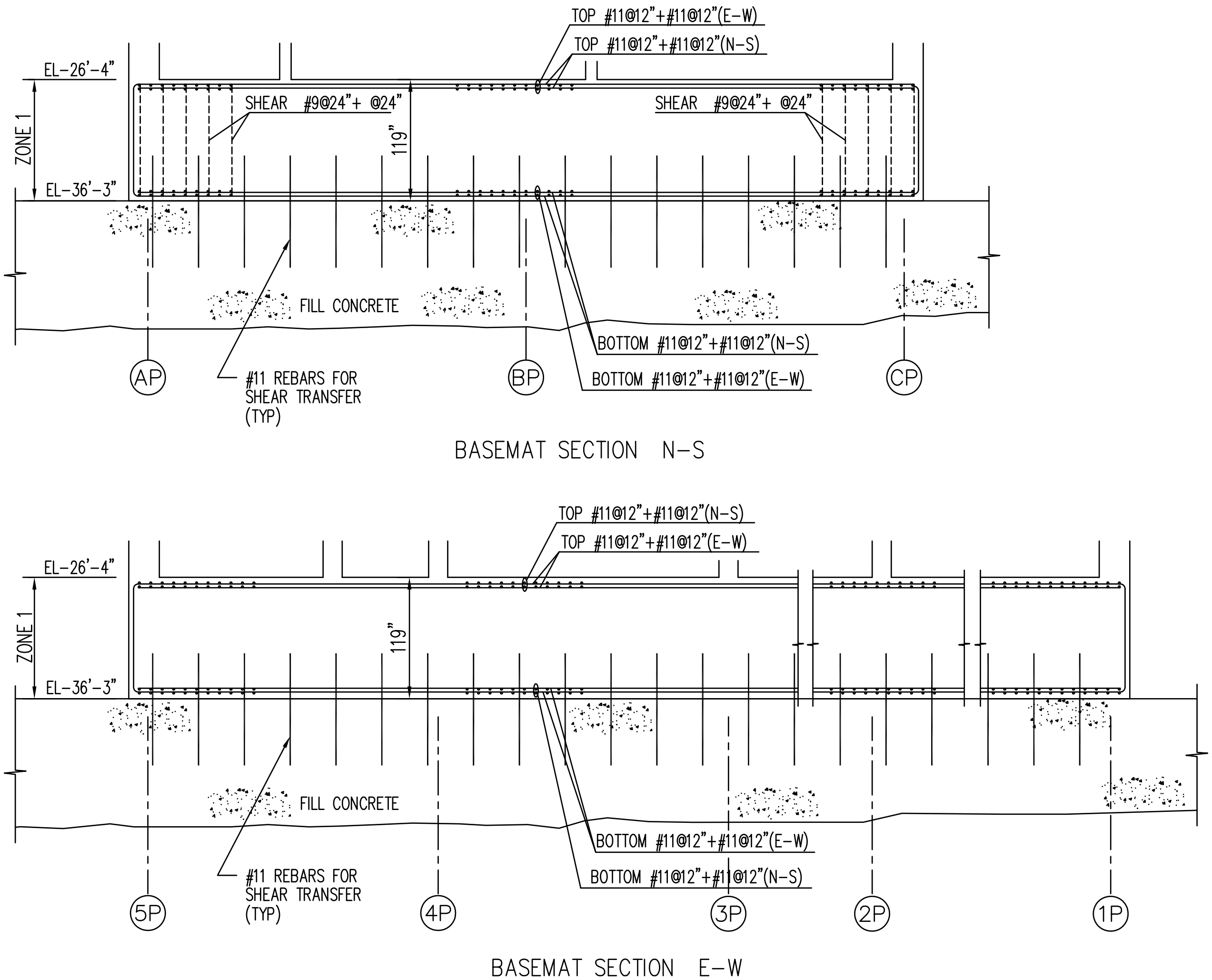
NAPS COL 3.8(25)
NAPS DEP 3.7(1)

Table 3.8-203 Load Combinations and Factor of Safety for Buildings and Structures

Building/Structure[1]	Load Combination (per SRP 3.8.5)	Overturning[7] (Fs_{ot})	Sliding[7] (FS_{sl})	Flotation (FS_{fl})
ESWPT	D + H + W	N/A	N/A	N/A
	$D + H + E_s$[5]	1.1	1.18	N/A
	$D + H + W_t$	N/A	N/A	N/A
	$D + F_b$[6]	N/A	N/A	1.59

1) The value shown is based on the conservative assumption that all three oil tanks are empty.
2) The value shown is based on the conservative assumption that the UHS basins are completely emptied of water.
3) Reinforcement dowels into underlying concrete fill are used to prevent sliding of the PSFSVs. Factor of safety for sliding of the PSFSVs is based on doweled condition.
4) Reinforcement dowels into underlying concrete fill are used to prevent overturning and sliding of the PS/B's (East and West). Factors of Safety for Overturning and Sliding of the PS/B's are based on doweled condition.
5) The factor of safety is governed by ESWPT Segment 1.
6) The factor of safety is governed by ESWPT Segment 2.
7) Overturning and Sliding factors of safety are based on site-specific groundwater levels.

Figure 3.8.5-13R Typical Reinforcement in PS/B Basemats



NAPS COL 3.8(19)

Figure 3.8-201 General Arrangement of ESWPT, UHSRS, and PSFSV

NAPS COL 3.8(19)

Figure 3.8-202 Section Through UHSRS Showing Pipe Chase and Missile Shield Wall, and Section Showing UHSRS Pipe Chase Between UHS B and C

NAPS COL 3.8(19)

Figure 3.8-203 Typical Section for ESWPT

NAPS COL 3.8(19) **Figure 3.8-204 Section at PS/B and PSFSVs Showing Fuel Pipe/ Access Tunnel**

NAPS DEP 9.5(1)

NAPS COL 3.8(19)

Figure 3.8-205 Section of ESWPT at R/B and T/B Interface

NAPS COL 3.8(19)

Figure 3.8-206 General Arrangement of UHS Basin

NAPS COL 3.8(19)

Figure 3.8-207 Plan of Fan-Supporting Structure and Concrete, and Slab/Grating Plan Above the Fan

NAPS COL 3.8(19)

Figure 3.8-208 Typical Section of UHS Looking North at Pump House, UHS Basin and Cooling Tower Fans

NAPS COL 3.8(19)

Figure 3.8-209 Typical Section Looking West at UHS Basin and Pump House Interface with ESWPT

NAPS COL 3.8(19)

Figure 3.8-210 Typical Section Looking West at UHS Basin and Cooling Tower

NAPS COL 3.8(19)

Figure 3.8-211 Typical Section Looking North at UHS Basin, Elevated Cooling Tower and Pump House Slabs

NAPS COL 3.8(19)

Figure 3.8-212 Plan of East and West PSFSVs

NAPS COL 3.8(19)

Figure 3.8-213 Typical Section Looking West at PSFSV

NAPS DEP 9.5(1)

NAPS COL 3.8(19)

Figure 3.8-214 Typical Section Looking North at PSFSV

NAPS DEP 9.5(1)

3.9 Mechanical Systems and Components

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.9.2.4.1 Background

NAPS COL 3.9(2) Replace the first, second and third paragraphs in DCD Subsection 3.9.2.4.1 with the following.

Comanche Peak Nuclear Power Plant (CPNPP) Unit 3 is the first operational US-APWR. The CPNPP Unit 3 reactor internals are classified as prototype in accordance with RG 1.20 (Reference 3.9-21). Upon qualification of a valid prototype, the NAPS Unit 3 reactor internals will be classified as non-prototype Category I, based on the classifications in RG 1.20.

Following the recommendation of RG 1.20, a pre-operational vibration measurement program will be developed for the first operational US-APWR reactor internals. Subsequent to the completion of the vibration assessment program for the prototype reactor internals, the prototype vibration analysis results will be used to qualify the NAPS Unit 3 reactor internals under the criteria for non-prototype Category I.

If Comanche Peak Unit 3 successfully completes its vibration assessment program without experiencing any adverse inservice vibration phenomena, then NAPS Unit 3 will reference Comanche Peak Unit 3 as the valid prototype. Under this scenario, NAPS Unit 3 will be classified as a non-prototype, Category I plant. Per RG 1.20, regulatory position 3.1, the vibration measurement program will be omitted (with the exception of the vibration measurement program related to the evaluation of the potential adverse flow effect from pressure fluctuations and vibrations in piping systems) and an inspection program implemented. For this scenario, the inspection program for NAPS Unit 3 will be developed and made available for NRC review 60 days prior to the beginning of the inspections. This inspection program will meet the guidance specified in RG 1.20 for non-prototype, Category I reactor internals. The results of the inspection program will be provided to the NRC 180 days following completion of the program.

If Comanche Peak Unit 3 experiences adverse vibration phenomena during its assessment program, then NAPS Unit 3 will be considered a non-prototype Category II plant for applicable internal components. A vibration assessment program, consistent with DCD Section 3.9.2.4, will be implemented for these internal components. Procedures for the inspection program will be made available 60 days prior to the beginning of the inspections. This inspection program will meet the guidance specified in RG 1.20 for prototype reactor internals. Under this scenario, the preliminary and final reports which together summarize the results of the vibration analysis, measurement, and inspection programs will be submitted to the NRC within 60 days and 180 days, respectively, following completion of the vibration testing and inspection.

3.9.3.3.1 Pump Operability

STD COL 3.9(10)

Replace the last sentence of the first paragraph in DCD Subsection 3.9.3.3.1 with the following.

The site-specific list of active pumps is provided in Table 3.9-201.

3.9.3.4.2.5 Design Specifications

STD COL 3.9(1)

Replace the second paragraph of DCD Subsection 3.9.3.4.2.5 with the following.

The design specification for snubbers installed in harsh service conditions (e.g., high humidity, temperature, radiation levels) is evaluated for the projected life of the snubber to assure snubber functionality including snubber materials (e.g., lubricants, hydraulic fluids, seals).

3.9.6 Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

STD COL 3.9(8)

Replace the second sentence of the third paragraph in DCD Subsection 3.9.6 with the following.

The inservice testing (IST) program for pumps, valves, and dynamic restraints is administratively controlled to ensure that the equipment will be capable of performing its safety function throughout the life of the plant.

3.9.6.2 IST Program for Pumps

STD COL 3.9(11)

Replace the third paragraph in DCD Subsection 3.9.6.2 with the following.

The site-specific safety-related pump IST parameters and frequencies are provided in Table 3.9-202.

3.9.6.3 IST Program for Valves

STD COL 3.9(12)

Replace the fifth paragraph in DCD Subsection 3.9.6.3 with the following.

The types of testing and frequencies of site-specific valves subject to IST in accordance with the ASME Code are provided in Table 3.9-203.

3.9.6.4 IST Program for Dynamic Restraints

NAPS COL 3.9(6)

Replace the second paragraph in DCD Subsection 3.9.6.4 with the following.

The IST program plan for dynamic restraints (snubbers) complies with the requirements in the latest edition and addenda of the Nonmandatory Appendix A of ASME OM Code, incorporated by reference in 10 CFR 50.55a (Reference 3.9-29), 12 months prior to initial fuel load. The IST program plan for dynamic restraints will be provided 12 months prior to fuel load.

3.9.9 Combined License Information

Replace the content of DCD Subsection 3.9.9 with the following.

STD COL 3.9(1)

3.9(1) ***Snubber functionality***

This COL item is addressed in Subsection 3.9.3.4.2.5.

NAPS COL 3.9(2)

3.9(2) ***Classification of reactor internals***

This COL item is addressed in Subsection 3.9.2.4.1.

3.9(3) ***Deleted from the DCD.***

3.9(4) ***Deleted from the DCD.***

3.9(5) ***Deleted from the DCD.***

NAPS COL 3.9(6)

3.9(6) ***Program plan for IST of dynamic restraints***

This COL item is addressed in Subsection 3.9.6.4.

3.9(7) ***Deleted from the DCD.***

STD COL 3.9(8)

3.9(8) ***Administrative control of the edition and addenda used for the IST program***

This COL item is addressed in Subsection 3.9.6.

3.9(9) ***Deleted from the DCD***

STD COL 3.9(10)
NAPS COL 3.9(10)

3.9(10) ***Site-specific active pumps***

This COL item is addressed in Subsection 3.9.3.3.1, and Table 3.9-201.

STD COL 3.9(11)
NAPS COL 3.9(11)

3.9(11) ***Site-specific, safety-related pump IST parameters and frequency***

This COL item is addressed in Subsection 3.9.6.2, and Table 3.9-202.

STD COL 3.9(12)
NAPS COL 3.9(12)

3.9(12) ***Testing and frequency of site-specific valves subject to IST***

This COL item is addressed in Subsection 3.9.6.3, and Table 3.9-203.

NAPS COL 3.9(10)

Table 3.9-201 List of Site-Specific Active Pumps

Pump	System	ASME Class	Normal Operation Mode	Post LOCA Mode[(2)]	Basis[(1)(3)]
A-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
B-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
C-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
D-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins

Notes:

1. Except for during IST, pumps do not operate during normal operation mode. In the post LOCA mode, the pumps are operated remotely when required.
2. As necessary to maintain basin level.
3. Under normal operating conditions the UHS Transfer Pumps are not required, however, for freeze protection the pumps may be operated to maintain system availability (see Section 9.2.5.3).

NAPS COL 3.9(11)

Table 3.9-202 Site-Specific Pump IST Requirements

Tag No.	Description	Pump Type	ASME IST Category	Required Test: Outlet Flow	Required Test: Differential Pressure	Required Test: Vibration	Required Test: Speed	Test Frequency	Acceptance Criteria
UHS-MPP-001A	A-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1) Quarterly, Required Test is conducted (2) Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code-(Reference 3.9-13) is applied.
UHS-MPP-001B	B-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1) Quarterly, Required Test is conducted (2) Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code-(Reference 3.9-13) is applied.
UHS-MPP-001C	C-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1) Quarterly, Required Test is conducted (2) Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code-(Reference 3.9-13) is applied.
UHS-MPP-001D	D-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1) Quarterly, Required Test is conducted (2) Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code-(Reference 3.9-13) is applied.

NAPS COL 3.9(12)

Table 3.9-203 Site-Specific Active Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	IST Type and Frequency	IST Notes
UHS-VLV-502A	A-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise/ Refueling Outage	3
UHS-VLV-502B	B-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise/ Refueling Outage	3
UHS-VLV-502C	C-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	3
UHS-VLV-502D	D-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	3
UHS-MOV-503A	A-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-503B	B-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-503C	C-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-503D	D-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

NAPS COL 3.9(12)

Table 3.9-203 Site-Specific Active Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	IST Type and Frequency	IST Notes
UHS-MOV-506A	A-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506B	B-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506C	C-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506D	D-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-507A	A-UHS Transfer Pump Discharge Valve (Winter Operation)	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-507B	B-UHS Transfer Pump Discharge Valve (Winter Operation)	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-507C	C-UHS Transfer Pump Discharge Valve (Winter Operation)	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

NAPS COL 3.9(12)

Table 3.9-203 Site-Specific Active Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	IST Type and Frequency	IST Notes
UHS-MOV-507D	D-UHS Transfer Pump Discharge Valve (Winter Operation)	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-508A	A-UHS Winter Operation Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-508B	B-UHS Winter Operation Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-508C	C-UHS Winter Operation Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-508D	D-UHS Winter Operation Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-509A	A-UHS Cooling Tower Isolation Valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-509B	B-UHS Cooling Tower Isolation Valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

NAPS COL 3.9(12)

Table 3.9-203 Site-Specific Active Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	IST Type and Frequency	IST Notes
UHS-MOV-509C	C-UHS Cooling Tower Isolation Valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-509D	D-UHS Cooling Tower Isolation Valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-510A	A-UHS Cooling Tower Bypass Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-510B	B-UHS Cooling Tower Bypass Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-510C	C-UHS Cooling Tower Bypass Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-510D	D-UHS Cooling Tower Bypass Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
EWS-HCV-010	A-UHS Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

NAPS COL 3.9(12)

Table 3.9-203 Site-Specific Active Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	IST Type and Frequency	IST Notes
EWS-HCV-011	B-UHS Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
EWS-HCV-012	C-UHS Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
EWS-HCV-013	D-UHS Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

Notes:

1) Not used.
2) Not used.
3) The check valve exercise test is performed during refueling outage. Valves in the inaccessible primary containment can not be tested during power operation. Test of valves in operating systems may cause impact of power operation. Simultaneous testing of valves in the same system group will be considered.
4) Not used.
5) Not used.
6) Not used
7) Not used.
8) Not used.
9) Not used.
10) Not used.
11) Not used.
12) Not used.

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

STD COL 3.10(3)

Replace the second sentence of the fifth paragraph in DCD Section 3.10 with the following.

The files generated by the environmental qualification (EQ) Program referenced in Subsection 3.10.4.1 include provisions for recording seismic qualification information including test results. The records that form the equipment qualification files include provisions for recording seismic qualification information and are sometimes referred to as equipment qualification summary data sheets (EQSDS). The qualification records for each seismic category I and II piece of equipment are updated for individual components as new information becomes available. Information is recorded during the analysis, design, procurement (including testing information), construction, and preoperational testing phases of the project and will be available for review throughout the duration of the project. The implementation of the Operational EQ Program prior to fuel load is a license condition in accordance with Table 13.4-201.

3.10.1 Seismic Qualification Criteria

NAPS COL 3.10(8)

Replace the last two sentences of the third paragraph in DCD Subsection 3.10.1 with the following.

For design of Seismic Category I and Seismic Category II SSCs, the OBE is described in Subsection 3.7.1.1. The OBE is not used in explicit design analysis, except for fatigue effects as explained below.

3.10.2 Methods and Procedures for Qualifying Mechanical and Electrical Equipment and Instrumentation

NAPS COL 3.10(9)

Replace the last two sentences of the fourth paragraph in DCD Subsection 3.10.2 with the following.

As discussed in Section 3.7, site-specific FIRS for each Seismic Category I structure exceed the CSDRS in the mid- to HF range. This causes exceedances of some of the ISRS used as input for equipment design and qualification. The required response spectra (RRS) for seismic qualification for each Seismic Category I structure are used to analyze the worst-case input motion applicable to the equipment.

When exceedances of the ISRS exist, additional evaluation of HF sensitive equipment is required. The additional evaluation is to be conducted by screening and subsequent qualification testing, depending on screening results, as stated in Section B.14 of Technical Report MUAP-08015, "US-APWR Equipment Qualification Program" (Reference 3.11-3), Attachment B. Further discussion of HF qualification follows.

NAPS COL 3.10(9)

Replace the seventh paragraph in DCD Subsection 3.10.2 with the following.

Where site-specific ISRS result in HF exceedances of the standard design ISRS, acceptable methods for resolving HF concerns not already addressed by certified design qualification include: review existing equipment qualification test data for adequate HF input motion; review circuits containing potentially sensitive items for inappropriate system actions due to intermediacy or set point drifts; or perform a screening test to confirm equipment does not have HF vulnerabilities.

NAPS COL 3.10(5)

Replace the first two sentences of the twenty-seventh paragraph (starts with "Components that have been previously tested …") in DCD Subsection 3.10.2 with the following.

Mechanical and electrical equipment seismic qualification testing is performed according to IEEE 344-2004, Section 8 (Reference 3.10-8).

3.10.4.1 Implementation Program and Milestones

Replace the second sentence in DCD Subsection 3.10.4.1 with the following.

STD COL 3.10(1)

Technical Report MUAP-08015, "US-APWR Equipment Qualification Program" (DCD Reference 3.11-3) describes the EQ Program, as defined in DCD Tier 2 Section 3.11, for all COL applicants using the US-APWR technology. The Technical Report was submitted to the NRC as part of the US-APWR Design Certification application. Figure 2.1 of MUAP-08015 established the overall framework for implementing the EQ Program including seismic qualification. The seismic qualification program implementation schedule is part of the EQ Program implementation milestone schedule provided in FSAR Section 3.11. The seismic qualification program is implemented during the design, procurement, construction and preoperational testing phases of the project as described in MUAP-08015. The project-specific implementation milestone for the seismic qualification program is consistent with the EQ Program implementation milestone identified in FSAR Table 13.4-201. Project-specific implementation of the US-APWR EQ Program provides for the turnover of all EQ Program records to the licensee. The EQ Program is the basis for the seismic qualification program applicable to replacement parts and components during plant operation.

3.10.5 Combined License Information

Replace the content of DCD Subsection 3.10.5 with the following.

STD COL 3.10(1) *3.10(1)* ***Equipment seismic qualification program***

This COL item is addressed in Subsection 3.10.4.1.

3.10(2) ***Deleted from the DCD.***

STD COL 3.10(3) *3.10(3)* ***Maintenance of equipment qualification files, including EQSDSs***

This COL item is addressed in Section 3.10.

3.10(4) ***Deleted from the DCD.***

NAPS COL 3.10(5) *3.10(5)* ***Previously tested components***

This COL item is addressed in Subsection 3.10.2.

3.10(6) ***Deleted from the DCD.***

3.10(7) ***Deleted from the DCD.***

NAPS COL 3.10(8) *3.10(8)* ***Site-specific OBE***

This COL item is addressed in Subsection 3.10.1.

NAPS COL 3.10(9) *3.10(9)* ***Applicability of high frequency***

This COL item is addressed in Subsection 3.10.2.

3.10(10) ***Deleted from the DCD.***

3.11 Environmental Qualification of Mechanical and Electrical Equipment

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

NAPS COL 3.11(1)
NAPS COL 3.11(3)

Delete the last sentence of the fifth paragraph and replace the first sentence of the sixth paragraph in DCD Section 3.11 with the following.

Implementation of the EQ program, including development of the plant-specific EQ document, will be in accordance with the milestone defined in Section 13.4.

NAPS COL 3.11(4)

Replace the eighth paragraph in DCD Section 3.11 with the following.

This subsection addresses EQ implementation in conjunction with the initial design, procurement, construction, startup and testing up to the point of turnover. Implementation of the operational EQ program is included in Table 13.4-201. Periodic tests, calibrations, and inspections which verify that the identified equipment remains capable of fulfilling its intended function are described in Reference 3.11-3.

3.11.1.1 Equipment Identification

STD COL 3.11(5)

Replace the last sentence of the first paragraph in DCD Subsection 3.11.1.1 with the following.

Table 3D-201 identifies site-specific electrical and mechanical equipment locations and environmental conditions (both normal and accident) to be addressed in the EQ program. This table lists information on site-specific safety-related equipment and non-safety-related equipment which is important to safety. The provisions in the US-APWR DCD for the environmental qualification of mechanical equipment are applied to the plant-specific systems.

3.11.1.2 Definition of Environmental Conditions

STD COL 3.11(9)

Replace the fourth sentence of the first paragraph in DCD Subsection 3.11.1.2 with the following.

Plant-specific EQ parameters are documented in the corresponding equipment specifications, drawings, procedures, instructions, and qualification packages.

3.11.3 Qualification Test Results

STD COL 3.11(2)

Replace the fifth paragraph in DCD Subsection 3.11.3 with the following.

Test results for electrical and mechanical equipment are maintained with the project records as auditable files. Such records are maintained from the time of initial receipt through the entire period during which the subject equipment remains installed in the plant or is stored for future use. Documentation for the qualification of safety-related equipment and nonsafety-related equipment which is important to safety is ultimately the responsibility of the COL Applicant who, later as the licensee, maintains a complete set of EQ records. The EQ records are maintained for the life of plant to fulfill the records retention requirements delineated in 10 CFR 50.49 (Reference 3.11-2) and in compliance with the QAP described in Chapter 17.

3.11.4 Loss of Ventilation

STD COL 3.11(6)

Replace the second paragraph in DCD Subsection 3.11.4 with the following.

Site-specific electrical and mechanical equipment (including instrumentation and control and certain accident monitoring equipment), subject to environmental stress associated with loss of ventilation or other environmental control systems including heat tracing, heating, and air conditioning, is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.5 Estimated Chemical and Radiation Environment

STD COL 3.11(7)

Replace paragraph in DCD, Subsection 3.11.5 with the following.

Chemical and radiation environmental requirements for site-specific electrical and mechanical equipment (including instrumentation and control and certain accident monitoring equipment) are included in MUAP-08015 (Reference 3.11-3). This equipment is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.6 Qualification of Mechanical Equipment

STD COL 3.11(8) Replace the second paragraph in DCD, Subsection 3.11.6 with the following.

Site-specific mechanical equipment requirements are to be included in Table 3D-201 by completion of detailed design. This equipment is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.7 Combined License Information

Replace the content of DCD Subsection 3.11.7 with the following.

NAPS COL 3.11(1) *3.11(1)* ***Environmental qualification document assembly and maintenance***

This COL item is addressed in Section 3.11.

STD COL 3.11(2) *3.11(2)* ***Qualification tests results recorded***

This COL item is addressed in Subsection 3.11.3.

NAPS COL 3.11(3) *3.11(3)* ***Schedule for EQ program implementation milestones***

This COL item is addressed in Section 3.11.

NAPS COL 3.11(4) *3.11(4)* ***Periodic tests, calibrations, and inspections***

This COL item is addressed in Section 3.11.

STD COL 3.11(5)
NAPS COL 3.11(5) *3.11(5)* ***Site-specific equipment addressed in EQ program***

This COL item is addressed in Subsection 3.11.1.1 and Table 3D-201.

STD COL 3.11(6) *3.11(6)* ***Site-specific equipment, equivalent qualification process***

This COL item is addressed in Subsection 3.11.4.

STD COL 3.11(7) *3.11(7)* ***Site-specific chemical and radiation environmental requirements***

This COL item is addressed in Subsection 3.11.5.

STD COL 3.11(8)
NAPS COL 3.11(8) *3.11(8)* ***Site-specific mechanical equipment requirements***

This COL item is addressed in Subsection 3.11.6 and Table 3D-201.

STD COL 3.11(9)

3.11(9) ***Parameters based on site-specific considerations***

This COL item is addressed in Subsection 3.11.1.2.

3.12 Piping Design Review

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.12.3.7 Non-seismic/Seismic Interaction (II/I)

NAPS SUP 3.12(1)

Add the following at the end of this section.

The location and distance between piping systems will be established as part of the completion of ITAAC. The FSAR will be revised as necessary, in a subsequent update to include this information.

3.12.5.1 Seismic Input Envelope vs. Site-Specific Spectra

STD COL 3.12(2)

Replace the second paragraph in DCD Subsection 3.12.5.1 with the following.

For piping located in the yard that is not part of the US-APWR standard design, site specific response spectra described in Subsection 3.7.1 are used for piping analysis.

3.12.5.3.6 Wind/Tornado Loads

NAPS COL 3.12(3)

Replace the paragraph in DCD Subsection 3.12.5.3.6 with the following.

There is no ASME Code, Section III (Reference 3.12-2) Class 2 or 3 piping directly exposed to wind or tornado impingement loading. ASME Code, Section III Class 2 or 3 piping and non-Section III piping, such as B31.1 piping (Reference 3.12-1), are evaluated to the applicable wind and tornado loading identified in Section 3.3 using the applicable piping code load combinations.

3.12.5.6 High-Frequency Modes

NAPS COL 3.12(4)

Replace the second sentence in the second paragraph in DCD Subsection 3.12.5.6 with the following.

Site-specific FIRS for each seismic category I structure exceed the CSDRS in the mid- to HF range. This causes exceedances of some of the ISRS used as input for standard plant piping design. Piping systems identified as seismic category I are designed using the DCD standard ISRS and evaluated using the Unit 3 site-specific ISRS.

3.12.7 Combined License Information

Replace the content of DCD Subsection 3.12.7 with the following.

3.12(1) ***Deleted from the DCD.***

STD COL 3.12(2)

3.12(2) ***Site-specific seismic response spectra for design of piping***

This COL item is addressed in Subsection 3.12.5.1.

NAPS COL 3.12(3)

3.12(3) ***Site-specific ASME Code, Section III, Class 2 or 3 piping, exposed to wind or tornado loads***

This COL item is addressed in Subsection 3.12.5.3.6.

NAPS COL 3.12(4)

3.12(4) ***Piping systems evaluation for sensitivity to high frequency modes***

This COL item is addressed in Subsection 3.12.5.6.

3.13 Threaded Fasteners (ASME Code Class 1, 2, and 3)

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.13.1.5 Certified Material Test Reports

STD COL 3.13(3)

Replace the first sentence in the first paragraph in DCD Subsection 3.13.1.5 with the following.

Quality records, including certified material test reports for all property test and analytical work performed on nuclear threaded fasteners, are maintained for the life of plant as part of the QAP described in Chapter 17.

3.13.2 Inservice Inspection Requirements

STD COL 3.13(4)

Replace the last sentence of the first paragraph in DCD Subsection 3.13.2 with the following.

Compliance with the requirements of the ISI program relating to threaded fasteners, including any applicable PSI and IST, is implemented as part of the operational programs. The ISI program is baselined using PSI. A PSI program relating to threaded fasteners will be implemented after the start of construction and prior to initial plant startup to comply with the requirements of ASME Section XI (Reference 3.13-14). Additionally, in accordance with ASME Section XI, IWA-1200, the PSI code requirements may be performed irrespective of location (such as at manufacturer) once the construction Code requirements have been met.

STD COL 3.13(5)

Replace the first sentence of the fifth paragraph in DCD Subsection 3.13.2 with the following.

An ISI program for the pressure testing of mechanical joints utilizing threaded fasteners is implemented in accordance with the requirements of ASME Code, Section XI, IWA-5000 (Reference 3.13-14), and the requirements of 10 CFR 50.55a(b)(2)(xxvi) (Reference 3.13-11), Pressure Testing Class 1, 2, and 3 Mechanical Joints, and Removal of Insulation, paragraph (xxvii).

3.13.3 Combined License Information

Replace the content of DCD Subsection 3.13.3 with the following.

3.13(1) ***Deleted from the DCD.***

3.13(2) ***Deleted from the DCD.***

STD COL 3.13(3)

3.13(3) ***Quality records including certified material test reports for property test and analytical work on threaded fasteners***

This COL item is addressed in Subsection 3.13.1.5.

STD COL 3.13(4)

3.13(4) ***Compliance with ISI requirements***

This COL item is addressed in Subsection 3.13.2.

STD COL 3.13(5)

3.13(5) ***Complying with requirements of ASME Code, Section XI, and 10 CFR 50.55a***

This COL item is addressed in Subsection 3.13.2.

Appendix 3A Heating, Ventilation, and Air Conditioning Ducts and Duct Supports

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3B Bounding Analysis Curve Development for Leak Before Break Evaluation of High-Energy Piping for United States - Advanced Pressurized Water Reactor

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3C Reactor Coolant Loop Analysis Methods

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3D Equipment Qualification List Safety and Important to Safety Electrical and Mechanical Equipment

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3D.1.6 Determination of Seismic Requirements

STD COL 3.11(5)
STD COL 3.11(8)

Replace the third and fourth sentences of DCD Appendix 3D, Subsection 3D.1.6 with the following.

The seismic class of safety-related mechanical, electrical, and Instrumentation and Control are shown in Table 3D-201 and DCD Table 3D-2. 10 CFR 50 Appendix B requirements will be applied to seismic category I electrical instrumentation and control (I&C), and mechanical equipment contained in Table 3D-201 and DCD Table 3D-2, as discussed in DCD Subsections 3.2.1.1.1 and 3.2.1.1.2.

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
1	UHS-LT-010A	A - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
2	UHS-LT-010B	A – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
3	UHS-LT-011A	B – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
4	UHS-LT-011B	B - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
5	UHS-LT-012A	C - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
6	UHS-LT-012B	C - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
7	UHS-LT-013A	D - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
8	UHS-LT-013B	D – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
9	UHS-LT-010	A - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
10	UHS-LT-011	B - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
11	UHS-LT-012	C - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
12	UHS-LT-013	D - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
13	VRS-MFN-601A	A - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
14	VRS-MFN-601B	B - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
15	VRS-MFN-601C	C - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
16	VRS-MFN-601D	D - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
17	VRS-MFN-602A	A - Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
18	VRS-MFN-602B	B - Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
19	VRS-MFN-602C	C - Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
20	VRS-MFN-602D	D - Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
21	VRS-MEH-601A	A - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
22	VRS-MEH-601B	B - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
23	VRS-MEH-601C	C - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
24	VRS-MEH-601D	D - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
25	VRS-MEH-602A	A - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
26	VRS-MEH-602B	B - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
27	VRS-MEH-602C	C - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
28	VRS-MEH-602D	D - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
29	VRS-MEH-603A	A - Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
30	VRS-MEH-603B	B - Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
31	VRS-MEH-603C	C - Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
32	VRS-MEH-603D	D - Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
33	VRS-TS-803	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
34	VRS-TS-804	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
35	VRS-TS-805	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
36	VRS-TS-806	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
37	VRS-TS-812	A - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
38	VRS-TS-813	A - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
39	VRS-TS-814	A - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
40	VRS-TS-815	A - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
41	VRS-TS-823	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
42	VRS-TS-824	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
43	VRS-TS-825	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
44	VRS-TS-826	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
45	VRS-TS-832	B - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
46	VRS-TS-833	B - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
47	VRS-TS-834	B - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
48	VRS-TS-835	B - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
49	VRS-TS-843	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
50	VRS-TS-844	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
51	VRS-TS-845	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
52	VRS-TS-846	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
53	VRS-TS-852	C -Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location: PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose: ESF, PAM, Other	Operational Duration	Environmental Conditions: Harsh or Mild	Qualification Process: E=Electrical M=Mechanical	Seismic Category: I, II, Non	Comments
54	VRS-TS-853	C - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
55	VRS-TS-854	C - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
56	VRS-TS-855	C - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
57	VRS-TS-863	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
58	VRS-TS-864	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
59	VRS-TS-865	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
60	VRS-TS-866	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
61	VRS-TS-872	D - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
62	VRS-TS-873	D - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
63	VRS-TS-874	D - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
64	VRS-TS-875	D - Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
65	UHS-MPP-001A	A - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location: PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose: ESF, PAM, Other	Operational Duration	Environmental Conditions: Harsh or Mild	Qualification Process: E=Electrical M=Mechanical	Seismic Category: I, II, Non	Comments
66	UHS-MPP-001B	B - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
67	UHS-MPP-001C	C - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
68	UHS-MPP-001D	D - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
69	UHS-MFN-001A	A - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
70	UHS-MFN-001B	B - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
71	UHS-MFN-001C	C - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
72	UHS-MFN-001D	D - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
73	UHS-MFN-002A	A - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
74	UHS-MFN-002B	B - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
75	UHS-MFN-002C	C - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
76	UHS-MFN-002D	D - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
77	UHS-MOV-503A	A - UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
78	UHS-MOV-503B	B - UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
79	UHS-MOV-503C	C - UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location: PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose: ESF, PAM, Other	Operational Duration	Environmental Conditions: Harsh or Mild	Qualification Process: E=Electrical M=Mechanical	Seismic Category: I, II, Non	Comments
80	UHS-MOV-503D	D -UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
81	UHS-MOV-506A	A - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
82	UHS-MOV-506B	B - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
83	UHS-MOV-506C	C - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
84	UHS-MOV-506D	D - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
85	EWS-HCV-010	A - UHS Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
86	EWS-HCV-011	B - UHS Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
87	EWS-HCV-012	C - UHS Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
88	EWS-HCV-013	D - UHS Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
89	UHS-MOV-507A	A - UHS Transfer Pump Discharge Valve (Winter Operation)	UHSRS	ESF	1 yr	Mild	M	I	
90	UHS-MOV-507B	B - UHS Transfer Pump Discharge Valve (Winter Operation)	UHSRS	ESF	1 yr	Mild	M	I	
91	UHS-MOV-507C	C - UHS Transfer Pump Discharge Valve (Winter Operation)	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

			Location	Purpose		Environmental Conditions	Qualification Process	Seismic Category	
Item Number	Equipment Tag	Description	PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other	Operational Duration	Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	Comments
92	UHS-MOV-507D	D - UHS Transfer Pump Discharge Valve (Winter Operation)	UHSRS	ESF	1 yr	Mild	M	I	
93	UHS-MOV-508A	A - UHS Winter Operation Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
94	UHS-MOV-508B	B - UHS Winter Operation Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
95	UHS-MOV-508C	C - UHS Winter Operation Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
96	UHS-MOV-508D	D - UHS Winter Operation Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
97	UHS-MOV-509A	A - UHS Cooling Tower Isolation Valve	UHSRS	ESF	1 yr	Mild	M	I	
98	UHS-MOV-509B	B - UHS Cooling Tower Isolation Valve	UHSRS	ESF	1 yr	Mild	M	I	
99	UHS-MOV-509C	C - UHS Cooling Tower Isolation Valve	UHSRS	ESF	1 yr	Mild	M	I	
100	UHS-MOV-509D	D - UHS Cooling Tower Isolation Valve	UHSRS	ESF	1 yr	Mild	M	I	
101	UHS-MOV-510A	A - UHS Cooling Tower Bypass Valve	UHSRS	ESF	1 yr	Mild	M	I	

NAPS COL 3.11(5)
NAPS COL 3.11(8)

Table 3D-201 Site-Specific Environmental Qualification Equipment List

Item Number	Equipment Tag	Description	Location: PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose: ESF, PAM, Other	Operational Duration	Environmental Conditions: Harsh or Mild	Qualification Process: E=Electrical M=Mechanical	Seismic Category: I, II, Non	Comments
102	UHS-MOV-510B	B - UHS Cooling Tower Bypass Valve	UHSRS	ESF	1 yr	Mild	M	I	
103	UHS-MOV-510C	C - UHS Cooling Tower Bypass Valve	UHSRS	ESF	1 yr	Mild	M	I	
104	UHS-MOV-510D	D - UHS Cooling Tower Bypass Valve	UHSRS	ESF	1 yr	Mild	M	I	

Appendix 3E High Energy and Moderate Energy Piping in the Prestressed Concrete Containment Vessel and Reactor Building

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3F Design of Conduit and Conduit Supports

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3G Seismic Qualification of Cable Trays and Supports

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3H Model Properties for Lumped Mass Stick Models of R/B-PCCV-Containment Internal Structure on a Common Basemat

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3H.1 Introduction

NAPS DEP 3.7(4) Replace the first paragraph in Section 3H.1 with the following.

Refer to MUAP-10001, "Seismic Design Bases of the US-APWR Standard Plant" (Reference 3H-4R) for the model properties for lumped mass stick model of R/B – prestressed concrete containment vessel (PCCV) – CIS on a common basemat.

3H.4 References

Replace Reference 3H.4 with the following.

3H-4R Seismic Design Bases of the US-APWR Standard Plant, MUAP-10001, Rev. 1, Mitsubishi Heavy Industries, May 2010.

Appendix 3I In-Structure Response Spectra

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3I.1 Introduction

NAPS DEP 3.7(4)

Replace the paragraph in Section 3I.1 with the following.

Refer to MUAP-10006 (Reference 3I-3R) for the ISRS for various buildings and elevations of the US-APWR standard plant.

3I.2 References

NAPS DEP 3.7(4)

Replace reference 3I-3 with the following.

3I-3R Soil-Structure Interaction Analyses and Results for the US-APWR Standard Plant, MUAP-10006, Revision 0, Mitsubishi Heavy Industries, Ltd., April 2010.

Appendix 3J Reactor, Power Source and Containment Internal Structural Design

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3K Components Protected from Internal Flooding

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3L [Deleted]

NAPS COL 3.7(3)
NAPS COL 3.7(12)
NAPS COL 3.7(26)
NAPS COL 3.7(29)
NAPS DEP 3.7(1)

Appendix 3LL Model Properties and Seismic Analysis Results for Site-Specific Seismic Category I Structures

The model properties and seismic analysis results for the Unit 3 site-specific structures are provided in the report, “Model Properties and Seismic Analysis Results for Site-Specific Seismic Category I Structures,” which is incorporated by reference and included in COLA Part 11.

NAPS COL 3.7(20)
NAPS COL 3.7(23)
NAPS COL 3.7(25)
NAPS DEP 3.7(1)
NAPS DEP 3.7(4)

Appendix 3NN Model Properties and Seismic Analysis Results R/B-PCCV-CIS and PS/B

3NN.1 Introduction

This appendix documents the site-specific soil-structure interaction (SSI) modeling and analysis results of the US-APWR PCCV, CIS, R/B including the FH/A, (referred to as R/B complex in the following text); and the PS/ Bs of Unit 3.

As stated in Section 3.7.2.4.1, site-specific SSI analyses are performed to validate the US-APWR standard plant seismic design, and to confirm that site-specific SSI effects are enveloped by the SSI analysis used for the standard design described in Section 3.7.2.4 and Technical Reports MUAP-10001 and MUAP-10006 (References 3NN-7 and 3NN-8). The ACS SASSI computer program (Reference 3NN-1) serves as a computational platform for the site-specific SSI analyses. The SASSI site-specific analyses are conducted using methods and approaches consistent with ASCE 4-98 (Reference 3NN-2).

The SSI analyses documented herein address the following conditions that influence the site-specific SSI effects:

- Layering of the rock subgrade.
- Frequency-dependence of soil-structure interaction impedance.
- Foundation flexibility.
- Embedment of the foundation and layering of sidewall backfill material.
- Incoherency and scattering of the input control motion.
- Elevation of the water table.

Three sets of SSI analyses are performed in order to address the site-specific SSI effects on the response of the R/B complex and PS/B structures considering:

- Surface foundation subjected to coherent input ground motion.
- Surface foundation subjected to incoherent input ground motion.
- Embedded foundation subjected to coherent ground motion.

The comparison of the results obtained from the first two sets of SSI analyses shows the effects of the incoherency of the input ground motion on the seismic response of the surface foundation R/B complex model.

The results obtained from the second two sets of SSI analyses performed with the coherent input motion are compared to assess the effect of embedment on the seismic response.

The results of the site-specific SSI analyses are used to develop seismic demands that are specific for the Unit 3 site. The site-specific seismic demands/loads obtained from the three sets of SSI analyses considering surface and embedded foundation and coherent and incoherent motion are all enveloped by the input seismic loads used for the standard design of R/B complex and PS/B structures. This validates the applicability of the standard seismic design of structural members and components for Unit 3.

The site-specific SSI analyses provide results for the response of the R/B complex and the PS/Bs at different locations within the buildings in terms of broadened ISRS. The ISRS that define the site-specific seismic demands on substructures, subsystems, mechanical components and equipment include the combined effects of embedment and incoherency. The 5 percent damping ISRS obtained from the site-specific SSI analyses of the R/B complex and PS/Bs are compared with the corresponding ISRS that serve as the basis for the standard seismic design of Seismic Category I substructures, subsystems, mechanical components and equipment. In general, the standard design ISRS envelope the site specific ISRS with exceptions where the Unit 3 ISRS exceed the standard plant ISRS at frequencies higher than 10 Hz.

3NN.2 Seismological and Geotechnical Considerations

The R/B complex and PS/Bs are founded on rock or on a layer of fill concrete placed on rock as described in Section 2.5.4. The bottom of foundations is at nominal elevation of 251'-2" NAVD88 (252.02 ft NGVD29). NAVD88 is used throughout this Appendix and it is noted that NGVD29 is +0.86 ft. above NAVD88. The foundation sidewalls are backfilled with a 40 ft. (nominal) thick layer of engineered fill material to establish the nominal elevation of the plant ground surface at 290 ft.

In order to take into account the variation of soil properties and the uncertainties associated with the measurement of the properties of the site materials, three sets of properties are used for each set of SSI analyses of R/B complex. Four sets of profiles represent the site conditions at the Unit 3 east (EPS/B) and west PS/B (WPS/B) (these and all other directions used in this report are with respect to Plant North which is at 142.46 degrees counter-clock wise from the State North). Two BE sets of profiles, BE-EPSB and BE-WPSB, represent the properties of the subgrade and embedment for the EPS/Bs and WPS/Bs, respectively. Besides the BE values, the site-specific analyses address the variation of the subgrade properties by considering LB and upper bound (UB) properties. The LB and UB properties are presented in Appendix 3OO, Section 3OO.2. The layering and the dynamic properties of the subgrade materials such as unit weight, strain compatible S-wave and P-wave velocities and damping are obtained from the site response analyses described in Appendix 3OO. The site models for SSI analysis of the R/B complex use a total of 41 horizontally infinite layers to represent the top 560 ft of subgrade materials. 23 horizontally infinite layers model the top 134 ft of subgrade under the East and West PS/B. The properties of the subgrade at greater depths are represented by an elastic half-space. The SSI site models use 10 visco-elastic layers to represent the elastic half space. Each half-space layer has a thickness of:

$$\text{layer thickness} = \frac{(1.5Vs) \div f}{n}$$

where:

- Vs = the shear wave velocity of the half-space
- f = the frequency of analysis
- n = the number of half-space layers

Viscous dashpots are modeled at the base of the simulated half-space.

Figures 3NN-1, 3NN-2, and 3NN-3 show the LB, BE and UB profiles for the S-wave velocity (Vs), P-wave velocity (Vp) and damping properties of the subgrade under the R/B complex. Figures 3NN-7, 3NN-8, and 3NN-9 present the four profiles of the S-wave velocity, P-wave velocity, and damping properties of the subgrade under the east and west PS/Bs. Identical damping values are assigned to the profiles used to model the dissipation of energy in the subgrade material associated with both S-wave and P-wave velocities.

Tables 3NN-1 and 3NN-2 provide the dynamic properties of the soil in which the basements of the Unit 3 R/B complex and PS/B are embedded. The dynamic properties of the embedment soil are compatible with the strains generated by the input ground motion. These strain compatible profiles are developed using the results of the site response analyses of the randomized soil profiles. Figures 3NN-4, 3NN-5, and 3NN-6 present the profiles representing the strain-compatible S-wave velocity, P-wave velocity and damping properties of the embedment around the R/B complex basement.

Figures 3NN-10, 3NN-11, and 3NN-12 present the four profiles representing the strain-compatible S-wave velocity, P-wave velocity, and damping properties of the embedment around the east and west PS/Bs.

The figures show in solid lines the dynamic strain-compatible soil properties obtained from the site response analyses of the R/B complex and PS/B site response analyses described in Section 3OO.2. These sidewall backfill profiles are adjusted to match the geometry of the FE mesh of the SSI basement models. The S-wave and P-wave velocities of the sidewall backfill (Vs and Vp) are adjusted using the equivalent arrival time methodology as follows:

$$Vs = \frac{D}{\sum \frac{d_i}{Vs_i}} \text{ and } Vp = \frac{D}{\sum \frac{d_i}{Vp_i}}$$

where:

D is the thickness of the embedment soil layer in SASSI site model, d_i are the thicknesses of embedment soil layers in the site response analysis model, Vs_i and Vp_i are the strain-compatible S-wave and P-wave velocities corresponding to the layering of the site response model. The soil damping (Ds) of the backfill layers in the SASSI site model is calculated as weighted average using the following formula:

$$Ds = \frac{\sum d_i \cdot Ds_i}{D}$$

where Ds_i is the damping of the soil corresponding to the layering of the model used for site response analysis.

In the figures, the profiles of the SASSI site models used for the SSI analyses are shown with dashed lines.

The GMRS and acceleration time histories established in Appendix 3OO represent the safe-shutdown earthquake (SSE) design motion for seismic analyses of the R/B complex and PS/Bs specified at the bottom of the buildings' foundations at nominal elevation of 251'-2". The response spectra and acceleration time histories obtained from the site response analyses of truncated profiles (geologic outcrop motion) define the ground motion used for site-specific SSI analyses of surface foundations.

The response spectra and acceleration time histories obtained from the full-column site-response analyses define the input ground motion used for the SSI analyses of embedded foundation conditions. The three time histories representing the ground motion in two horizontal directions and vertical direction are statistically independent. The time step of the acceleration time histories used as input for the SSI analysis is 0.005 seconds corresponding to a Nyquist frequency of 100 Hz in accordance with the guidance of SRP 3.7.1. In the SSI analyses, the input object motion is applied at the bottom of the foundation basemats. The outcrop acceleration time histories used as input for the SSI analyses of surface foundations are applied at the top of the site model or the foundation bottom elevation. The analyses of embedded foundations use input acceleration time histories of the “within” motion in the subgrade top layer at foundation bottom elevation. Figures 3NN-19 and 3NN-20 present the 5 percent damping ARS that define the input ground motion used for site-specific SSI analyses of the R/B complex and the PS/B, respectively. The figures present in dashed lines the ARS that define the ground motion for SSI analyses of embedded foundations and in solid lines the ARS that define the ground motion for SSI analyses of surface foundations.

The 2007 Abrahamson hard-rock plane-wave coherency functions from EPRI (Reference 3NN-3) serve to account for the spatial variation of the horizontal and vertical ground motion. This hard-rock model is based on coherency functions that describe the relationship between the ground motions at separate locations within the hard rock site as a function of the frequency of the ground motion frequency and the separation distance between the two locations.

The SSI analyses consider the incoherency of the input ground motion using spectral factorization of the coherency kernel as proposed by Tseng and Lilhanand (Reference 3NN-4). The response of the structure under incoherent ground motion is obtained as an average of the results obtained from a set of 10 stochastic SSI simulations similar to Monte Carlo simulations used for probabilistic analyses. The stochastic simulation approach is described in EPRI 1015111 (Reference 3NN-9).

3NN.3 ACS SASSI Model Description and Analysis Approach

3NN.3.1 R/B Complex

Model Description

The geometry, stiffness and mass inertia properties of the model used for site-specific SSI analyses of Unit 3 R/B complex are identical to those of the model used for the R/B complex of standard plant SSI analyses and seismic design. The lumped-mass stick models representing the dynamic properties of the structures and equipment above ground level are identical to those of the stick models used for the standard design analyses described in Section 3.7.2.4 and Technical Reports MUAP-10001 and MUAP-10006 (References 3NN-7 and 3NN-8).

The only difference between the standard and Unit 3 site-specific models is in the basement mesh size of the Unit 3 R/B complex model, which is adjusted to ensure that the size of the basemat FE mesh meets the maximum frequency requirements for the Unit 3 subgrade properties. The maximum frequency of analysis is determined from the rule in Reference 3NN-1 that the size of the soil layers or the FE model elements in contact with soil should not be bigger than 20 percent of the seismic wavelength for the given soil material. Table 3NN-13 provides the maximum frequencies of analyses that the FE mesh of the R/B complex basement model can capture for different soil cases considered.

The mesh size of the subgrade is sufficiently refined to capture the transmittal of seismic waves with frequencies up to 50 Hz through the subgrade and the base of the foundation. For the embedded SSI model, the mesh size affects the accuracy of the SSI model to capture the transmittal of high frequency seismic input motion through the relatively soft embedment soil. This limits the accuracy of the ISRS results in the HF range for the embedded conditions. However, the SSI analyses of embedded foundations capture the critical effects of the embedment in the lower frequency range, up to 10 Hz.

The following structural modeling information, presented for completeness, is identical for the standard plant R/B complex model and the site-specific model.

Tables 3NN-3 and 3NN-4 present the main dimensions and weights of the R/B complex model. The types of FEs used for modeling of the different structural components of the R/B complex are listed in Table 3NN-7.

Table 3NN-9 provides the material properties assigned to the ACS SASSI structural model of the R/B complex. Table 3NN-11 provides the fixed base frequencies of the R/B complex structures.

The structural model used for ACS SASSI analyses of R/B complex consist of FE model representing the dynamic properties of the basement shear walls and foundation basemat and lumped-mass stick models representing the dynamic properties of the major equipment and building structures above ground elevation, as shown in Figure 3NN-13. Lumped mass stick models represent the stiffness and mass inertia properties of the R/B, the PCCV, CIS that is coupled with the reactor coolant loop (RCL) lumped mass stick model representing the stiffness and mass inertia properties of the major equipment and the main piping. Lumped mass stick models of the reactor vessel (RV) and the four steam generators (SG) and RCPs are included in the RCL model. Single degree of freedom (SDOF) models are included in the lumped mass stick model representing the dynamic properties of the R/B and the FH/A. The SDOF models serve to capture the local out-of-plane response of the flexible slabs and walls at frequencies up to 50 Hz. The properties of the lumped-mass stick models are adjusted to account for the cracking of the concrete in the reinforced concrete members subject to high stress demands under the combination of normal operating and seismic loads.

The basement FE model allows an accurate representation of the interaction of the soil with the building basemat and the basement exterior walls. ACS SASSI solid FE model elements, shown in Figure 3NN-14, model the stiffness and mass inertia properties of the building basemat. The nominal size of the basemat mesh is 14 ft and 15 ft for the surface and embedded model, respectively. The mesh size of the embedment is set to four layers. The modeling of the basemat supporting the PCCV and CIS is simplified to minimize the size of the ACS SASSI model. Rigid shell elements connect the basemat with the floor slabs at the ground elevation. Rigid 3D beam elements connect the PCCV and CIS lumped-mass stick models to the rigid shell elements as shown in Figure 3NN-15. Massless shell elements are added at the top of the basemat solid element to accurately model the bending stiffness of the central part of the mat. ACS SASSI 3D shell elements model the basement shear walls and the R/B slabs at ground floor elevation. The elastic modulus and unit weight assigned to the material of the shell elements modeling the R/B basement shear walls shown in

Figure 3NN-16 are adjusted to account for the reductions of stiffness due to the openings. The shell elements of the walls extend into the basemat solid elements to enable transmittal of nodal rotations.

Rigid 3D beam elements connect the top of the basement shear walls with lumped-mass stick model representing the above ground portion of the R/B and FH/A. This modeling approach enables the R/B-FH/A to be connected to the flexible part of the building basement and decoupled from the thick central part that serves as foundation to the PCCV and CIS part of the building. A Cartesian coordinate system with origin established at the ground surface elevation at the center of the PCCV foundation serves as a reference to the structural model of the R/B complex.

The mesh size of the subgrade is well refined to capture the transmittal of seismic waves with frequencies up to 50 Hz through the subgrade and the base of the foundation. The mesh size affects the accuracy of the ACS SASSI model to capture the transmittal of high frequency seismic through the relatively soft embedment soil. This imposes limitations on the accuracy of the ISRS results in HF range obtained from the SSI analyses of the embedded foundation models.

Analysis Approach

The ACS SASSI computer program (Reference 3NN-1) serves as the platform for the site-specific SSI analyses. The program employs the complex response method and FE technique to solve for the seismic response of the SSI system in the frequency domain. The response is calculated at selected frequencies of analysis and then interpolated for the range of frequencies of interest. The Fast Fourier Transformation (FFT) and inverse FFT techniques are used to transform the input motion and the nodal responses of the system between frequency and time domain.

The ACS SASSI analysis employs the flexible interface or substructuring method to obtain the SSI impedance at interaction nodes. All the nodes at the contact of the building basement with the subgrade and the sidewall backfill serve as interaction nodes. The design earthquake is input at the center of the common basemat foundation of the R/B complex at the level of foundation bottom nominal elevation of 251'-2", where the SSI input motion in Appendix 3OO for Unit 3 R/B complex is defined. The S-waves propagating upward represent the two horizontal components of the design earthquake motion H1 and H2 that are applied in N-S and E-W direction, respectively. The vertical component of the design earthquake (V) is represented by vertically propagating P-waves. The three components of the earthquake are applied to the model separately. The acceleration time histories compatible to the horizontal and vertical FIRS described in Section 3NN.2 are used as input for the analyses.

The basement of the Unit 3 R/B complex is separated from the buildings around it by expansion joints to prevent their interaction during an earthquake. The R/B foundation is embedded in sidewall backfill of engineered granular material.

The site-specific SSI analyses address the effects of these site-specific conditions by considering both a surface foundation and a foundation basement embedded in sidewall backfill that is modeled as infinite in the horizontal direction. Three profiles with BE, LB and upper bound (UB) subgrade and embedment soil properties are considered in order to account for the variation of the properties of the site materials. The layering and the strain compatible dynamic properties of the site used as input for the site-specific SSI analyses are described in Section 3NN.2. Two sets of analyses, with coherent and incoherent input ground motion, are performed on the SSI model of the R/B complex as a surface foundation. Table 3NN-15 presents the matrix of the nine sets of site-specific SSI analyses performed to provide the seismic response of the R/B complex at the Unit 3 site. The ACS SASSI analyses provide the following results that are post-processed to evaluate the response of the R/B Complex structures:

- Acceleration transfer functions at major floor mass nodes.
- Maximum accelerations at major floor mass nodes.
- Maximum displacements at major floor mass or outrigger nodes relative to free field motion.
- Maximum member forces and moments in the stick elements modeling the stiffness of the PCCV, CIS and R/B structures.
- 5 percent damping ARS of the response in the three orthogonal direction at the lumped mass and outrigger nodes of PCCV, CIS and R/B structures including out-of-plane SDOF mass nodes.

The acceleration transfer functions were interpolated using the recommended interpolation approach Option 2 in the ACS SASSI MOTION module (Reference 3NN-1) for analyses using incoherent input ground motion. This interpolation option includes an unbiased moving average scheme that is well-suited for incoherent SSI analyses. The transfer function interpolation error smoothing parameter values were selected so that the interpolated acceleration transfer function curve best fits the computed acceleration transfer function points from the SSI analyses. The application of the acceleration transfer functions phase adjustment for incoherent SSI analyses was validated by Reference 3NN-9. The effect of the acceleration transfer functions phase adjustment for HF seismic inputs is to increase the interpolated incoherent acceleration transfer functions' amplitudes in the HF range as discussed in Reference 3NN-9, Appendix C.

The results for maximum accelerations at PCCV, CIS and R/B lumped-mass floor locations obtained from different sets of SSI runs are calculated and tabulated to help determine effects of different site conditions on the seismic response. The results of the site-specific SSI analyses for maximum displacements serve to confirm that the gap between the buildings is sufficient to prevent them from colliding during an earthquake.

The results of the site-specific SSI analyses for maximum member forces/moments in the stick elements of the lumped-mass-stick models serve as basis for development of the site-specific seismic demands on the R/B complex structures. The following procedure is used for calculation of site-specific seismic demands for each major floor elevation:

1. Develop shear forces, axial force, bending moments and torsional moment diagrams from the ACS SASSI results for maximum member forces and moments in the stick elements.

2. Develop equivalent horizontal loads F_{Hi} in north-south (N-S) and east-west (E-W) direction from the shear force diagrams for each floor elevation.

3. Develop equivalent vertical loads F_{Vi} from the axial force diagram for each floor elevation.

4. Develop equivalent floor rocking moment M_{Ri} in N-S and E-W direction from the bending moments diagrams for each floor elevation.

5. Develop equivalent floor torsional moment M_{Ti} from the torsional moments diagrams for each floor elevation.

6. Use the square root of sum of squares (SRSS) method to combine the seismic demands that are due to three components of the earthquake and envelope the results from all soil profiles considered.

7. Adjust the magnitude of the vertical load P_V to include the effect of the floor rocking due to its rotational mass moment of inertia response using the following equation:

$$F'_V = \sqrt{F_V^2 + \left(\frac{M_{NS}}{L_{NS}}\right)^2 + \left(\frac{M_{EW}}{L_{EW}}\right)^2}$$

where M_{NS} and M_{EW} are the floor rocking moments in N-S and E-W direction and the L_{NS} and L_{EW} are the N-S and E-W length of the floor. This increase is applied to the vertical design SSE loads for the detailed FE model in calculating demands on structural members.

8. Adjust the magnitude of the horizontal floor loads F_H to include the effect of the floor torsional response M_T using the following equation:

$$F'_{NS} = F_{NS} + \frac{M_T}{L_{EW}} \qquad F'_{EW} = F_{EW} + \frac{M_T}{L_{NS}}$$

The design also includes the accidental torsion discussed in DCD Section 3.7.2.11.

9. Envelope the equivalent floor loads and moments results from the SSI analyses of different soil cases and divide them by the corresponding floor weights to obtain the seismic demands in terms of equivalent static accelerations floor loads.

10. Envelope the results for maximum acceleration at SDOF masses from SSI analyses from different soil cases. Calculate the magnitude of the out-of-plane seismic demand on flexible slabs and walls as envelope of the SDOFs.

The ACS SASSI results for the member forces and moments in the stick elements at ground floor elevation provide the reactions from the portion of the building structures located above ground elevation. The SSI results for maximum accelerations at basement lumped mass nodes provide the seismic loads on the portion of the building located at and below ground elevation. The following procedure is used for calculation of site-specific values of the base reaction forces overturning moments for each of the soil case considered:

1. Extract the SSI results for maximum member forces and moments in the PCCV, CIS and RB stick elements at ground elevation to obtain the horizontal forces, vertical force, bending moment and torsional moment reactions at ground elevation.
2. Calculate equivalent static loads at ground floor elevation as the product of the SSI results for maximum accelerations at mass nodal points plant grade elevation and the corresponding nodal lumped mass.
3. Calculate the equivalent static loads for the portion of the building below ground elevation as the product of the SSI results for maximum accelerations at mass nodal point BS01 and the corresponding mass of the basement.
4. From static equilibrium equations, calculate the seismic horizontal shear reactions, vertical reaction and overturning moments at the base elevation using the ground floor reactions obtained from Step 1 and basement forces obtained from Steps 2 and 3.
5. For each soil case considered, combine the seismic base reactions that are due to three components of the earthquake using the Newmark 100:40:40 method.

The developed base reactions serve as input for seismic stability evaluations and calculation of dynamic bearing pressures.

3NN.3.2 PS/B

Model Description

The site-specific SSI analyses of the east and west PS/B use two 3-D FE models. Figure 3NN-17 presents the model used for the SSI analyses of the building as surface foundation, and Figure 3NN-18 is used for SSI analyses of the building as an embedded foundation. The models reflect the geometry and dynamic properties of the west PS/B of the US-APWR documented in Technical Report MUAP-10001 (Reference 3NN-7).

Since the east and west PS/Bs are nearly identical, the models of the east PS/B are also used for the analyses of the west PS/B. The geometry and the dynamic properties of the models used for site-specific SSI analyses of PS/B are identical to that of the model used for the standard plant SSI analyses described in Section 3.7.2.4 and Technical Reports MUAP-10001 and MUAP-10006 (References 3NN-7 and 3NN-8).

The PS/B models use shell elements to represent the stiffness and inertia properties of structural walls and slabs, including the floor slabs and roof slabs. The properties of the shell elements are adjusted to consider the effect of the concrete cracking on the out-of-plane stiffness of the slab elements. The mass density properties of the slab shell elements are adjusted to include the mass of the equipment, the mass associated with additional dead and live loads. The mass of the equipment is distributed over a representative floor area or equipment support footprint area. Beam elements model the structural beams and columns of the PS/B. Solid brick elements with eight nodes represent the basemat of the building. At the connections between the basemat and the walls, the shell elements extend into the basemat solid elements to transmit nodal rotations. The extended elements share nodes with the corresponding face of the solid elements but have no mass. The model of embedded structure also includes a row of solid elements representing the sidewall backfill around the building basement as shown in Figure 3NN-18. These solid elements provide stress results that serve for calculation of dynamic soil pressures and have properties identical to the dynamic properties of the embedment soil layers.

The major dimensions that define the geometry of the FE model are listed in Table 3NN-5. Table 3NN-6 presents the weights of the PS/B, and Table 3NN-8 presents the types of SASSI FEs used in the PS/B model. The material properties of the PS/B reinforced concrete structural members are shown in Table 3NN-10. Table 3NN-12 provides a summary of the building fixed base modal properties in terms of natural frequencies of major modes of vibration. Table 3NN-14 presents the maximum frequencies of analyses that the PS/B FE model can capture for different Unit 3 soil profiles considered.

Analysis Approach

The methodology used for site-specific PS/B SSI analyses is identical to that used for the site-specific SSI analyses of R/B complex described above.

Similar to the R/B complex, the basement of the Unit 3 PS/B's is separated from the buildings around it by expansion joints to prevent their interaction during earthquake. A part of the PS/B foundations are embedded in sidewall backfill of engineered granular material. The site-specific SSI analyses address the effects of these site-specific conditions by considering both surface foundation and foundation basement embedded in sidewall backfill that is infinite in the horizontal direction. Two BE site properties are considered that represent the site conditions at the east PS/B (BE-EPS/B) and at the west PS/B (BE-WPS/B). The site-specific SSI analyses consider additional two profiles, LB and upper bound (UB) profiles in order to account for the variation of the properties of the site materials.

A set of three SSI stochastic simulations are performed of the PS/B subjected to incoherent ground motion. The incoherent motion SSI simulation considers the PS/B as surface foundation resting on the surface of the LB, UB, and BEW-PS/B subgrades. Table 3NN-16 provides a matrix of the site-specific SSI analyses of the east and west PS/Bs. The ACS SASSI analyses provide the following results that are post-processed to evaluate the response of the east and west PS/B at Unit 3 site:

- Acceleration transfer functions at selected locations. The acceleration transfer functions were interpolated using the same methodology as discussed in Section 3NN.3.1.
- Maximum accelerations at all structural nodes.
- Maximum displacements at building corner at major floor elevation relative to free field motion.
- 5 percent damping ARS of the response in selected locations.
- Stresses in the soil elements modeling the embedment soil in contact with the PS/B basement exterior walls.

The results for maximum accelerations at selected locations obtained from different sets of SSI analyses are tabulated and compared to assess the effects of different site conditions on the seismic response. The maximum displacements results serve to demonstrate that the gap between the buildings is sufficient to prevent them from colliding during an earthquake.

The site-specific demands on the PS/B structural members are developed in the form of equivalent static accelerations as follows:

1. Calculate maximum accelerations in each of the three response directions due to each of the three direction input motions from the results of the SSI results of PS/B as surface foundation.

2. Envelope the results the maximum nodal accelerations results from the four surface foundation soil cases.

3. Create nine plots of the envelope maximum accelerations in three directions representing the response of the PS/B at particular floor elevation due to the three components of the earthquake.

4. Apply the SRSS rule to combine the enveloped nodal maximum accelerations due to the three directions of the earthquake. Plot the SRSS of the maximum acceleration responses in the three orthogonal directions.

5. Calculate weighted average accelerations at floor elevation "f" as follows:

$$A_i^f = \frac{\sum a_i^k \cdot w_k}{W_f}$$

where W_f is the total weight of the floor "f", w_k is the weight participating to node "k", A_i^f is the weighted average acceleration of floor "f" in "i' direction, and a_i^k is the maximum SRSS acceleration at node "k" in "i' direction.

6. Determine equivalent seismic demand at each floor elevation based on the maximum acceleration plots and the weighted average accelerations obtained from items 3, 4 and 5. The design also includes the accidental torsion discussed in DCD Section 3.7.2.11.

7. Determine the out of plane seismic demands on slabs and walls with large unsupported areas based on the plots of the maximum acceleration plots obtained in step 4.

8. Calculate story shear diagram for the PS/B structure. The total shear at each floor elevation is obtained as the sum of the all nodal inertial forces at and above that elevation. The nodal inertial forces are the product of the nodal mass and the equivalent static acceleration acting on the node.

Base shear and moment reactions are calculated at the bottom of the basemat foundation for each soil condition considered to be used for evaluations of seismic stability and dynamic bearing pressures.

3NN.4 Seismic Analysis Results

3NN.4.1 Seismic Response

Table 3NN-17 summarizes the influence of different SSI effects on the site-specific seismic responses of the R/B complex and PS/B structures that are observed from the results of the site-specific SSI analyses.

Tables 3NN-18A, 3NN-18B and 3NN-18C present the maximum displacements at selected locations of the PCCV, CIS, and R/B -FH/A respectively, relative to the free field motion for the Unit 3 plant site and the standard plant site. The displacements are an envelope of the results obtained from SSI analyses of surface and embedded foundations. The tables show that the site specific displacements are always enveloped by the standard design displacements. Table 3NN-19 presents the maximum seismic displacements of the PS/B relative to the free field motion for the Unit 3 site and standard plant site. The table presents the maximum displacements at the corners of the building that represent the envelope of the results obtained from the SSI analyses of surface foundation with coherent input motion (SLB, SBE, SBW and SUB). The results show that the displacements of the buildings at Unit 3 site are enveloped by the displacements of the standard design. It is also noted that the displacement due to the high frequency input motions are much smaller than 1 inch. This confirms that the structural gap of 4 inches between the buildings is sufficient to ensure that the buildings will not collide during earthquake.

3NN.4.2 Seismic Demands on Structural Members

Tables 3NN-20A, 3NN-20B, and 3NN-20C show the site-specific seismic demands on the structural members of the PCCV, CIS, and R/B-FH/A respectively, obtained from the three sets of SSI analyses considering surface and embedded foundation with coherent motion and surface foundation with incoherent motion. The demands presented in terms of horizontal and vertical load at major floor elevations are obtained using the same procedure used for evaluation of the seismic loads for standard design as described in Section 3NN.3.1. Tables 3NN-20D and 3NN-20E list the site-specific seismic demands due to out-of-plane response of flexible slabs, roofs and walls of R/B. The demands are presented in terms of equivalent static accelerations that represent the maximum load demands acting on specific group of slabs, roofs or walls. The grouping of the out-of-plane demands on slabs and walls for Unit 3 site is identical to that used for evaluation of the out-of-plane seismic loads for the standard design.

The site-specific seismic demands for the structural members of the east and west PS/B are evaluated in terms of equivalent static accelerations as described in Section 3NN.3.2. The enveloping maximum accelerations results obtained from the SSI analyses of surface foundation with coherent input ground motion are used for the evaluation. The evaluation follows identical methodology as the one used for evaluation of seismic loads for the standard design of the PS/B. Table 3NN-21A presents the site-specific seismic demands at major floor elevations that represent the weighted average of the maximum accelerations at the particular floor elevation. Table 3NN-21B presents the out-of-plane seismic demands on the roof, slabs and walls of the PS/B.

The seismic demands on the structural members that are obtained from the site-specific SSI analyses of Unit 3 R/B complex and PS/B are compared to the corresponding seismic loads used for design of these structures documented in Technical Report MUAP-10006 (Reference 3NN-8). The comparison shows that the standard design seismic loads envelope the seismic demands specific to the Unit 3 site, and thus confirms the validity of the standard design of the structural members of R/B complex and PS/B.

3NN.5 In-Structure Response Spectra

The ISRS representing the envelope response at particular locations within the buildings are obtained from the 5 percent damping ARS responses at different locations. The methodology used for grouping of the ARS is identical to that used for calculation of ISRS that serve for the standard design of Seismic Category I and II subsystems and SSCs.

Three sets of broadened ISRS are developed that represent the enveloped response for different site conditions considered that are obtained from SSI analyses of: 1) surface foundation with coherent motion, 2) embedded foundation with coherent motion and 3) surface foundation with incoherent motion. The ISRS obtained from the SSI analyses using coherent input ground motion are compared to quantify the amplification of the ISRS due to the embedment effects. The final broadened incoherent ISRS curves are obtained by adjusting the ISRS developed from the SSI analyses of surface foundation with incoherent input ground motion to incorporate the amplifications that are due to the embedment effects. These ISRS that include foundation embedment and ground motion incoherency effects define the site-specific seismic demands for Seismic Category I and II SSCs and subsystems.

Figure 3NN-23 (Sheets 1 through 143) presents the 5 percent critical damping broadened ISRS developed for the R/B complex from the site-specific SSI analysis results. Figure 3NN-21 (Sheets 1 through 12) presents the 5 percent critical damping broadened ISRS obtained for the PS/B from the site-specific SSI analysis results. Each of the plots in the figures shows two site-specific ISRS representing the response of the structure under coherent and incoherent input ground motion. The comparison of the two sets of site-specific ISRS illustrates the effect of the ground motion incoherency on the seismic response at particular building locations. The corresponding 5 percent critical damping standard design ISRS obtained from the standard plant SSI analyses are also included in the figures for comparison.

3NN.6 Lateral Earth Pressure

The standard plant is based on lateral earth pressure for a water table location of 1 ft below grade. The site specific observations are as follows:

- The post-construction piezometric head contour map (Figure 2.4-216) indicates that maximum groundwater level elevations in the power block area range from about 83.4 to 86.0 m (270.0 to 284.4 ft).
- The maximum groundwater level elevation in the power block RB/PCCV area of Unit 3 is 282.3 ft or 7.7 ft below the design plant grade elevation of 290 ft NAVD88 (290.86 ft NGVD29).
- The maximum groundwater level elevation near the UHSRS is 284.4 ft or 5.6 ft below the design plant grade elevation.

- Figure 2.4-216 shows that the water levels for the PS/Bs and PSFSVs are below Elevation 282.3 ft. However site specific analysis presented below was performed based on a ground water level of 283 ft.

Lateral earth pressure loads are applied to all below-grade exterior walls that are in contact with embedment soil. The earth pressure loads are applied along the whole embedment height of the walls conservatively assuming that during an earthquake there is no separation between the walls and the soil. Hydrostatic pressures are applied at elevations below the nominal water table elevation specified (7 ft below the nominal plant grade i.e., Elevation 283 ft). Hydrostatic pressure due to ground water is also included in the design/analysis of below-grade exterior walls where expansion joints are present. The site-specific dynamic (and static) lateral pressure distributions are calculated using material properties and data for granular structural fill consistent with Table 2.5-212.

The site-specific static lateral earth pressure on the subgrade exterior walls is computed using methods described in Subsection 2.5.4.10.3. The site-specific static lateral earth pressure is computed considering a Rankine at-rest pressure coefficient and using classic formulas in which static earth pressure, including hydrostatic pressure, increases linearly with depth. Lateral load on below-grade walls due to surcharge loading at the surface is also considered. Lateral load due to surcharge loading is computed by multiplying the Rankine at-rest pressure coefficient for granular structural fill times the surcharge area load. Figure 2.5-254 shows a general static earth pressure diagram for nonyielding walls which includes a lateral load due to surcharge.

The site-specific dynamic lateral pressure on the subgrade exterior walls consists of dynamic earth pressure and hydrodynamic water pressure.

The dynamic earth pressure distributions are determined using Wood's soil pressure distributions presented in Figure 3.5-1 of ASCE 4-98 (Reference 3NN-2). To calculate the dynamic earth pressure using Wood's soil pressure distribution, the weighted average soil unit weight is determined as follows:

$$\gamma = \frac{\gamma_m H_w + (\gamma_s - \gamma_w)(H - H_w)}{H}$$

Where γ_m and γ_s are the moist and saturated unit weight of the sidewall backfill, respectively; H_w is the ground water table depth (7 ft); γ_w is unit weight of water and H is the depth of foundation bottom (38.83 ft).

The hydrodynamic water pressure distributions are calculated using Westergaard formula (Reference 3NN-6):

$$P_W = \frac{7}{8}\frac{a_h}{g}\gamma_w\sqrt{z_w h}$$

Where, a_h is horizontal seismic coefficient (PGA) in g's, Z_w and h are the depth of calculation point and total depth of water (38.83-7 =31.83 ft), respectively.

The total seismic (dynamic) lateral load on the wall is determined as the sum of the Wood's dynamic soil pressures and Westergaard hydrodynamic water pressures. SASSI analyses on the embedded model of PS/B were performed to validate the calculated total seismic lateral loads. Four soil cases, denoted as ELB, EBE-EPS, EBE-WPS and EUB representing LB, BE for the east PS/B, BE for the west PS/B and upper bound soils, respectively, are considered in analyses (refer to Section 3NN.3.2 for details).

The SASSI soil pressure distributions are developed using following procedure:

1. For each soil cases, the maximum stress responses on the center of the near field (sidewall backfill) soil elements to each of three input motions are extracted from the SASSI runs.
2. For each soil case, co-linear responses (response in the same direction) from the three directions of input motion are combined using SRSS.
3. The SRSS combined stresses normal to the wall are considered as the soil pressures due to the three direction input motions.

Results of the analysis have been presented graphically in Figure 3NN-22. For comparison, Figure 3NN-22 shows site specific seismic lateral load (curve NA3 Dynamic Wood+Westergaard), SASSI analysis results (curves EBE-EPS SRSS, EBEWPS SRSS, ELB SRSS and EUB SRSS), and the seismic earth pressure loading used in the standard design (Standard Plant Design curve) for a typical section of

N-S direction wall. Figure 3NN-22 also includes plots of the Unit 3 total lateral earth pressure and the standard plant total lateral earth pressure which include both the static and dynamic components. These plots demonstrate that the total (static and dynamic) earth pressure loading used in the standard design envelopes the site-specific loading on the basement wall, which includes the effect of the SRSS soil pressures obtained from site-specific SASSI analyses.

3NN.7 References

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Table 3NN-1 Embedment Strain Compatible Properties: R/B Complex

Layer	Thick. (ft)	Top Elev. (ft)	Unit Weight (kcf)	S-wave velocity (fps)			P-wave velocity (fps)			Damping		
				BE	LB	UB	BE	LB	UB	BE	LB	UB
1	10.91	290	130	648	407	1033	1803	1144	2743	3.78%	6.09%	2.34%
2	8.50	279.09	130	718	436	1183	3662	2224	5000	5.25%	8.25%	3.35%
3	8.50	270.59	130	760	460	1254	3873	2345	5000	5.63%	8.82%	3.59%
4	9.92	262.09	130	796	461	1374	4059	2350	5000	5.80%	9.41%	3.57%

Properties used for SSI analyses of BE, Lower Bound and Upper Bound site condition are designated as BE, LB and UB respectively.

Table 3NN-2 Embedment Strain Compatible Properties: PS/B

Layer	Thick. (ft)	Top Elev. (ft)	Unit Weight (pcf)	S-wave velocity (fps)				P-wave velocity (fps)				Damping (%)			
				BE EPS/B	BE WPS/B	LB	UB	BE EPS/B	BE WPS/B	LB	UB	BE EPS/B	BE WPS/B	LB	UB
1	5	290	130	548	625	350	923	1026	1169	654	1727	5.39	3.03	3.35	1.98
2	5	285	130	620	703	388	1063	3159	3587	1976	5000	7.45	4.24	4.66	2.78
3	5	280	130	653	725	407	1125	3328	3698	2073	5000	8.16	4.77	5.25	3.15
4	5	275	130	679	741	415	1145	3462	3780	2116	5000	8.56	5.35	5.51	3.53
5	5	270	130	697	774	424	1189	3554	3946	2164	5000	9.14	5.29	5.92	3.59
6	5	265	130	692	776	410	1258	3528	3957	2091	5000	9.96	5.72	6.24	3.62
7	5	260	130	739	781	446	1304	3770	3983	2275	5000	9.54	5.91	6.13	3.71
8	4	255	130	762	833	461	1344	3888	4247	2350	5000	9.96	5.74	6.32	3.61

Properties used for SSI analyses of BE-East PS/B, BE-West PS/B, Lower Bound and Upper Bound site condition are designated as BE EPS/B, BE WPS/B, LB, and UB respectively.

Table 3NN-3 R/B Complex Model Main Dimensions

Item	Value
Basemat Length in N-S Direction	308'-11"
Basemat Length in E-W Direction	213'-4"
PCCV Foundation Diameter	187'-0"
PCCV Foundation Thickness (1)	23'-9" / 39'-10"
R/B Basemat Thickness	9'-11"
Basement Exterior Wall Thickness (1)	3'-4" / 3'-8"
Nominal Basemat Bottom Elevation	251'-2"
Nominal Ground Elevation	290'-0"
PCCV Dome Top Elevation	519'-5"
FH/A Roof Elevation	441'-11"

Note (1): Thickness varies

Table 3NN-4 Weight of R/B Complex Model

Structure	Weight (kips)
PCCV Above Ground Elevation	74,347
CIS Above Ground Elevation	85,738
RCL System	9,553
R/B Above Ground Elevation	277,730
PCCV at Ground Elevation	3,941
R/B at Ground Elevation	116,019
CIS at Ground Elevation	21,801
Basement	187,000
Total Weight of R/B Complex	776,129
Equivalent Uniform Bearing Pressure = 11.96 ksf	

Table 3NN-5 PS/B Model Main Dimensions

Item	Value
Basemat Length in N-S Direction	69'-4"
Basemat Length in E-W Direction	114'-10"
Basemat Thickness	9'-11"
Basement Exterior Wall Thickness	2'-8"
Nominal Basemat Bottom Elevation	251'-2"
Nominal Ground Elevation	290'-0"
Main Roof Slab Top Elevation (not including roof appurtenances)	326'-11"

Table 3NN-6 Weight of PS/B Model

Location/ Component	Weight (kips)
Roof Level	7,940
Ground Floor Level	12,410
Basemat Level	16,400
Total	36,750

Equivalent Uniform Bearing Pressure = 4.62 ksf

Table 3NN-7 Finite Elements Assigned to R/B Complex Model

Structural Member	Element	Mass	Stiffness
Upper Portion of Reactor Mat	Shell	Weightless	Concrete f_c=4000psi
N-S Exterior Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)
E-W Exterior Walls	Shell	Concrete (adjusted)	Concrete f_c =4000psi (adjusted)
N-S Basement Inner Shear Walls	Shell	Weightless	Concrete f_c =4000psi (adjusted)
Connecting Shells	Shell	Weightless	Rigid
Ground Floor Slabs	Shell	Weightless	Concrete f_c =4000psi
Basemat	Solid	Concrete	Concrete f_c =4000psi (adjusted)
Rigid Rim at top of Reactor Mat	Beam	Weightless	Rigid
PCCV Stick Rigid Connection	Beam	Weightless	Rigid
CIS Stick Rigid Connection	Beam	Weightless	Rigid
R/B-Fuel Handling Area Stick Rigid Connection	Beam	Weightless	Rigid
BS01 Lumped Mass Rigid Connection	Beam	Weightless	Rigid
PCCV stick elements	Beam	Weightless	Concrete f_c=7000psi
CIS stick elements	Beam/Spring	Weightless	Concrete f_c=4000psi
R/B and FH/A stick elements	Beam/Spring	Weightless	Concrete f_c=4000psi
RCL model	Beam/Spring	Weightless	Steel ASME properties
Stick model offsets	Beam	Weightless	Rigid

Table 3NN-8 Finite Elements Assigned to PS/B Model

Structural Member	Element
Beams and Columns	Beam
Floor slabs	Shell
Shear Walls	Shell
Basemat	Solid

Table 3NN-9 R/B Complex Input Material Properties

Structural Component	Concrete Compressive Strength (psi)	Young's Modulus ($\times 10^5$ ksf)	Poisson's Ratio	Damping
PCCV	7000	6.87	0.17	5%
R/B including FH/A, and Basement	4000	5.19	0.17	7%
CIS	4000	5.19	0.17	5%

Table 3NN-10 PS/B Input Material Properties

Structural Component	Concrete Compressive Strength (psi)	Young's Modulus ($\times 10^5$ ksf)	Poisson's Ratio	Damping SSE
Foundation	4000	5.19	0.17	7%
Walls and Slabs	4000	5.19	0.17	7%

Table 3NN-11 Fixed Base Modal Properties of R/B Complex

Structure	Mode	N-S	E-W	Vertical
PCCV	1	4.5	4.5	12.2
	2	12.8	12.8	16.0
	3	26.2	26.2	17.3
CIS	1	5.0	5.3	14.4
	2	7.5	7.6	18.1
	3	10.0	10.0	18.7
R/B -FH/A	1	5.6	6.0	11.3
	2	7.5	7.3	11.9
	3	9.3	9.0	17.5

Table 3NN-12 Fixed Base Modal Properties of PS/B

(First Five Modes) Frequency (Hz)		
N-S	E-W	Vertical
8.7	10.3	13.9
12.8	12.3	16.9
19.9	20.6	26.0
20.2	22.3	33.5
21.4	23.5	36.8

Table 3NN-13 Attributes at Maximum Frequency of Analysis for R/B Complex

Model	Nominal Mesh Size	Component	Max. Frequency (Hz) BE	LB	UB
Surface	14 ft	Basement Mesh	98.1	80.1	120.1
		Subgrade Profile	73.0	59.6	89.4
Embedded	15 ft	Basement Mesh	91.5	74.7	112.1
		Subgrade Profile	73.0	59.6	89.4
		Sidewall Backfill	11.9	7.5	18.9

Table 3NN-14 Attributes at Maximum Frequency of Analysis for PS/B

Model	Nominal Mesh Size*	Component	Max. Frequency (Hz) BE-EPSB	BE WPSB	LB	UB
Surface	6.3 ft (horizontal)	Basement Mesh	116	184	90	226
		Subgrade Profile**	73	73	60	90
Embedded	7.58 ft (vertical) 8.0 ft (horizontal)	Basement Mesh	116	184	90	226
		Subgrade Profile	73	73	60	90
		Sidewall Backfill***	16	18	10	27

* The nominal mesh size is the maximum distance between two adjacent nodes in vertical and/or horizontal soil-structure interface.

** Refers to soil/rock below foundation bottom level

*** Refers to soils above foundation bottom level

Table 3NN-15 Matrix of ACS SASSI Analyses of R/B Complex

SASSI Run		Subgrade Properties	Embedment	No. of Frequency of Analysis	Cut-off Frequency
1	SLB -	Lower Bound	No Embedment	231	49.8
2	SBE -	Best Estimate	No Embedment	231	49.8
3	SUB -	Upper Bound	No Embedment	231	49.8
4	ELB -	Lower Bound	Lower Bound	33	8.0
5	EBE -	Best Estimate	Best Estimate	49	12.0
6	EUB -	Upper Bound	Upper Bound	81	20.0
7	ILB -	Lower Bound	No Embedment	170	49.8
8	IBE -	Best Estimate	No Embedment	170	49.8
9	IUB -	Upper Bound	No Embedment	170	49.8

Table 3NN-16 Matrix of ACS SASSI Analyses of PS/B

SASSI Run		Subgrade Properties	Embedment	No. of Frequency of Analysis	Cut-off Frequency
1	SLB -	Lower Bound	No Embedment	100	49.7
2	SBE -	Best Estimate East PS/B	No Embedment	100	49.7
3	SBW	Best Estimate West PS/B	No Embedment	100	49.7
4	SUB -	Upper Bound	No Embedment	100	49.7
5	ELB -	Lower Bound	Lower Bound	34	15.0
6	EBE -	Best Estimate East PS/B	Best Estimate East PS/B	56	25.0
7	EBW	Best Estimate West PS/B	Best Estimate West PS/B	62	28.0
8	EUB -	Upper Bound	Upper Bound	75	33.0
9	ILB -	Lower Bound	No Embedment	231	49.8
10	IBE -	Best Estimate East PS/B	No Embedment	231	49.8
11	IUB -	Upper Bound	No Embedment	231	49.8

Table 3NN-17 SSI Effects on R/B Complex and PS/B Seismic Response

SSI Effect	Observed Response
Rock Subgrade	The rock subgrade, due to its high stiffness, has insignificant effect on the main frequency of the seismic response of PCCV, R/B complex and PS/B structures. The structural natural frequencies characterize the response obtained from ACS SASSI analyses of the surface foundation.
Sidewall Backfill Embedment	The embedment effects slightly reduce the seismic response of R/B complex and PS/B structures. This results in slightly lower maximum relative displacements and absolute accelerations. The embedment also slightly lowers the member forces and moments in the stick elements of the R/B complex structures. Due to the mismatch in the properties of the sidewall backfill and the subgrade, there is an upward wave reflection that amplifies the free-field motion at ground surface. The engineered sidewall backfill effects amplify locally the transfer functions at the basement level of the R/B complex resulting in sharp peaks in the amplification transfer functions at the sidewall backfill column fundamental frequencies of 2.9 Hz, 4.9 Hz and 8 Hz. The sidewall backfill side-soil SSI effects amplify only slightly and locally the ISRS computed at the basement level of the R/B complex in LF ranges that correspond to sidewall backfill column frequencies up to 10 Hz.
Site-Specific Motion Effects including Incoherency and Scattering	Pronounced high frequency content characterizes the site-specific motion at North Anna Unit 3 site. The intensity of the ground motion is relatively small at frequencies that are near the natural frequency of the R/B complex and PS/B structures. The higher modes of vibration govern the structural response resulting in smaller displacement and stresses than those generated by the standard plant design CSDRS. These characteristics are more pronounced for structures of the R/B complex that are more flexible and have lower natural frequencies than those of the PS/B. Motion scattering effects are inherent in the ACS SASSI analysis results. The dynamic properties mismatch between the sidewall backfill and the rock results in reflection of the seismic waves within the sidewall backfill stratum. The incoherency of the ground motion reduces the response of the R/B complex and PS/B structures in the high frequency range. The reduction in the 5% damping ISRS is up to 40% for the horizontal response and 60% for the vertical response. The comparison of the responses obtained from the incoherency SSI simulations with different subgrade properties indicate that the effect of soil property variations are small on the incoherency effects.

Table 3NN-17 SSI Effects on R/B Complex and PS/B Seismic Response

Basemat Flexibility	The results of the SSI analyses do not indicate any significant effect of the common basemat flexibility on the seismic response of the R/B complex and PS/B structures.

Table 3NN-18A Maximum Relative Displacements of PCCV

Location				Envelope of Maximum SRSS Displacements (in)			Standard Plant Envelope of Maximum SRSS Displacements (in)		
Node	**x (ft)**	**y (ft)**	**z (ft)**	d_{NS}	d_{EW}	d_V	d_{NS}	d_{EW}	d_V
CV11	0.00	0.00	230.17	0.402	0.437	0.127	1.667	2.104	0.244
CV10	0.00	0.00	225.00	0.395	0.430	0.112	1.649	2.076	0.240
CV09	0.00	0.00	201.67	0.361	0.392	0.083	1.561	1.945	0.234
CV08	0.00	0.00	173.08	0.314	0.341	0.067	1.447	1.776	0.230
CV07	0.00	0.00	145.58	0.266	0.288	0.061	1.333	1.608	0.228
CV06	0.00	0.00	115.50	0.210	0.227	0.053	1.204	1.416	0.226
CV05	0.00	0.00	92.17	0.166	0.179	0.044	1.103	1.267	0.223
CV04	0.00	0.00	76.42	0.136	0.146	0.040	1.034	1.165	0.221
CV03	0.00	0.00	68.25	0.121	0.130	0.037	0.998	1.114	0.220
CV02	0.00	0.00	50.17	0.089	0.096	0.031	0.922	1.000	0.217
CV01	0.00	0.00	25.25	0.049	0.054	0.024	0.821	0.847	0.214
CV00	0.00	0.00	1.92	0.023	0.032	0.016	0.732	0.738	0.210

Table 3NN-18B Maximum Relative Displacements of CIS

Location				Envelope of Maximum SRSS Displacements (in)			Standard Plant Envelope of Maximum SRSS Displacements (in)		
Node	x (ft)	y (ft)	z (ft)	d_{NS}	d_{EW}	d_V	d_{NS}	d_{EW}	d_V
IC09	39.29	0.00	139.50	0.545	0.562	0.065	1.415	1.565	0.245
IC18	39.24	0.00	110.75	0.308	0.349	0.060	1.208	1.362	0.245
IC08	39.29	0.00	112.33	0.323	0.362	0.061	1.220	1.374	0.245
IC05	3.36	0.74	76.42	0.098	0.157	0.025	0.964	1.118	0.215
IC72	7.29	44.03	112.00	0.179	0.259	0.080	1.090	1.336	0.319
IC71	8.11	43.98	112.00	0.168	0.253	0.078	1.087	1.333	0.318
IC62	3.88	37.65	96.58	0.139	0.209	0.062	1.034	1.243	0.292
IC61	3.94	-37.73	96.58	0.132	0.212	0.061	1.033	1.242	0.292
IC15	3.36	0.74	59.17	0.071	0.116	0.022	0.905	1.019	0.214
IC04	1.92	-0.61	50.17	0.058	0.097	0.020	0.876	0.966	0.212
IC14	1.92	-0.61	45.67	0.050	0.088	0.020	0.859	0.938	0.212
IC03	-2.28	0.13	35.88	0.038	0.065	0.019	0.826	0.881	0.212
IC02	-2.38	-0.18	25.25	0.028	0.047	0.018	0.791	0.824	0.212
IC01	1.22	0.05	16.00	0.025	0.040	0.017	0.766	0.782	0.210
IC00	1.22	0.05	1.92	0.023	0.032	0.016	0.732	0.738	0.209

Table 3NN-18C Maximum Relative Displacements of R/B and FH/A

Location				Envelope of Maximum SRSS Displacements (in)			Standard Plant Envelope of Maximum SRSS Displacements (in)		
Node	**x (ft)**	**y (ft)**	**z (ft)**	d_{NS}	d_{EW}	d_V	d_{NS}	d_{EW}	d_V
FH08	-116.67	17.44	154.50	0.323	0.221	0.096	1.351	1.500	0.448
NE08	-146.58	106.67	154.50	0.325	0.221	0.170	1.351	1.502	0.767
NW08	-146.58	-71.42	154.50	0.320	0.221	0.157	1.352	1.502	0.653
FH07	-120.08	18.37	125.67	0.217	0.184	0.092	1.216	1.357	0.457
RE05	115.42	6.17	115.50	0.102	0.149	0.088	1.092	1.279	0.406
FH06	-120.81	17.41	101.00	0.134	0.144	0.085	1.091	1.228	0.456
RE41	-28.46	-77.07	101.00	0.088	0.139	0.083	1.044	1.219	0.449
RE42	3.48	79.00	101.00	0.085	0.133	0.071	1.043	1.214	0.448
RE04	119.54	-7.83	101.00	0.089	0.133	0.089	1.048	1.210	0.416
RE03	9.95	2.01	76.42	0.067	0.101	0.029	0.968	1.090	0.220
NE03	-146.58	106.67	76.42	0.070	0.100	0.119	0.968	1.093	0.738
NW03	-146.58	-106.67	76.42	0.067	0.100	0.114	0.970	1.093	0.734
SE03	161.67	106.67	76.42	0.070	0.106	0.134	0.968	1.086	0.748
SW03	161.67	-106.67	76.42	0.067	0.106	0.131	0.970	1.086	0.744
RE02	-5.50	-2.93	50.17	0.052	0.073	0.024	0.886	0.962	0.217
RE01	-5.34	-4.09	25.25	0.036	0.052	0.020	0.805	0.839	0.215
RE00	1.24	-0.25	3.58	0.023	0.032	0.016	0.736	0.742	0.209

Table 3NN-19 Maximum Relative Displacements of PS/B

Node Location	Elevation	Envelope of Maximum SRSS Displacements (in)			Standard Plant Envelope of Maximum SRSS Displacements (in)		
		d_{NS}	d_{EW}	d_V	d_{NS}	d_{EW}	d_V
North West Corner	Roof	0.09	0.08	0.02	0.37	0.23	0.12
South East Corner	Roof	0.11	0.08	0.03	0.37	0.23	0.13
South West Corner	Roof	0.11	0.09	0.03	0.39	0.24	0.13
North East Corner	Roof	0.12	0.09	0.03	0.41	0.25	0.13
North West Corner	Ground Floor	0.04	0.04	0.02	0.23	0.16	0.12
South East Corner	Ground Floor	0.05	0.05	0.02	0.23	0.17	0.12
South West Corner	Ground Floor	0.04	0.05	0.02	0.23	0.16	0.12
North East Corner	Ground Floor	0.05	0.04	0.02	0.23	0.16	0.12
North West Corner	Basemat Top	0.01	0.02	0.01	0.13	0.11	0.11
South East Corner	Basemat Top	0.01	0.02	0.01	0.13	0.11	0.11
South West Corner	Basemat Top	0.01	0.02	0.01	0.13	0.11	0.11
North East Corner	Basemat Top	0.01	0.01	0.01	0.12	0.11	0.10

Table 3NN-20A Site Specific Seismic Demand Comparison: PCCV

	Standard Design			Unit 3								
	Coherent Motion			Coherent Motion						Incoherent Motion		
	Surface Foundation			Surface Foundation			Embedded Foundation			Surface Foundation		
Floor	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V
CV11	1,597	2,129	1,907	691	947	1,860	614	814	1,243	899	998	1,154
CV10	7,378	9,838	6,558	3,093	4,302	6,499	2,795	3,692	5,088	4,189	4,631	4,094
CV09	13,275	17,180	10,152	5,501	6,984	9,668	4,831	5,842	7,062	7,528	8,540	5,062
CV08	13,161	16,557	8,916	5,261	5,320	8,439	4,717	5,669	6,205	7,397	9,870	4,534
CV07	16,661	19,637	11,306	6,354	5,000	10,609	5,626	6,733	7,948	8,582	8,764	6,219
CV06	10,419	12,231	7,248	3,946	4,036	6,604	3,290	4,189	5,062	4,975	6,455	4,213
CV05	7,529	8,282	5,270	2,523	4,752	4,527	2,085	3,345	3,471	3,551	5,086	3,129
CV04	4,175	4,407	3,247	1,230	2,810	2,359	1,130	2,367	1,808	1,715	2,156	3,043
CV03	3,766	3,987	5,316	1,066	2,879	2,021	976	2,091	1,541	2,393	1,354	5,210
CV02	5,090	5,090	3,999	1,263	3,533	2,489	1,347	2,789	2,069	2,237	2,866	2,822
CV01	4,527	4,115	4,115	880	1,833	1,653	958	1,421	1,887	1,424	2,253	2,136

T_{NS} and T_{EW} – Horizontal Loads in N-S and E-W direction

P_V – Vertical Load

Table 3NN-20B Site Specific Seismic Demand Comparison: CIS

	Standard Design			Unit 3								
	Coherent Motion			Coherent Motion						Incoherent Motion		
	Surface Foundation			Surface Foundation			Embedded Foundation			Surface Foundation		
Floor	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V
IC09	2,864	2,112	1,360	1,140	1,461	1,348	1,354	1,296	598	1,943	1,974	579
IC18	4,160	4,056	3,536	1,595	2,665	3,468	1,805	2,184	1,656	2,585	3,112	1,560
IC08	650	650	547	283	466	536	287	343	264	439	537	292
IC05	12,079	16,609	10,569	5,425	6,499	10,362	5,281	5,508	6,439	7,264	8,396	3,737
IC72	2,002	1,797	1,185	1,973	1,771	1,136	1,207	1,388	564	976	1,423	599
IC71	2,496	2,184	1,508	2,439	2,059	1,461	1,637	1,598	745	1,219	1,608	728
IC62	4,212	4,212	2,808	3,236	2,993	2,736	2,336	2,229	1,474	2,478	2,671	1,288
IC61	3,300	3,190	2,200	2,300	2,538	2,111	1,795	1,936	892	2,020	2,364	967
IC15	1,265	264	132	104	74	126	44	84	72	1,256	261	51
IC04	8,195	8,195	8,195	5,788	4,705	7,359	2,796	2,744	4,473	3,522	5,067	3,716
IC14	1,253	1,094	177	704	1,053	142	452	496	103	1,082	985	149
IC03	6,631	7,073	5,747	3,792	3,909	3,066	3,279	2,550	3,964	2,416	4,897	3,219
IC02	10,440	10,440	11,310	2,056	3,110	7,229	3,657	3,451	5,267	2,186	2,713	5,397
IC01	10,175	10,175	9,250	2,622	6,323	3,843	3,485	3,565	4,058	2,683	4,272	7,868

T_{NS} and T_{EW} – Horizontal Loads in N-S and E-W direction

P_V – Vertical Load

Table 3NN-20C Site Specific Seismic Demand Comparison: R/B-FH/A

	Standard Design			Unit 3								
	Coherent Motion			Coherent Motion						Incoherent Motion		
	Surface Foundation			Surface Foundation			Embedded Foundation			Surface Foundation		
Floor	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V	T_{NS}	T_{EW}	P_V
FH08	16,219	10,261	9,599	9,177	7,572	9,351	6,094	6,560	5,613	7,355	9,257	5,958
FH07	9,291	6,357	7,091	3,995	2,999	6,938	2,484	4,053	3,925	3,984	4,480	3,471
RE05	15,939	18,596	18,216	15,282	11,675	16,940	11,929	9,780	11,698	10,618	13,563	11,346
FH06	3,978	4,680	4,446	1,542	2,745	4,200	1,231	2,167	3,635	2,400	2,994	2,996
RE41	15,120	10,395	9,923	14,741	9,006	9,264	13,242	6,786	7,701	12,017	7,139	7,837
RE42	9,867	5,693	6,452	9,713	5,577	5,662	7,620	3,819	4,496	7,241	3,982	4,298
RE04	9,960	16,600	14,940	6,808	12,223	13,450	6,754	7,317	8,851	5,882	12,239	8,509
RE03	50,775	50,775	44,005	26,219	17,255	28,247	27,552	17,945	27,733	23,486	28,867	14,588
RE02	39,820	43,440	39,820	20,051	21,577	25,145	21,988	16,706	23,326	20,515	24,644	22,526
RE01	37,730	37,730	34,300	11,936	16,003	21,226	18,397	16,067	17,370	19,436	21,197	23,511

T_{NS} and T_{EW} – Horizontal Loads in N-S and E-W direction

P_V – Vertical Load

Table 3NN-20D Site Specific Out-of-Plane Seismic Demand on R/B-F/HA Slabs

Slab Group ID	Standard Design Seismic Demands (g)	Unit 3 Seismic Demands (g)		
		Coherent Surface	Coherent Embedded	Incoherent Surface
FH08Z1	3.70	3.26	3.38	2.83
RE05Z2	4.25	4.09	3.29	3.12
RE05Z1	3.00	2.93	2.13	1.98
RE41Z1	3.25	3.14	2.51	2.49
RE41Z3	3.50	3.38	1.87	2.26
RE41Z2	2.50	1.63	2.29	1.14
RE42Z1	3.50	3.46	2.98	2.56
RE04Z1	2.50	2.33	1.12	1.48
RE03Z1	2.00	1.92	1.41	1.26
RE03Z2	2.00	1.91	0.75	1.11
RE03Z3	2.00	1.89	1.00	1.00
RE03Z4	1.50	1.46	1.27	0.76
RE02Z1	2.00	1.75	0.98	1.29
RE02Z2	1.50	1.25	0.91	0.83
RE02Z3	1.50	1.32	0.52	0.78
RE02Z4	1.25	1.05	0.52	0.71
RE01Z1	1.50	1.47	0.65	0.99
RE01Z2	1.25	1.06	0.68	0.86
RE01Z3	1.50	1.48	0.39	1.16
RE01Z4	1.75	1.63	0.59	1.08
RE01Z5	1.00	0.97	0.62	0.69
RE00Z1	1.25	1.01	0.41	0.73
RE00Z2	1.00	0.85	0.41	0.69
RE00Z3	1.00	0.96	0.26	0.64
BS01Z1	1.00	0.93	0.27	0.71
BS01Z2	1.00	0.99	0.26	0.67

Table 3NN-20E Site Specific Out-of-Plane Seismic Demand on R/B-F/HA Walls

Slab Group ID	Standard Design Seismic Demands (g)	Unit 3 Seismic Demands (g)		
		Coherent Surface	Coherent Embedded	Incoherent Surface
Walls Spanning in E-W Direction				
FH07x1	2.25	1.21	1.07	1.15
RE04x1	1.50	1.33	1.22	1.23
RE03x1	1.00	0.78	0.40	0.51
RE02x1	1.00	0.75	0.37	0.47
RE00x1	1.00	0.82	0.36	0.45
Walls Spanning in N-S Direction				
FH07Y1	2.50	1.55	1.50	1.92
RE42Y1	3.50	3.33	2.61	2.62
RE41Y1	3.00	2.98	1.30	1.88
RE04Y1	1.20	0.82	0.72	1.06
RE03Y1	1.20	1.02	0.48	0.65
RE02Y1	1.00	0.91	0.60	0.78
RE00Y1	0.75	0.61	0.32	0.43

Table 3NN-21A SSE Seismic Demand on PS/B

Elevation (ft)	Standard Plant Design Seismic Demands (g)			Unit 3 Seismic Demands (g)		
	A_{NS}	A_{EW}	A_V	A_{NS}	A_{EW}	A_V
49.20	1.300	1.600	1.480	1.258	1.476	1.469
44.04	1.250	1.490	1.410	1.109	1.269	1.326
38.88	1.190	1.400	1.490	0.982	1.124	1.385
31.21	1.170	1.150	1.010	0.968	1.065	1.012
23.54	1.130	1.070	1.160	0.861	0.999	1.155
16.44	1.040	1.010	0.920	0.886	0.981	0.885
9.35	0.840	0.810	0.900	0.788	0.812	0.813
2.25	0.840	0.690	0.900	0.835	0.695	0.903
-5.33	0.840	0.690	0.680	0.849	0.694	0.677
-10.17	0.820	0.710	0.580	0.823	0.712	0.581
-15.00	0.660	0.620	0.660	0.664	0.620	0.657
-20.67	0.610	0.530	0.490	0.468	0.419	0.481
-26.33	0.520	0.490	0.470	0.525	0.491	0.406
-31.29	0.520	0.490	0.470	0.518	0.494	0.407
-36.25	0.510	0.490	0.460	0.508	0.491	0.404

Table 3NN-21B Out of Plane SSE Demands on PS/B Slabs and Walls

		Standard Plant Design Seismic Demands (g)			Unit 3 Seismic Demands (g)		
Wall/Slab	Location	A_{NS}	A_{EW}	A_V	A_{NS}	A_{EW}	A_V
Ground Slab	Between Cl. 4P and 5P	--	--	0.88	--	--	0.86
	Between Cl. 1P and 4P	--	--	0.94	--	--	0.92
Roof Slab	El. 39'-6"	--	--	1.49			1.38
Wall at Line 1P	Above Ground	--	1.69	--	--	1.66	--
	Below Ground	--	0.64	--	--	0.63	--
Wall at Line 2P	Above Ground	--	1.16	--	--	1.14	--
	Below Ground	--	0.63	--	--	0.62	--
Wall at Line 5P	Above Ground	--	1.09	--	--	1.07	--
	Below Ground	--	0.86	--	--	0.84	--
Wall at 3P	Below Ground	--	0.87	--	--	0.61	--
Wall at 4P	Below Ground	--	0.74	--	--	0.73	--
Wall at Line AP	Above Ground	1.14	--	--	1.11	--	--
	Below Ground	0.93	--	--	0.91	--	--
Wall at Line CP	Above Ground	1.14	--	--	1.12	--	--
	Below Ground	0.75	--	--	0.73	--	--
Wall at Line BP	Above Ground	0.96	--	--	0.94	--	--

Figure 3NN-1 R/B Complex: Subgrade S-Wave Velocity Profiles

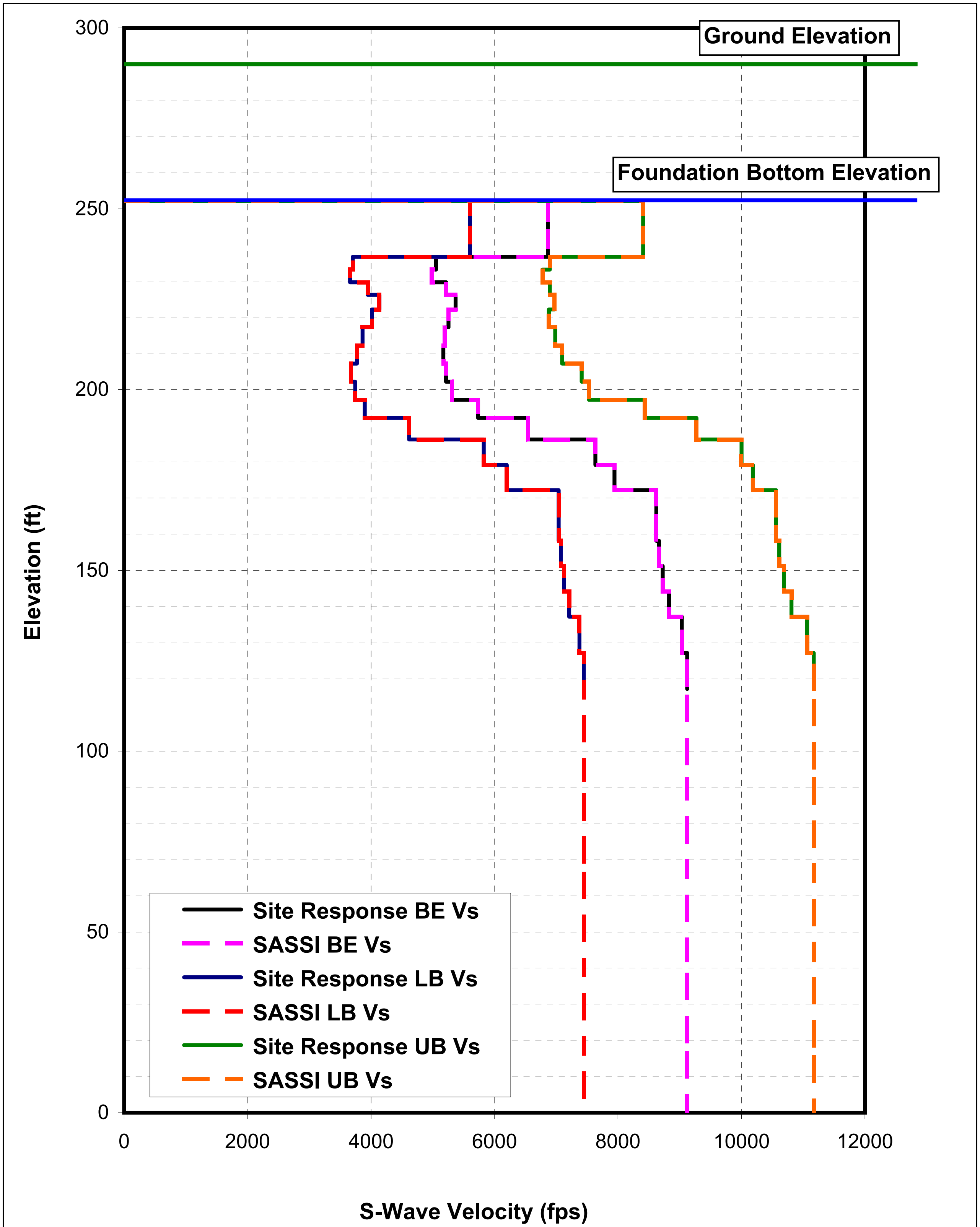


Figure 3NN-2 R/B Complex: Subgrade P-Wave Velocity Profiles

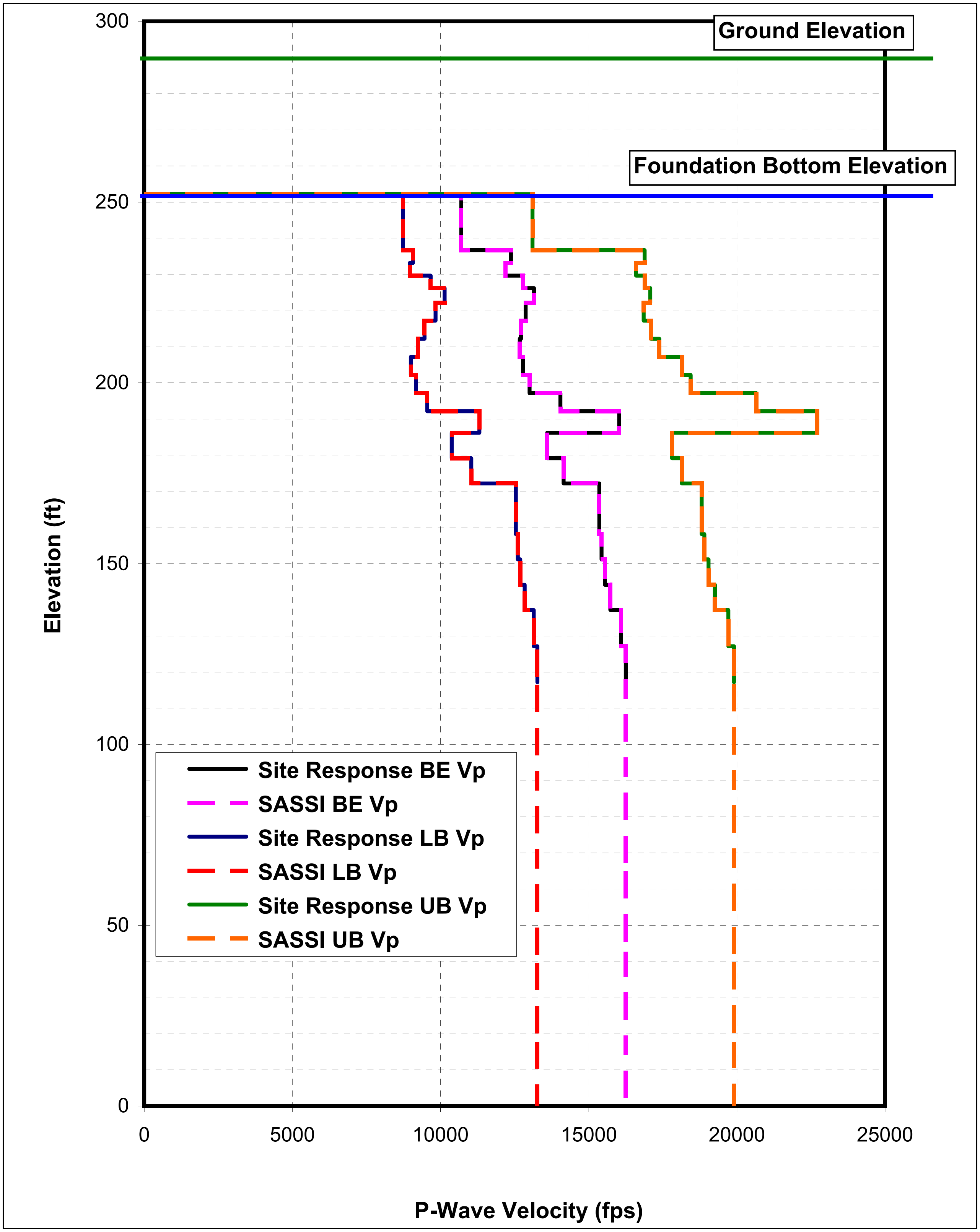


Figure 3NN-3 R/B Complex: Subgrade Damping Profiles

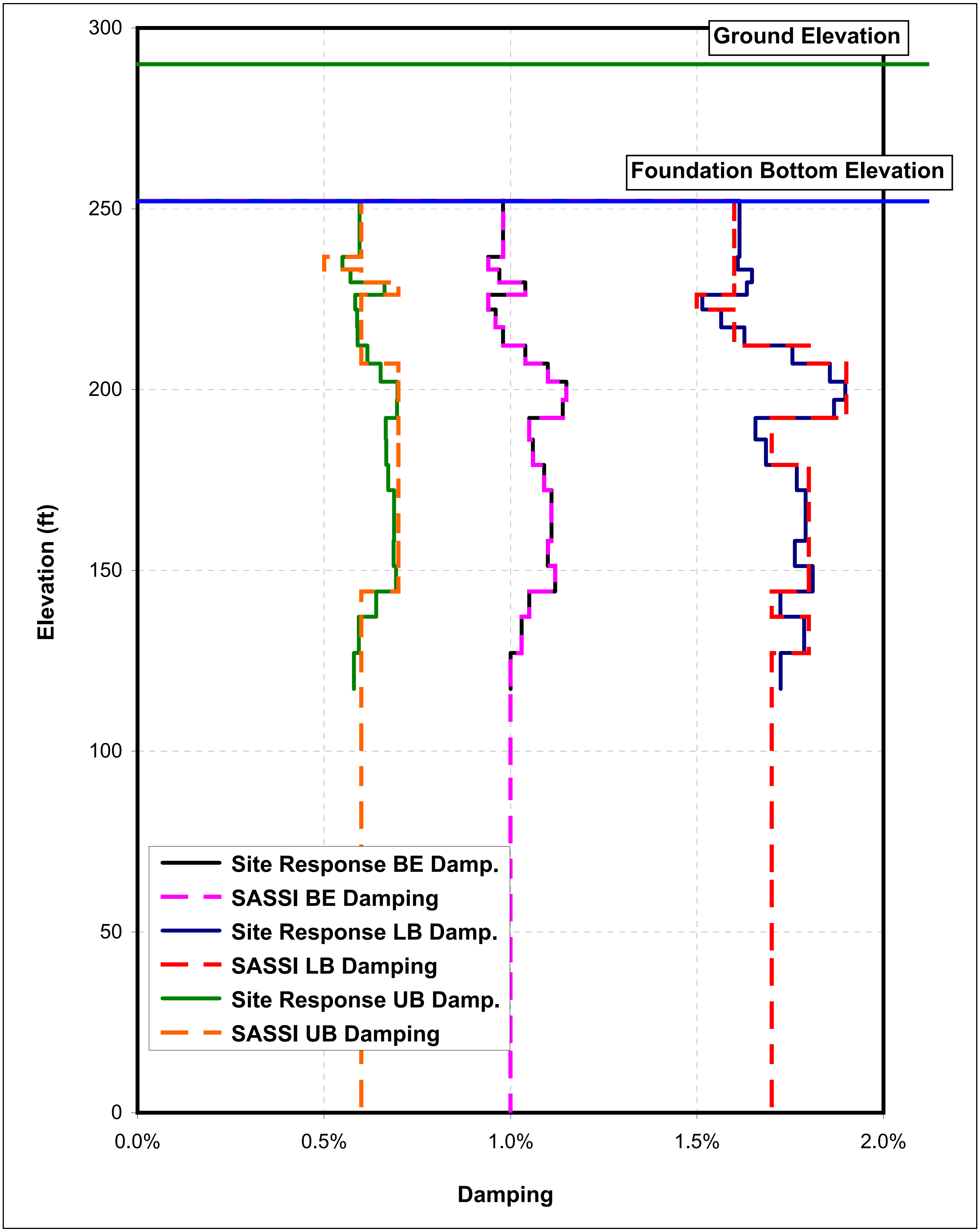


Figure 3NN-4 R/B Complex: Embedment Strain-Compatible S-Wave Velocity Profiles

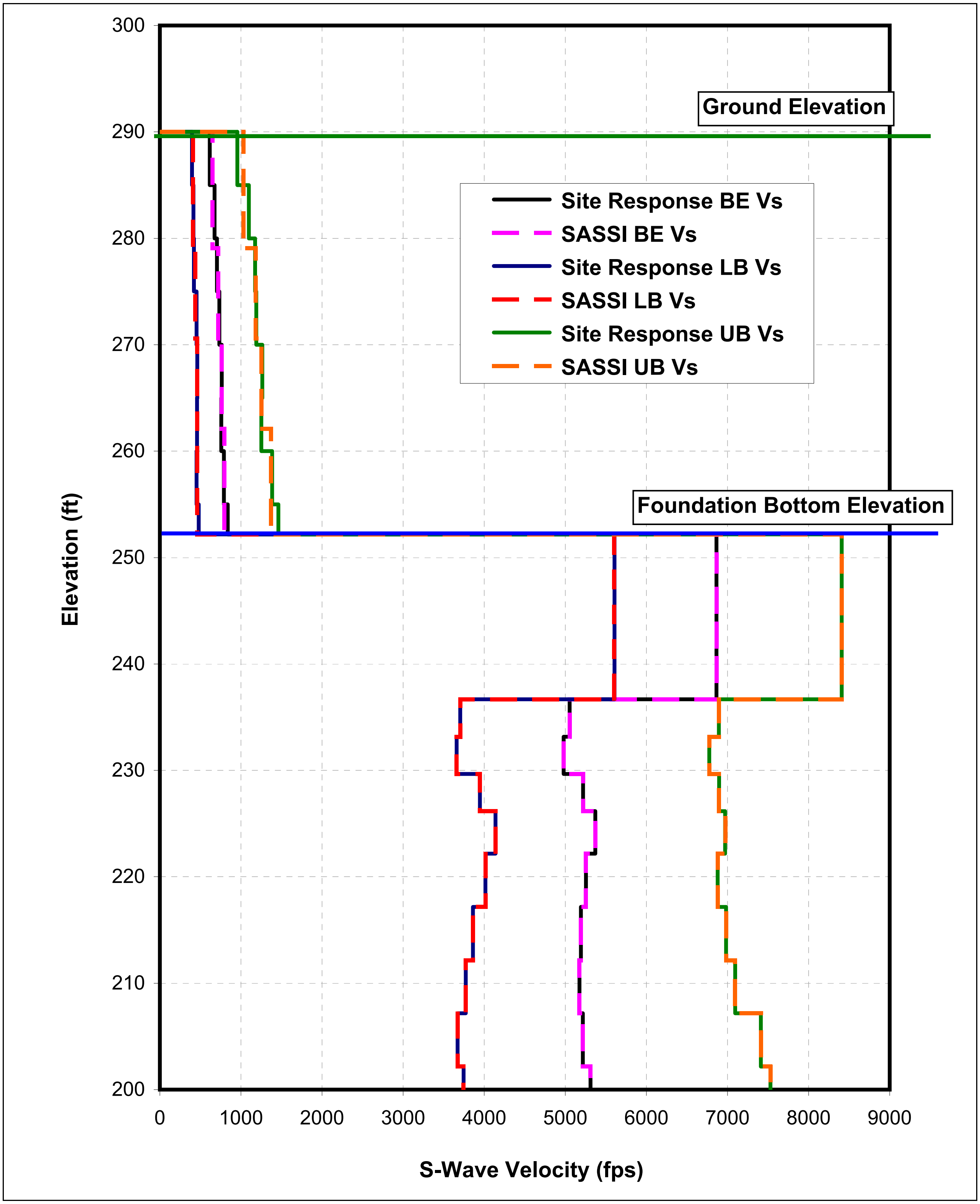


Figure 3NN-5 R/B Complex: Embedment Strain-Compatible P-Wave Velocity Profiles

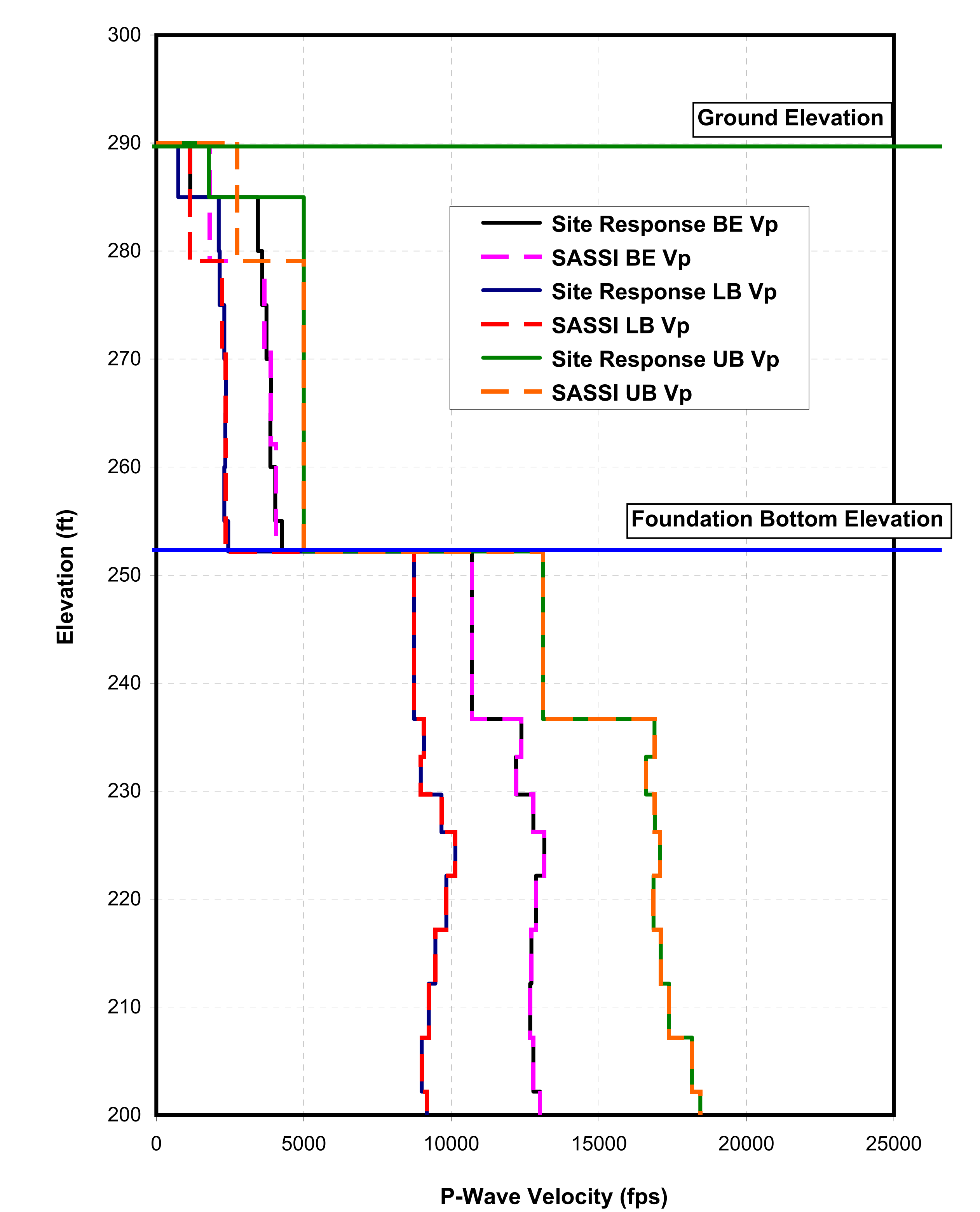


Figure 3NN-6 R/B Complex: Embedment Strain-Compatible Damping Profiles

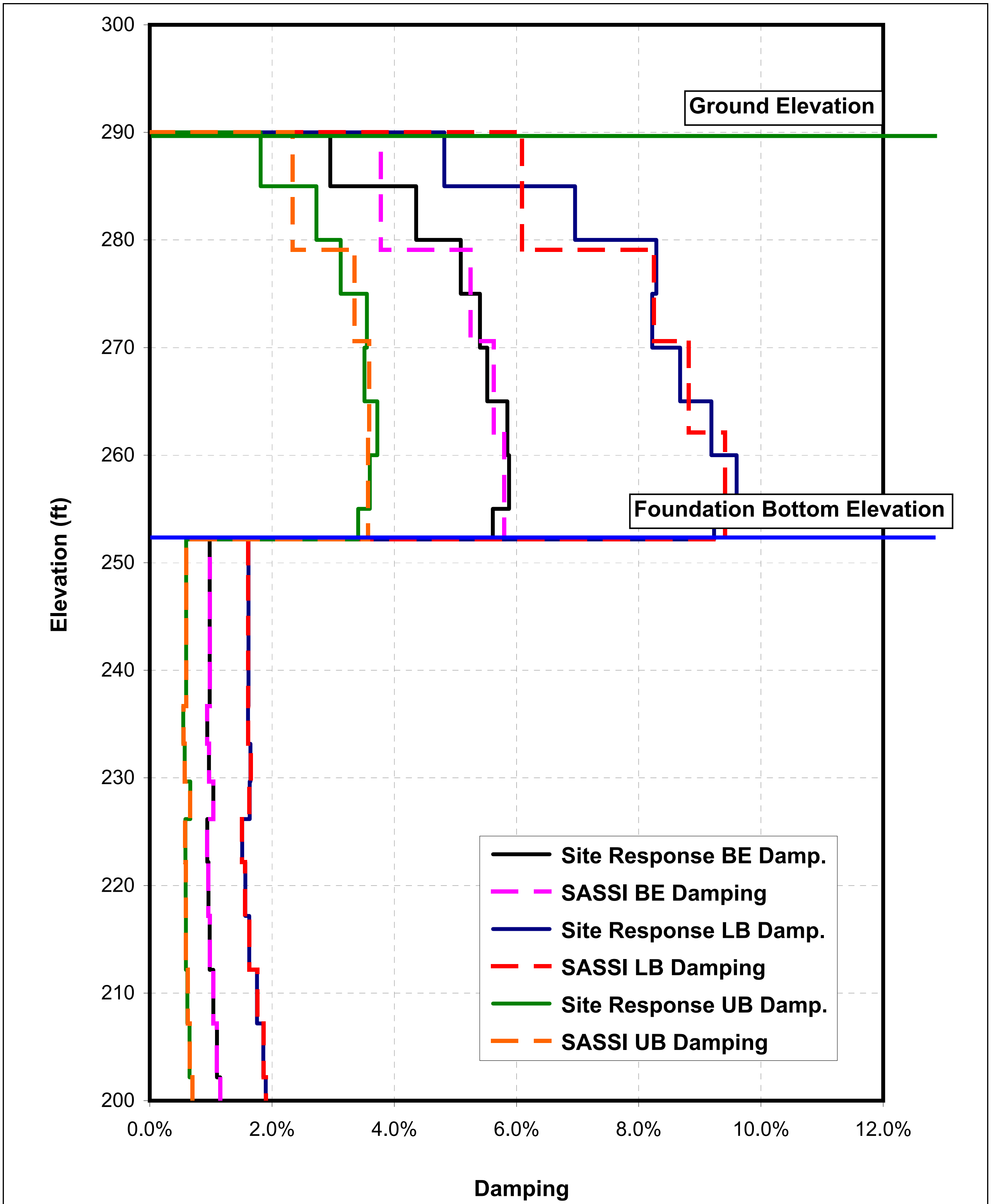


Figure 3NN-7 PS/B: Subgrade S-Wave Velocity Profiles

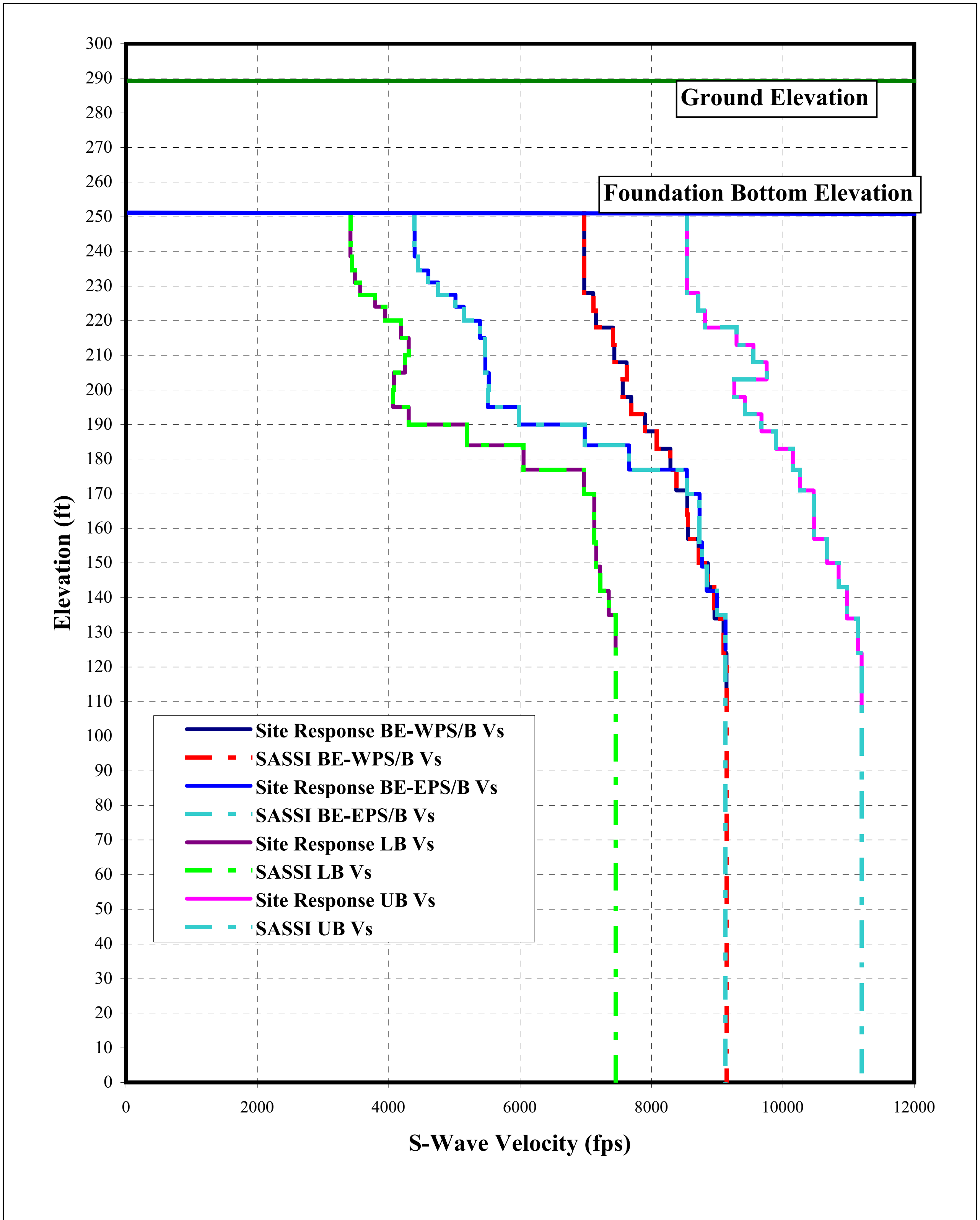


Figure 3NN-8 PS/B: Subgrade P-Wave Velocity Profiles

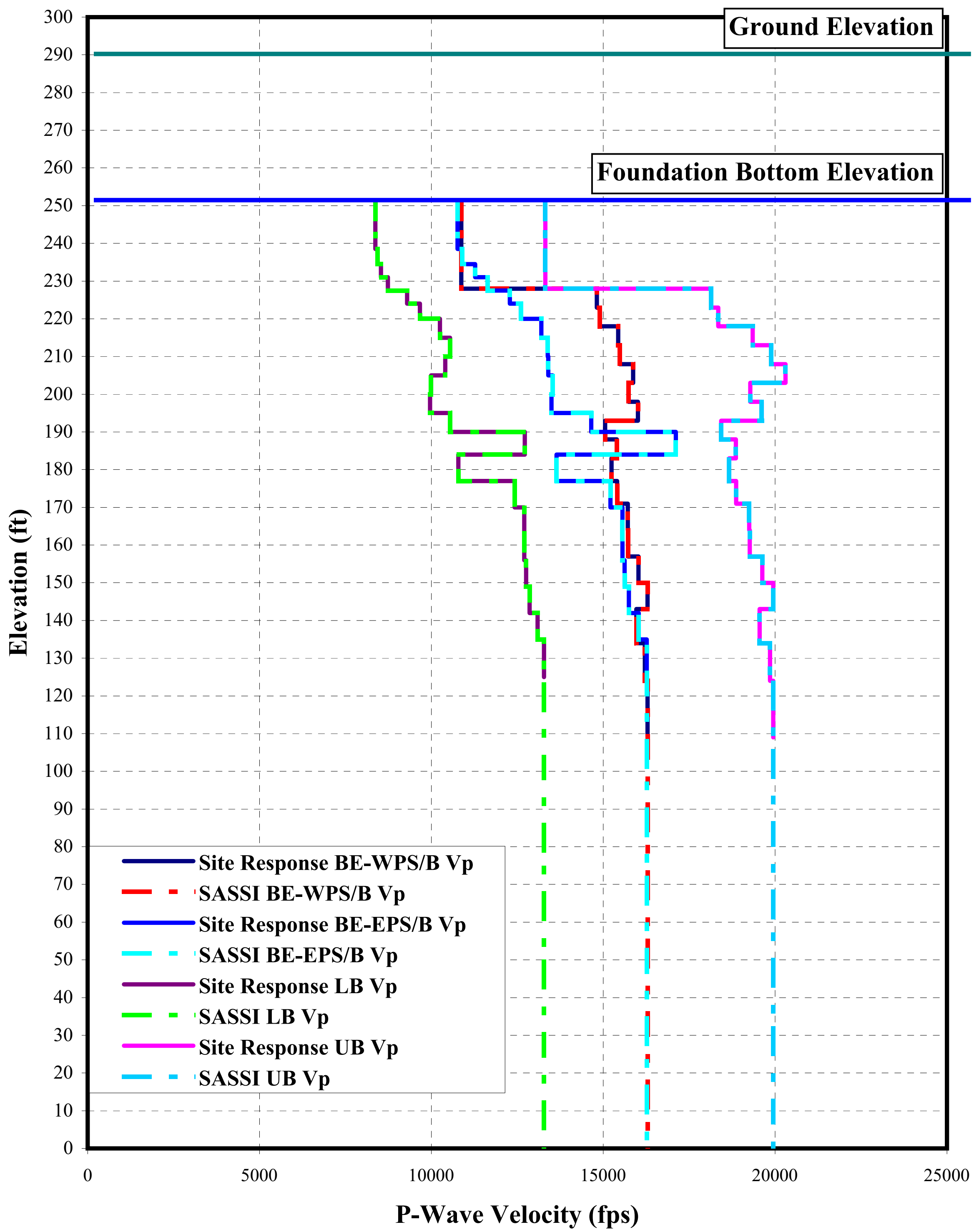


Figure 3NN-9 PS/B: Subgrade Damping Profiles

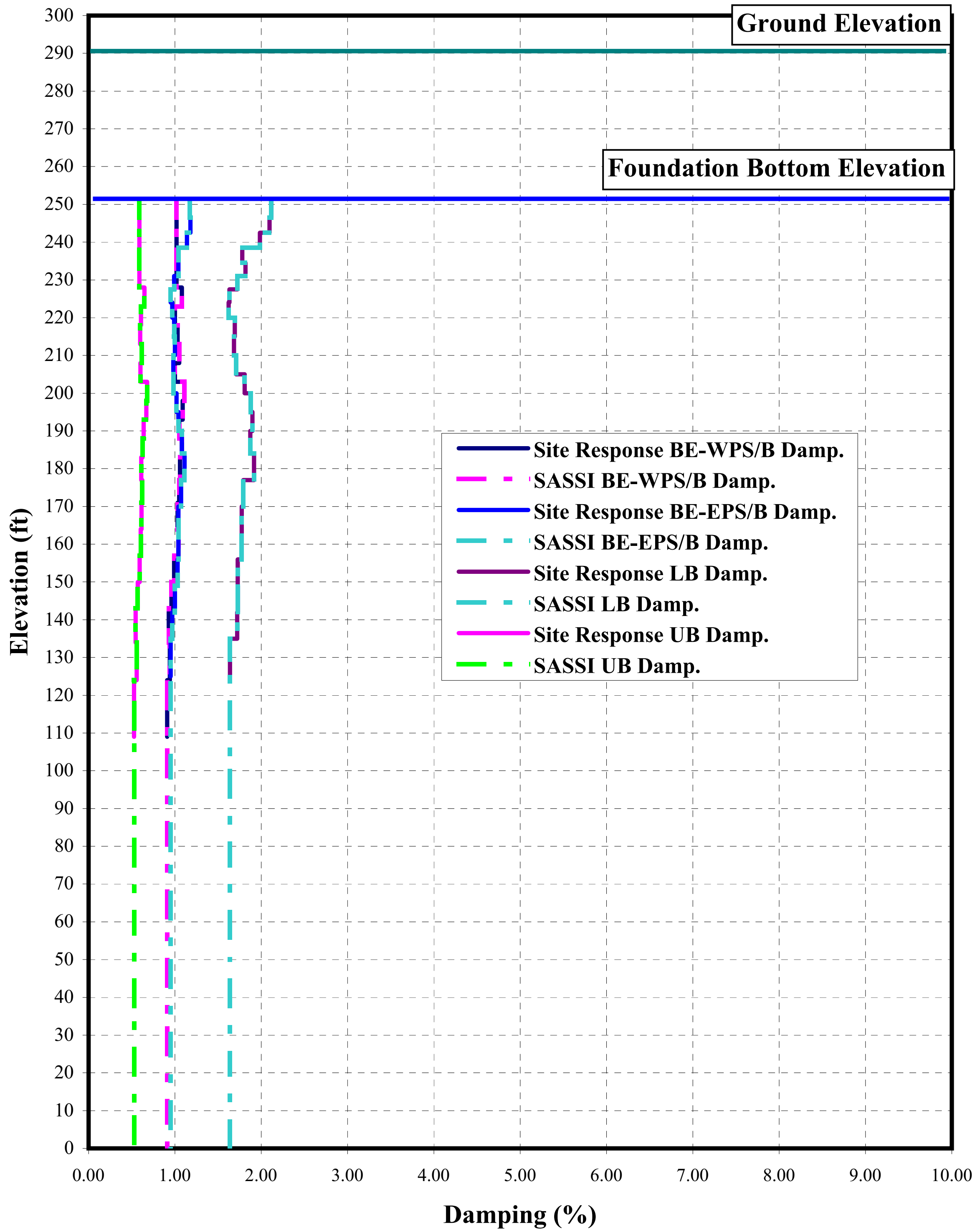


Figure 3NN-10 PS/B: Embedment Strain-Compatible S-Wave Velocity Profiles

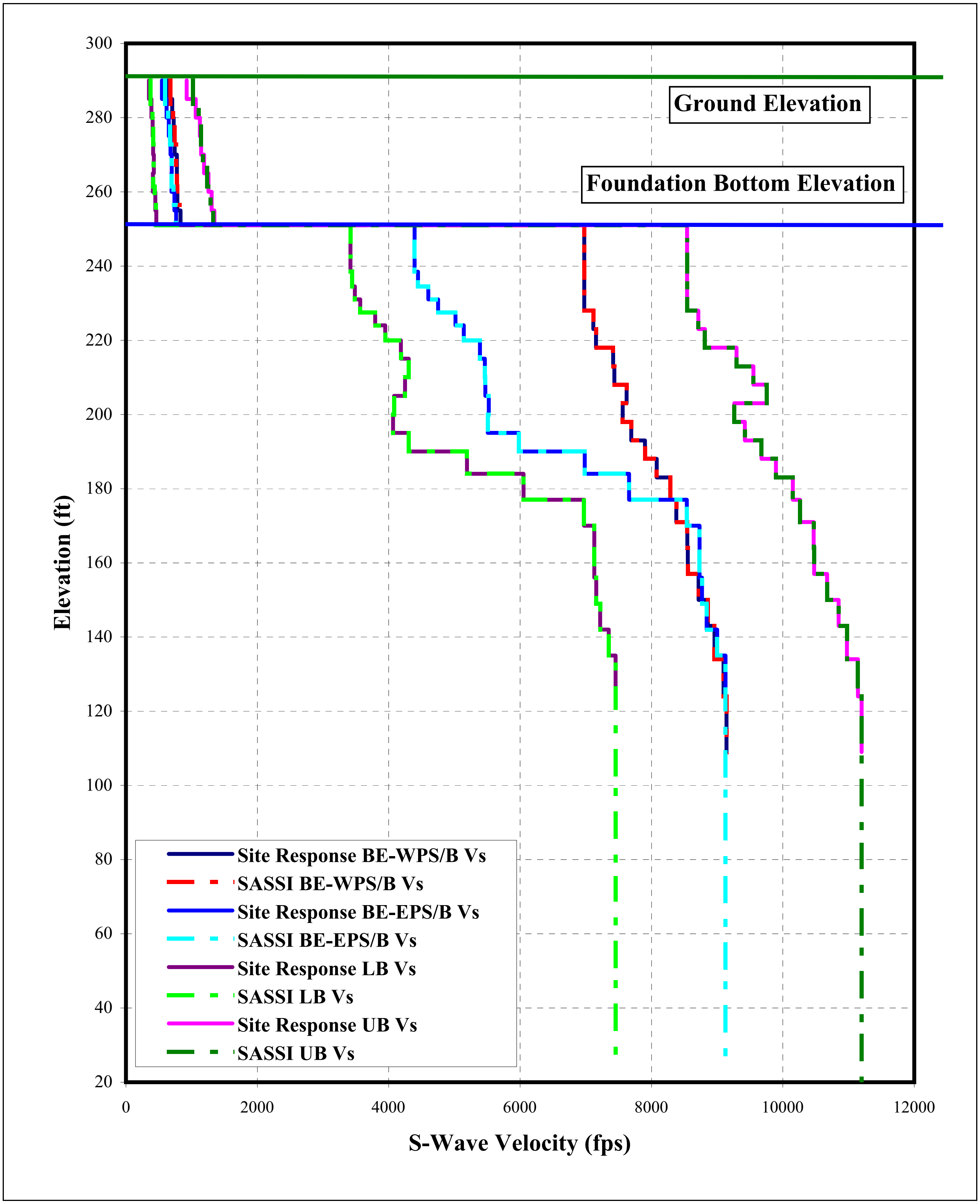


Figure 3NN-11 PS/B: Embedment Strain-Compatible P-Wave Velocity Profiles

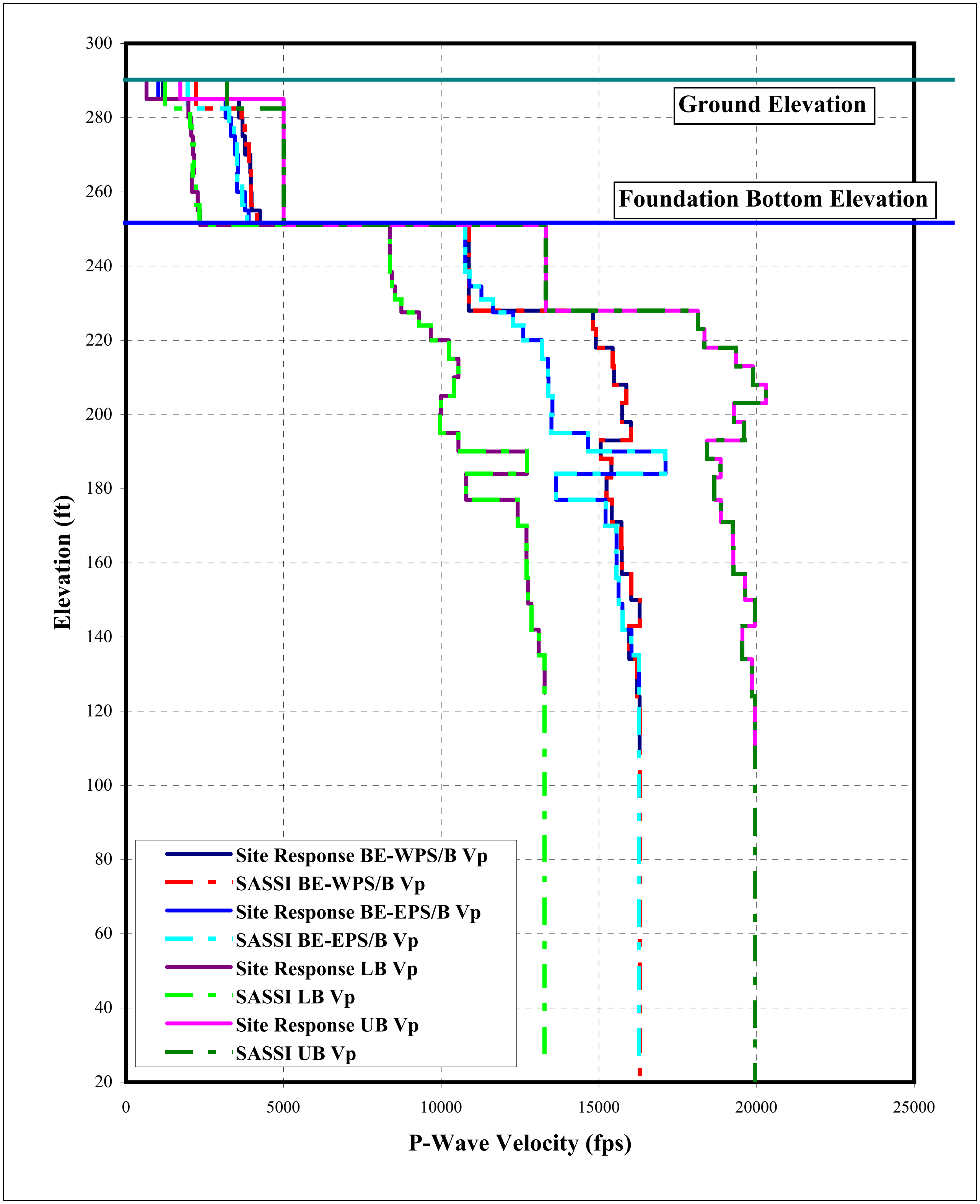


Figure 3NN-12 PS/B: Embedment Strain-Compatible Damping Profiles

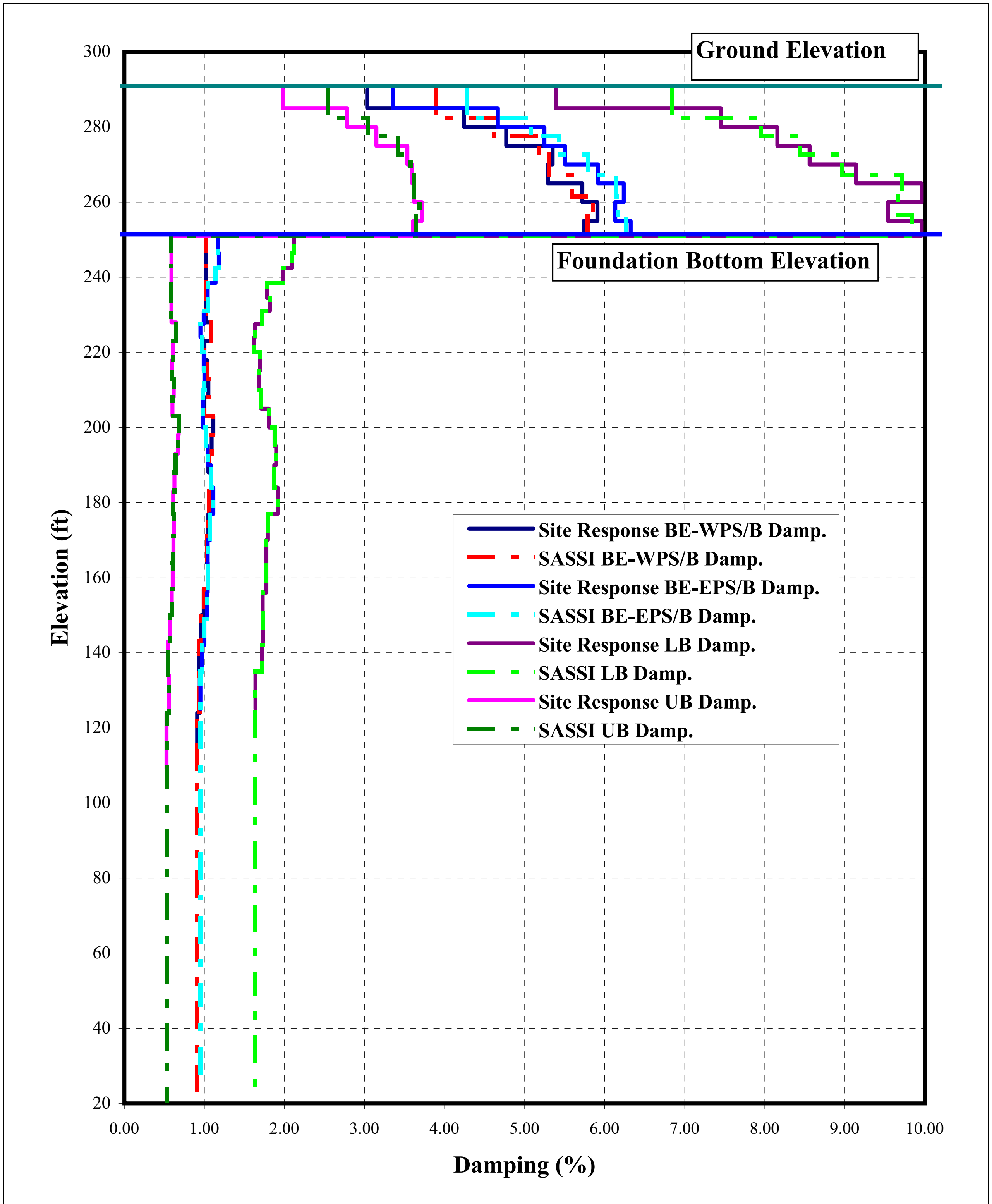


Figure 3NN-13 ACS SASSI Model of R/B Complex Structures

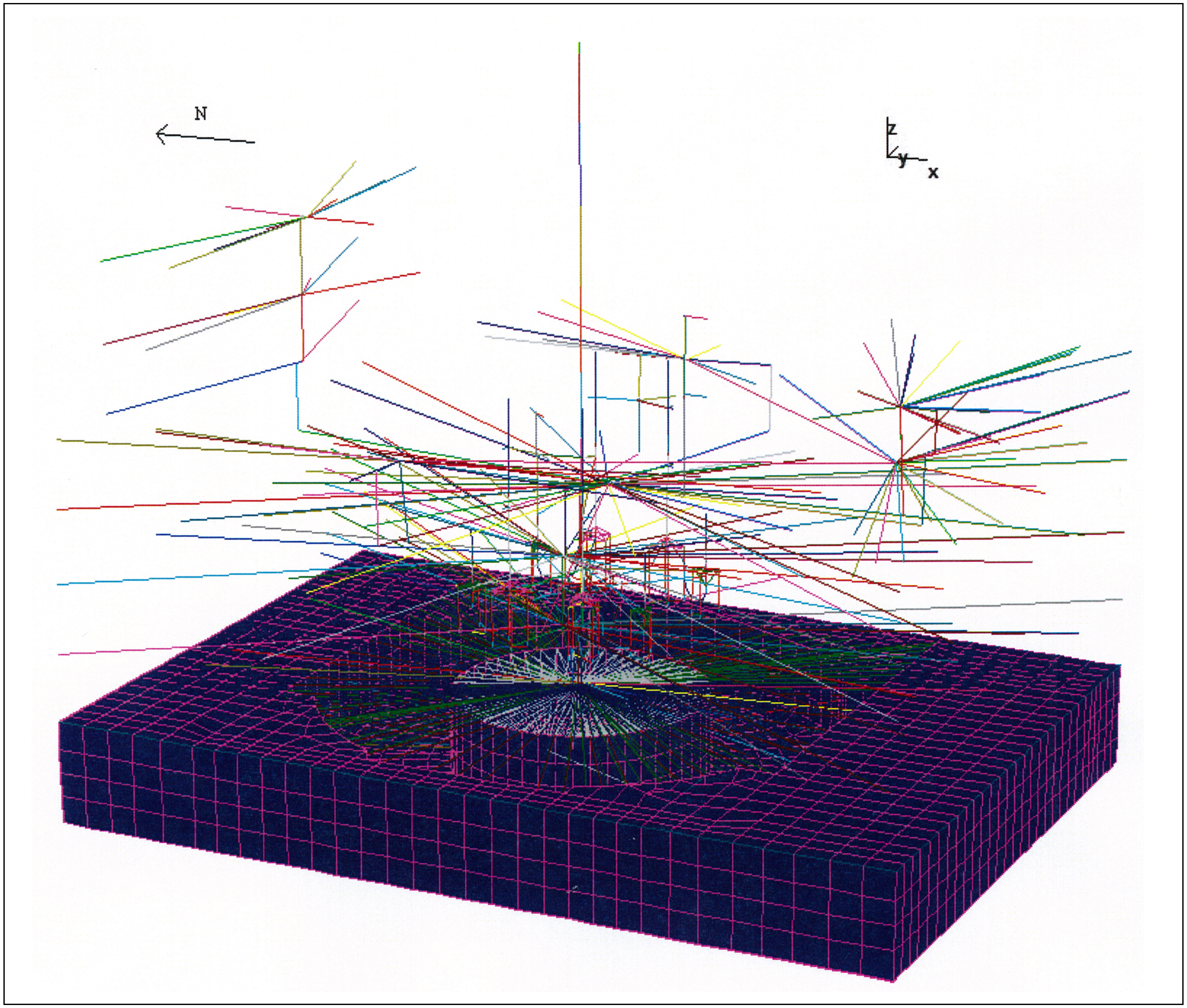


Figure 3NN-14 R/B Basemat Solid Elements

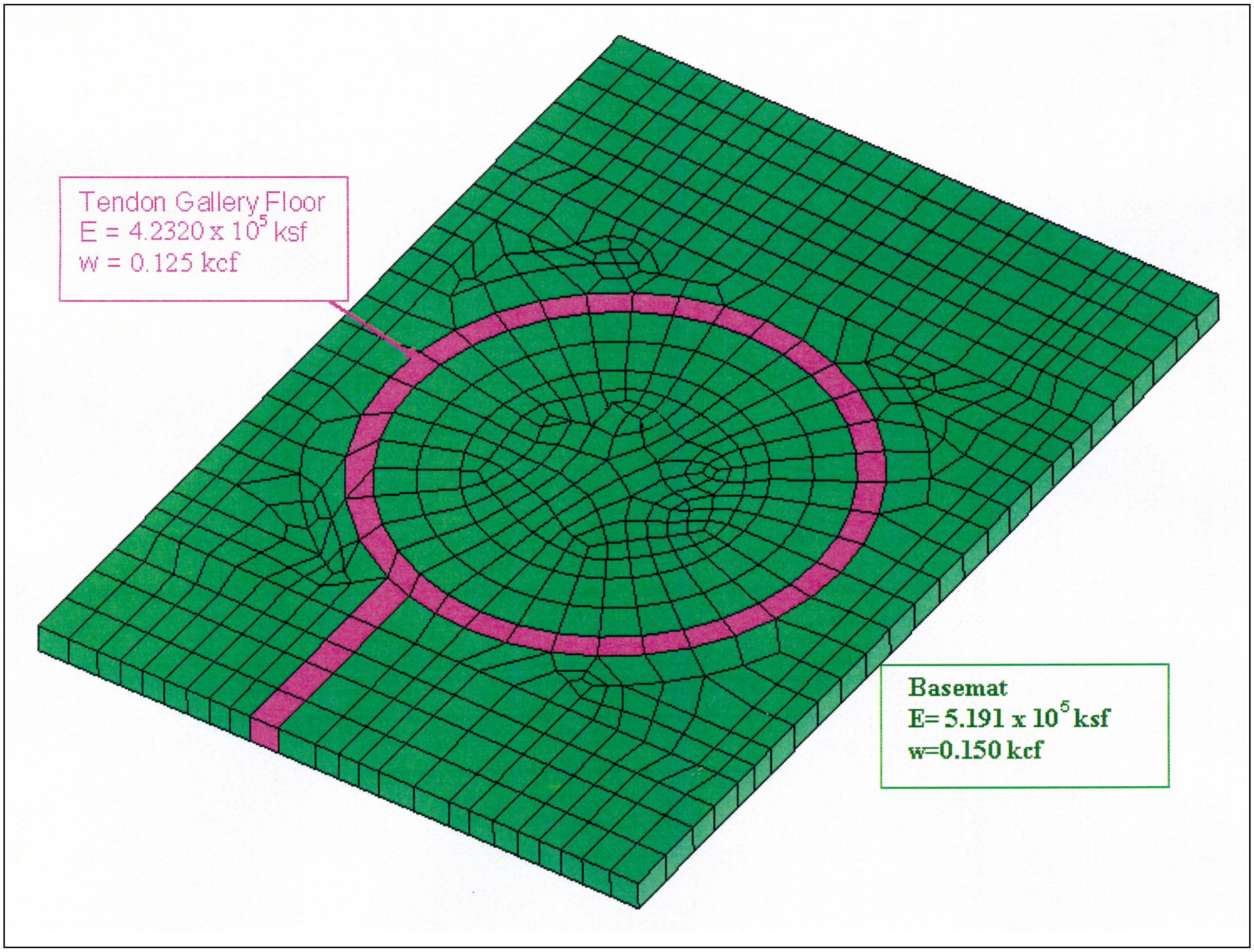


Figure 3NN-15 FE Model – Components Beneath PCCV

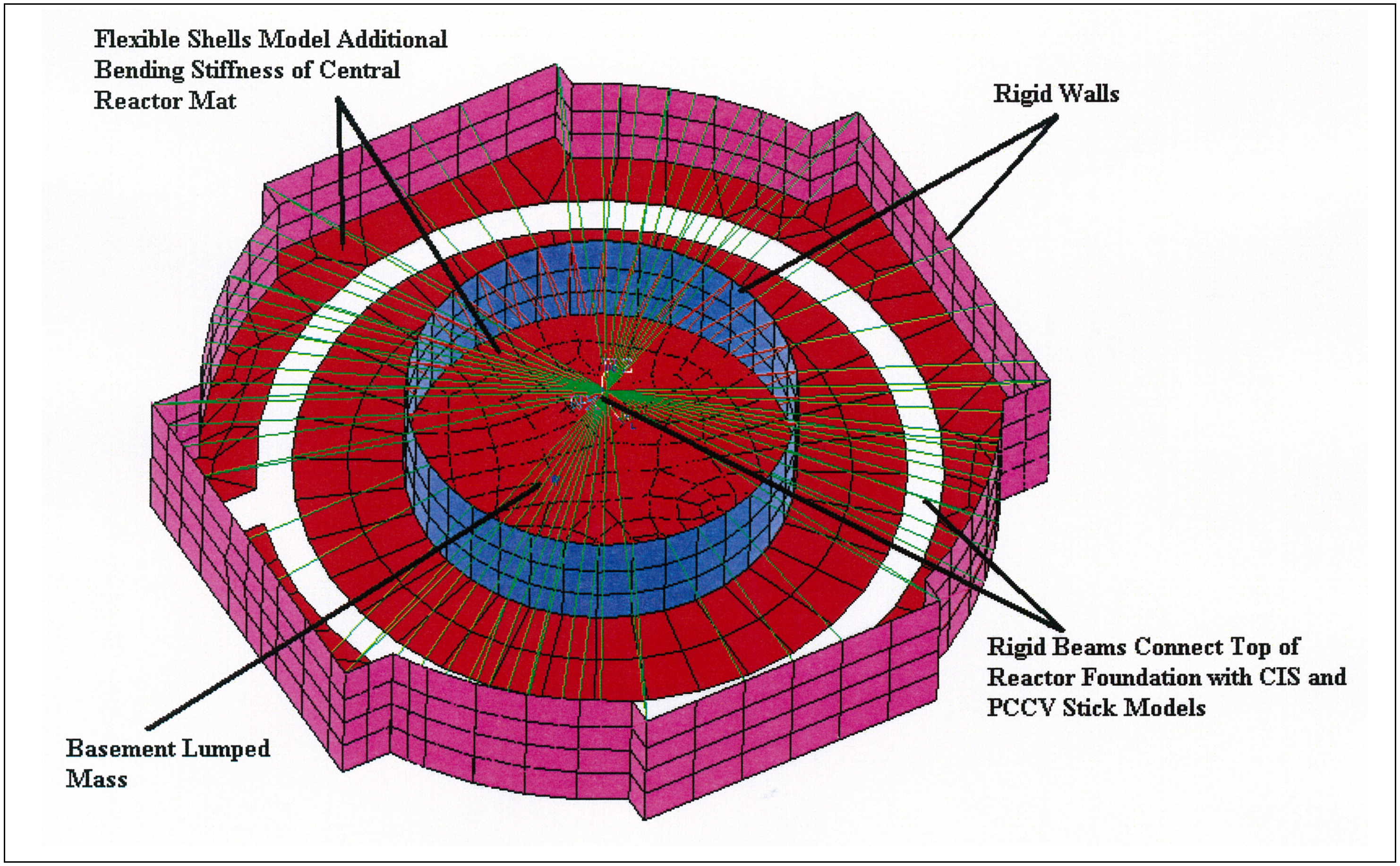


Figure 3NN-16 R/B Basement Shear Walls

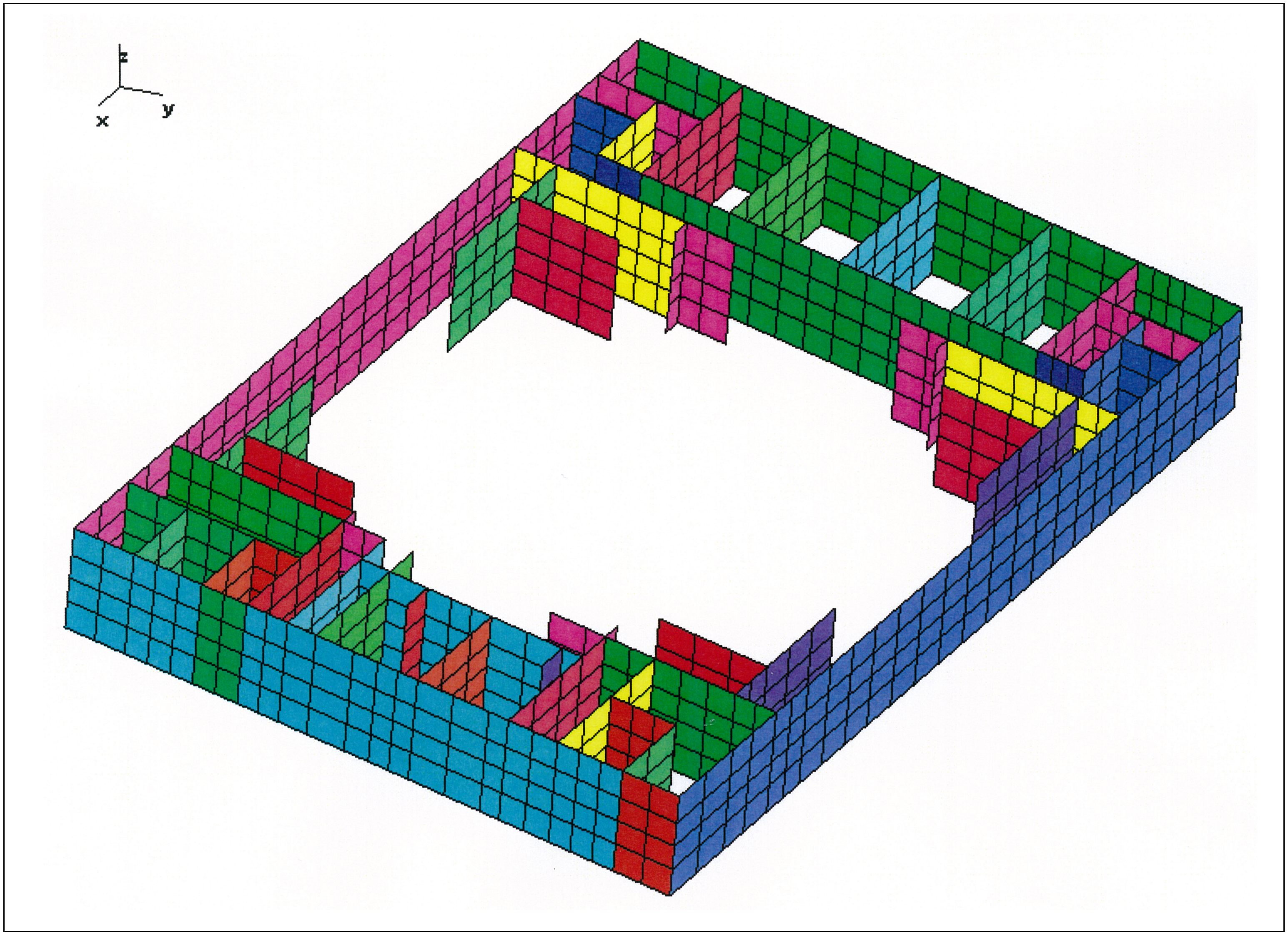


Figure 3NN-17 PS/B: ACS SASSI Model of Surface Foundation

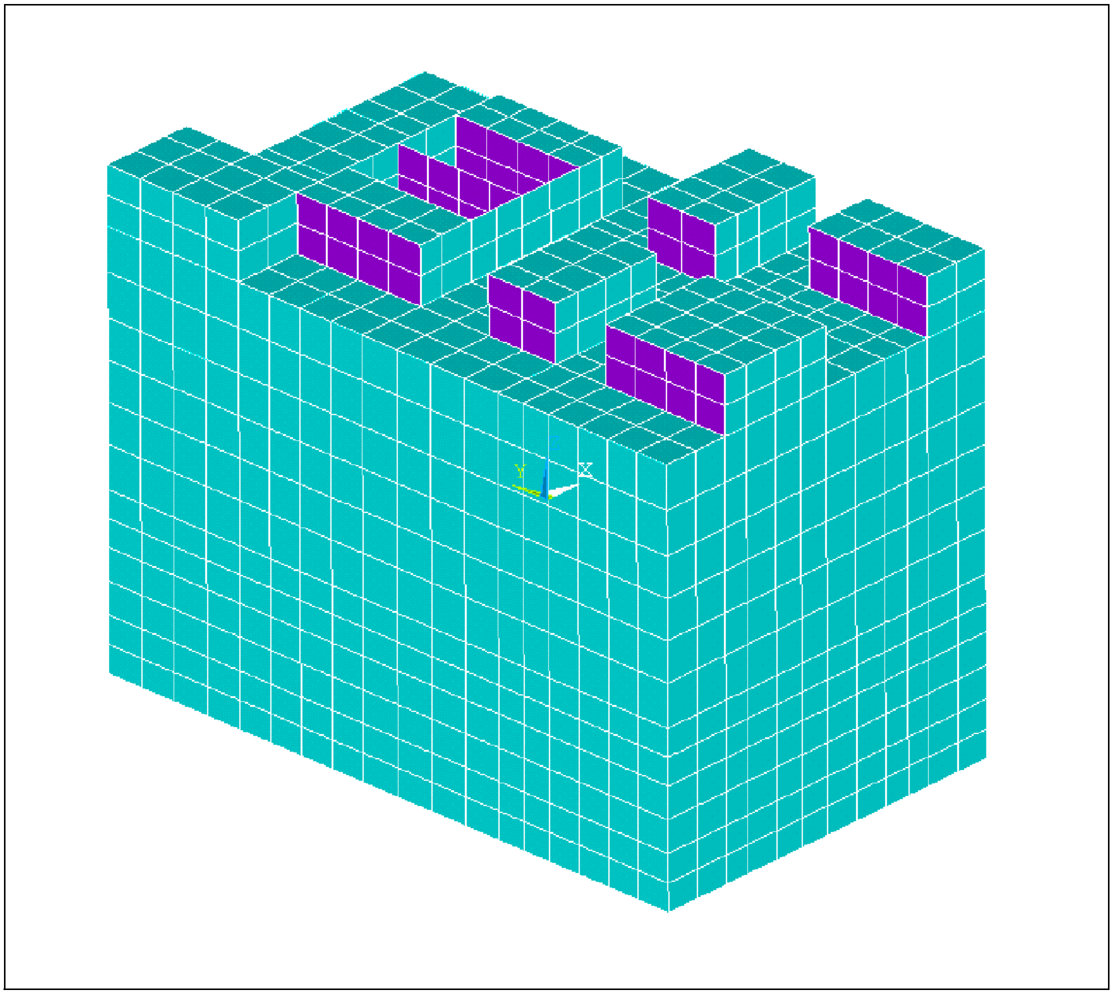


Figure 3NN-18 PS/B: ACS SASSI Model of Embedded Foundation

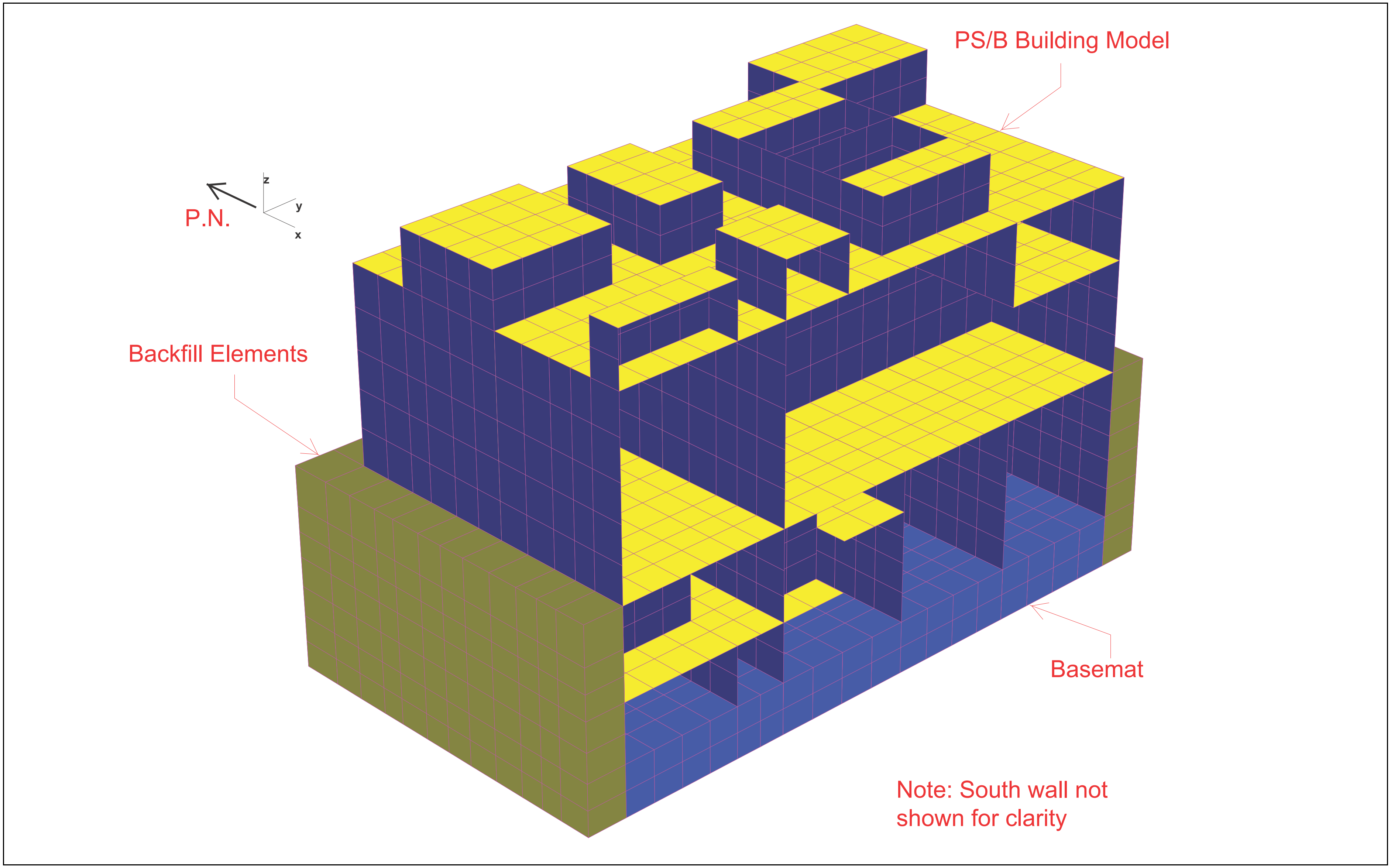


Figure 3NN-19 R/B: 5% Damping SSI Input Response Spectra

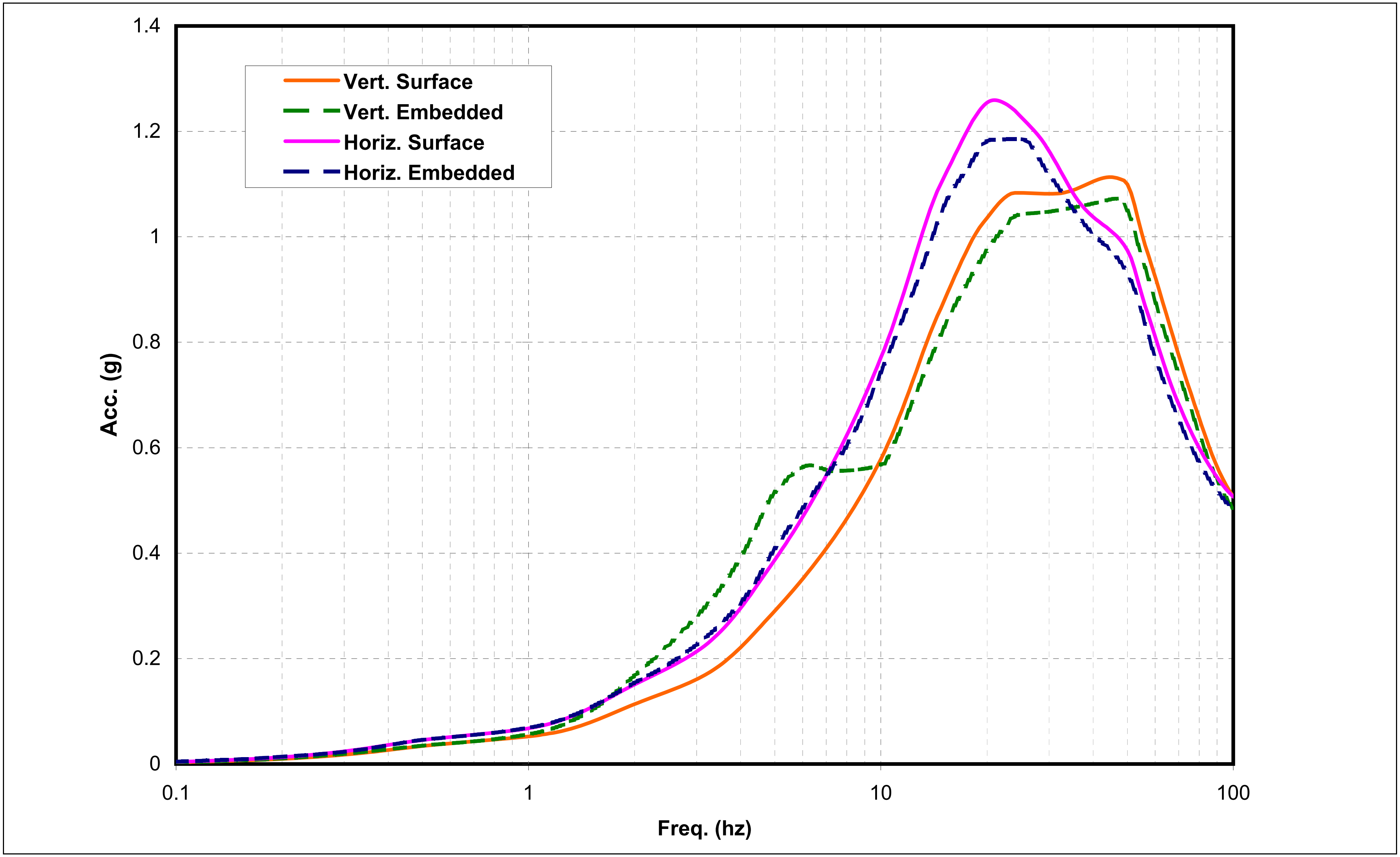


Figure 3NN-20 PS/B: 5% Damping SSI Input Response Spectra

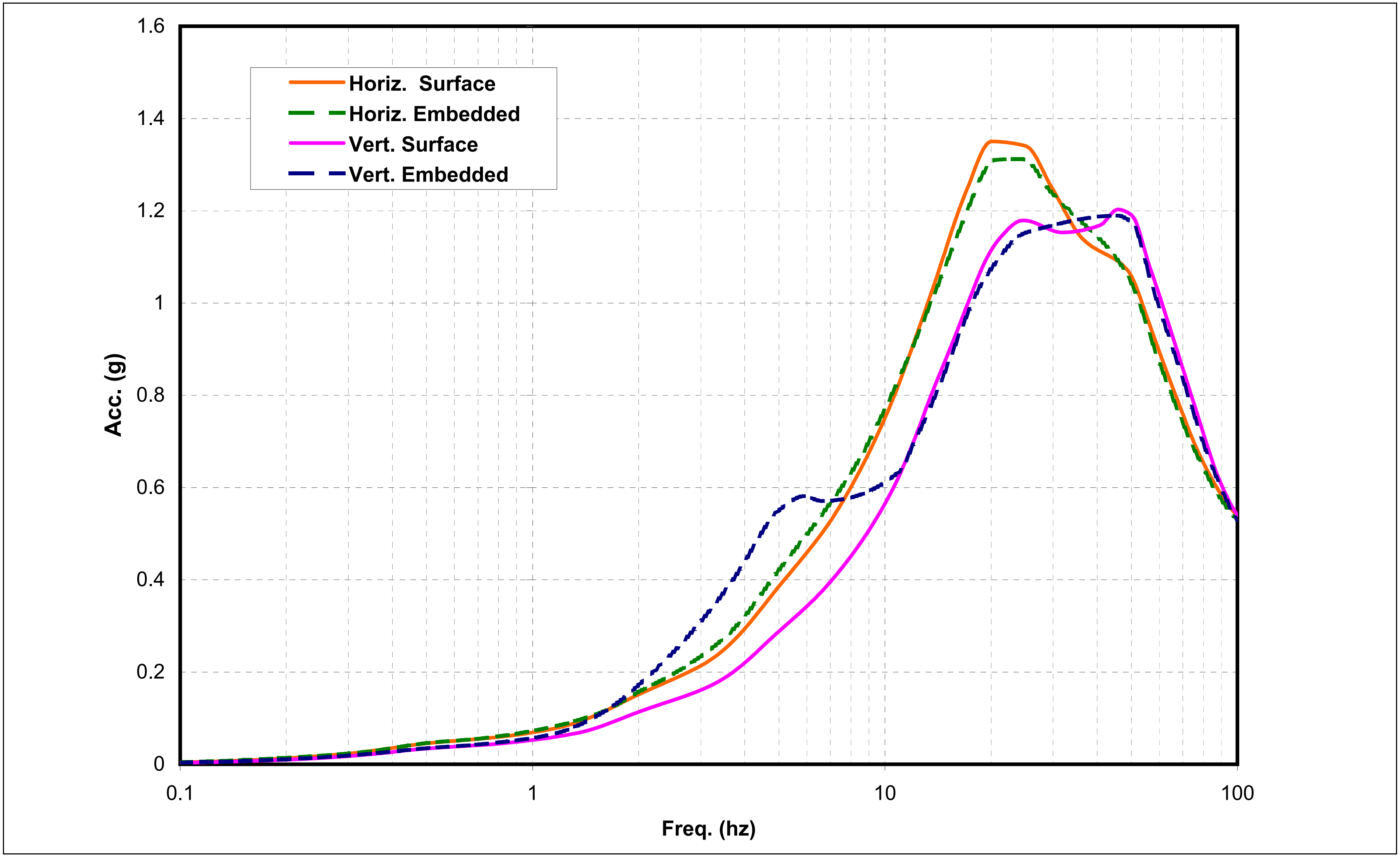


Figure 3NN-21 ISRS for PS/B N-S Direction at Basemat Elevation –26'-4" (Sheet 1 of 12)

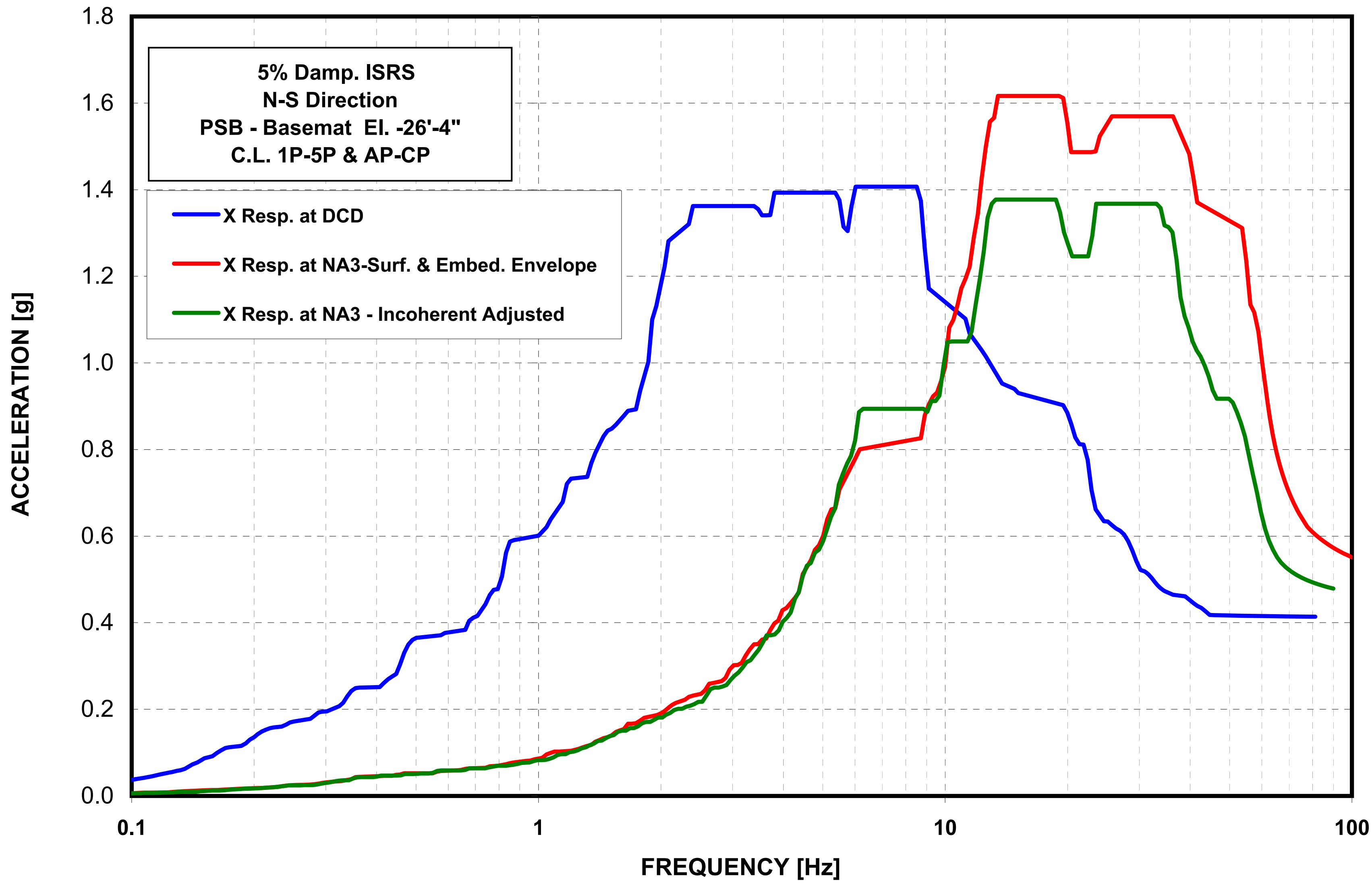


Figure 3NN-21 ISRS for PS/B E-W Direction at Basemat, Elevation –26'-4" (Sheet 2 of 12)

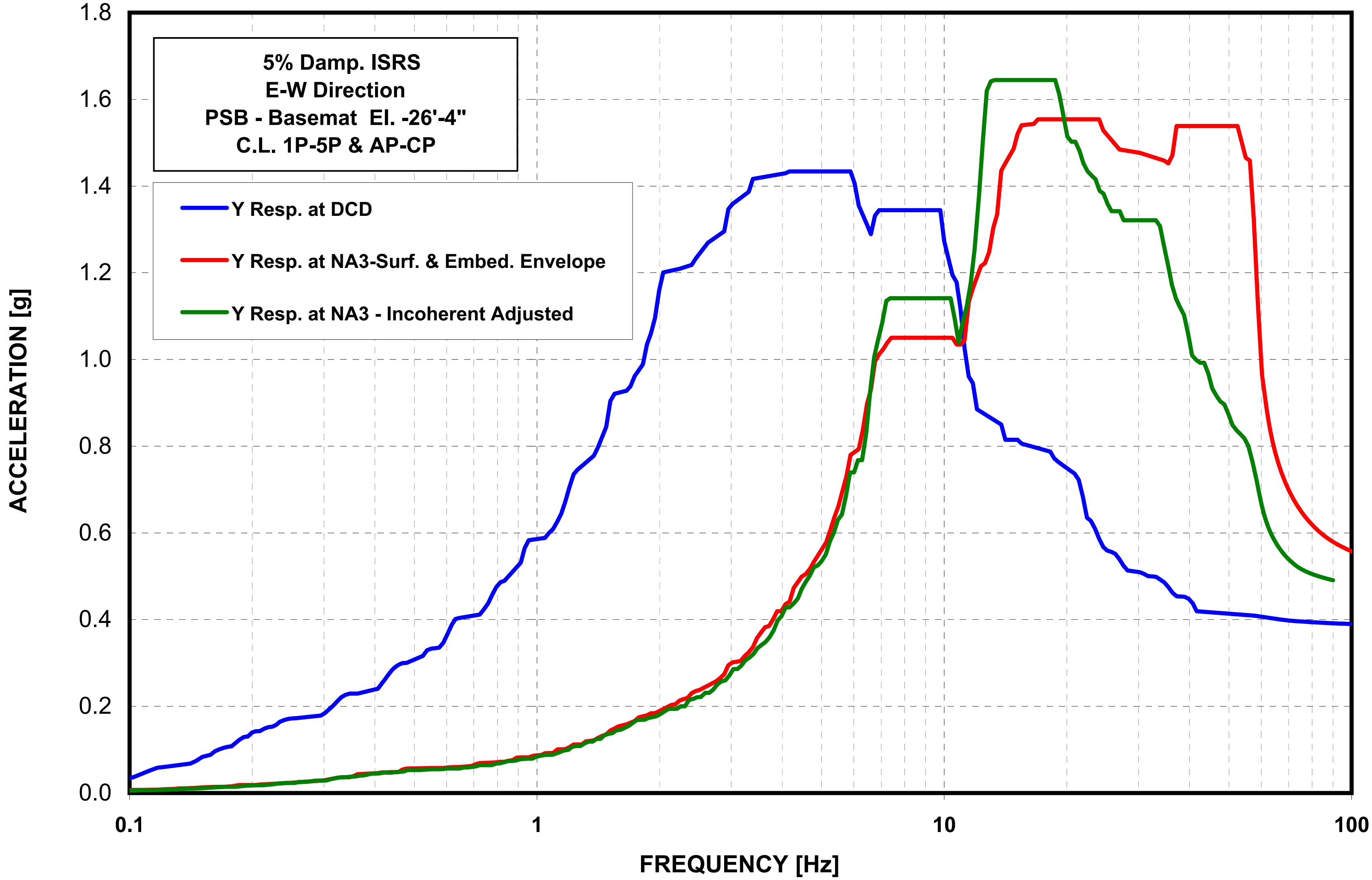


Figure 3NN-21 ISRS for PS/B Vertical Direction at Basemat, Elevation –26'-4" (Sheet 3 of 12)

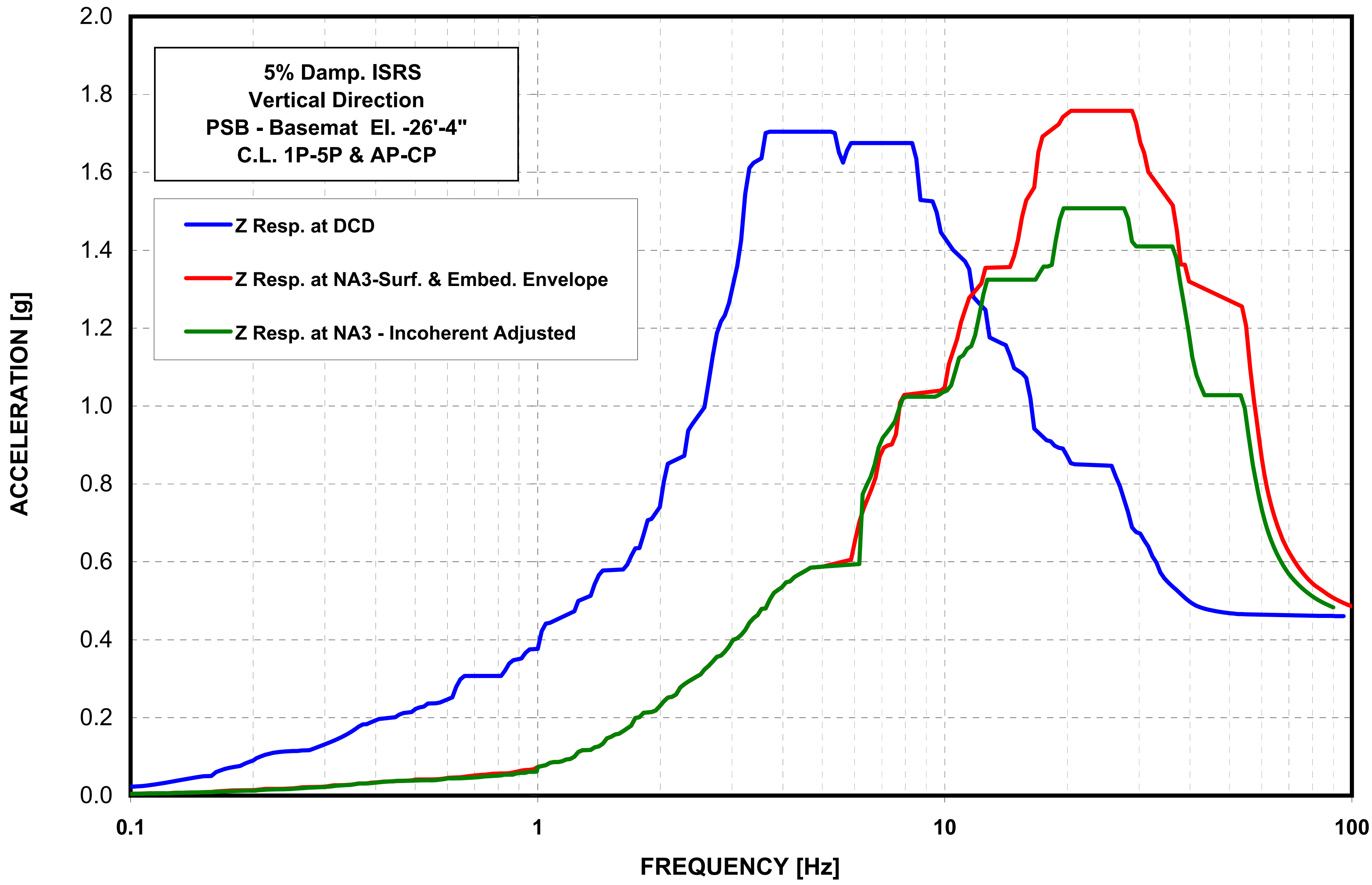


Figure 3NN-21 ISRS for PS/B N-S Direction at Ground Floor, Elevation 3'-7" (Sheet 4 of 12)

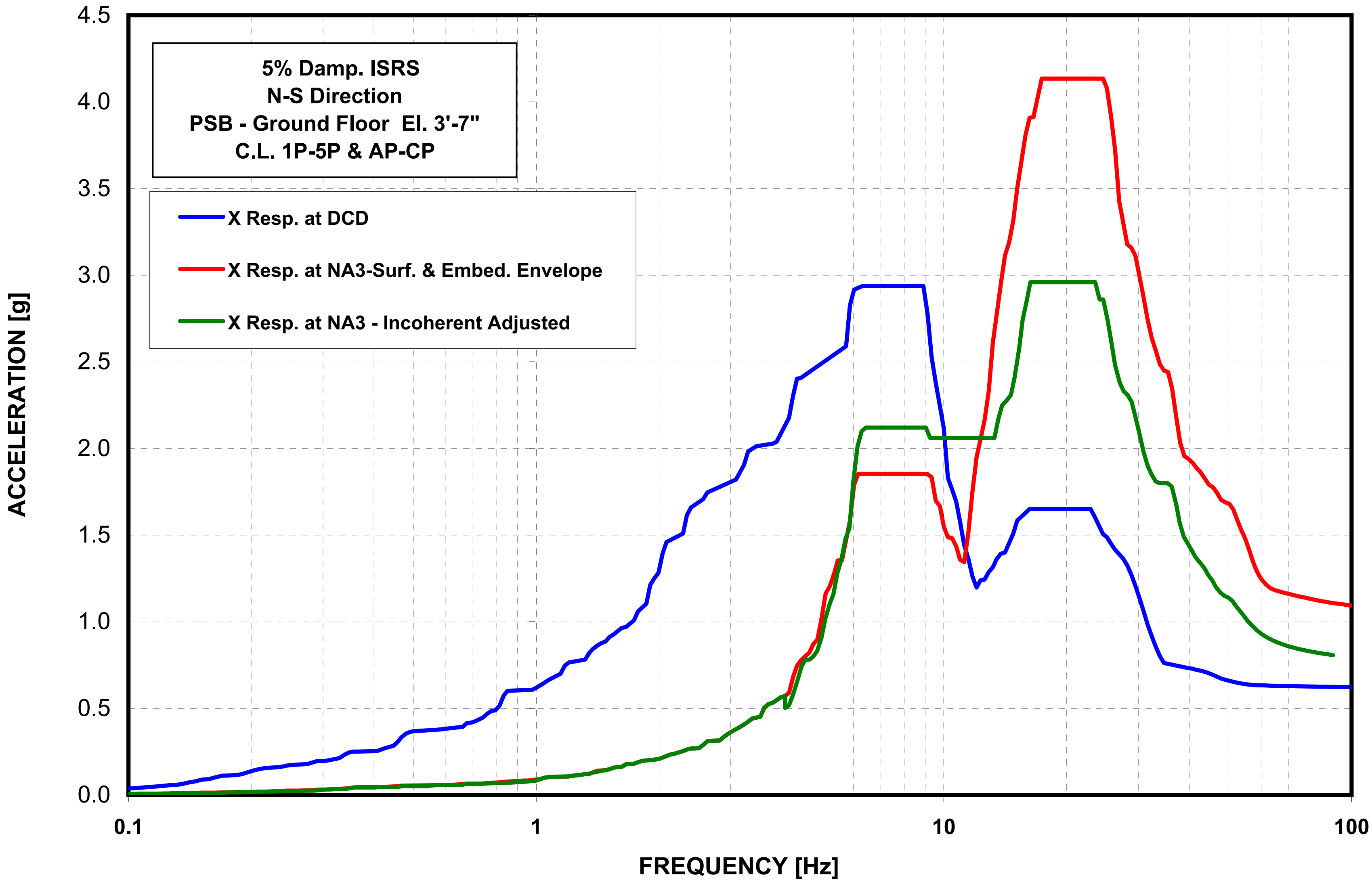


Figure 3NN-21 ISRS for PS/B E-W Direction at Ground Floor, Elevation 3'-7" (Sheet 5 of 12)

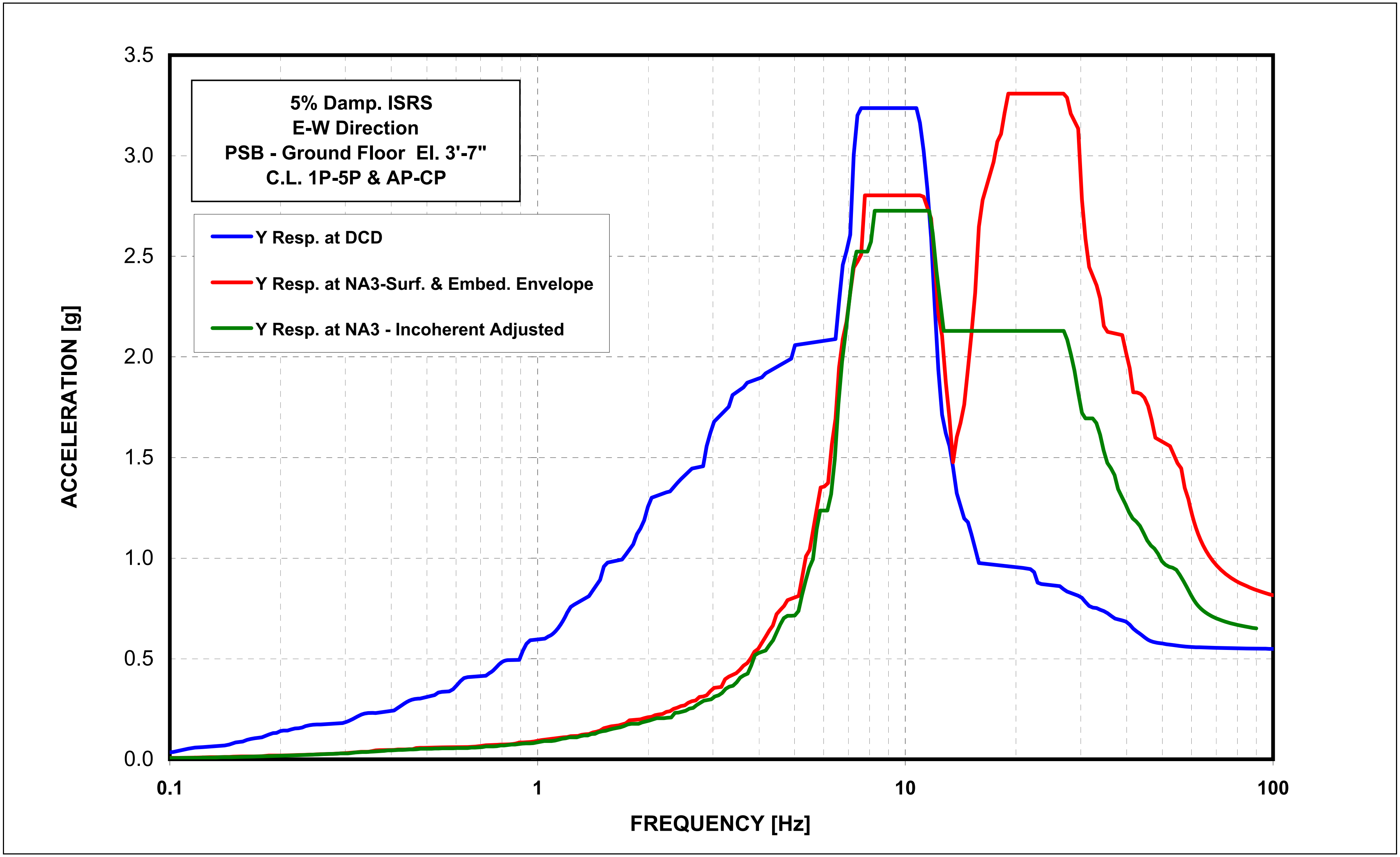


Figure 3NN-21 ISRS for PS/B Vertical Direction at Gas Turbine Generator B, Elevation 3'-7" (Sheet 6 of 12)

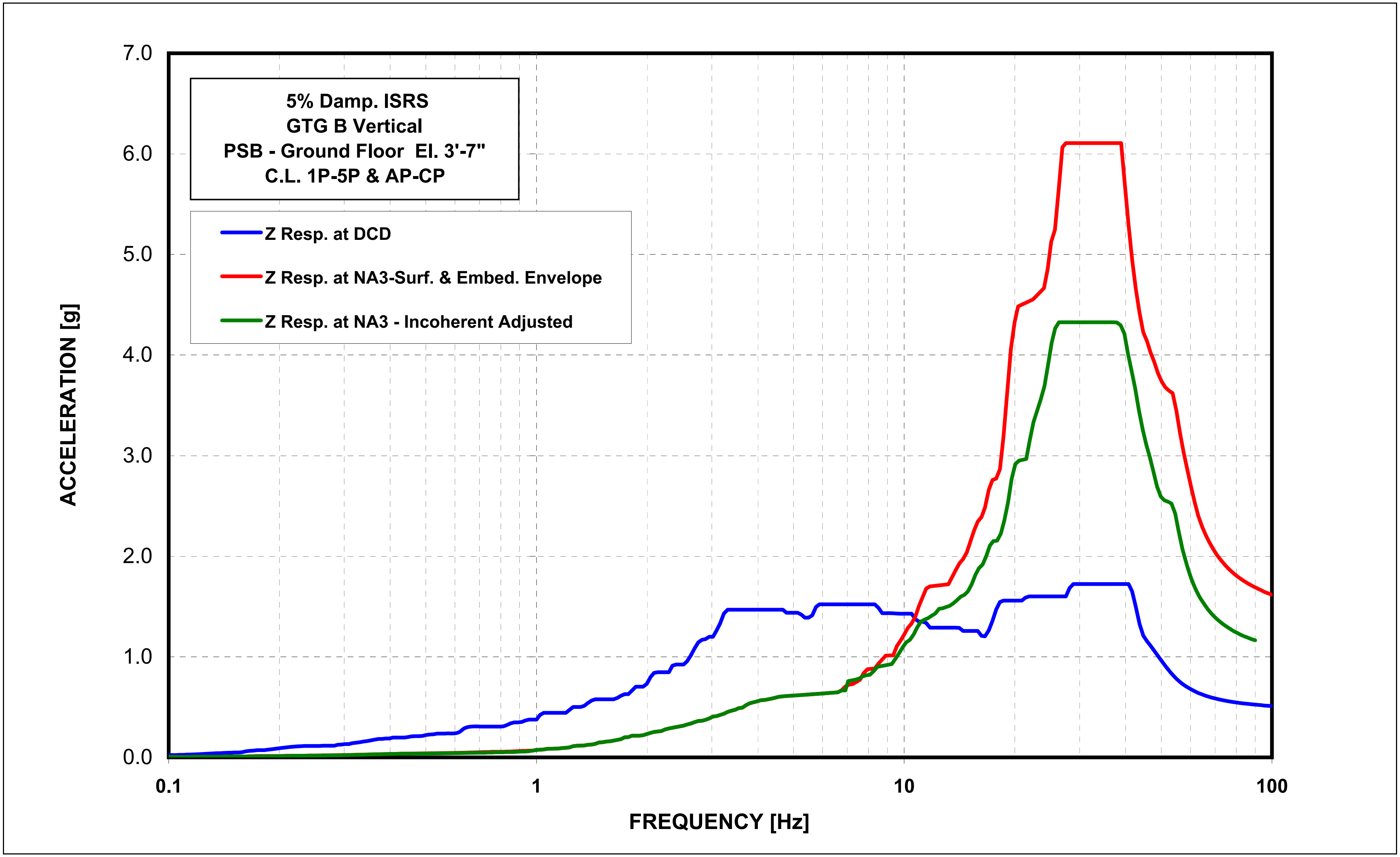


Figure 3NN-21 ISRS for PS/B Vertical Direction at Gas Turbine Generator C, Elevation 3'-7" (Sheet 7 of 12)

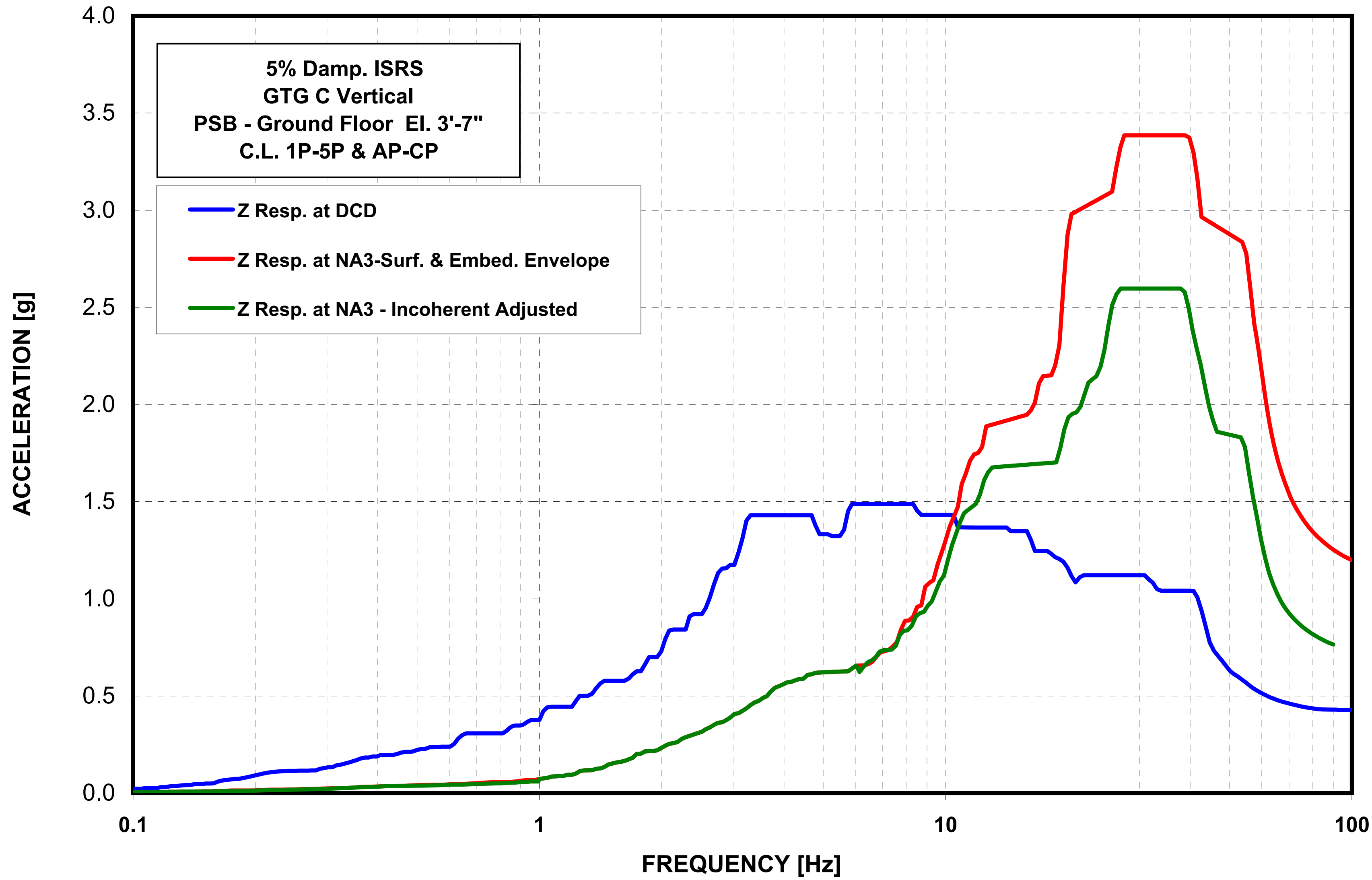


Figure 3NN-21 ISRS for PS/B Vertical Direction at Gas Turbine Generator D, Elevation 3'- 7" (Sheet 8 of 12)

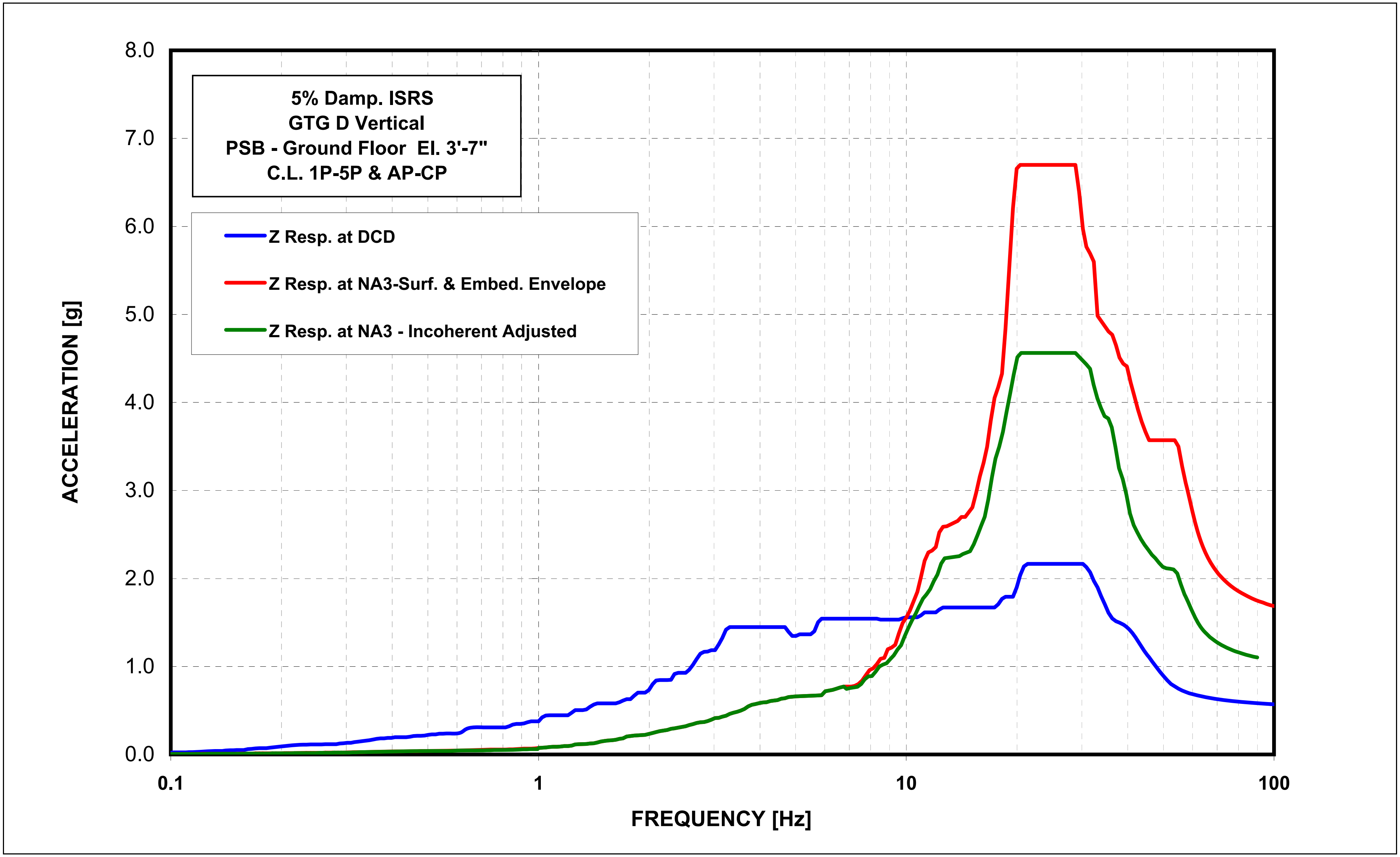


Figure 3NN-21 ISRS for PS/B Vertical Direction at Gas Turbine Generator Panels, Elevation 3'-7" (Sheet 9 of 12)

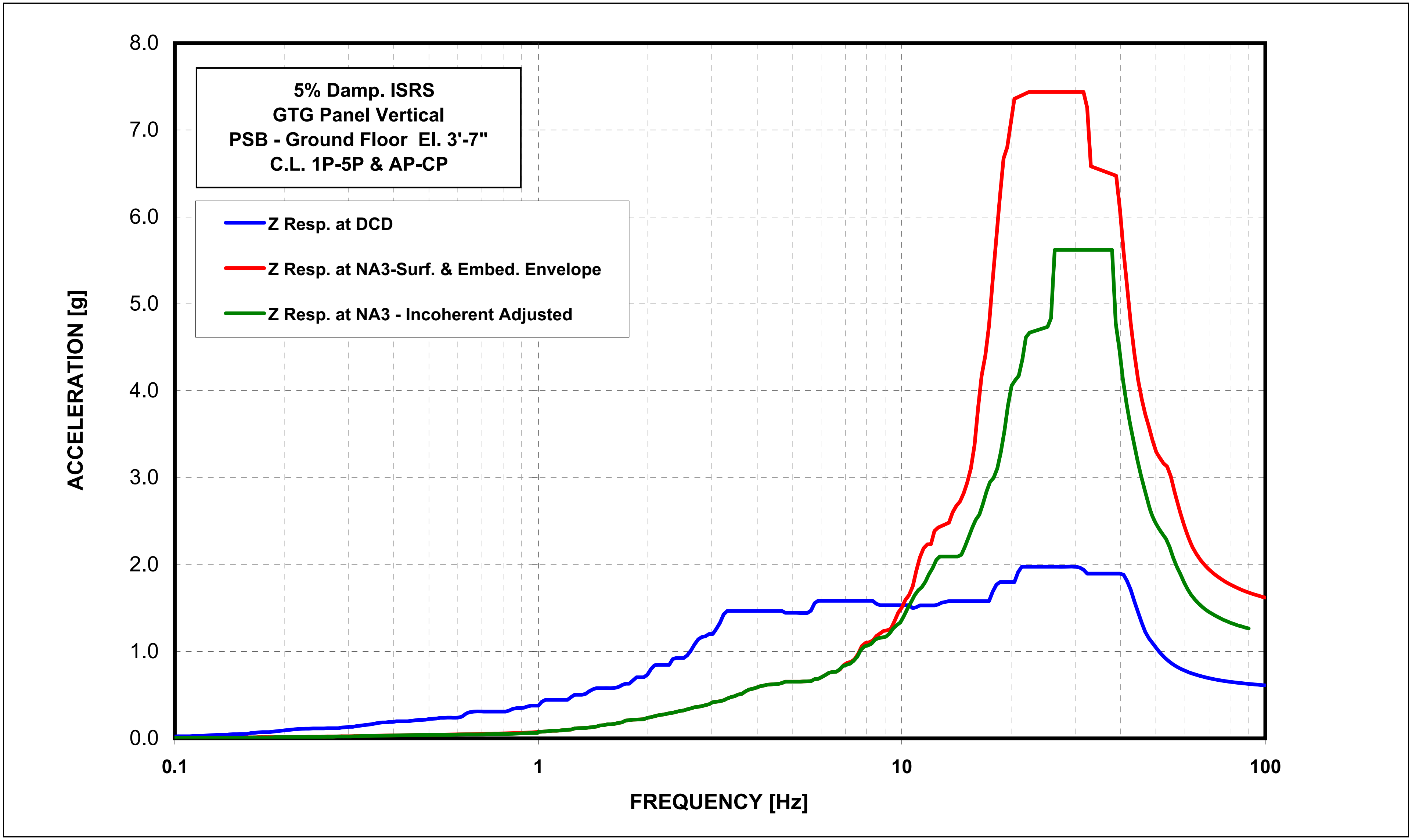


Figure 3NN-21 ISRS for PS/B N-S Direction at Roof, Elevation 39'- 6" (Sheet 10 of 12)

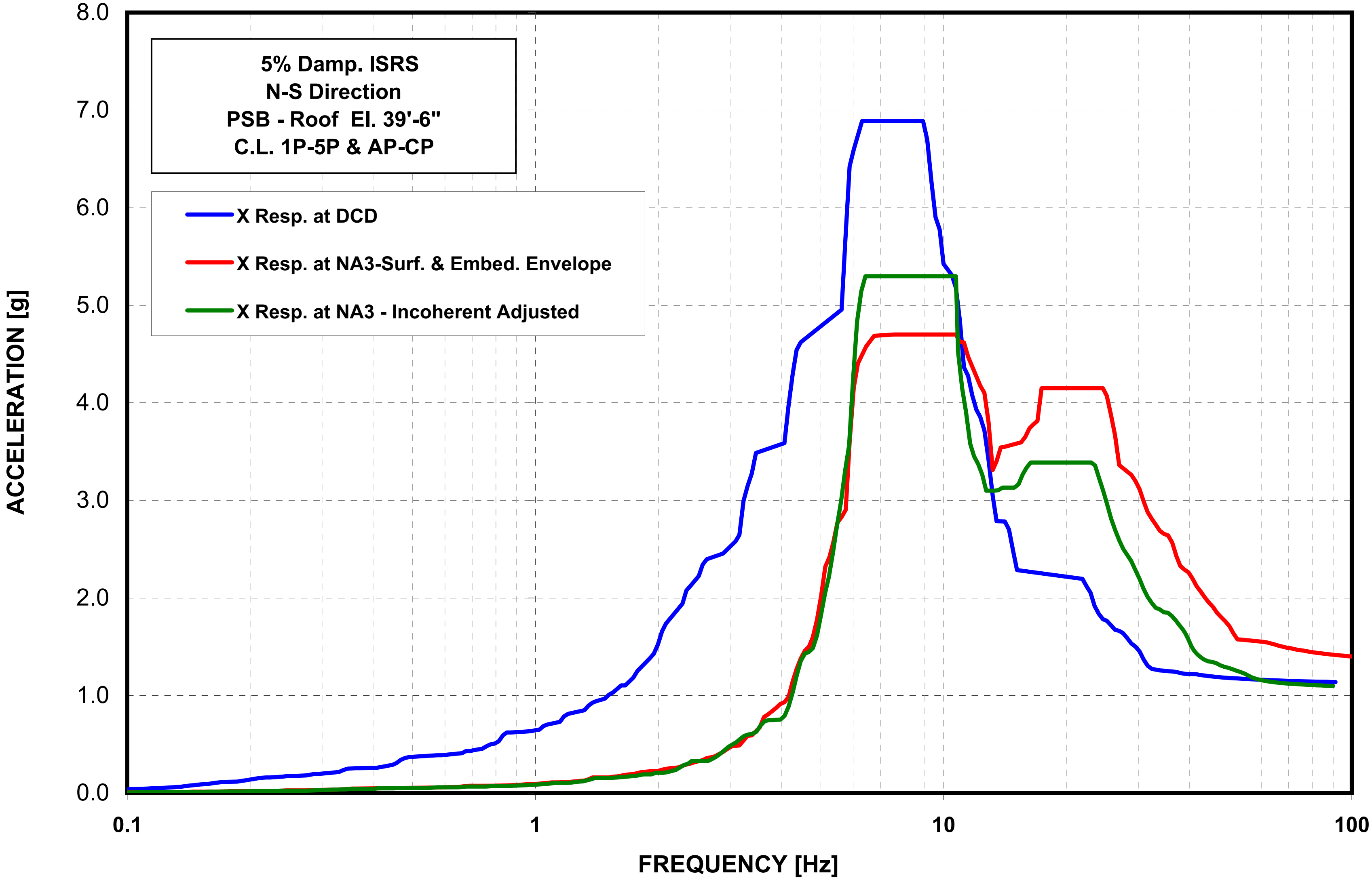


Figure 3NN-21 ISRS for PS/B E-W Direction at Roof, Elevation 39'-6" (Sheet 11 of 12)

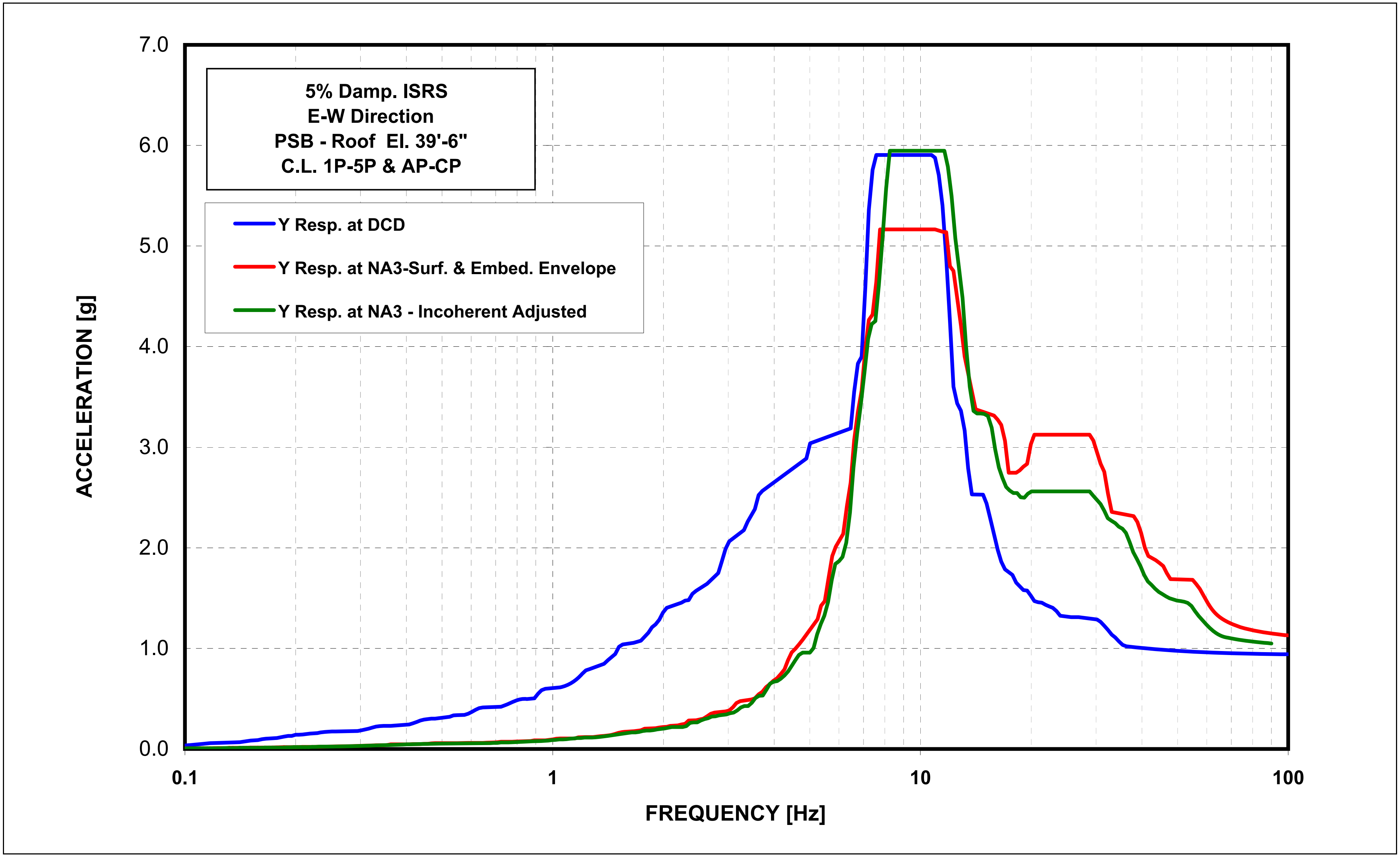
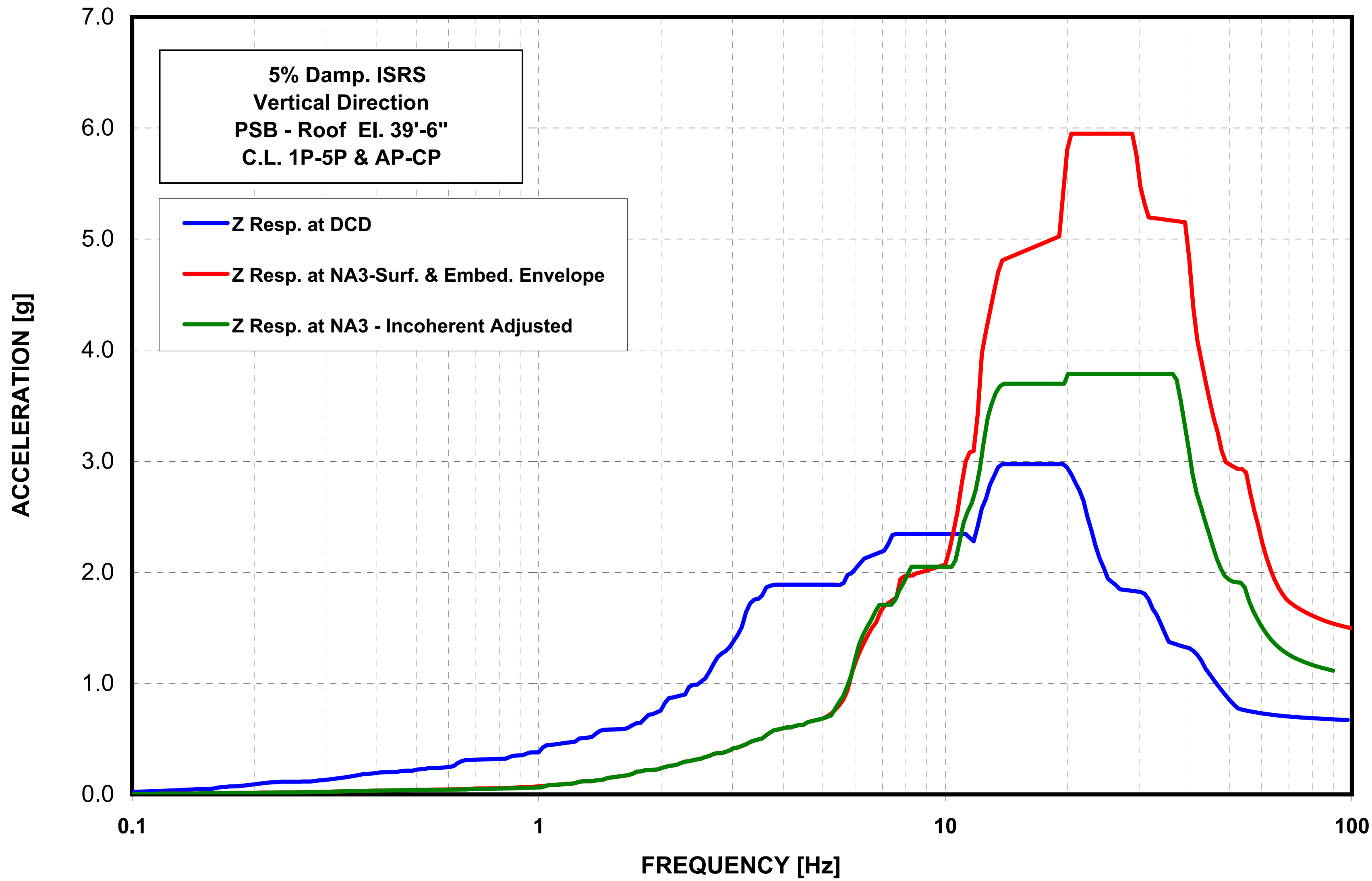
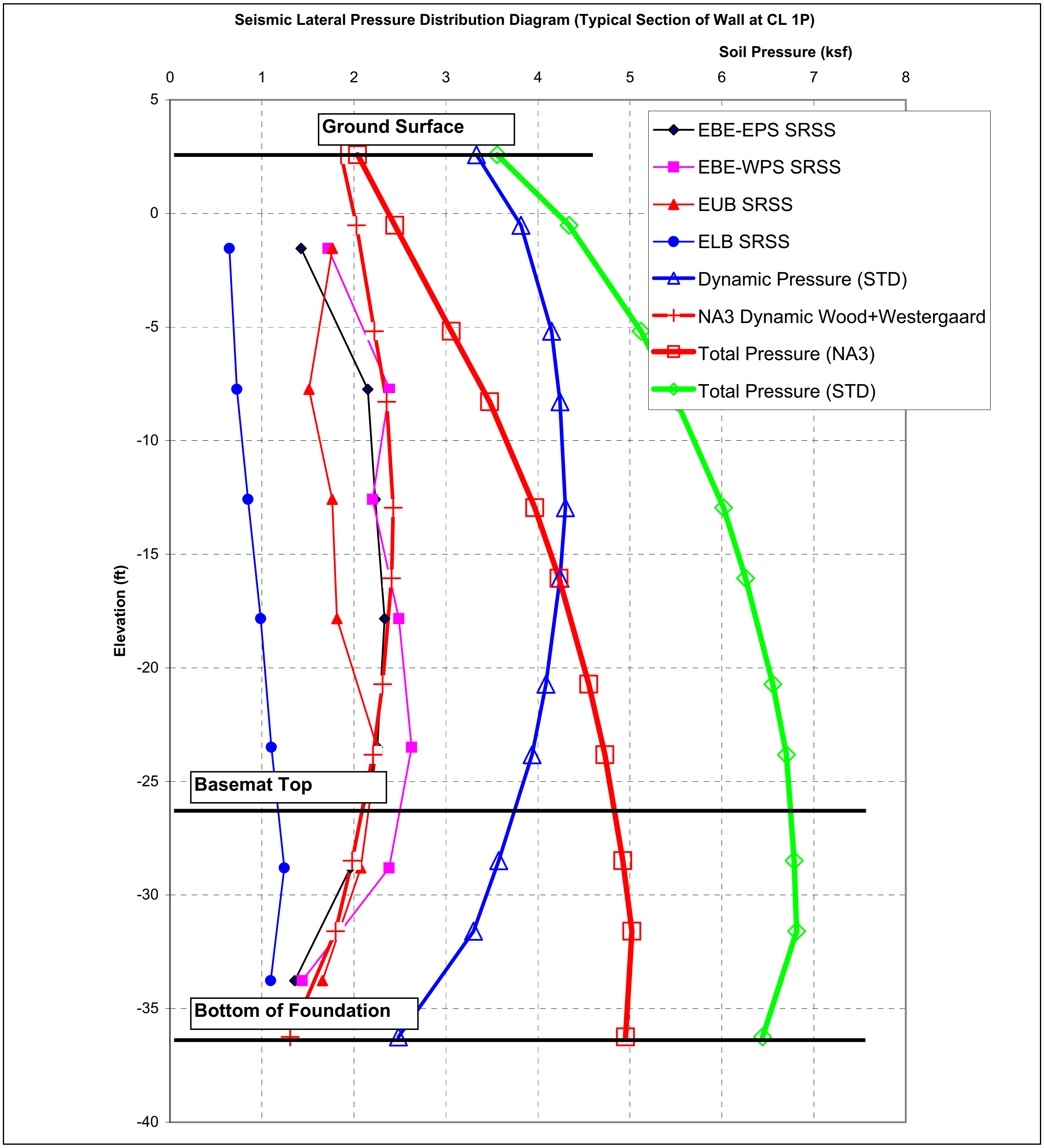


Figure 3NN-21 ISRS for PS/B Vertical Direction at Roof, Elevation 39'-6" (Sheet 12 of 12)



NAPS DEP 3.7(4) **Figure 3NN-22 US-APWR PS/B Embedded Model Seismic Lateral Soil Pressure Distribution**



1. Elevations shown are based on the standard plant design reference elevations, not Unit 3 values.
2. STD indicates standard plant design.
3. Total pressure plots include static and dynamic pressures.
4. Standard plant lateral pressure based on Soil Structure Interaction Analyses and Results for the US-APWR Standard Plant, MUAP-10006, Revision 1, Mitsubishi Heavy Industries, Ltd., January 2011.

Figure 3NN-23 ISRS for R/B N-S Direction at Basemat - Elevation –8'-7" (Sheet 1 of 143)

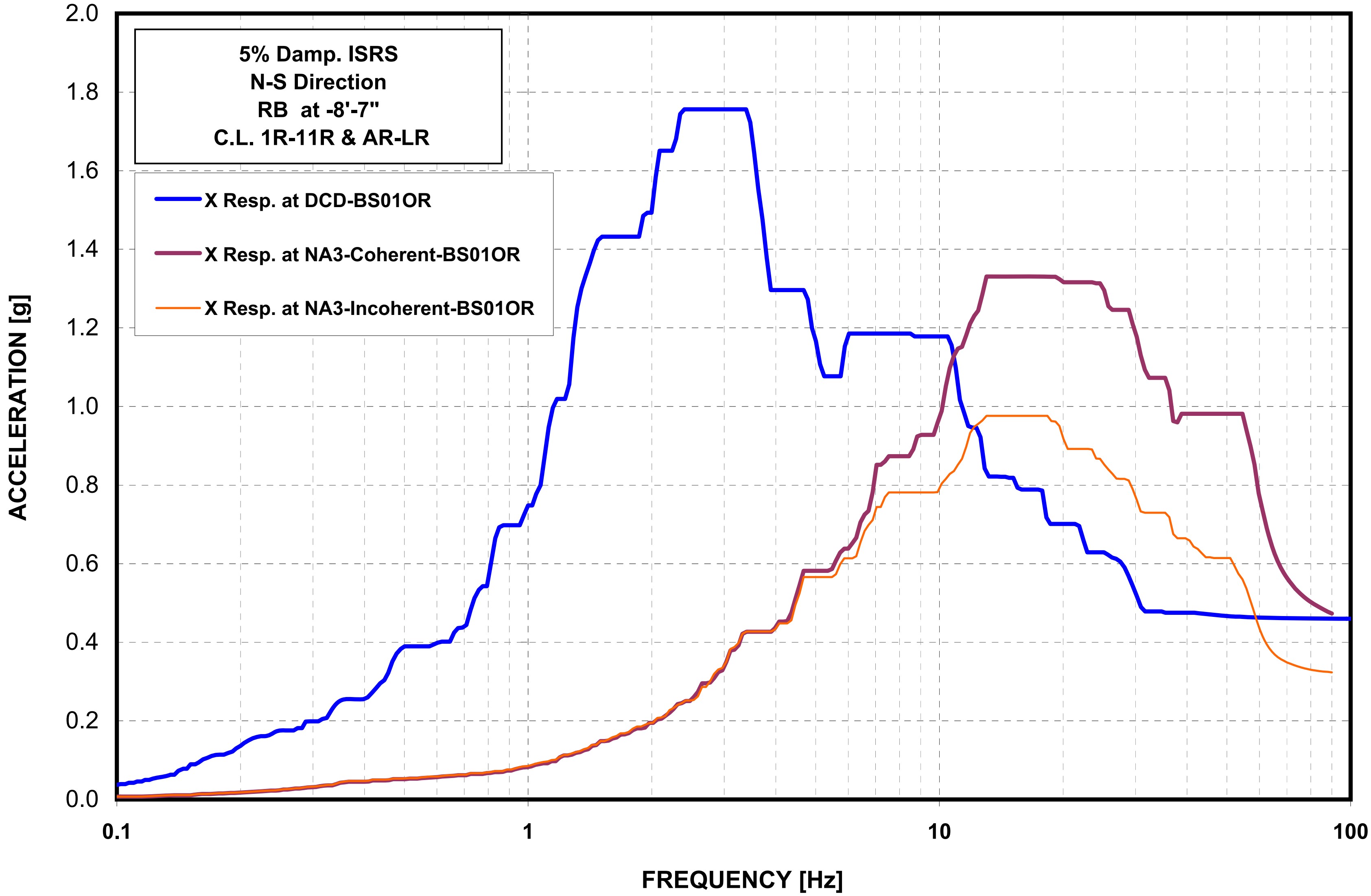


Figure 3NN-23 ISRS for R/B E-W Direction at Basemat - Elevation –8'- 7" (Sheet 2 of 143)

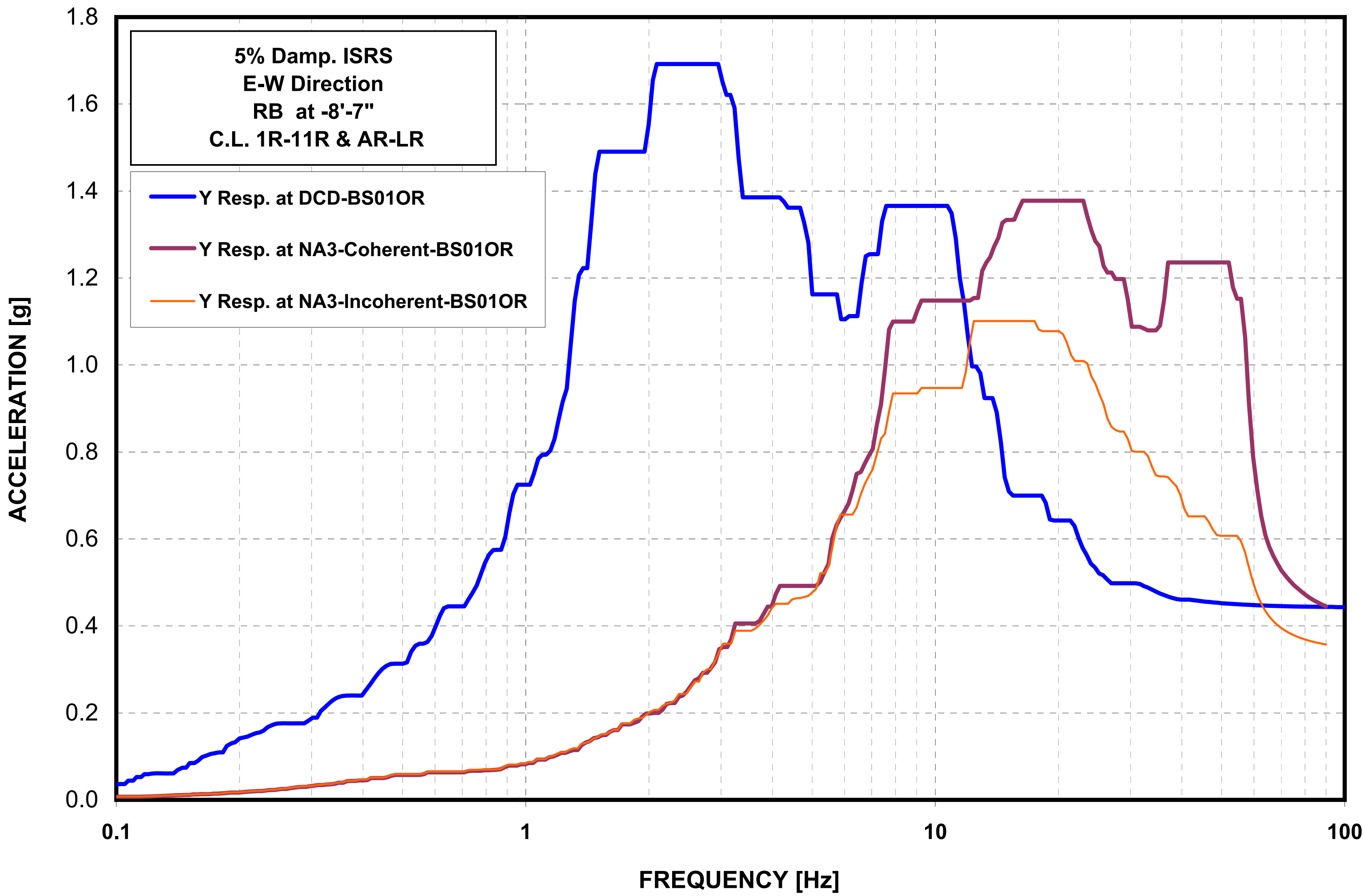


Figure 3NN-23 ISRS for R/B Vertical Direction at Basemat - Elevation –8'-7" (Sheet 3 of 143)

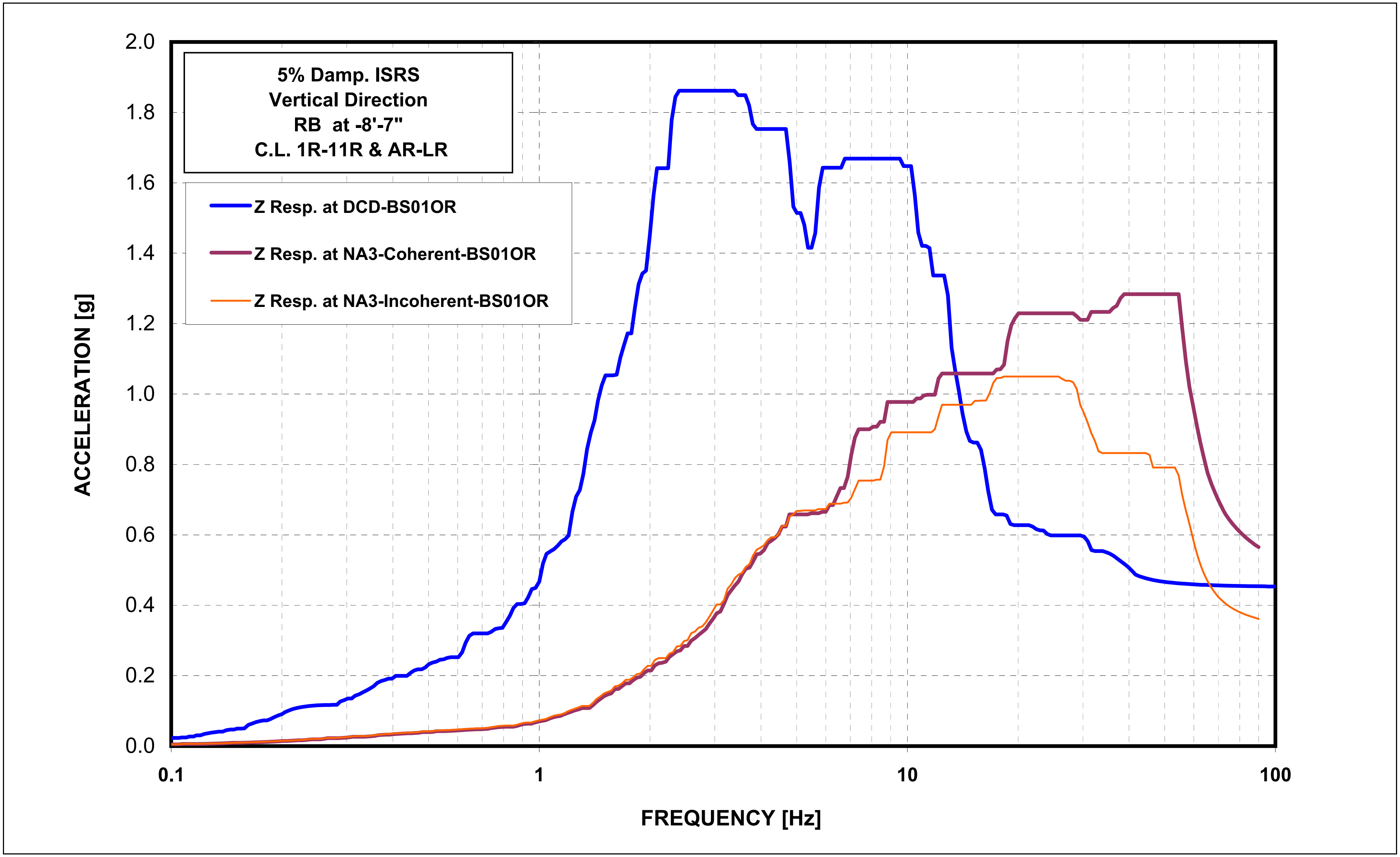


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at Basemat - Elevation –8'- 7" (Sheet 4 of 143)

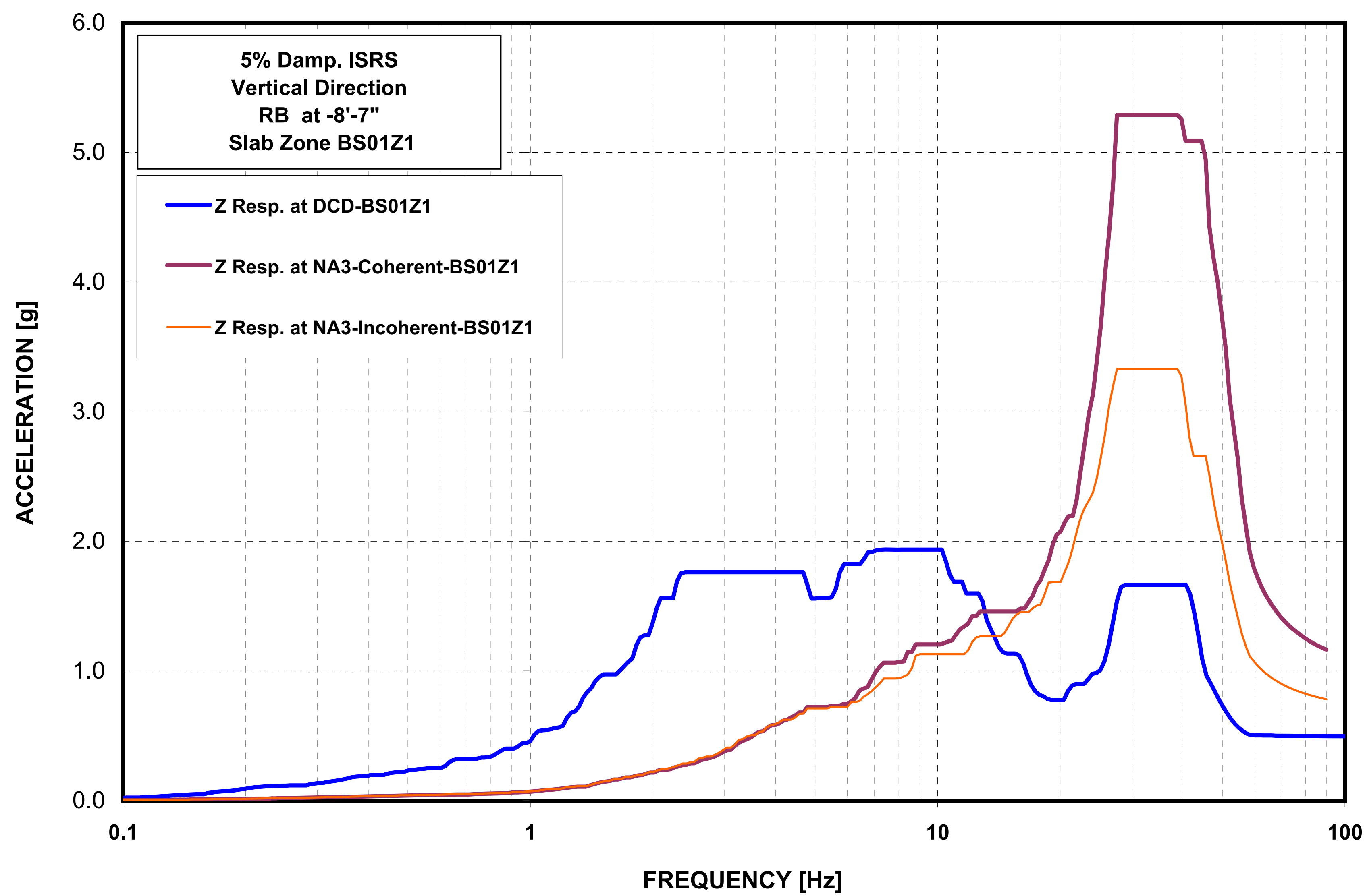


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at Basemat - Elevation –8'- 7" (Sheet 5 of 143)

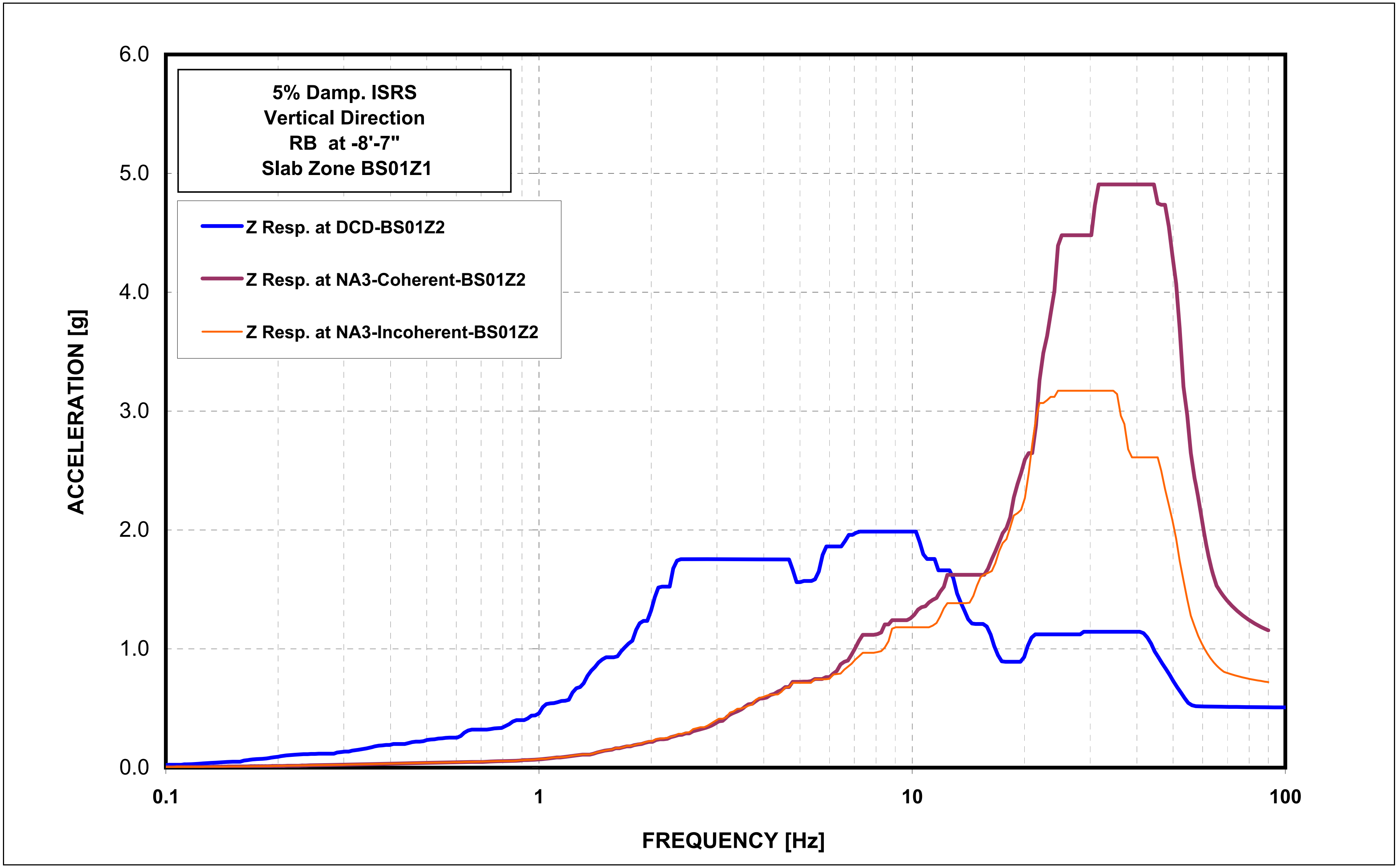


Figure 3NN-23 ISRS for R/B N-S Direction at RE00 - Elevation 3'-7" (Sheet 6 of 143)

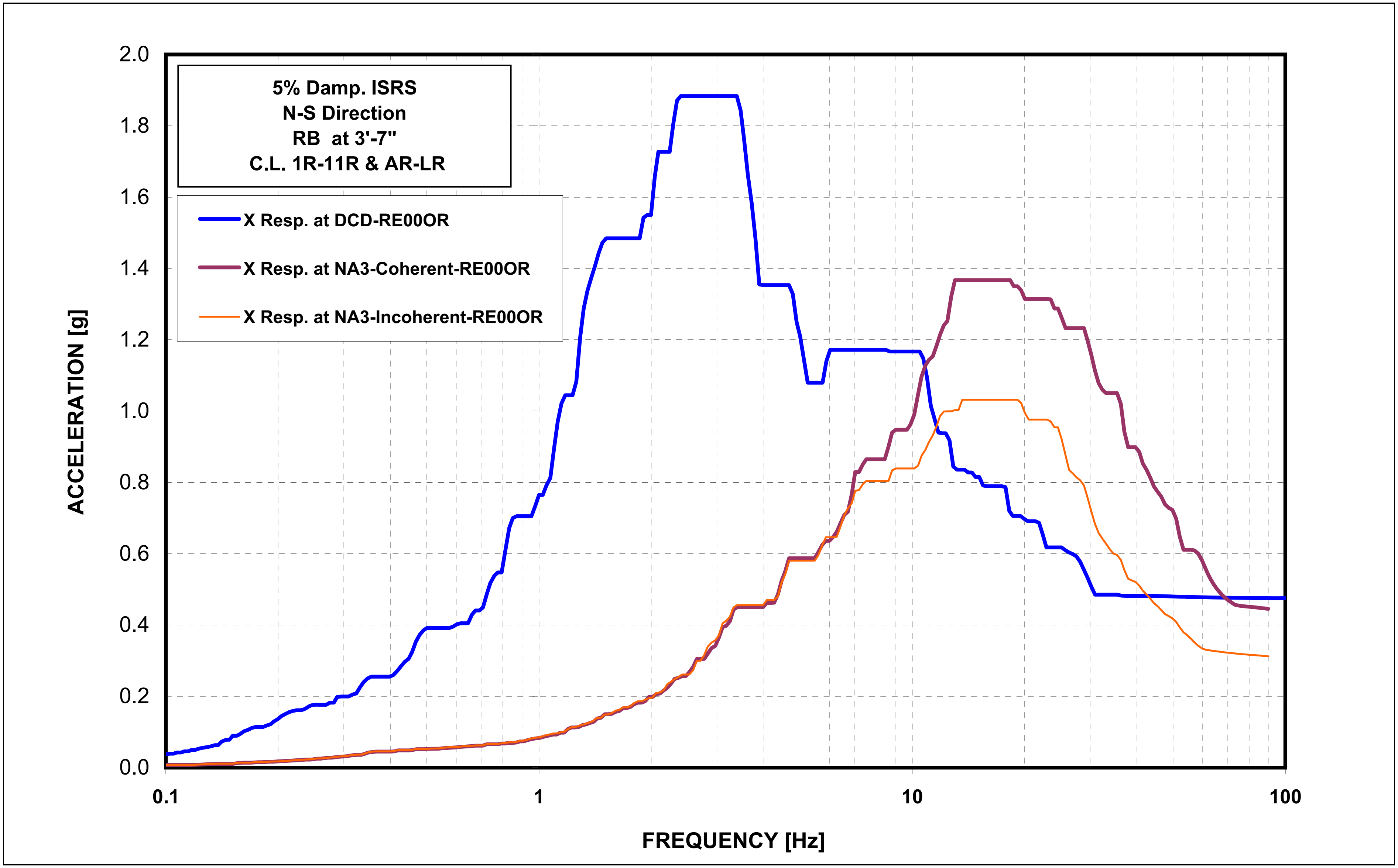


Figure 3NN-23 ISRS for R/B E-W Direction at RE00 - Elevation 3'-7" (Sheet 7 of 143)

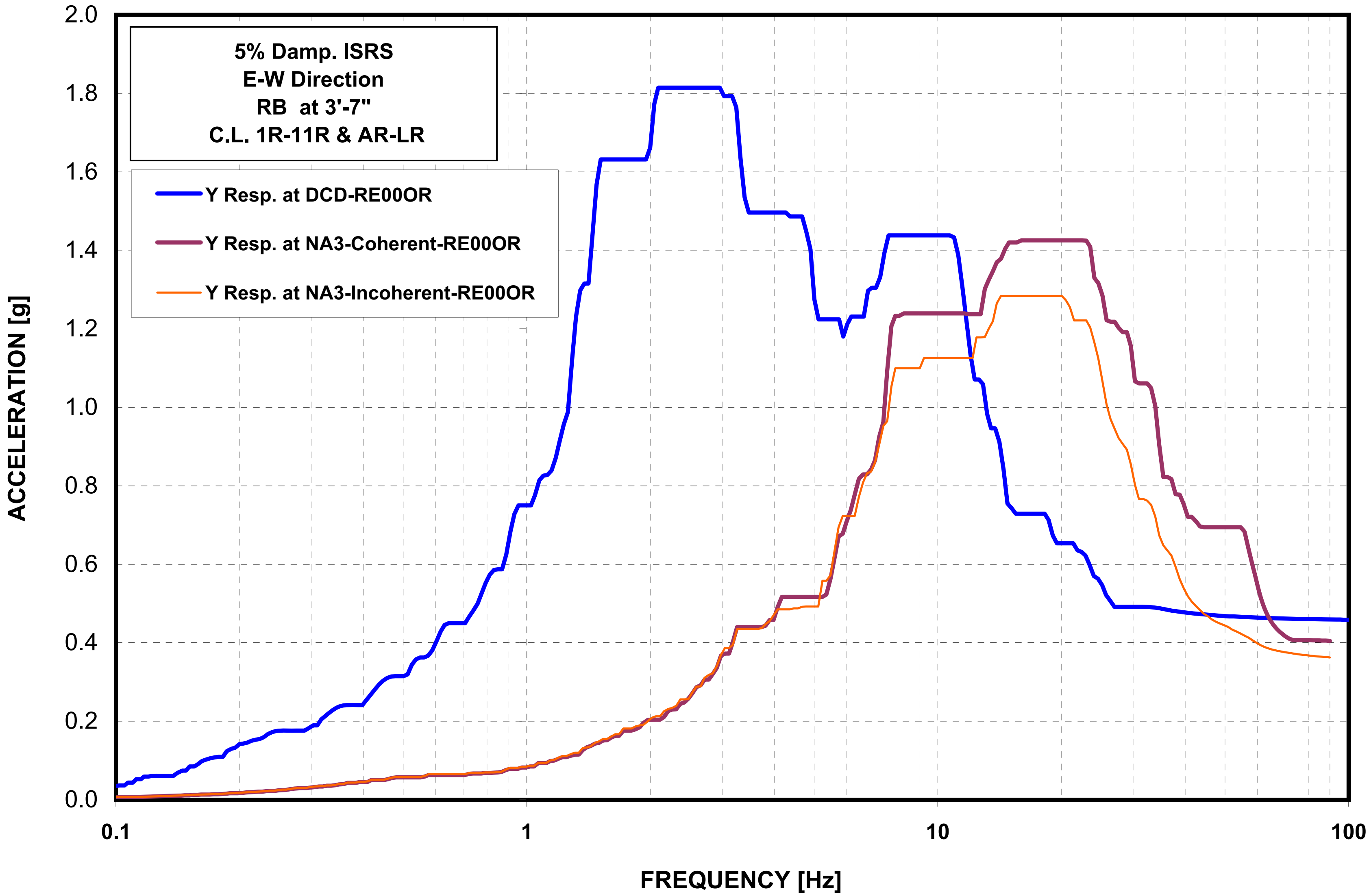


Figure 3NN-23 ISRS for R/B Vertical Direction at RE00 - Elevation 3'-7" (Sheet 8 of 143)

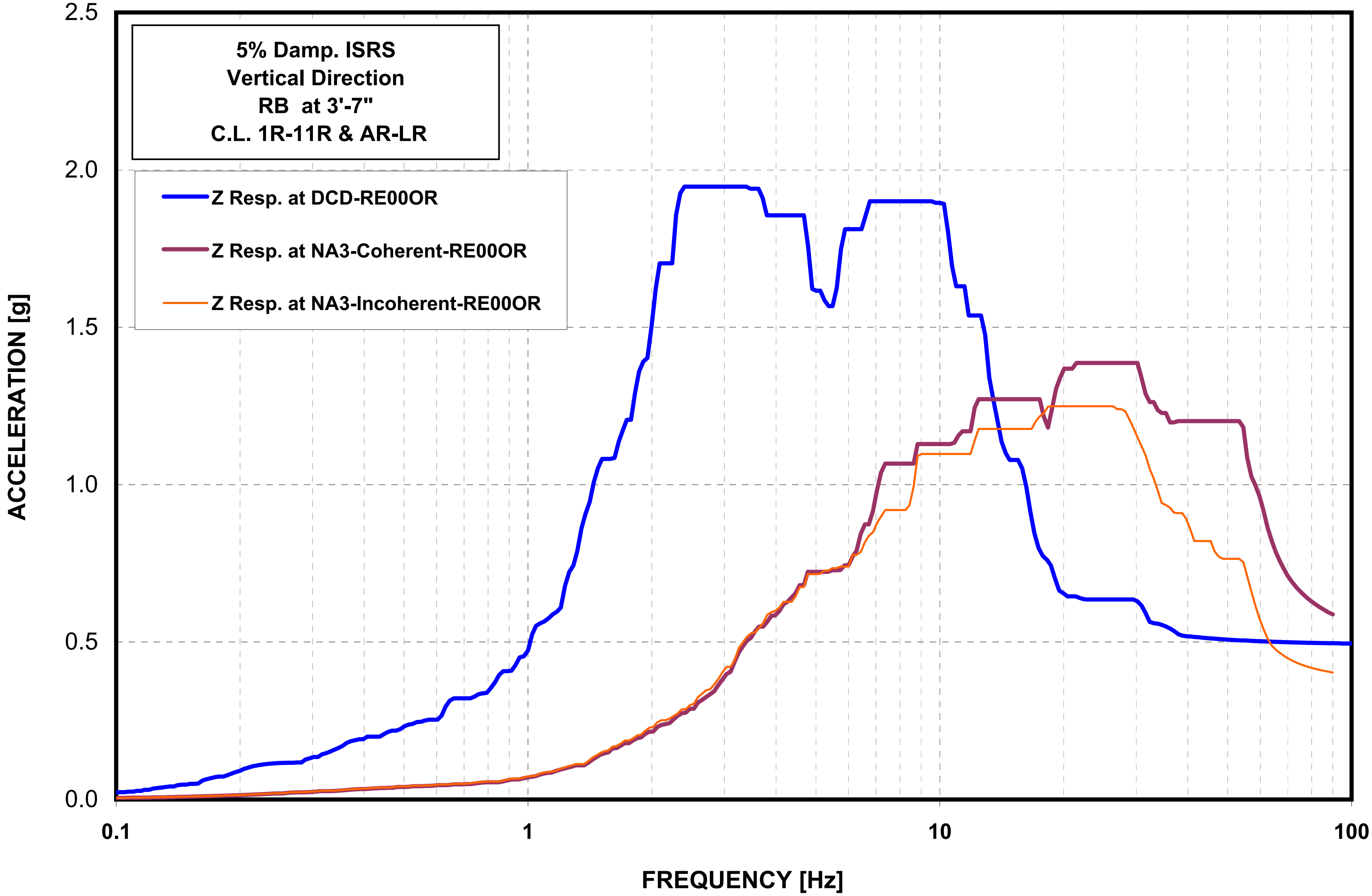


Figure 3NN-23 ISRS for R/B SDOF N-S Direction at RE00X1 - Elevation 3'-7" (Sheet 9 of 143)

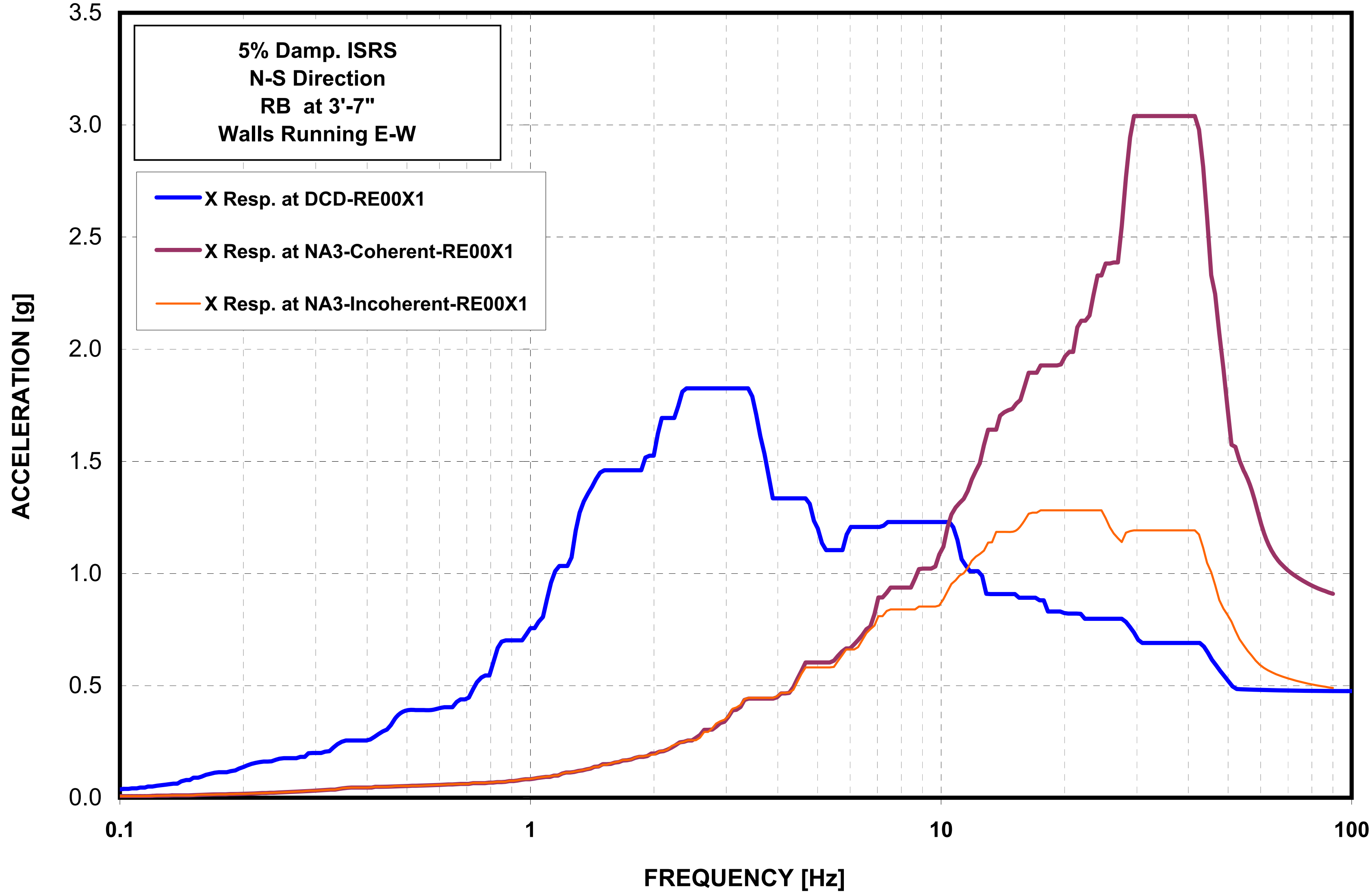


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE00Y1 - Elevation 3'-7" (Sheet 10 of 143)

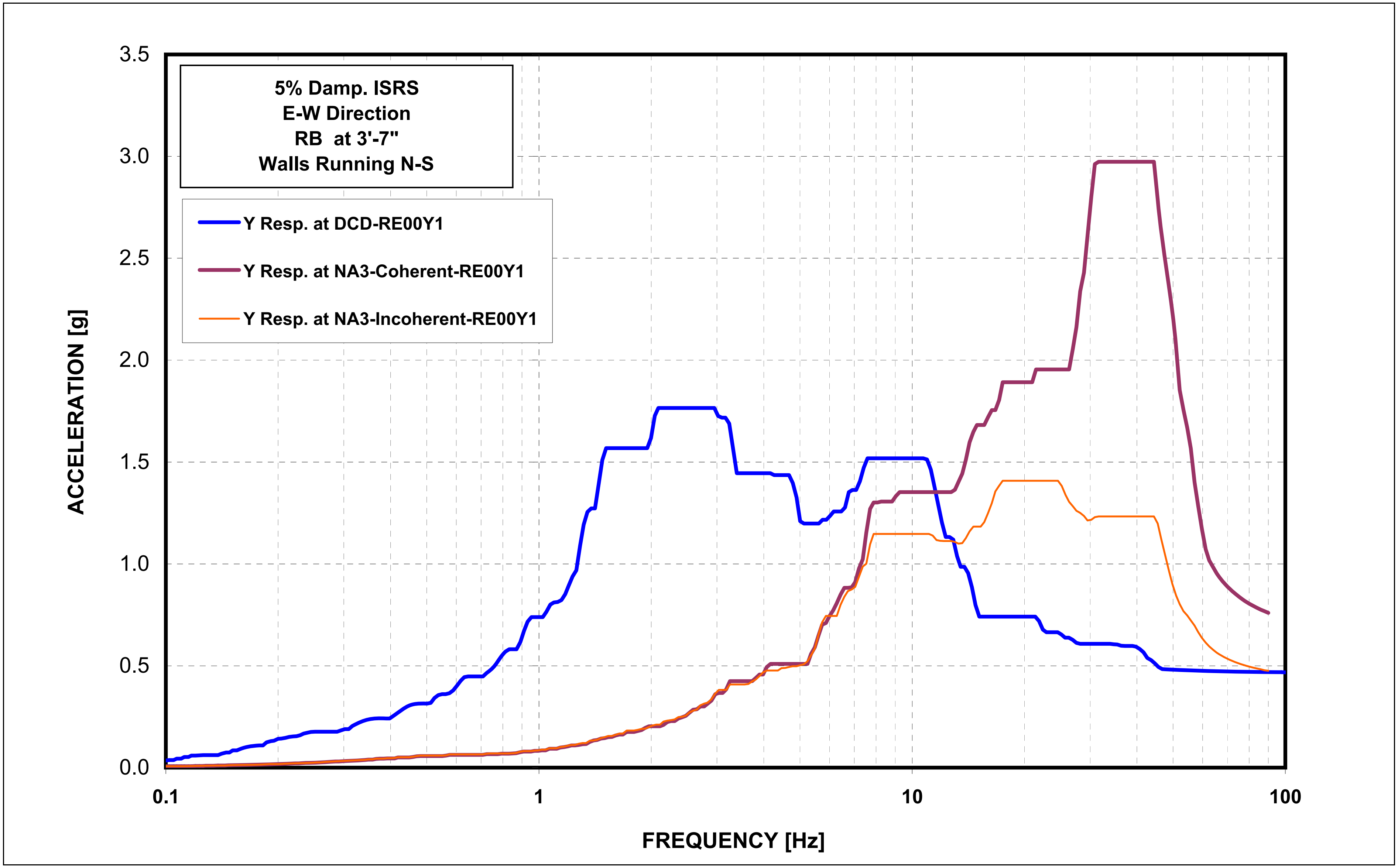


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE00Z1 - Elevation 3'-7" (Sheet 11 of 143)

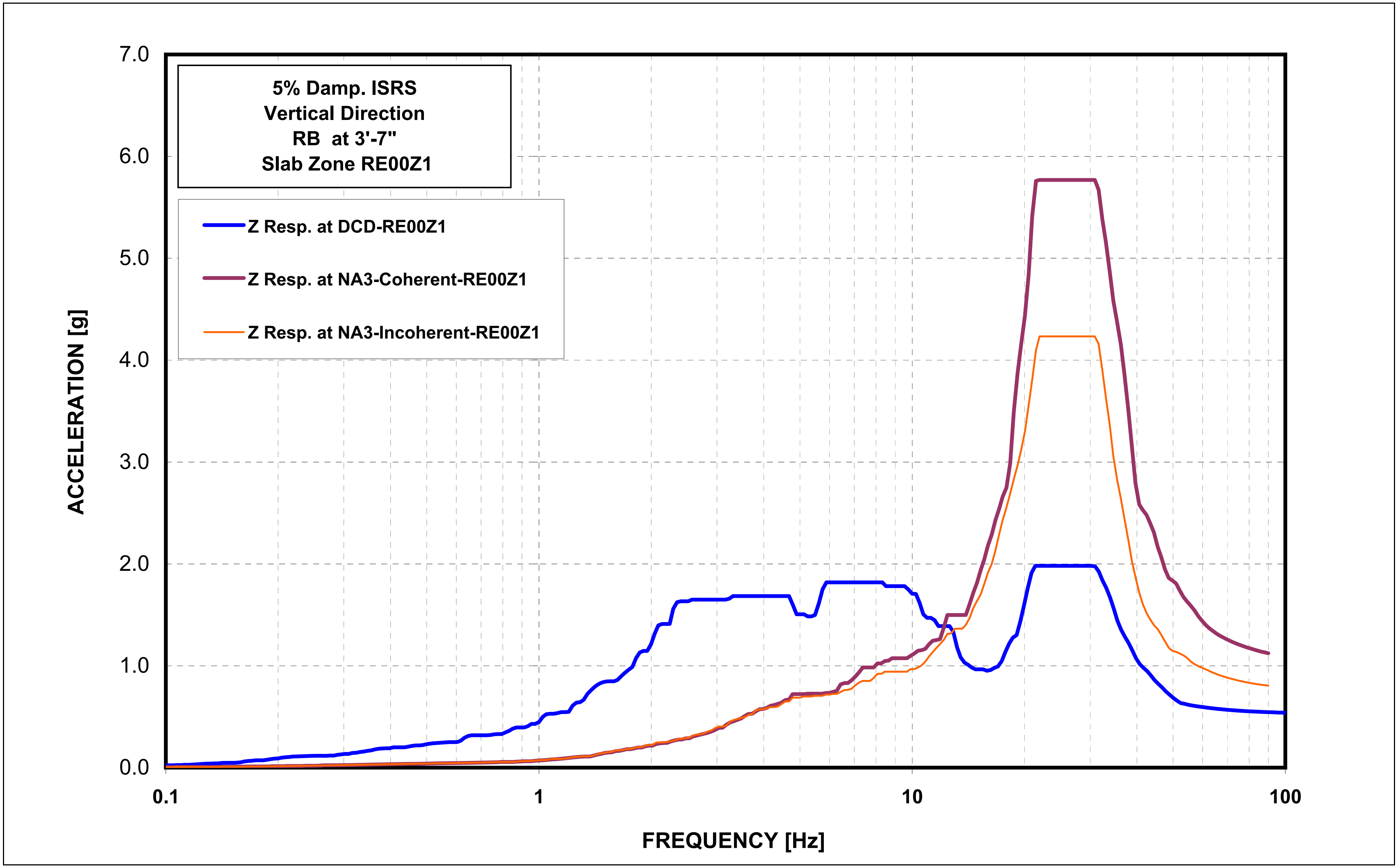


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE00Z2 - Elevation 3'-7" (Sheet 12 of 143)

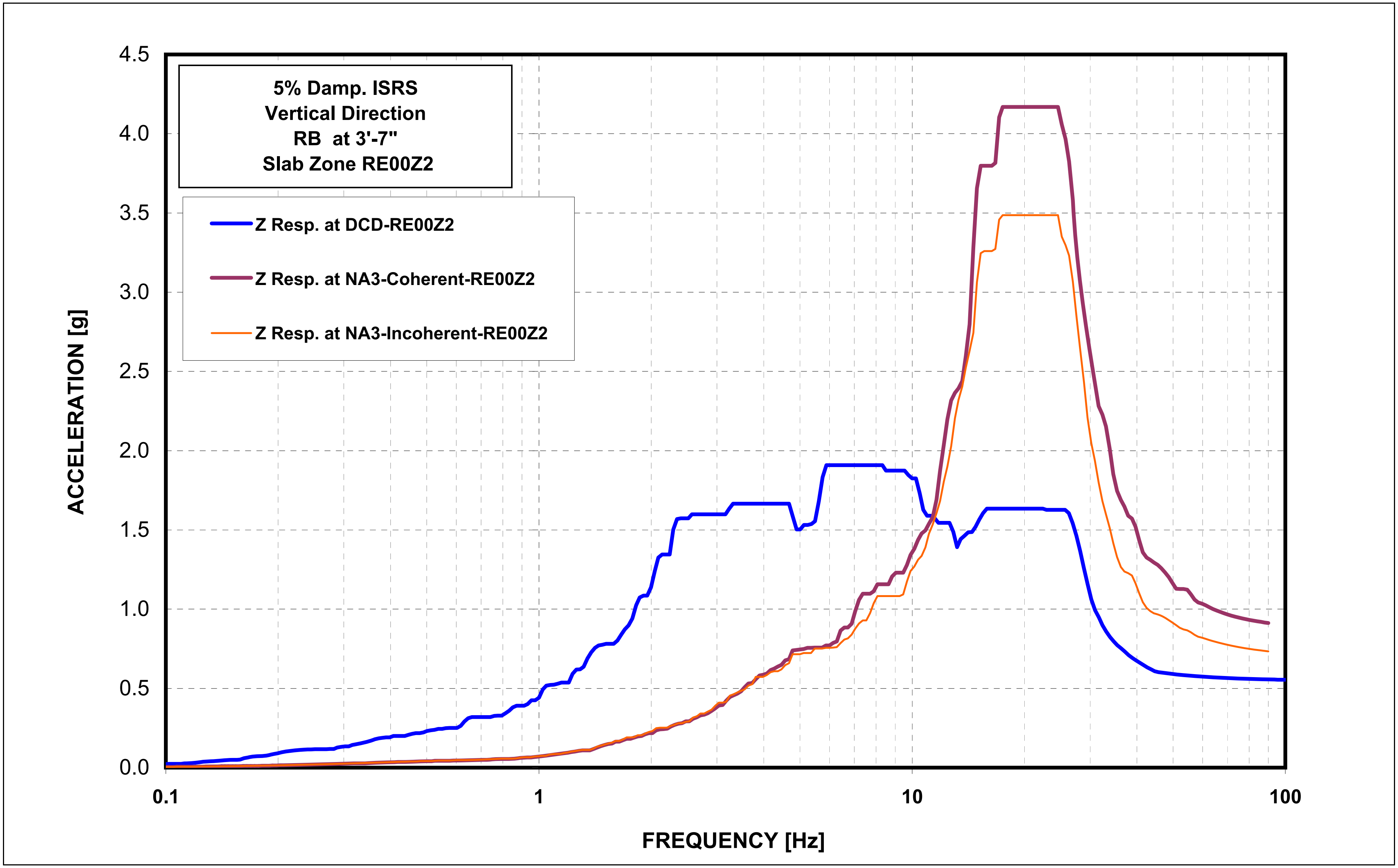


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE00Z3 - Elevation 3'-7" (Sheet 13 of 143)

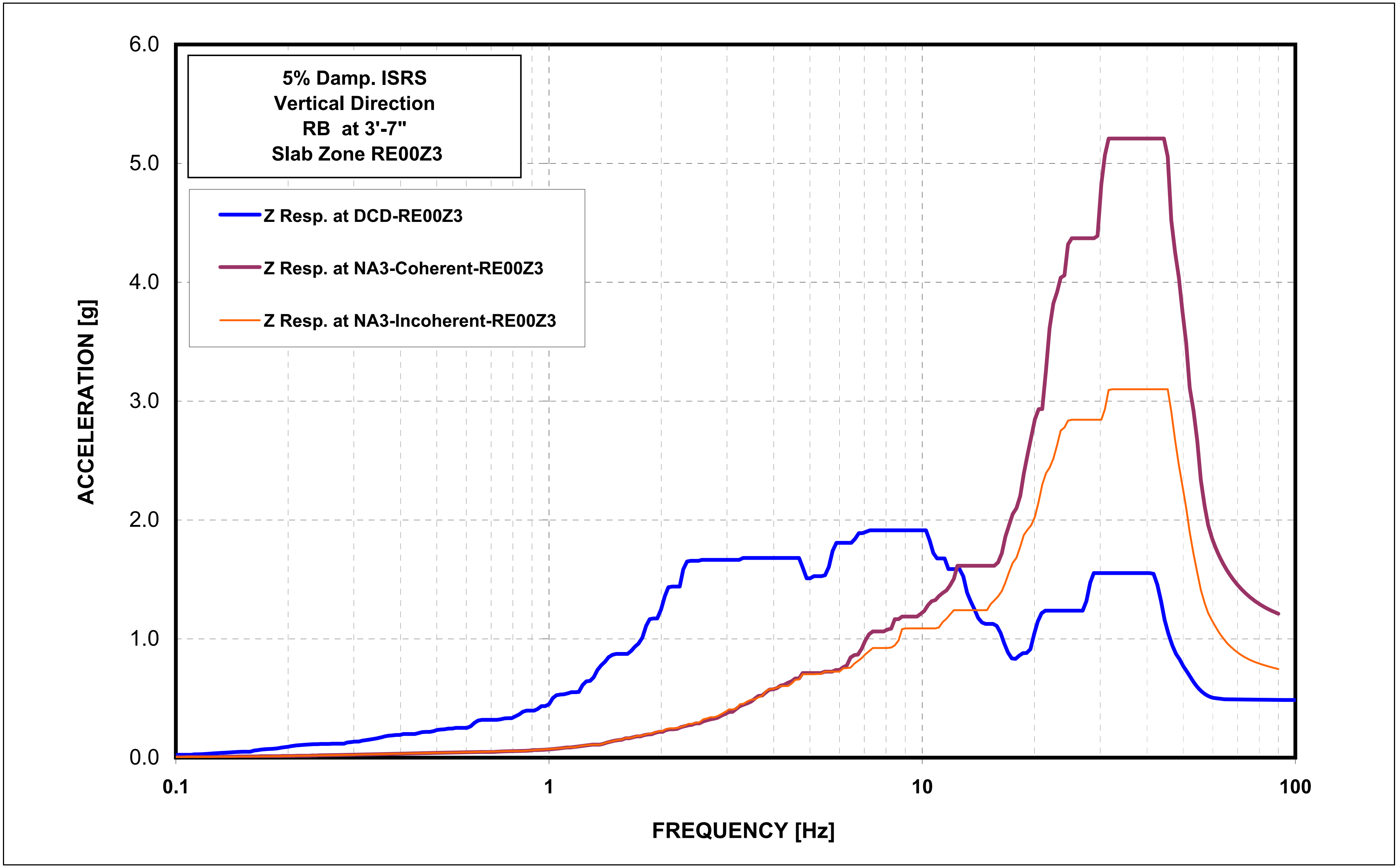


Figure 3NN-23 ISRS for R/B N-S Direction at RE01 - Elevation 25'-3" (Sheet 14 of 143)

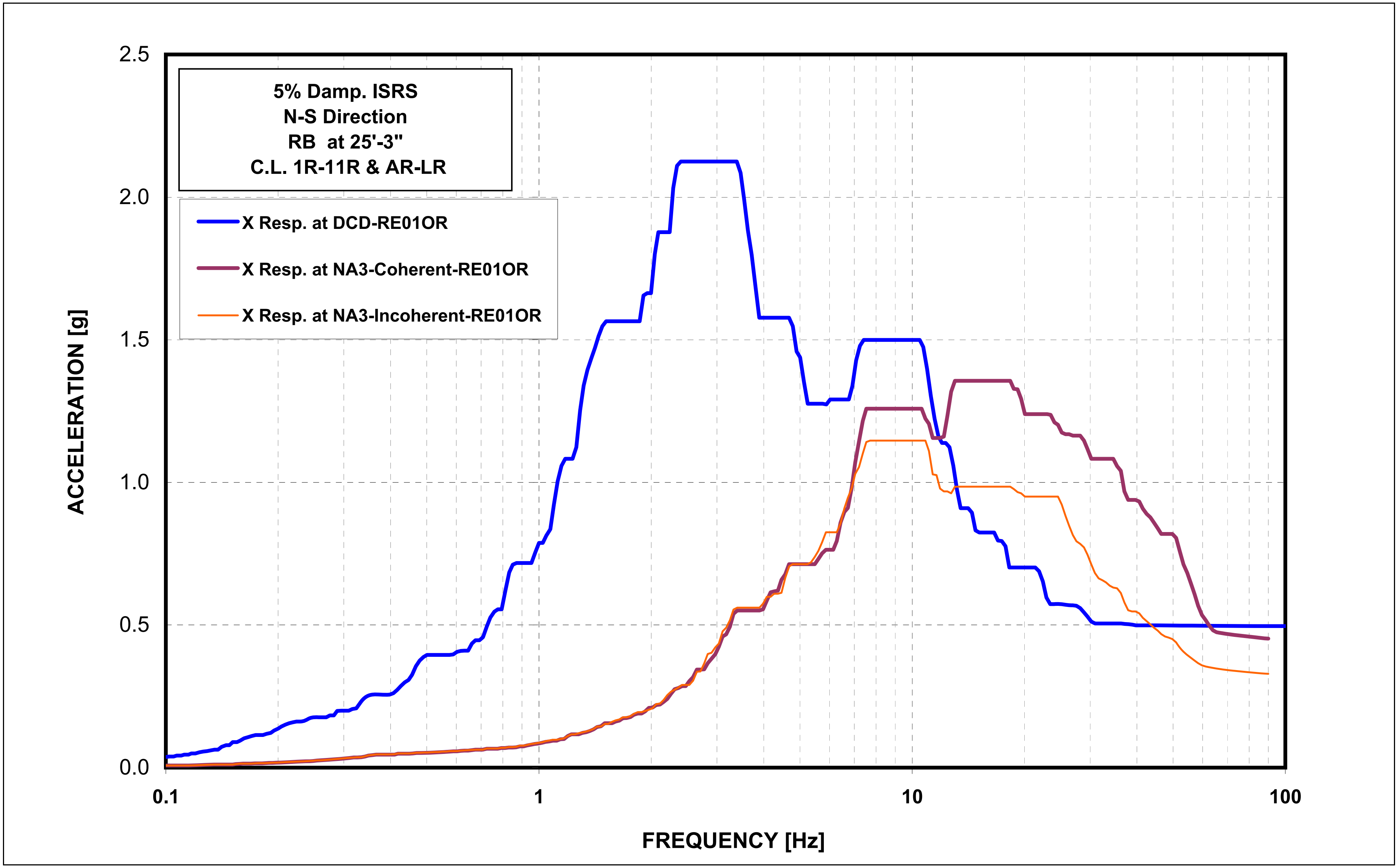


Figure 3NN-23 ISRS for R/B E-W Direction at RE01 - Elevation 25'-3" (Sheet 15 of 143)

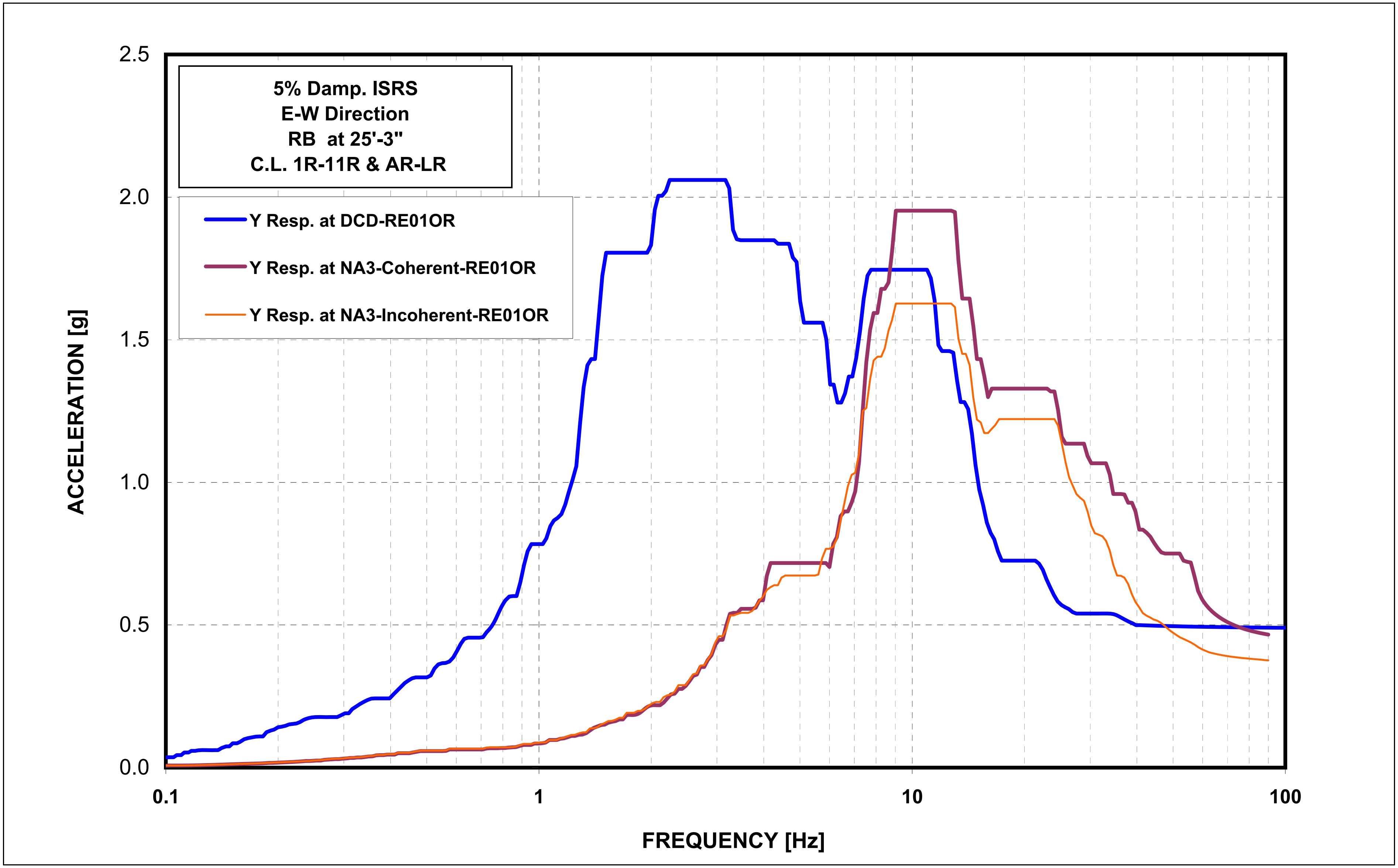


Figure 3NN-23 ISRS for R/B Vertical Direction at RE01 - Elevation 25'-3" (Sheet 16 of 143)

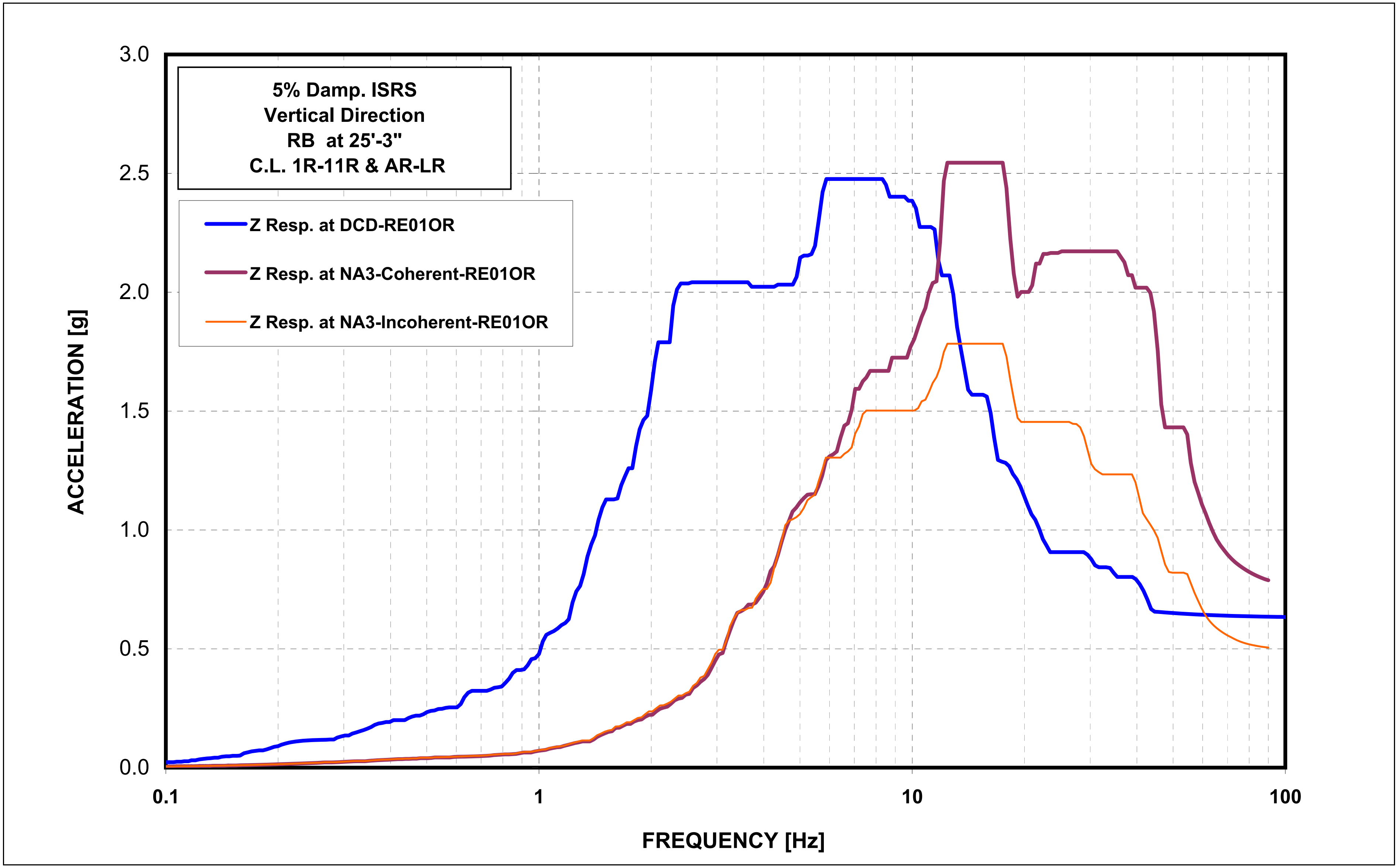


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE01Z1 - Elevation 25'- 3" (Sheet 17 of 143)

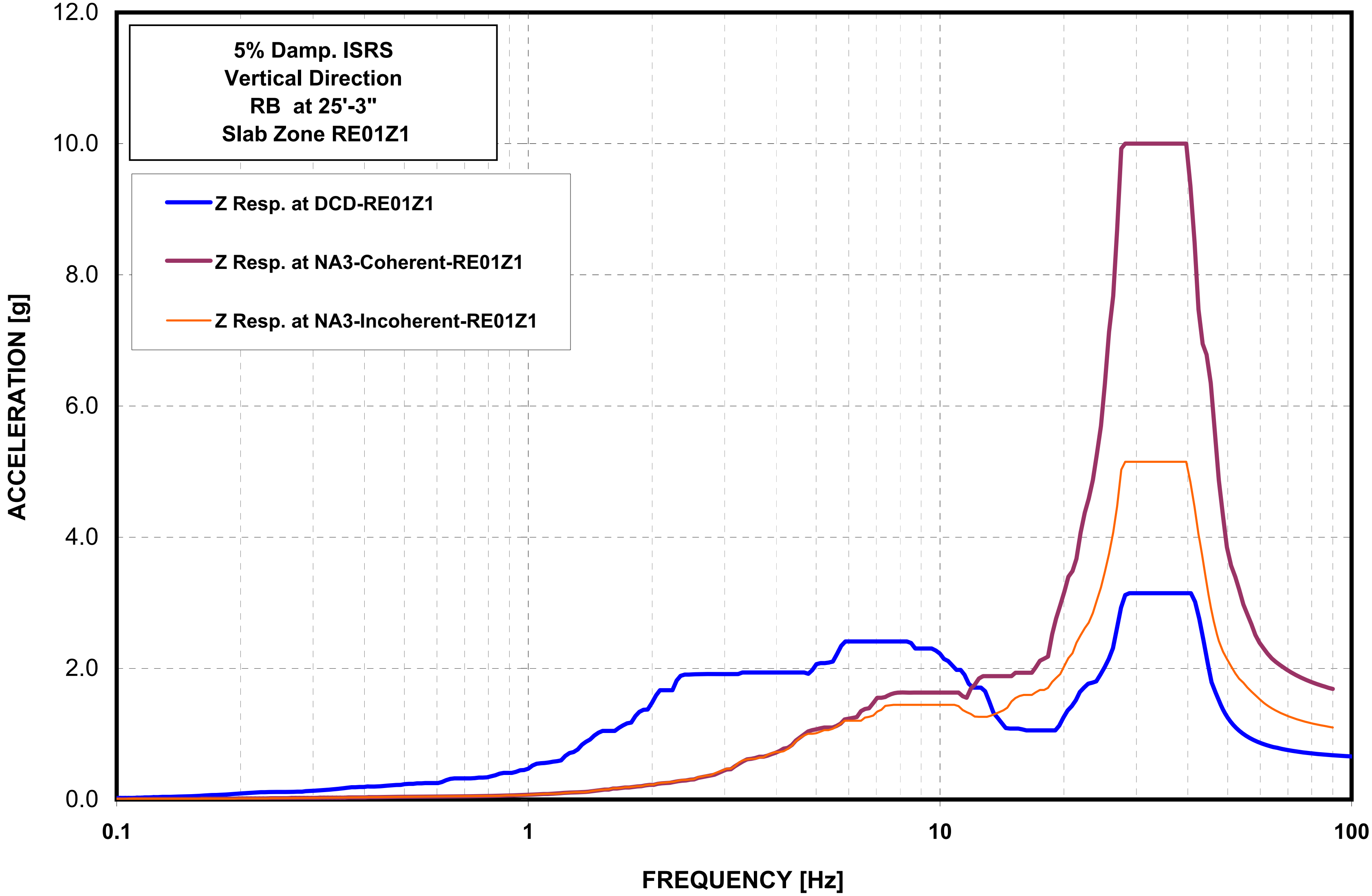


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE01Z2 - Elevation 25'- 3" (Sheet 18 of 143)

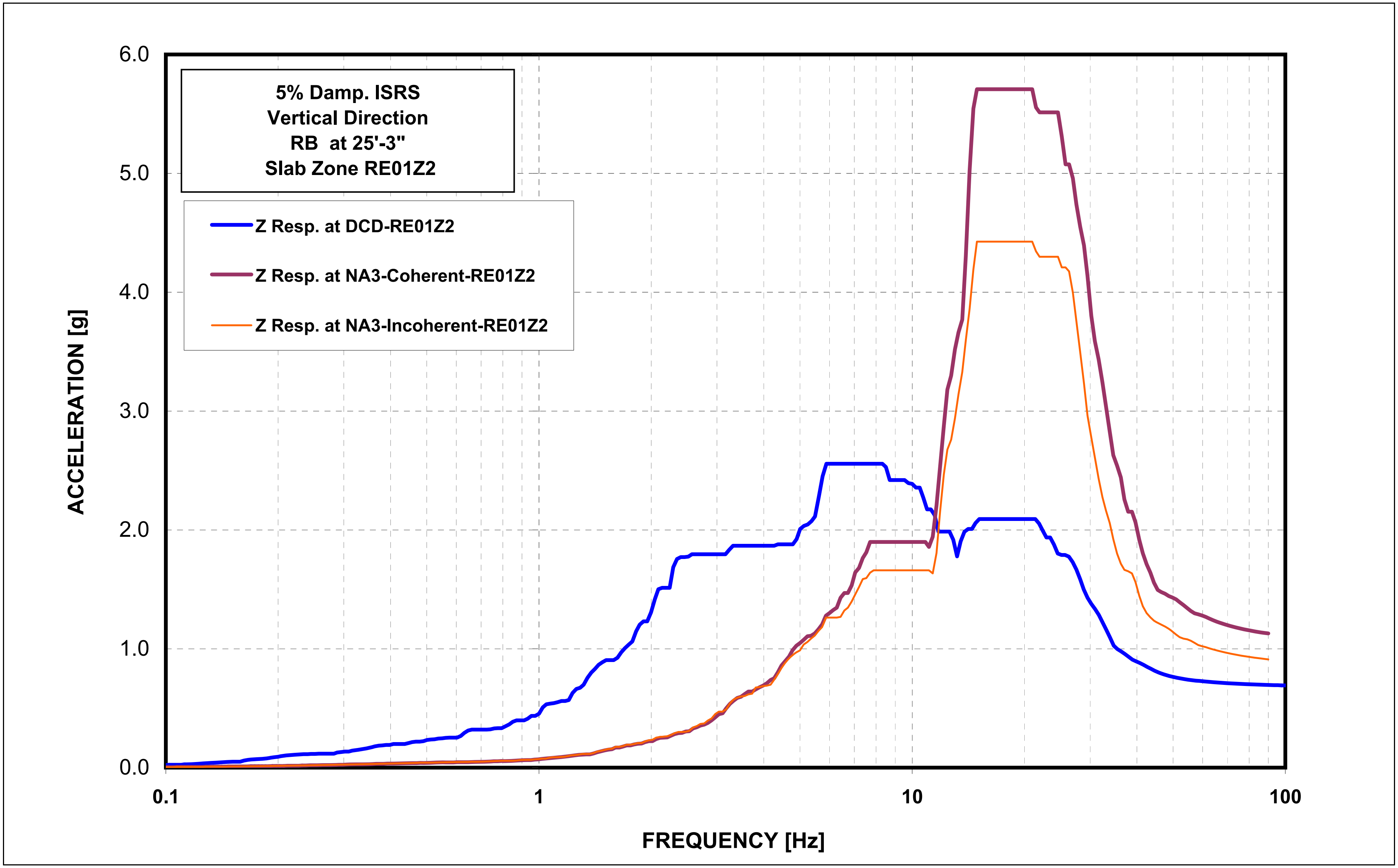


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE01Z3 - Elevation 25'-3" (Sheet 19 of 143)

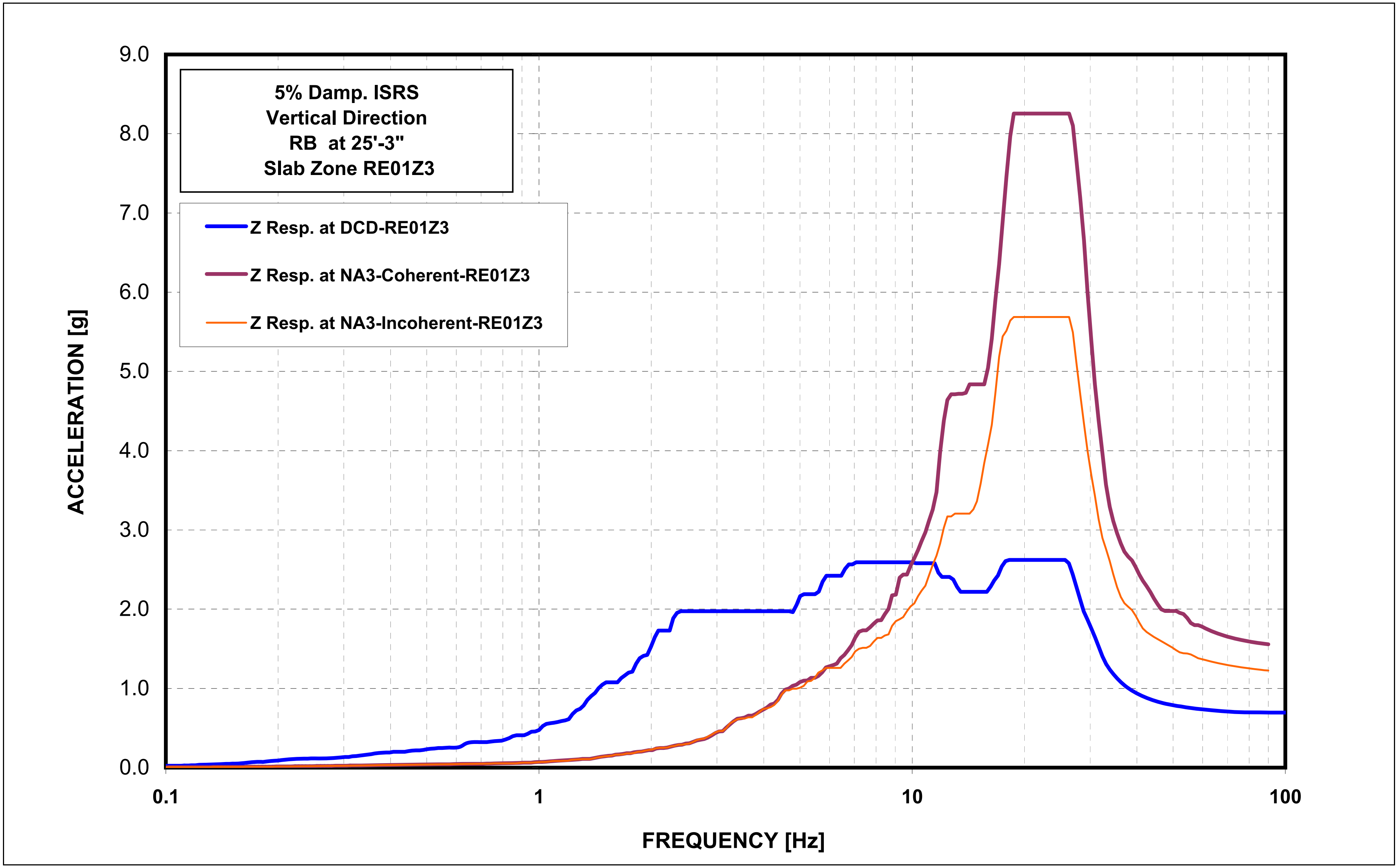


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE01Z4 - Elevation 25'- 3" (Sheet 20 of 143)

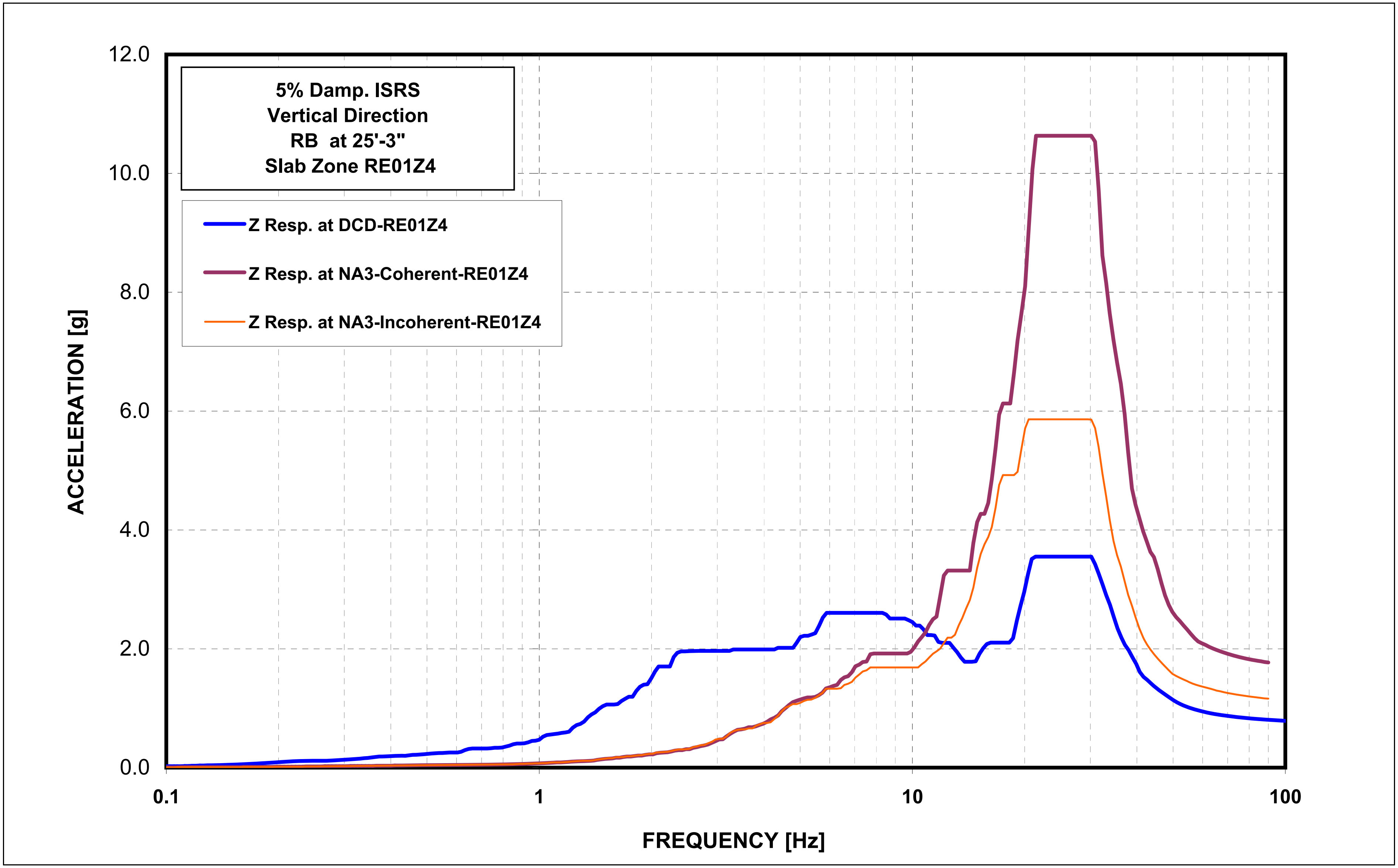


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE01Z5 - Elevation 25'-3" (Sheet 21 of 143)

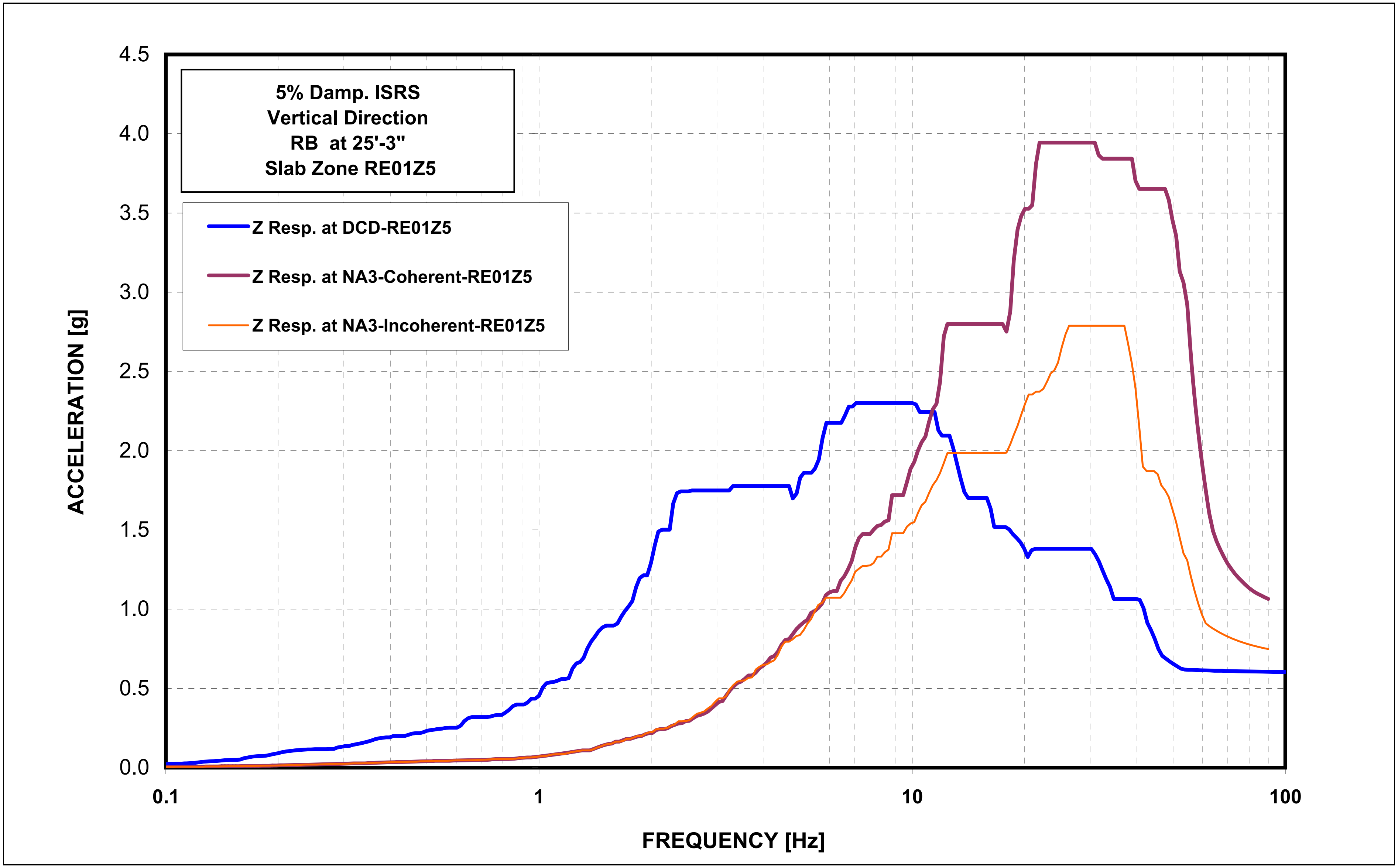


Figure 3NN-23 ISRS for R/B N-S Direction at RE02 - Elevation 50'-2" (Sheet 22 of 143)

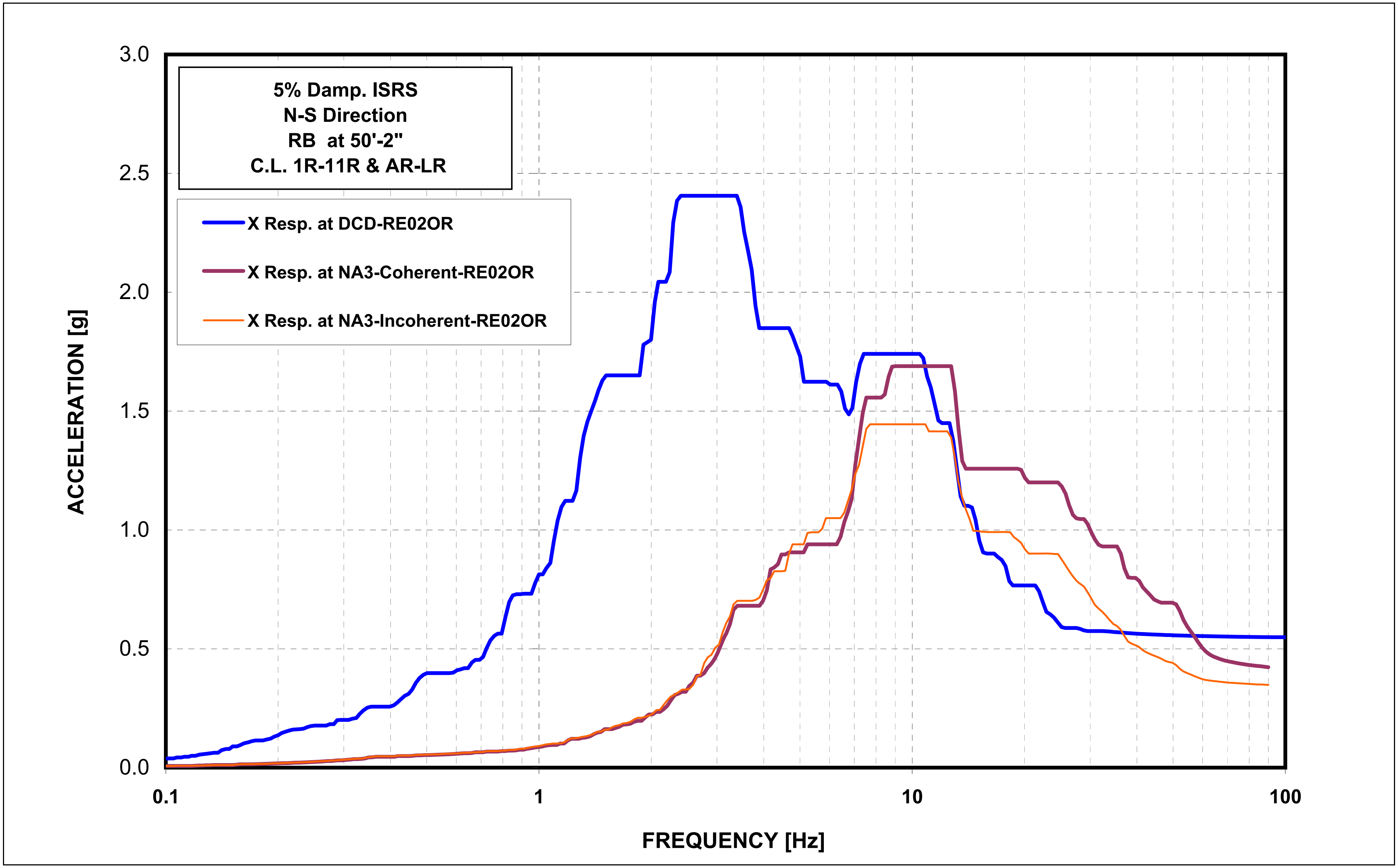


Figure 3NN-23 ISRS for R/B E-W Direction at RE02 - Elevation 50'-2" (Sheet 23 of 143)

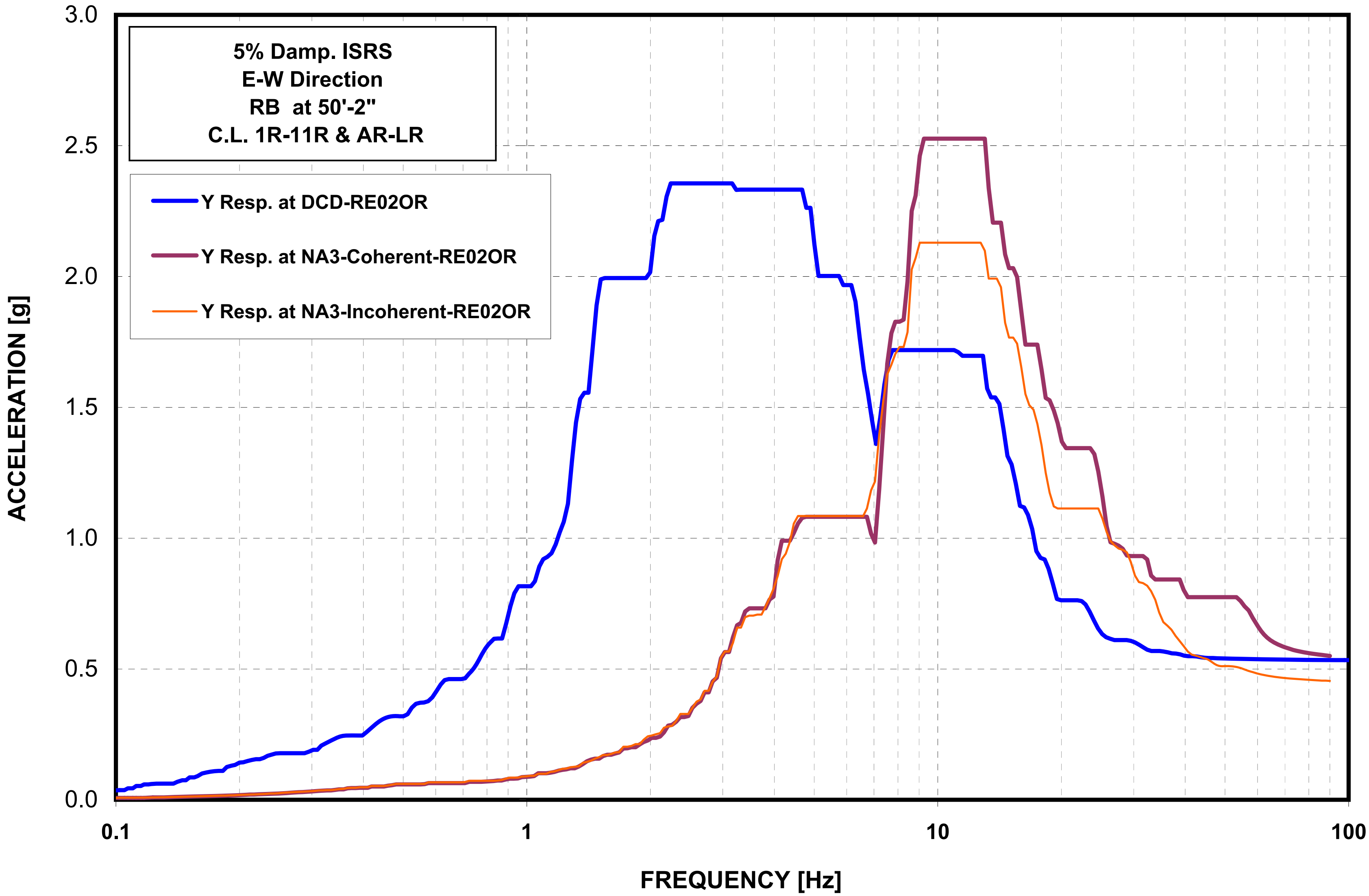


Figure 3NN-23 ISRS for R/B Vertical Direction at RE02 - Elevation 50'-2" (Sheet 24 of 143)

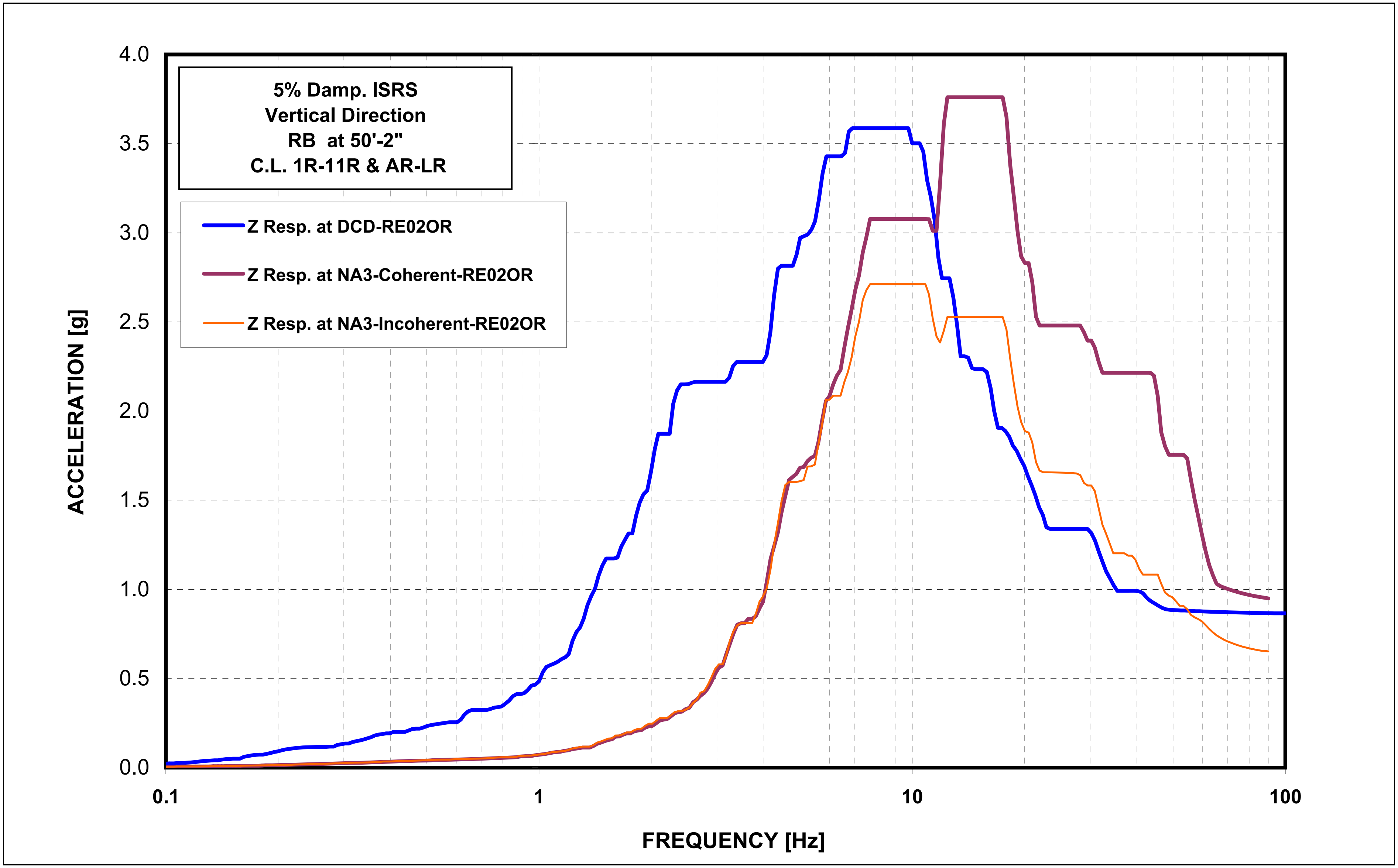


Figure 3NN-23 ISRS for R/B SDOF N-S Direction at RE02X1 - Elevation 50'- 2" (Sheet 25 of 143)

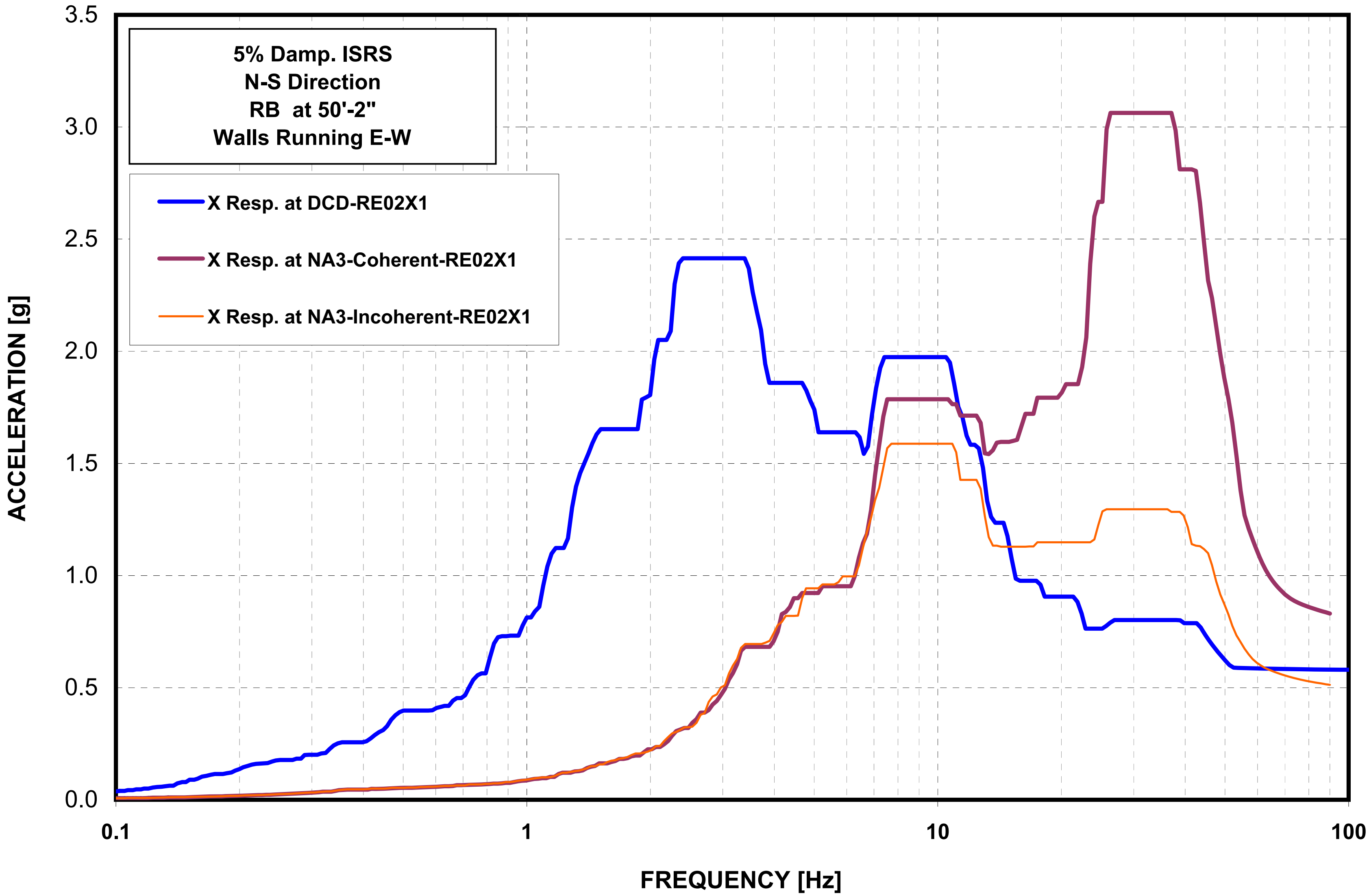


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE02Y1 - Elevation 50'-2" (Sheet 26 of 143)

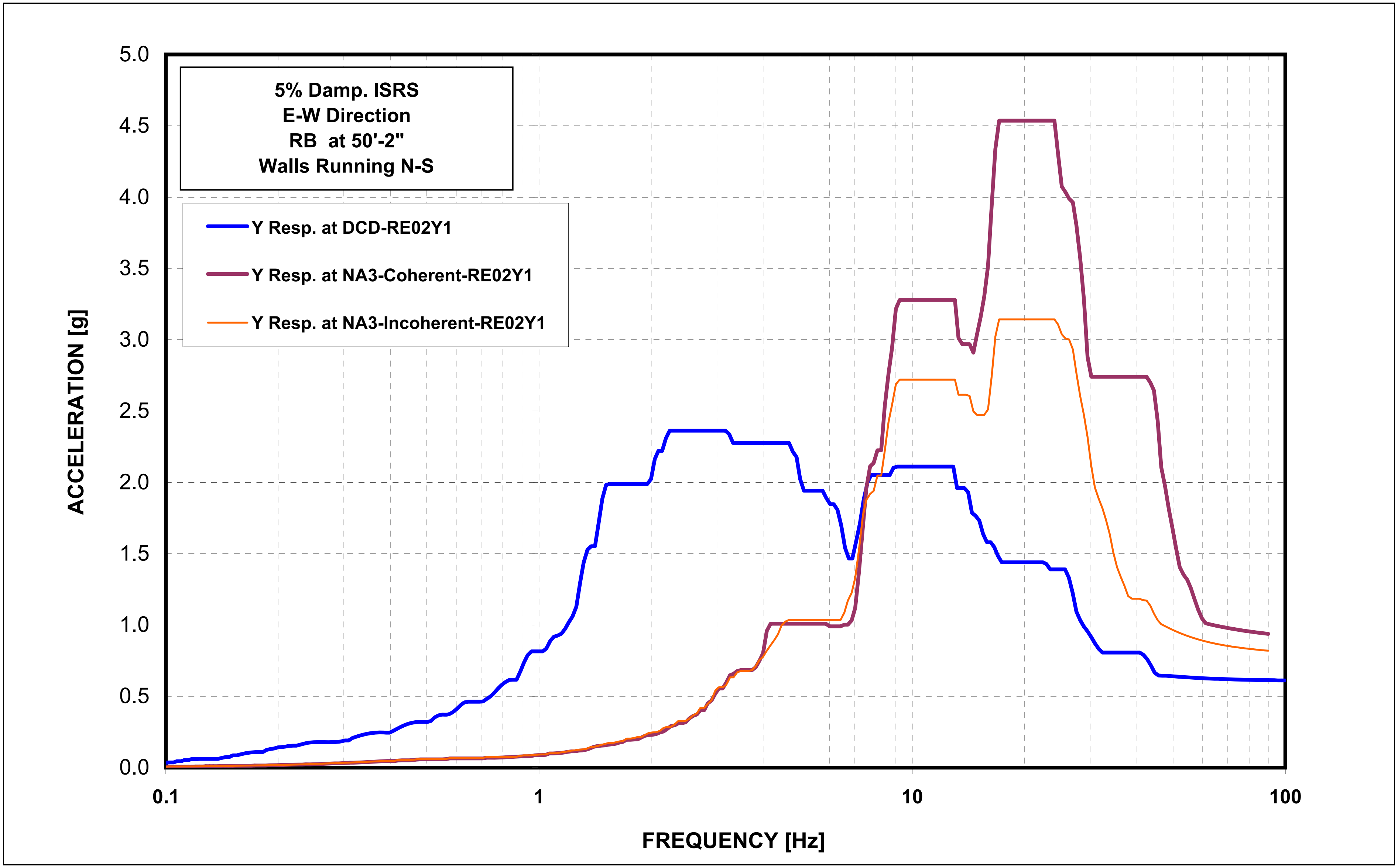


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE02Z1 - Elevation 50'- 2" (Sheet 27 of 143)

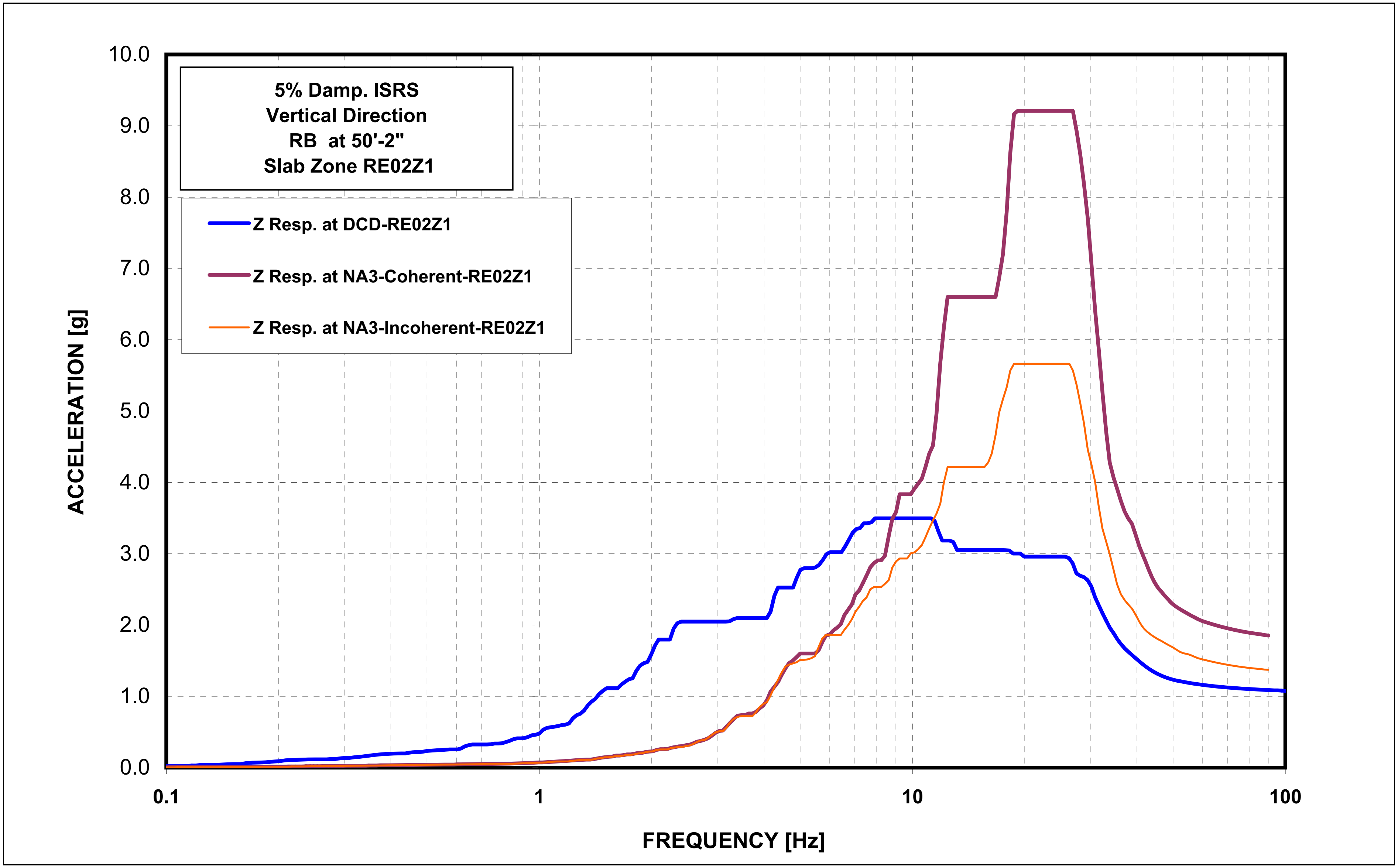


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE02Z2 - Elevation 50'- 2" (Sheet 28 of 143)

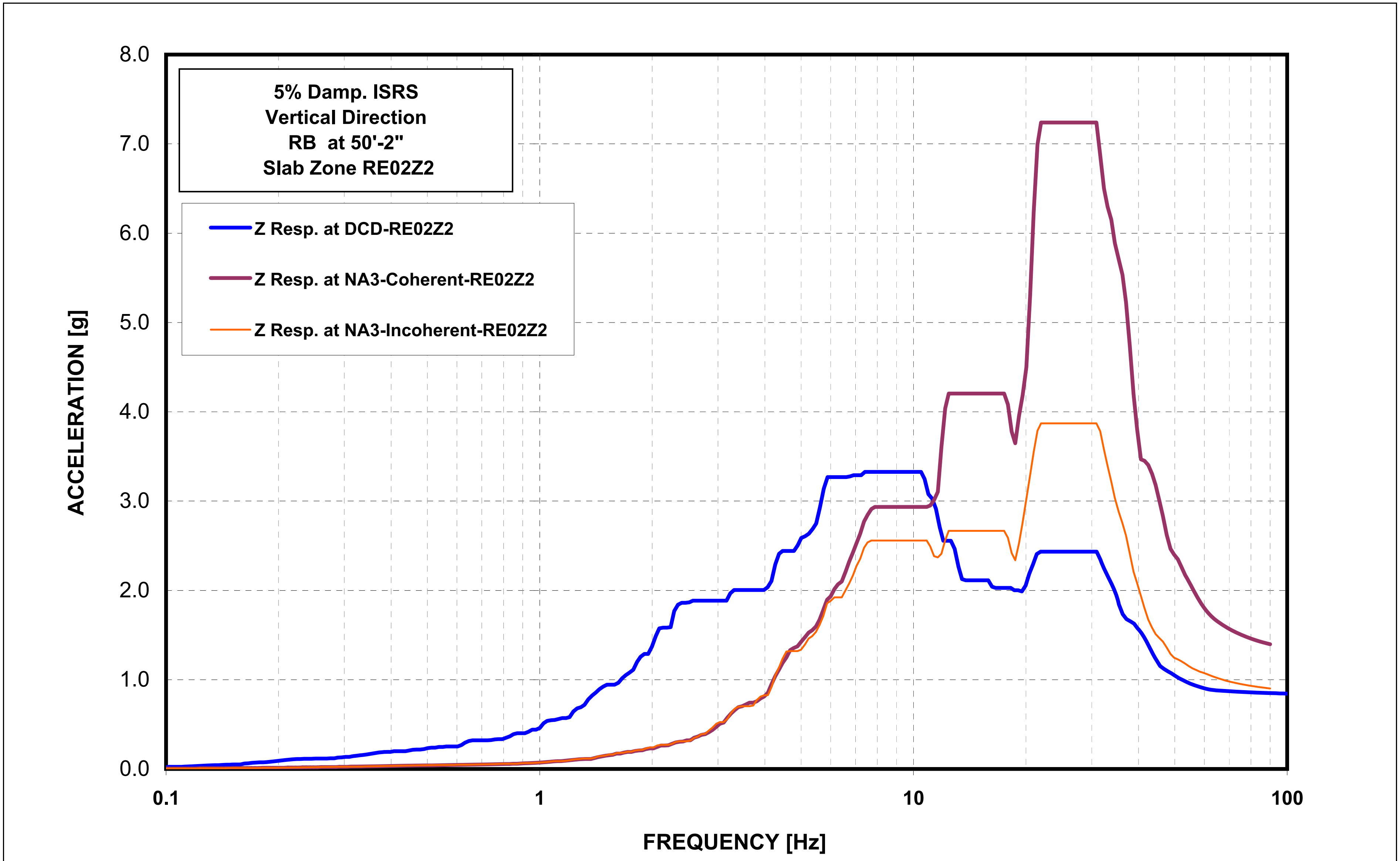


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE02Z3 - Elevation 50'- 2" (Sheet 29 of 143)

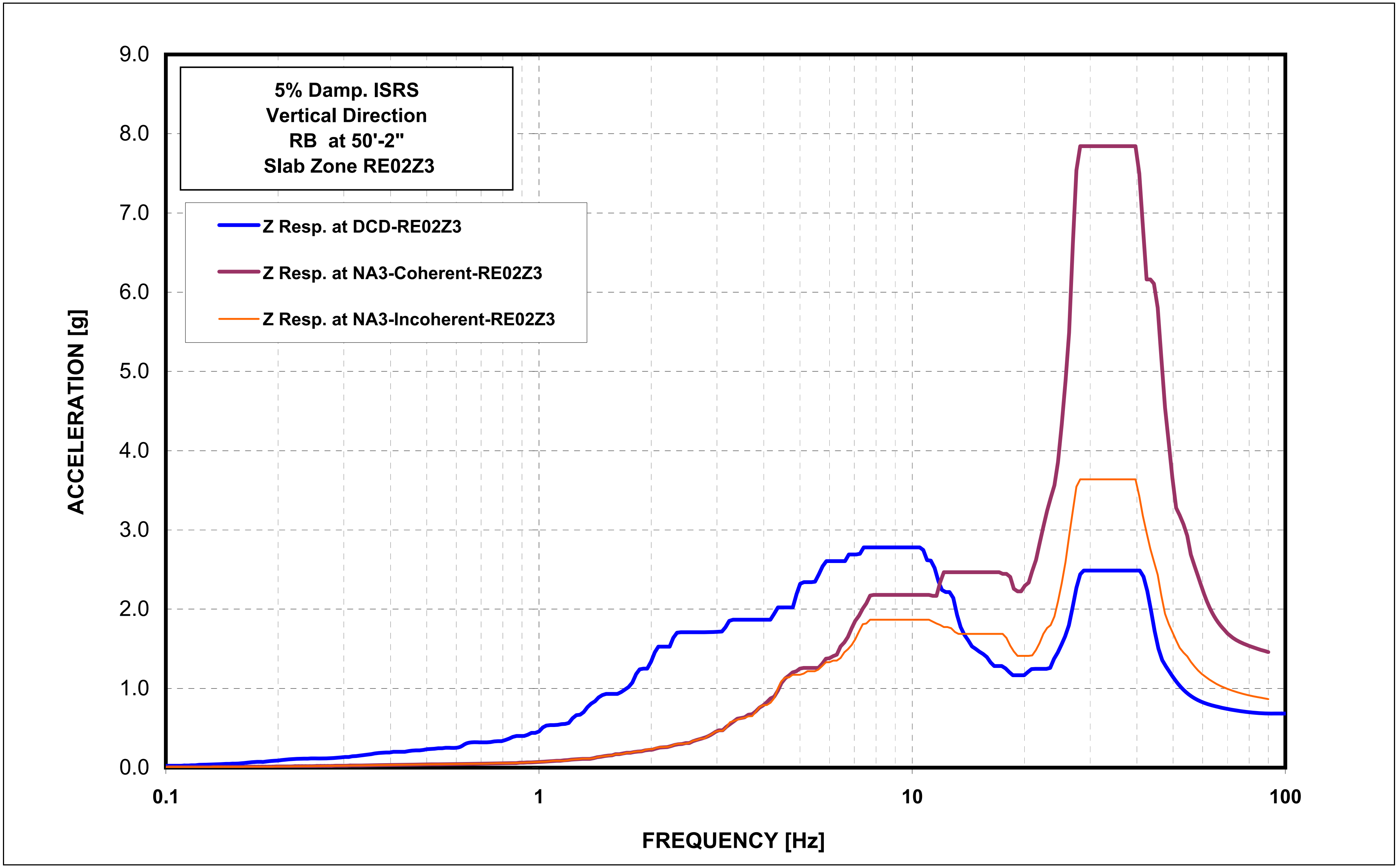


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE02Z4 - Elevation 50'- 2" (Sheet 30 of 143)

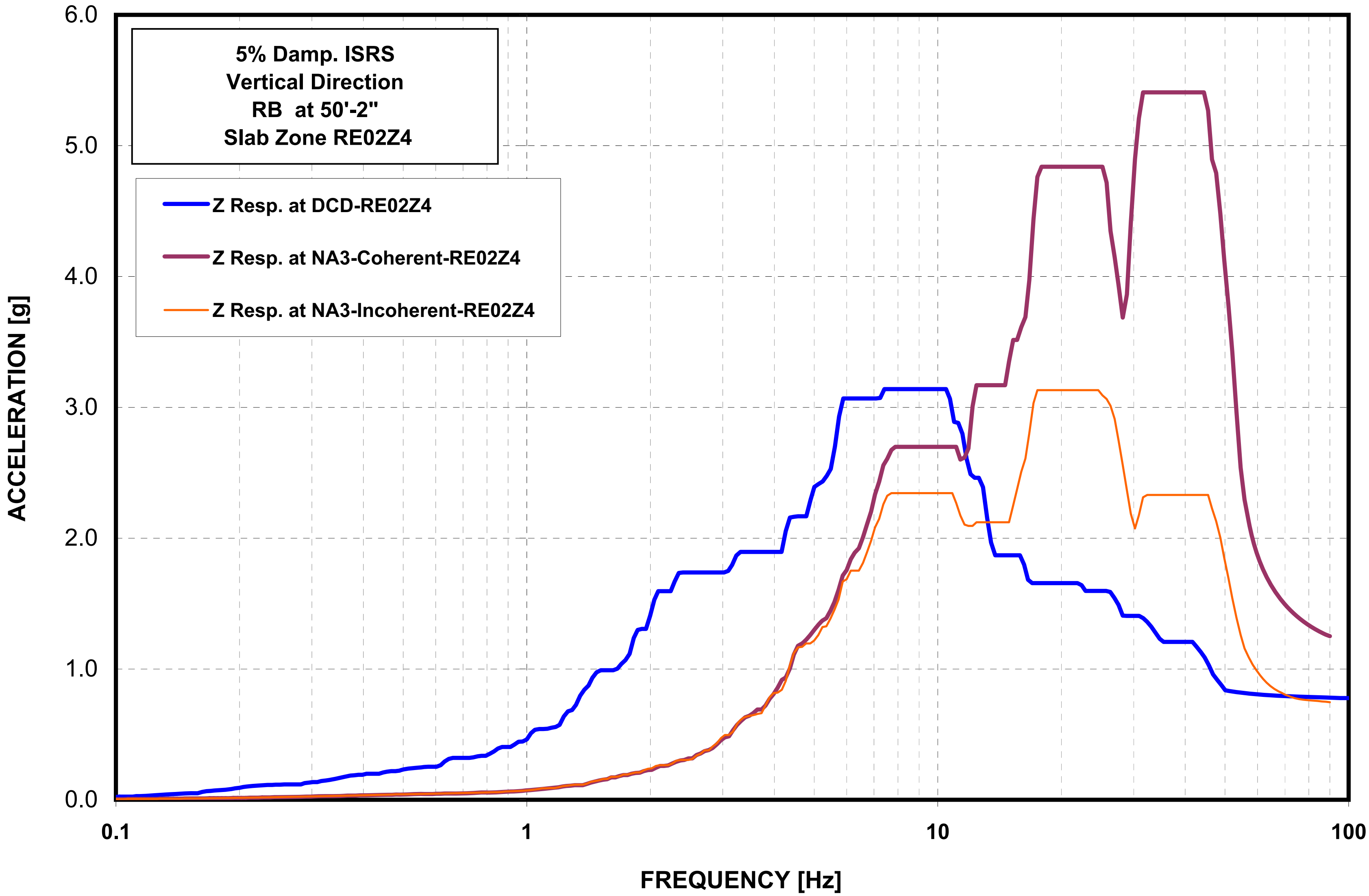


Figure 3NN-23 ISRS for R/B N-S Direction at RE03 - Elevation 76'-5" (Sheet 31 of 143)

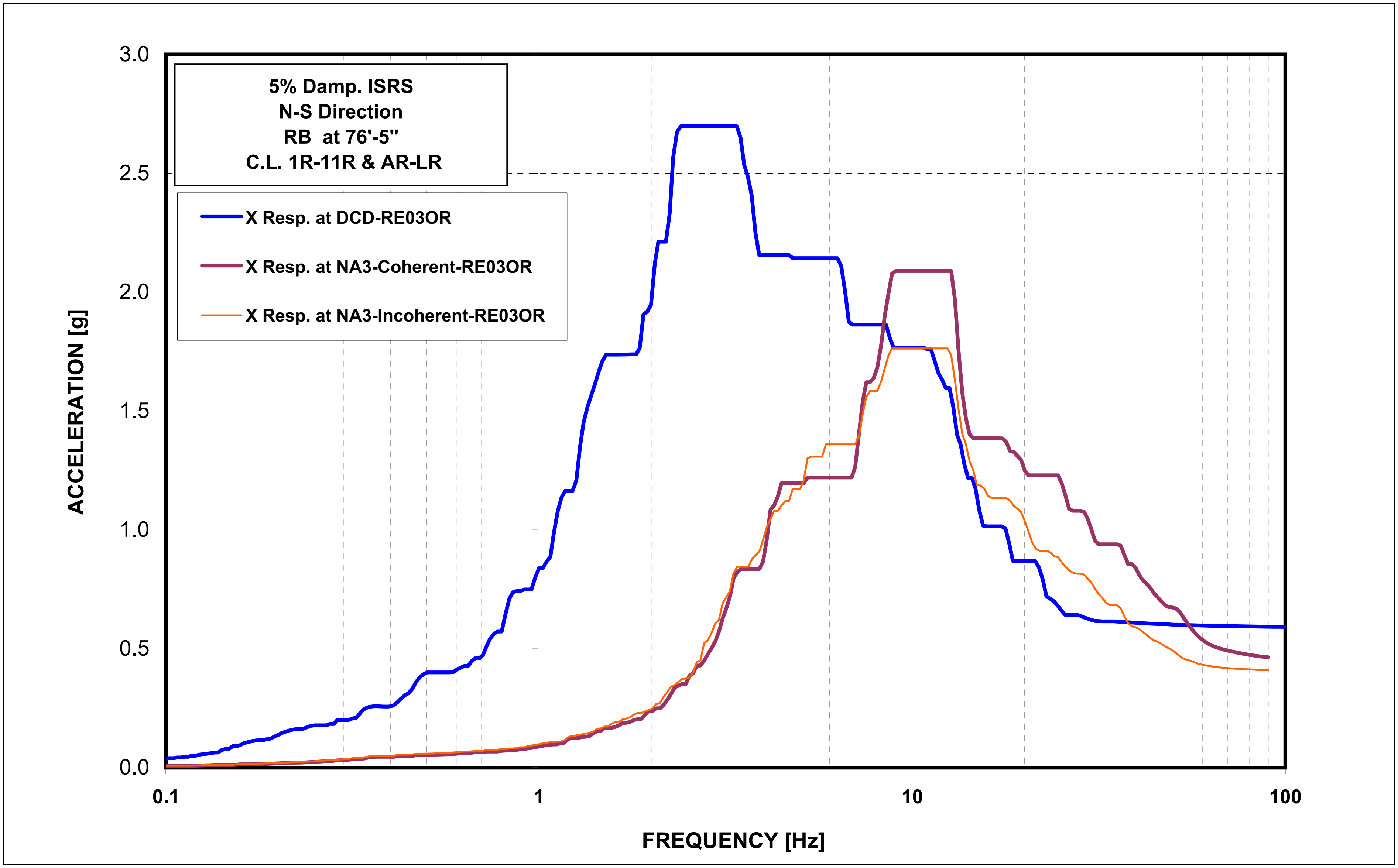


Figure 3NN-23 ISRS for R/B E-W Direction at RE03 - Elevation 76'-5" (Sheet 32 of 143)

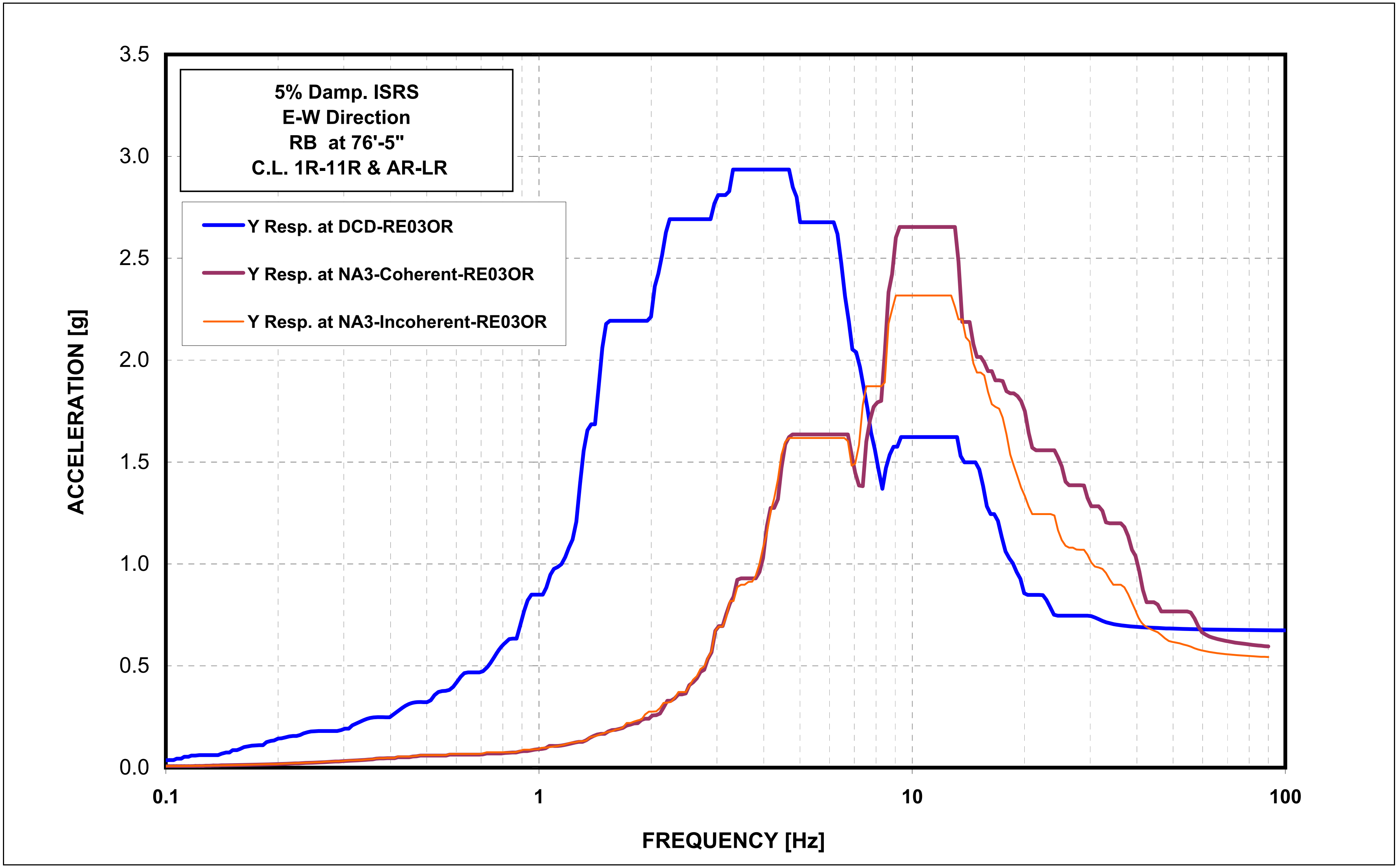


Figure 3NN-23 ISRS for R/B Vertical Direction at RE03 - Elevation 76'-5" (Sheet 33 of 143)

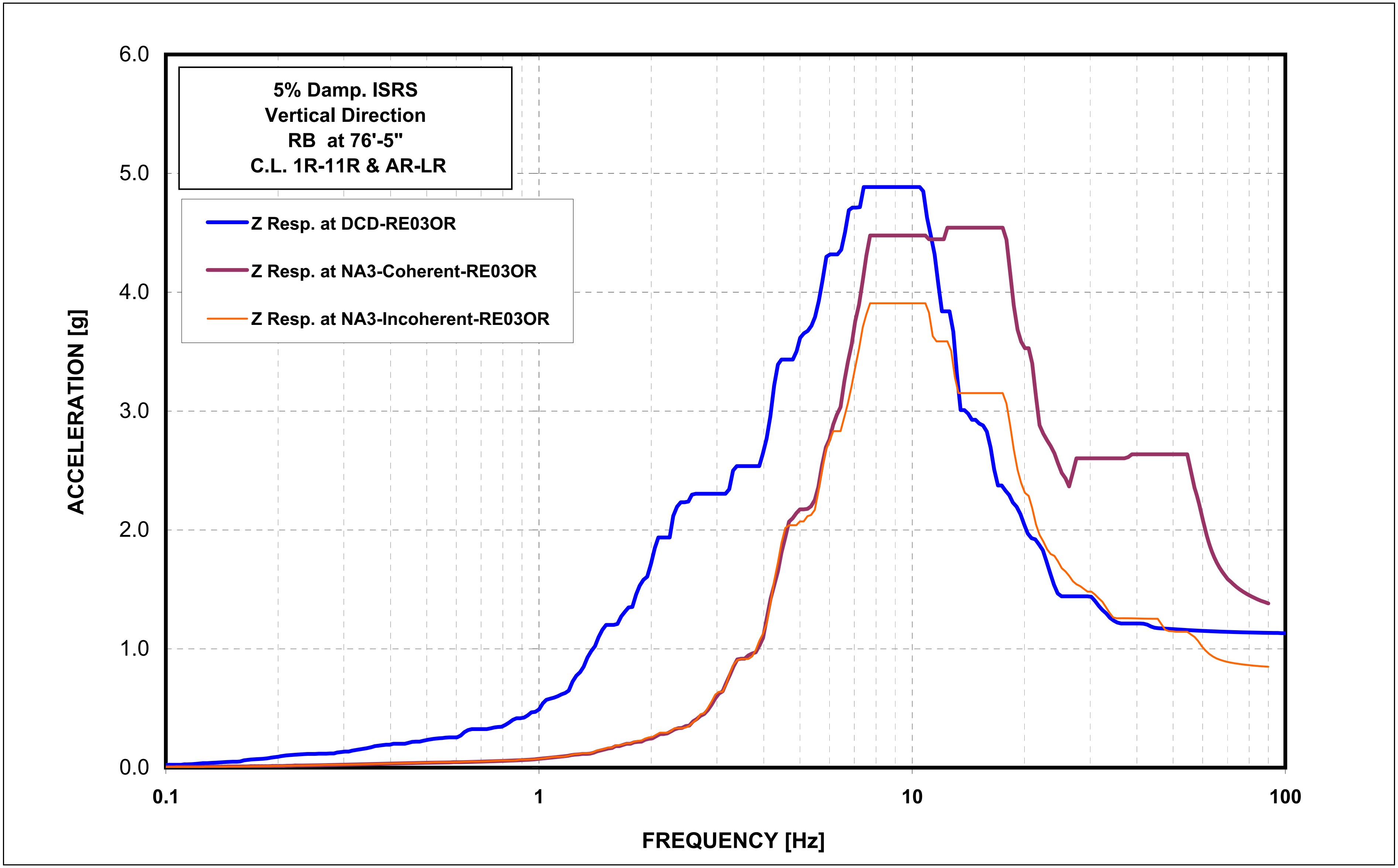


Figure 3NN-23 ISRS for R/B SDOF N-S Direction at RE03X1 - Elevation 76'- 5" (Sheet 34 of 143)

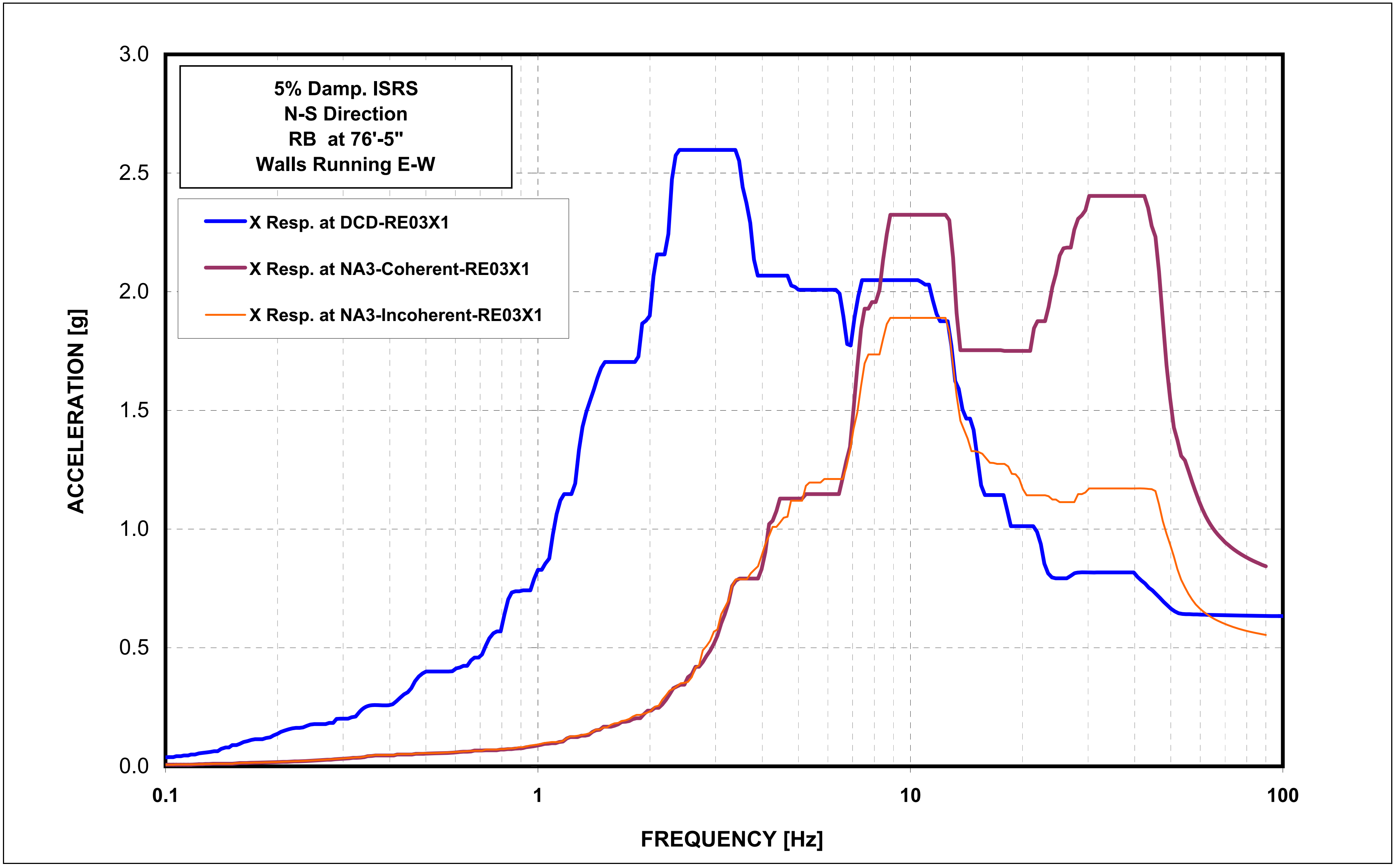


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE03Y1 - Elevation 76'-5" (Sheet 35 of 143)

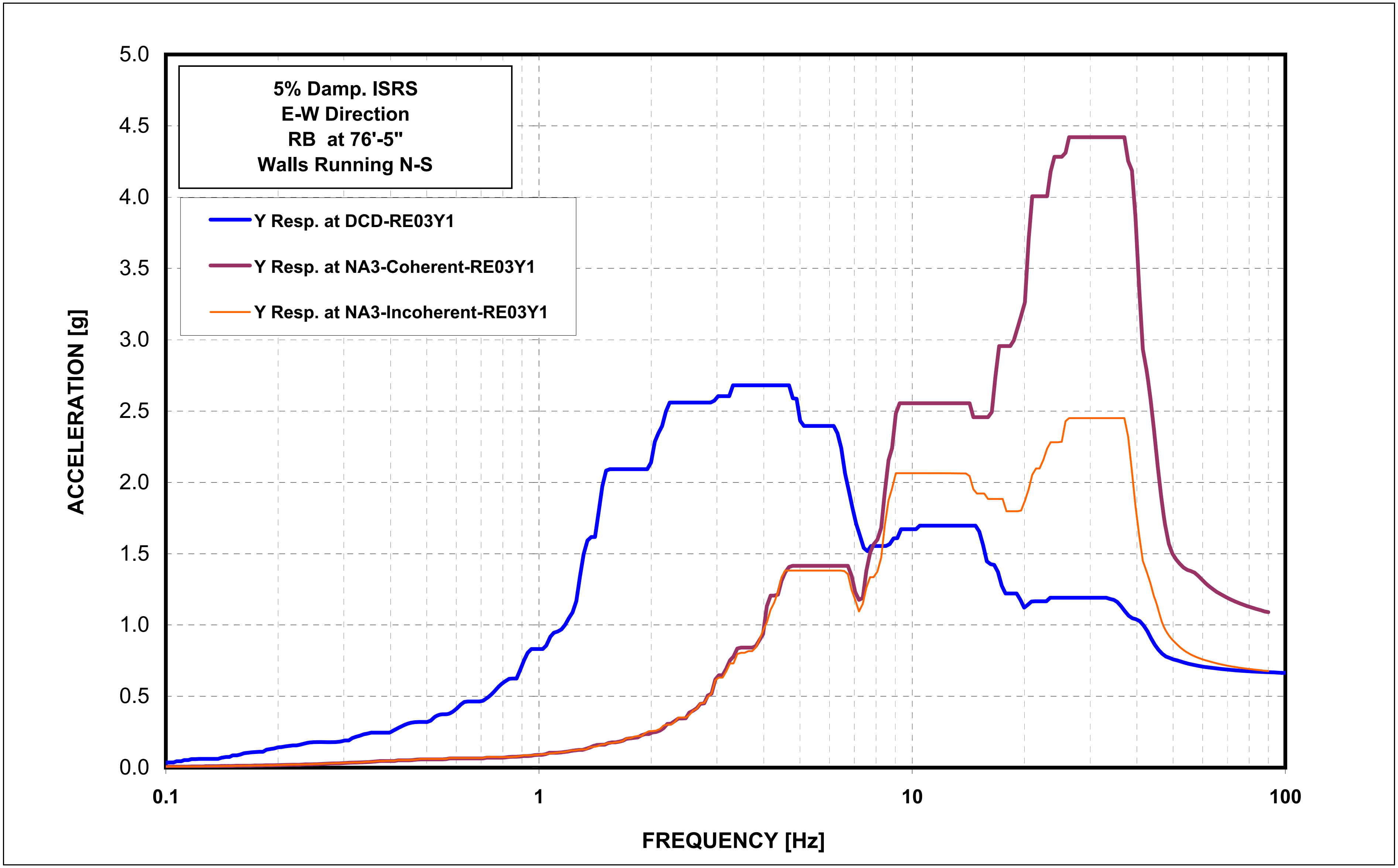


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE03Z1 - Elevation 76'- 5" (Sheet 36 of 143)

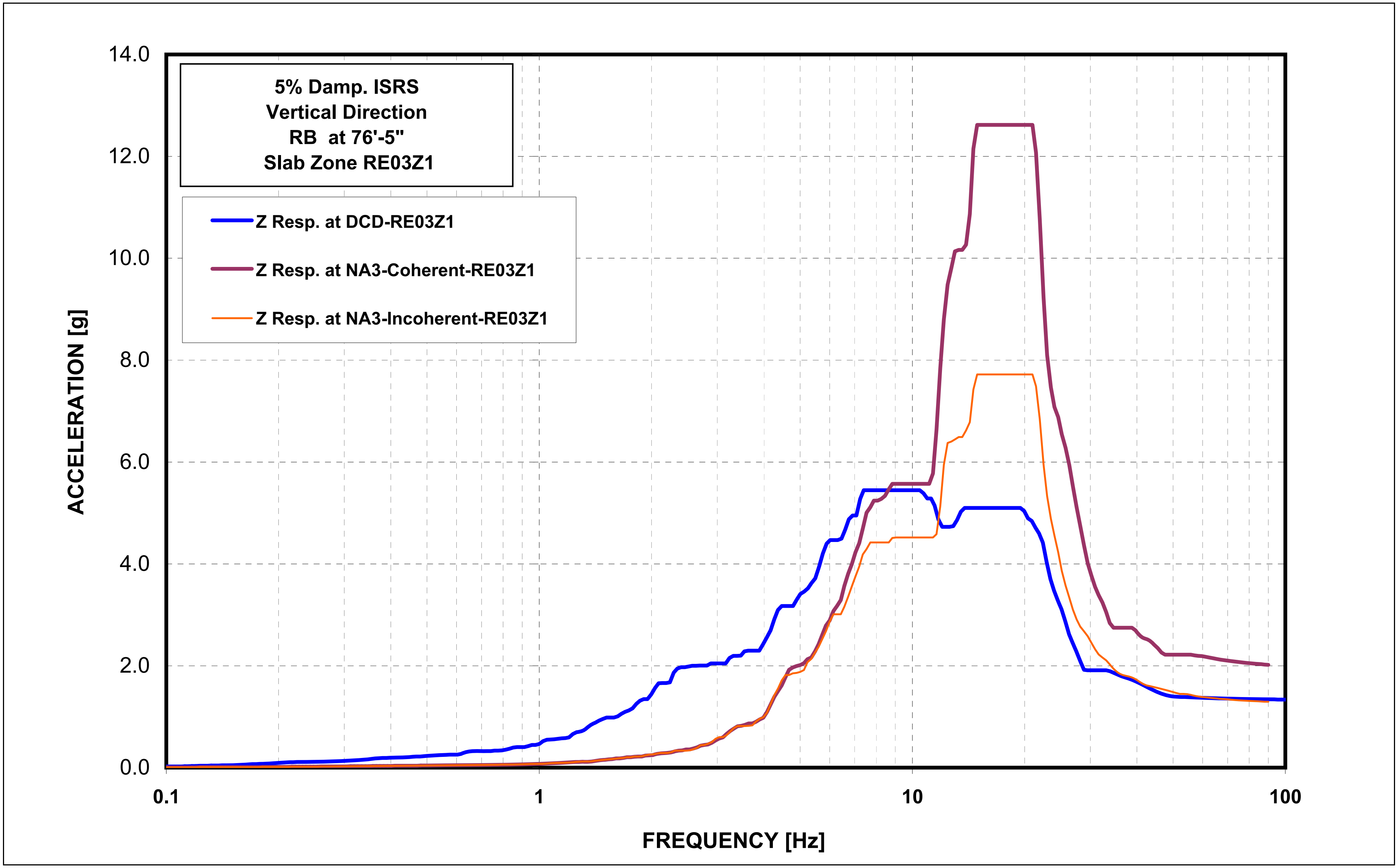


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE03Z2 - Elevation 76'-5" (Sheet 37 of 143)

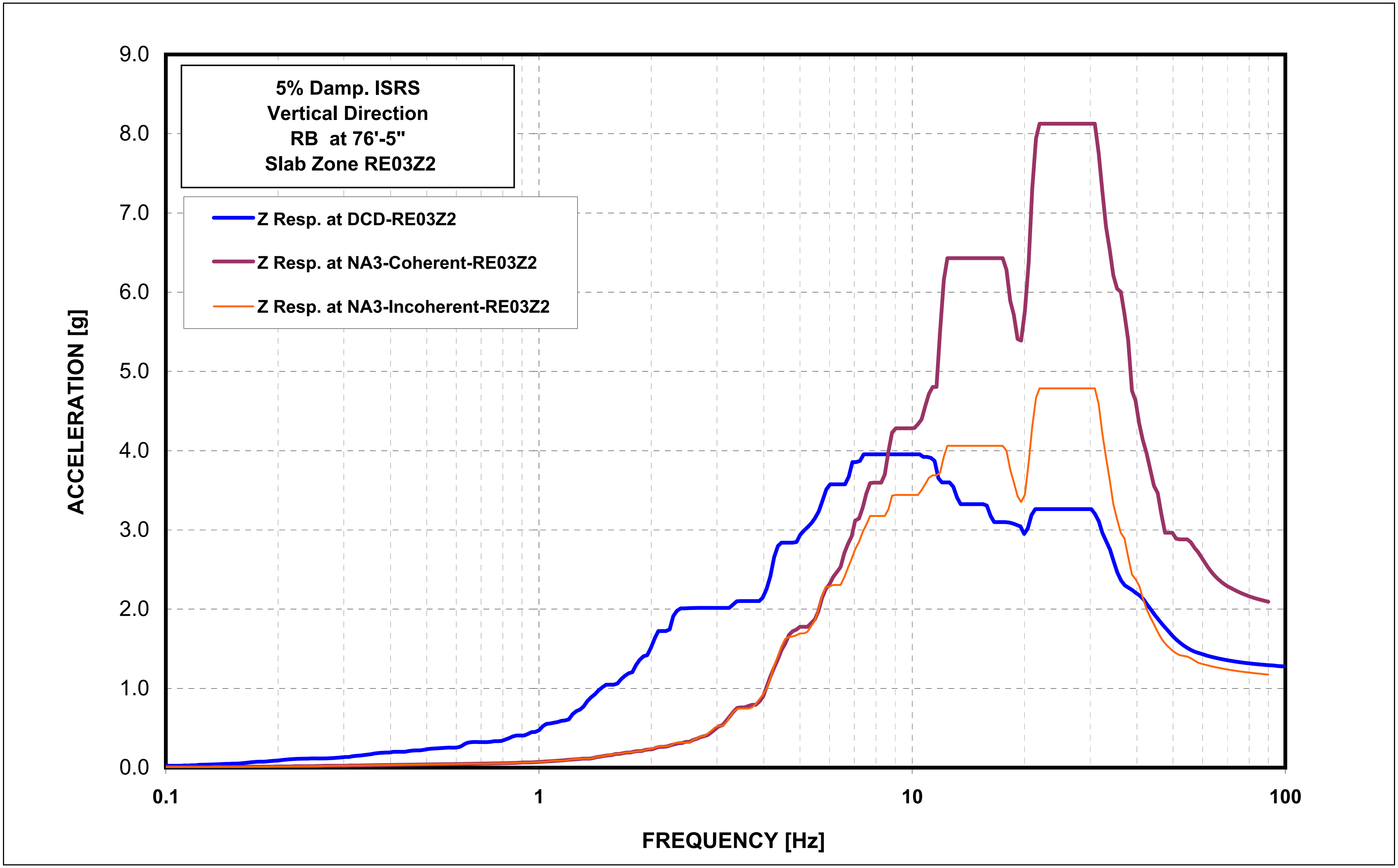


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE03Z3 - Elevation 76'-5" (Sheet 38 of 143)

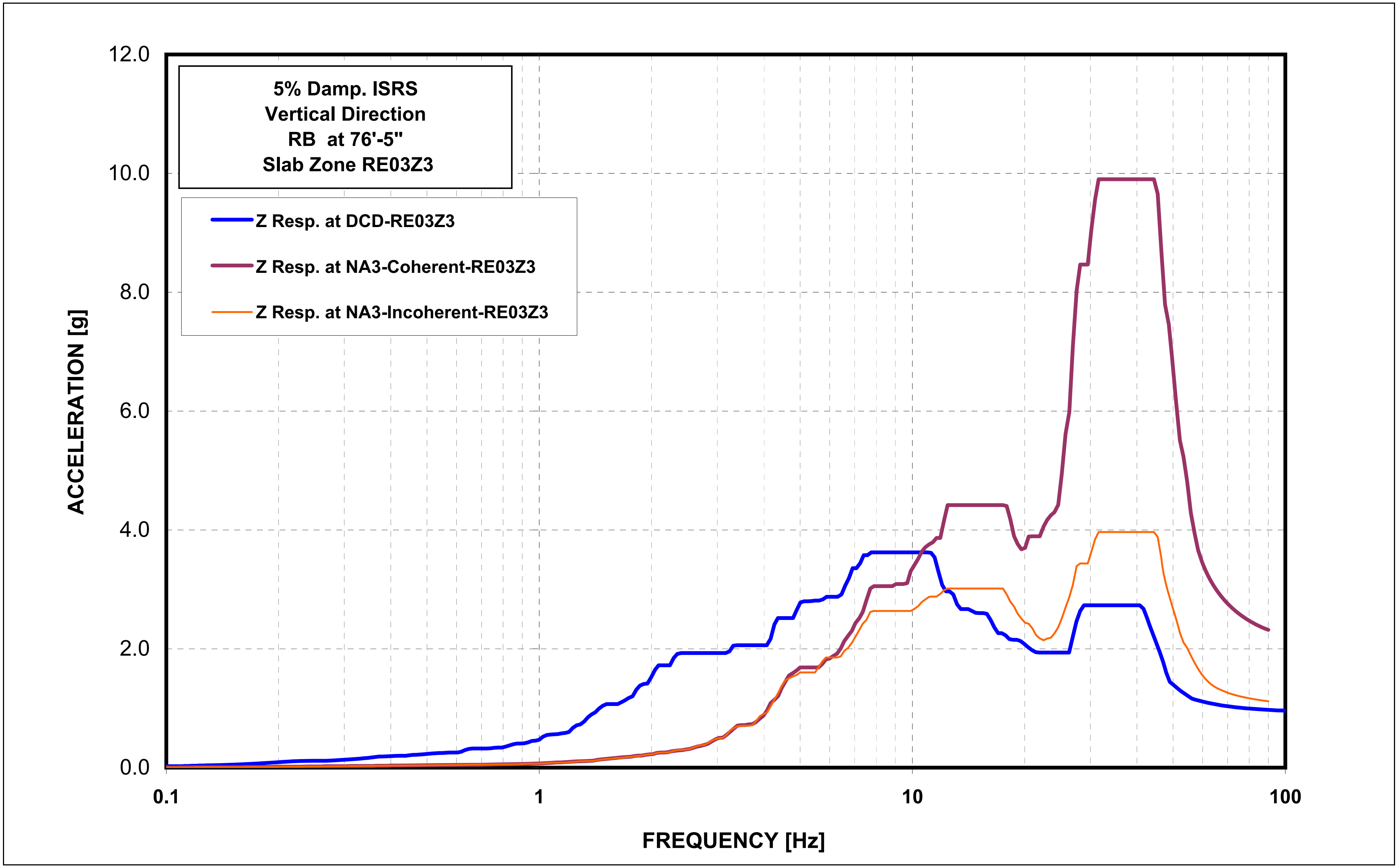


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE03Z4 - Elevation 76'- 5" (Sheet 39 of 143)

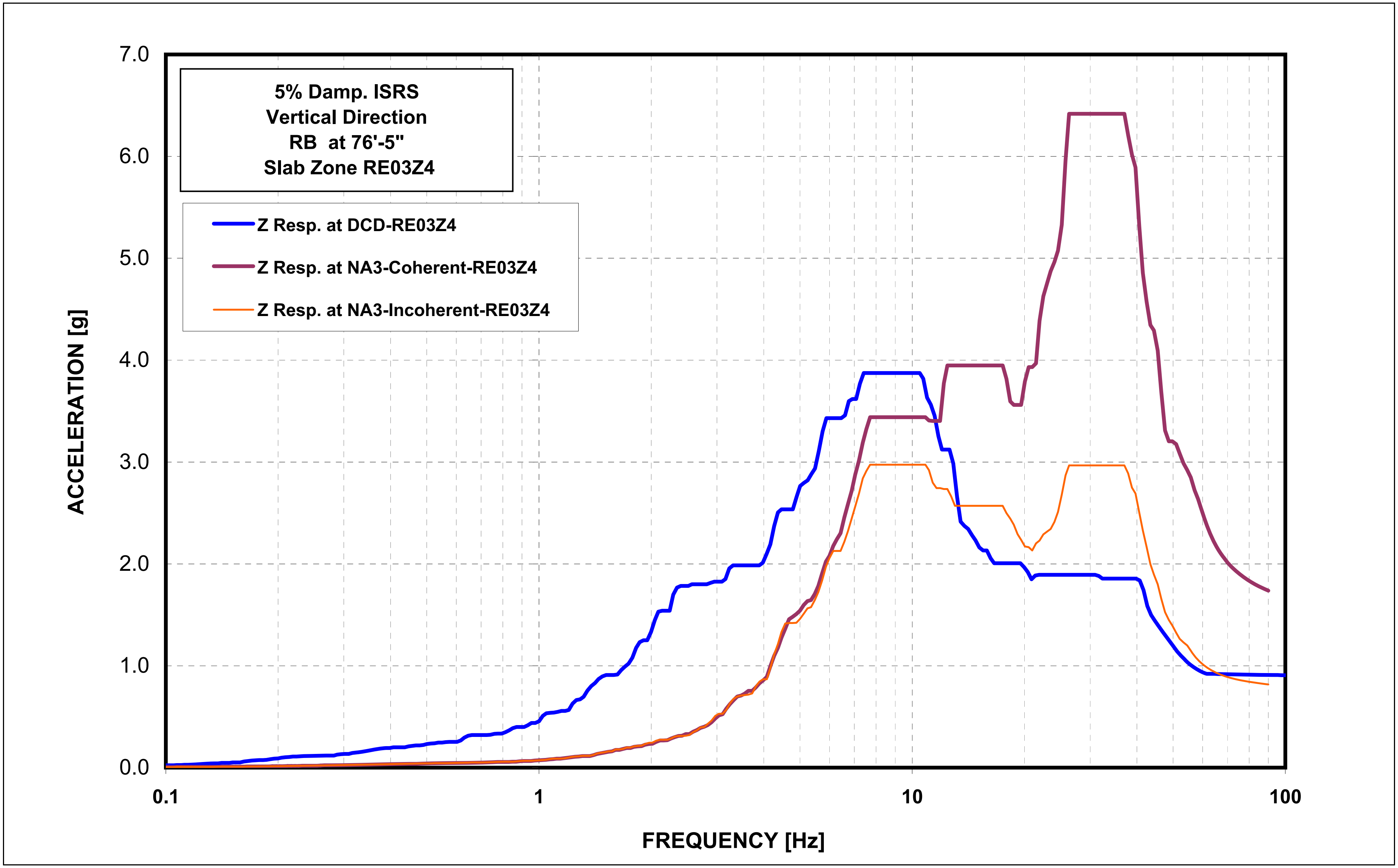


Figure 3NN-23 ISRS for R/B N-S Direction at RE04 - Elevation 101'-0" (Sheet 40 of 143)

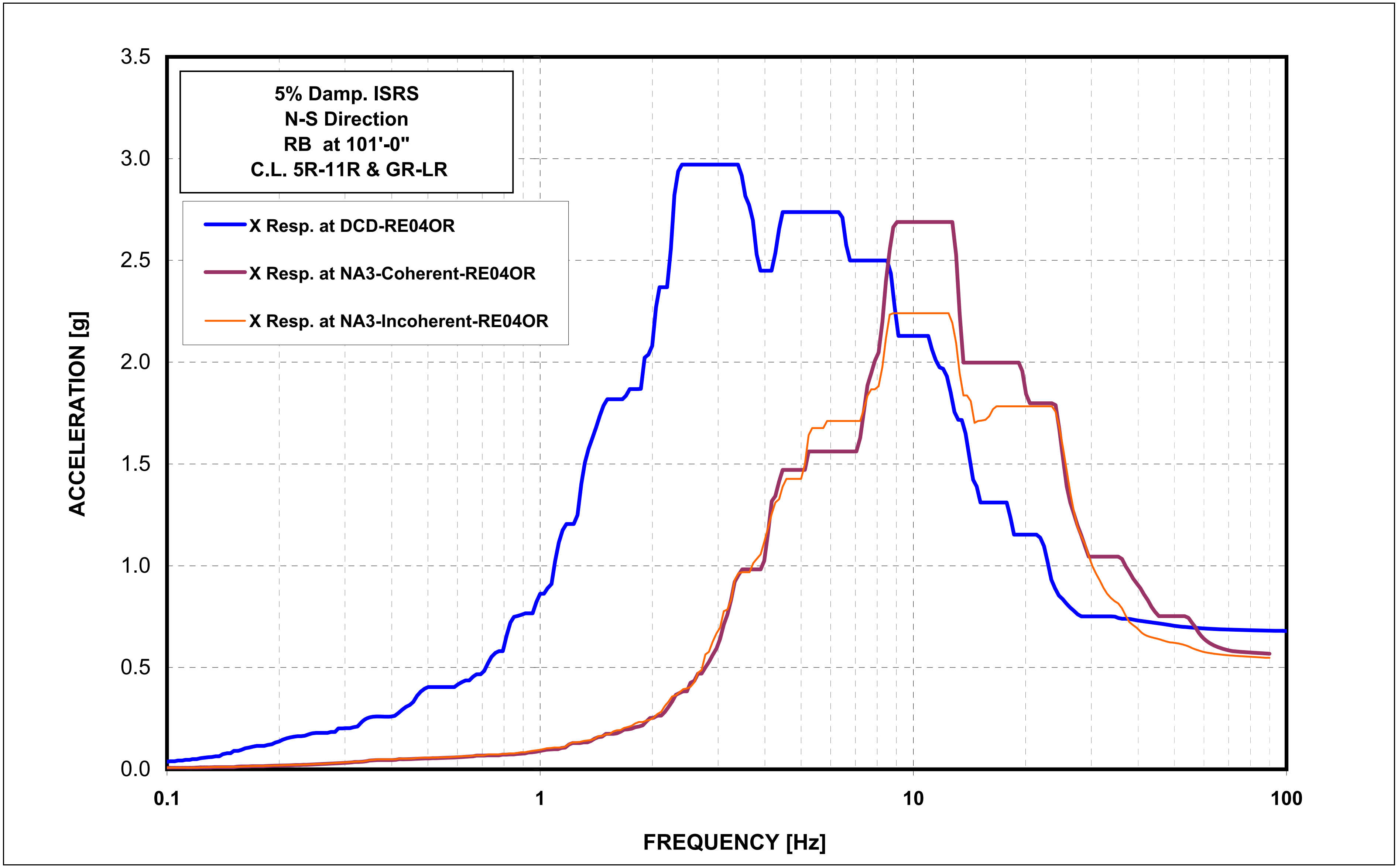


Figure 3NN-23 ISRS for R/B E-W Direction at RE04 - Elevation 101'- 0" (Sheet 41 of 143)

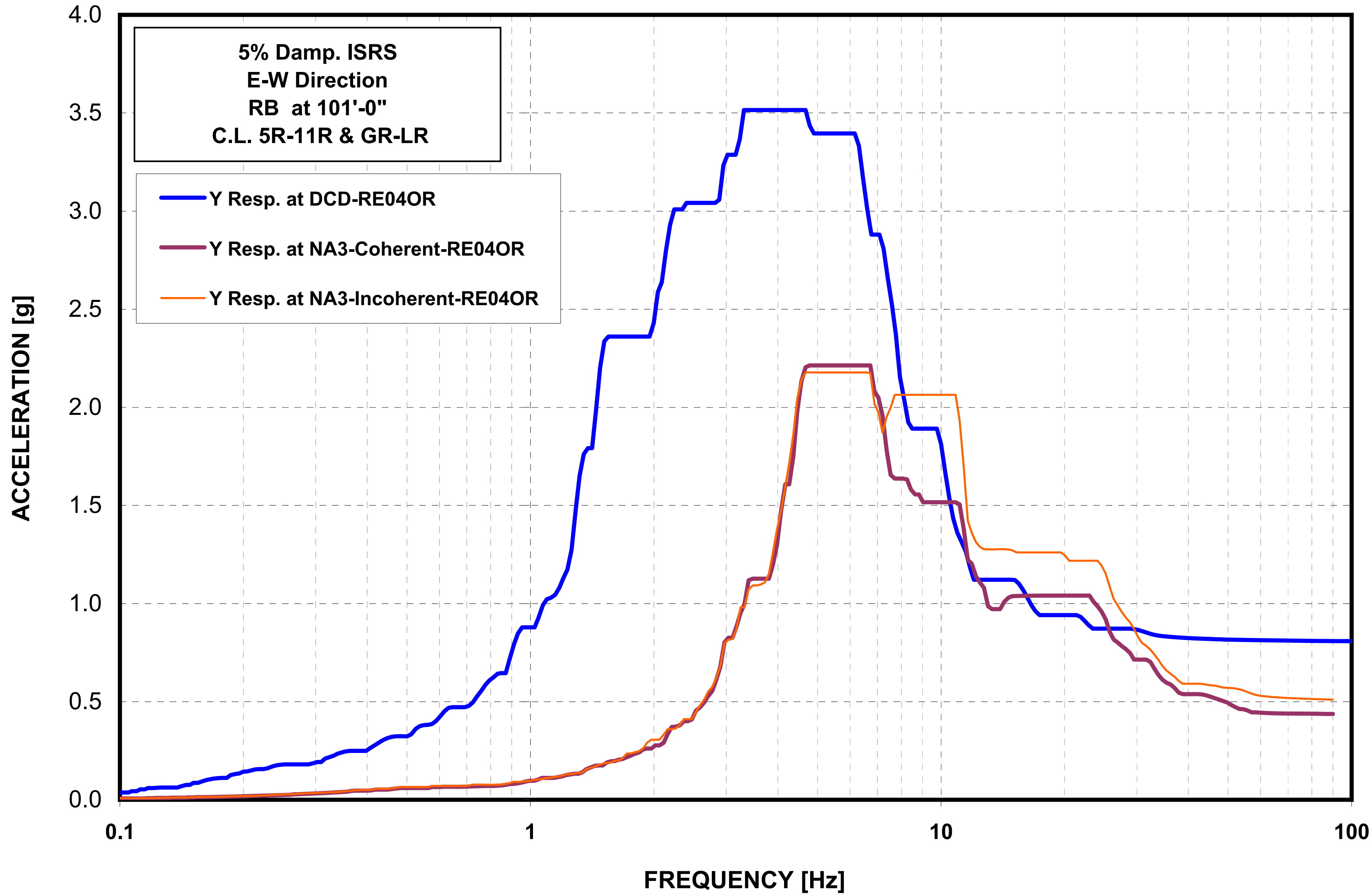


Figure 3NN-23 ISRS for R/B Vertical Direction at RE04 - Elevation 101'- 0" (Sheet 42 of 143)

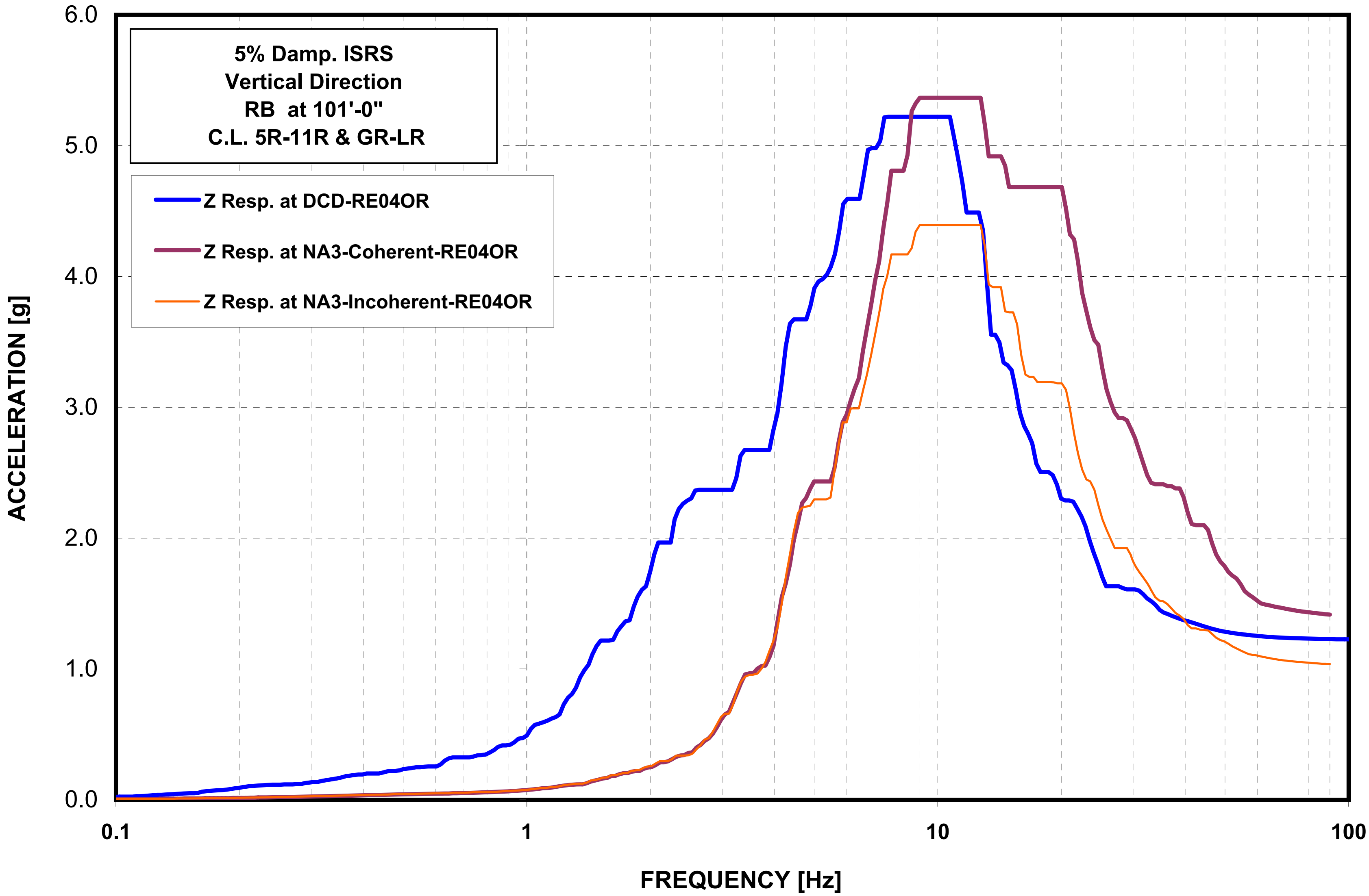


Figure 3NN-23 ISRS for R/B SDOF N-S Direction at RE04X1 - Elevation 101'- 0" (Sheet 43 of 143)

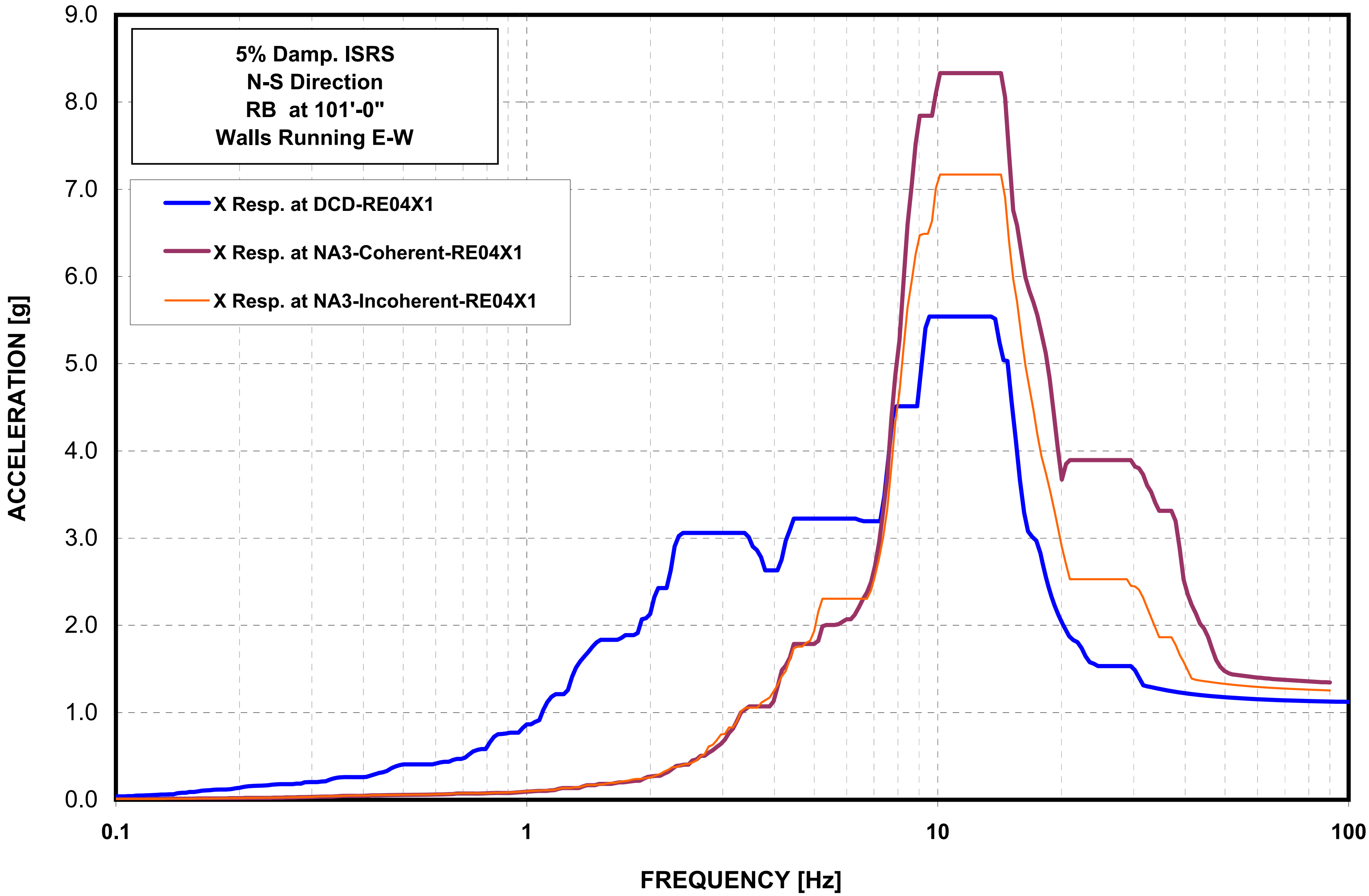


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE04Y1 - Elevation 101'-0" (Sheet 44 of 143)

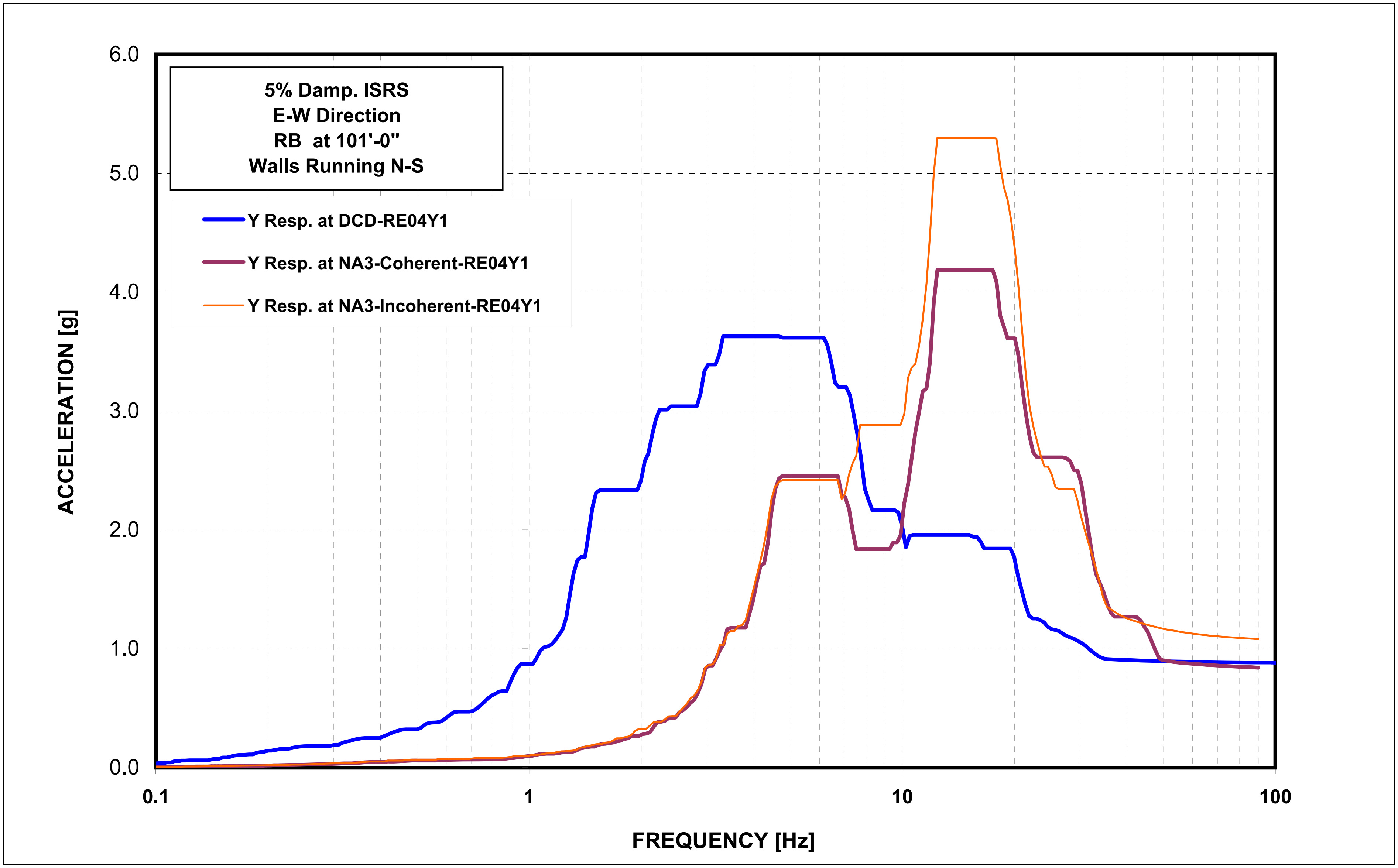


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE04Z1 - Elevation 101'- 0" (Sheet 45 of 143)

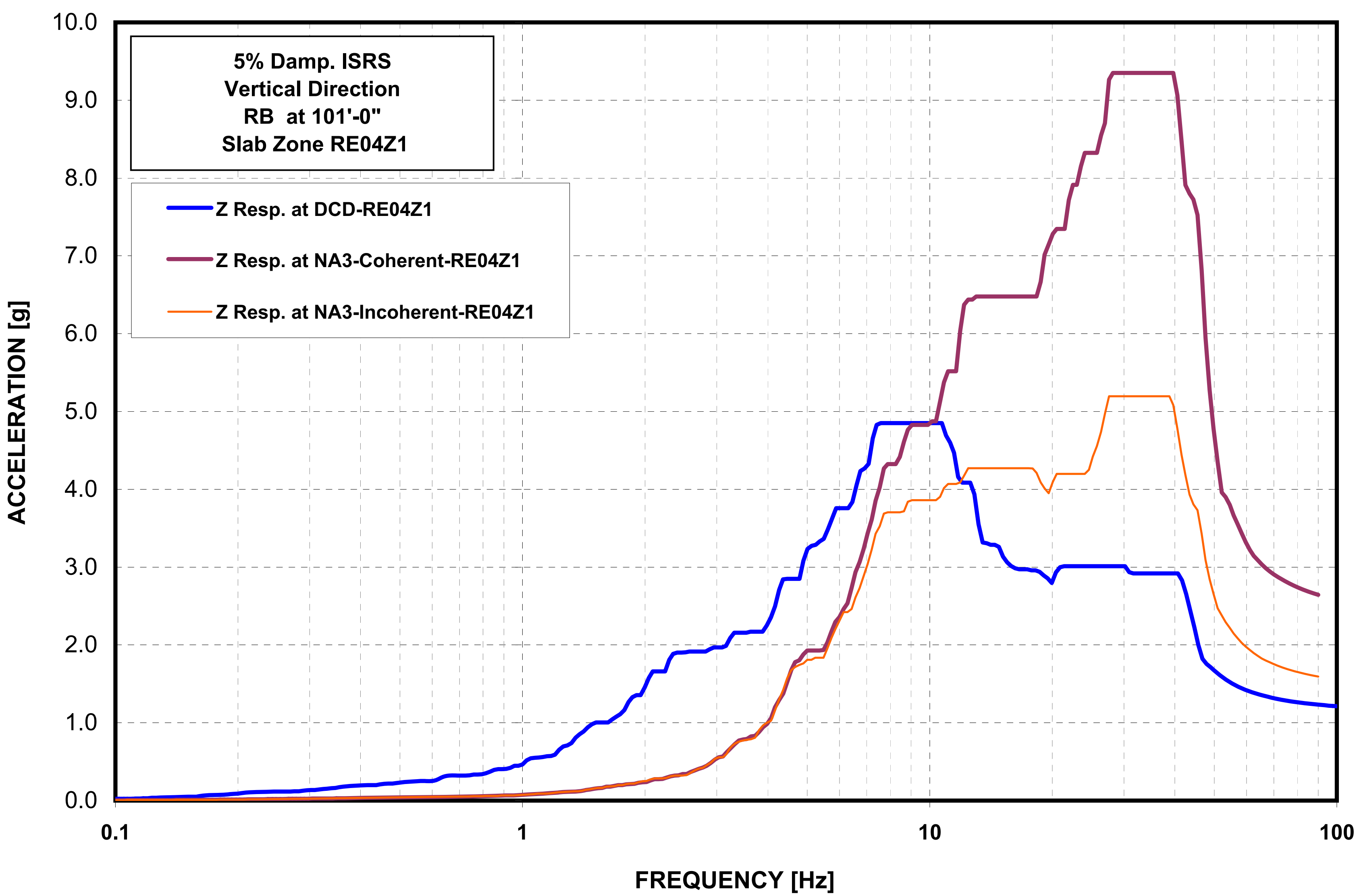


Figure 3NN-23 ISRS for R/BNS Direction at RE05 - Elevation 115'- 6" (Sheet 46 of 143)

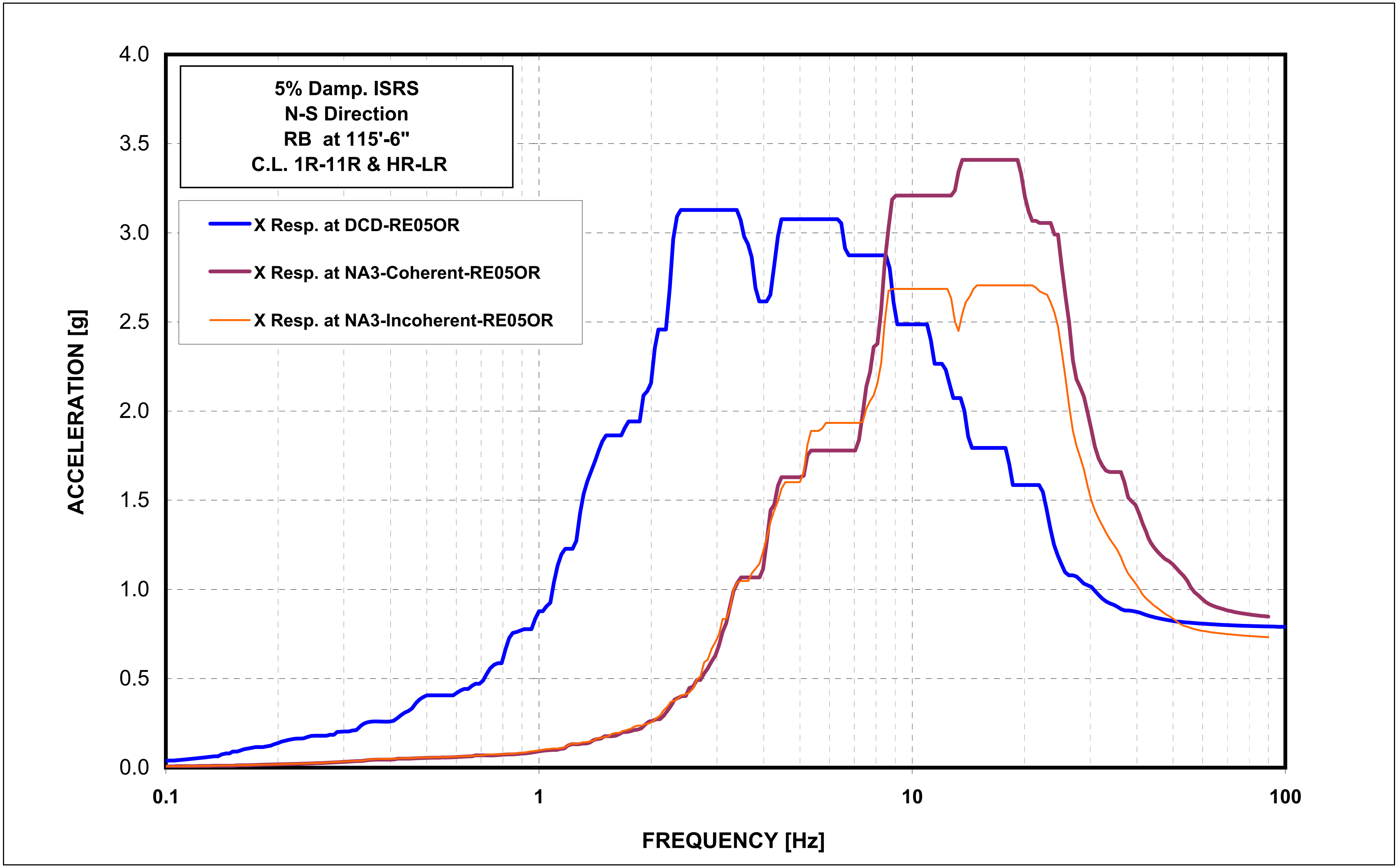


Figure 3NN-23 ISRS for R/BEW Direction at RE05 - Elevation 115'-6" (Sheet 47 of 143)

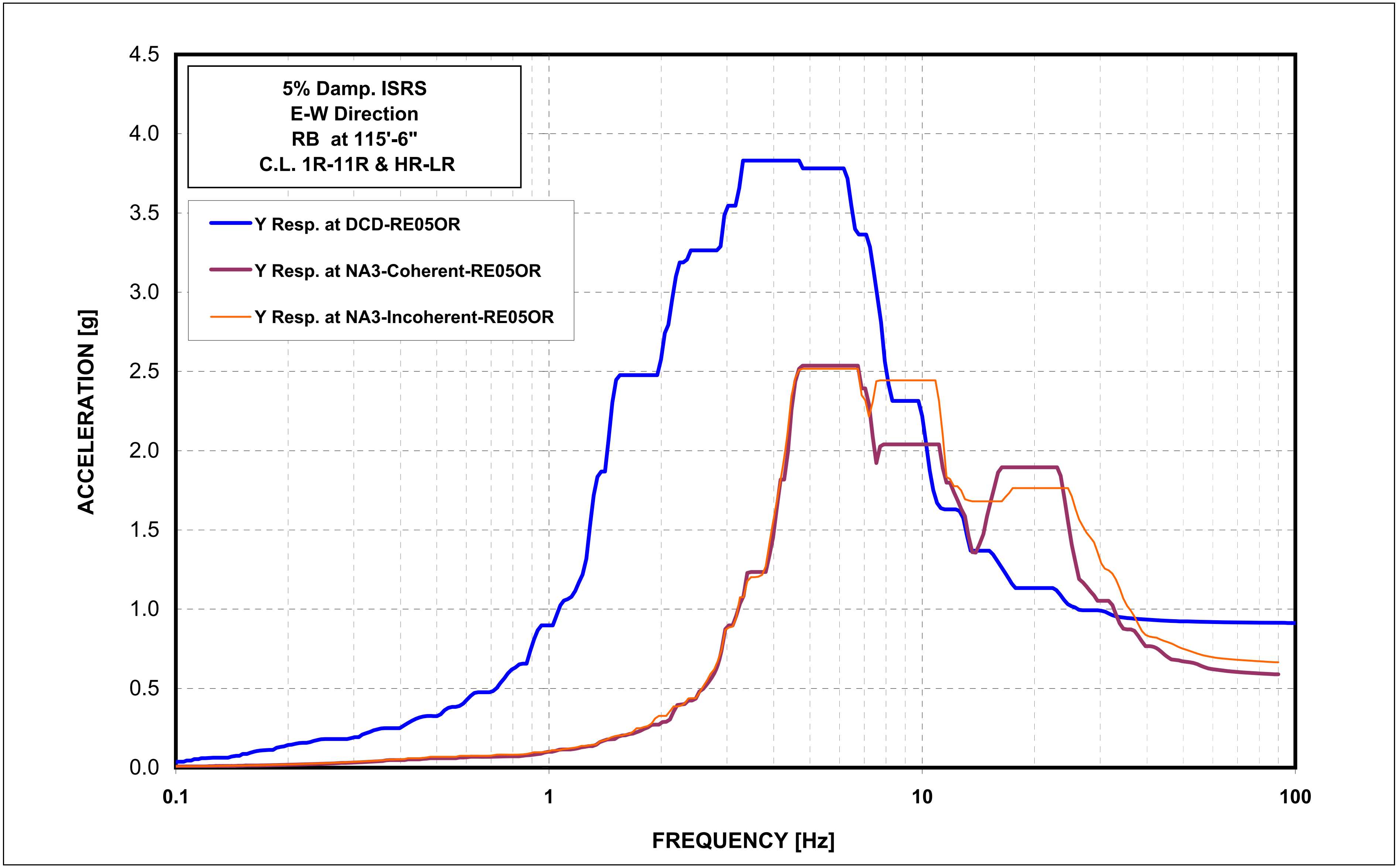


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE05Z1 - Elevation 115'-6" (Sheet 48 of 143)

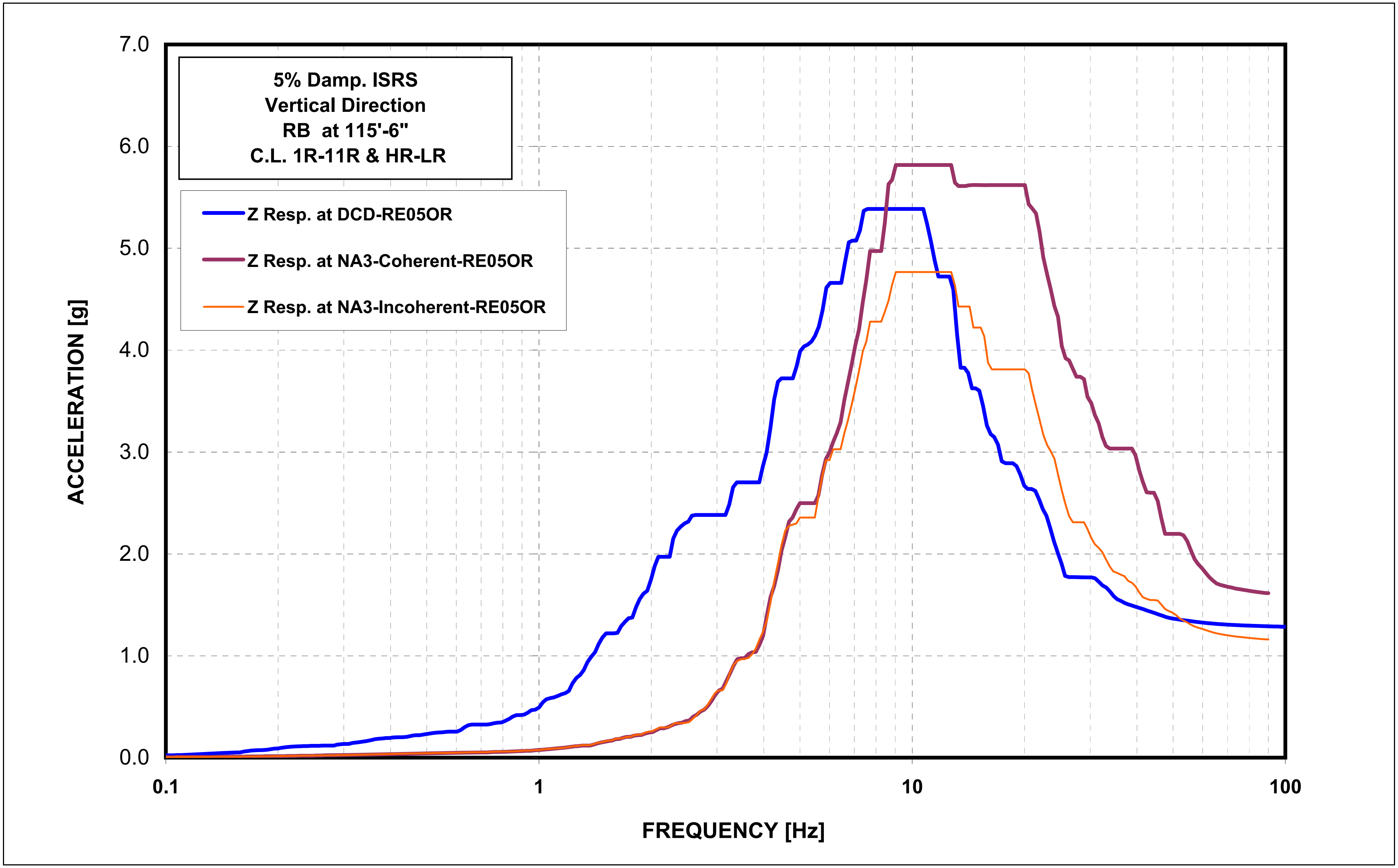


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE05Z1 - Elevation 115'- 6" (Sheet 49 of 143)

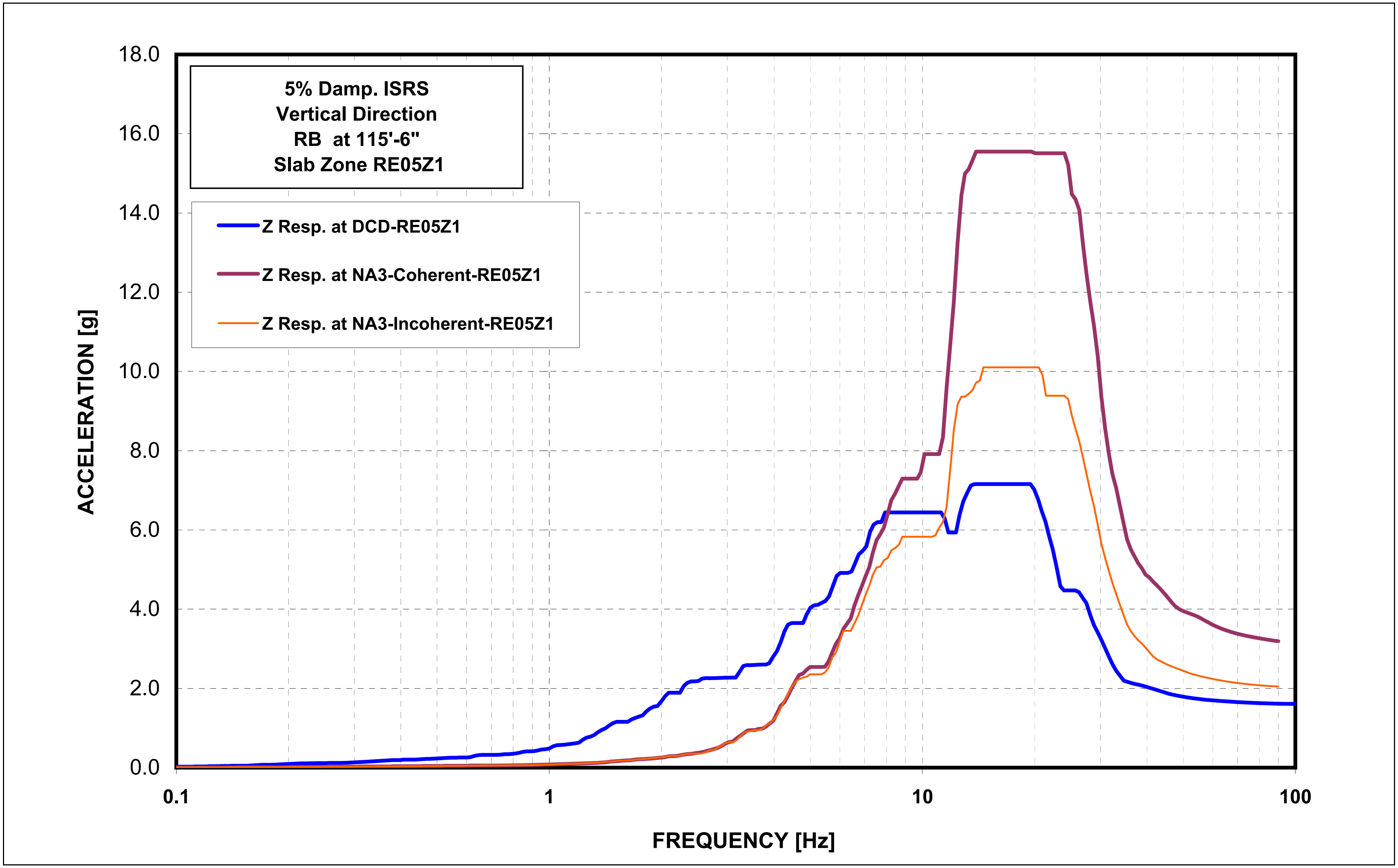


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE05Z2 - Elevation 115'-6" (Sheet 50 of 143)

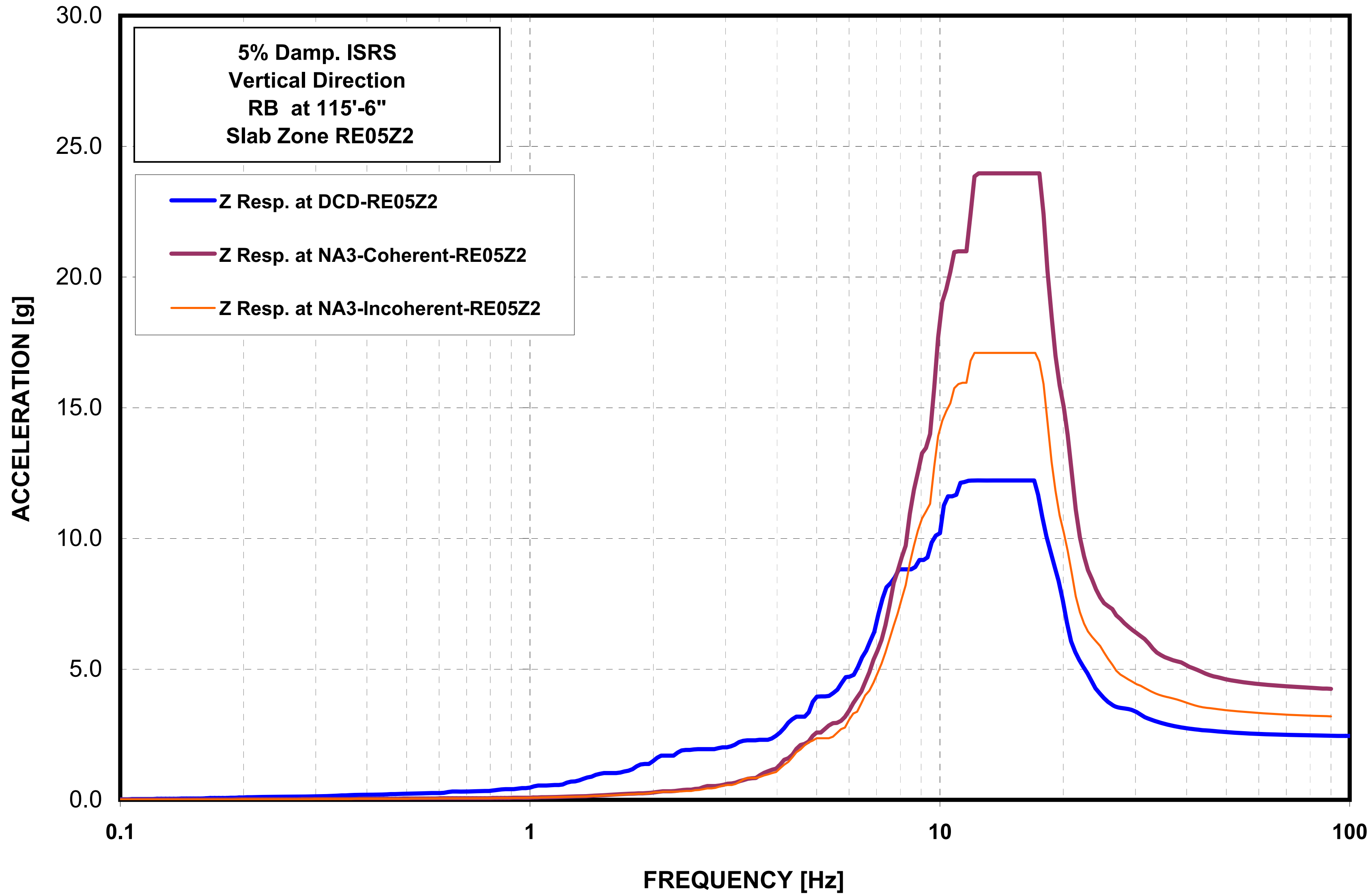


Figure 3NN-23 ISRS for R/B N-S Direction at RE41 - Elevation 101'-0" (Sheet 51 of 143)

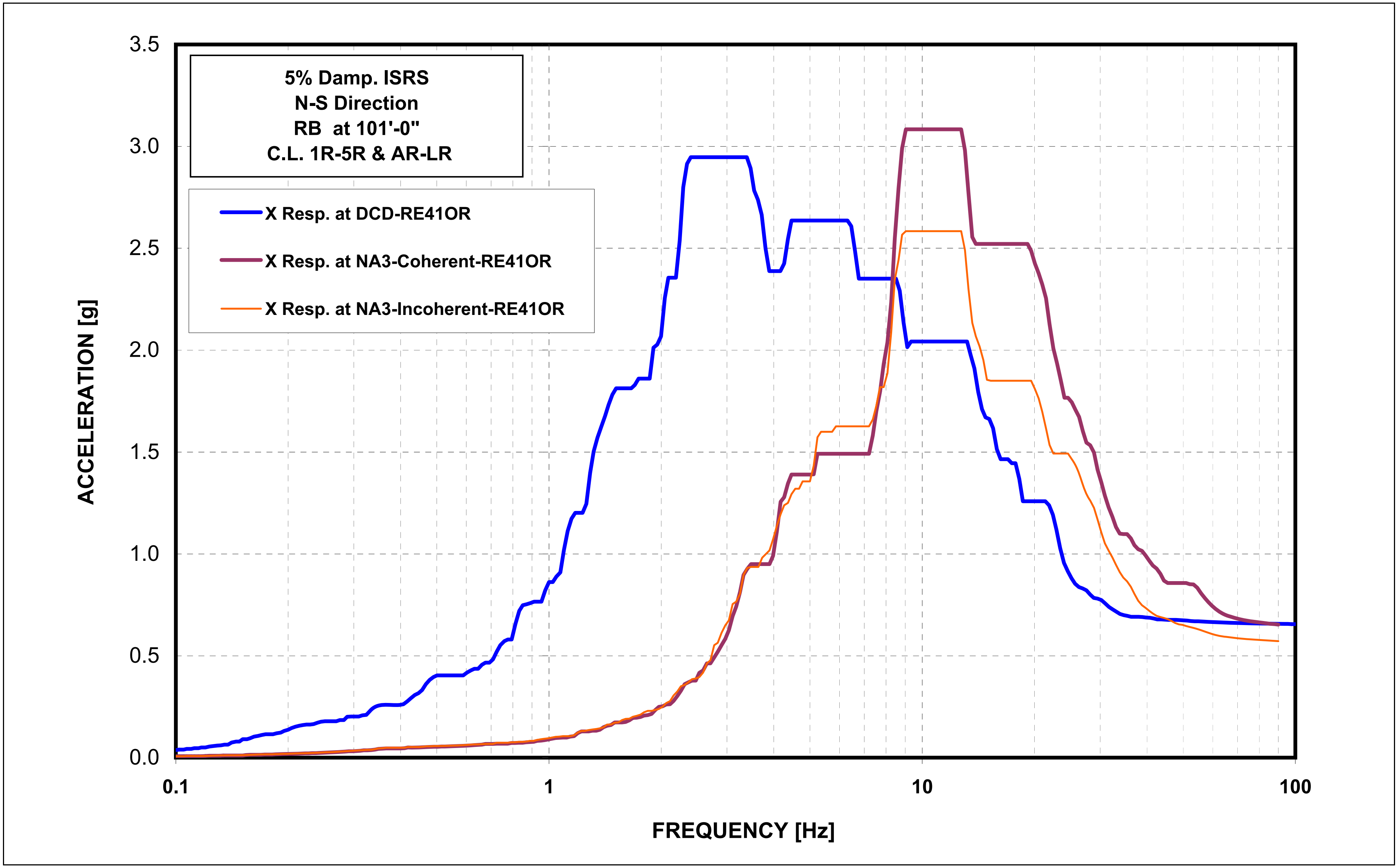


Figure 3NN-23 ISRS for R/B E-W Direction at RE41 - Elevation 101'- 0" (Sheet 52 of 143)

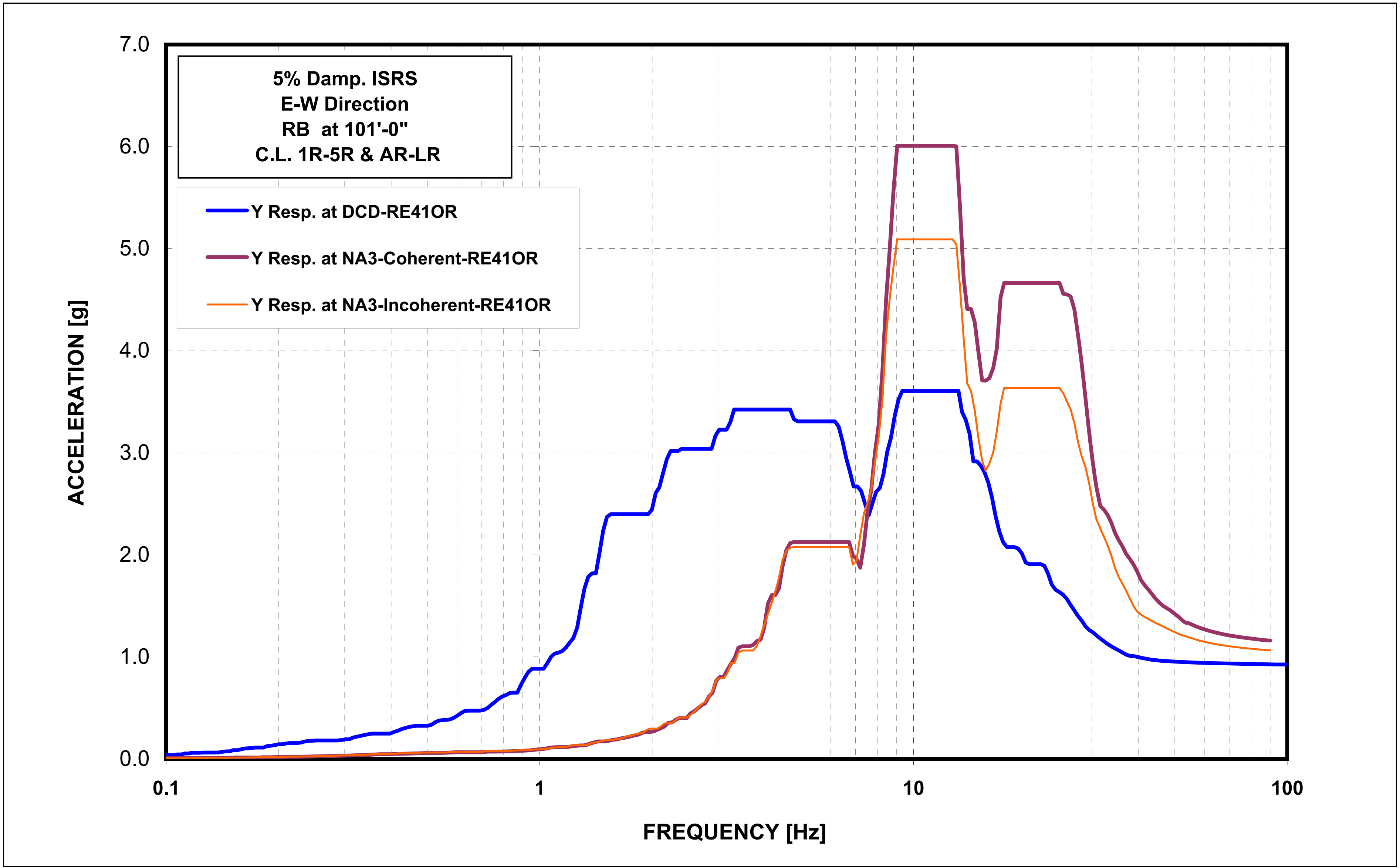


Figure 3NN-23 ISRS for R/B Vertical Direction at RE41 - Elevation 101'- 0" (Sheet 53 of 143)

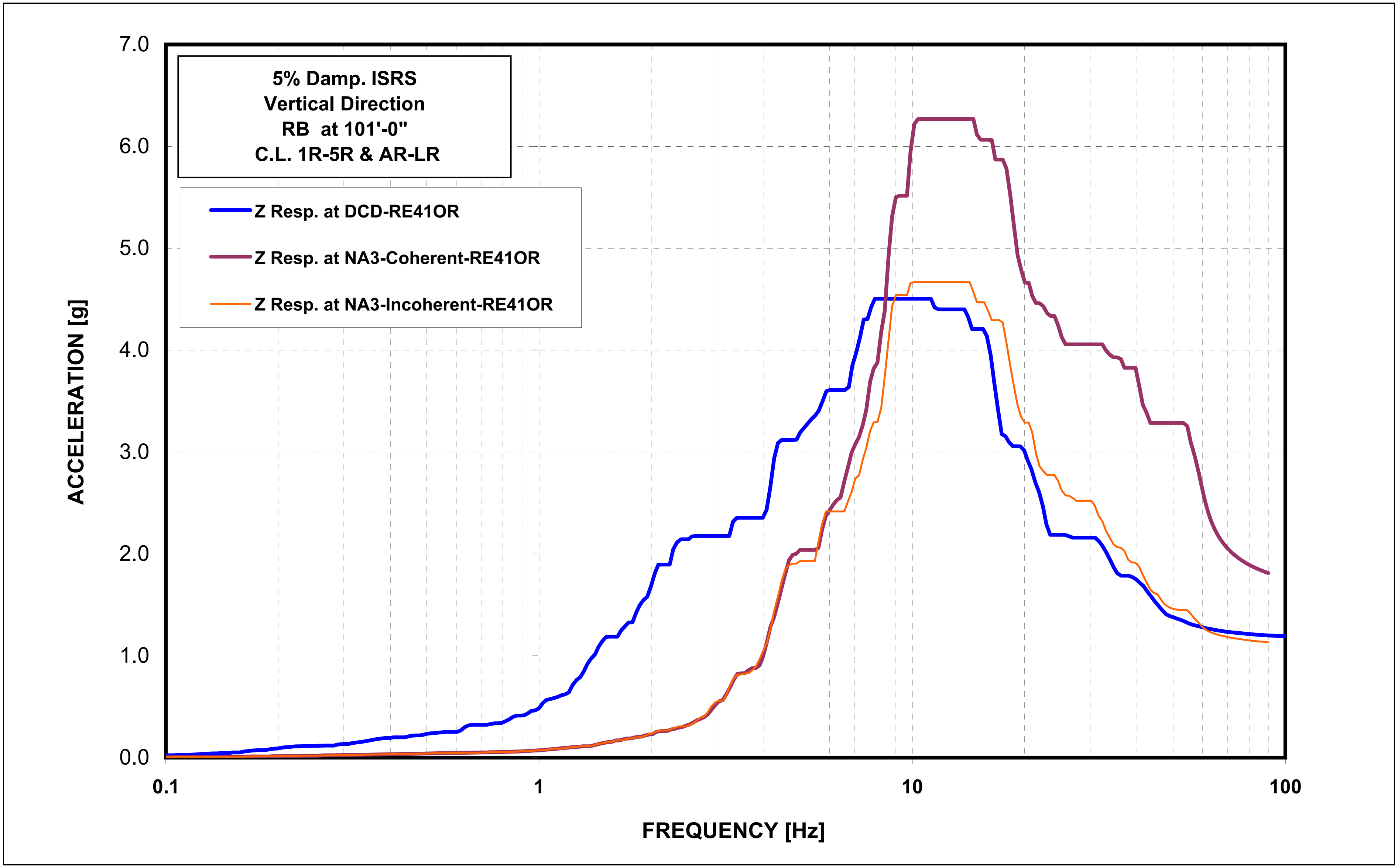


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE41Y1 - Elevation 101'-0" (Sheet 54 of 143)

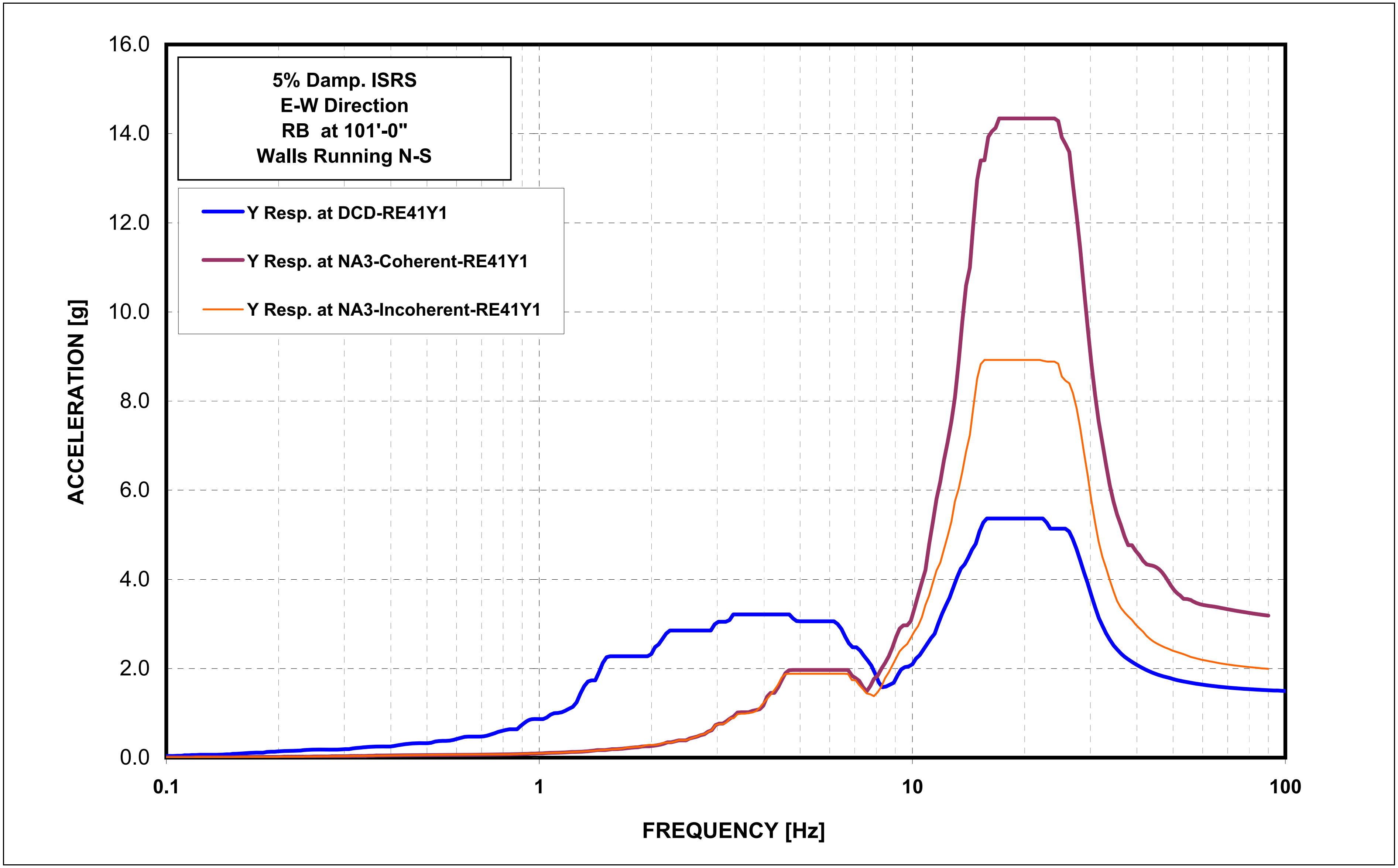


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE41Z1 - Elevation 101'-0" (Sheet 55 of 143)

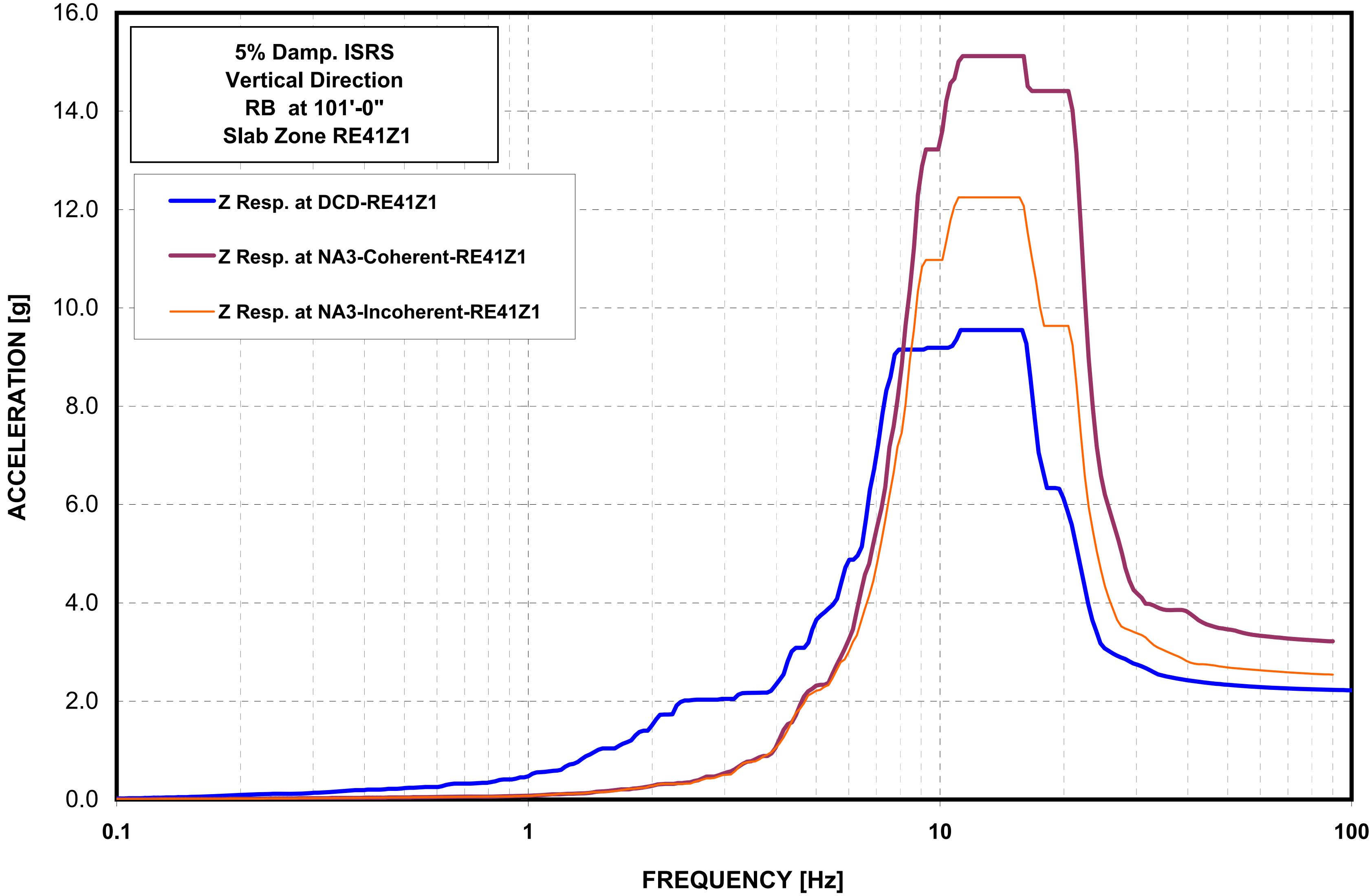


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE41Z2 - Elevation 101'- 0" (Sheet 56 of 143)

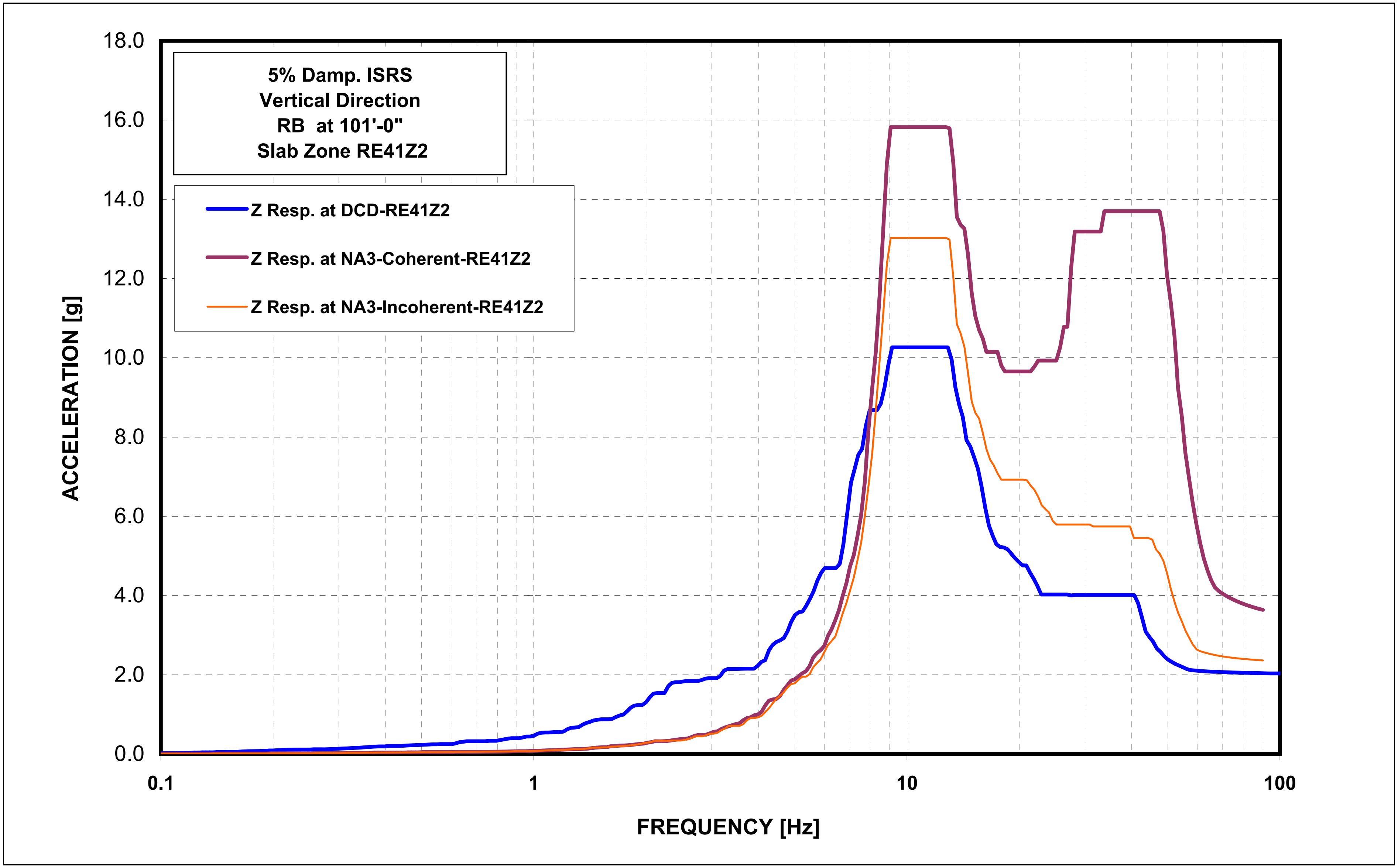


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE41Z3 - Elevation 101'-0" (Sheet 57 of 143)

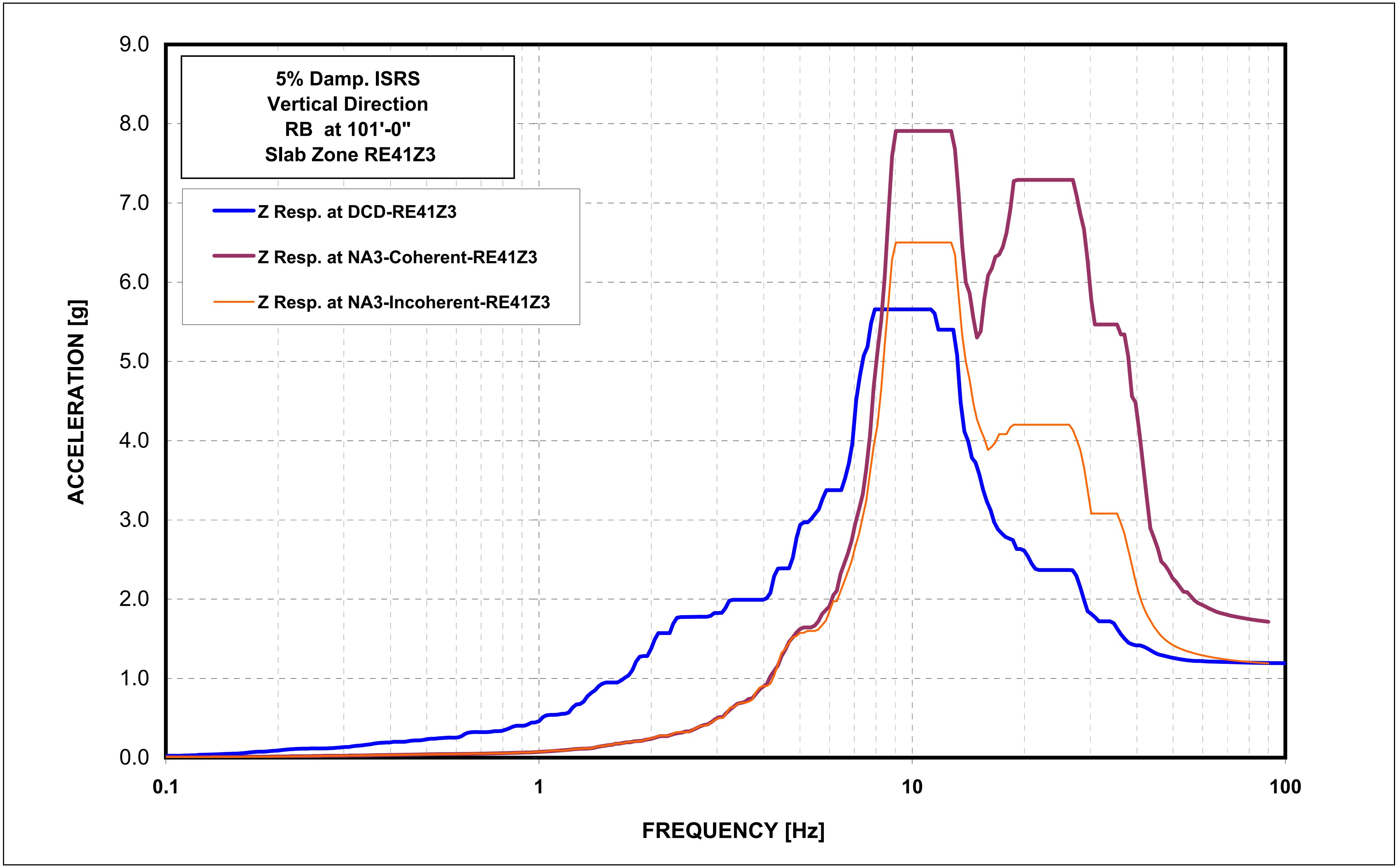


Figure 3NN-23 ISRS for R/B N-S Direction at RE42 - Elevation 101'- 0" (Sheet 58 of 143)

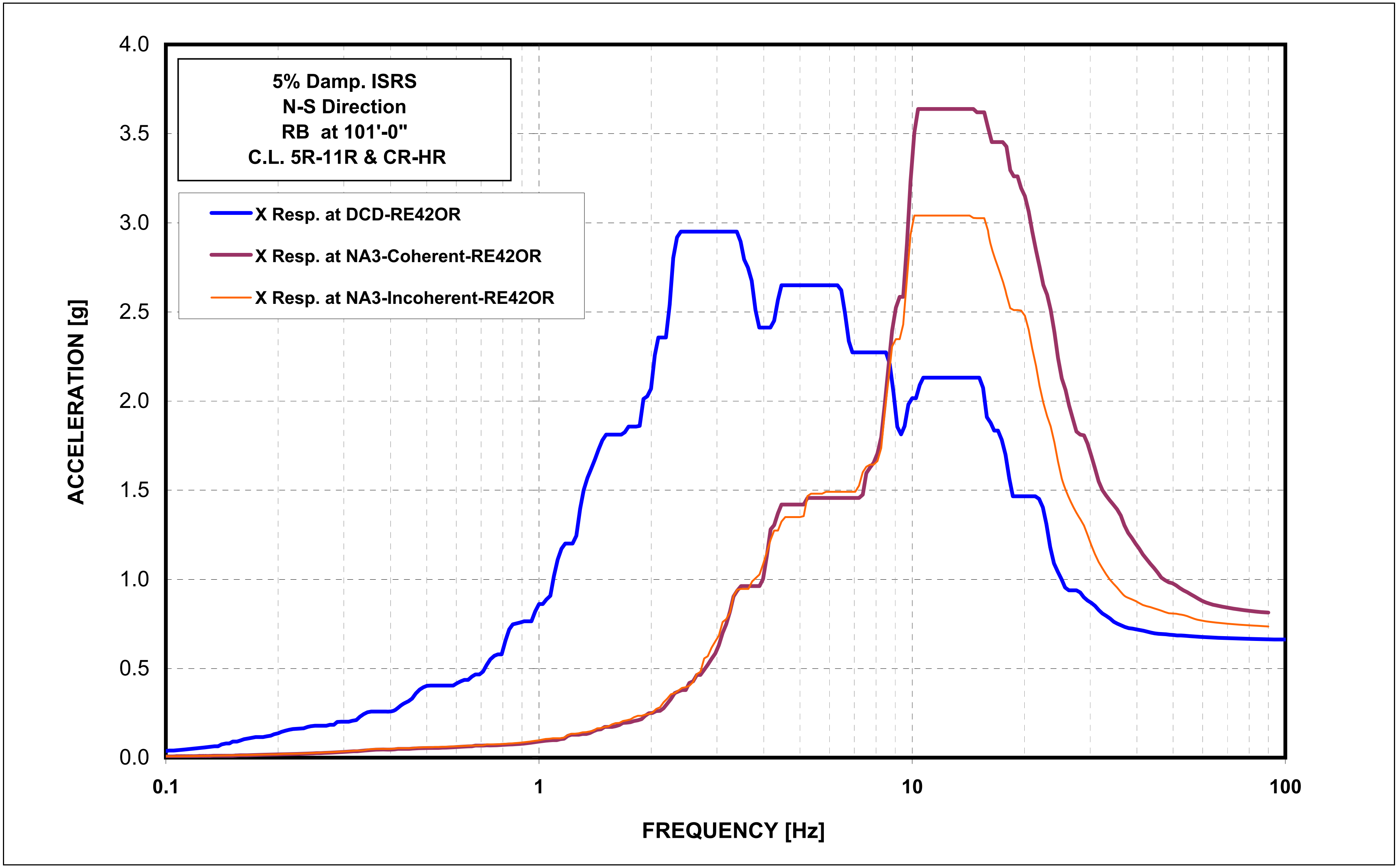


Figure 3NN-23 ISRS for R/B E-W Direction at RE42 - Elevation 101'-0" (Sheet 59 of 143)

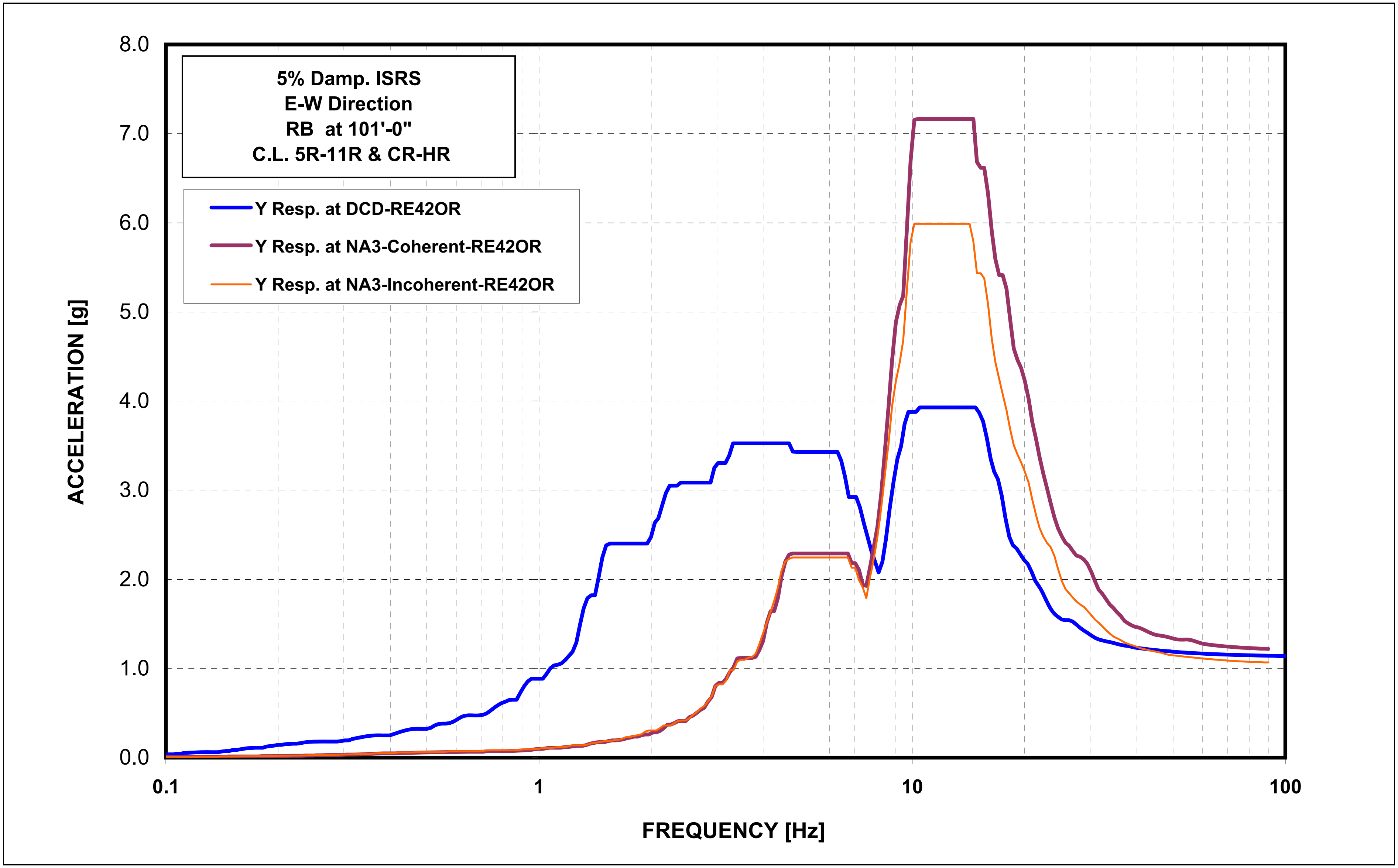


Figure 3NN-23 ISRS for R/B Vertical Direction at RE42 - Elevation 101'- 0" (Sheet 60 of 143)

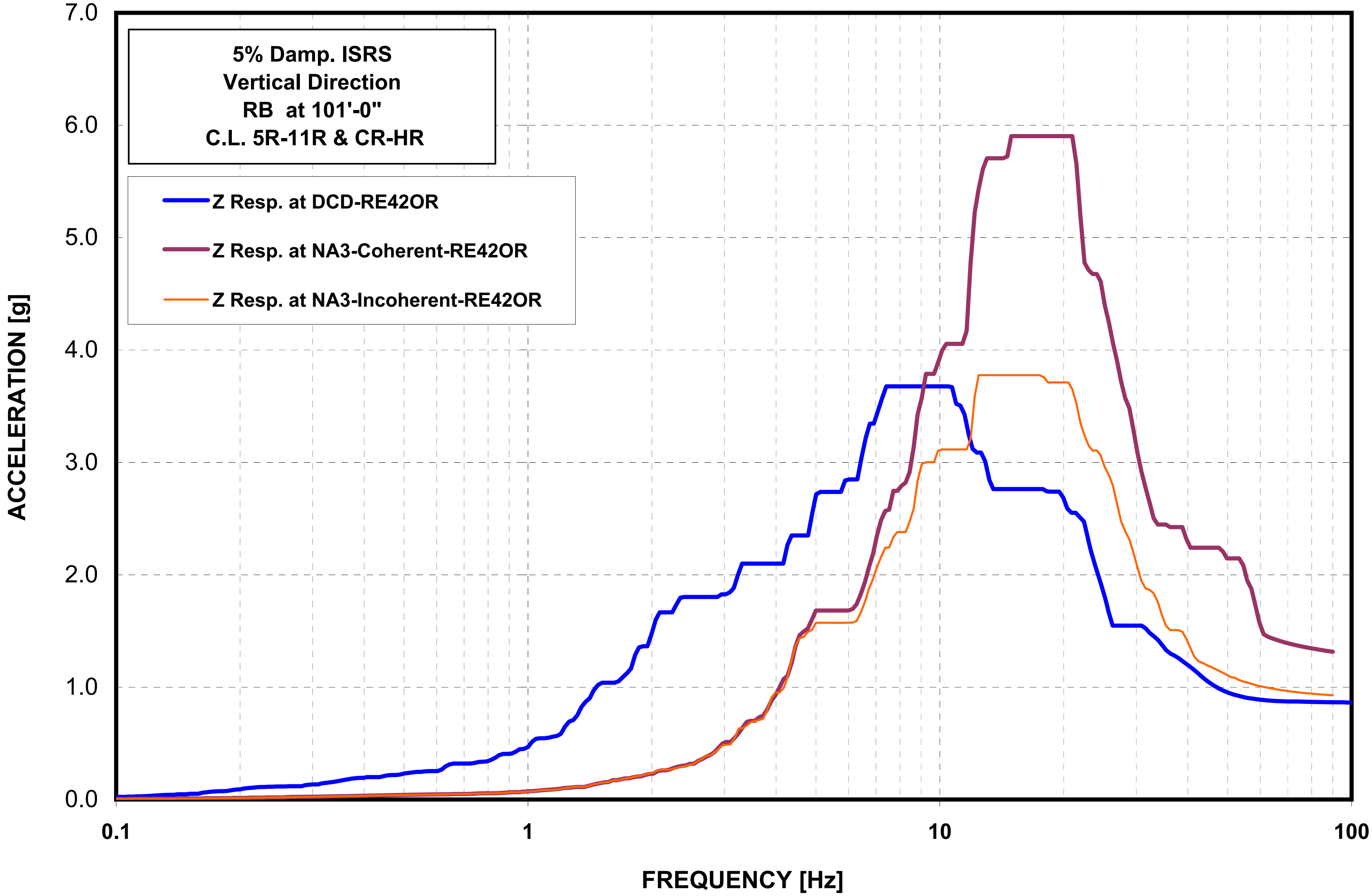


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at RE42Y1 - Elevation 101'-0" (Sheet 61 of 143)

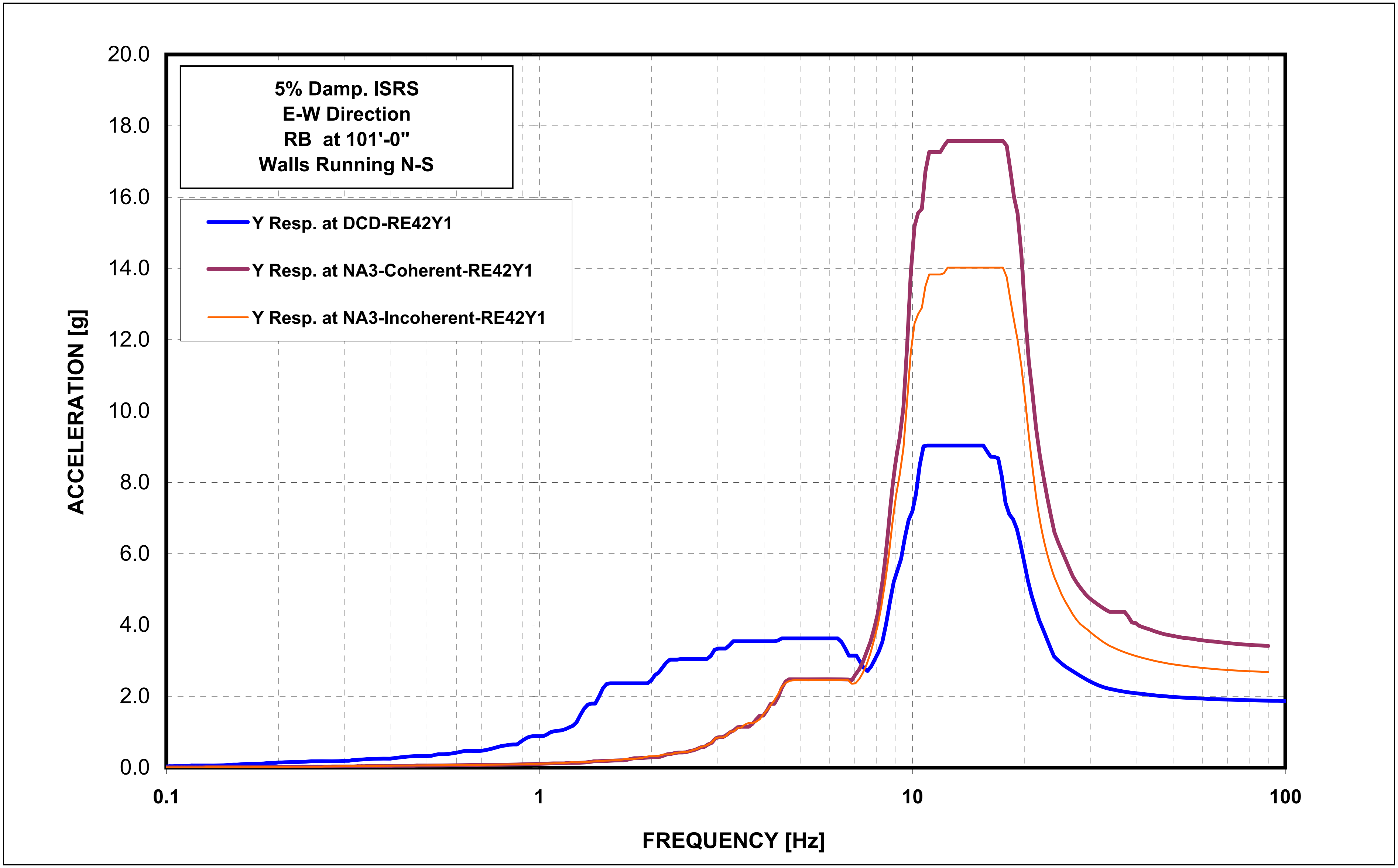


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at RE42Z1 - Elevation 101'- 0" (Sheet 62 of 143)

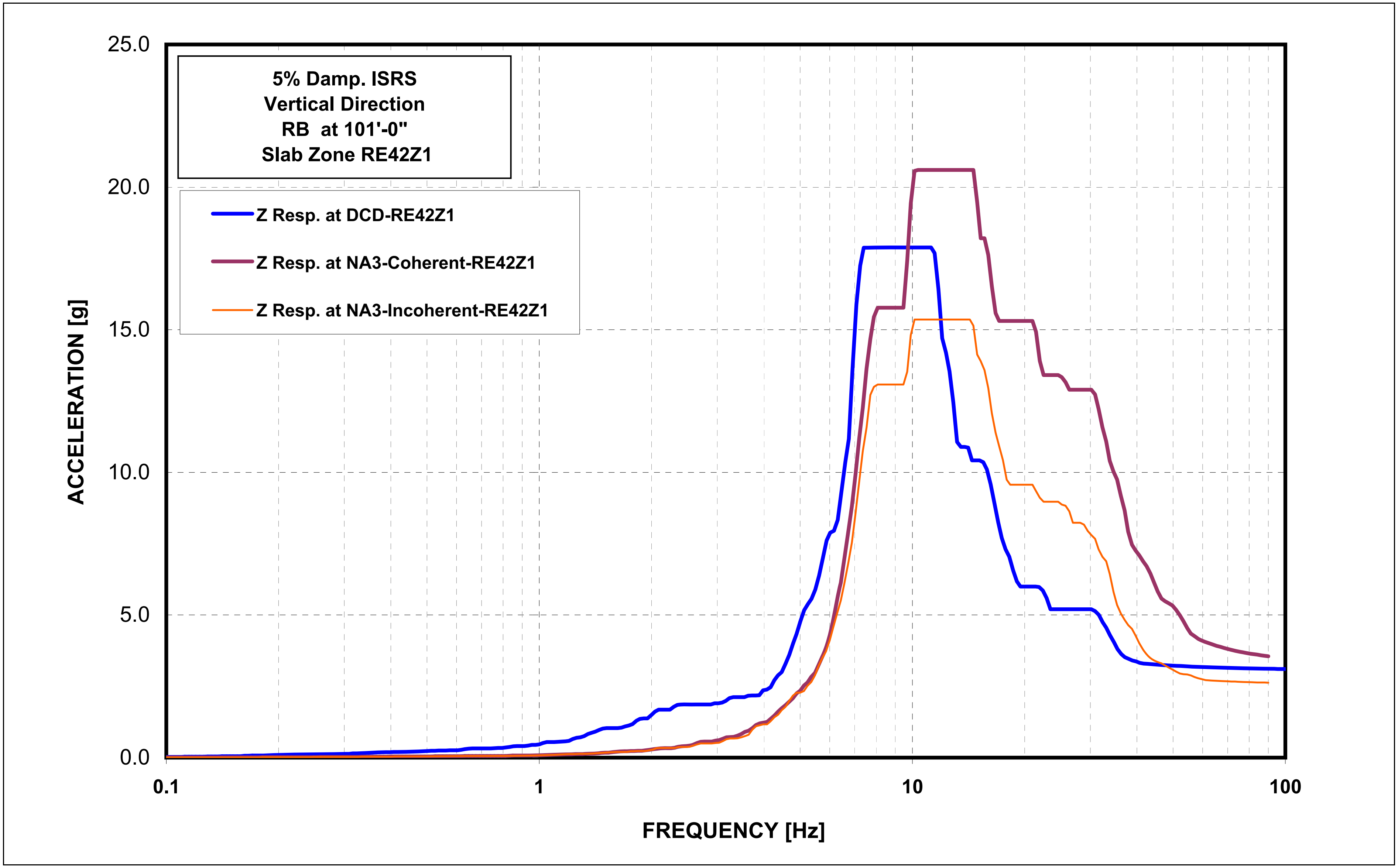


Figure 3NN-23 ISRS for R/B N-S Direction at FH06 - Elevation 101'-0" (Sheet 63 of 143)

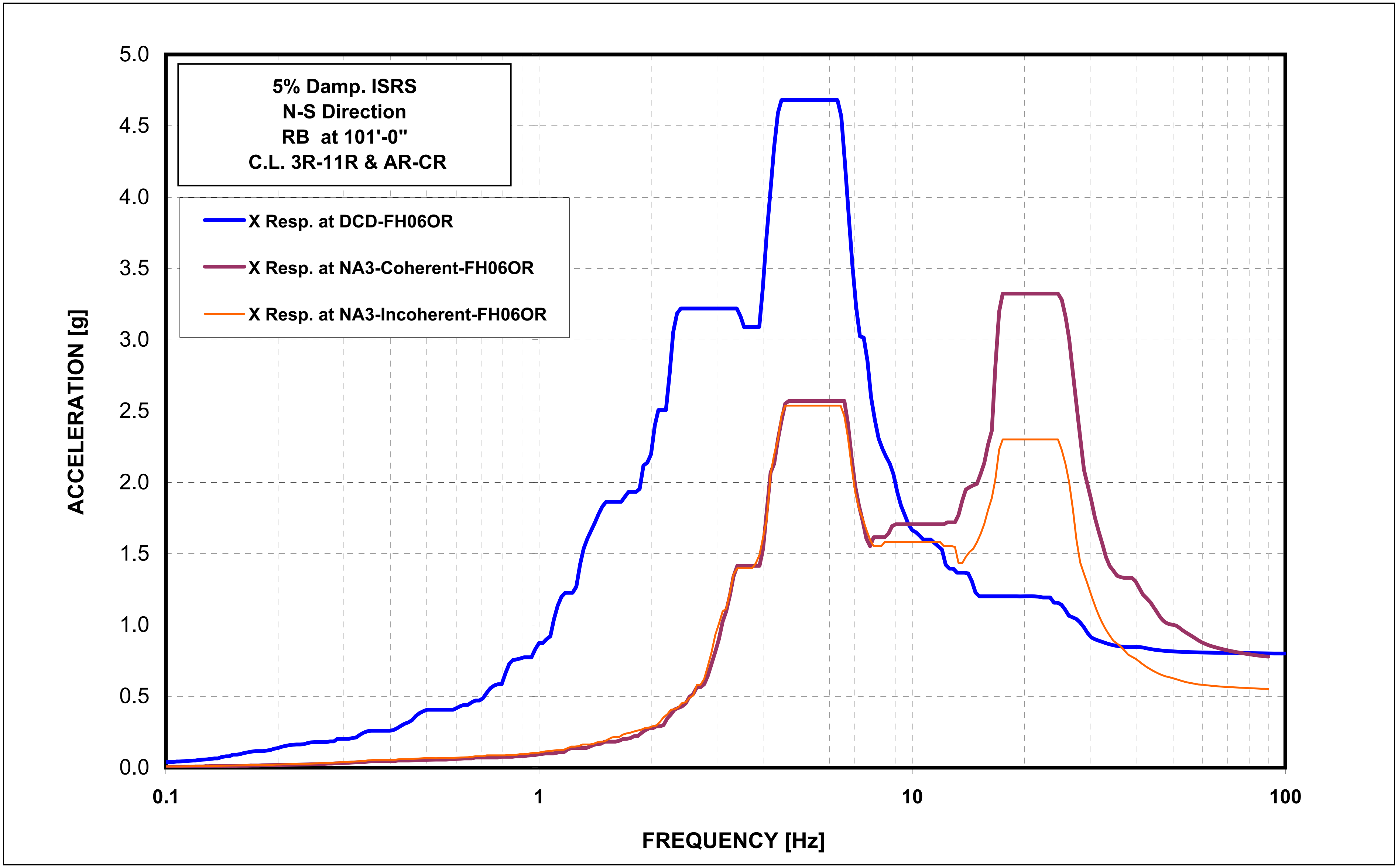


Figure 3NN-23 ISRS for R/B E-W Direction at FH06 - Elevation 101'-0" (Sheet 64 of 143)

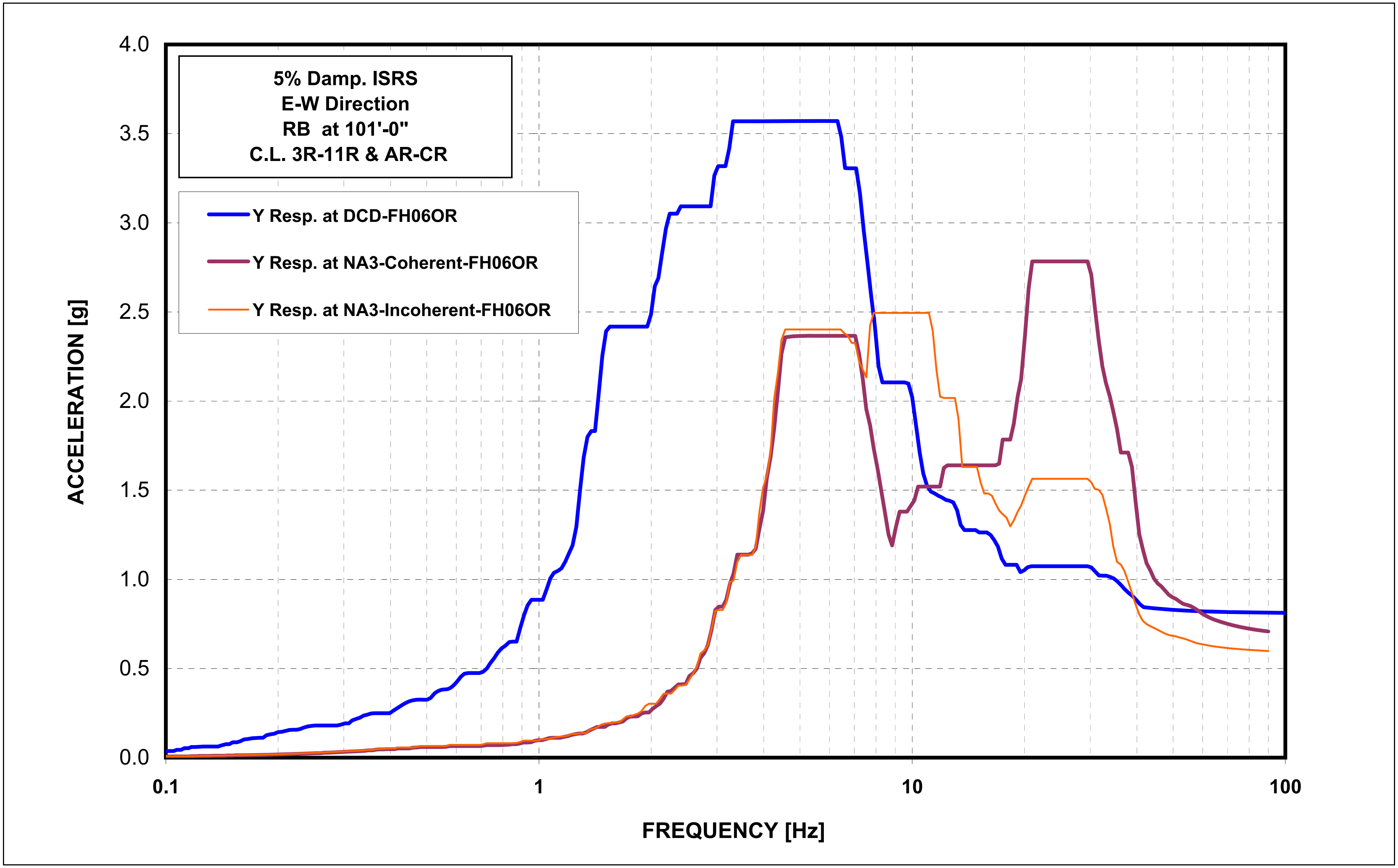


Figure 3NN-23 ISRS for R/B Vertical Direction at FH06 - Elevation 101'- 0" (Sheet 65 of 143)

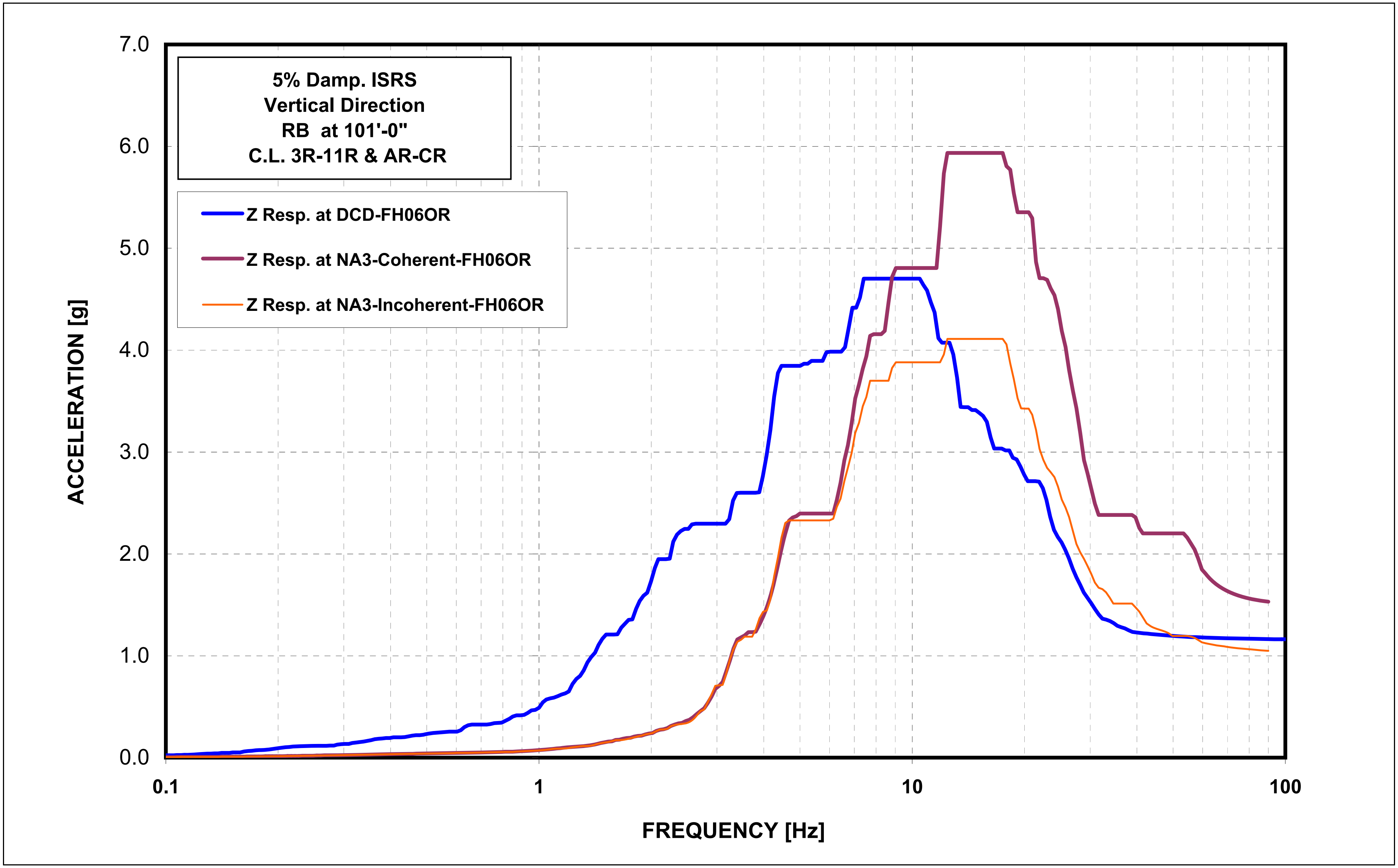


Figure 3NN-23 ISRS for R/B N-S Direction at FH07 - Elevation 125'-4" (Sheet 66 of 143)

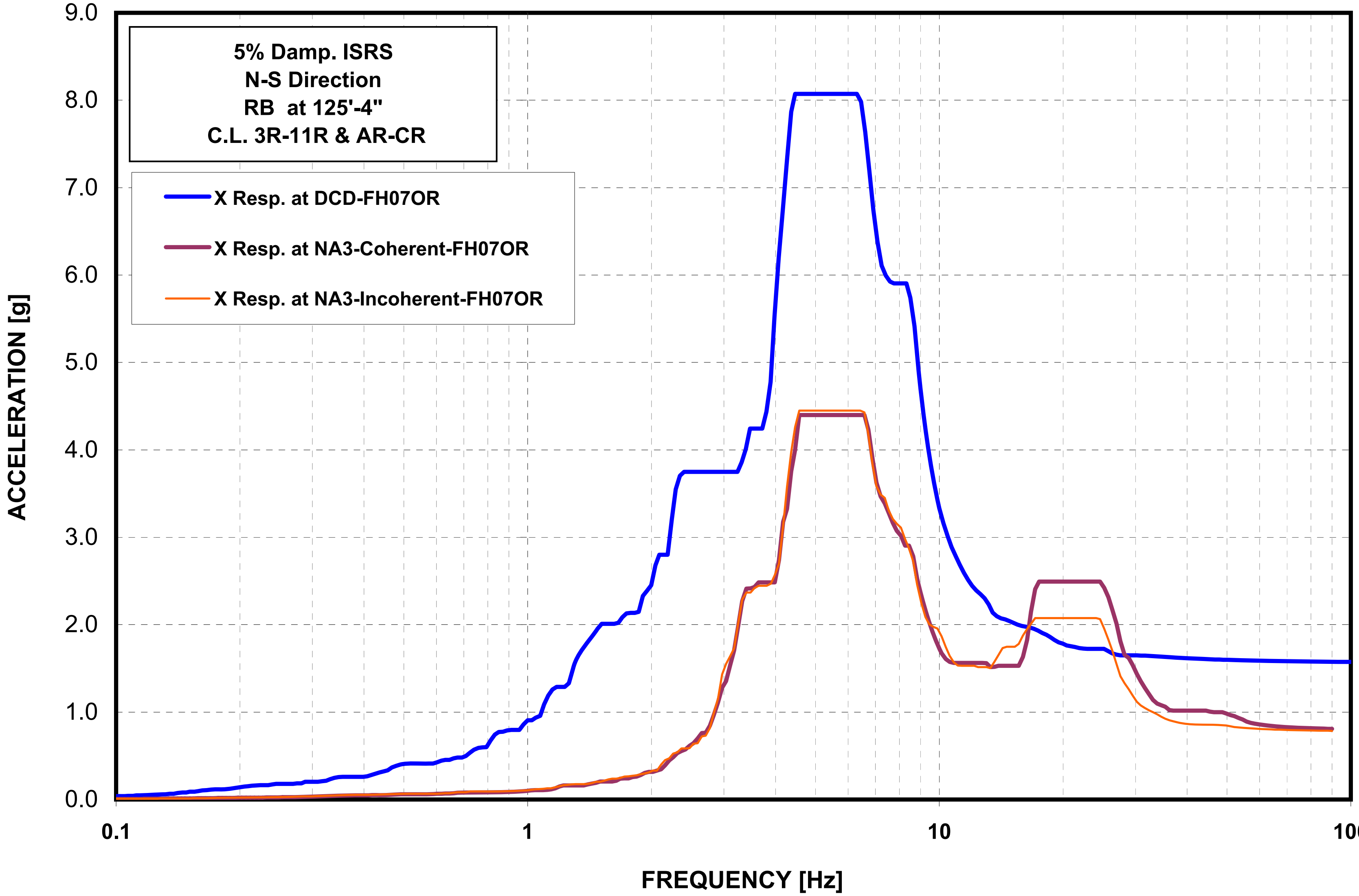


Figure 3NN-23 ISRS for R/B E-W Direction at FH07 - Elevation 125'-4" (Sheet 67 of 143)

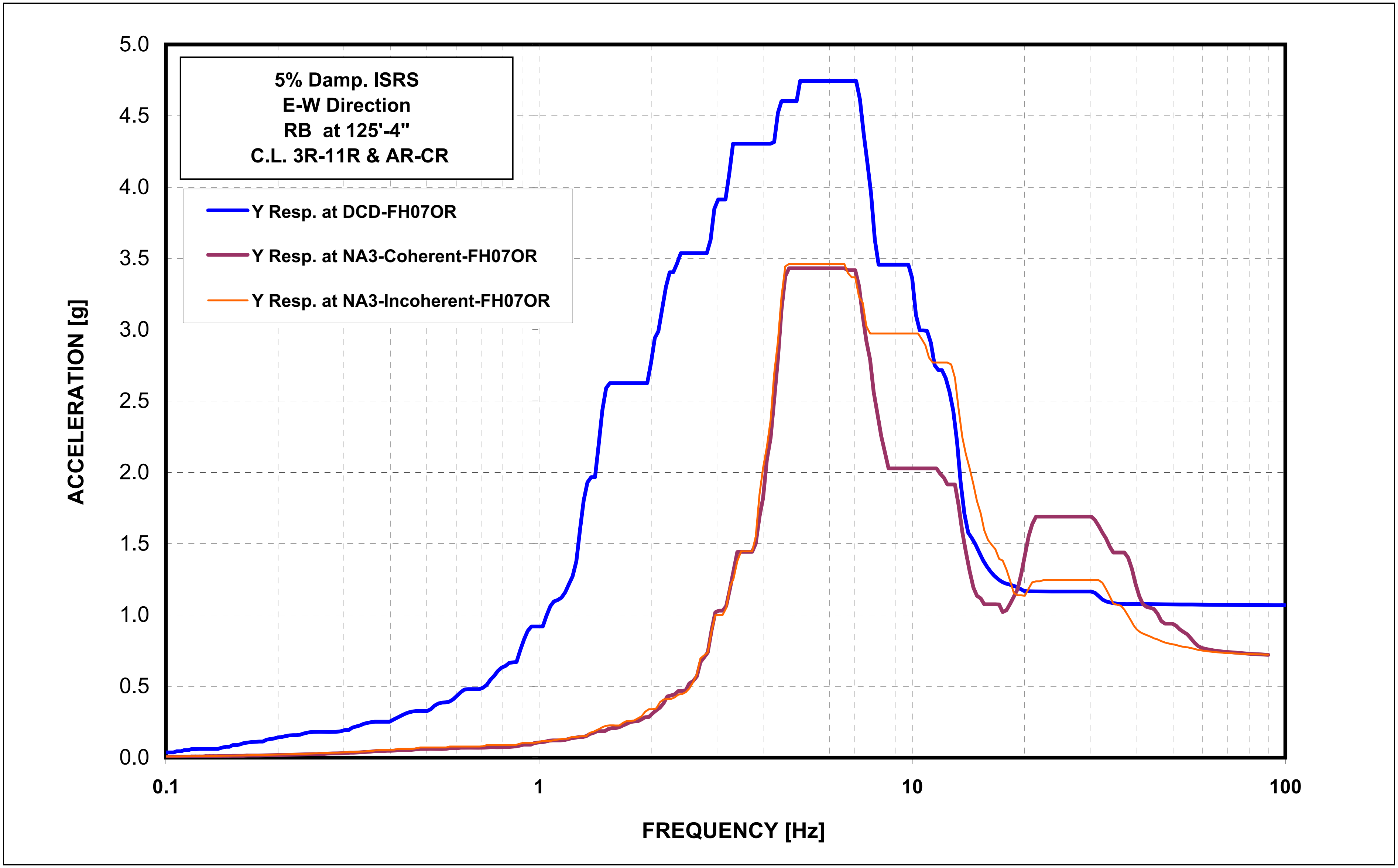


Figure 3NN-23 ISRS for R/B Vertical Direction at FH07 - Elevation 125'-4" (Sheet 68 of 143)

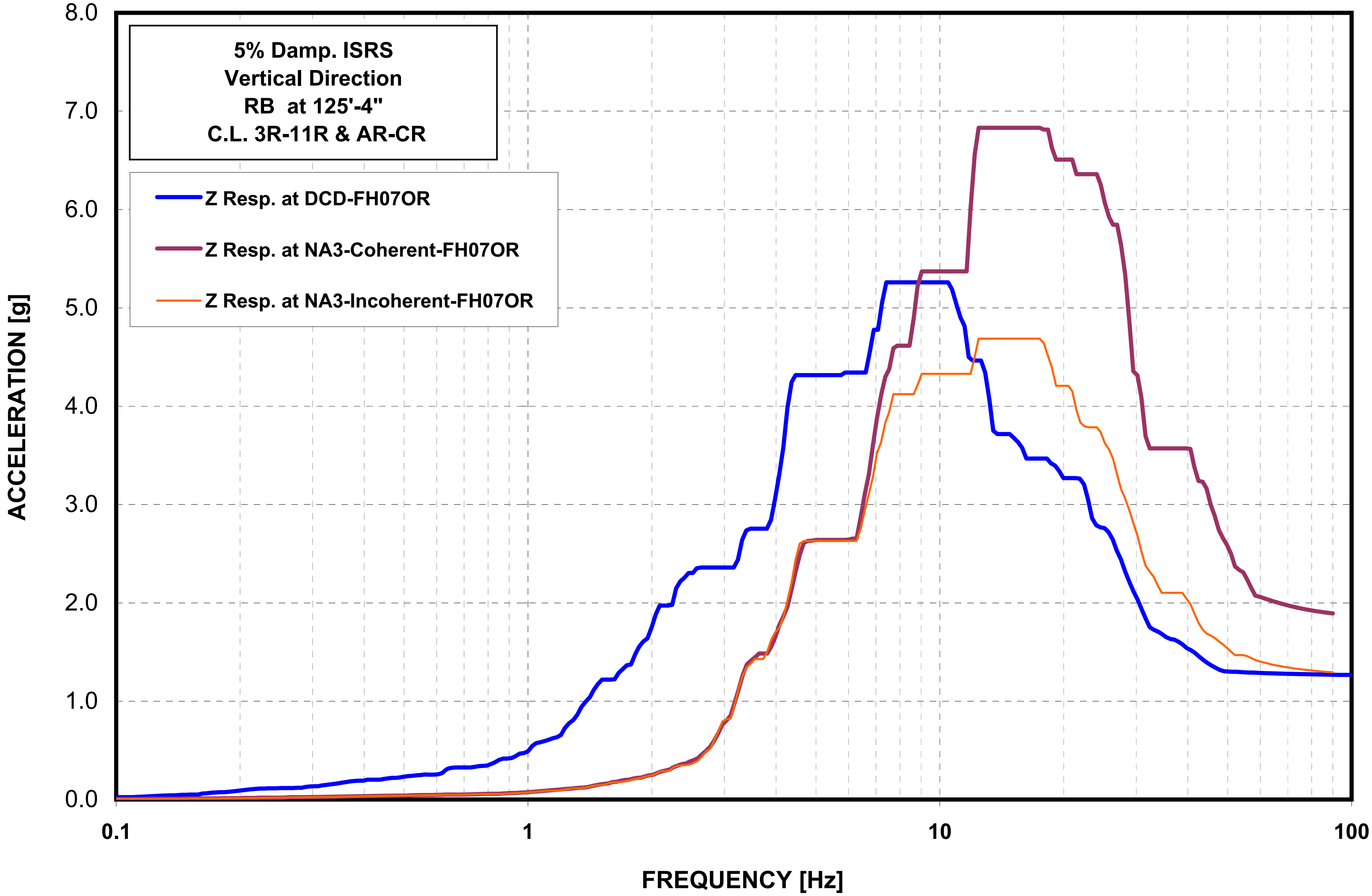


Figure 3NN-23 ISRS for R/B SDOF N-S Direction at FH07X1 - Elevation 125'-4" (Sheet 69 of 143)

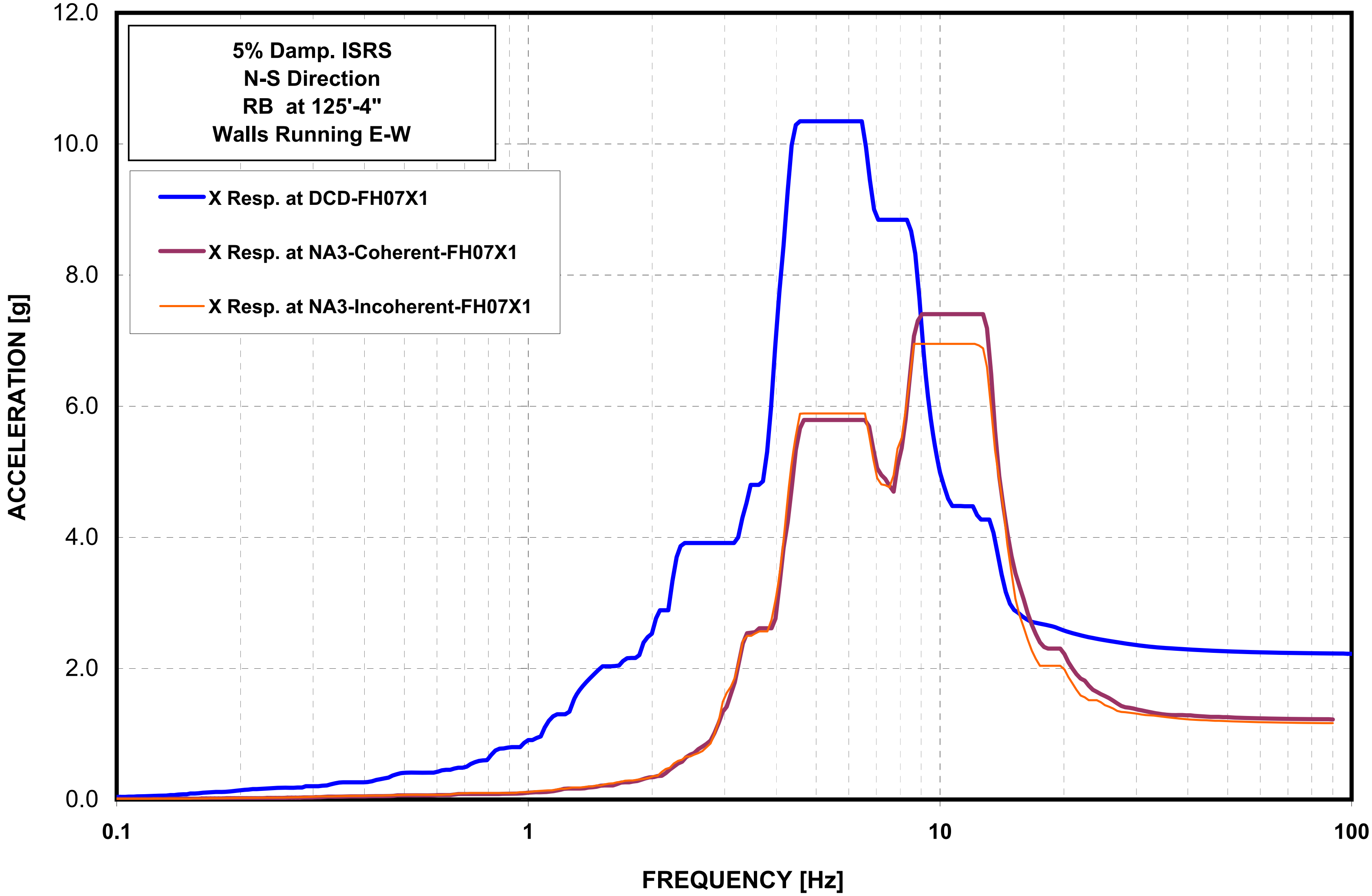


Figure 3NN-23 ISRS for R/B SDOF E-W Direction at FH07Y1 - Elevation 125'-4" (Sheet 70 of 143)

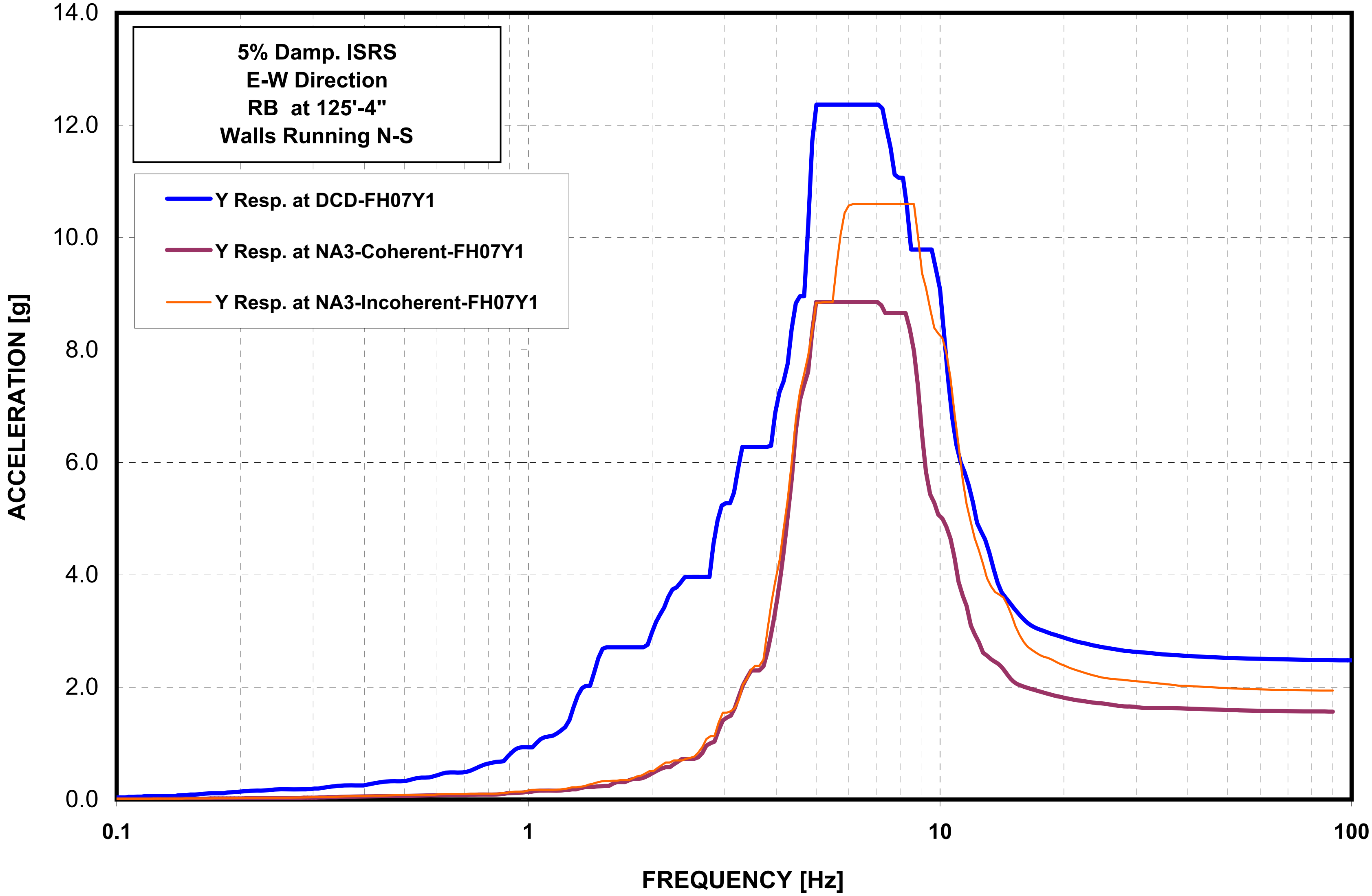


Figure 3NN-23 ISRS for R/B N-S Direction at FH08 - Elevation 154'-8" (Sheet 71 of 143)

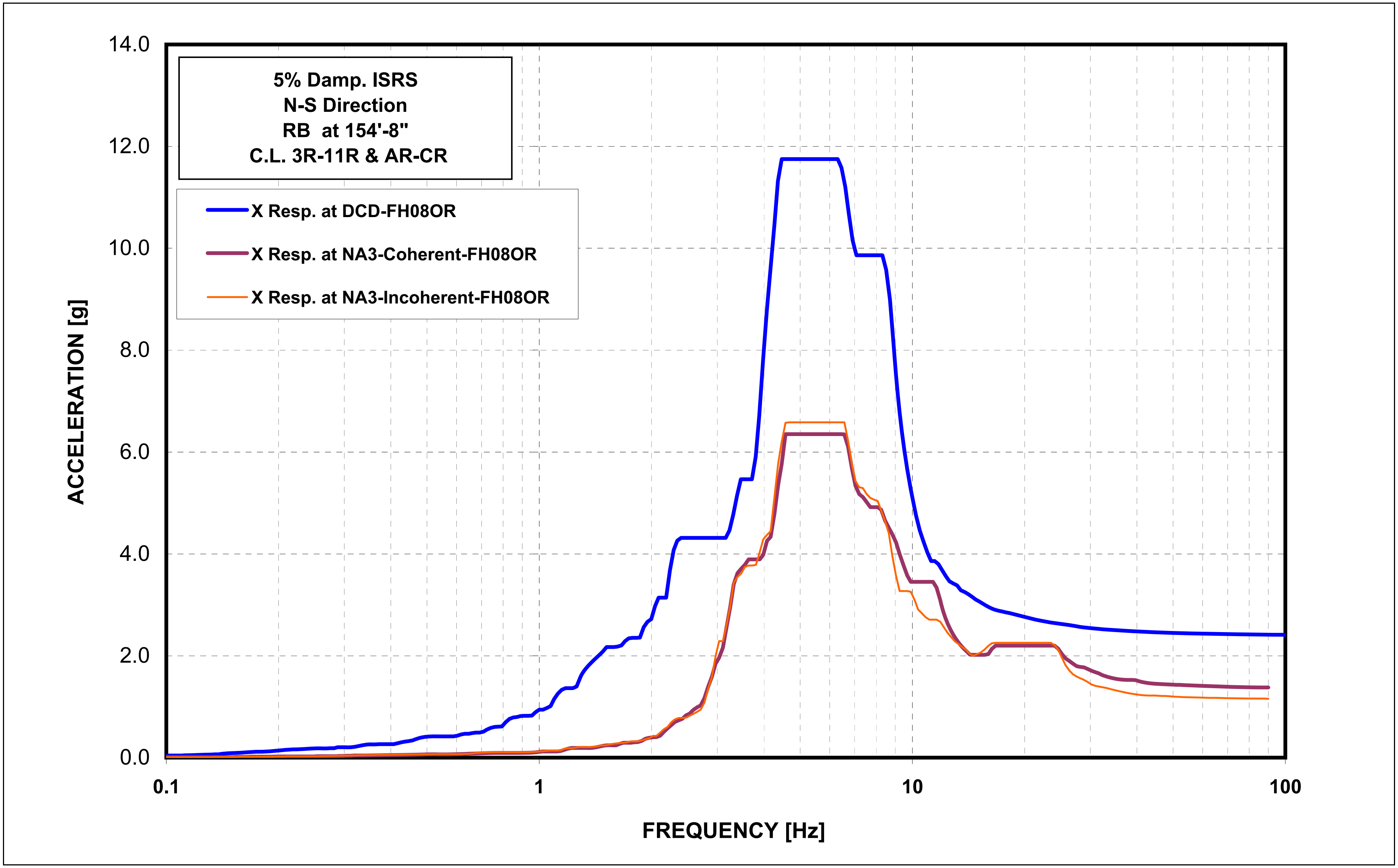


Figure 3NN-23 ISRS for R/B E-W Direction at FH08 - Elevation 154'-8" (Sheet 72 of 143)

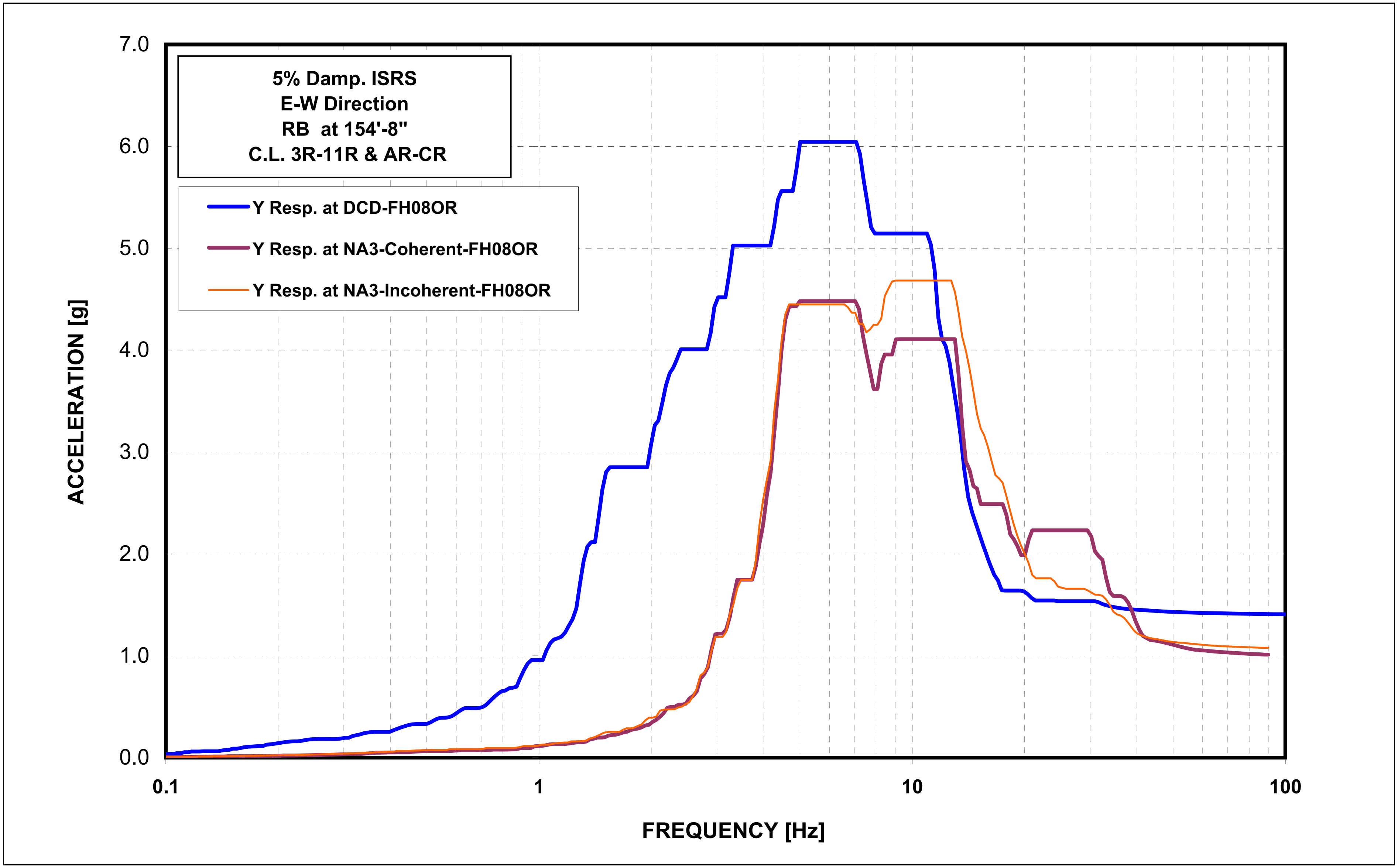


Figure 3NN-23 ISRS for R/B Vertical Direction at FH08 - Elevation 154'-8" (Sheet 73 of 143)

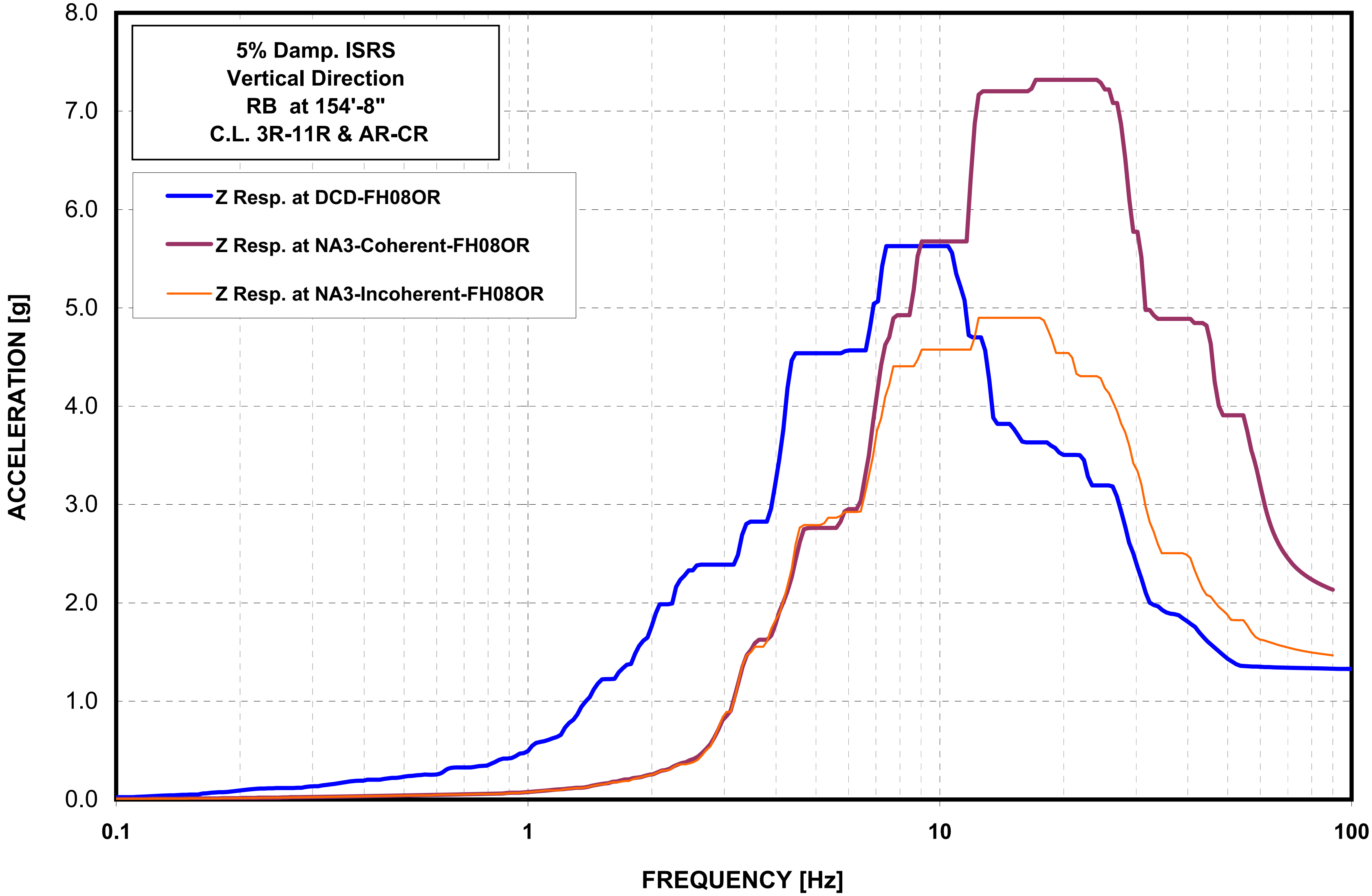


Figure 3NN-23 ISRS for R/B SDOF Vertical Direction at FH08Z1 - Elevation 154'- 8" (Sheet 74 of 143)

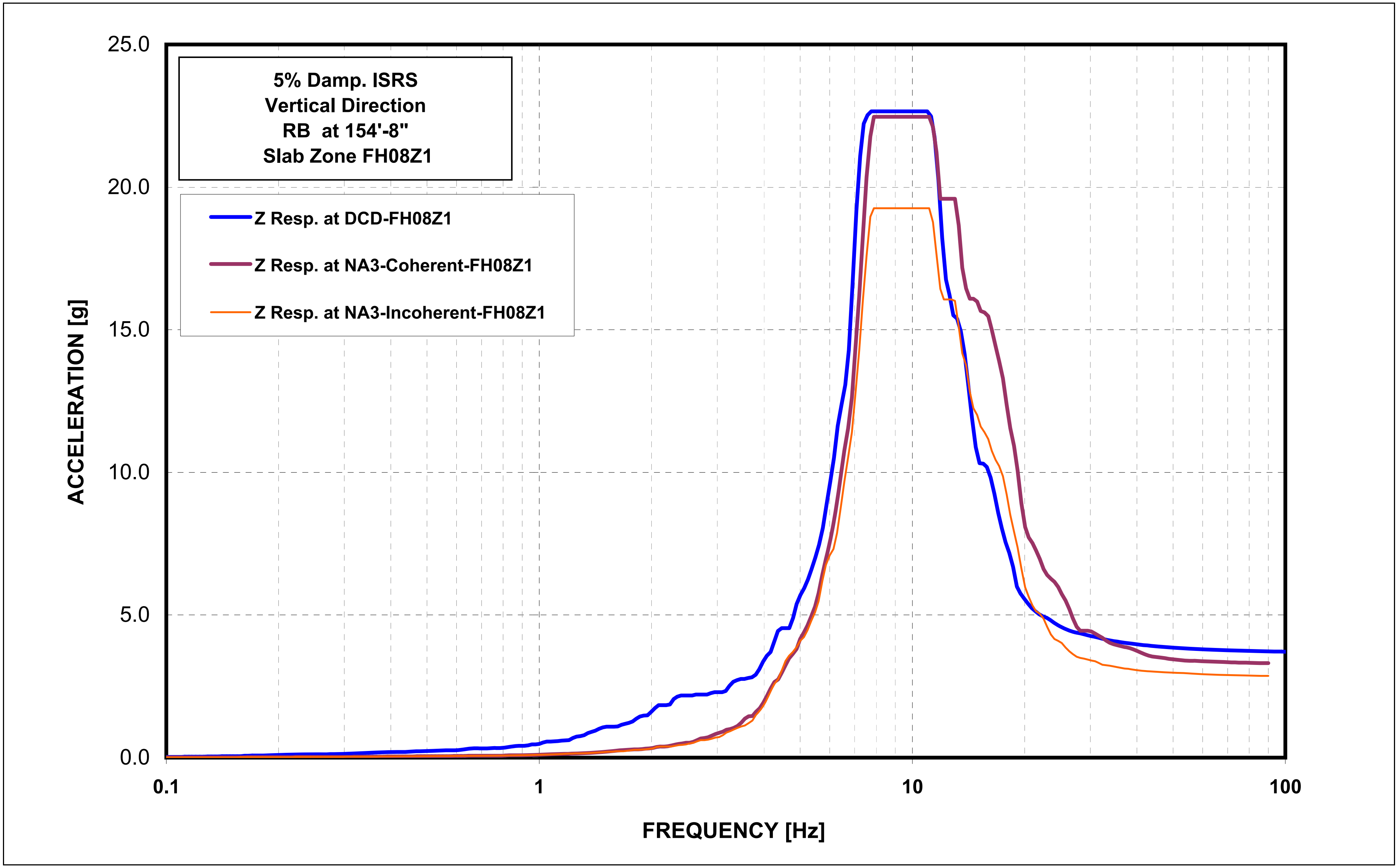


Figure 3NN-23 ISRS for PCCV N-S Direction at CV00 - Elevation 1'-11" (Sheet 75 of 143)

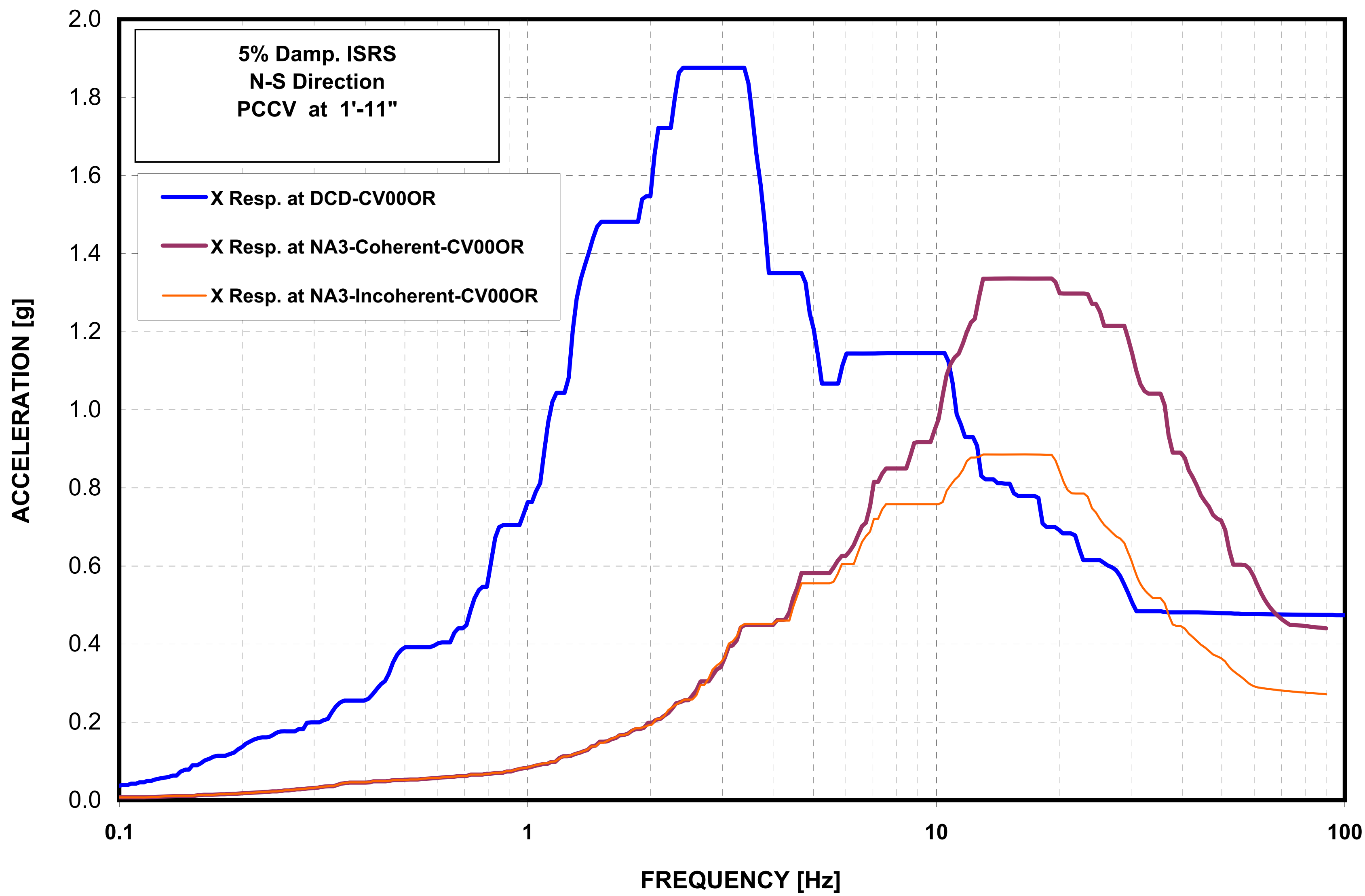


Figure 3NN-23 ISRS for PCCV E-W Direction at CV00 - Elevation 1'-11" (Sheet 76 of 143)

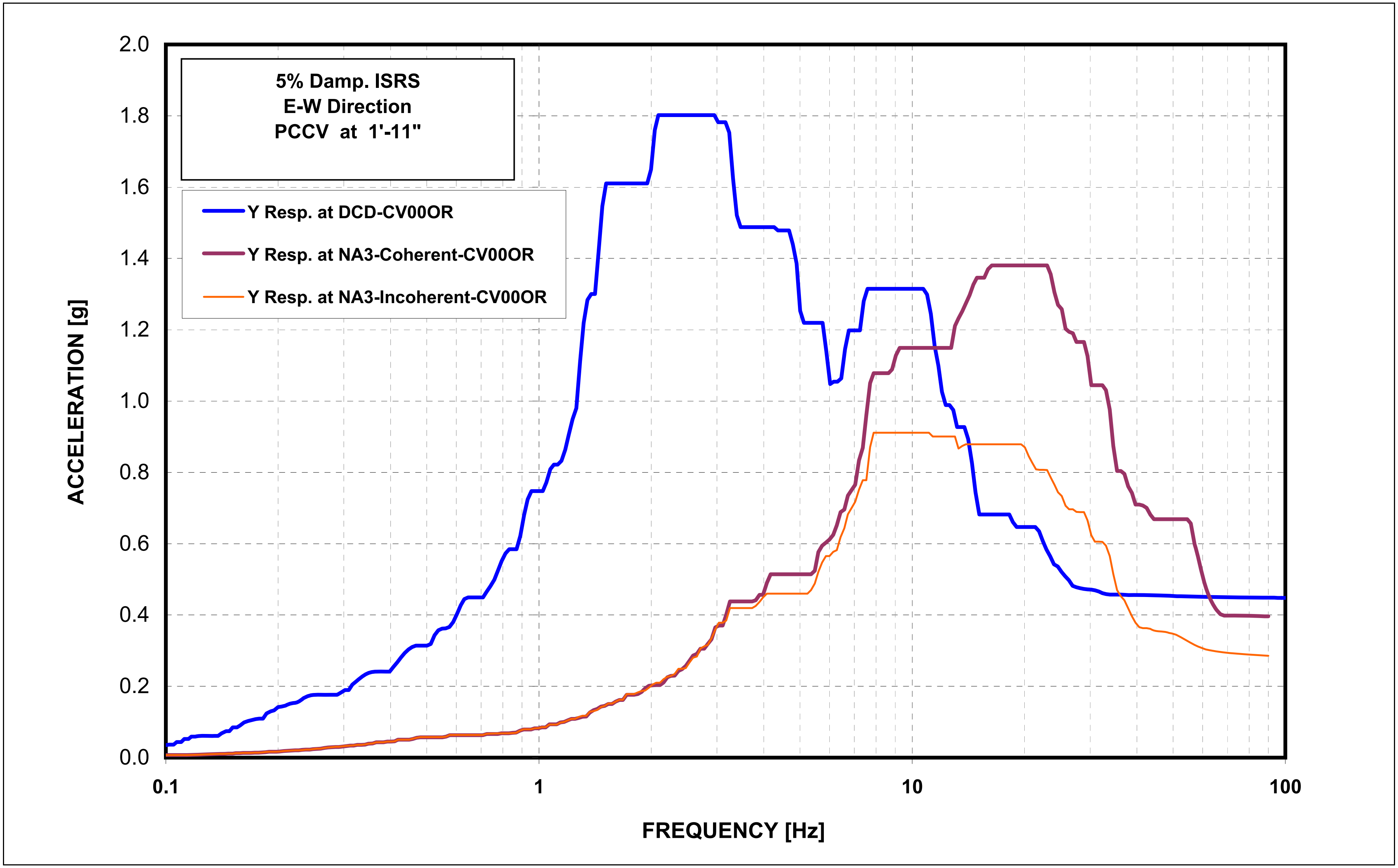


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV00 - Elevation 1'-11" (Sheet 77 of 143)

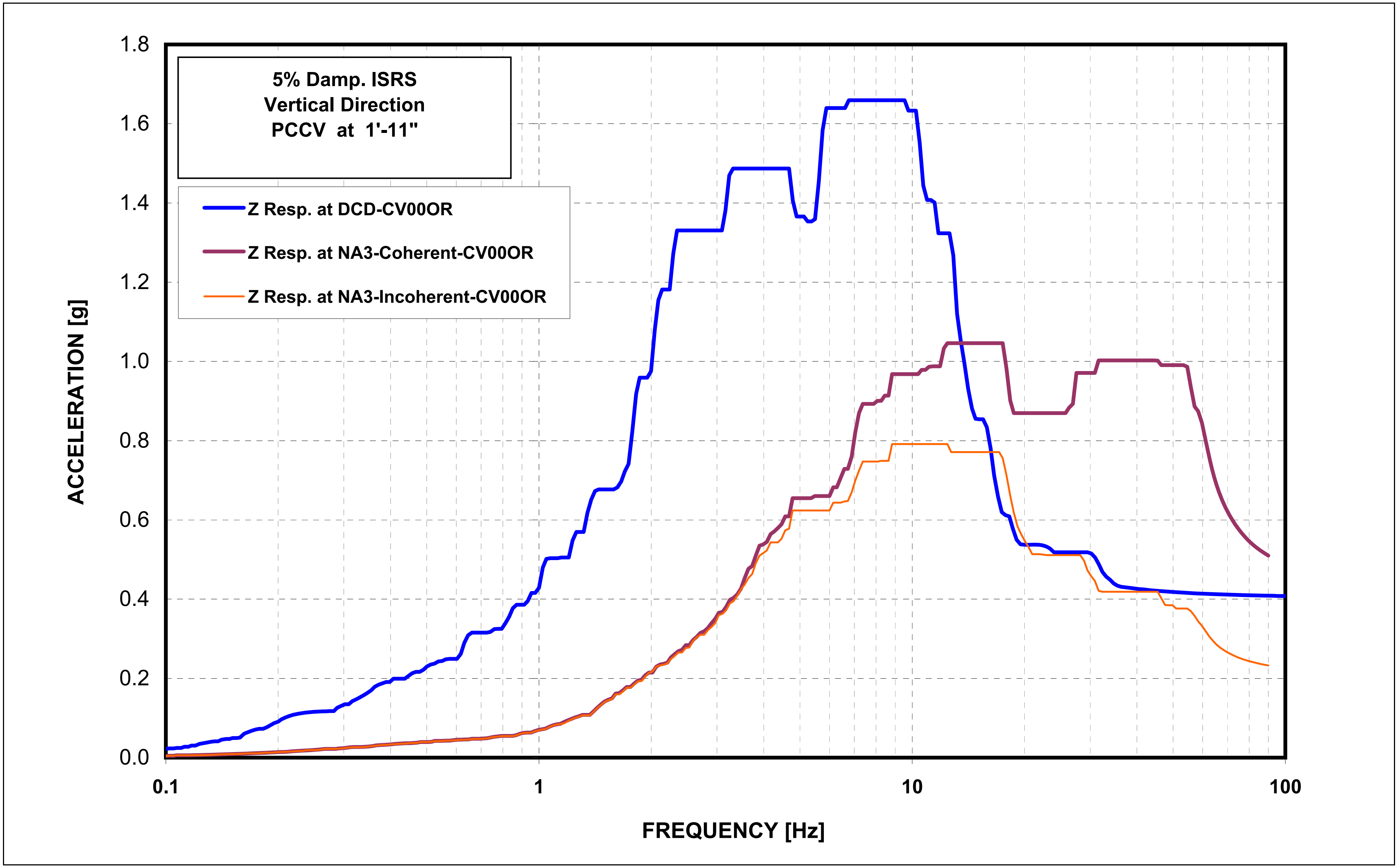


Figure 3NN-23 ISRS for PCCV N-S Direction at CV01 - Elevation 25'-3" (Sheet 78 of 143)

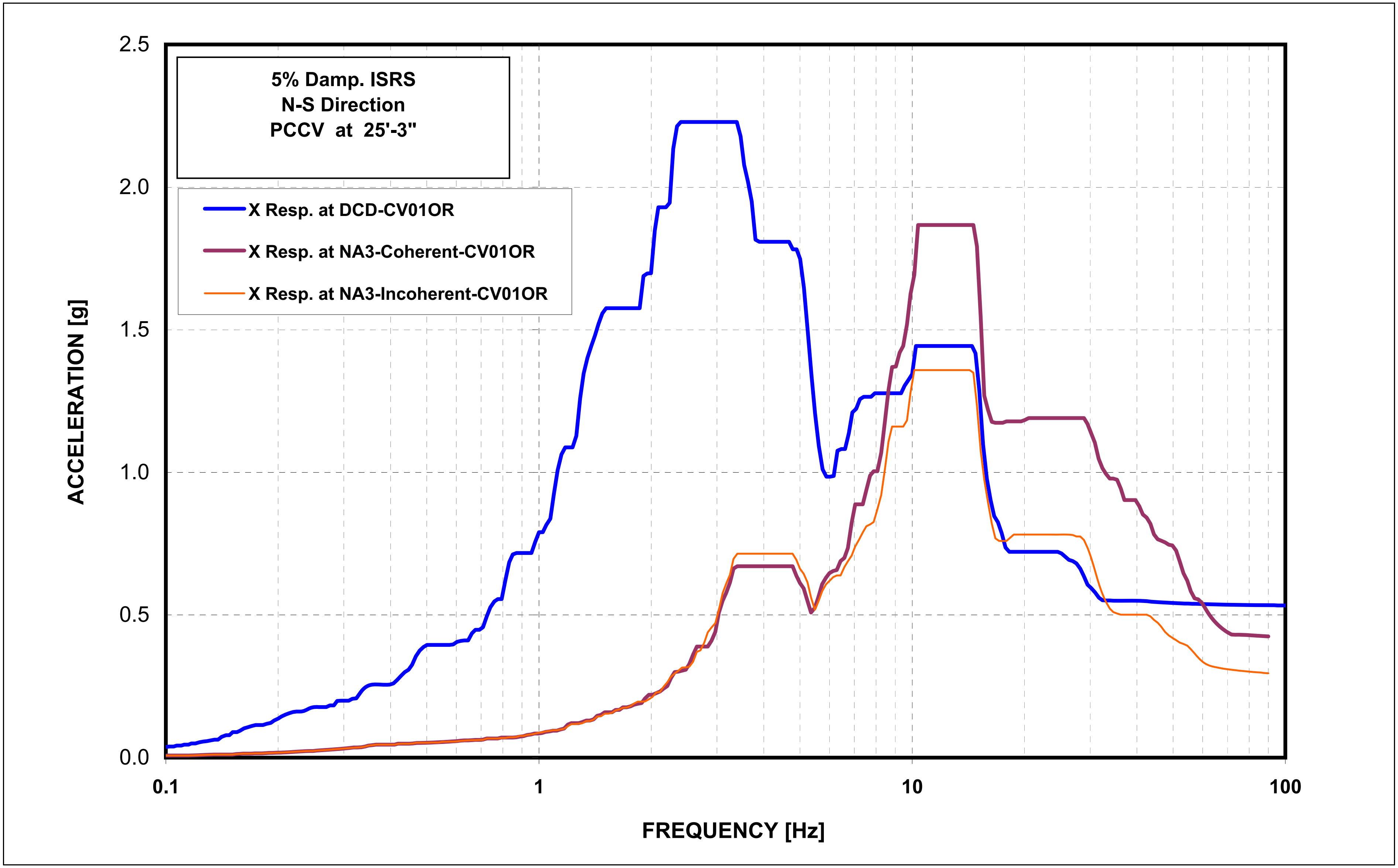


Figure 3NN-23 ISRS for PCCV E-W Direction at CV01 - Elevation 25'-3" (Sheet 79 of 143)

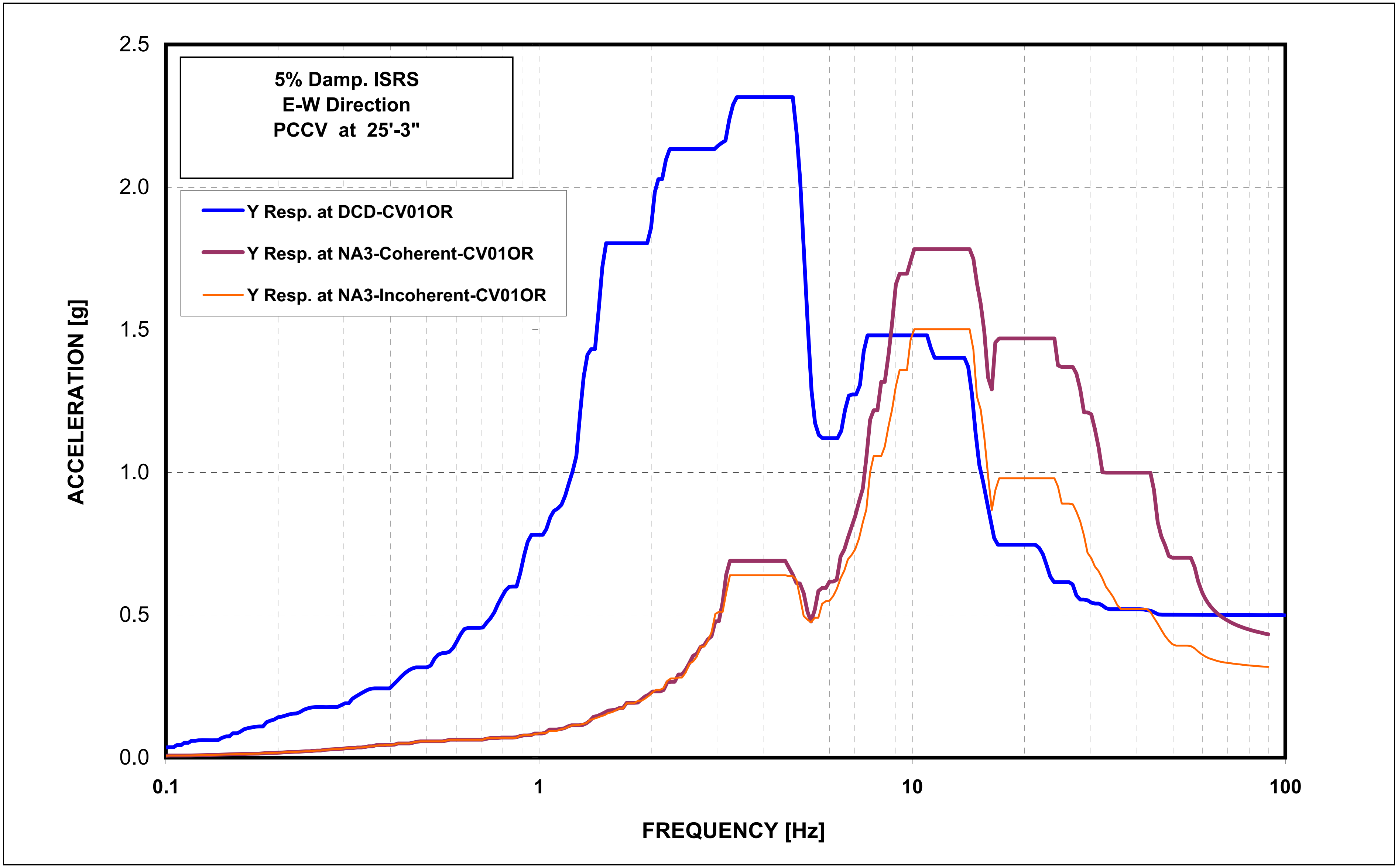


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV01 - Elevation 25'- 3" (Sheet 80 of 143)

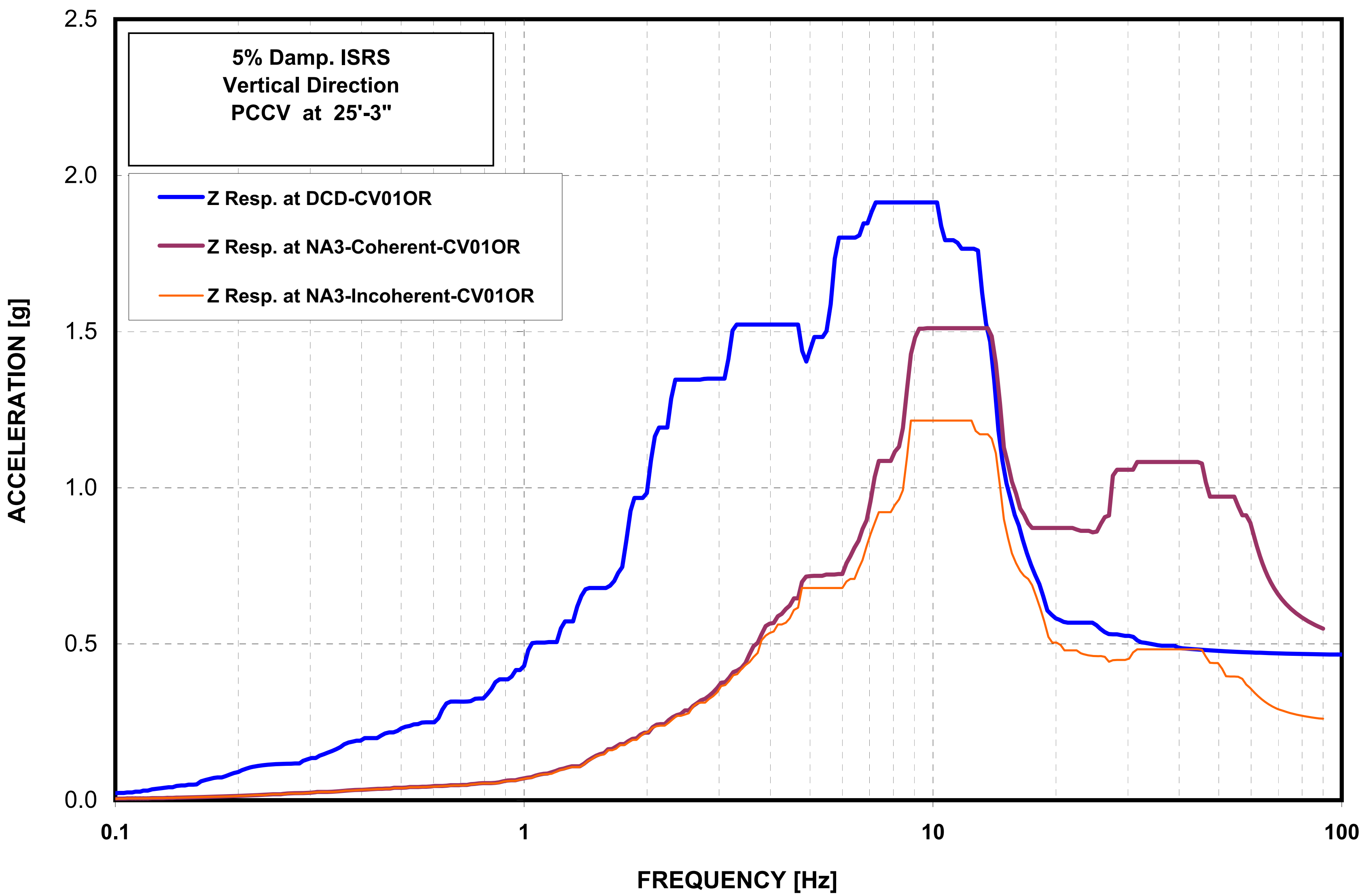


Figure 3NN-23 ISRS for PCCV N-S Direction at CV02 - Elevation 50'-2" (Sheet 81 of 143)

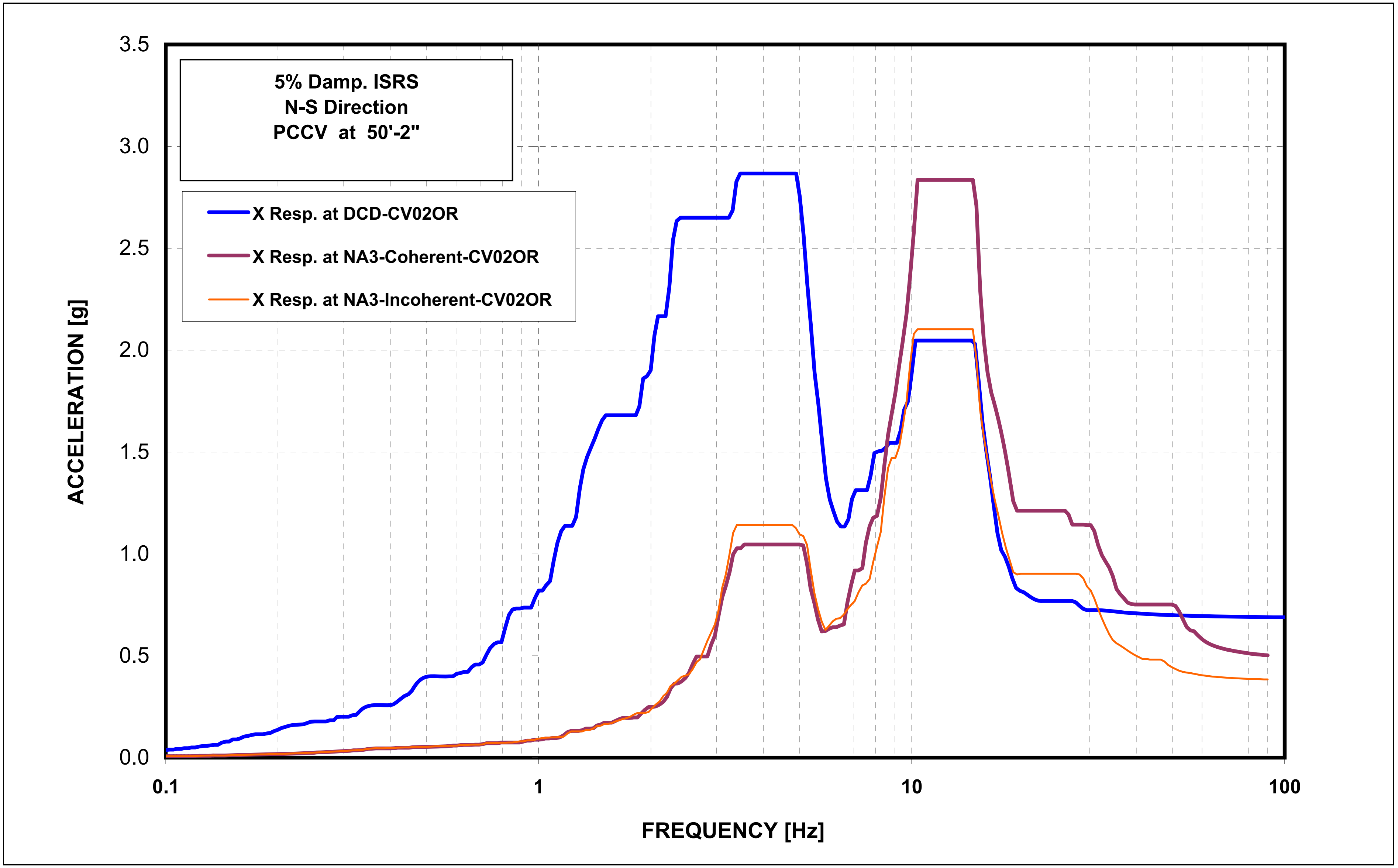


Figure 3NN-23 ISRS for PCCV E-W Direction at CV02 - Elevation 50'-2" (Sheet 82 of 143)

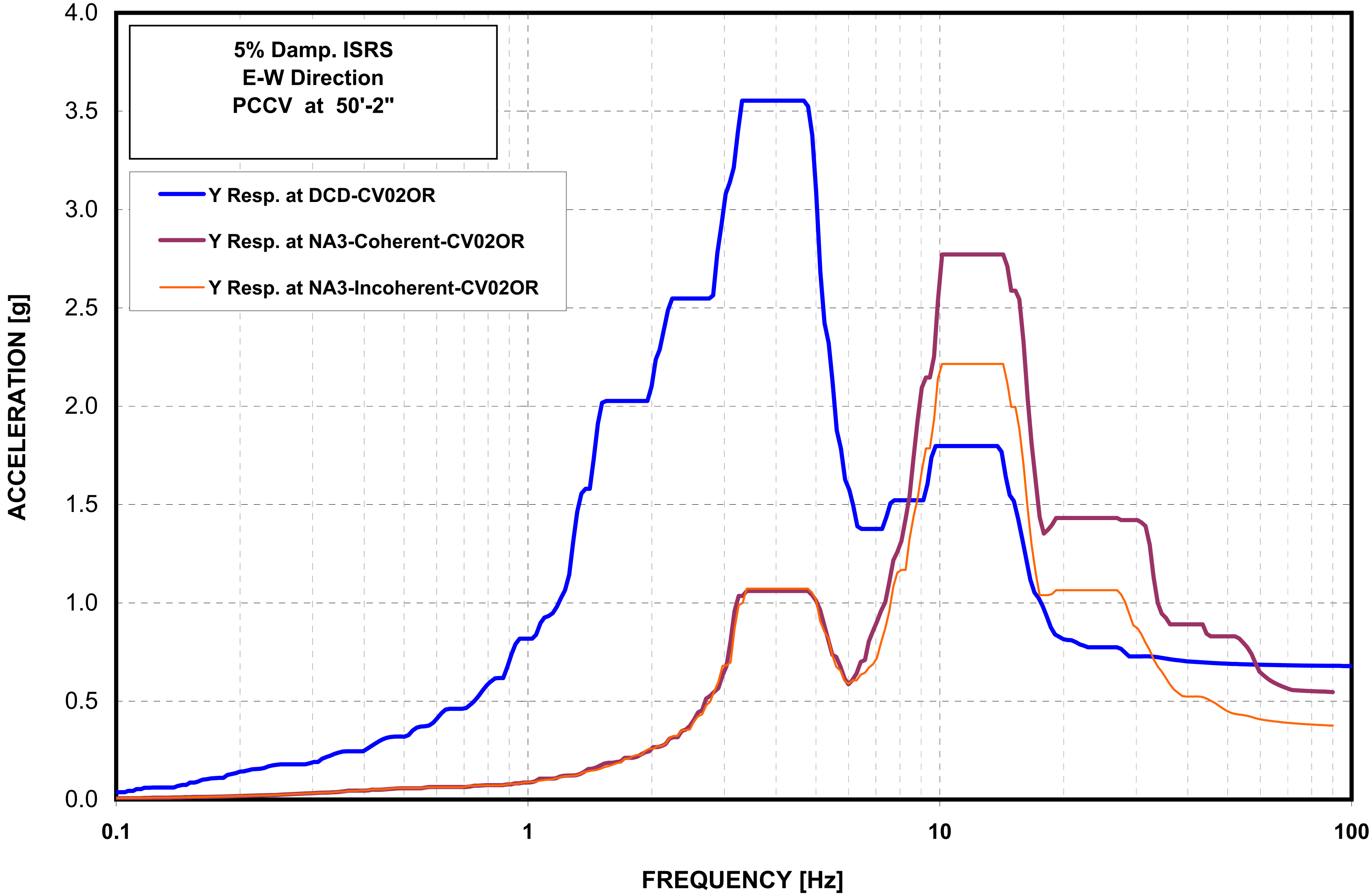


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV02 - Elevation 50'- 2" (Sheet 83 of 143)

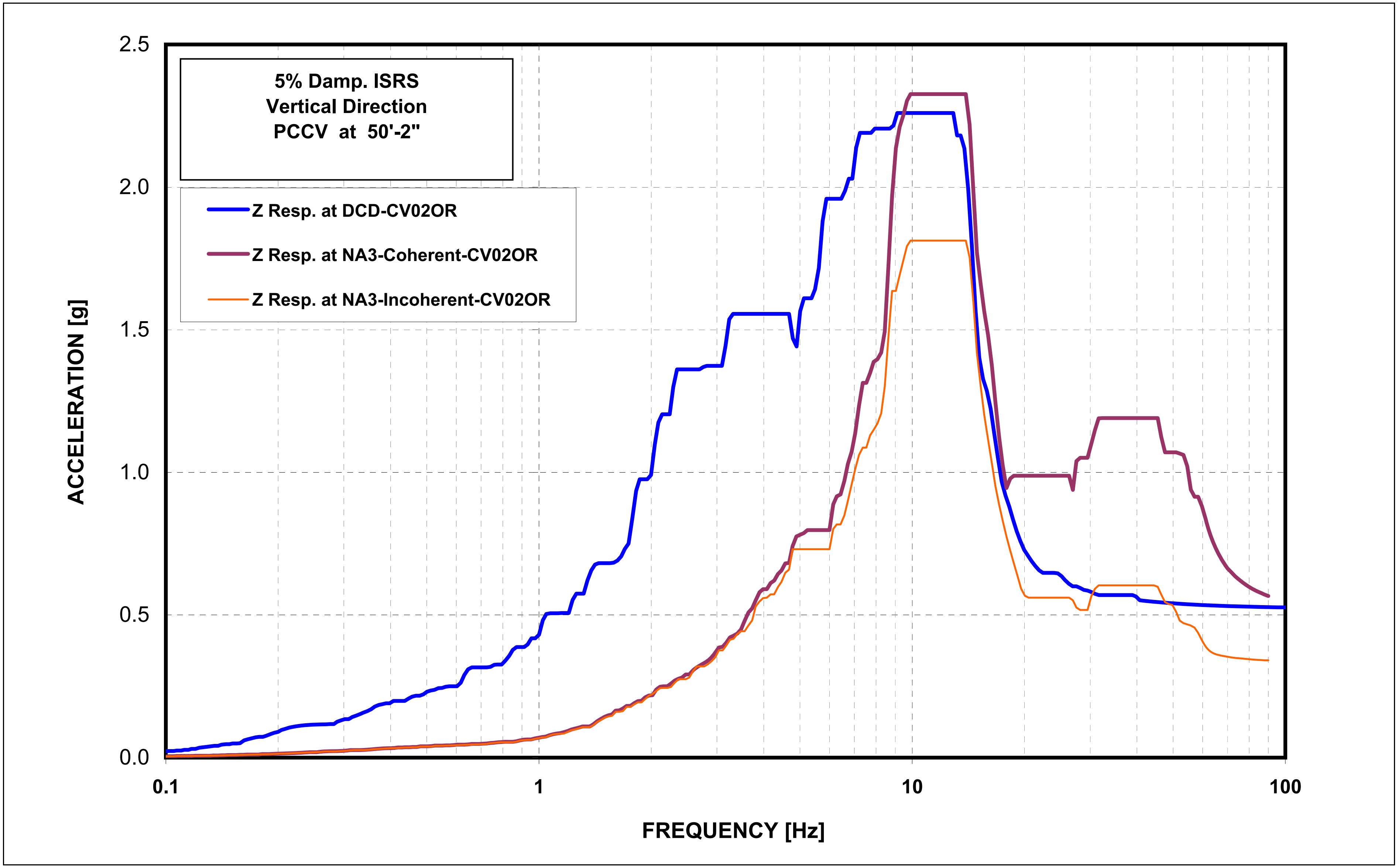


Figure 3NN-23 ISRS for PCCV N-S Direction at CV03 - Elevation 68'- 3" (Sheet 84 of 143)

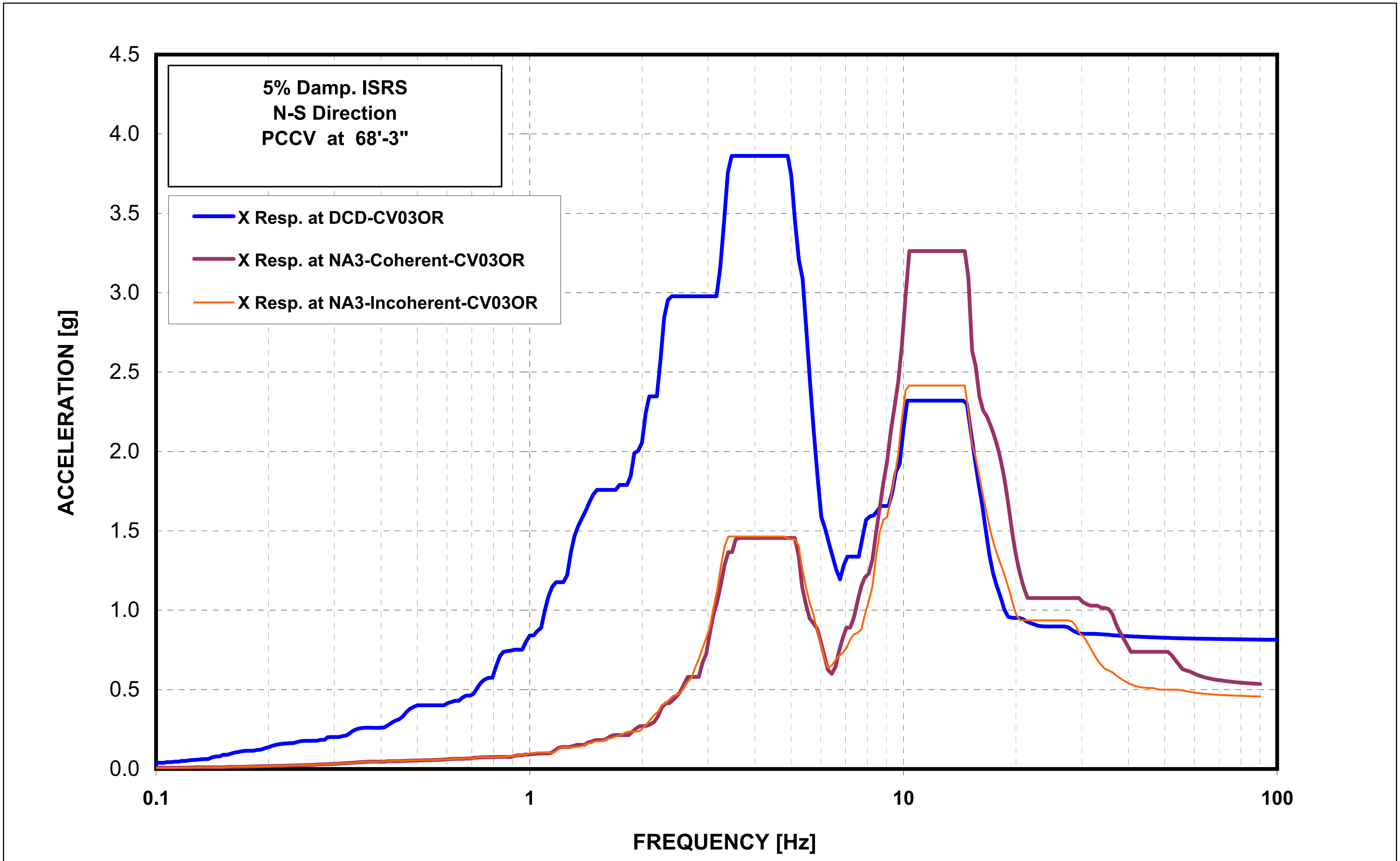


Figure 3NN-23 ISRS for PCCV E-W Direction at CV03 - Elevation 68'-3" (Sheet 85 of 143)

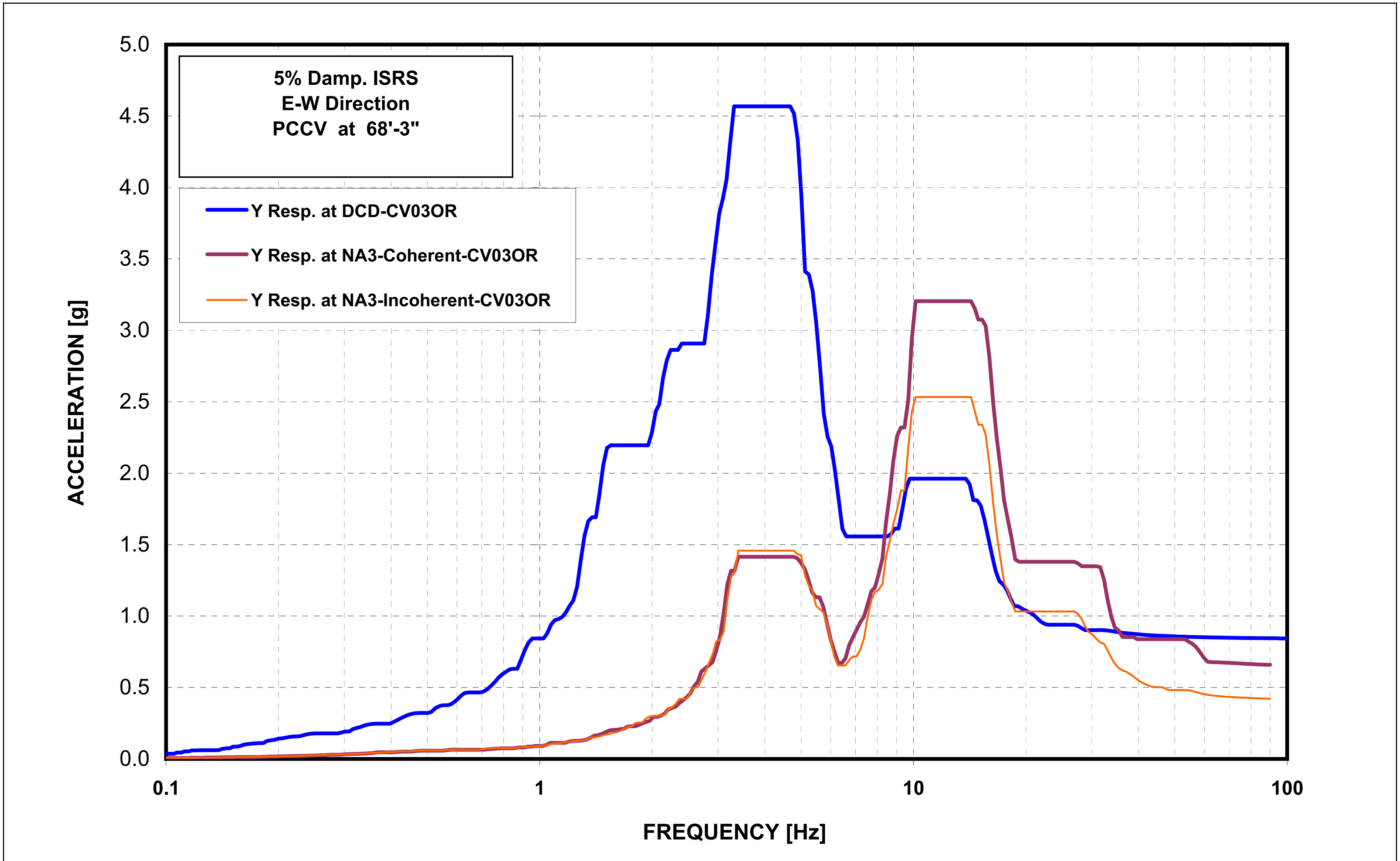


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV03 - Elevation 68'-3" (Sheet 86 of 143)

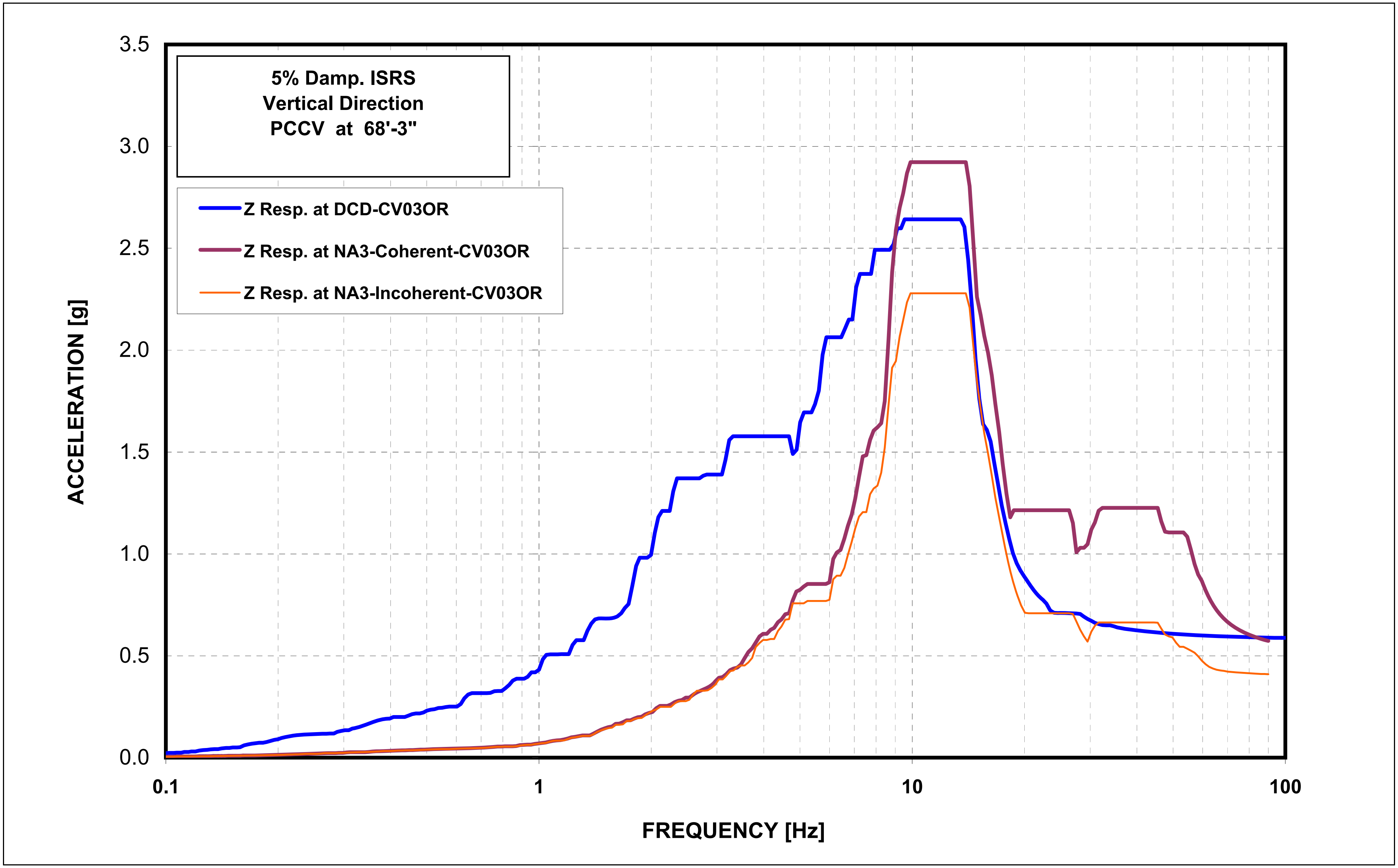


Figure 3NN-23 ISRS for PCCV N-S Direction at CV04 - Elevation 76'- 5" (Sheet 87 of 143)

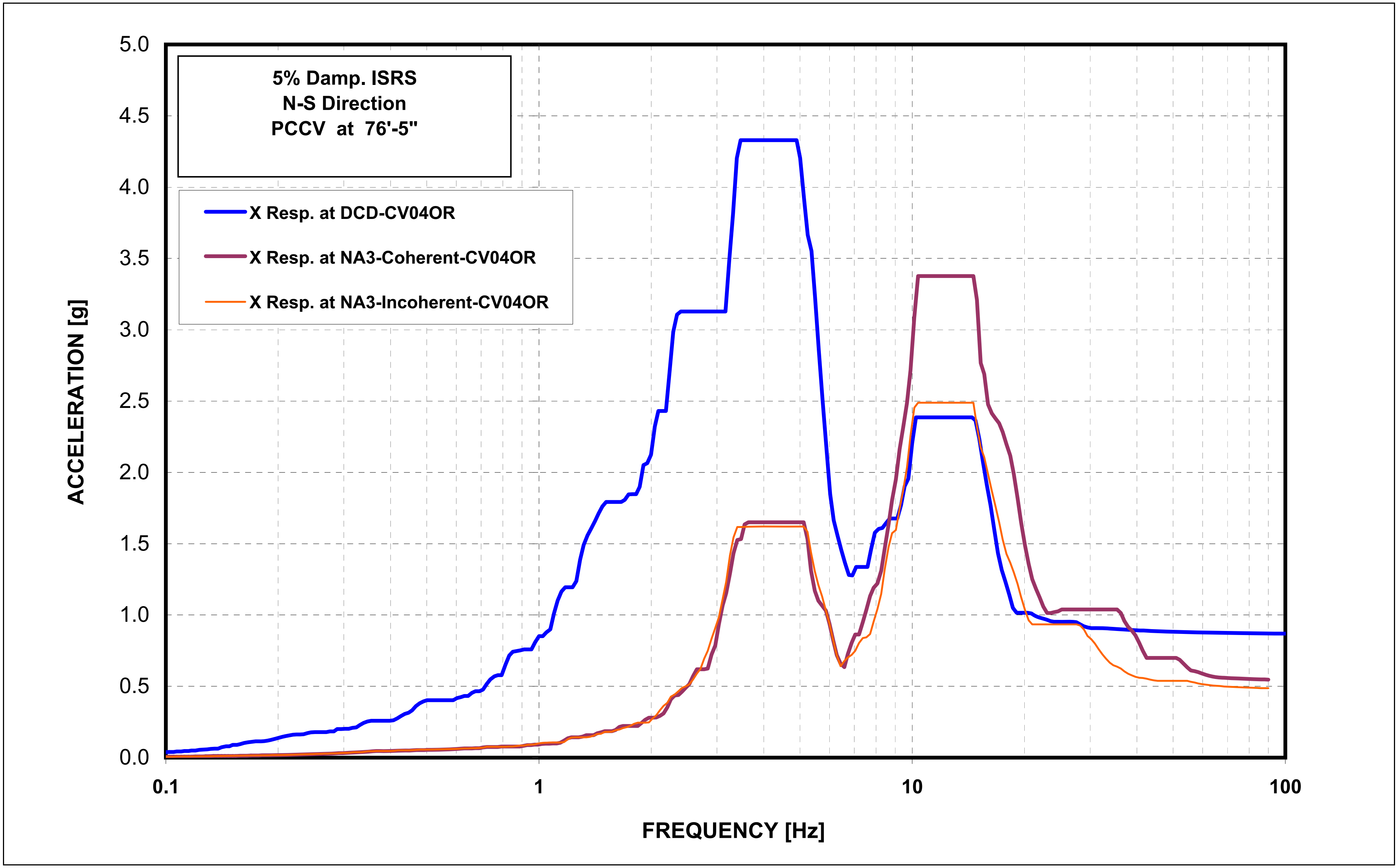


Figure 3NN-23 ISRS for PCCV E-W Direction at CV04 - Elevation 76'-5" (Sheet 88 of 143)

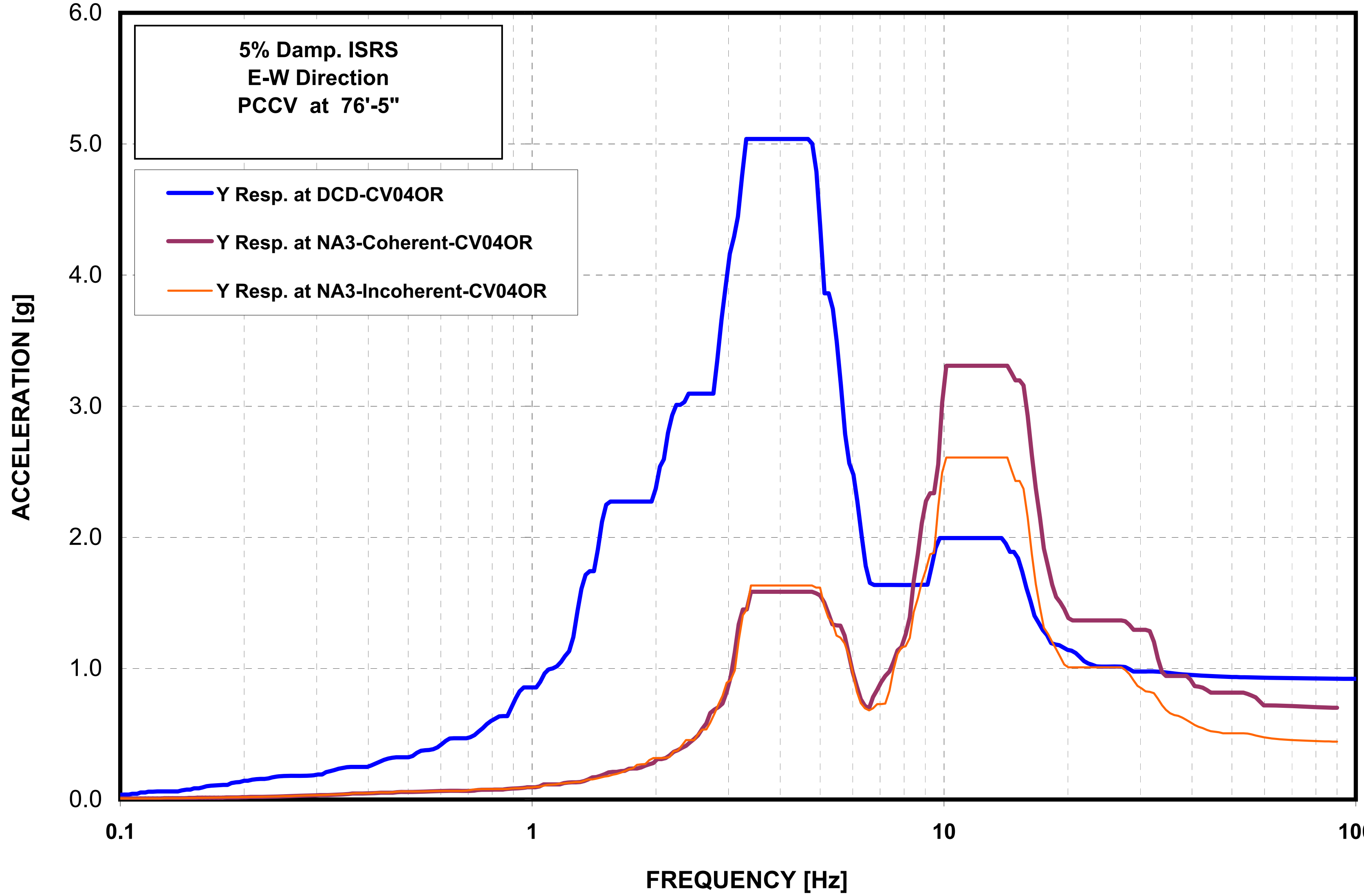


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV04 - Elevation 76'- 5" (Sheet 89 of 143)

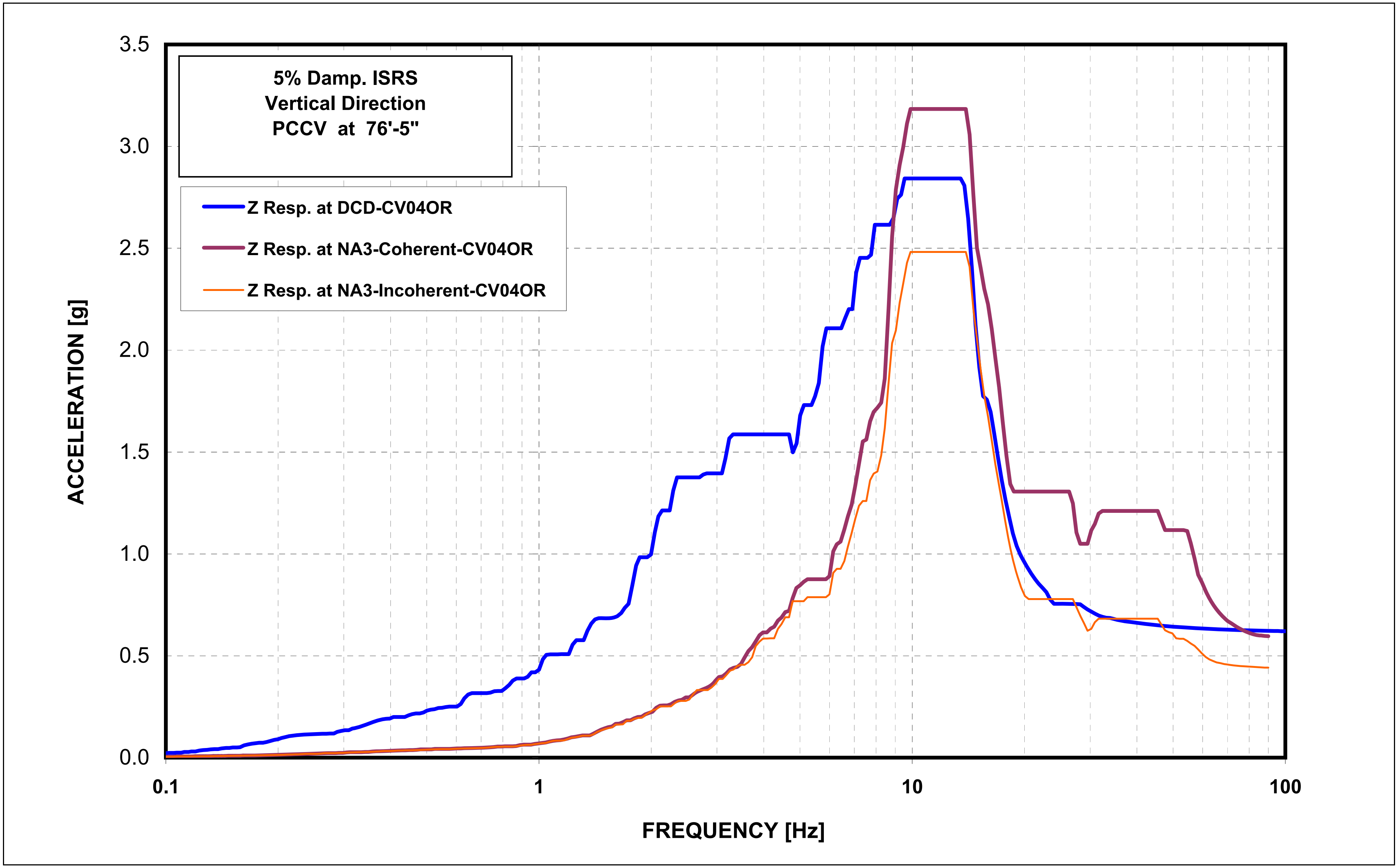


Figure 3NN-23 ISRS for PCCV N-S Direction at CV05 - Elevation 92'-2" (Sheet 90 of 143)

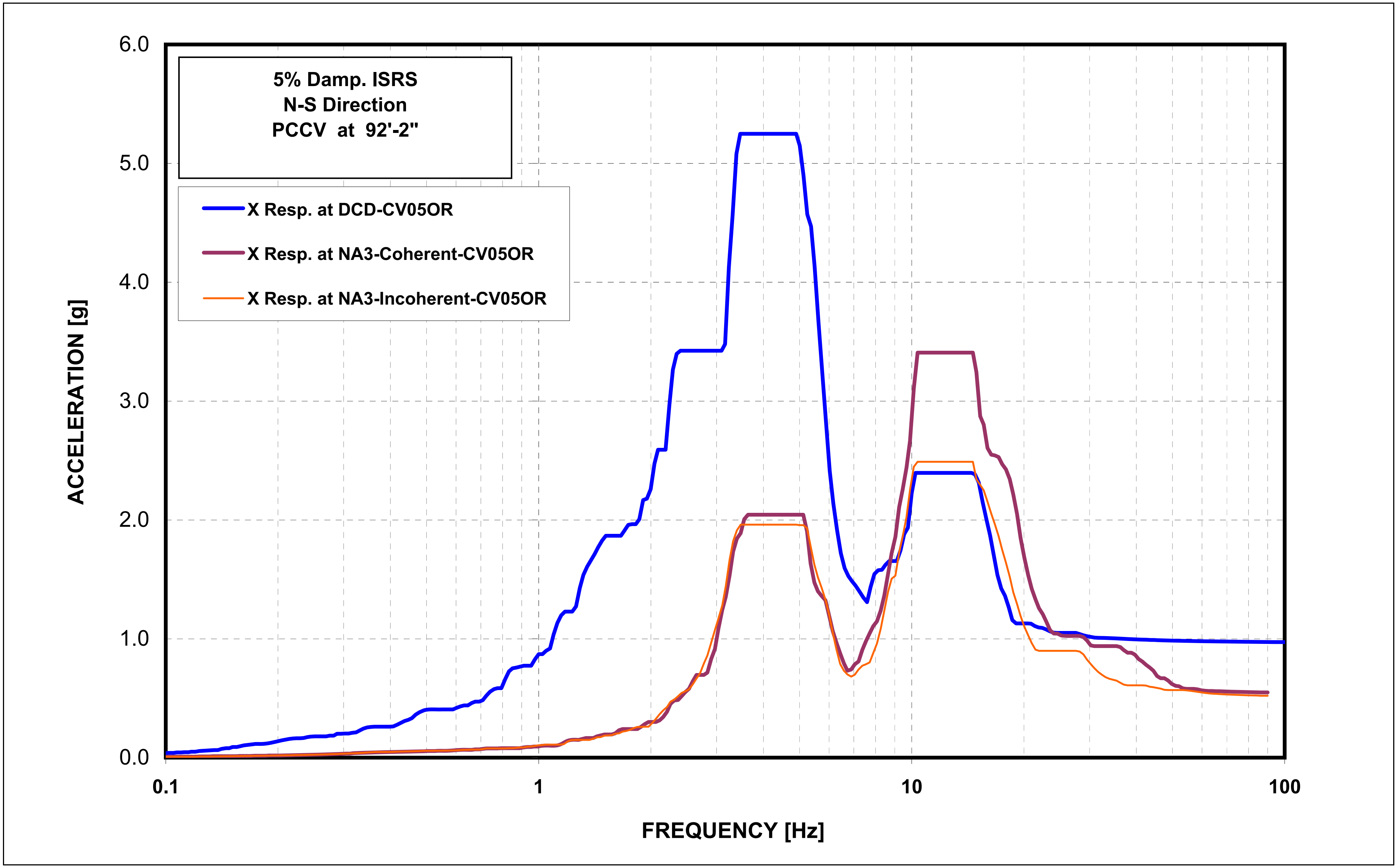


Figure 3NN-23 ISRS for PCCV E-W Direction at CV05 - Elevation 92'-2" (Sheet 91 of 143)

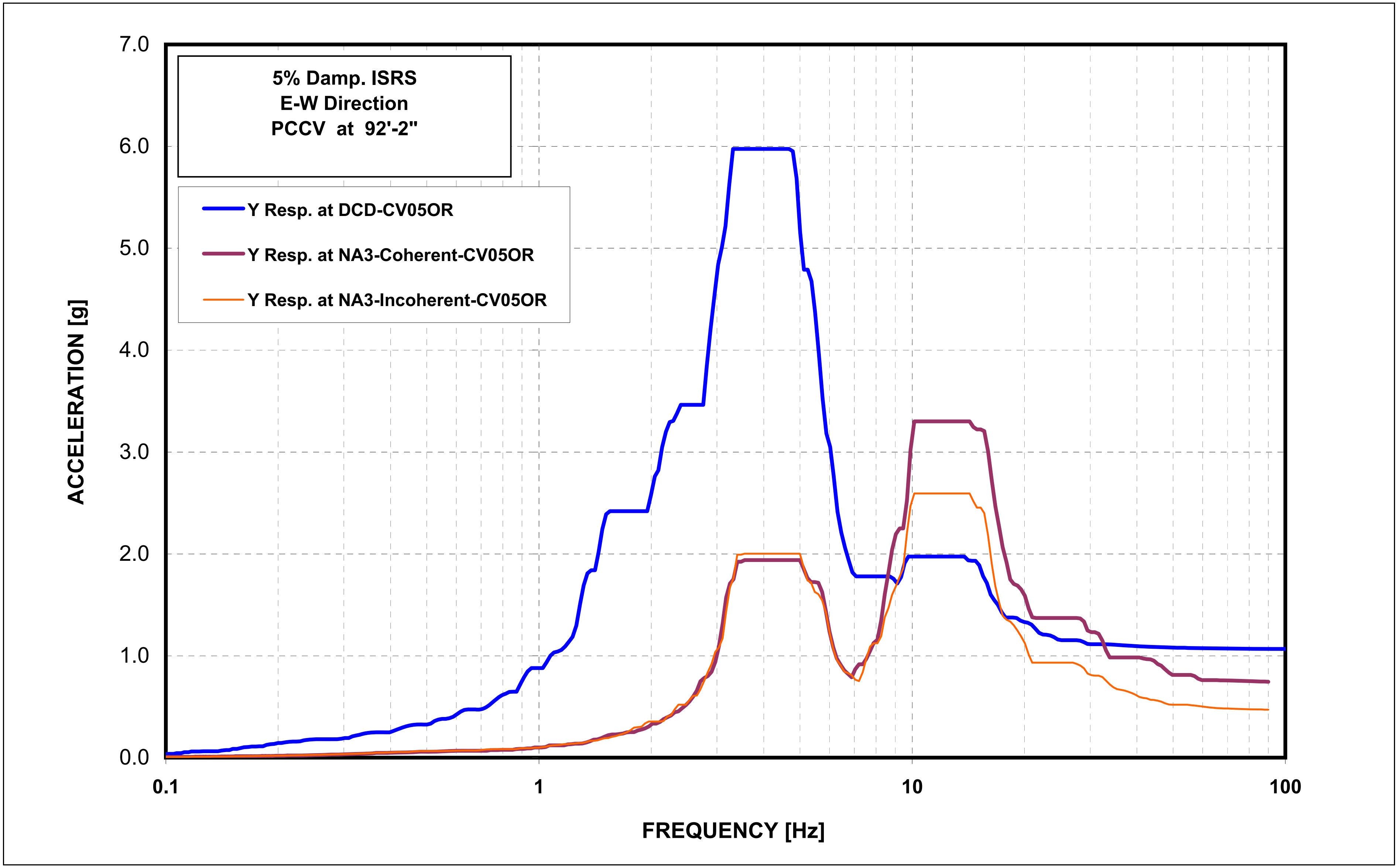


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV05 - Elevation 92'- 2" (Sheet 92 of 143)

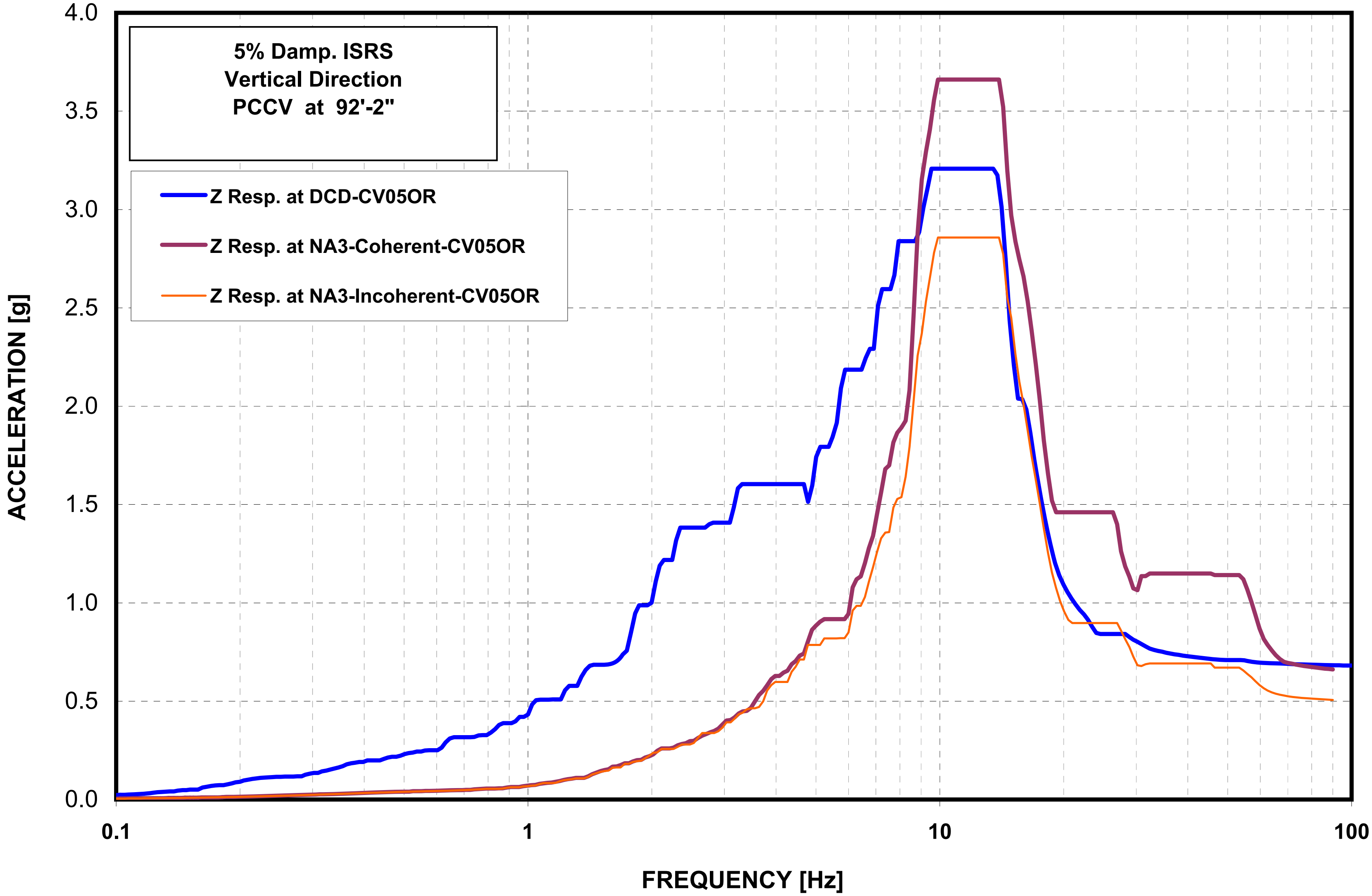


Figure 3NN-23 ISRS for PCCV N-S Direction at CV06 - Elevation 115'- 6" (Sheet 93 of 143)

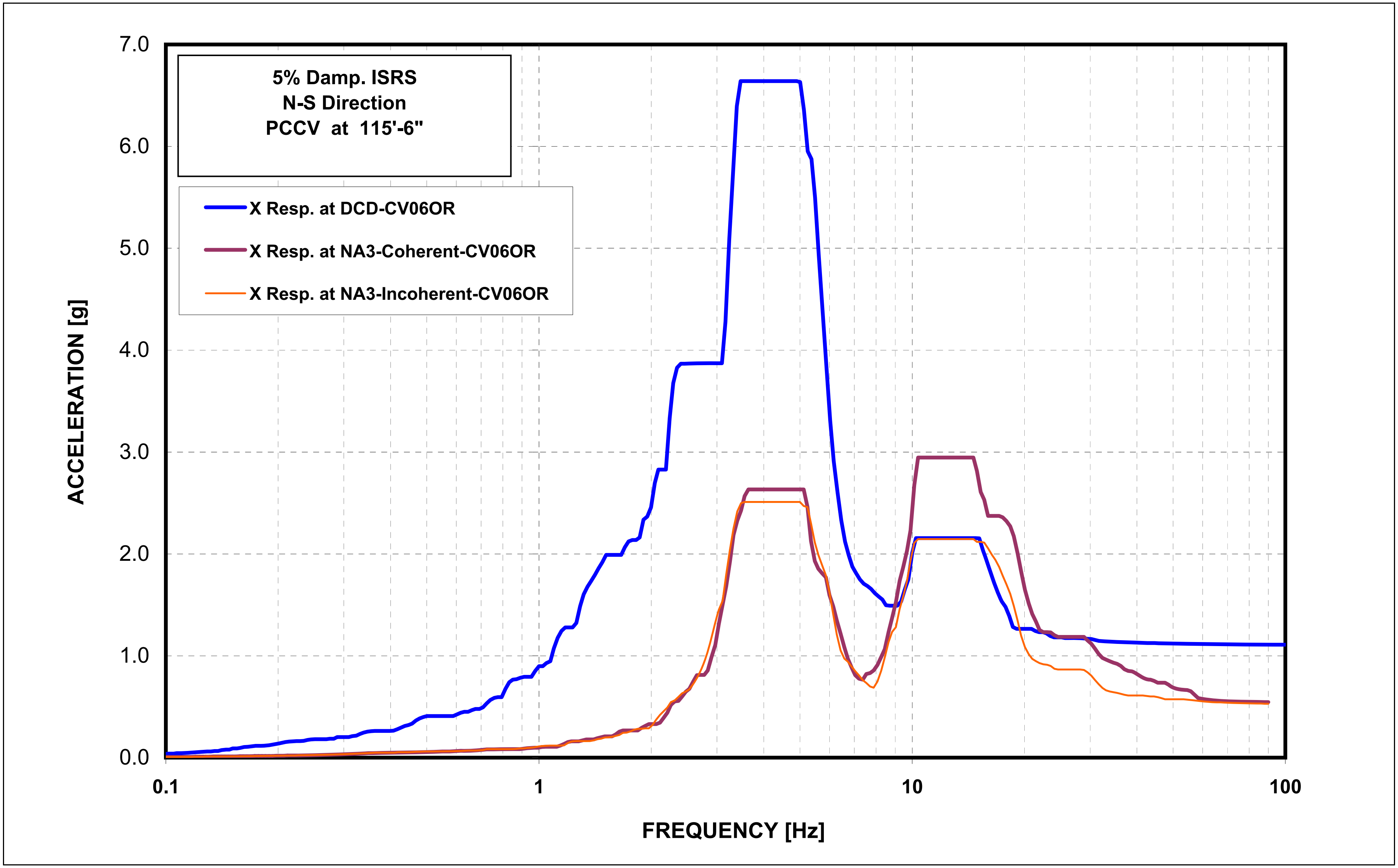


Figure 3NN-23 ISRS for PCCV E-W Direction at CV06 - Elevation 115'-6" (Sheet 94 of 143)

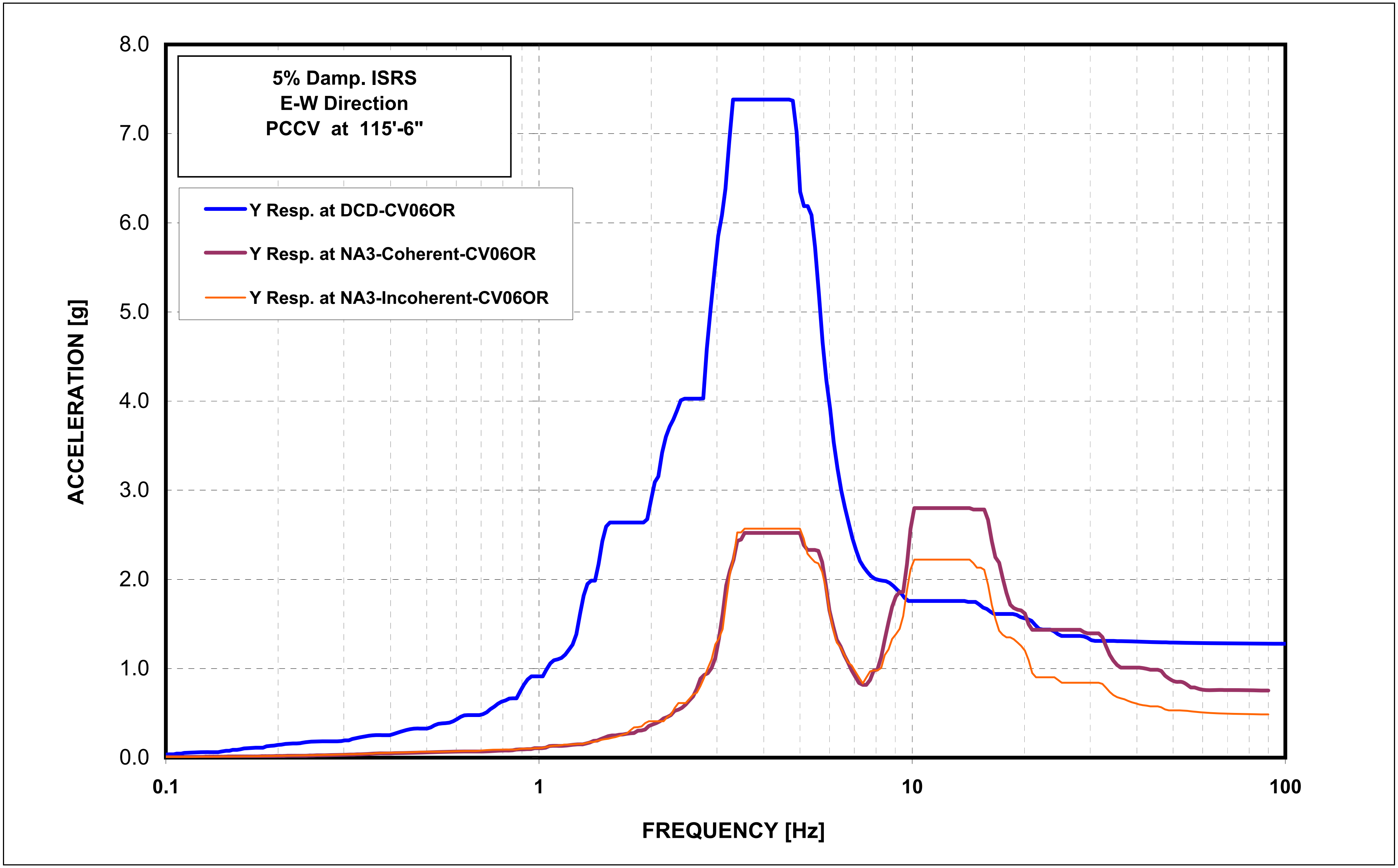


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV06 - Elevation 115'- 6" (Sheet 95 of 143)

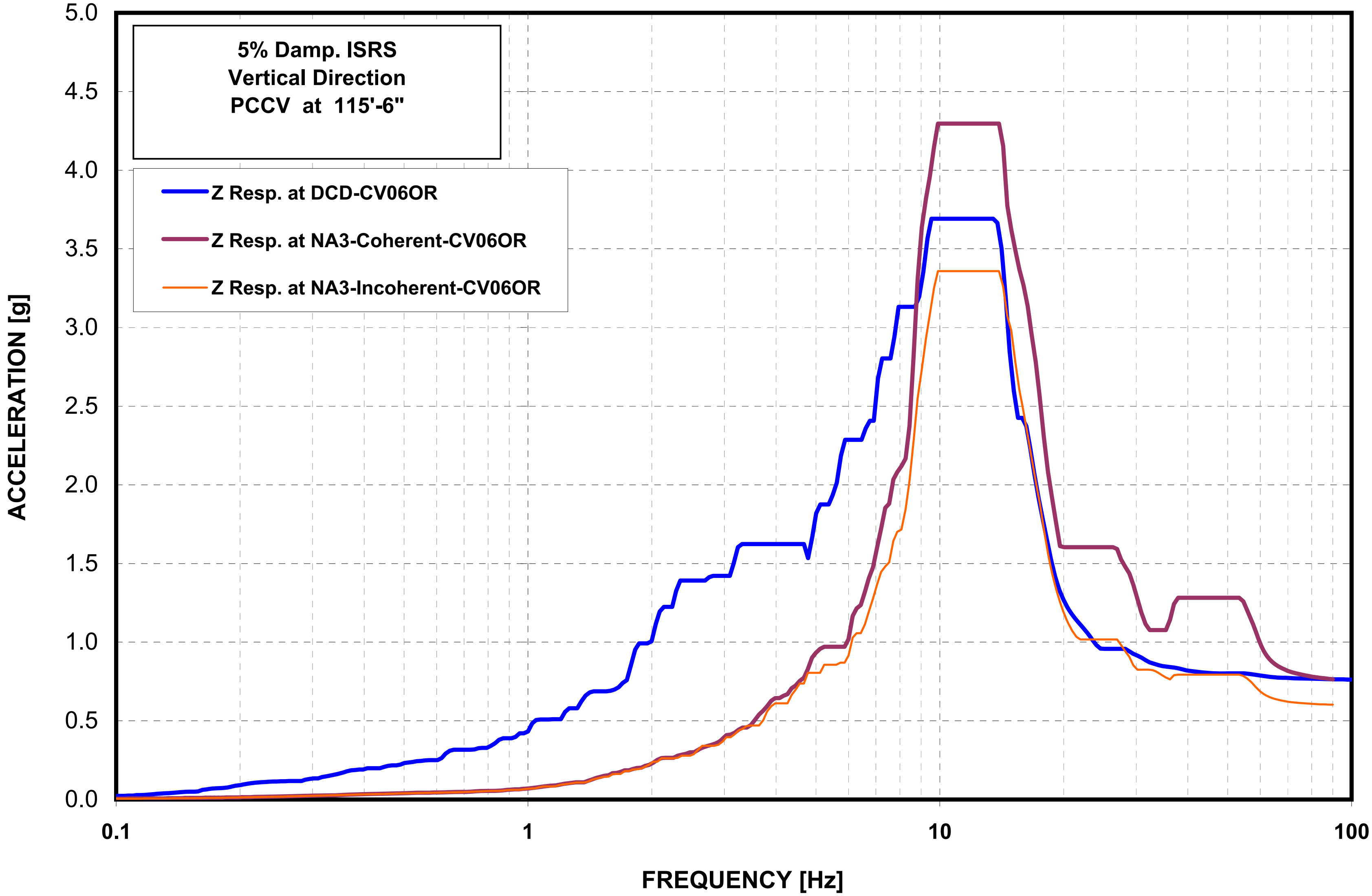


Figure 3NN-23 ISRS for PCCV N-S Direction at CV07 - Elevation 145'-7" (Sheet 96 of 143)

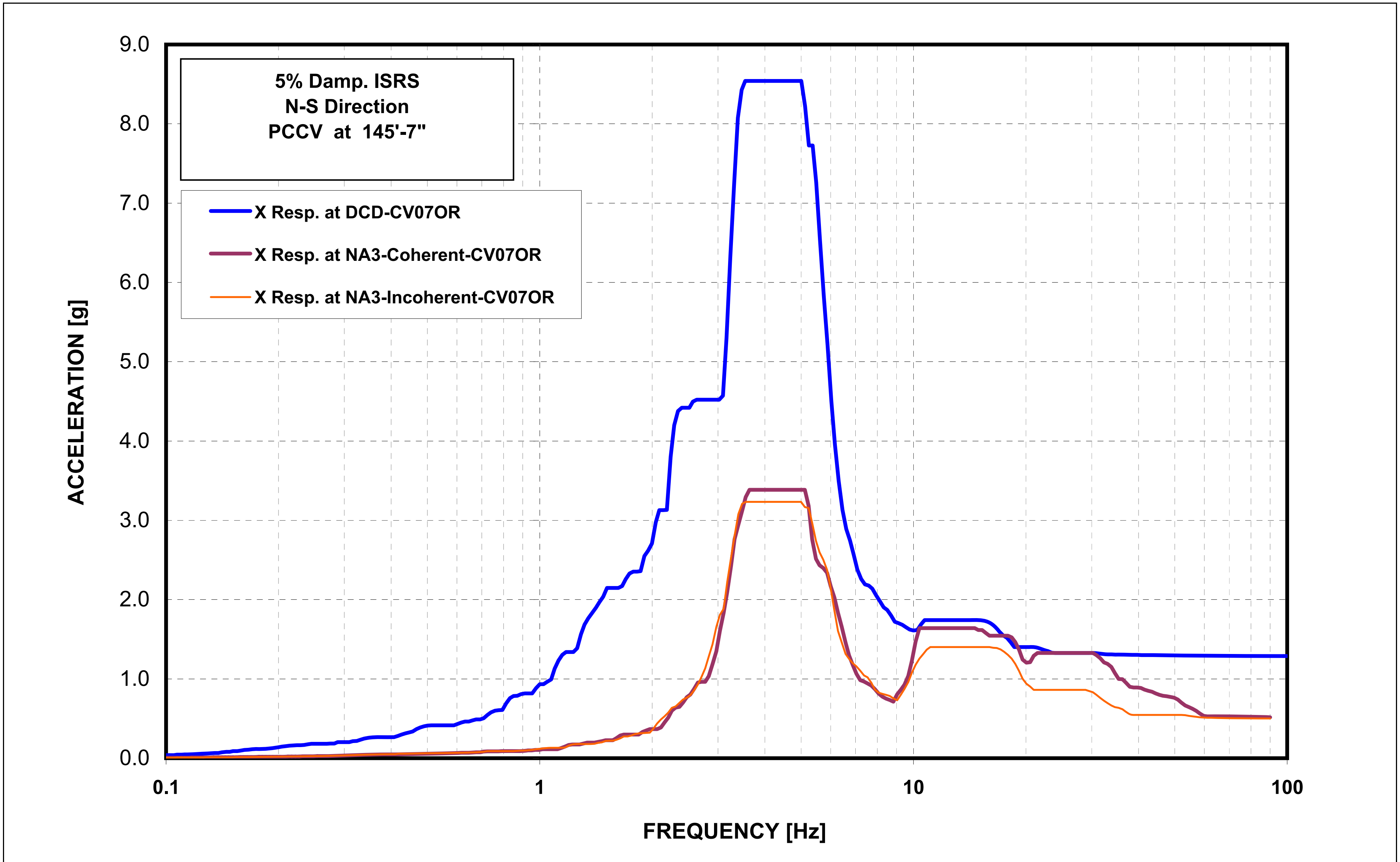


Figure 3NN-23 ISRS for PCCV E-W Direction at CV07 - Elevation 145'-7" (Sheet 97 of 143)

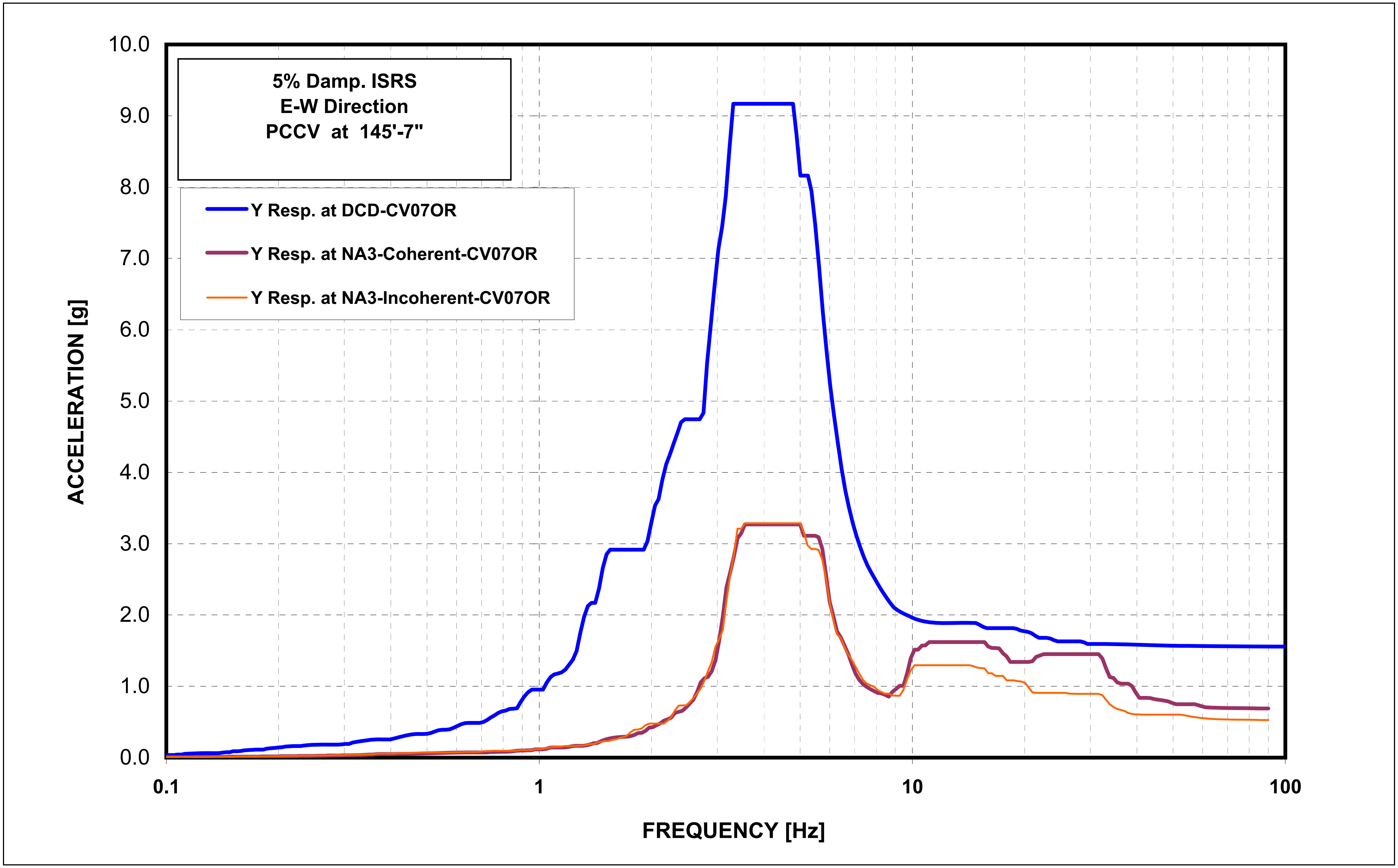


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV07 - Elevation 145'-7" (Sheet 98 of 143)

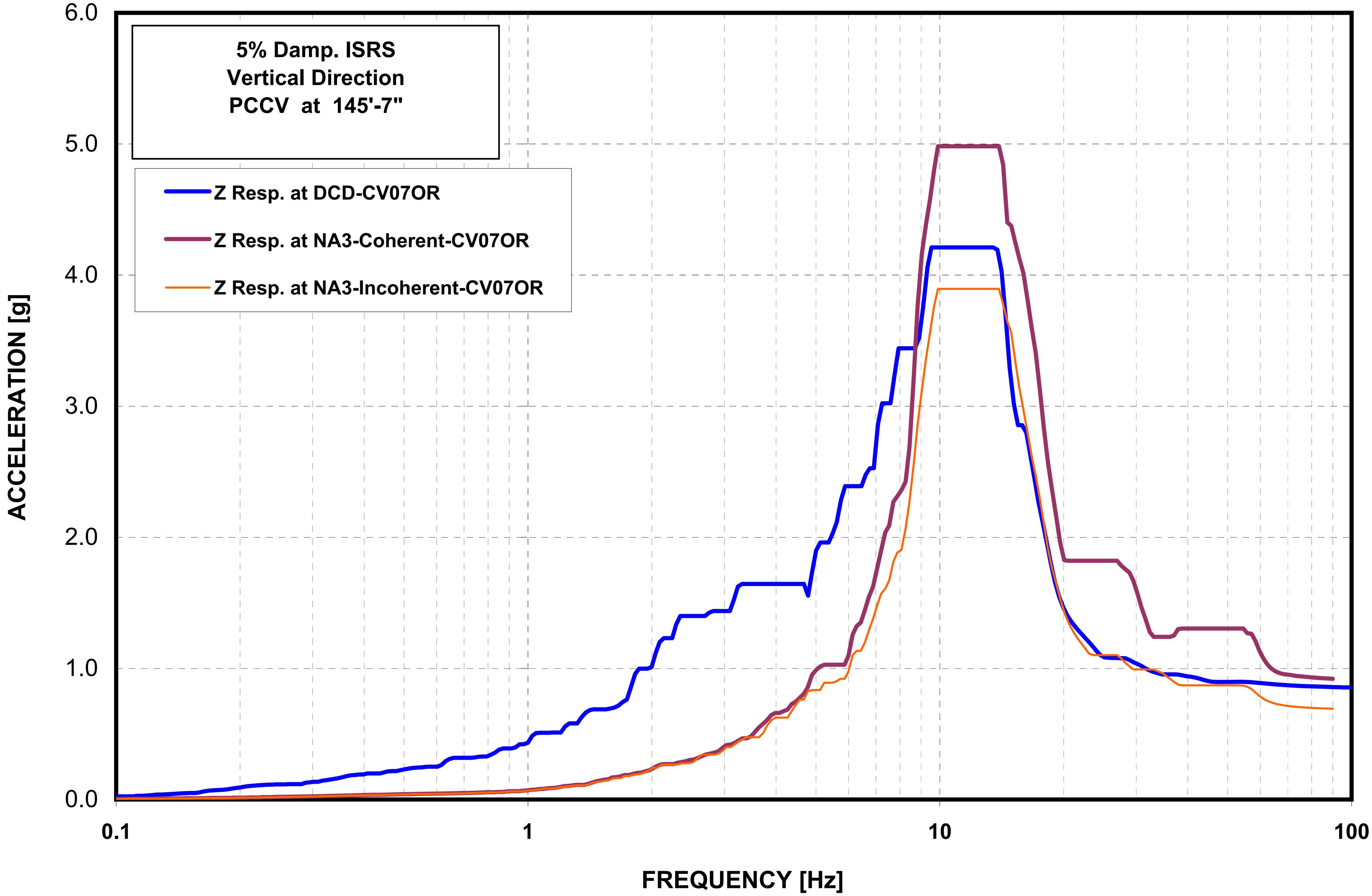


Figure 3NN-23 ISRS for PCCV N-S Direction at CV08 - Elevation 173'- 1" (Sheet 99 of 143)

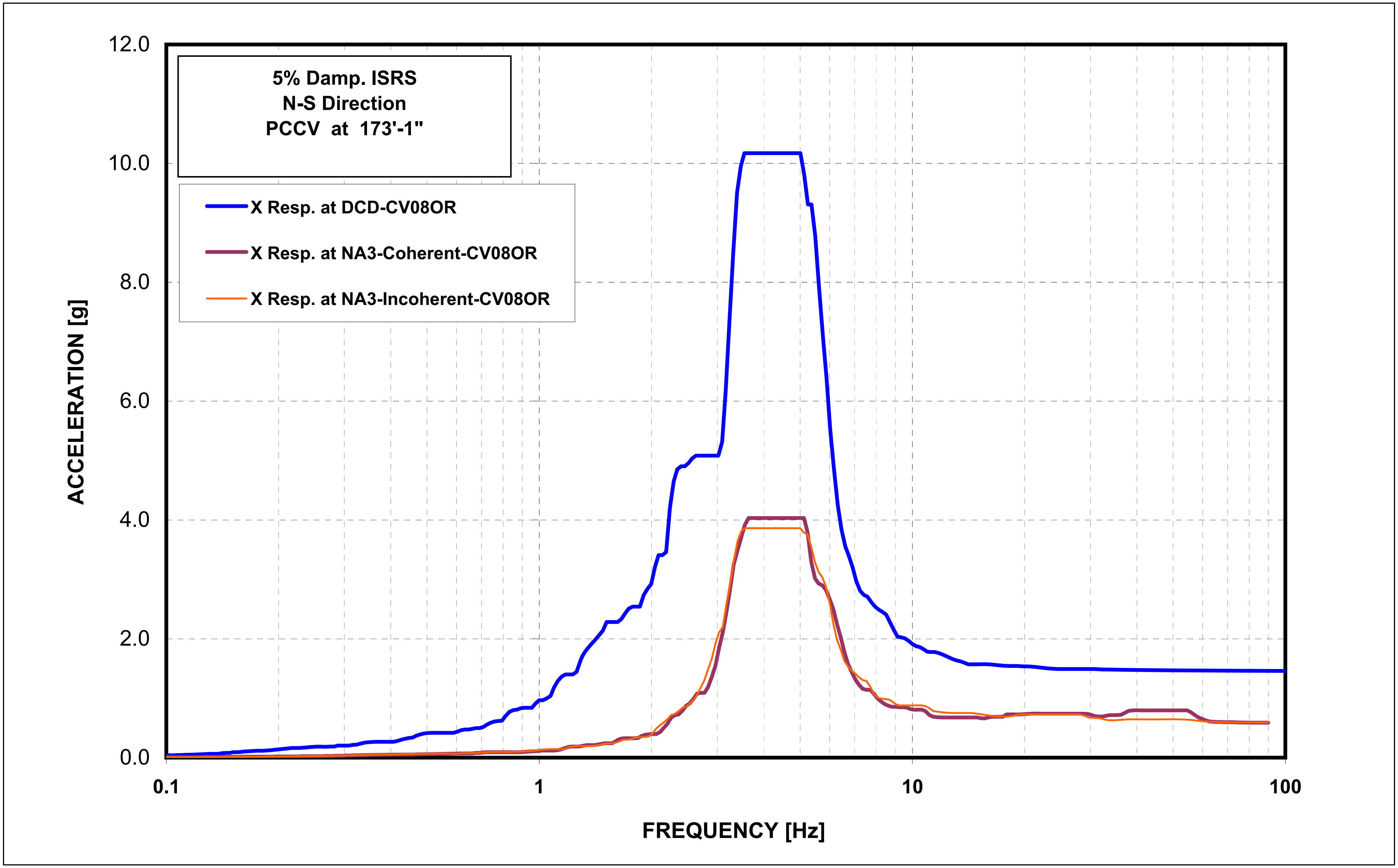


Figure 3NN-23 ISRS for PCCV E-W Direction at CV08 - Elevation 173'-1" (Sheet 100 of 143)

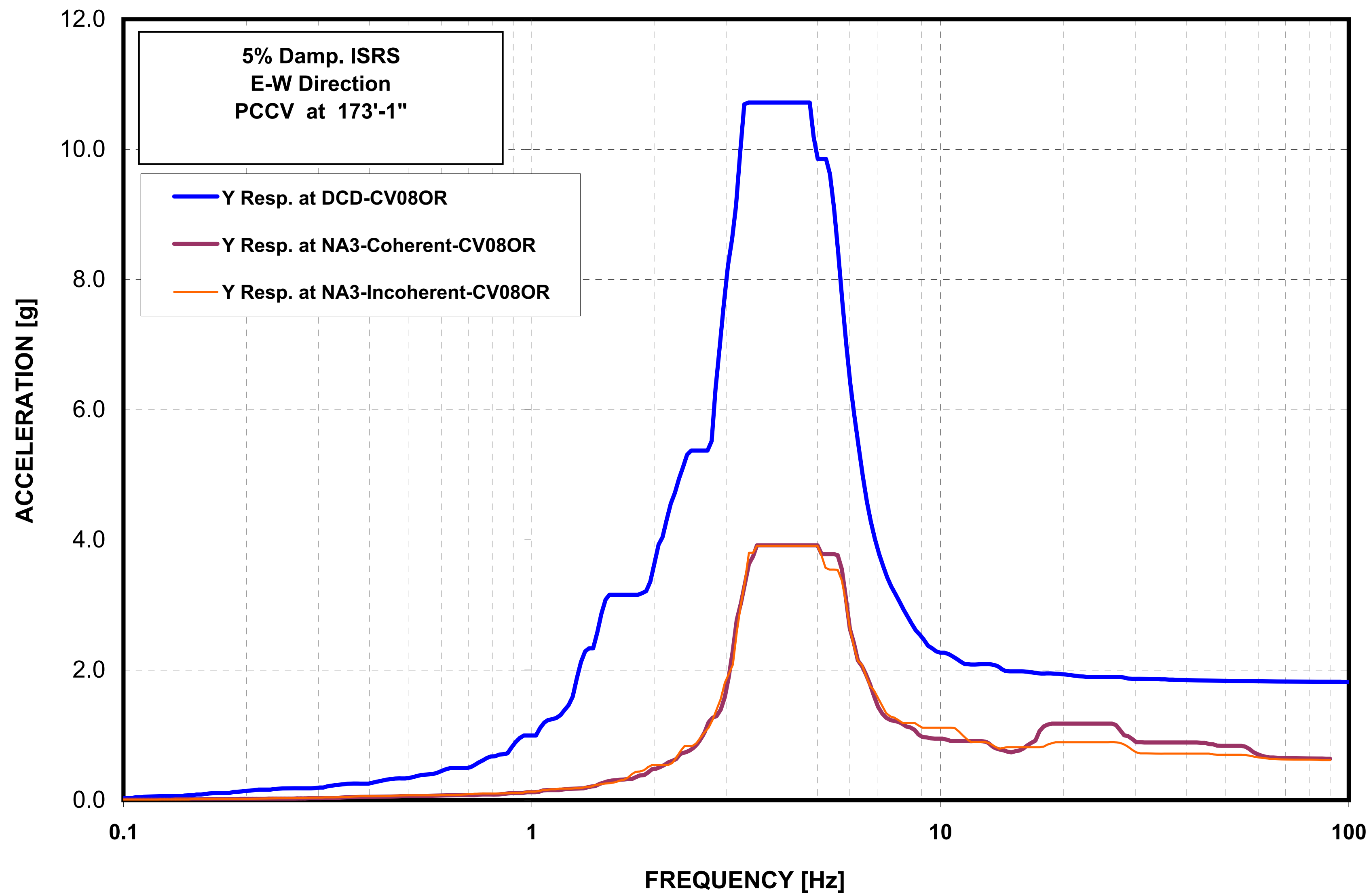


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV08 - Elevation 173'- 1" (Sheet 101 of 143)

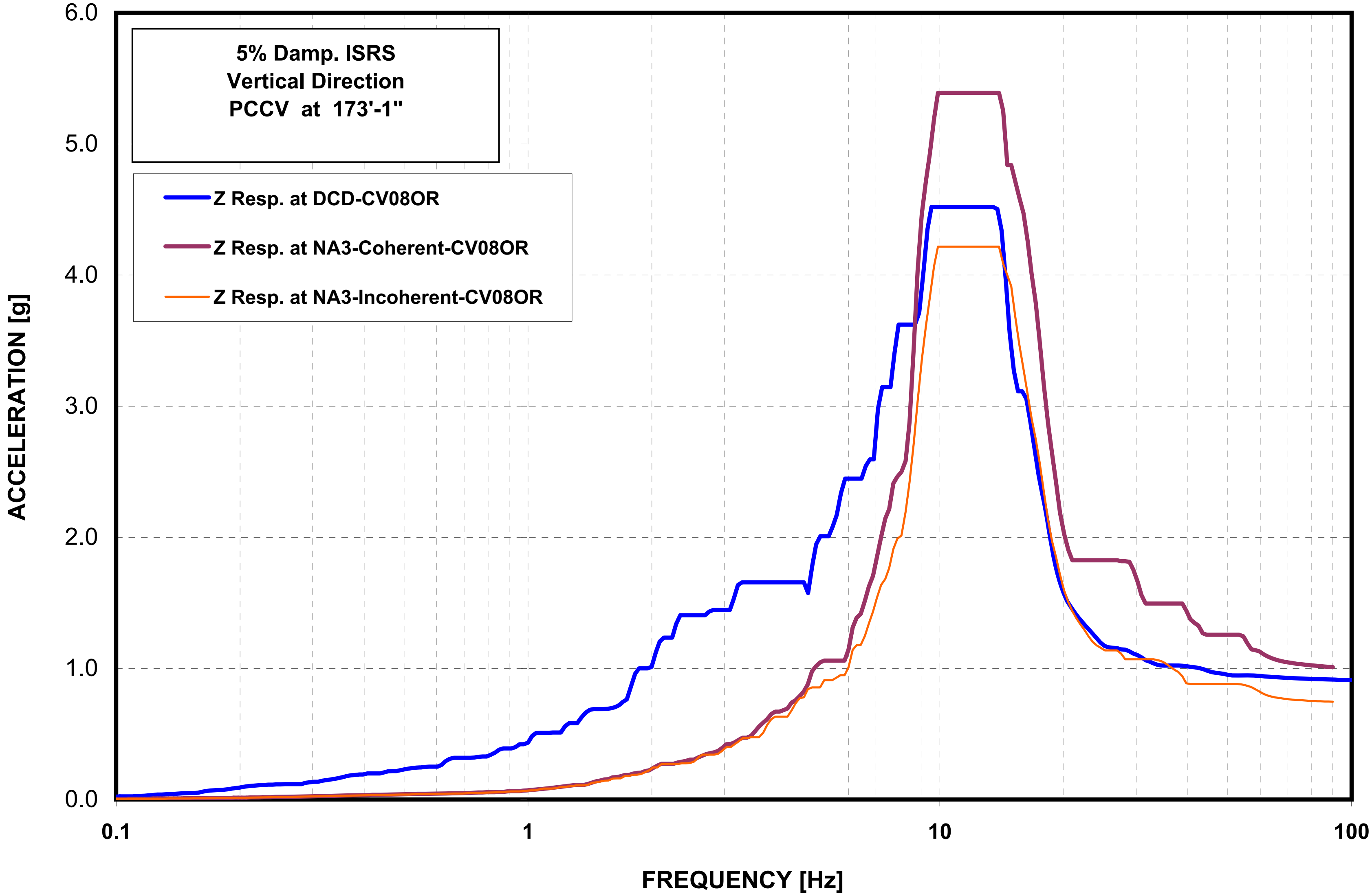


Figure 3NN-23 ISRS for PCCV N-S Direction at CV09 - Elevation 201'- 8" (Sheet 102 of 143)

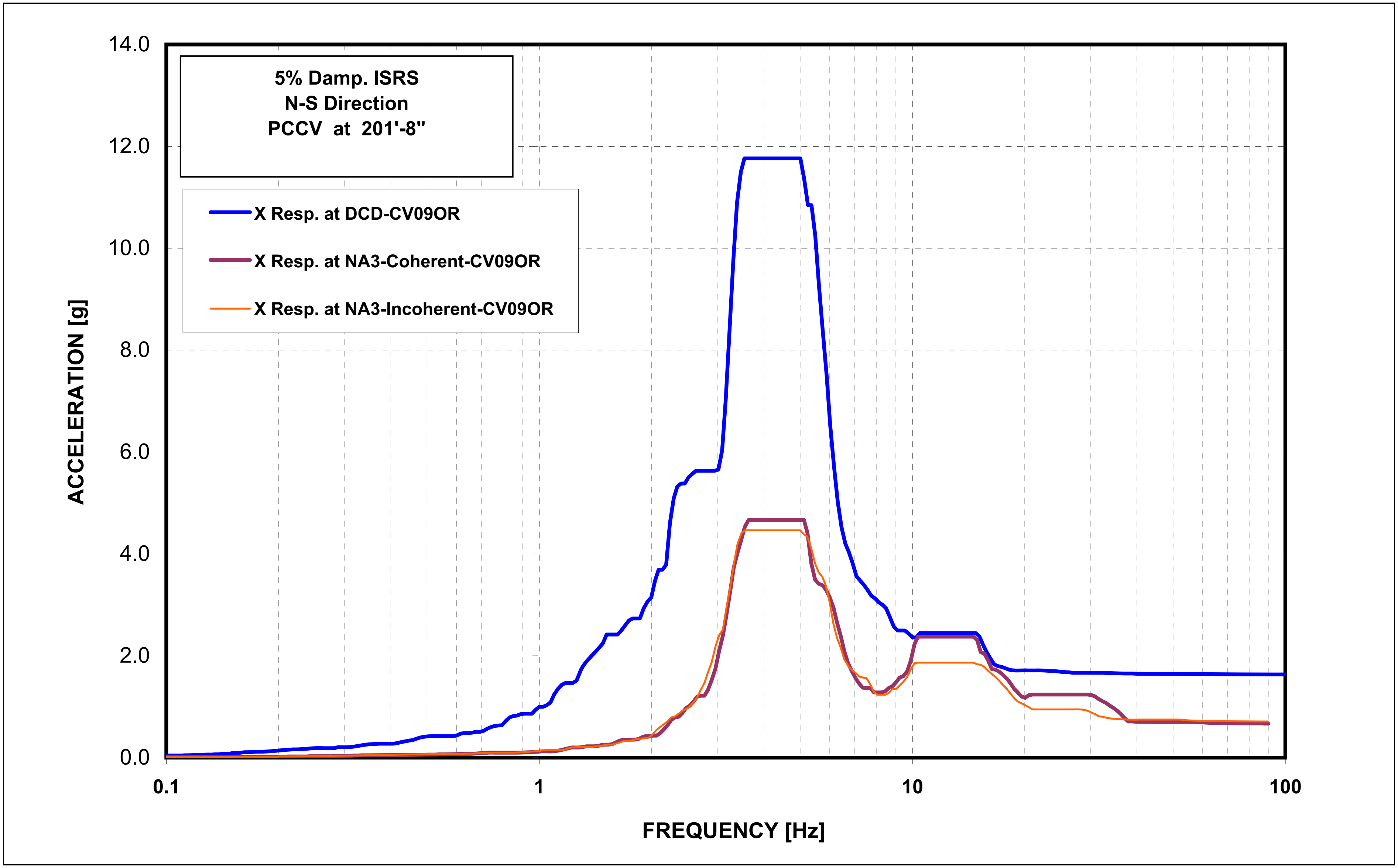


Figure 3NN-23 ISRS for PCCV E-W Direction at CV09 - Elevation 201'-8" (Sheet 103 of 143)

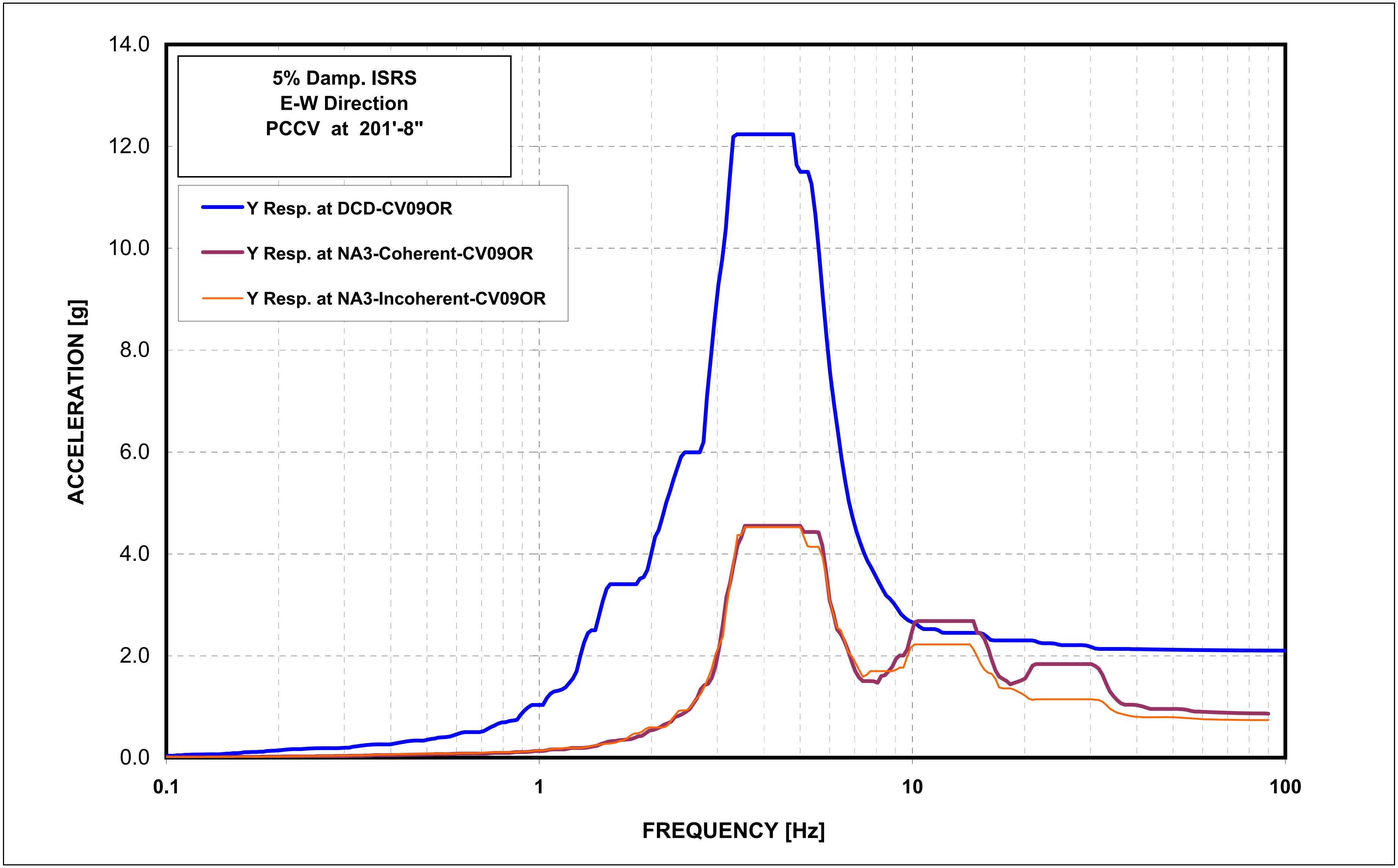


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV09 - Elevation 201'-8" (Sheet 104 of 143)

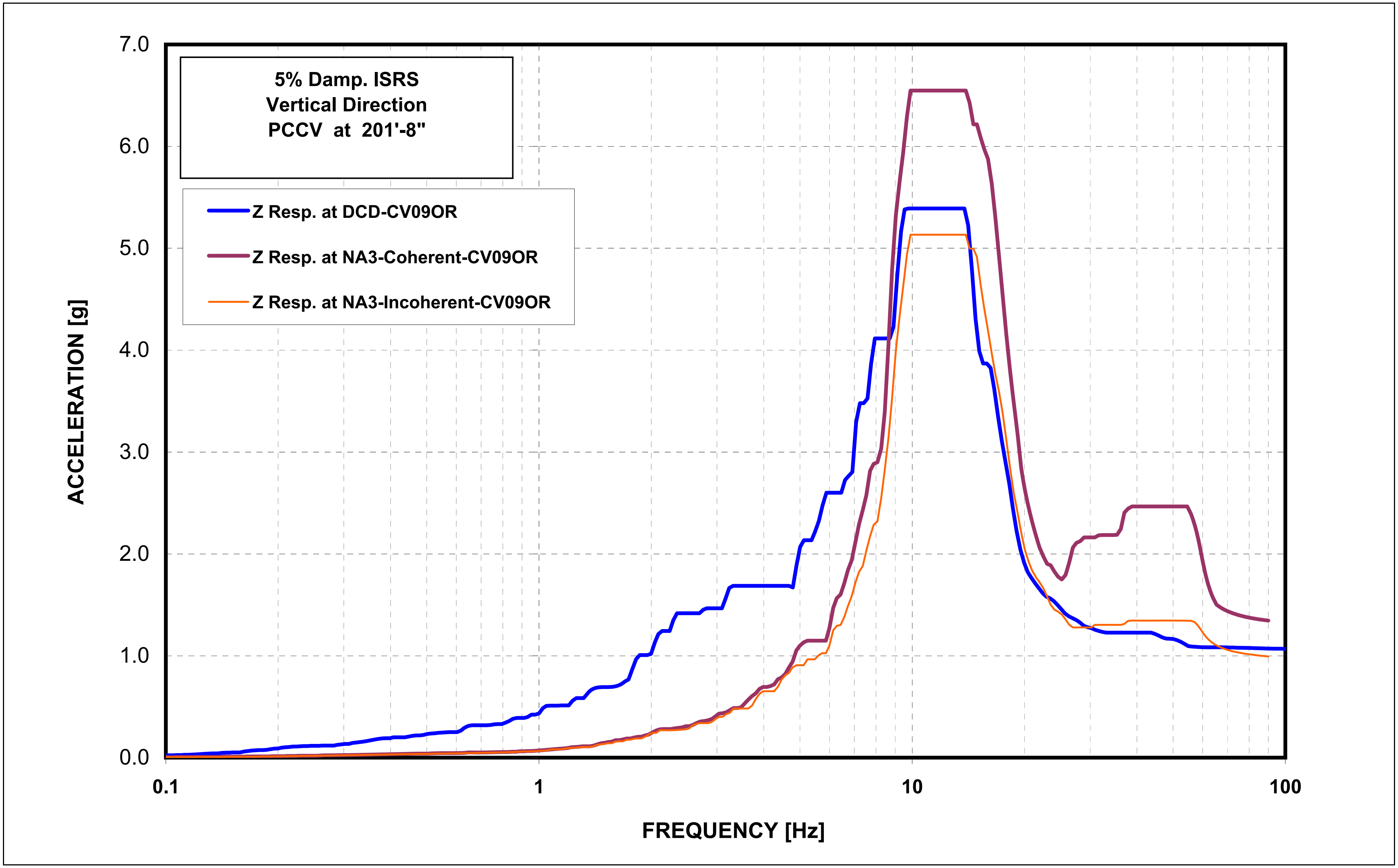


Figure 3NN-23 ISRS for PCCV N-S Direction at CV10 - Elevation 225'-0" (Sheet 105 of 143)

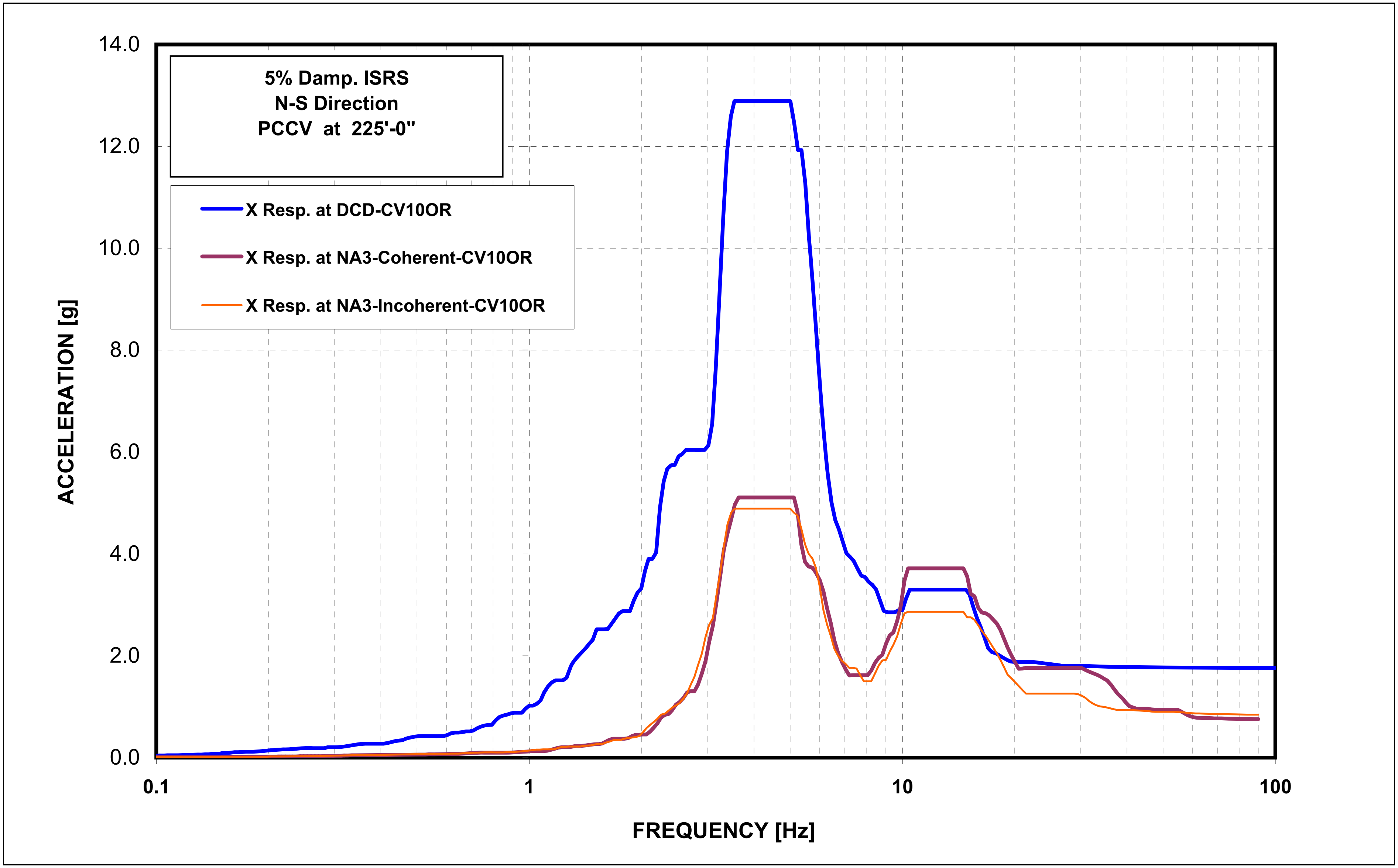


Figure 3NN-23 ISRS for PCCV E-W Direction at CV10 - Elevation 225'- 0" (Sheet 106 of 143)

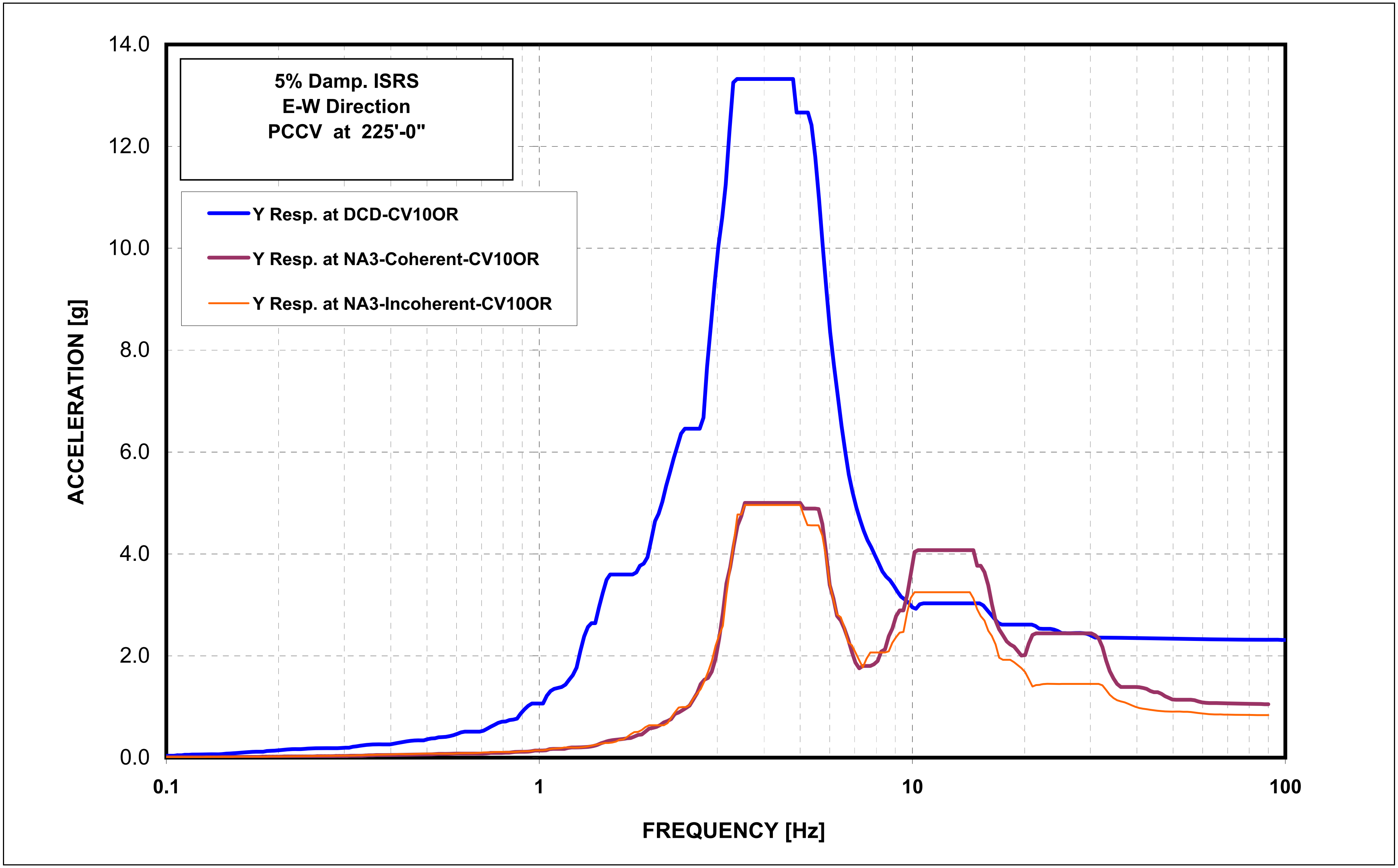


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV10 - Elevation 225'- 0" (Sheet 107 of 143)

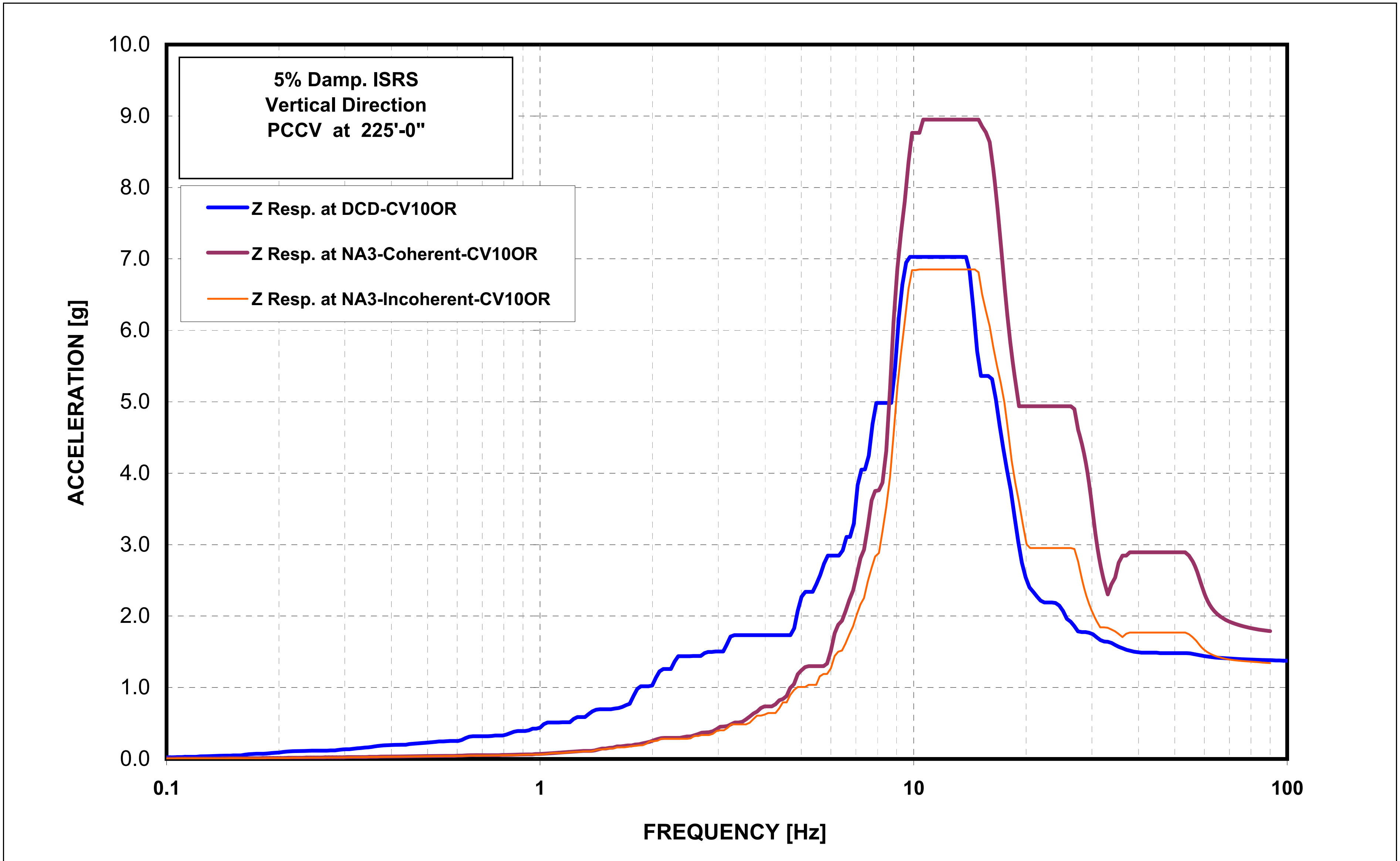


Figure 3NN-23 ISRS for PCCV N-S Direction at CV11 - Elevation 230'-2" (Sheet 108 of 143)

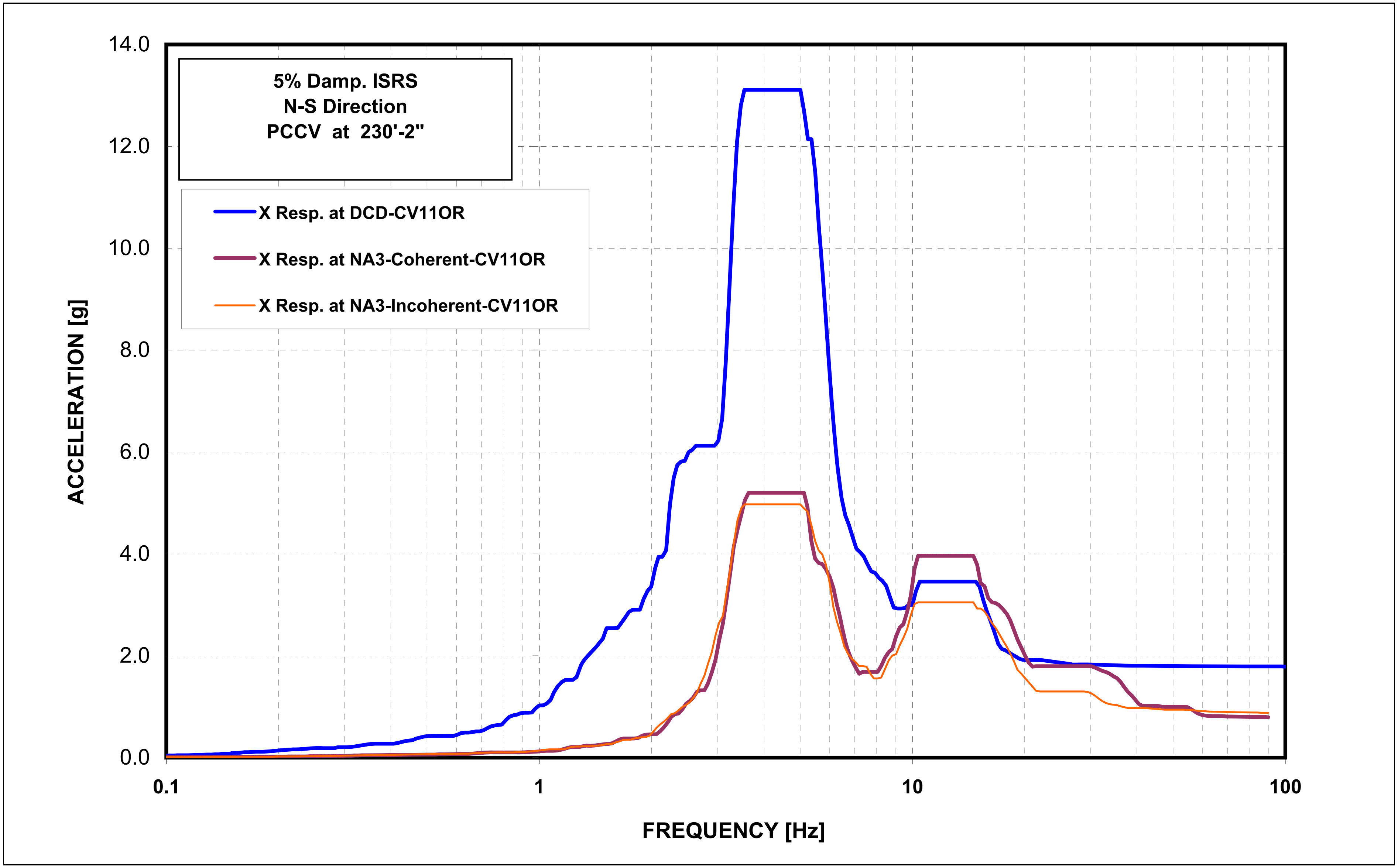


Figure 3NN-23 ISRS for PCCV E-W Direction at CV11 - Elevation 230'-2" (Sheet 109 of 143)

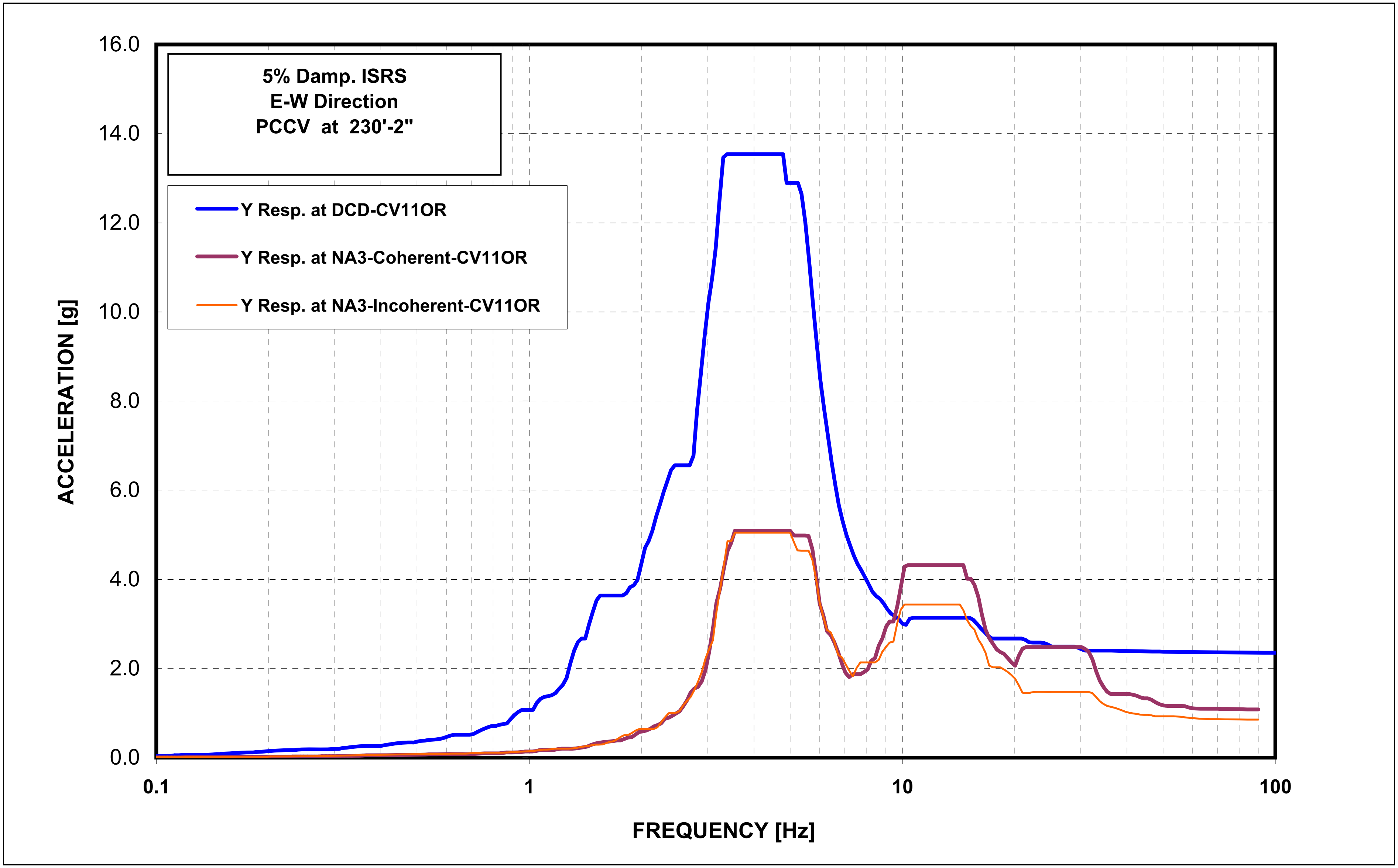


Figure 3NN-23 ISRS for PCCV Vertical Direction at CV11 - Elevation 230'-2" (Sheet 110 of 143)

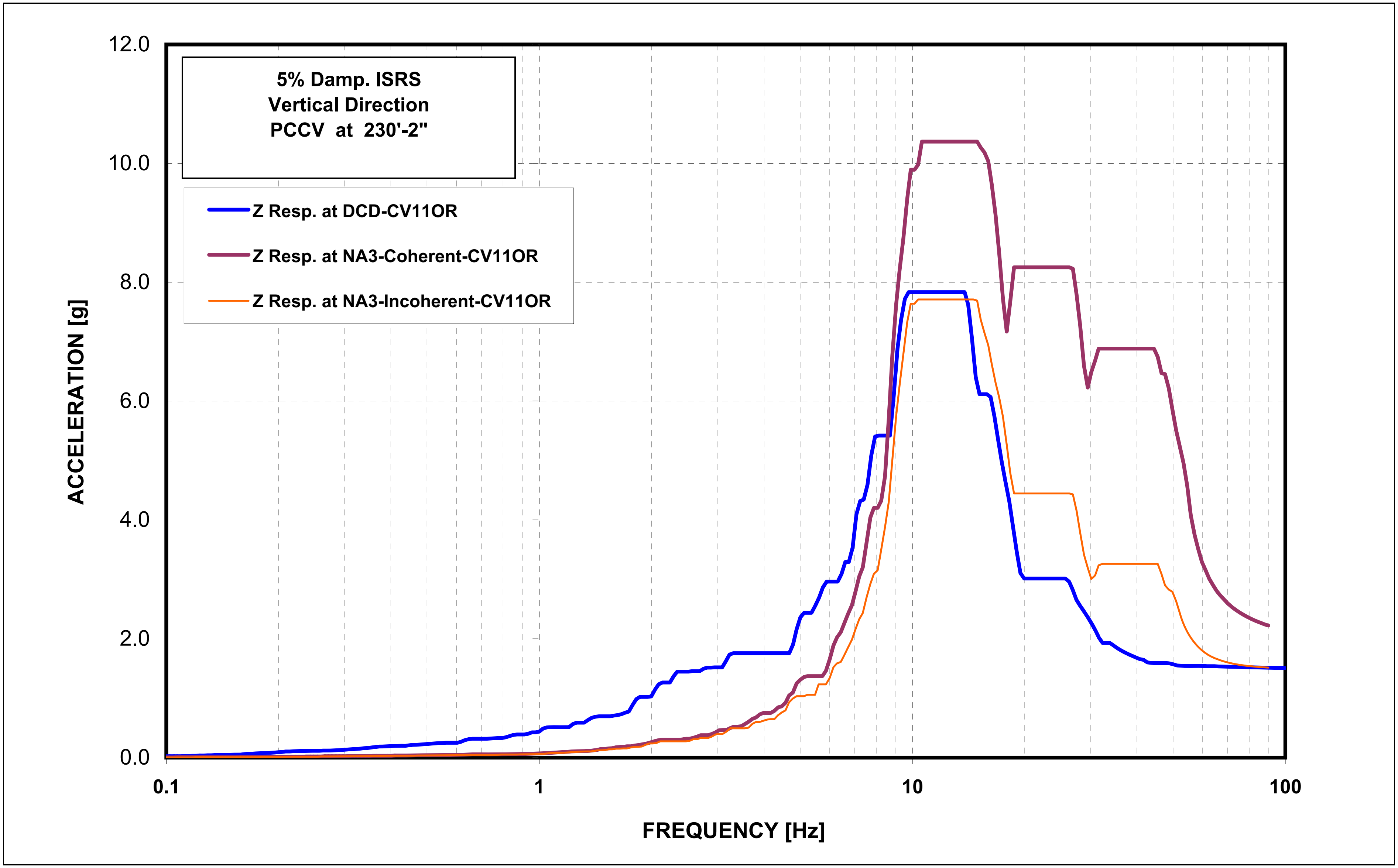


Figure 3NN-23 ISRS for CIS N-S Direction at IC00 - Elevation 1'-10" (Sheet 111 of 143)

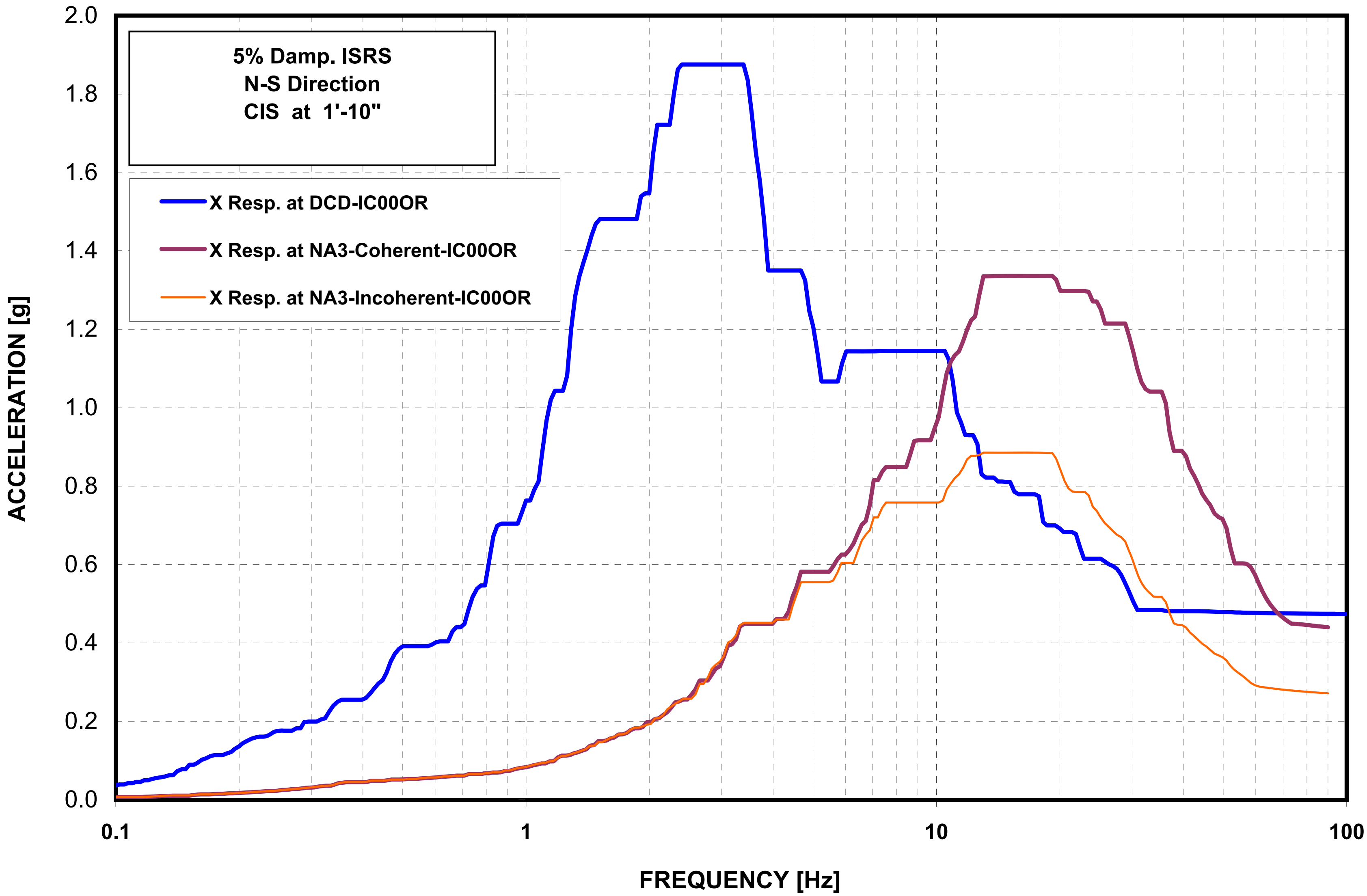


Figure 3NN-23 ISRS for CIS E-W Direction at IC00 - Elevation 1'-10" (Sheet 112 of 143)

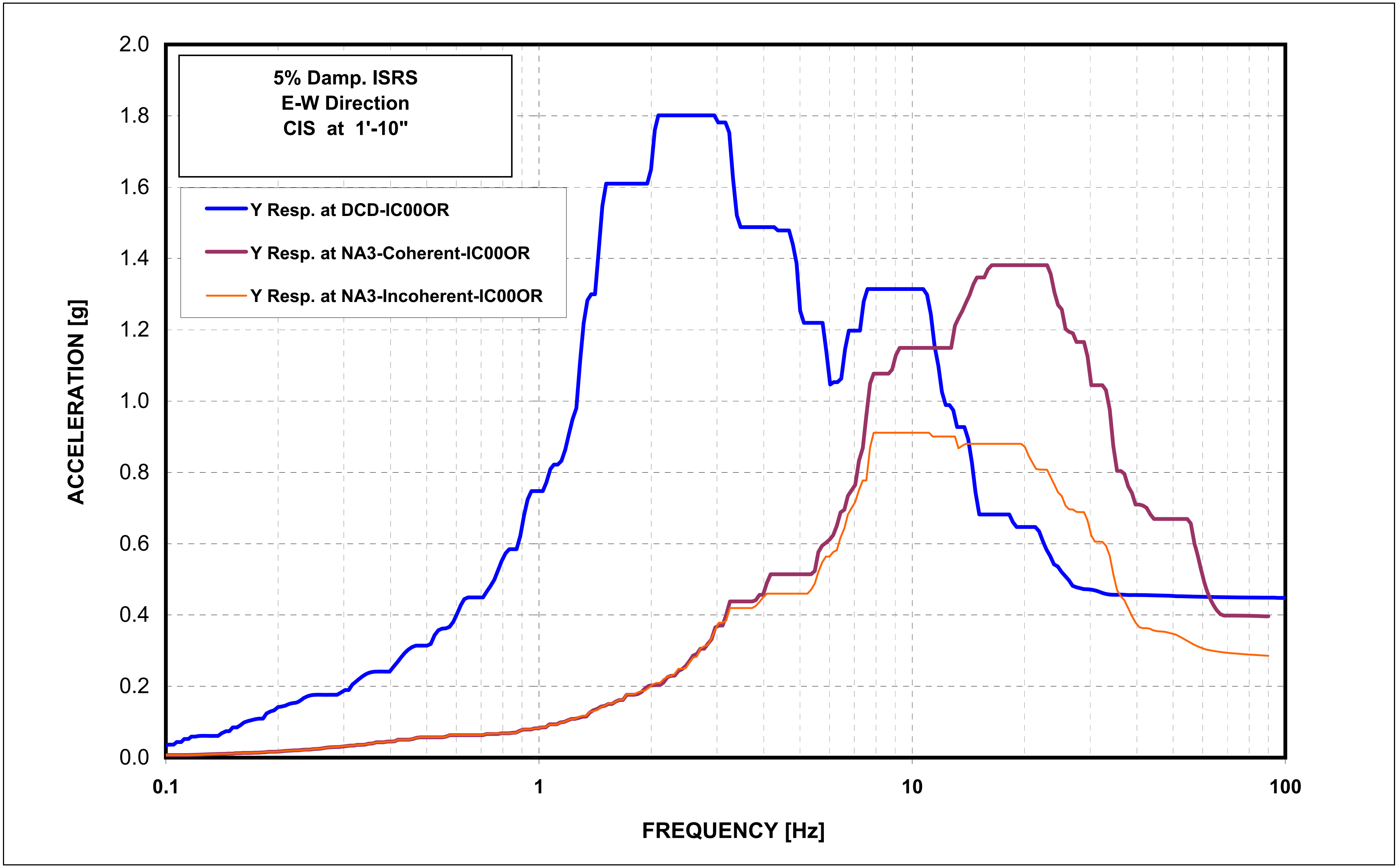


Figure 3NN-23 ISRS for CIS Vertical Direction at IC00 - Elevation 1'-10" (Sheet 113 of 143)

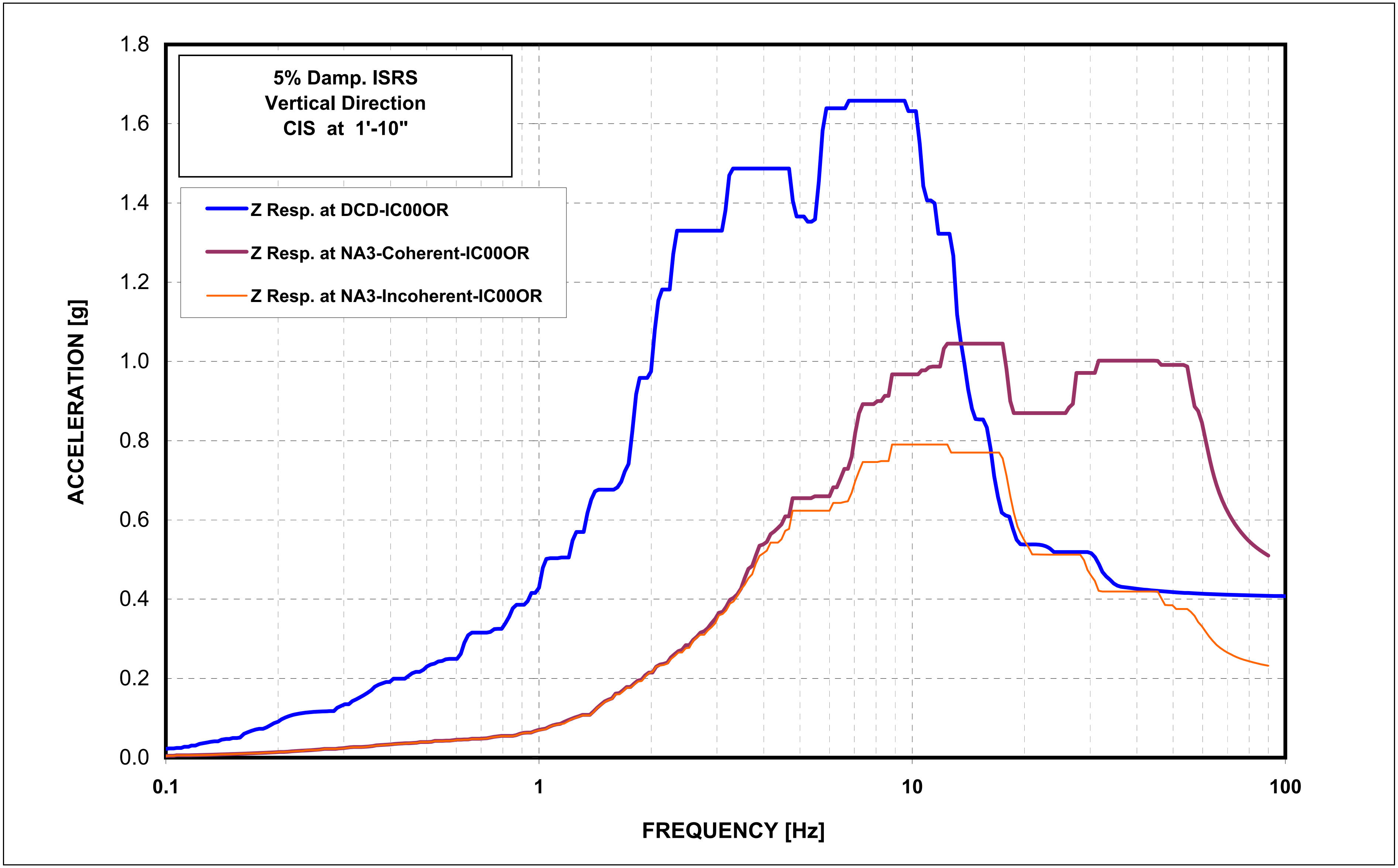


Figure 3NN-23 ISRS for CIS N-S Direction at IC01 - Elevation 16'-0" (Sheet 114 of 143)

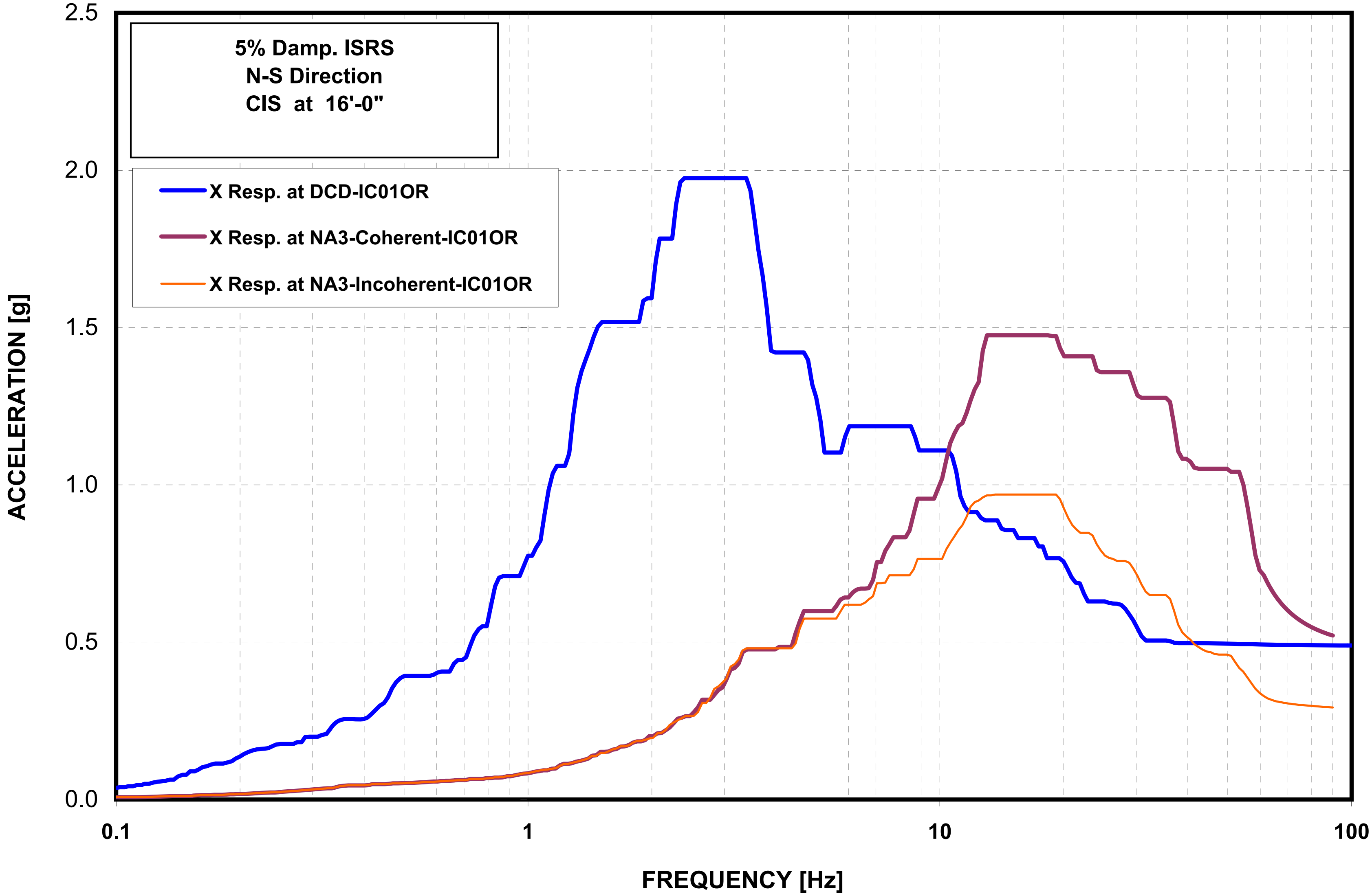


Figure 3NN-23 ISRS for CIS E-W Direction at IC01 - Elevation 16'- 0" (Sheet 115 of 143)

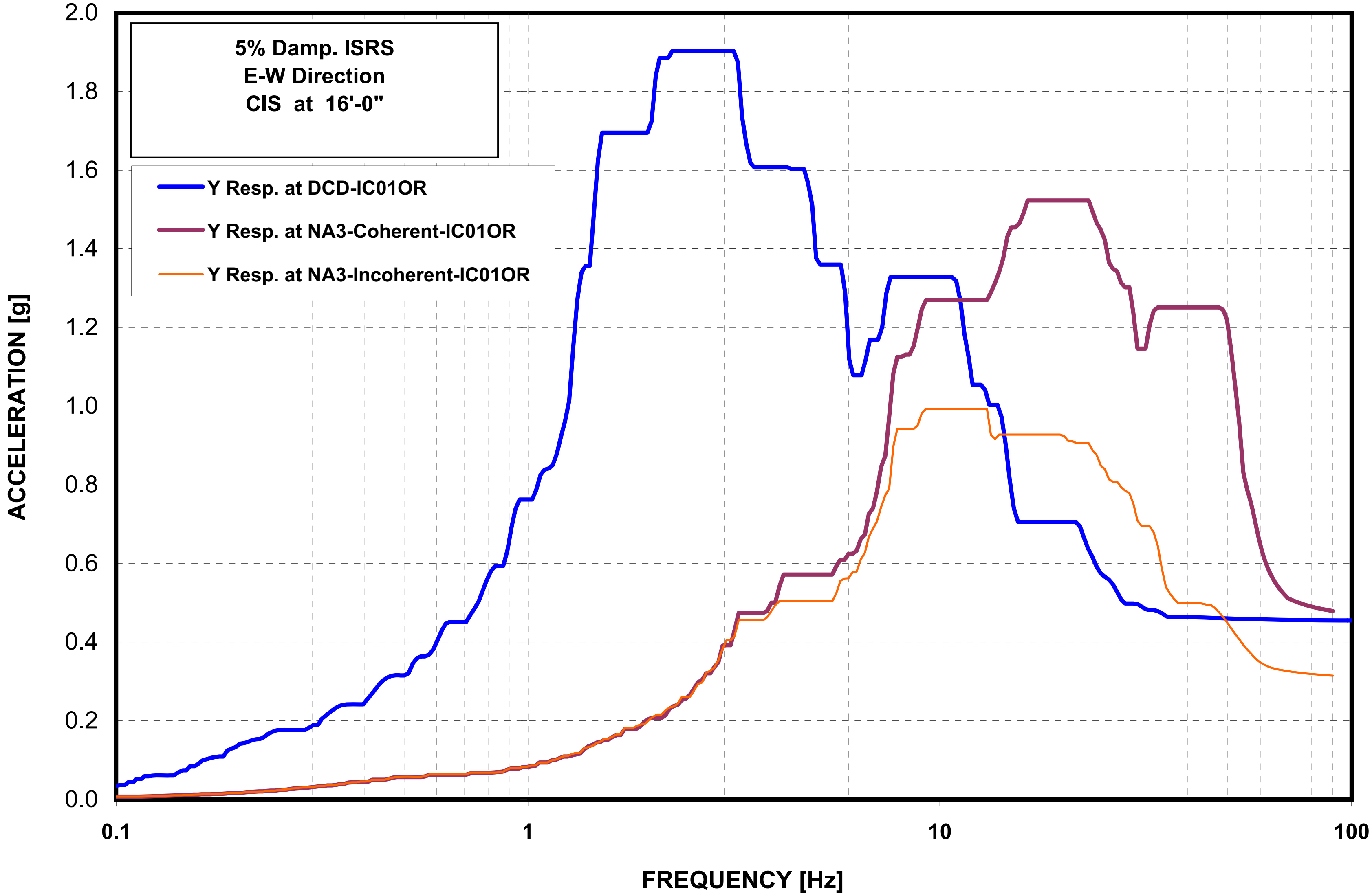


Figure 3NN-23 ISRS for CIS Vertical Direction at IC01 - Elevation 16'-0" (Sheet 116 of 143)

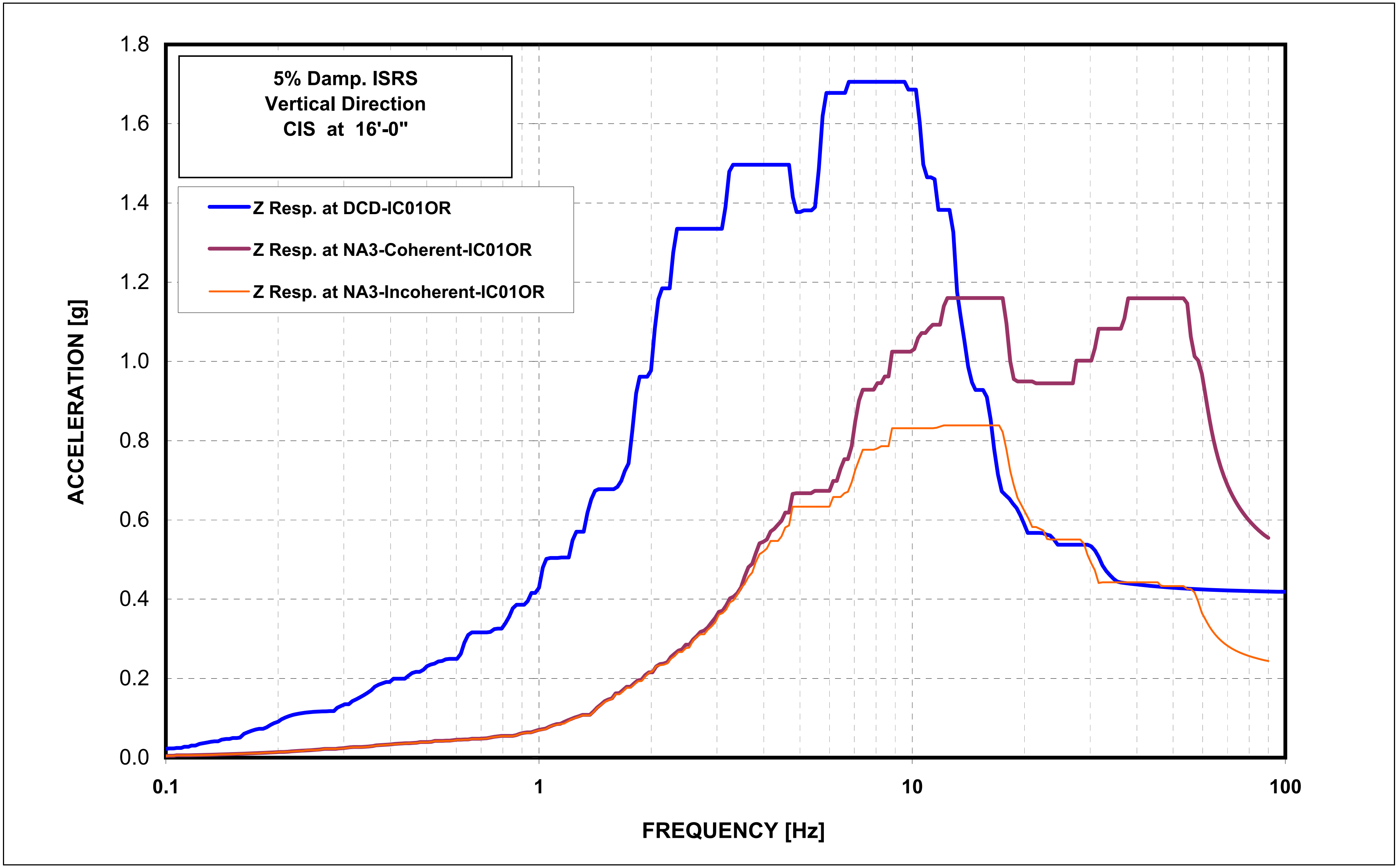


Figure 3NN-23 ISRS for CIS N-S Direction at IC02 - Elevation 25'-3" (Sheet 117 of 143)

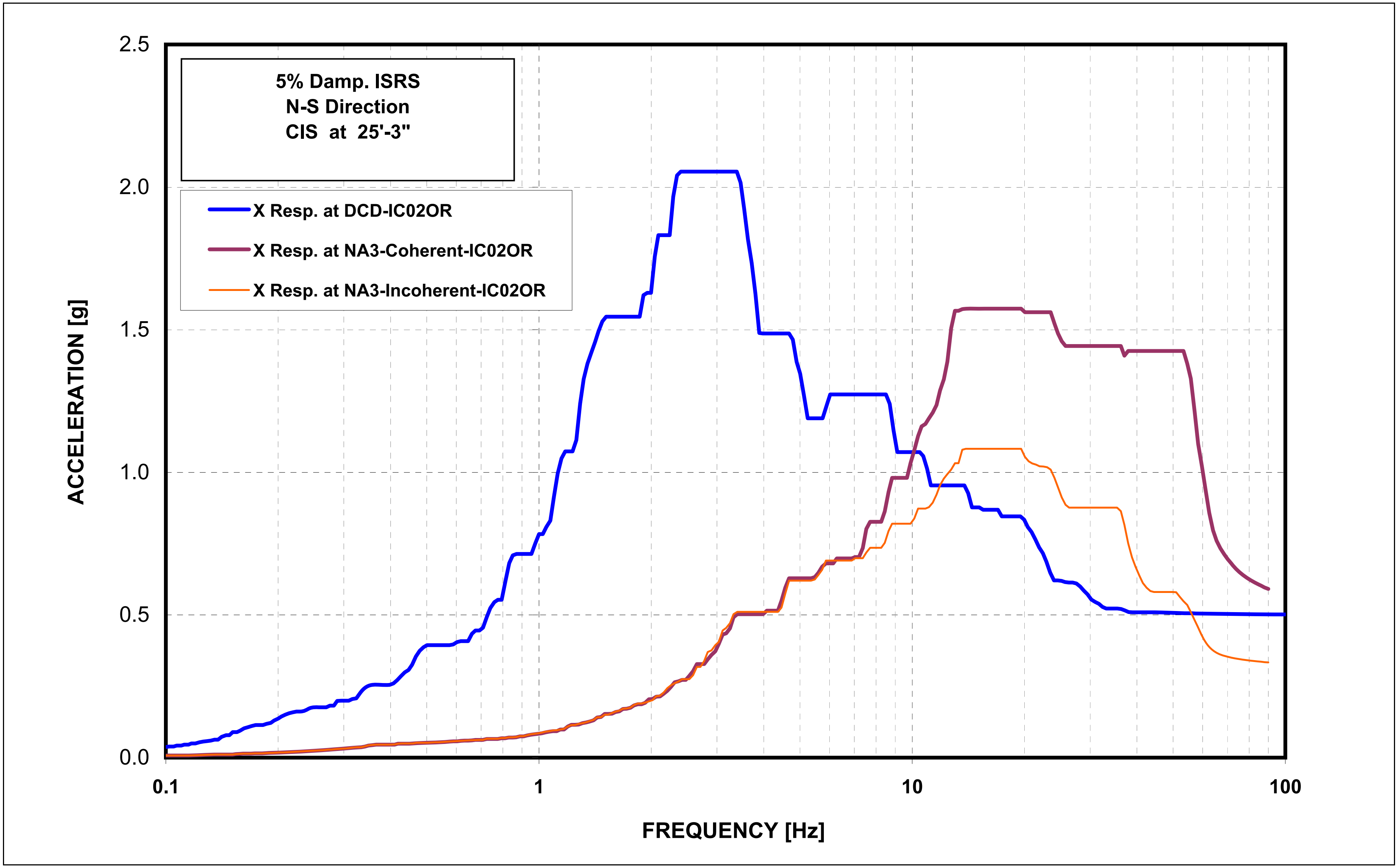


Figure 3NN-23 ISRS for CIS E-W Direction at IC02 - Elevation 25'- 3" (Sheet 118 of 143)

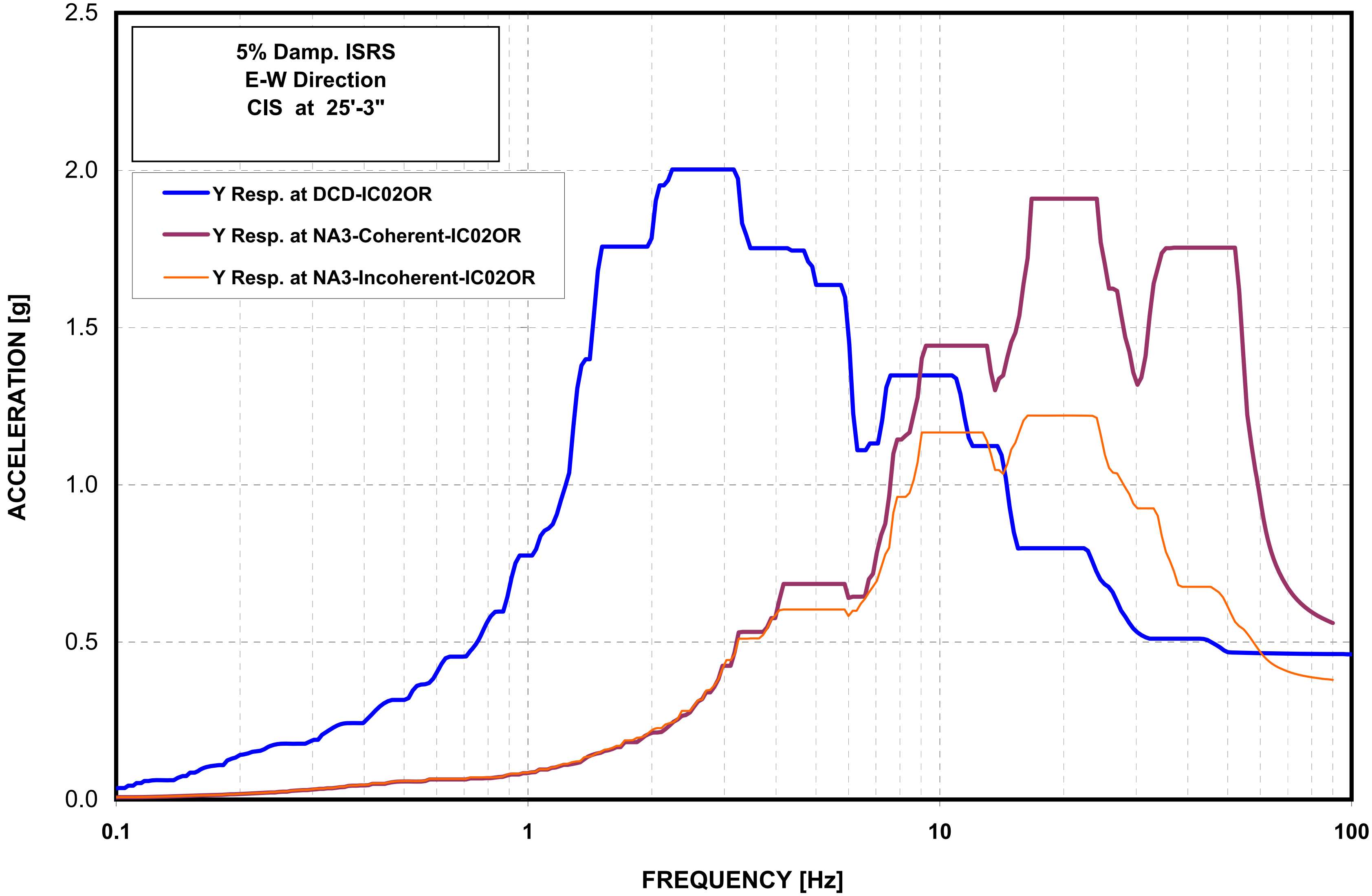


Figure 3NN-23 ISRS for CIS Vertical Direction at IC02 - Elevation 25'-3" (Sheet 119 of 143)

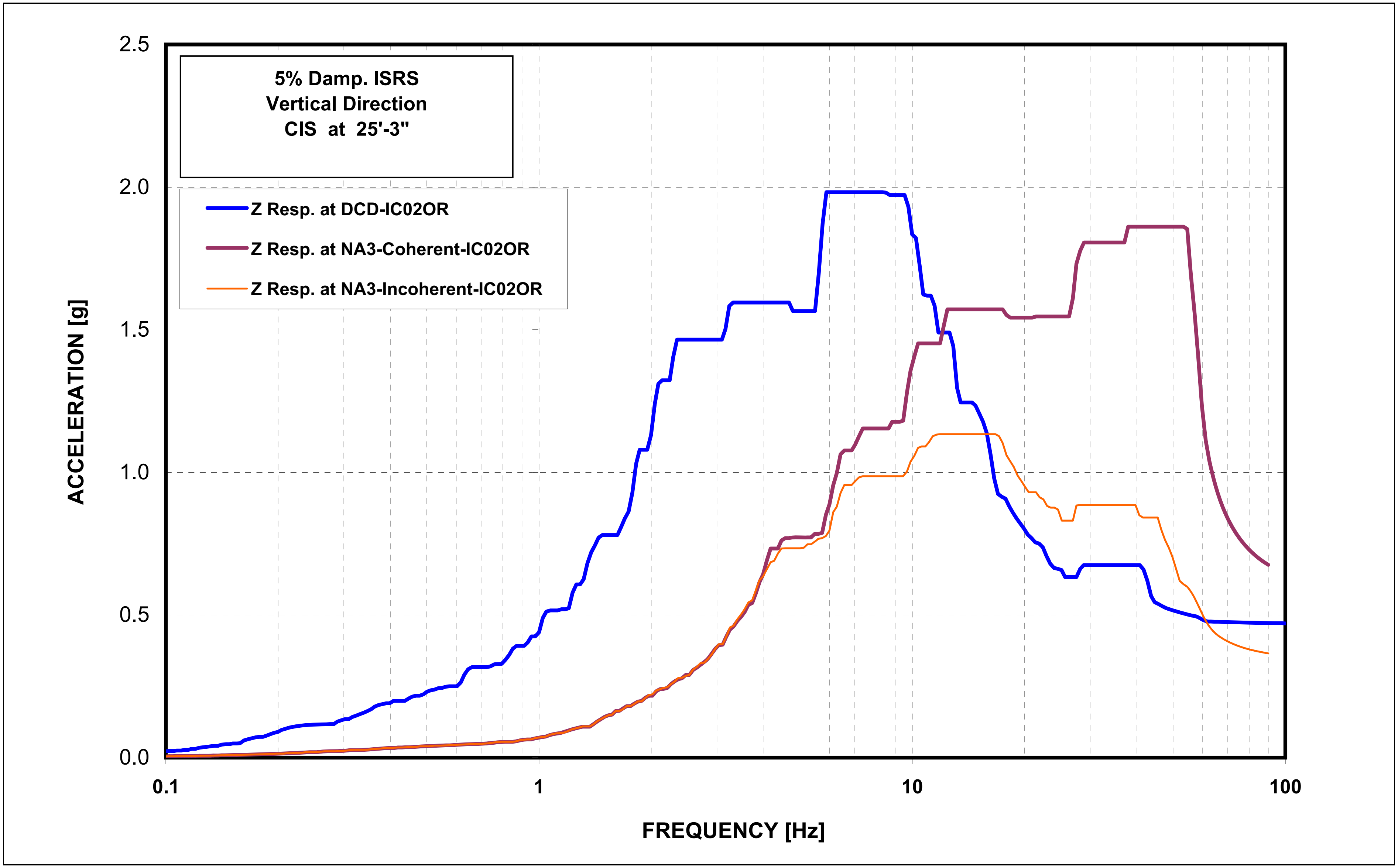


Figure 3NN-23 ISRS for CIS N-S Direction at IC03 - Elevation 35'-9" (Sheet 120 of 143)

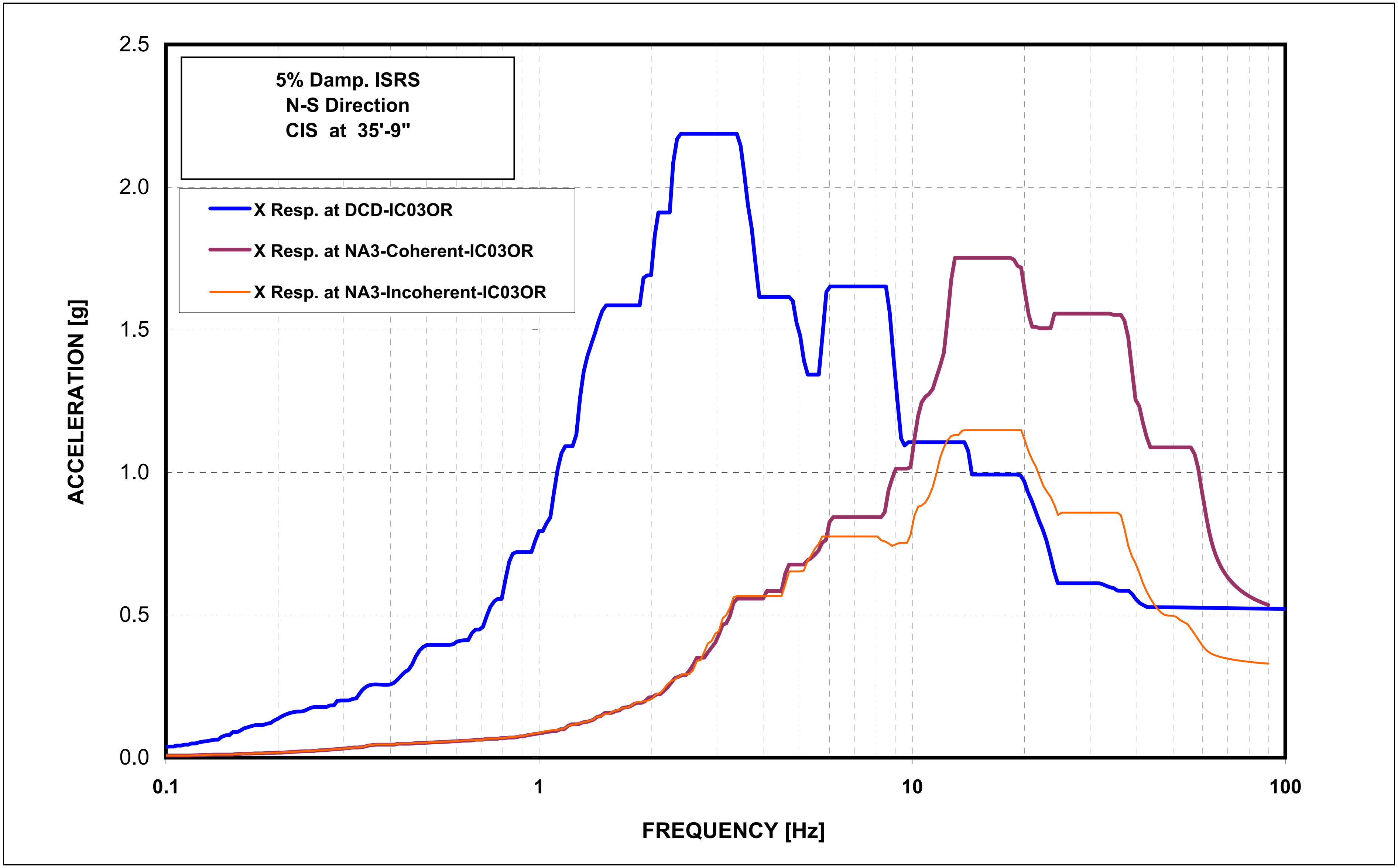


Figure 3NN-23 ISRS for CIS E-W Direction at IC03 - Elevation 35'-9" (Sheet 121 of 143)

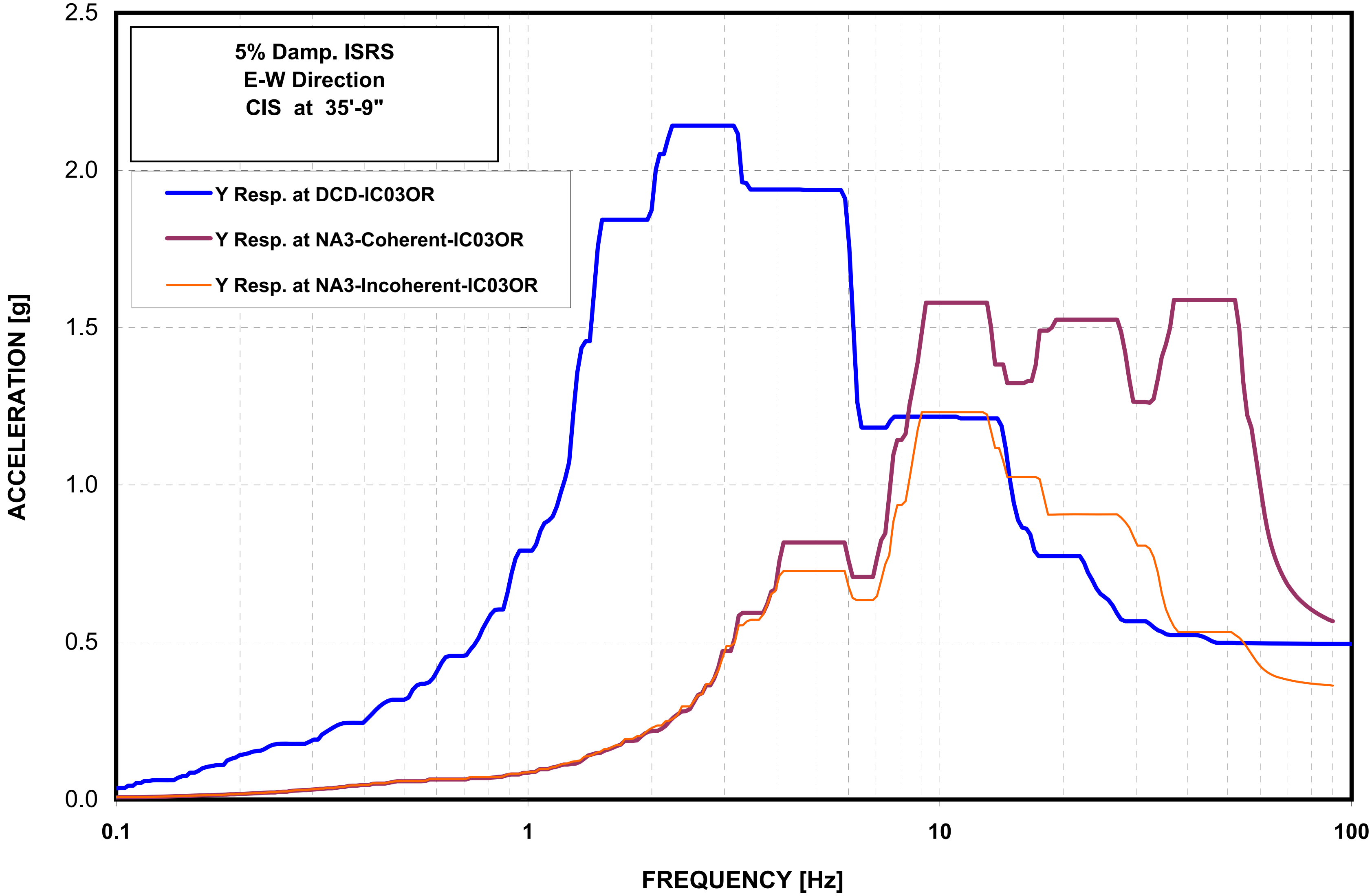


Figure 3NN-23 ISRS for CIS Vertical Direction at IC03 - Elevation 35'-9" (Sheet 122 of 143)

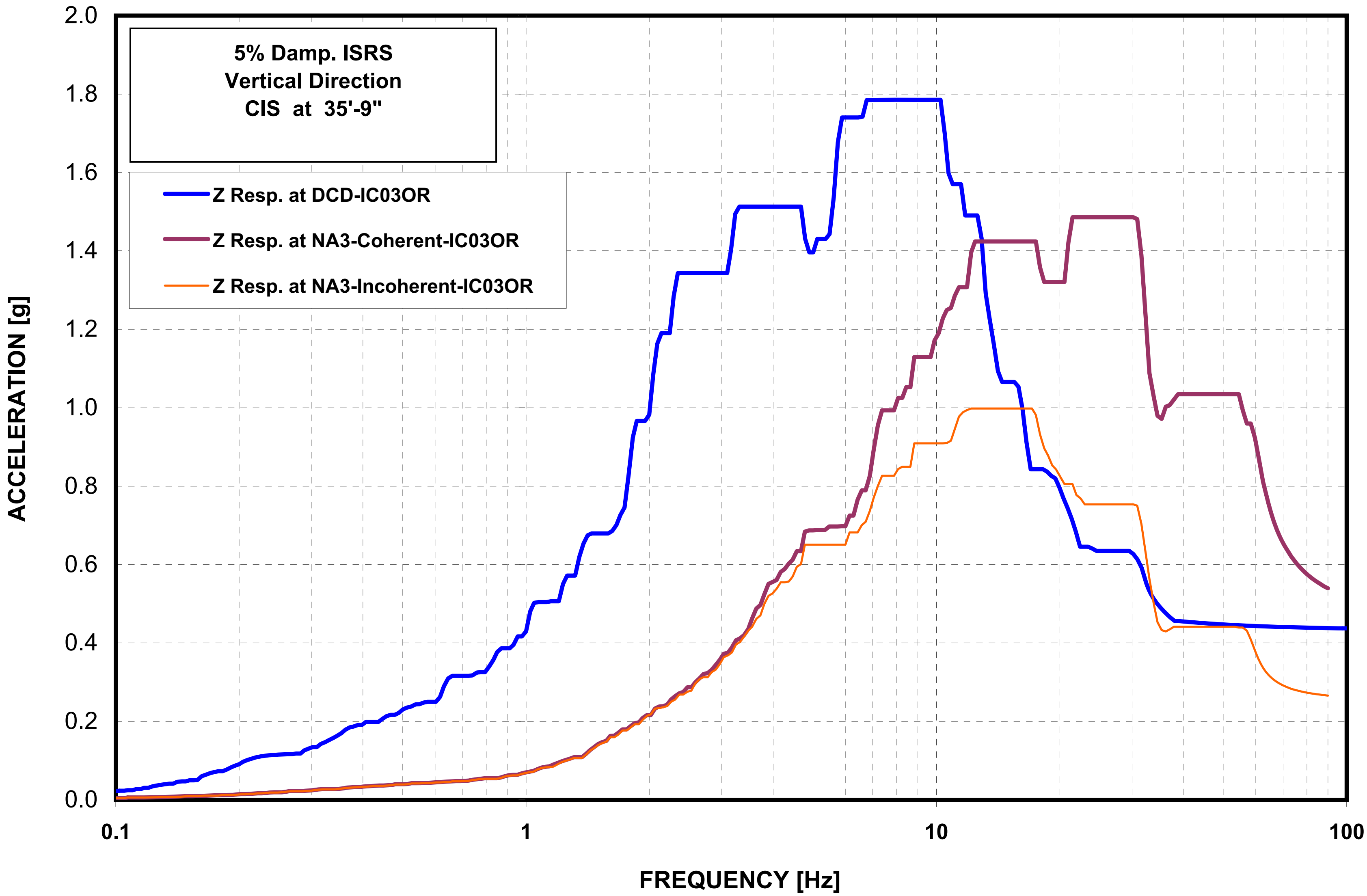


Figure 3NN-23 ISRS for CIS N-S Direction at IC04 - Elevation 50'-2" (Sheet 123 of 143)

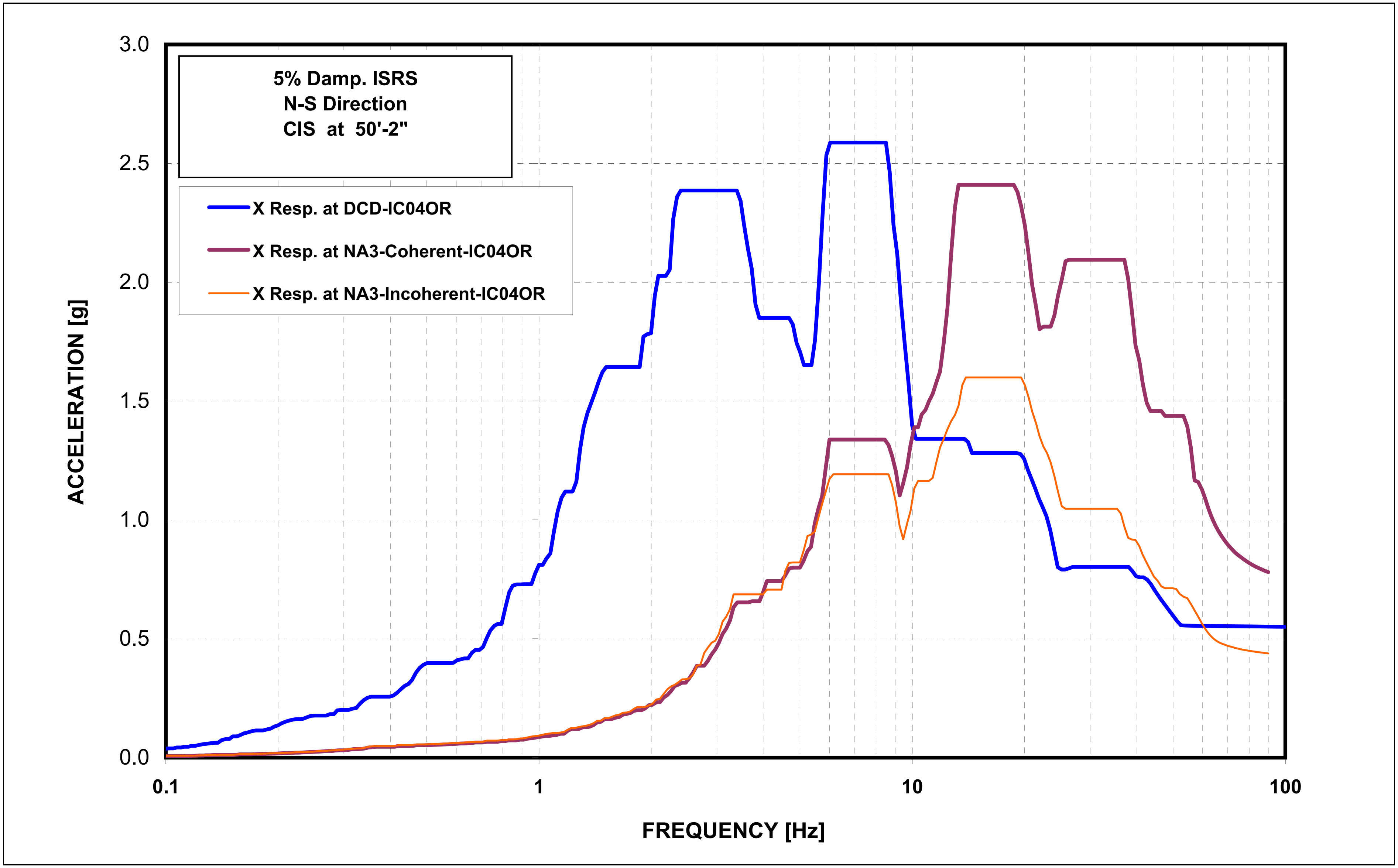


Figure 3NN-23 ISRS for CIS E-W Direction at IC04 - Elevation 50'-2" (Sheet 124 of 143)

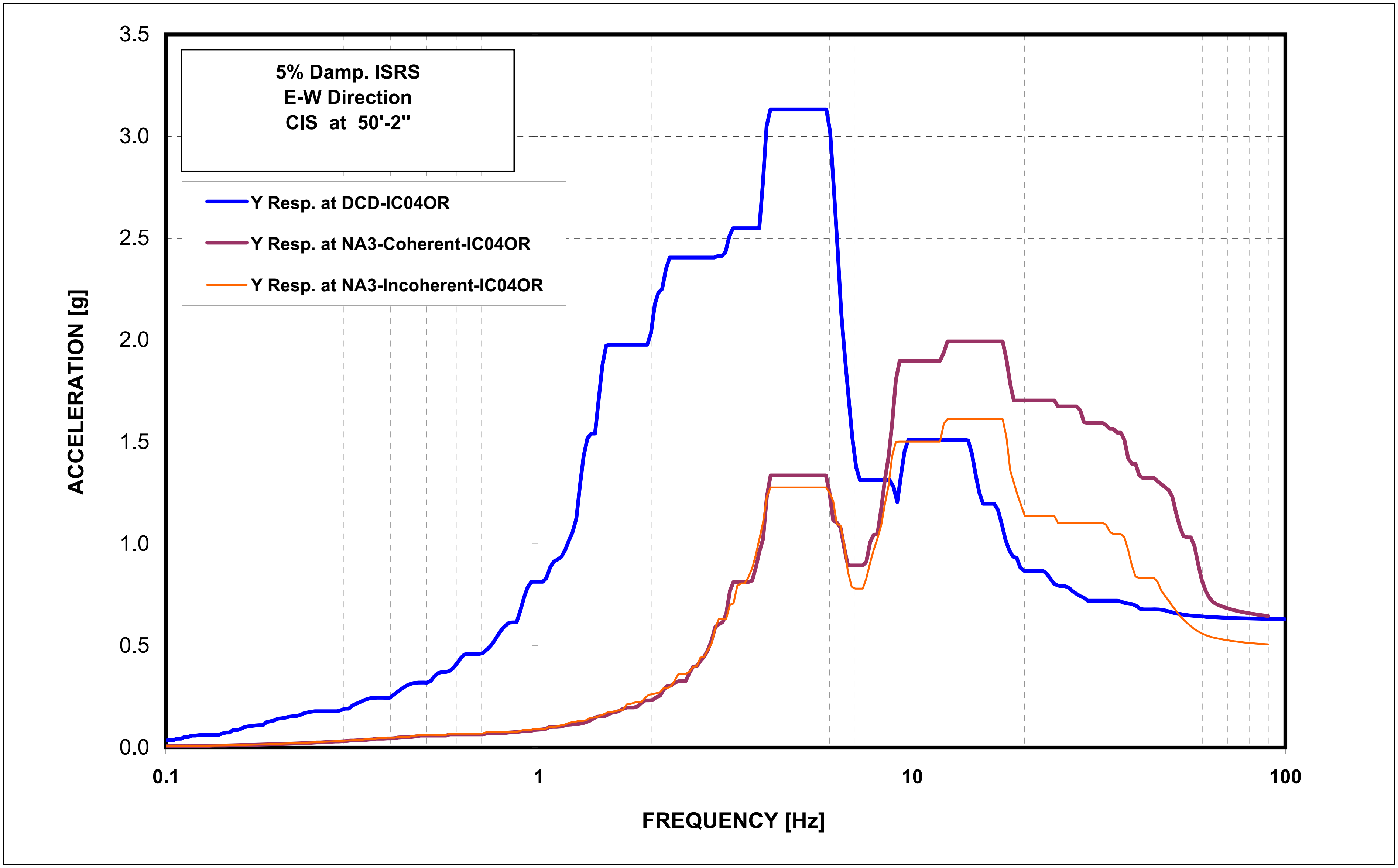


Figure 3NN-23 ISRS for CIS Vertical Direction at IC04 - Elevation 50'- 2" (Sheet 125 of 143)

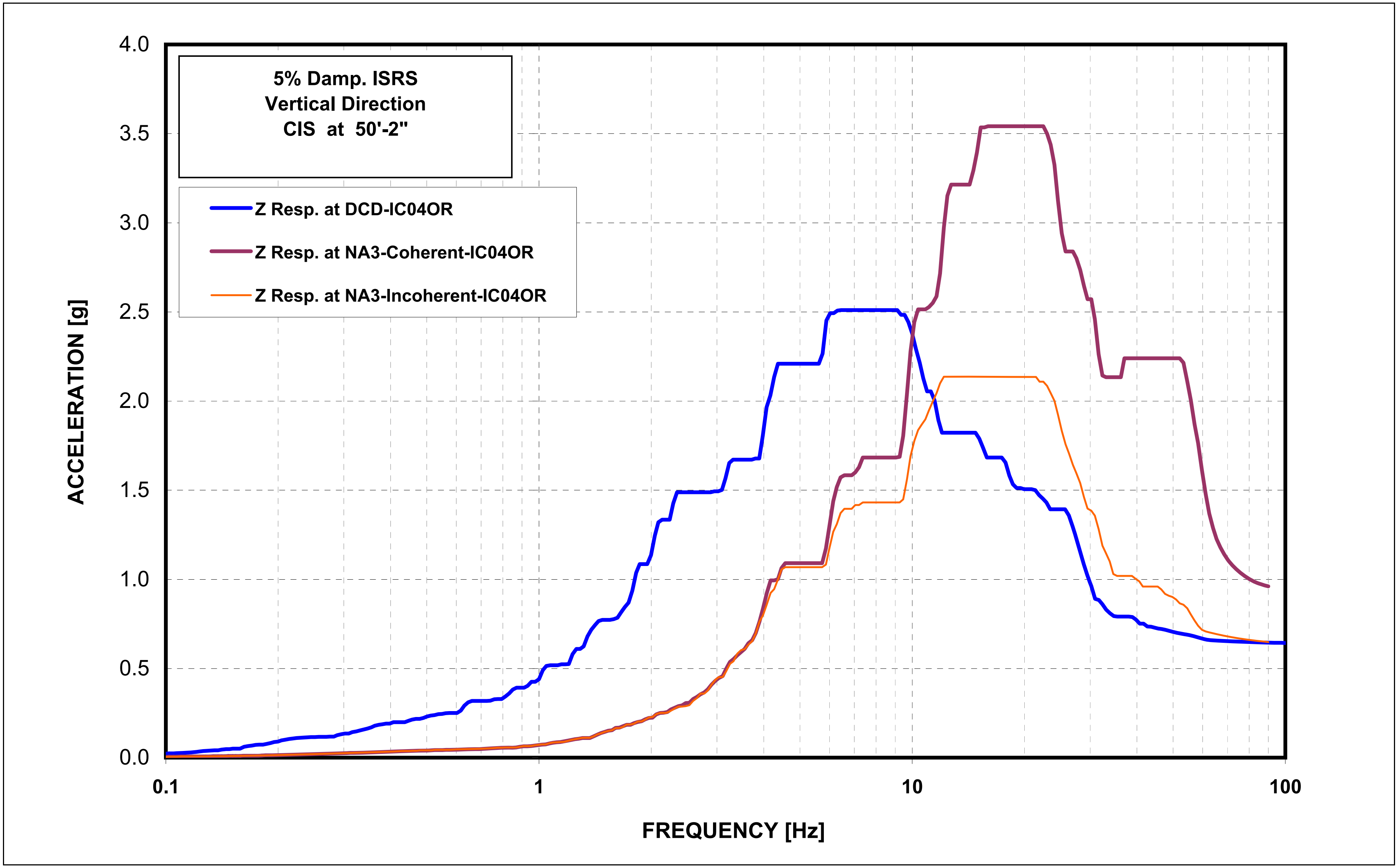


Figure 3NN-23 ISRS for CIS N-S Direction at IC05 - Elevation 76'-5" (Sheet 126 of 143)

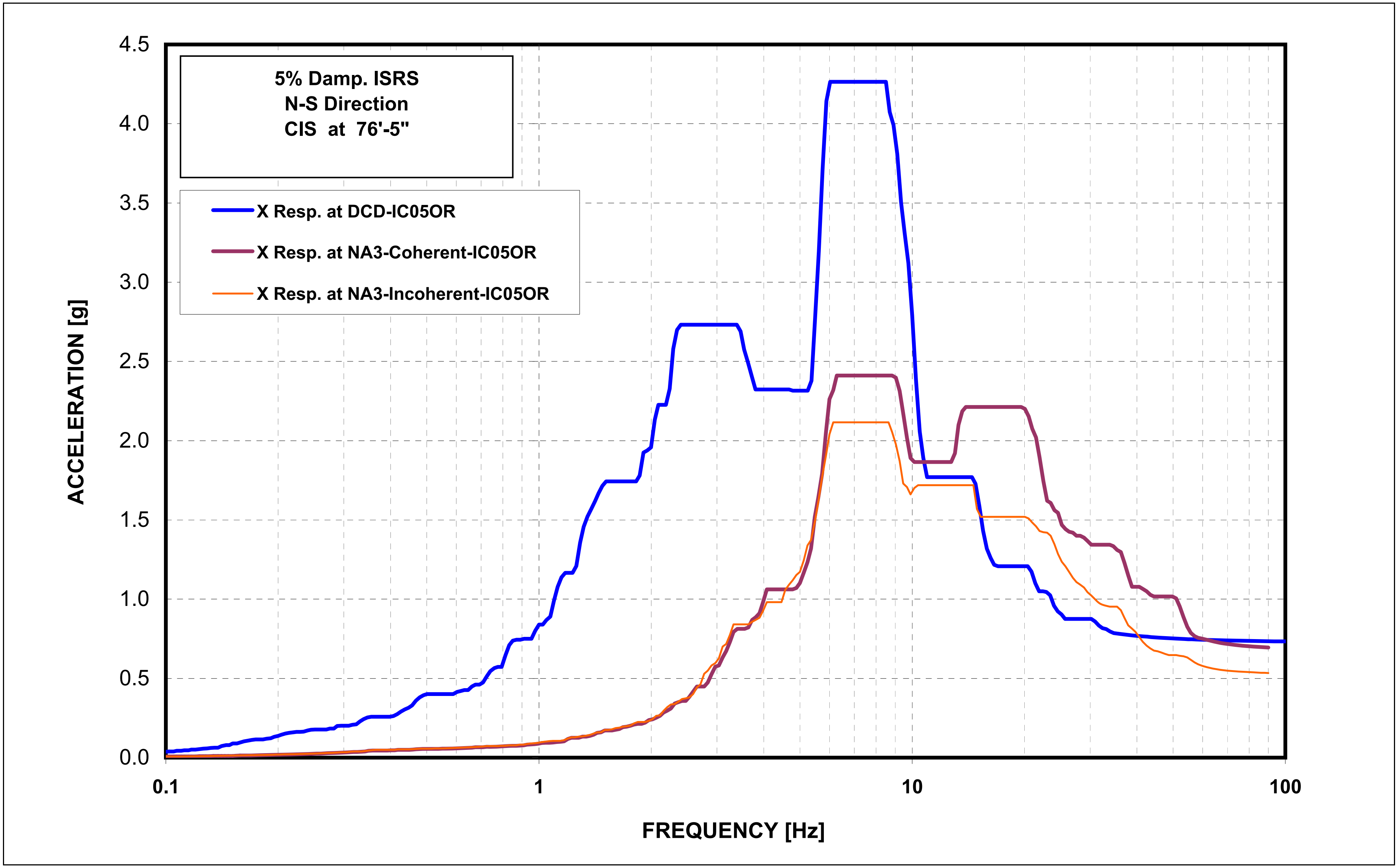


Figure 3NN-23 ISRS for CIS E-W Direction at IC05 - Elevation 76'- 5" (Sheet 127 of 143)

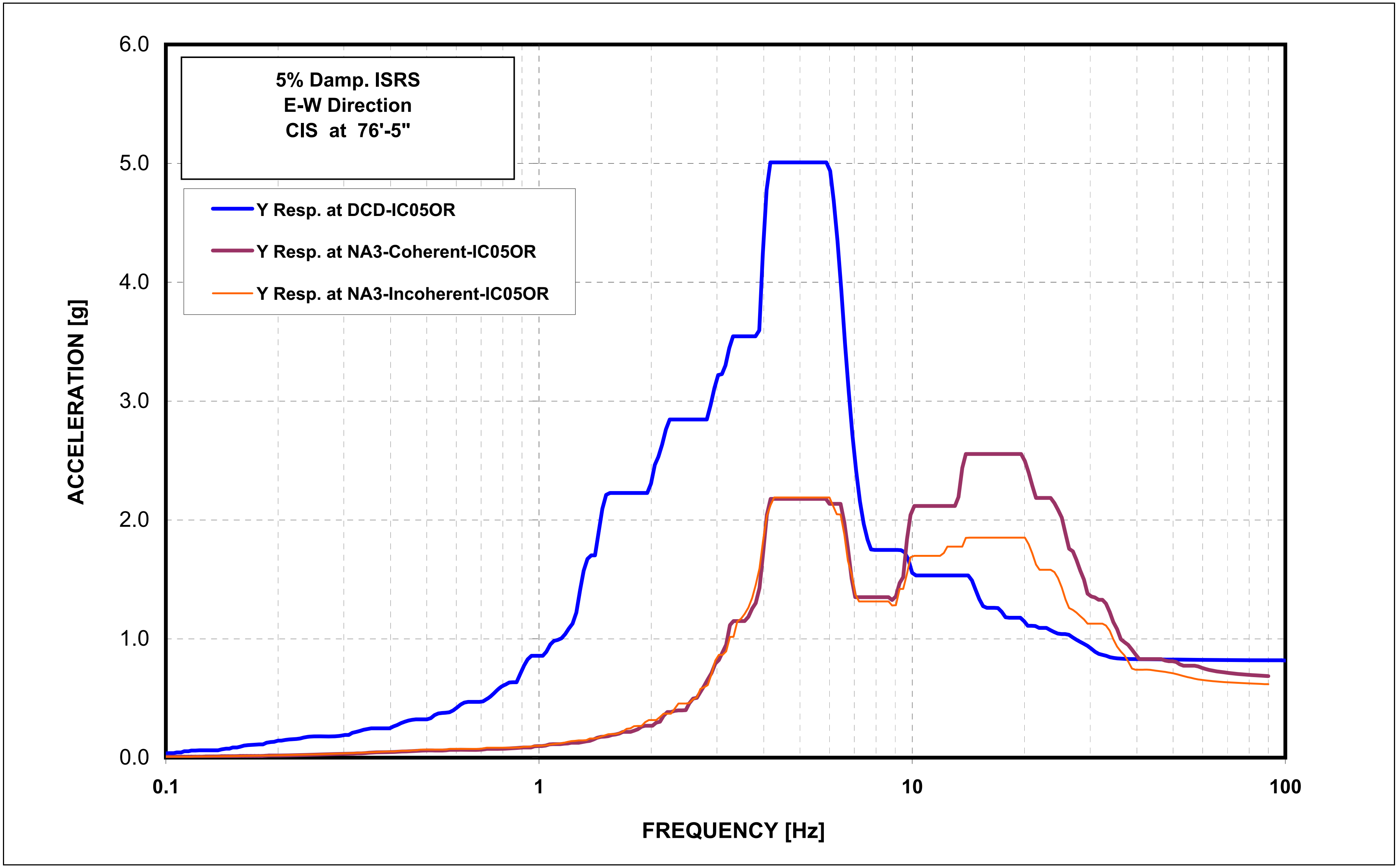


Figure 3NN-23 ISRS for CIS Vertical Direction at IC05 - Elevation 76'- 5" (Sheet 128 of 143)

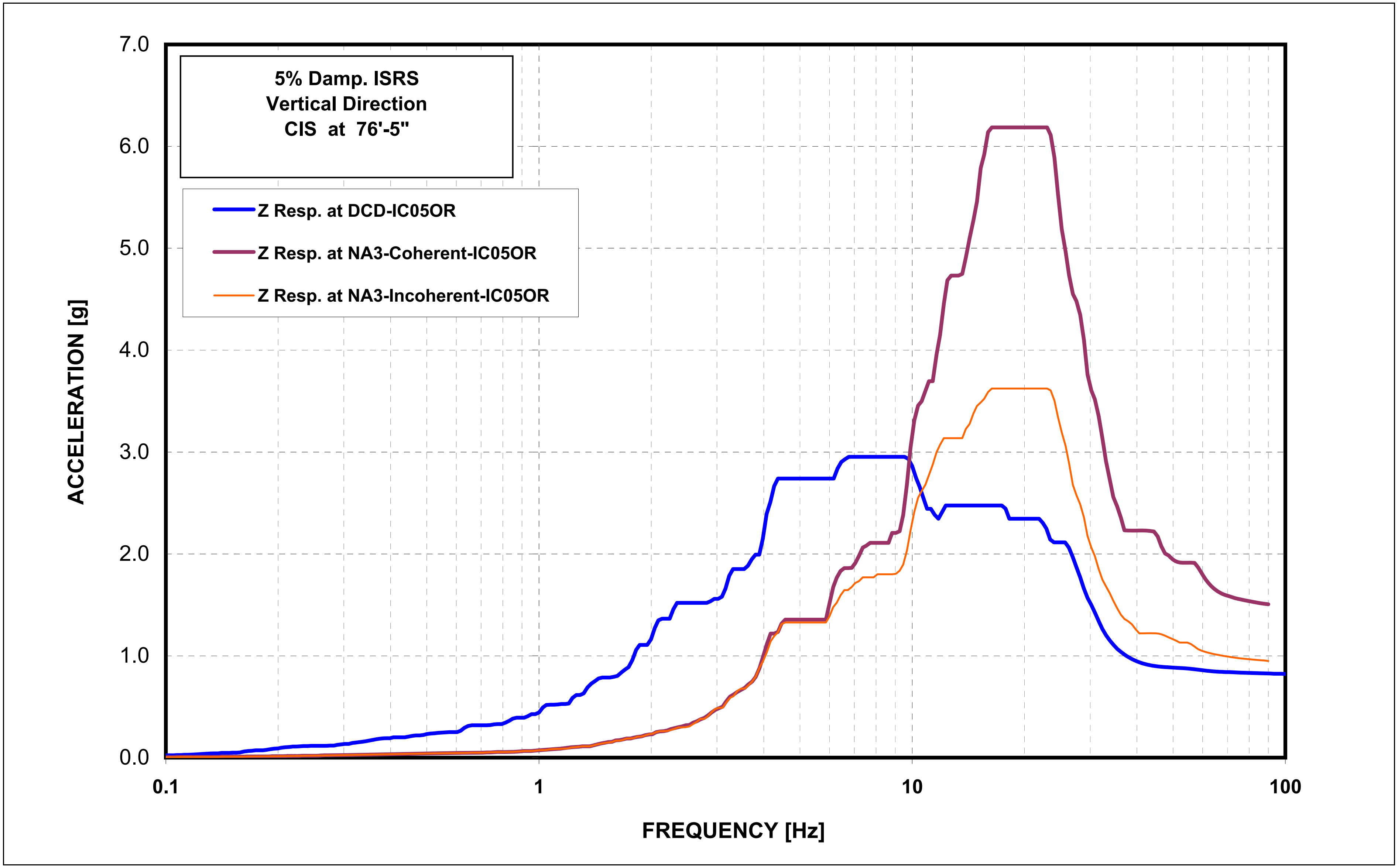


Figure 3NN-23 ISRS for CIS N-S Direction at IC15 - Elevation 59'-2" (Sheet 129 of 143)

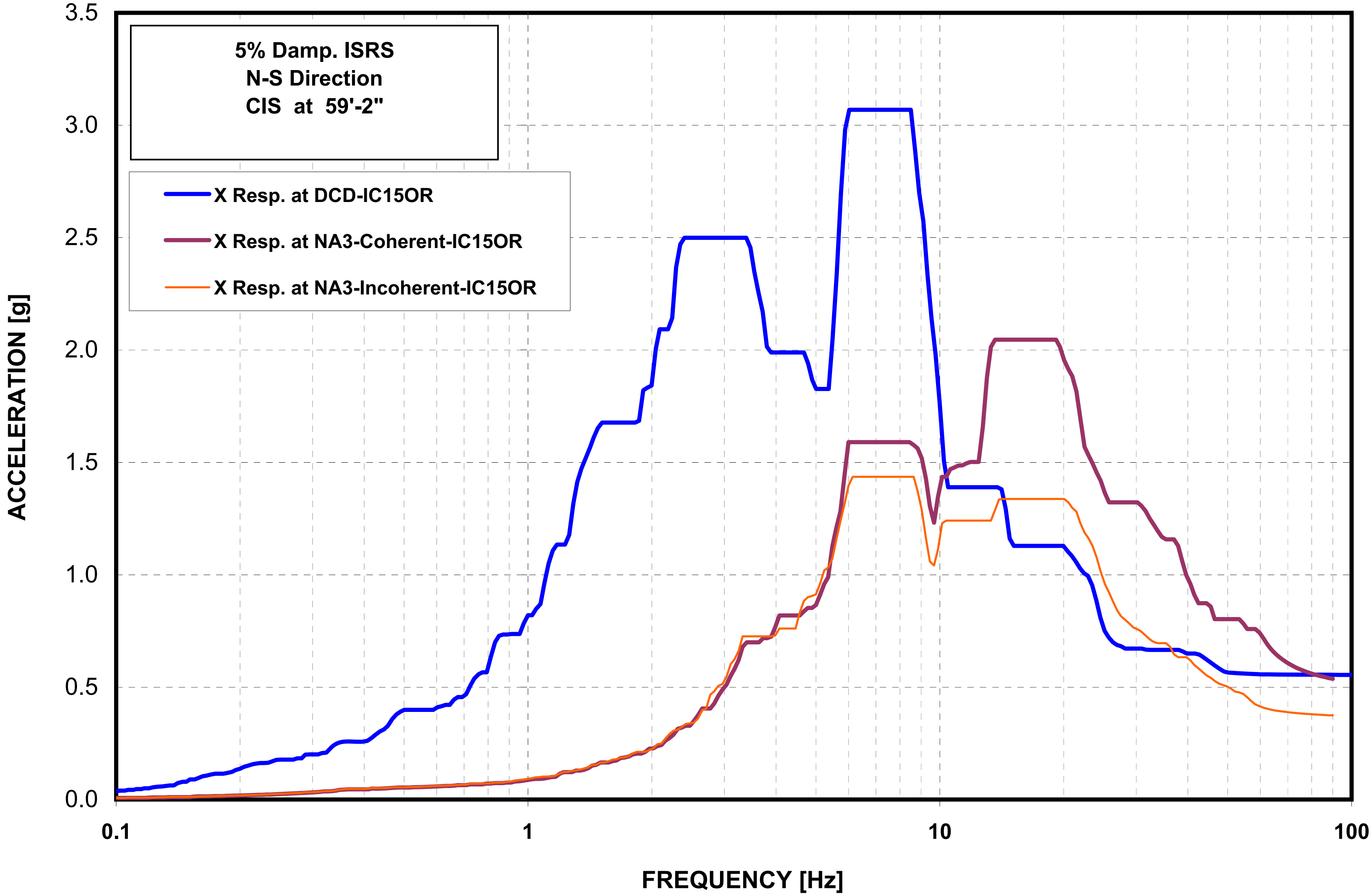


Figure 3NN-23 ISRS for CIS E-W Direction at IC15 - Elevation 59'-2" (Sheet 130 of 143)

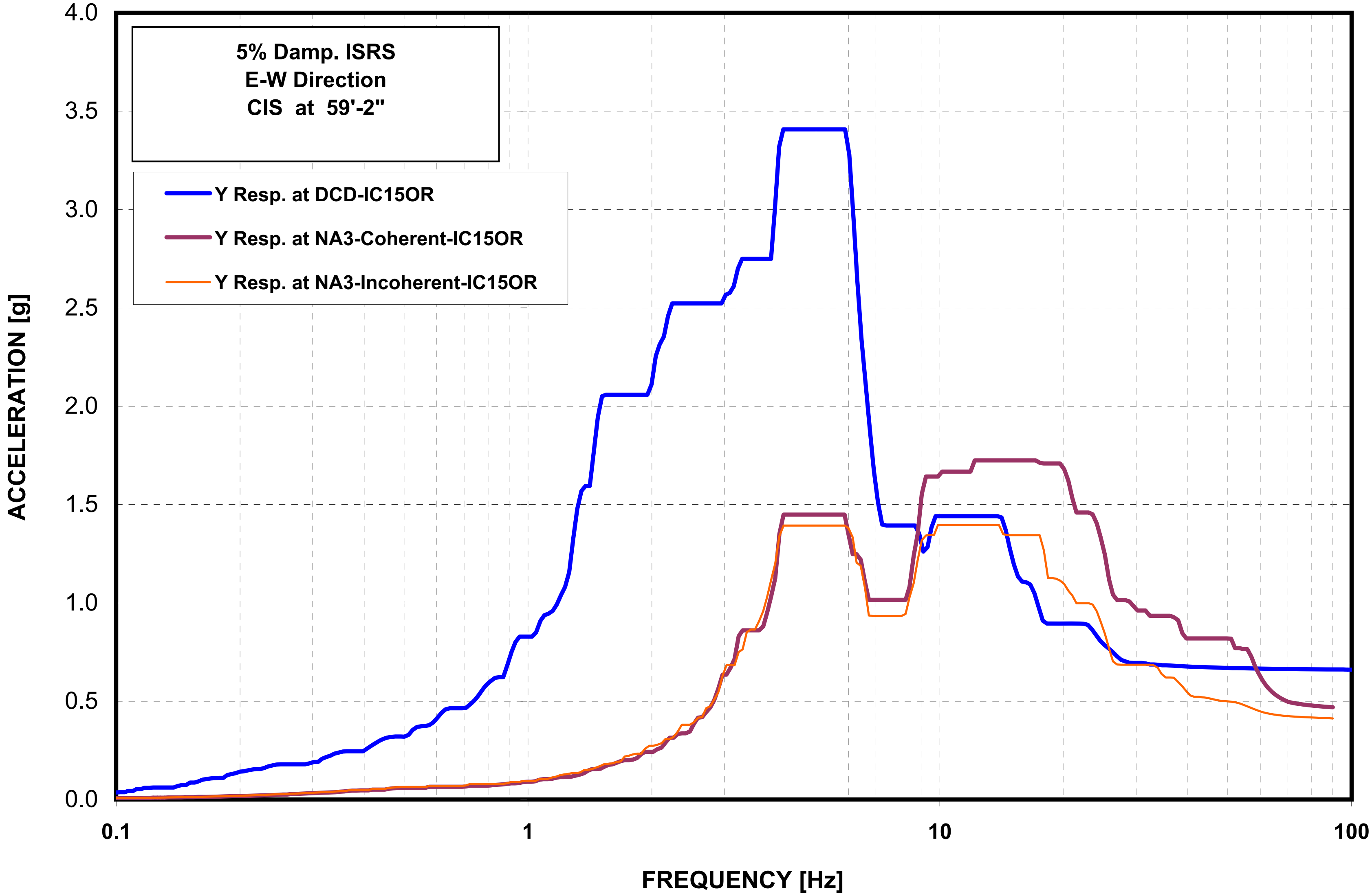


Figure 3NN-23 ISRS for CIS Vertical Direction at IC15 - Elevation 59'-2" (Sheet 131 of 143)

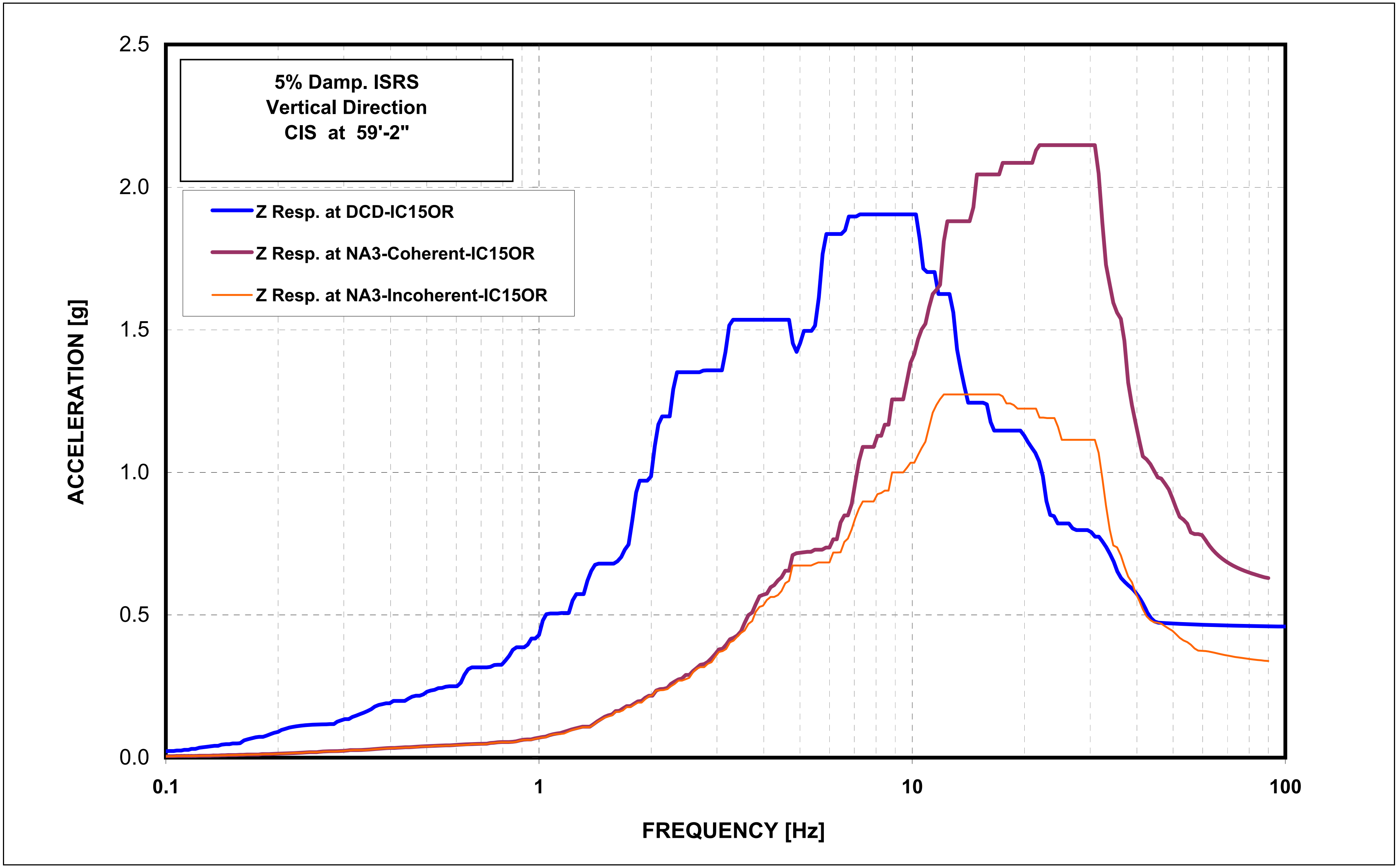


Figure 3NN-23 ISRS for CIS N-S Direction at ICP1 - Elevation 76'- 5" (Sheet 132 of 143)

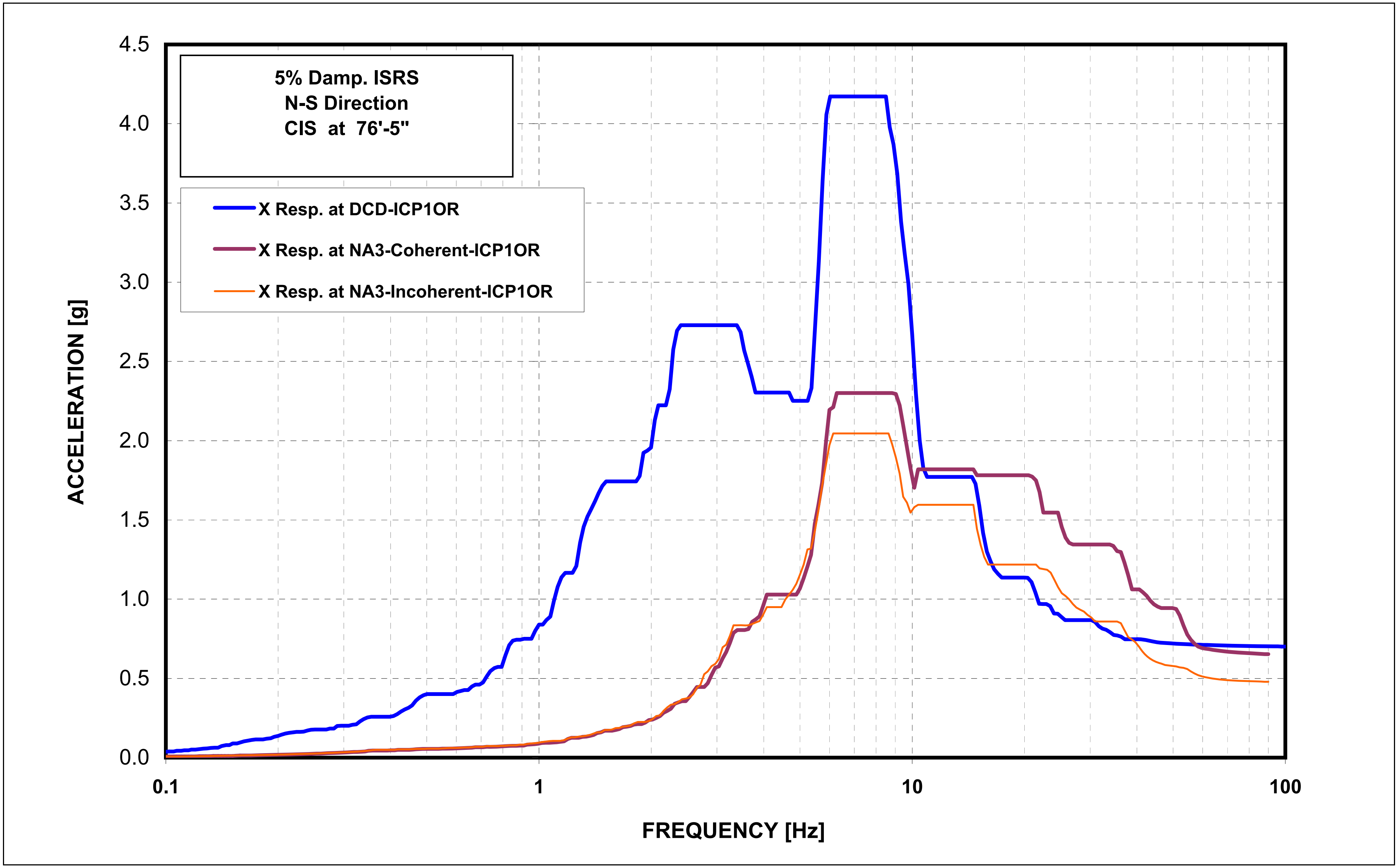


Figure 3NN-23 ISRS for CIS E-W Direction at ICP1 - Elevation 76'- 5" (Sheet 133 of 143)

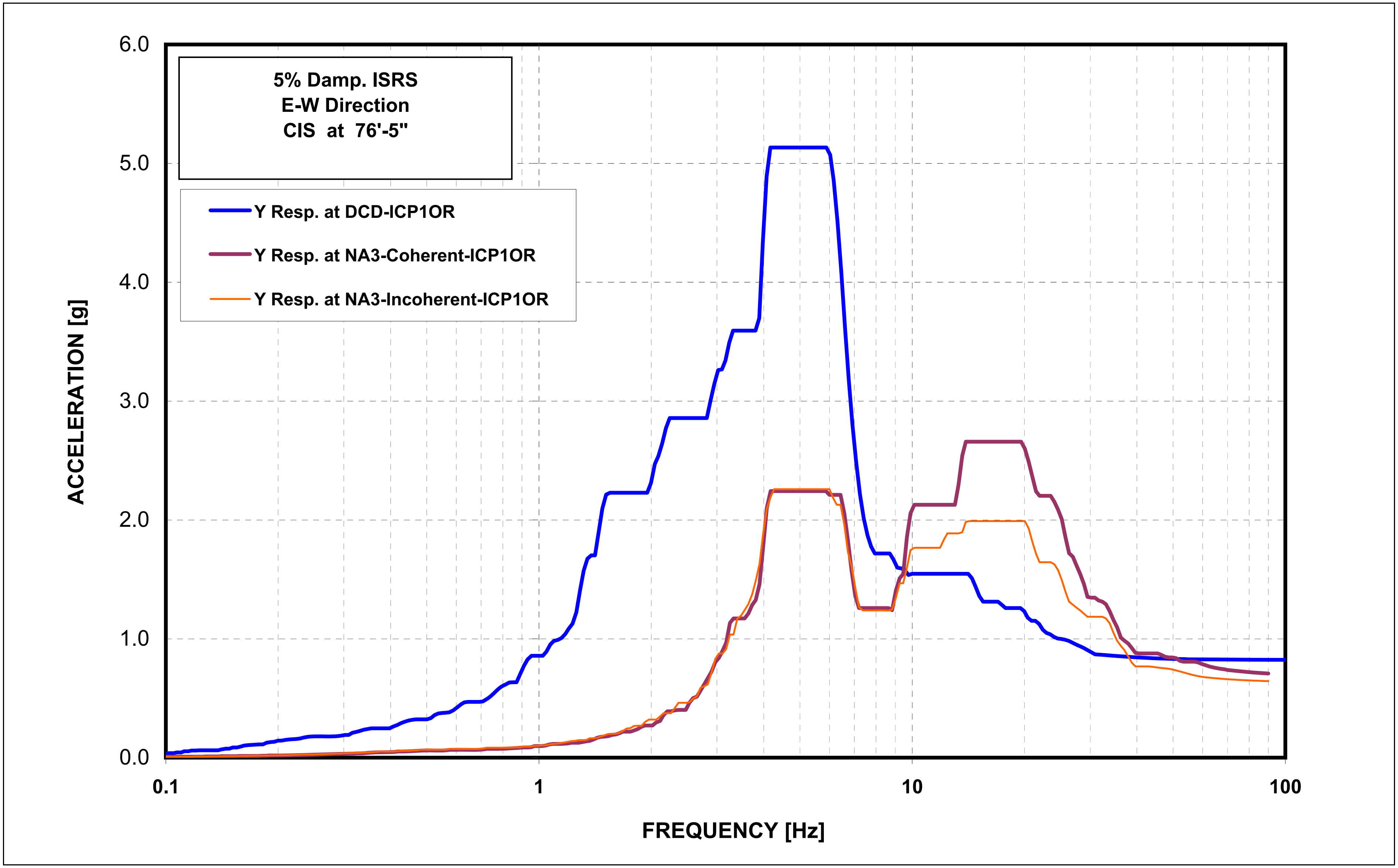


Figure 3NN-23 ISRS for CIS Vertical Direction at ICP1 - Elevation 76'- 5" (Sheet 134 of 143)

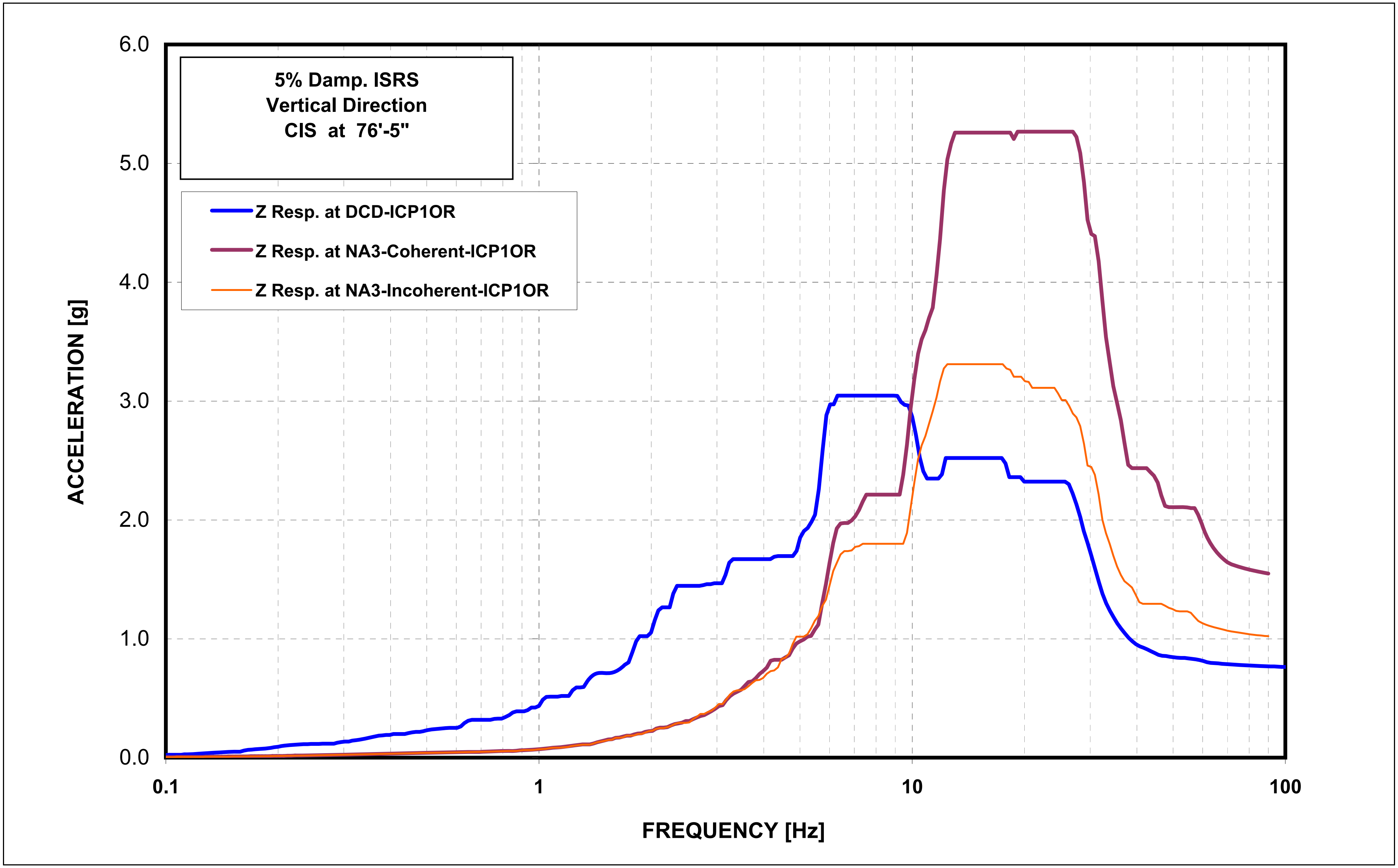


Figure 3NN-23 ISRS for CIS N-S Direction at ICP2 - Elevation 112'-4" (Sheet 135 of 143)

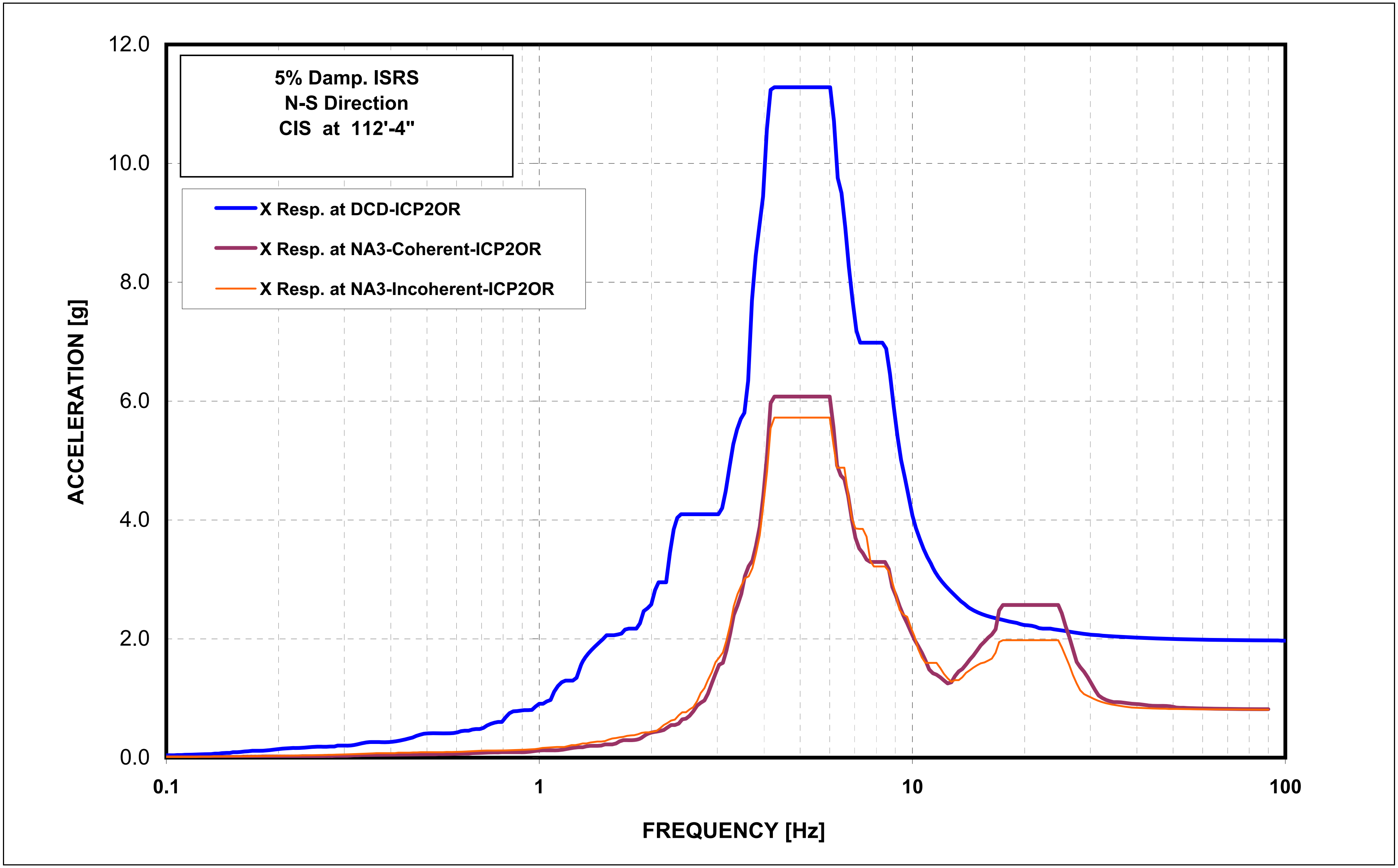


Figure 3NN-23 ISRS for CIS E-W Direction at ICP2 - Elevation 112'-4" (Sheet 136 of 143)

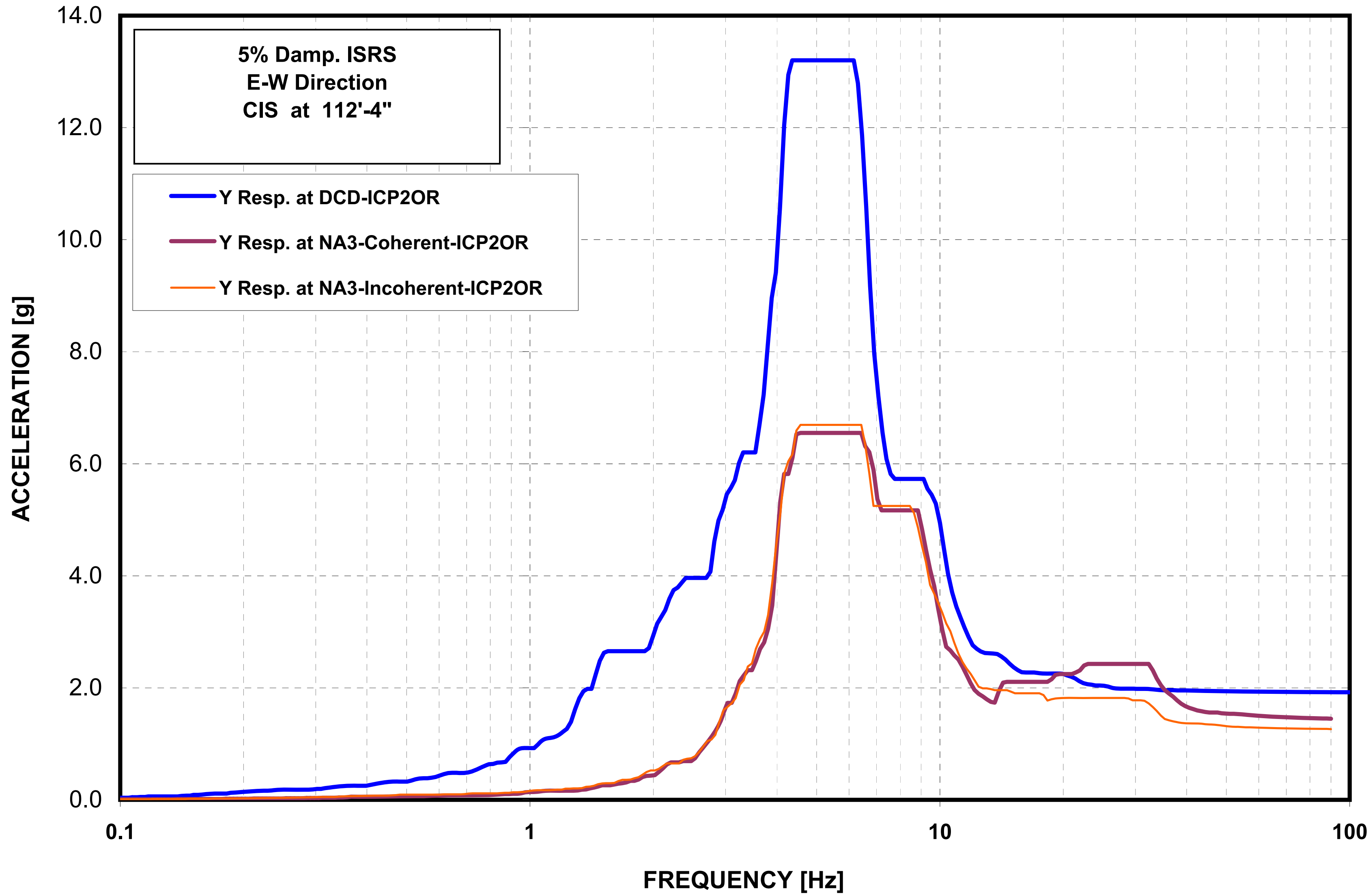


Figure 3NN-23 ISRS for CIS Vertical Direction at ICP2 - Elevation 112'- 4" (Sheet 137 of 143)

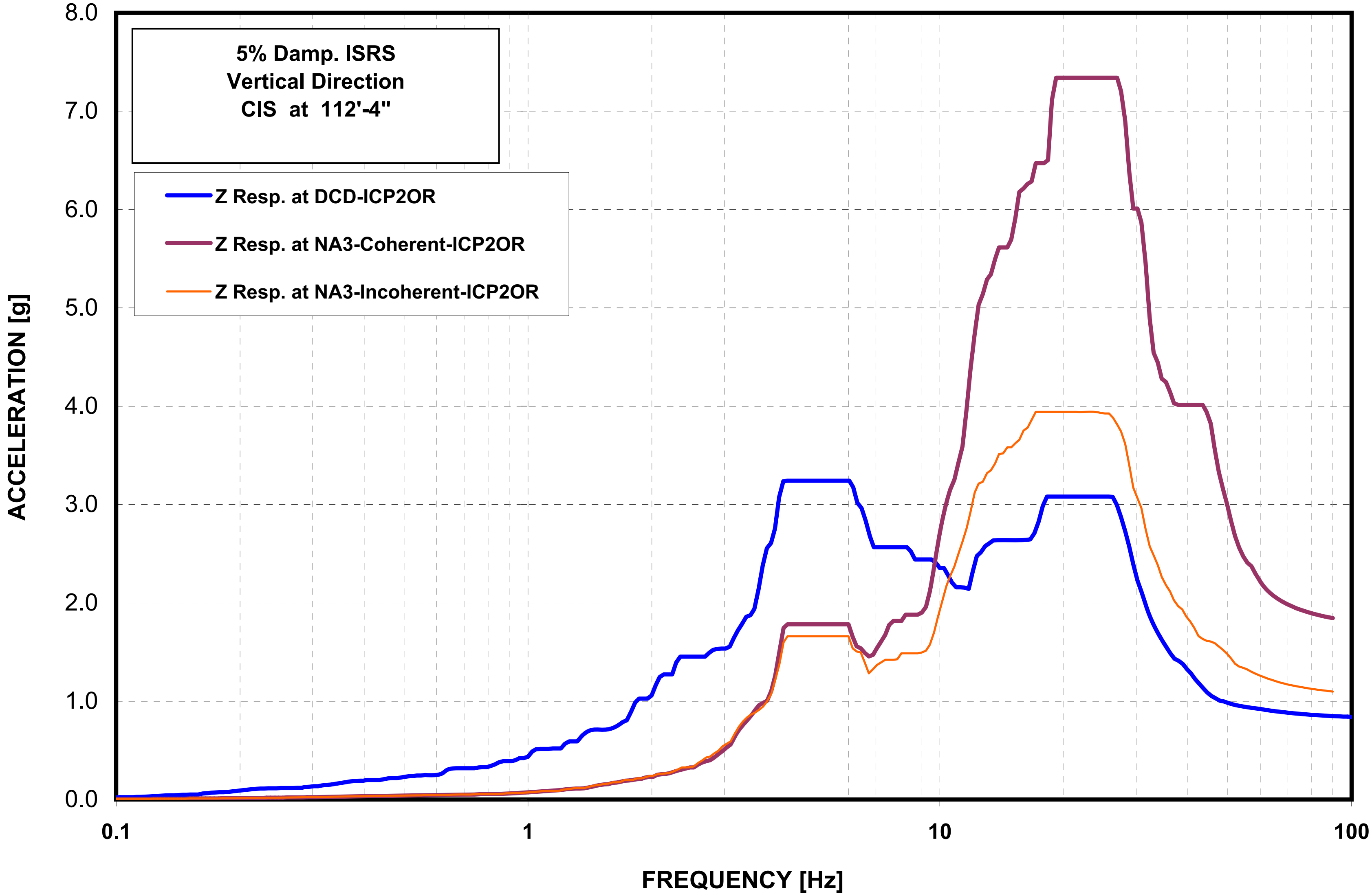


Figure 3NN-23 ISRS for CIS N-S Direction at ICP3 - Elevation 139'- 5" (Sheet 138 of 143)

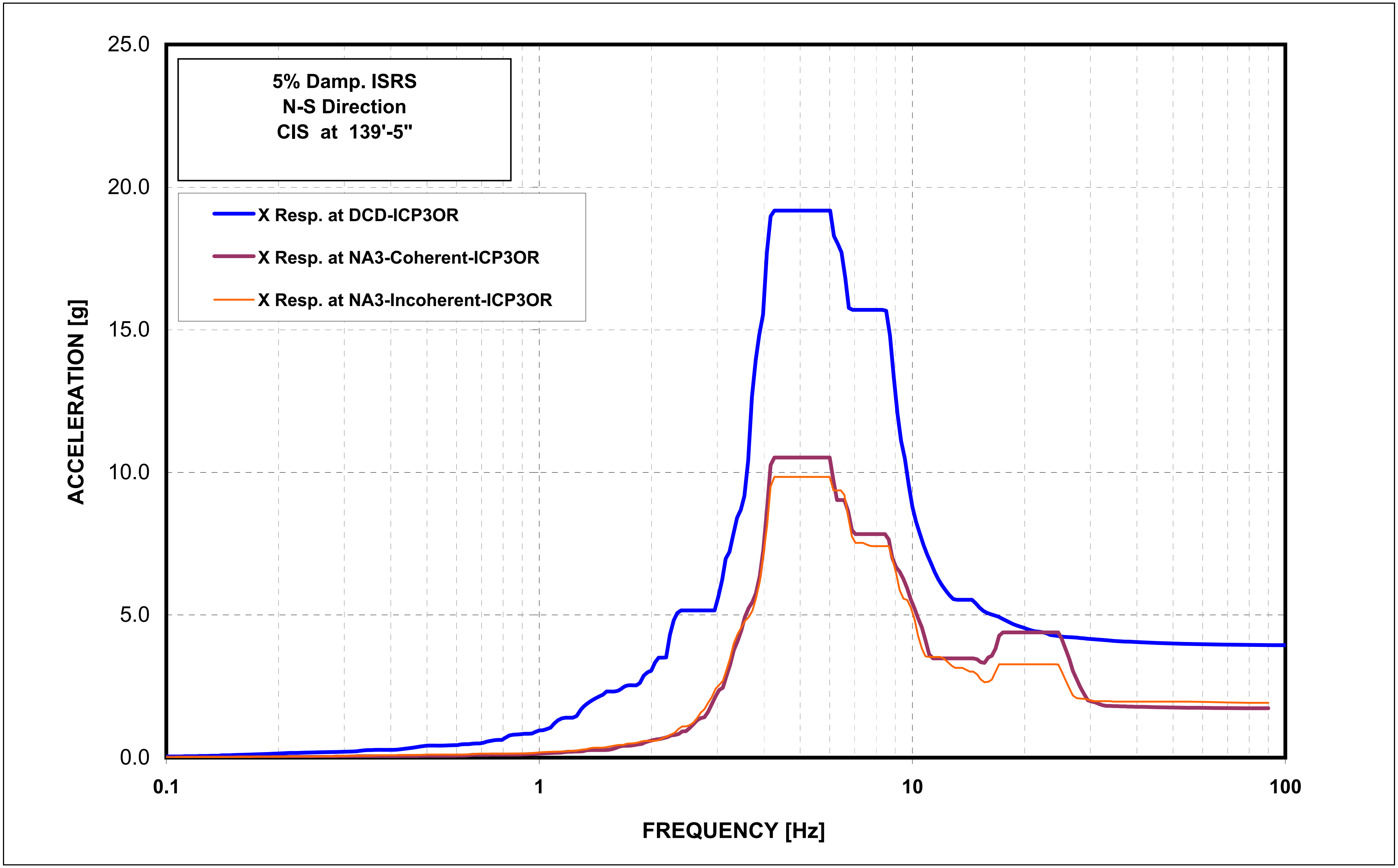


Figure 3NN-23 ISRS for CIS E-W Direction at ICP3 - Elevation 139'-5" (Sheet 139 of 143)

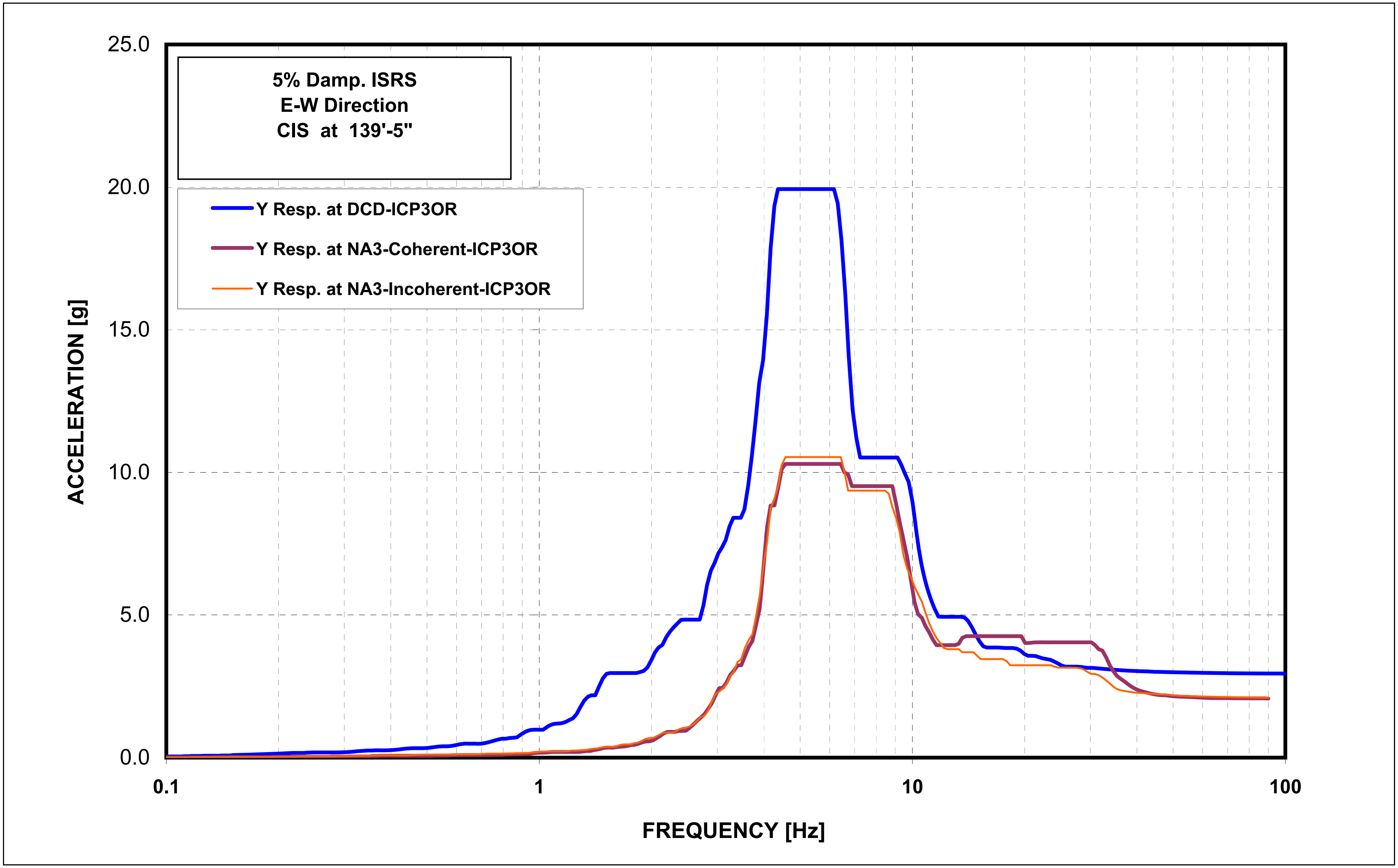


Figure 3NN-23 ISRS for CIS Vertical Direction at ICP3 - Elevation 139'- 5" (Sheet 140 of 143)

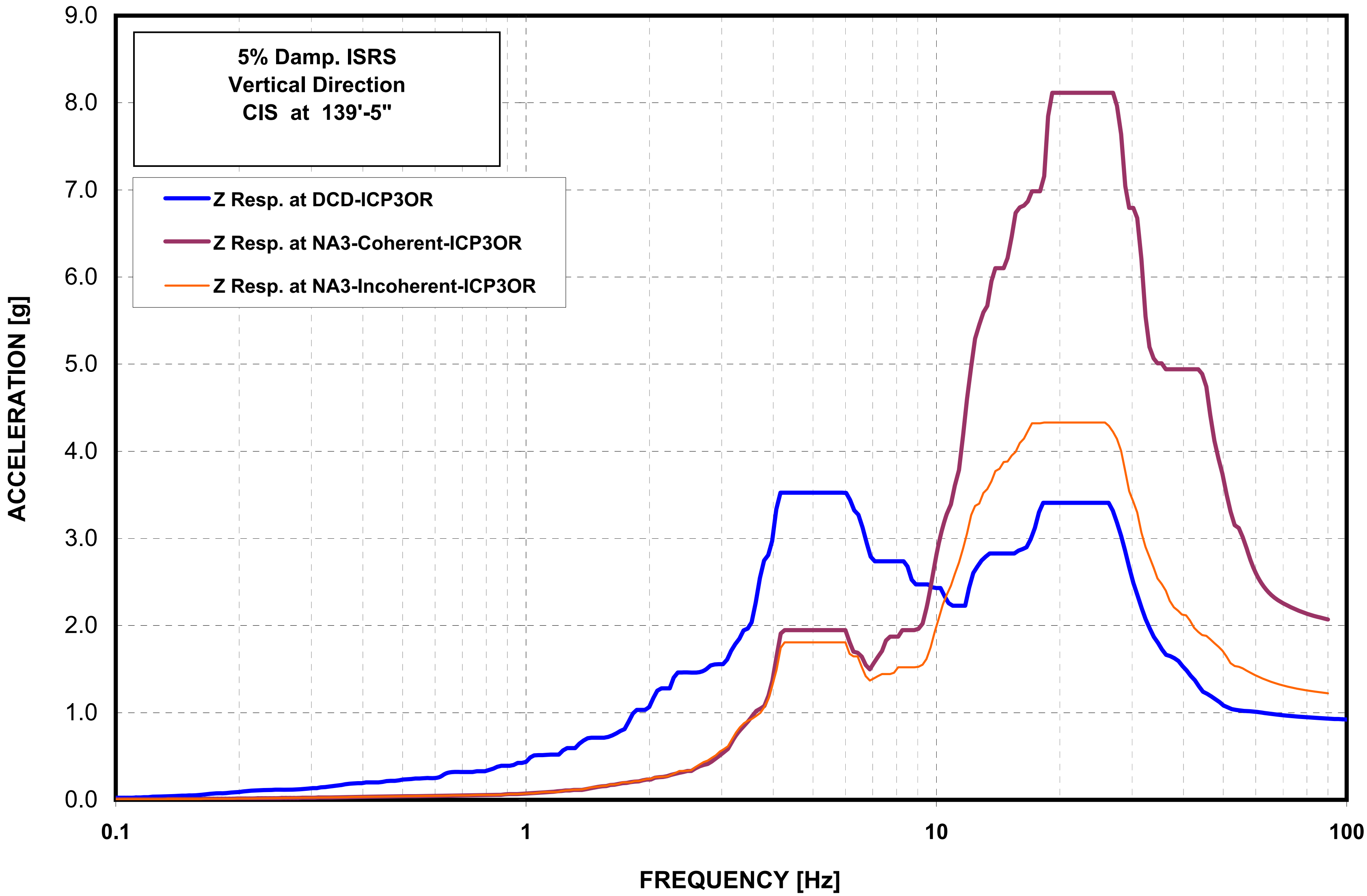


Figure 3NN-23 ISRS for CIS N-S Direction at ICSG - Elevation 112'-0" (Sheet 141 of 143)

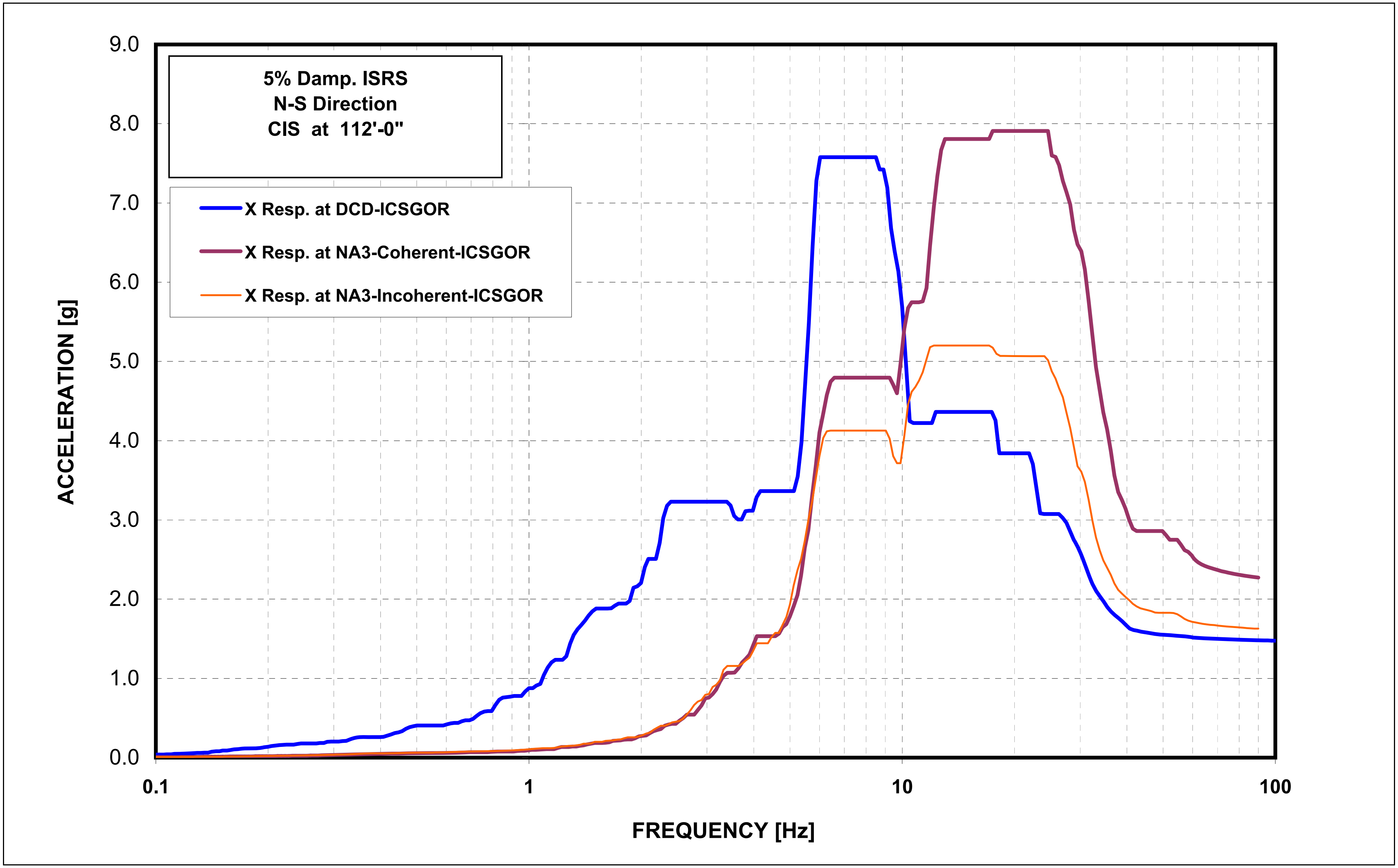


Figure 3NN-23 ISRS for CIS E-W Direction at ICSG - Elevation 112'-0" (Sheet 142 of 143)

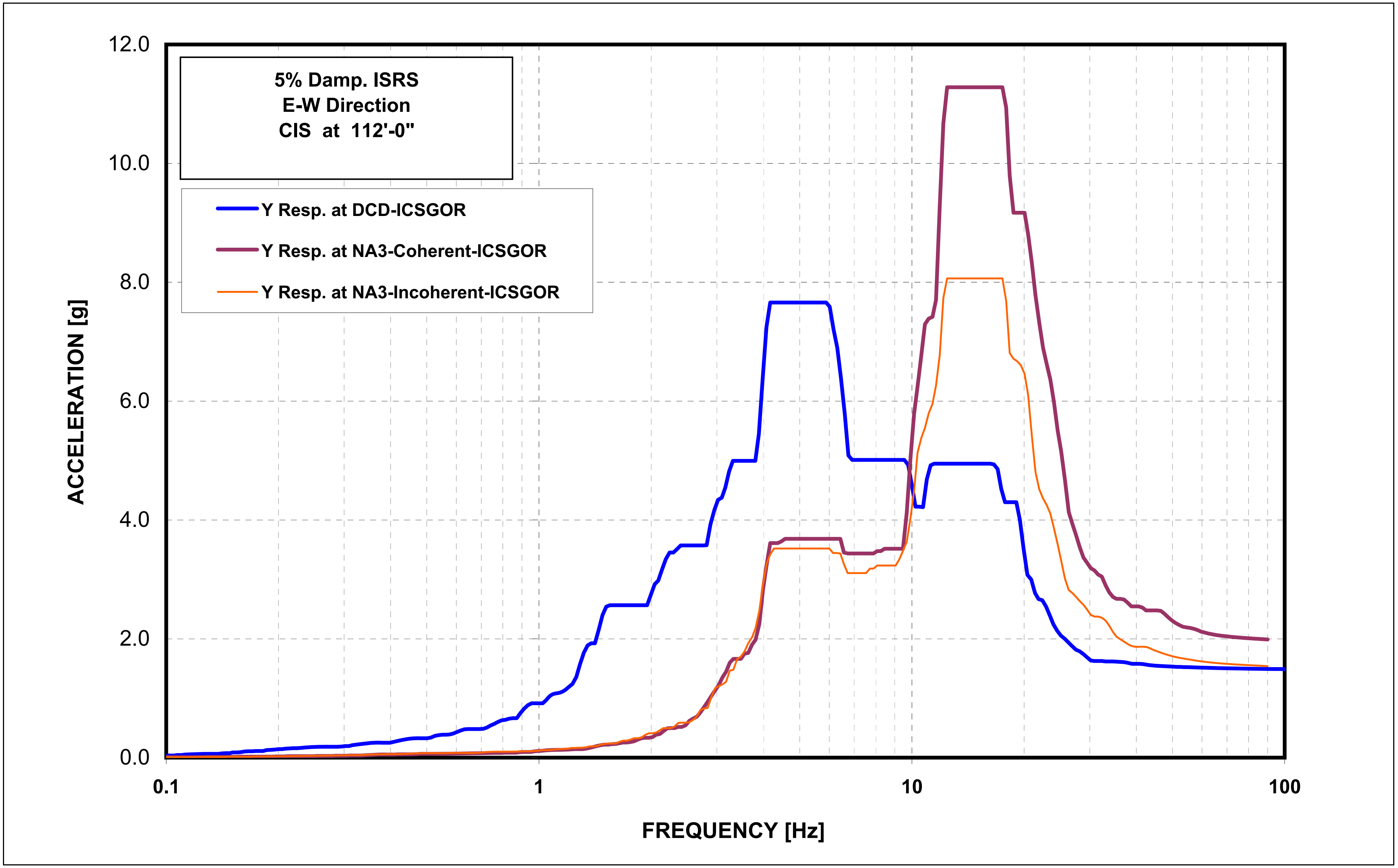
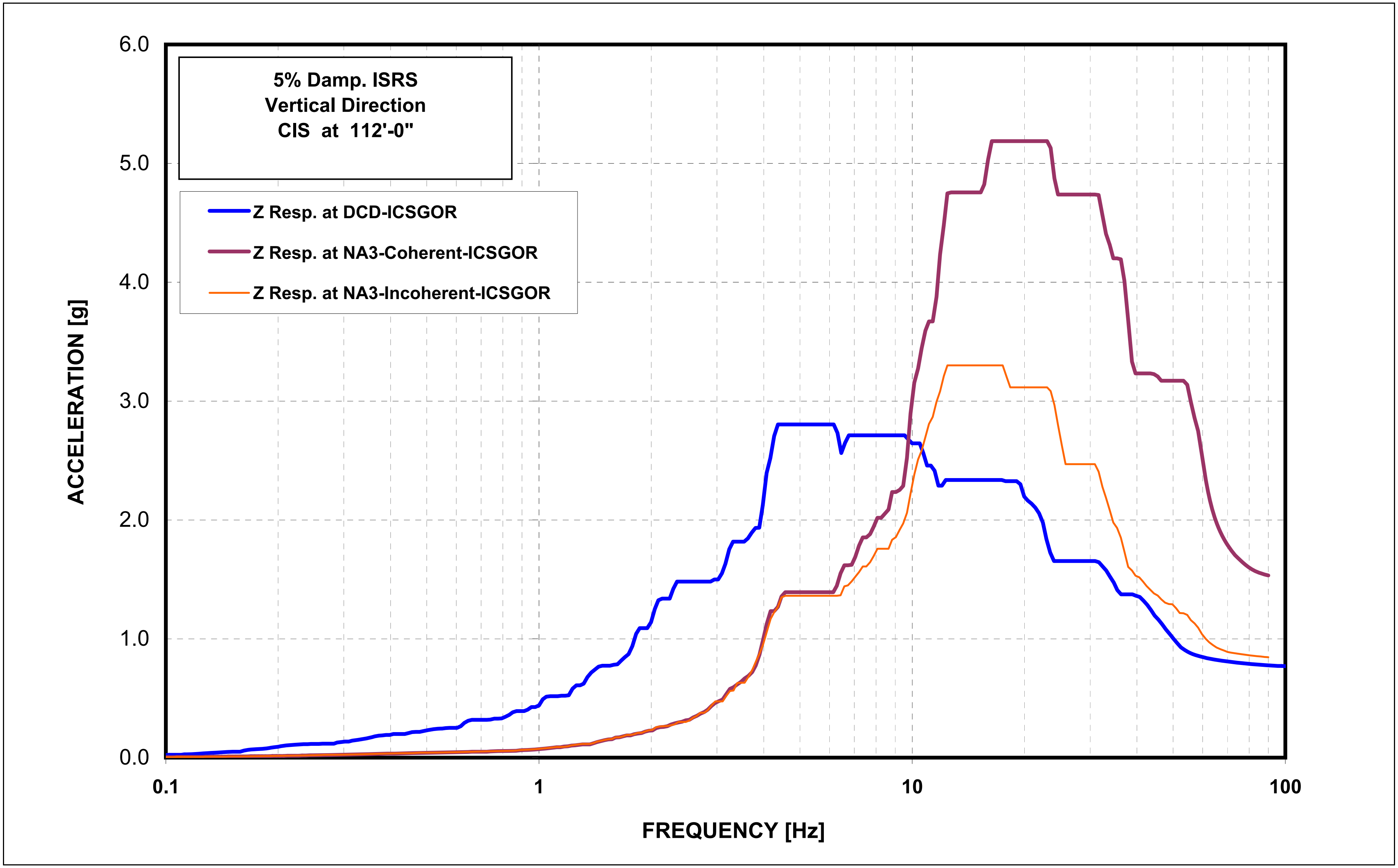


Figure 3NN-23 ISRS for CIS Vertical Direction at ICSG - Elevation 112'-0" (Sheet 143 of 143)



NAPS COL 3.7(5)
NAPS COL 3.7(6)
NAPS COL 3.7(24)
NAPS COL 3.7(30)
NAPS DEP 3.7(1)
NAPS SUP 3.7(2)
NAPS SUP 3.7(3)

Appendix 3OO Site Response Analysis and Development of SSI Analysis Input

This appendix describes the development of the seismic design ground motions and the strain-compatible soil profile properties, which are used in the Soil-Structure Interaction (SSI) analysis of the following seismic category I structures:

- Reactor Building Complex (R/B Complex); this includes the R/B, the PCCV and the CIS, which all rest on a common basemat
- East and West PS/B
- East and West PSFSV
- UHSRS A, B, C and D
- East and West ESWPT

Note that while the R/B Complex and PS/B are included in the US-APWR standard plant design, the PSFSV, UHSRS and ESWPT are site-specific structures.

Section 3OO.1 describes the development of the FIRS and the resulting SSI Input motions, and SSI soil profiles. The soil amplification functions are developed in accordance with Approach 2 in NUREG/CR-6728 (Reference 3OO-6), through seismic site response analysis using the LF and HF hard rock motions, presented in Section 2.5.2.6.7, and the soil profile properties, presented in Section 2.5.4.2. The LF and HF hard rock spectra are defined in Section 2.5.2.6.7.

The development of the SSI soil property profiles is described in Section 3OO.2. The acceleration time histories that are applied at the foundation of the structures in the SSI analysis are presented in Section 3OO.3. Section 3OO.4 presents a list of the references.

3OO.1 FIRS and SSI Input Motions

The Unit 3 site includes several seismic category I structures founded at different elevations. Table 3OO-201 presents the embedment elevations and depths of these structures. Note that all elevations are based on the NAVD88 datum with design plant grade at Elevation +290 ft (+290.86 ft based on NGVD29). The design ground water table information is provided in Section 2.4.12.

The generation of low-strain, site-specific, simulated soil property profiles is described in Section 3OO.1.1, the site response analysis is described in Section 3OO.1.2, and the calculation of FIRS is presented in Section 3OO.1.3. For site-specific structures, the FIRS are augmented with the Certified Seismic Design Response Spectra (CSDRS) scaled to a PGA of 0.1g. The CSDRS scaled to a PGA of 0.1g satisfies the minimum design response spectra requirements as described in 10 CFR 50, Appendix S (Reference 3OO-5). The SSI Input motions are obtained from the FIRS following the guidance of ISG-017 (References 3OO-8 and 3OO-4).

The development of the smooth SSI Input motions, satisfying 10 CFR 50, Appendix S, is described in Section 3OO.1.4.

3OO.1.1 Dynamic Soil Profile and Stochastic Simulation

As described in Section 2.5.4.2, the upper in situ soil is characterized as residual clays and clayey silts (Zone I) which is scarce across the site and will be removed. This zone is followed by saprolite (Zone IIA and Zone IIB), followed by rock which is classified into three zones: Zone III (weathered rock), Zone III-IV (moderately weathered to slightly weathered rock) and Zone IV (slightly weathered to fresh rock). The extent of excavation at the location of each structure is described in detail in Section 2.5.4.5. Structural backfill is used on the sides of all the Seismic Category I structures.

The computer program SPS is used to generate site-specific simulated (randomized) soil profiles to represent the dynamic properties of the site while considering the uncertainty associated with each of these properties. The generation of the low-strain simulated soil profiles uses the input BE properties and their associated uncertainty. The uncertainty is expressed in terms of statistical distribution, standard deviation (SD), and correlation among engineering parameters.

Section 2.5.4.2 provides the static and dynamic soil properties including shear wave velocity profiles, soil layer thicknesses, unit weights, Poisson's ratios, as well as strain-dependent property curves and damping ratios. The properties of the different soil, rock and concrete layers under each structure provide the BE properties and an estimate of the variation of these properties. Profile simulation accounts for the variation of the shear wave velocities, damping ratios, strain-dependent property curves, as well as the thicknesses of the different layers to generate the simulated profile sets for the considered structures.

In the case of the R/B Complex, profiles 1 and 2, as defined in Section 2.5.4.2, are combined by taking their log-mean and augmenting it with backfill properties for the top 40 ft to develop the BE profile. Figure 3NN-1 presents the site-specific BE shear-wave velocity profile for the R/B Complex. Note that the concrete fill, starting at a depth of 40 ft, has a BE shear-wave velocity of 7000 ft/sec, while backfill properties are used in the top 40 ft. Figure 3OO-202 presents the set of 60 shear-wave velocity simulated profiles before including thickness variation, i.e. based on the BE thicknesses provided for each soil layer. Note that the log-average (simulated median) profile matches the input BE profile very closely. Maximum and minimum bounds of twice the SD around the BE are imposed to prevent unrealistic shear-wave velocity realizations. Figure 3OO-203 presents the set of 60 shear-wave velocity simulated profiles, including thickness variation, representing the site conditions under the R/B Complex. Note that while the simulated median profile matches the input BE profile, it shows smoother transitions between the consecutive strata, which is the result of the combination of shear-wave velocity and thickness variation in the simulated profiles. For the purposes of site response analysis, halfspace bedrock, where the input hard rock motion is applied, is defined by a minimum shear-wave velocity of 9200 ft/sec. Bedrock depth varies across the site and is generally found at a depth of around 145 ft from finished grade (refer to Section 2.5.4).

As described in Section 2.5.4.2, the structural backfill, in situ saprolite, and Zone III rock are each assigned a set of strain-dependent property curves (shear modulus degradation and damping), while concrete fill, Zone III-IV rock, and Zone IV rock are assigned linear properties (strain-independent shear modulus and damping). Figure 3OO-204 presents the simulated strain-dependent property curves for the top structural backfill layer of the R/B Complex site (referred to as Fill1). In these plots, the BE and simulated median are compared, as well as the input log-standard deviation (Input SD) and simulated log-standard deviation (Simulated SD). Maximum and minimum bounds of twice the SD around the BE are imposed on the strain-dependent property curves. Note that damping curves, in Figure 3OO-204, are truncated at a maximum of 15 percent as described by SRP Section 3.7.1 (Reference 3OO-7), which explains the discrepancy between input and simulated properties once that upper limit is reached. The damping truncation at 15 percent is a conservative measure with respect to the subsequent use of the curves in site response analysis. The remaining strata (concrete fill, Zone III-IV rock, and Zone IV rock) are assigned strain-independent damping ratios, based on BE damping ratios of 1 percent with a log-standard deviation of 0.6. This amounts to damping values with one standard deviation range of 0.5 percent to 1.5 percent. The resulting low-strain damping ratio profiles are presented in Figure 3OO-205.

The soil profile simulation is conducted in the same manner to represent the site conditions under the other considered structures. As in the case of the R/B Complex, each set of simulated profiles is based on the site-specific BE profile for that particular structure, including the site-specific thicknesses of the different strata. The strain-independent and strain-dependent damping ratios are assigned for each stratum based on the soil classification of the stratum.

Figure 3OO-206 presents the BE shear-wave velocity profiles for the East and West PS/B, which are taken to represent the site conditions under the PSFSV given the proximity and similar conditions of the two structures. Note that the foundation elevation of the east PS/B is modeled at a depth of 40 ft, compared to a depth of 39 ft for the west PS/B, as described in Table 3OO-201. The BE shear-wave velocity profile for the East PS/B below Elevation 250 ft NAVD88 (250.86 ft NGVD29) (40 ft depth) exactly matches the GMRS shear wave velocity profile described in Section 2.5.2.5. Figure 3OO-207 presents the BE shear wave velocity profiles for the four UHSRS, and Figure 3OO-208 presents the BE shear wave velocity profiles for the East and West ESWPT. The South segment of the ESWPT is modeled as part of or using the same input to the SSI analysis of the PS/B, or the PSFSV according to the locations of various parts of that segment, as described in Section 3.7.2, therefore alleviating the need for the generation of the corresponding simulated soil profile sets. The BE shear wave velocity profile for the UHSRS Pipe Chase is presented in Figure 3OO-208. Note that the UHSRS Pipe Chase is the only structure which includes in situ soils (saprolite) near the sides of the chase as part of its BE profile, due to the limited excavation/backfill around the UHSRS Pipe Chase. The in situ soils are there fore modeled for the free-field site response analysis (refer to Section 3.7.2).

3OO.1.2 Site Response Analysis

The LF and HF input hard rock spectra are presented in Section 2.5.2.6.7, Figure 2.5-202a. The hard rock spectra are applied at bedrock having a shear wave velocity of 9,200 ft/sec, and are propagated from bedrock to the ground surface, through the sets of 60 simulated profiles, representing the site-specific conditions under each structure, using the computer program P-SHAKE.

As input for site response analysis, the duration of the input motion is specified as a parameter in P-SHAKE. The strong motion durations are determined as a function of the magnitudes (M) of the LF and HF input hard rock motions, from Table 2.3-1 in ASCE 4-98 (Reference 3OO-1). The magnitudes and corresponding durations are reported in Table 3OO-202. An additional parameter required for P-SHAKE is the effective strain ratio (equivalent uniform strain divided by maximum strain), which is calculated as a function of earthquake magnitude, as shown in Equation 3OO-1 (Reference 3OO-2). The resulting effective strain ratios used in site response analysis are reported in Table 3OO-202.

$$\text{Effective Strain Ratio} = (M-1)/10 \qquad \text{Equation (3OO-1)}$$

P-SHAKE implements an equivalent-linear iterative approach similar to SHAKE (References 3OO-2 and 3OO-9), where a number of iterations is needed to reach a converged solution. The free field 5 percent damping ARS, at the ground surface and at the bottom of foundation elevations, are computed as *full-column outcrop* motions through analysis of the full soil column up to the ground surface. The *full-column outcrop* motions are suitable for developing the SSI Input motion when the considered structure is modeled in the SSI analysis as embedded.

It should be noted that the R/B Complex, PS/B and PSFSV are analyzed assuming both embedded and surface foundations. The UHSRS are analyzed as surface founded structures, except for the UHSRS Pipe Chase which is analyzed with embedded foundation; while the east and west segments of the ESWPT are analyzed as embedded structures. Table 3OO-201 summarizes the SSI analysis condition of the considered structures.

In the case where the SSI analysis models the structure as surface founded, removing the soil layers on the sides of the structure, geologic outcrop motions need to be computed. In this case, a truncated soil column response (TSCR) is calculated, where the site response analysis is first conducted using the full soil column as described earlier, and then repeated using the strain-compatible properties obtained from the first step, without any further iteration, and truncating the soil layers corresponding to the embedment depth (Reference 3OO-209). As a result, the calculated horizontal ARS at the truncated surface is considered a geologic outcrop motion.

All spectra are calculated at 301 points equally spaced in log-scale in the frequency range from 0.1 to 100 Hz (a period range of 0.01 to 10 seconds). The cut-off frequency of the P-SHAKE runs is 100 Hz. Each set of 60 simulated profiles results in a set of ARS at the selected horizons and strain-compatible properties. ARS amplification functions are calculated at each horizon, by dividing the computed horizontal ARS at the given horizon by the ARS of the input hard rock motion. The natural logarithmic average of the resulting ARS is calculated and the exponent applied to the base *e* (where *e* = 2.718) of that average is labeled “Log-mean” ARS. Log-mean ARS amplification functions, and strain-compatible properties are calculated in the same manner.

Figure 3OO-209 and Figure 3OO-210 present the *full-column outcrop* ARS amplification functions calculated at the foundation level for the R/B Complex for the LF and HF motions, respectively. Figure 3OO-211 and Figure 3OO-212 present the corresponding *geologic outcrop* ARS amplification functions calculated at the same horizon. In these figures, the thin gray lines designate the response of the individual profiles, while the thick red line designates the log-mean response. The resulting log-mean ARS amplification functions are presented in Figure 3OO-213 and Figure 3OO-214 for the *full-column outcrop* and *geologic outcrop* ARS, respectively. The resulting 5 percent damping *full-column outcrop* log-mean ARS at foundation level and at finished grade are presented in Figure 3OO-215, along with the input bedrock HF and LF motions. Figure 3OO-216 presents the 5 percent damping *geologic outcrop* log-mean ARS at foundation level. It is to be noted that the same HF and LF rock motions are used for the site response analysis for all considered structures.

The PS/B ARS at the foundation level are calculated in the same manner and the log-mean *full-column outcrop* and *geologic outcrop* ARS are presented in Figure 3OO-217 and Figure 3OO-218, respectively for the east PS/B. Figure 3OO-219 and Figure 3OO-220 present the corresponding plots for the west PS/B. Note that the ARS developed for PS/B are also applicable to the PSFSV (including the adjacent ESWPT segment) due to their proximity and similar soil column profiles, and given the SSI analysis approach for PSFSV, which includes the concrete fill below PSFSV basemat extended to the foundation elevation of PS/B.

In the case of the four UHSRS, only *geologic outcrop* ARS are calculated, to be consistent with their SSI analysis as surface founded structures. The developed ARS for the four UHSRS are presented in Figure 3OO-221.

For the ESWPT, the *full-column outcrop* ARS at foundation level and at round surface are presented in Figures 3OO-222 and 3OO-223 for the East and West ESWPT segments, respectively. Figure 3OO-224 presents the *full-column outcrop* ARS at foundation level and at ground surface for the UHSRS Pipe Chase.

The P-SHAKE runs provide the strain-compatible shear wave velocities and damping ratio profiles (presented in Section 3OO.2) as well as the maximum strains within each soil layer. Figure 3OO-225 presents the log-mean maximum strain profiles for the R/B Complex. With the exception of the backfill layers (above the foundation elevation), the computed maximum strains are small (less than 0.002 percent) which confirms the adequacy of the strain-independent properties for the concrete fill and in situ rock layers. Similarly small strain levels, with the exception of backfill and saprolite layers, are computed for all considered structures.

3OO.1.3 **FIRS Calculation**

The horizontal performance-based surface response spectra (PBSRS) are calculated by enveloping the LF and HF log-mean 5 percent damping ARS at finished grade. Similarly, the horizontal FIRS are calculated by enveloping the LF and HF log-mean 5 percent damping ARS for the horizon of interest.

The horizontal PBSRS and FIRS are scaled by an appropriate V/H scaling function to obtain the corresponding vertical PBSRS and FIRS. For this calculation, the V/H function is that presented in Section 2.5.2.6.7 (Table 2.5-201).

Figure 3OO-226 presents the horizontal FIRS calculated as full-column outcrop motions for the R/B Complex, as well as the East and West PS/B, while Figure 3OO-227 presents the corresponding vertical spectra.

Similarly, Figure 3OO-228 and Figure 3OO-229 present the horizontal and vertical FIRS, respectively, for these structures calculated as geologic outcrop motions. The horizontal and vertical geological outcrop FIRS calculated for the East PS/B are exactly the same as the horizontal and vertical GMRS described in Section 2.5.2.6.7. The CSDRS, which is also shown in these figures, is clearly exceeded by the site-dependent FIRS in the high frequency range. A site-specific SSI analysis is therefore performed, as documented in Section 3.7.2, in order to validate the US-APWR for installation at the Unit 3 site.

In the case of the UHSRS, which are analyzed as surface founded structures, only *geologic outcrop* FIRS are needed, except for the UHSRS Pipe Chase which is analyzed with embedded foundation. The responses of UHSRS A, B and C are enveloped to yield one set of FIRS, in addition to another set for UHSRS D. Figure 3OO-230 presents the *geologic outcrop* FIRS for the UHSRS in the horizontal and vertical directions, in addition to the horizontal and vertical CSDRS scaled to a PGA of 0.1g representing the minimum requirements for the design GMRS.

In the case of the ESWPT and the UHSRS Pipe Chase, which are analyzed with embedded foundations, only *full-column outcrop* FIRS are needed. Figure 3OO-231 presents the *full-column outcrop* FIRS for the East and West ESWPT, and the UHSRS Pipe Chase in the horizontal direction, in addition to the horizontal CSDRS scaled to a PGA of 0.1g representing the minimum requirements for the design ground motion. Figure 3OO-232 presents the corresponding vertical spectra.

The PBSRS at the location of the considered structures are presented in Figure 3OO-233 and Figure 3OO-234.

3OO.1.4 **SSI Input Motions**

To develop the SSI Input motions starting from the calculated FIRS, the "NEI check" described below is performed for all *full-column outcrop* FIRS, and adjustments are made as necessary. In addition, in the case of the site-specific structures UHSRS and ESWPT, the FIRS are augmented by the CSDRS scaled to a PGA of 0.1g to satisfy the minimum design ground motion requirements of 10 CFR 50, Appendix S (Reference 3OO-5). The resulting ARS are smoothed and are labeled "SSI Input" motions.

NEI Check

The adequacy of the horizontal and vertical *full-column outcrop* FIRS, calculated at depth, as input ground motions for SSI analysis is verified. This verification is referred to as the “NEI check” in reference to the Nuclear Energy Institute (NEI) white paper (Reference 3OO-4) and Interim Staff Guidance (Reference 3OO-8). The check is conducted for each of the *full-column outcrop* FIRS, at the foundation elevation of the structures analyzed as embedded in SSI analysis, namely: R/B Complex, PS/B (same FIRS for PSFSV), UHSRS Pipe Chase and ESWPT (refer to Table 3OO-201).

To perform the NEI check, the horizontal and vertical FIRS are applied at the foundation level using the LB, BE, and UB SSI strain-compatible soil properties, presented in Section 3OO.2, using P-SHAKE. The horizontal FIRS are convolved to the surface using vertically propagating shear-waves (V_s) and the vertical FIRS are convolved to the surface through vertically propagating P-waves (V_p). Shear-wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. The horizontal and vertical free field 5 percent damping ARS at surface corresponding to each FIRS are determined and the envelope ARS resulting from the LB, BE and UB soil columns is compared to the PBSRS. In the event the envelope of the LB, BE and UB ARS (at surface) does not envelop the corresponding PBSRS, the FIRS must be modified. The frequency dependent adjustment factor is taken as unity or the ratio of PBSRS to the envelope of LB, BE, and UB ARS, whichever is greater. This adjustment factor is applied to the computed FIRS at the foundation level to yield the horizontal and vertical Adjusted FIRS.

Figure 3OO-235 presents the horizontal 5 percent damping ARS calculated at the ground surface using the FIRS at 40 ft depth for the R/B Complex as input to P-SHAKE, and using the LB, BE and UB SSI strain-compatible damping and shear-wave velocity profiles. The PBSRS is compared to the envelope of the response of the 3 soil cases to calculate the FIRS adjustment factor as described above, which is applied to the FIRS, resulting in the “Adjusted FIRS”. Figure 3OO-236 presents the corresponding plot for the vertical 5 percent damping ARS. Note that in the case of the horizontal FIRS, very little adjustment is made, while a larger amplification of the vertical FIRS is needed at the frequencies ranging from 1 to 9 Hz. This check was also performed for the other full-column outcrop FIRS for embedded structures (PS/B, UHSRS Pipe Chase and ESWPT), but the corresponding figures are not presented herein. Note that in the cases of PS/B, UHSRS Pipe Chase and ESWPT where more than one BE profile is developed, see Section 3OO.2, all SSI strain compatible profiles are used in performing the NEI check.

Minimum Requirements for Design Ground Motions

In the case of the R/B Complex, the *full-column outcrop* Adjusted FIRS, and the *geologic outcrop* FIRS are smoothed and labeled “SSI Input” motions. The SSI Input motion spectra (*full-column outcrop* and *geologic outcrop*) serve as the target spectra for the acceleration time history spectral matching, described in Section 3OO.3. The same procedure is implemented in the case of the PS/B except that the East and West motions are enveloped to yield one set of SSI Input motions. Figure 3OO-237 and Table 3OO-209 present the horizontal and vertical *full-column outcrop* SSI Input motion spectra for R/B Complex and PS/B, while Figure 3OO-238 and Table 3OO-210 present the corresponding spectra for the *geologic outcrop* SSI Input motions. Note that the minimum RRS check is not necessary for the R/B Complex and PS/B, which are covered by the standard design (Reference 3OO-8).

As discussed earlier, in the case of the UHSRS and ESWPT, the FIRS are augmented by the CSDRS scaled to a PGA of 0.1g to satisfy the minimum design ground motion requirements of 10 CFR 50, Appendix S (Reference 3OO-5). Moreover, the East and West ESWPT spectra are enveloped to yield one set of SSI Input motions representing the design ground motions for both the East and West segments of the ESWPT. A separate set is developed for the UHSRS Pipe Chase. The resulting ARS are smoothed and are labeled “SSI Input” motions. Figure 3OO-239 and Table 3OO-211 present the *geologic outcrop* SSI Input motion spectra for the four UHSRS units, while Figure 3OO-240 and Table 3OO-212 present the *full-column outcrop* SSI Input motion spectra for the UHSRS Pipe Chase and ESWPT.

3OO.2 SSI Strain-Compatible Soil Profiles

BE, LB and upper bound (UB) soil properties are calculated consistent with the FIRS for use in SSI analysis. The BE profile consists of the log-mean strain-compatible profile properties. The following equations, where S is the soil property considered, μ_{ln} is the log-mean and σ_{ln} is the log-standard deviation of that property, are used to calculate LB and UB properties:

$$S_{LB} = \exp(\ln(\mu_{ln}) - \sigma_{ln}) \qquad \text{Equation (3OO-2)}$$

$$S_{UB} = \exp(\ln(\mu_{ln}) + \sigma_{ln}) \qquad \text{Equation (3OO-3)}$$

LB and upper bound damping ratios are calculated as ± one log-standard deviation from the log average values using Equation 3OO-2 and Equation 3OO-3, respectively. LB shear wave velocity profiles are calculated as the minimum resulting from Equation 3OO-2 and $BE(V_S)/\sqrt{1.5}$, and upper bound shear wave velocity profiles are calculated as the maximum resulting from Equation 3OO-3 and $BE(V_S) \times \sqrt{1.5}$. LB, BE, and UB primary wave velocities (V_P) are calculated using Equation 3OO-4 where ν is the Poisson's ratio, and V_S is LB, BE, and UB shear wave velocities. In addition, below the ground water level, a minimum P-wave velocity of 5,000 ft/sec is imposed, on the condition that ν does not exceed 0.48.

$$V_P = V_S\sqrt{\frac{2-2\nu}{1-2\nu}} \qquad \text{Equation (3OO-4)}$$

Figure 3OO-241 presents the SSI shear wave velocity profiles for the R/B Complex. SSI damping and P-wave velocity profiles, for the R/B Complex, are presented in Figure 3OO-242 and Figure 3OO-243, respectively. Note that the lower shear wave and P-wave velocity are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile. Table 3OO-203 presents the digital values for the R/B Complex SSI soil profiles.

In the case of the PS/B, consistent with the SSI Input motions (one set for East and West PS/B), a set of four SSI profiles is developed. This set consists of the LB and BE profiles for East PS/B, in addition to the BE and UB profiles for the West PS/B. These profiles are developed in a similar manner to those developed for the R/B Complex. Figure 3OO-244 presents the shear wave velocity SSI profiles for the PS/B. The corresponding SSI damping and P-wave velocity profiles are presented in Figure 3OO-245 and Figure 3OO-246, respectively. Table 3OO-204 presents the digital values for the PS/B SSI soil profiles, which are also applicable to the PSFSV.

Similarly, in the case of UHSRS, one set of SSI profiles (LB, BE and UB) is developed for UHSRS D, as shown in Figure 3OO-247 through Figure 3OO-249 and Table 3OO-205), and another set for UHSRS units A, B and C (overall LB, BE for UHSRS A, BE for UHSRS B, BE for UHSRS C, and overall UB), as shown in Figure 3OO-250 through Figure 3OO-252 and Table 3OO-206.

In the case of ESWPT, one set of SSI profiles is developed for the East and West segments (overall LB, BE for East ESWPT, BE for West ESWPT, and overall UB), as shown in Figure 3OO-253 through Figure 3OO-255 and Table 3OO-207. The SSI strain-compatible soil profiles for the UHSRS Pipe Chase (LB, BE and UB) are shown in Figure 3OO-256 through Figure 3OO-258 and Table 3OO-208.

3OO.3 SSI Input Acceleration Time Histories

Corresponding to each set of horizontal and vertical SSI Input motion spectra, described in Section 3OO.1.4, a three component set (two horizontal and one vertical) of spectrum compatible acceleration time histories is developed for use as input time histories for SSI analysis. The starting seed time histories are selected from the database of acceleration time histories contained within NUREG CR-6728 (Reference 3OO-6). The selection is based on the resulting deaggregation Mbar and Dbar values for LF case associated with the hard rock (i.e., 9200 ft/sec) spectra. Based on the deaggregation information the starting seed time histories were selected from the Magnitude > 7 and distance between 100–200 km bins of CEUS time histories. The same seed time histories were used in the development of the spectrum compatible time histories for all Seismic Category I structures.

One set of three statistically independent acceleration time histories of motions (i.e., two horizontal and one vertical component) is developed for each set of SSI Input motion spectra. These time histories are modified to be spectrum compatible following Option 1, Approach 2 of SRP 3.7.1 (Reference 3OO-7). The input seed time histories are modified to be spectrum compatible using the computer program RSPM. The baseline correction program BLINE, a component program of RSPM, is also used in the process after each iteration of RSPM.

For each time history the average ratio between the acceleration time history response spectrum and the corresponding target acceleration response spectrum (both at a spectral damping of 5 percent) was greater than 1.0. In addition, the spectral matching criteria given in SRP 3.7.1 (Reference 3OO-7) for Option 1, Approach 2 were satisfied in each spectral matching case.

The comparison between the scaled spectrum compatible ARS and the target spectra and boundary range is plotted in Figure 3OO-259 for the first horizontal direction (H1). Figure 3OO-260 and Figure 3OO-261 show the same comparisons for the second horizontal direction (H2) and the vertical direction (UP), respectively.

The zero-lag cross correlation for each three component sets of spectrum compatible acceleration time histories are computed to verify the acceptability of the acceleration time histories. As an example the zero-lag cross correlations for the R/B Complex case are listed in Table 3OO-213. These computed values are less than the required maximum acceptable value of 0.16.

In addition to the cross-correlation values, the peak ground motion parameters and associated ratios are listed in Table 3OO-214 for the R/B Complex case with embedded foundation. Based on the target spectra used in the spectral matching procedure being a composite of both the HF and LF cases (i.e., the deaggregation values are bi-modal), the resulting V/A and $A*D/V^2$ ratios do not fall within the bin values reported in NUREG CR-6728 (Reference 3OO-6). This observed deviation from the reported bin values is caused by the relatively large PGA value from the high frequency case (i.e., small magnitude event at relative close distances) compared to the intermediate and longer spectral period range PGV and PGD which is controlled by the LF case (i.e., large magnitude event at a relatively large distance). Given this understanding of the composite nature of the target spectra used in the spectral matching procedure, the peak ground motion parameter values and associated ratios listed in Table 3OO-214 are acceptable.

The total time length of the time histories is 59.0 seconds which is greater than the required minimum of 20 seconds. In addition, the Arias durations given in Table 3OO-214 are longer than the minimum value of 6 seconds given in SRP 3.7.1 (Reference 3OO-7). Figure 3OO-262 presents the acceleration, velocity and displacement time histories for the first horizontal direction (H1) spectrally matched to the SSI Input motion for the R/B Complex analyzed as surface foundation. Figure 3OO-263 and

Figure 3OO-264 present the corresponding plots for the second horizontal direction (H2), and the vertical direction (UP), respectively.

Figure 3OO-265 through Figure 3OO-267 present the corresponding set of time histories spectrally matched to the SSI Input motion for the R/B Complex analyzed as embedded foundation. The input time histories needed for SSI analysis of the R/B Complex with embedded foundation are *within* motions corresponding to each of the SSI soil profiles. As such, each of the *outcrop* acceleration time histories (2 horizontal and 1 vertical), is used as input at the foundation level of the R/B Complex to a SHAKE2000 soil column model of the SSI soil profiles (LB, BE and UB), and their corresponding 5 percent damping *within* time histories are obtained at the same horizon. The horizontal acceleration time histories are applied using strain compatible shear-wave velocities (V_S) and the vertical acceleration time-history is applied using corresponding P-wave velocities (V_P). The strain compatible shear-wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. This analysis results in a set of 3 *within* motions for each SSI soil profile: two horizontal and one vertical, presented in Figure 3OO-268, Figure 3OO-269 and Figure 3OO-270 for the LB, BE and UB soil profiles of the R/B Complex, respectively.

The same procedure for the generation of acceleration time histories for the SSI analysis of the R/B Complex, with surface and embedded foundations, is implemented, as applicable, for the other Seismic Category I structures: PS/B (same input motions used for PSFSV), UHSRS and ESWPT. The SSI analysis approach for Seismic Category I structures is summarized in Table 3OO-201.

3OO.4 References

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3OO-5 NRC (2008). Domestic Licensing of Production and Utilization Facilities, 10 CFR Part 50, U.S. Nuclear Regulatory Commission, February 2008.

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Table 3OO-201 Bottom of Foundation Depths and Elevations of Seismic Category I Structures

Building	Foundation Bottom Elevation* [ft]	Embedment Depth to Bottom of Foundation** [ft]	SSI Analysis Approach
R/B Complex	+251	39***	Embedded and surface foundation
PS/B (East & West)	+251	39***	Embedded and surface foundation
PSFSV (East & West)	+272	18	Embedded and surface foundation
UHSRS (4 units)	+277	13	Surface foundation
UHSRS Pipe Chase (btw/ UHSRS B & UHSRS C)	+286	4	Embedded foundation
ESWPT (East & West)	+259	31	Underground structure**** (embedded foundation)

* All elevations are based on NAVD88 datum. The conversion from NAVD88 datum elevations to NGVD29 datum elevations is +0.86 ft.

** Embedment depth is measured from finished grade at Elevation +290 ft

*** Embedment depths for R/B Complex and East PS/B are modeled at 40 ft depth

****The SSI analysis for part of East ESWPT (adjacent to East PS/B) is implemented separately as surface founded, and uses the design ground motion for East PS/B.

Table 3OO-202 Input Hard Rock Motions and Associated Parameters

Rock Motion	Magnitude *(*M*)	Strong Motion Duration [sec]	Effective Strain Ratio
LF	7.2	13	0.62
HF	5.4	5	0.44

* Controlling earthquake magnitudes from SSAR Table 2.5-25

Table 3OO-203 SSI Strain-Compatible Soil Property Profiles for R/B Complex

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	BE Vs [ft/sec]	BE Vp [ft/sec]	BE Damping [%]	LB Vs [ft/sec]	LB Vp [ft/sec]	LB Damping [%]	UB Vs [ft/sec]	UB Vp [ft/sec]	UB Damping [%]
1	5	0	0.13	615	1150	2.95	396	740	4.82	956	1788	1.81
2	5	5	0.13	676	3444	4.36	415	2118	6.96	1098	5000	2.73
3	5	10	0.13	703	3584	5.09	420	2144	8.29	1175	5000	3.13
4	5	15	0.13	733	3738	5.40	452	2303	8.22	1190	5000	3.55
5	5	20	0.13	764	3894	5.52	461	2352	8.68	1264	5000	3.51
6	5	25	0.13	758	3864	5.85	459	2340	9.19	1251	5000	3.73
7	5	30	0.13	791	4035	5.88	452	2307	9.60	1384	5000	3.60
8	5	35	0.13	836	4263	5.61	478	2439	9.23	1461	5000	3.41
9	3.5	40	0.145	6865	10698	0.98	5605	8735	1.61	8408	13103	0.60
10	4	43.5	0.145	6865	10698	0.98	5605	8735	1.61	8408	13103	0.60
11	4	47.5	0.145	6865	10698	0.98	5605	8735	1.61	8408	13103	0.60
12	4	51.5	0.145	6865	10698	0.98	5605	8735	1.61	8408	13103	0.60
13	3.5	55.5	0.163	5054	12380	0.94	3705	9075	1.61	6895	16888	0.55
14	3.5	59	0.163	4979	12197	0.97	3659	8963	1.65	6776	16599	0.57
15	3.5	62.5	0.163	5218	12781	1.04	3947	9669	1.63	6897	16894	0.66
16	4	66	0.163	5371	13156	0.94	4138	10135	1.51	6972	17077	0.58
17	5	70	0.163	5255	12873	0.96	4015	9834	1.56	6880	16851	0.59
18	5	75	0.163	5192	12718	0.98	3861	9457	1.63	6982	17102	0.59
19	5	80	0.163	5173	12671	1.04	3772	9238	1.76	7095	17380	0.62
20	5	85	0.163	5217	12778	1.10	3671	8993	1.86	7412	18155	0.65

Table 3OO-203 SSI Strain-Compatible Soil Property Profiles for R/B Complex

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	BE Vs [ft/sec]	BE Vp [ft/sec]	BE Damping [%]	LB Vs [ft/sec]	LB Vp [ft/sec]	LB Damping [%]	UB Vs [ft/sec]	UB Vp [ft/sec]	UB Damping [%]
21	5	90	0.163	5310	13006	1.15	3744	9172	1.90	7529	18443	0.70
22	5	95	0.163	5734	14044	1.14	3899	9549	1.87	8432	20655	0.70
23	6	100	0.163	6543	16027	1.05	4617	11308	1.66	9273	22715	0.67
24	7	106	0.163	7633	13599	1.06	5827	10381	1.68	9999	17815	0.67
25	7	113	0.163	7944	14153	1.09	6197	11040	1.77	10185	18145	0.67
26	7	120	0.163	8623	15362	1.11	7041	12543	1.79	10561	18815	0.69
27	7	127	0.163	8623	15362	1.11	7041	12543	1.79	10561	18815	0.69
28	7	134	0.163	8665	15437	1.10	7075	12604	1.76	10612	18906	0.69
29	7	141	0.163	8726	15546	1.12	7125	12693	1.81	10687	19040	0.69
30	7	148	0.163	8828	15727	1.05	7208	12841	1.72	10812	19262	0.64
31	10	155	0.163	9034	16094	1.03	7376	13141	1.79	11064	19711	0.59
32	10	165	0.163	9122	16251	1.00	7448	13269	1.72	11172	19904	0.58

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-204 SSI Strain-Compatible Soil Property Profiles for East and West PS/B (Applicable to East and West PSFSV)

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	LB - East and West PS/B			BE - East PS/B		
				Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	5	0	0.13	350	654	5.39	548	1026	3.35
2	5	5	0.13	388	1976	7.45	620	3159	4.66
3	5	10	0.13	407	2073	8.16	653	3328	5.25
4	5	15	0.13	415	2116	8.56	679	3462	5.51
5	5	20	0.13	424	2164	9.14	697	3554	5.92
6	5	25	0.13	410	2091	9.96	692	3528	6.24
7	5	30	0.13	446	2275	9.54	739	3770	6.13
8	4	35	0.13	461	2350	9.96	762	3888	6.32
9	4.5	39	0.163	3418	8372	2.12	4393	10760	1.17
10	4	43.5	0.163	3418	8372	2.10	4393	10760	1.18
11	4	47.5	0.163	3418	8372	1.99	4393	10760	1.14
12	4	51.5	0.163	3443	8433	1.78	4448	10894	1.04
13	3.5	55.5	0.163	3483	8531	1.82	4604	11277	1.04
14	3.5	59	0.163	3567	8738	1.72	4751	11638	0.99
15	3.5	62.5	0.163	3795	9296	1.63	5015	12285	0.95
16	4	66	0.163	3948	9670	1.62	5143	12599	0.97
17	5	70	0.163	4185	10251	1.69	5390	13202	0.99
18	5	75	0.163	4305	10544	1.69	5463	13382	1.00
19	5	80	0.163	4247	10402	1.71	5471	13401	0.98

Table 3OO-204 SSI Strain-Compatible Soil Property Profiles for East and West PS/B (Applicable to East and West PSFSV)

				LB - East and West PS/B			BE - East PS/B		
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
20	5	85	0.163	4080	9995	1.81	5522	13525	0.98
21	5	90	0.163	4067	9961	1.88	5509	13493	1.02
22	5	95	0.163	4305	10545	1.90	5980	14647	1.04
23	6	100	0.163	5193	12719	1.87	6985	17110	1.08
24	7	106	0.163	6052	10782	1.92	7658	13642	1.11
25	7	113	0.163	6972	12422	1.79	8539	15213	1.07
26	7	120	0.163	7129	12701	1.77	8732	15556	1.04
27	7	127	0.163	7129	12701	1.77	8732	15556	1.04
28	7	134	0.163	7159	12754	1.73	8768	15621	1.03
29	7	141	0.163	7217	12858	1.73	8839	15748	1.00
30	7	148	0.163	7349	13092	1.72	9000	16034	0.97
31	10	155	0.163	7453	13279	1.64	9129	16263	0.95

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-204 SSI Strain-Compatible Soil Property Profiles for East and West PS/B (Applicable to East and West PSFSV) *(continued)*

				BE - WPS/B			UB - East and West PS/B		
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	5	0	0.13	625	1169	3.03	923	1727	1.98
2	5	5	0.13	703	3587	4.24	1063	5000	2.78
3	5	10	0.13	725	3698	4.77	1125	5000	3.15
4	5	15	0.13	741	3780	5.35	1145	5000	3.53
5	5	20	0.13	774	3946	5.29	1189	5000	3.59
6	5	25	0.13	776	3957	5.72	1258	5000	3.62
7	5	30	0.13	781	3983	5.91	1304	5000	3.71
8	4	35	0.13	833	4247	5.74	1344	5000	3.61
9	4	39	0.145	6975	10869	1.02	8542	13312	0.59
10	4	43	0.145	6975	10869	1.02	8542	13312	0.59
11	5	47	0.145	6975	10869	1.02	8542	13312	0.59
12	5	52	0.145	6975	10869	1.02	8542	13312	0.59
13	5	57	0.145	6975	10869	1.02	8542	13312	0.59
14	5	62	0.163	7115	14811	1.08	8714	18140	0.65
15	5	67	0.163	7156	14897	1.00	8815	18350	0.61
16	5	72	0.163	7415	15435	1.03	9294	19348	0.60
17	5	77	0.163	7436	15480	1.05	9550	19880	0.62
18	5	82	0.1631	7622	15867	1.00	9753	20302	0.60
19	5	87	0.1634	7562	15741	1.11	9261	19279	0.68

Table 3OO-204 SSI Strain-Compatible Soil Property Profiles for East and West PS/B (Applicable to East and West PSFSV) *(continued)*

				BE - WPS/B			UB - East and West PS/B		
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
20	5	92	0.1635	7692	16013	1.09	9421	19612	0.67
21	5	97	0.1636	7899	15053	1.05	9674	18435	0.64
22	5	102	0.1637	8080	15397	1.08	9895	18857	0.62
23	6	107	0.1638	8288	15239	1.06	10150	18664	0.61
24	6	113	0.1639	8376	15402	1.05	10259	18864	0.62
25	7	119	0.1639	8546	15714	1.03	10467	19246	0.61
26	7	126	0.164	8552	15726	1.04	10475	19260	0.60
27	7	133	0.164	8715	16025	0.99	10674	19626	0.59
28	7	140	0.164	8857	16285	0.96	10847	19946	0.57
29	9	147	0.164	8960	15963	0.93	10974	19550	0.55
30	10	156	0.164	9098	16208	0.94	11143	19851	0.56
31	15	166	0.164	9143	16288	0.91	11198	19949	0.53

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-205 SSI Strain-Compatible Soil Property Profiles for UHSRS D

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	BE			LB			UB		
				Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	20	0	0.145	6929.6	10799.1	1.00	5658.0	8817.4	1.82	8487.0	13226.1	0.55
2	28	20	0.150	2220.0	7362.9	0.60	1491.2	5000.0	1.09	3305.0	10961.4	0.33
3	10	48	0.150	2565.0	10781.1	0.60	1722.9	7241.8	1.09	3818.6	16050.3	0.33
4	10	58	0.150	4120.0	9702.1	0.60	2767.4	6517.0	1.09	6133.6	14443.9	0.33
5	10	68	0.163	6435.0	14166.0	1.00	4798.0	10562.2	1.82	8630.6	18999.4	0.55
6	5	78	0.163	7415.0	15853.9	1.00	5528.7	11820.8	1.82	9945.0	21263.2	0.55
7	5	83	0.163	8615.0	16117.2	1.00	6423.4	12017.0	1.82	11554.4	21616.3	0.55
8	10	88	0.164	9865.0	17086.7	1.00	8054.7	13951.2	1.82	12082.1	20926.8	0.55
9	10	98	0.164	8450.0	15537.3	1.00	6899.4	12686.2	1.82	10349.1	19029.3	0.55
10	10	108	0.164	9040.0	17227.3	1.00	7381.1	14066.0	1.82	11071.7	21099.0	0.55
11		118	0.164	9200.0	17211.6	1.00	7511.8	14053.2	1.82	11267.7	21079.8	0.55

* Top-depth is measured from foundation elevation at +277 ft NAVD88 (+277.86 ft NGVD29)

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C

			LB- UHSRS A, B and C				BE-UHSRS C			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	6	0	0.145	5658.0	8817.4	1.82	0.145	6929.6	10799.1	1.00
2	1	6	0.150	1759.9	5000.0	1.09	0.145	6929.6	10799.1	1.00
3	4	7	0.150	1759.9	5000.0	1.09	0.150	2620.0	8689.6	0.60
4	1	11	0.150	1874.1	5000.0	1.09	0.150	3110.0	8874.6	0.60
5	7	12	0.150	1874.1	5000.0	1.09	0.150	3110.0	8874.6	0.60
6	3	19	0.150	2089.0	5961.2	1.09	0.150	3110.0	8874.6	0.60
7	2	22	0.150	2089.0	5961.2	1.09	0.150	3110.0	8874.6	0.60
8	4	24	0.150	2794.3	6151.4	1.09	0.150	4160.0	9157.8	0.60
9	19	28	0.163	3810.0	7405.4	1.82	0.163	7460.0	14809.9	1.00
10	4	47	0.163	3810.0	7405.4	1.82	0.163	7460.0	14809.9	1.00
11	12	51	0.163	5562.2	11042.3	1.82	0.163	7460.0	14809.9	1.00
12	9	63	0.163	6561.3	13025.8	1.82	0.163	8800.0	17470.1	1.00
13	1	72	0.163	6561.3	13025.8	1.82	0.163	8800.0	17470.1	1.00
14	3	73	0.164	7148.4	13373.5	1.82	0.164	9850.0	17296.0	1.00
15	6	76	0.164	7679.2	13680.8	1.82	0.164	9850.0	17296.0	1.00
16	1	82	0.164	7666.9	14097.4	1.82	0.164	9850.0	17296.0	1.00
17	10	83	0.164	7666.9	14097.4	1.82	0.164	9390.0	17265.7	1.00
18	8	93	0.164	6266.6	12440.7	1.82	0.164	7675.0	15236.7	1.00
19	2	101	0.164	6266.6	12440.7	1.82	0.164	7675.0	15236.7	1.00

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C

			LB- UHSRS A, B and C				BE-UHSRS C			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
20	4	103	0.164	7283.1	13175.7	1.82	0.164	8920.0	16136.9	1.00
21	4	107	0.164	7283.1	13175.7	1.82	0.164	8920.0	16136.9	1.00
22	2	111	0.164	7283.1	13175.7	1.82	0.164	8920.0	16136.9	1.00
23	19	113	0.164	7511.8	14053.2	1.82	0.164	9200.0	17211.6	1.00
24	4	132	0.164	7511.8	14053.2	1.82	0.164	9200.0	17211.6	1.00
25	25	136	0.164	7511.8	14053.2	1.82	0.164	9200.0	17211.6	1.00
26		161	0.164	7511.8	14053.2	1.82	0.164	9200.0	17211.6	1.00

* Top-depth is measured from foundation elevation at +277 ft NAVD88 (+277.86 ft NGVD29)

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C *(continued)*

			BE-UHSRS B				BE-UHSRS A			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	6	0	0.145	6929.6	10799.1	1.00	0.145	6929.6	10799.1	1.00
2	1	6	0.150	2790.0	5422.8	0.60	0.145	6929.6	10799.1	1.00
3	4	7	0.150	2790.0	5422.8	0.60	0.145	6929.6	10799.1	1.00
4	1	11	0.150	2790.0	5422.8	0.60	0.145	6929.6	10799.1	1.00
5	7	12	0.150	2790.0	5422.8	0.60	0.150	2790.0	5422.8	0.60
6	3	19	0.163	5110.0	9932.1	1.00	0.163	5110.0	9932.1	1.00
7	2	22	0.163	5110.0	9932.1	1.00	0.164	8755.0	16379.1	1.00
8	4	24	0.163	5110.0	9932.1	1.00	0.164	8755.0	16379.1	1.00
9	19	28	0.163	5110.0	9932.1	1.00	0.164	8755.0	16379.1	1.00
10	4	47	0.163	5110.0	9932.1	1.00	0.164	10565.0	18299.1	1.00
11	12	51	0.164	8755.0	16379.1	1.00	0.164	10565.0	18299.1	1.00
12	9	63	0.164	8755.0	16379.1	1.00	0.164	10565.0	18299.1	1.00
13	1	72	0.164	8755.0	16379.1	1.00	0.164	9405.0	16755.5	1.00
14	3	73	0.164	8755.0	16379.1	1.00	0.164	9405.0	16755.5	1.00
15	6	76	0.164	10565.0	18299.1	1.00	0.164	9405.0	16755.5	1.00
16	1	82	0.164	10565.0	18299.1	1.00	0.164	10760.0	18893.9	1.00
17	10	83	0.164	10565.0	18299.1	1.00	0.164	10760.0	18893.9	1.00
18	8	93	0.164	10565.0	18299.1	1.00	0.164	10760.0	18893.9	1.00
19	2	101	0.164	9405.0	16755.5	1.00	0.164	10760.0	18893.9	1.00

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C *(continued)*

			BE-UHSRS B				BE-UHSRS A			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
20	4	103	0.164	9405.0	16755.5	1.00	0.164	10760.0	18893.9	1.00
21	4	107	0.164	9405.0	16755.5	1.00	0.164	10250.0	18542.9	1.00
22	2	111	0.164	10760.0	18893.9	1.00	0.164	10250.0	18542.9	1.00
23	19	113	0.164	10760.0	18893.9	1.00	0.164	10250.0	18542.9	1.00
24	4	132	0.164	10760.0	18893.9	1.00	0.164	9200.0	17211.6	1.00
25	25	136	0.164	10250.0	18542.9	1.00	0.164	9200.0	17211.6	1.00
26		161	0.164	9200.0	17211.6	1.00	0.164	9200.0	17211.6	1.00

* Top-depth is measured from foundation elevation at +277 ft NAVD88 (+277.86 ft NGVD29)

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C *(continued)*

			UB - UHSRS units A, B and C			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	6	0	0.145	8487.0	13226.1	0.55
2	1	6	0.145	8487.0	13226.1	0.55
3	4	7	0.145	8487.0	13226.1	0.55
4	1	11	0.145	8487.0	13226.1	0.55
5	7	12	0.150	4630.0	13212.0	0.33
6	3	19	0.163	6853.5	13320.8	0.55
7	2	22	0.164	10722.6	20060.2	0.55
8	4	24	0.164	10722.6	20060.2	0.55
9	19	28	0.164	10722.6	20060.2	0.55
10	4	47	0.164	12939.4	22411.7	0.55
11	12	51	0.164	12939.4	22411.7	0.55
12	9	63	0.164	12939.4	22411.7	0.55
13	1	72	0.164	12939.4	22411.7	0.55
14	3	73	0.164	12939.4	22411.7	0.55
15	6	76	0.164	12939.4	22411.7	0.55
16	1	82	0.164	13178.3	23140.3	0.55
17	10	83	0.164	13178.3	23140.3	0.55
18	8	93	0.164	13178.3	23140.3	0.55
19	2	101	0.164	13178.3	23140.3	0.55

Table 3OO-206 SSI Strain-Compatible Soil Property Profiles for UHSRS units A, B and C *(continued)*

			UB - UHSRS units A, B and C			
Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
20	4	103	0.164	13178.3	23140.3	0.55
21	4	107	0.164	13178.3	23140.3	0.55
22	2	111	0.164	13178.3	23140.3	0.55
23	19	113	0.164	13178.3	23140.3	0.55
24	4	132	0.164	13178.3	23140.3	0.55
25	25	136	0.164	12553.6	22710.4	0.55
26		161	0.164	11267.7	21079.8	0.55

* Top-depth is measured from foundation elevation at +277 ft NAVD88 (+277.86 ft NGVD29)

Table 3OO-207 SSI Strain-Compatible Soil Property Profiles for East and West ESWPT

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	LB - East & West ESWPT			BE - West ESWPT		
				Vs [ft/sec]	Vp [ft/sec]	Damping [%]	Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	3	0	0.130	427	799	3.74	661	1237	2.30
2	4	3	0.130	389	728	6.51	633	1185	3.93
3	3	7	0.130	421	2147	7.46	678	3456	4.66
4	5	10	0.130	451	2298	7.49	724	3690	4.76
5	5	15	0.130	477	2433	7.80	764	3894	4.98
6	5	20	0.130	476	2428	8.44	778	3968	5.48
7	3	25	0.130	494	2516	8.47	815	4158	5.45
8	3	28	0.130	490	2501	9.03	848	4326	5.68
9	3	31	0.130	490	2501	9.03	848	4326	5.68
10	4	34	0.130	490	2501	9.03	848	4326	5.68
11	4	38	0.130	490	2501	9.03	848	4326	5.68
12	4	42	0.130	490	2501	9.03	848	4326	5.68
13	3	46	0.150	2187	6363	0.91	3066	8918	0.53
14	3	49	0.150	2187	6363	0.91	3066	8918	0.53
15	4	52	0.150	2187	6363	0.91	3066	8918	0.53
16	4	56	0.150	2187	6363	0.91	3066	8918	0.53
17	5	60	0.150	2187	6363	0.91	3066	8918	0.53
18	3	65	0.150	3345	7152	0.93	4610	9856	0.55
19	3	68	0.150	3345	7152	0.93	4610	9856	0.55
20	3	71	0.163	5831	11575	1.82	7820	15525	1.00

Table 3OO-207 SSI Strain-Compatible Soil Property Profiles for East and West ESWPT

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	LB - East & West ESWPT Vs [ft/sec]	LB - East & West ESWPT Vp [ft/sec]	LB - East & West ESWPT Damping [%]	BE - West ESWPT Vs [ft/sec]	BE - West ESWPT Vp [ft/sec]	BE - West ESWPT Damping [%]
21	3	74	0.163	5831	11575	1.82	7820	15525	1.00
22	5	77	0.163	5831	11575	1.82	7820	15525	1.00
23	5	82	0.163	5831	11575	1.82	7820	15525	1.00
24	5	87	0.163	5831	11575	1.82	7820	15525	1.00
25	5	92	0.163	5831	11575	1.82	7820	15525	1.00
26	10	97	0.164	6250	12519	1.82	7655	15333	1.00
27	10	107	0.164	6250	12519	1.82	7655	15333	1.00
28	10	117	0.164	6250	12519	1.82	7655	15333	1.00
29	10	127	0.164	6880	12803	1.82	8426	15680	1.00
30	10	137	0.164	6880	12803	1.82	8426	15680	1.00
31	10	147	0.164	6880	12803	1.82	8426	15680	1.00
32	10	157	0.164	7421	13468	1.82	9089	16495	1.00
33	10	167	0.164	7421	13468	1.82	9089	16495	1.00
34	10	177	0.164	7421	13468	1.82	9089	16495	1.00
35	10	187	0.164	7421	13468	1.82	9089	16495	1.00
Halfspace			0.164	7512	14053	1.82	9200	17212	1.00

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-207 SSI Strain-Compatible Soil Property Profiles for East and West ESWPT *(continued)*

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight kcf	BE - East ESWPT			UB - East & West ESWPT		
				Vs ft/sec	Vp ft/sec	Damping %	Vs ft/sec	Vp ft/sec	Damping %
1	3	0	0.130	714	1337	2.08	1094	2047	1.39
2	4	3	0.130	693	1296	3.61	1134	2122	2.22
3	3	7	0.130	754	3846	3.92	1187	5000	2.55
4	5	10	0.130	781	3984	4.52	1264	5000	2.88
5	5	15	0.130	798	4068	4.90	1309	5000	3.13
6	5	20	0.130	839	4279	4.90	1382	5000	3.10
7	3	25	0.130	827	4219	5.31	1347	5000	3.50
8	3	28	0.130	852	4347	5.57	1468	5000	3.57
9	3	31	0.130	852	4347	5.57	1468	5000	3.57
10	3	34	0.130	852	4347	5.57	1468	5000	3.57
11	4	37	0.130	852	4347	5.57	1468	5000	3.57
12	4	41	0.130	852	4347	5.57	1468	5000	3.57
13	3	45	0.150	3785	9389	0.63	5624	13952	0.37
14	3	48	0.150	3785	9389	0.63	5624	13952	0.37
15	3	51	0.163	6628	13659	1.00	8889	18319	0.55
16	3	54	0.163	6628	13659	1.00	8889	18319	0.55
17	3	57	0.163	5397	11954	1.00	7238	16033	0.55
18	3	60	0.163	5397	11954	1.00	7238	16033	0.55
19	3	63	0.163	5397	11954	1.00	7238	16033	0.55
20	4	66	0.163	5397	11954	1.00	7238	16033	0.55

Table 3OO-207 SSI Strain-Compatible Soil Property Profiles for East and West ESWPT *(continued)*

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight kcf	BE - East ESWPT			UB - East & West ESWPT		
				Vs ft/sec	Vp ft/sec	Damping %	Vs ft/sec	Vp ft/sec	Damping %
21	5	70	0.164	9145	16650	1.00	11200	20392	0.55
22	5	75	0.164	9145	16650	1.00	11200	20392	0.55
23	5	80	0.164	9145	16650	1.00	11200	20392	0.55
24	5	85	0.164	9145	16650	1.00	11200	20392	0.55
25	10	90	0.164	9145	16650	1.00	11200	20392	0.55
26	10	100	0.164	9145	16650	1.00	11200	20392	0.55
27	10	110	0.164	10064	17773	1.00	12326	21767	0.55
28	10	120	0.164	10064	17773	1.00	12326	21767	0.55
29	10	130	0.164	10064	17773	1.00	12326	21767	0.55
30	10	140	0.164	10064	17773	1.00	12326	21767	0.55
31	10	150	0.164	10064	17773	1.00	12326	21767	0.55
32	10	160	0.164	10047	17846	1.00	12305	21857	0.55
33	10	170	0.164	10047	17846	1.00	12305	21857	0.55
34	10	180	0.164	10047	17846	1.00	12305	21857	0.55
35	10	190	0.164	10047	17846	1.00	12305	21857	0.55
36	10	200	0.164	10047	17846	1.00	12305	21857	0.55
Halfspace			0.164	9200	17212	1.00	11268	21080	0.55

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-208 SSI Strain-Compatible Soil Property Profiles for UHSRS Pipe Chase

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	BE Vs [ft/sec]	BE Vp [ft/sec]	BE Damping [%]	LB Vs [ft/sec]	LB Vp [ft/sec]	LB Damping [%]
1	2	0	0.125	768	1882	2.29	512	1254	4.40
2	2	2	0.130	1423	4484	1.93	969	3055	3.73
3	3	4	0.130	1423	4484	1.93	969	3055	3.73
4	3	7	0.150	3762	9333	0.58	2666	6615	0.99
5	3	10	0.150	3762	9333	0.58	2666	6615	0.99
6	3	13	0.150	3762	9333	0.58	2666	6615	0.99
7	3	16	0.150	3762	9333	0.58	2666	6615	0.99
8	4	19	0.150	3762	9333	0.58	2666	6615	0.99
9	4	23	0.163	6628	13659	1.00	4942	10184	1.82
10	4	27	0.163	6628	13659	1.00	4942	10184	1.82
11	4	31	0.163	6628	13659	1.00	4942	10184	1.82
12	4	35	0.163	6628	13659	1.00	4942	10184	1.82
13	4	39	0.163	6628	13659	1.00	4942	10184	1.82
14	4	43	0.163	6628	13659	1.00	4942	10184	1.82
15	5	47	0.163	5397	11954	1.00	4024	8913	1.82
16	5	52	0.163	5397	11954	1.00	4024	8913	1.82
17	5	57	0.163	5397	11954	1.00	4024	8913	1.82
18	5	62	0.163	5397	11954	1.00	4024	8913	1.82
19	5	67	0.163	5397	11954	1.00	4024	8913	1.82
20	5	72	0.163	5397	11954	1.00	4024	8913	1.82

Table 3OO-208 SSI Strain-Compatible Soil Property Profiles for UHSRS Pipe Chase

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	BE Vs [ft/sec]	BE Vp [ft/sec]	BE Damping [%]	LB Vs [ft/sec]	LB Vp [ft/sec]	LB Damping [%]
21	5	77	0.163	5397	11954	1.00	4024	8913	1.82
22	5	82	0.163	5397	11954	1.00	4024	8913	1.82
23	5	87	0.163	5397	11954	1.00	4024	8913	1.82
24	5	92	0.163	5397	11954	1.00	4024	8913	1.82
25	5	97	0.164	9087	16598	1.00	7420	13552	1.82
26	5	102	0.164	9087	16598	1.00	7420	13552	1.82
27	5	107	0.164	9087	16598	1.00	7420	13552	1.82
28	5	112	0.164	9087	16598	1.00	7420	13552	1.82
29	5	117	0.164	10161	17719	1.00	8296	14467	1.82
30	5	122	0.164	10161	17719	1.00	8296	14467	1.82
31	5	127	0.164	10161	17719	1.00	8296	14467	1.82
32	5	132	0.164	10161	17719	1.00	8296	14467	1.82
33	5	137	0.164	9807	17742	1.00	8007	14486	1.82
34	5	142	0.164	9807	17742	1.00	8007	14486	1.82
35	10	147	0.164	10114	17835	1.00	8258	14563	1.82
36	10	157	0.164	10114	17835	1.00	8258	14563	1.82
Halfspace	10	157	0.164	10114	17212	1.00	8258	14563	1.82

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-208 SSI Strain-Compatible Soil Property Profiles for UHSRS Pipe Chase *(continued)*

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	UB		
				Vs [ft/sec]	Vp [ft/sec]	Damping [%]
1	2	0	0.125	1153	2824	1.19
2	2	2	0.130	2089	6581	1.00
3	3	4	0.130	2089	6581	1.00
4	3	7	0.150	5307	13167	0.34
5	3	10	0.150	5307	13167	0.34
6	3	13	0.150	5307	13167	0.34
7	3	16	0.150	5307	13167	0.34
8	4	19	0.150	5307	13167	0.34
9	4	23	0.163	8889	18319	0.55
10	4	27	0.163	8889	18319	0.55
11	4	31	0.163	8889	18319	0.55
12	4	35	0.163	8889	18319	0.55
13	4	39	0.163	8889	18319	0.55
14	4	43	0.163	8889	18319	0.55
15	5	47	0.163	7238	16033	0.55
16	5	52	0.163	7238	16033	0.55
17	5	57	0.163	7238	16033	0.55
18	5	62	0.163	7238	16033	0.55
19	5	67	0.163	7238	16033	0.55
20	5	72	0.163	7238	16033	0.55
21	5	77	0.163	7238	16033	0.55
22	5	82	0.163	7238	16033	0.55
23	5	87	0.163	7238	16033	0.55
24	5	92	0.163	7238	16033	0.55
25	5	97	0.164	11129	20329	0.55
26	5	102	0.164	11129	20329	0.55
27	5	107	0.164	11129	20329	0.55

Table 3OO-208 SSI Strain-Compatible Soil Property Profiles for UHSRS Pipe Chase *(continued)*

Layer #	Thickness [ft]	Top-Depth* [ft]	Unit Weight [kcf]	UB		
				Vs [ft/sec]	Vp [ft/sec]	Damping [%]
28	5	112	0.164	11129	20329	0.55
29	5	117	0.164	12445	21701	0.55
30	5	122	0.164	12445	21701	0.55
31	5	127	0.164	12445	21701	0.55
32	5	132	0.164	12445	21701	0.55
33	5	137	0.164	12011	21729	0.55
34	5	142	0.164	12011	21729	0.55
35	10	147	0.164	12387	21844	0.55
36	10	157	0.164	12387	21844	0.55
Half-space			0.164	11268	21080	0.55

* Top-depth is measured from finished grade at Elevation +290 ft NAVD88 (+290.86 ft NGVD29)

Table 3OO-209 Full-Column Outcrop SSI Input Motions for R/B Complex and PS/B with Embedded Foundations

Frequency [Hz]	Horizontal - R/B Complex [g]	Horizontal - PS/B [g]	Vertical - R/B Complex [g]	Vertical - PS/B [g]
0.1	4.44E-03	4.55E-03	3.41 E-03	3.45E-03
0.125	6.92E-03	6.67E-03	4.96E-03	5.00E-03
0.15	8.94E-03	9.08E-03	6.71E-03	6.72E-03
0.2	1.38E-02	1.41 E-02	1.06E-02	1.07E-02
0.3	2.32E-02	2.35E-02	1.93E-02	1.87E-02
0.4	3.56E-02	3.52E-02	2.80E-02	2.75E-02
0.5	4.58E-02	4.60E-02	3.48E-02	3.49E-02
0.6	5.09E-02	5.11E-02	3.92E-02	3.92E-02
0.7	5.52E-02	5.54E-02	4.29E-02	4.29E-02
0.8	5.94E-02	6.07E-02	4.72E-02	4.73E-02
0.9	6.64E-02	6.64E-02	5.15E-02	5.19E-02
1	6.88E-02	7.24E-02	5.64E-02	5.69E-02
1.25	8.87E-02	8.87E-02	7.43E-02	7.44E-02
1.5	1.07E-01	1.07E-01	1.01E-01	1.02E-01
2	1.54E-01	1.57E-01	1.67E-01	1.72E-01
2.5	1.89E-01	1.95E-01	2.26E-01	2.42E-01
3	2.26E-01	2.34E-01	2.80E-01	3.09E-01
4	3.06E-01	3.21 E-01	3.92E-01	4.39E-01
5	4.08E-01	4.21E-01	5.15E-01	5.51 E-01
6	4.85E-01	4.98E-01	5.63E-01	5.80E-01
7	5.47E-01	5.66E-01	5.58E-01	5.71 E-01
8	6.03E-01	6.31 E-01	5.57E-01	5.78E-01
9	6.71E-01	6.99E-01	5.60E-01	5.92E-01
10	7.43E-01	7.70E-01	5.68E-01	6.11 E-01
12.5	9.04E-01	9.38E-01	6.98E-01	7.21 E-01
15	1.05E+00	1.09E+00	8.23E-01	8.63E-01
20	1.18E+00	1.31E+00	9.74E-01	1.07E+00
25	1.19E+00	1.31E+00	1.04E+00	1.15E+00

Table 3OO-209 Full-Column Outcrop SSI Input Motions for R/B Complex and PS/B with Embedded Foundations

Frequency [Hz]	Horizontal - R/B Complex [g]	Horizontal - PS/B [g]	Vertical - R/B Complex [g]	Vertical - PS/B [g]
30	1.12E+00	1.24E+00	1.05E+00	1.17E+00
35	1.05E+00	1.19E+00	1.06E+00	1.18E+00
40	1.01E+00	1.14E+00	1.06E+OO	1.19E+00
45	9.73E-01	1.10E+00	1.07E+00	1.19E+00
50	9.31 E-01	1.04E+00	1.05E+00	1.18E+00
60	7.71 E-01	8.71 E-01	8.78E-01	9.90E-01
70	6.53E-01	7.39E-01	7.40E-01	8.35E-01
80	5.72E-01	6.42E-01	6.27E-01	6.96E-01
90	5.18E-01	5.74E-01	5.40E-01	5.98E-01
100	4.83E-01	5.30E-01	4.83E-01	5.30E-01

Table 3OO-210 Geologic Outcrop SSI Input Motions for R/B Complex and PS/B with Surface Foundations

Frequency [Hz]	Horizontal - R/B Complex [g]	Horizontal - PS/B [g]	Vertical - R/B Complex [g]	Vertical - PS/B [g]
	4.18E-03	4.18E-03	3.14E-03	3.14E-03
0.125	6.11 E-03	6.11E-03	4.53E-03	4.58E-03
0.15	8.27E-03	8.31E-03	6.16E-03	6.23E-03
0.2	1.30E-02	1.30E-02	9.81 E-03	9.81 E-03
0.3	2.39E-02	2.32E-02	1.75E-02	1.74E-02
0.4	3.61E-02	3.52E-02	2.65E-02	2.65E-02
0.5	4.53E-02	4.53E-02	3.41 E-02	3.42E-02
0.6	5.11E-02	5.07E-02	3.91 E-02	3.82E-02
0.7	5.56E-02	5.48E-02	4.30E-02	4.11E-02
0.8	5.95E-02	5.88E-02	4.62E-02	4.45E-02
0.9	6.32E-02	6.38E-02	4.92E-02	4.84E-02
1	6.76E-02	6.90E-02	5.23E-02	5.24E-02
1.25	8.41E-02	8.41E-02	6.29E-02	6.35E-02
1.5	1.07E-01	1.05E-01	7.91 E-02	7.75E-02
2	1.51E-01	1.51E-01	1.14E-01	1.14E-01
2.5	1.83E-01	1.84E-01	1.38E-01	1.39E-01
3	2.13E-01	2.14E-01	1.61E-01	1.61E-01
4	2.96E-01	2.94E-01	2.21 E-01	2.20E-01
5	3.87E-01	3.86E-01	2.90E-01	2.88E-01
6	4.69E-01	4.59E-01	3.51 E-01	3.43E-01
7	5.47E-01	5.27E-01	4.09E-01	3.96E-01
8	6.23E-01	6.00E-01	4.65E-01	4.51 E-01
9	6.98E-01	6.75E-01	5.21 E-01	5.07E-01
10	7.71E-01	7.51 E-01	5.78E-01	5.65E-01
12.5	9.62E-01	9.47E-01	7.39E-01	7.31E-01
15	1.11E+00	1.13E+00	8.74E-01	8.84E-01
20	1.25E+00	1.35E+00	1.04E+00	1.11E+00
25	1.23E+00	1.34E+00	1.08E+00	1.18E+00

Table 3OO-210 Geologic Outcrop SSI Input Motions for R/B Complex and PS/B with Surface Foundations

Frequency [Hz]	Horizontal - R/B Complex [g]	Horizontal - PS/B [g]	Vertical - R/B Complex [g]	Vertical - PS/B [g]
30	1.16E+00	1.25E+00	1.08E+00	1.16E+00
35	1.08E+00	1.15E+00	1.09E+00	1.16E+00
40	1.04E+00	1.12E+00	1.10E+00	1.17E+00
45	1.01E+00	1.09E+00	1.11E+00	1.20E+00
50	9.75E-01	1.06E+00	1.10E+00	1.19E+00
60	8.11E-01	8.96E-01	9.24E-01	1.02E+00
70	6.83E-01	7.59E-01	7.75E-01	8.57E-01
80	6.00E-01	6.53E-01	6.56E-01	7.18E-01
90	5.44E-01	5.84E-01	5.64E-01	6.07E-01
100	5.07E-01	5.40E-01	5.07E-01	5.40E-01

Table 3OO-211 Geologic Outcrop SSI Input Motions for the Four UHSRS Units with Surface Foundations

Frequency [Hz]	Horizontal - UHSRS D [g]	Horizontal - UHSRS A to C [g]	Vertical - UHSRS D [g]	Vertical - UHSRS A to C [g]
0.1	7.47E-03	7.47E-03	5.01E-03	5.01 E-03
0.125	1.17E-02	1.17E-02	7.83E-03	7.83E-03
0.15	1.68E-02	1.68E-02	1.13E-02	1.13E-02
0.2	2.99E-02	2.99E-02	2.01E-02	2.01E-02
0.3	5.43E-02	5.43E-02	3.66E-02	3.66E-02
0.4	6.88E-02	6.88E-02	4.69E-02	4.69E-02
0.5	8.28E-02	8.28E-02	5.68E-02	5.68E-02
0.6	9.63E-02	9.63E-02	6.64E-02	6.64E-02
0.7	1.09E-01	1.09E-01	7.58E-02	7.58E-02
0.8	1.22E-01	1.22E-01	8.49E-02	8.49E-02
0.9	1.35E-01	1.35E-01	9.40E-02	9.40E-02
1	1.47E-01	1.47E-01	1.03E-01	1.03E-01
1.25	1.77E-01	1.77E-01	1.25E-01	1.25E-01
1.5	2.05E-01	2.05E-01	1.46E-01	1.46E-01
2	2.61E-01	2.61E-01	1.86E-01	1.86E-01
2.5	3.11E-01	3.11E-01	2.26E-01	2.26E-01
3	3.07E-01	3.07E-01	2.64E-01	2.64E-01
4	3.72E-01	3.03E-01	3.02E-01	3.00E-01
5	5.73E-01	3.90E-01	4.31E-01	3.02E-01
6	7.57E-01	4.74E-01	5.66E-01	3.49E-01
7	9.08E-01	5.48E-01	6.85E-01	4.08E-01
8	1.03E+00	6.24E-01	7.77E-01	4.67E-01
9	1.13E+00	7.07E-01	8.42E-01	5.29E-01
10	1.16E+00	7.91E-01	8.75E-01	5.94E-01
12.5	1.15E+00	1.00E+00	8.82E-01	7.76E-01
15	1.12E+00	1.22E+00	8.88E-01	9.63E-01
20	1.15E+00	1.56E+00	9.57E-01	1.29E+00
25	1.11E+00	1.67E+00	9.83E-01	1.48E+00

Table 3OO-211 Geologic Outcrop SSI Input Motions for the Four UHSRS Units with Surface Foundations

Frequency [Hz]	Horizontal - UHSRS D [g]	Horizontal - UHSRS A to C [g]	Vertical - UHSRS D [g]	Vertical - UHSRS A to C [g]
30	1.10E+00	1.69E+00	1.02E+00	1.57E+00
35	1.05E+00	1.59E+00	1.03E+00	1.57E+00
40	9.90E-01	1.46E+00	1.03E+00	1.54E+00
45	9.17E-01	1.36E+00	1.01E+00	1.49E+00
50	8.49E-01	1.25E+00	9.64E-01	1.40E+00
60	7.30E-01	1.00E+00	8.26E-01	1.13E+00
70	6.49E-01	8.52E-01	7.33E-01	9.67E-01
80	5.98E-01	7.57E-01	6.66E-01	8.25E-01
90	5.64E-01	6.83E-01	6.03E-01	7.17E-01
100	5.46E-01	6.46E-01	5.46E-01	6.46E-01

Table 3OO-212 Full-Column Outcrop SSI Input Motions for ESWPT and UHSRS Pipe Chase with Embedded Foundations

Frequency [Hz]	Horizontal - East & West ESWPT [g]	Horizontal - UHSRS Pipe Chase [g]	Vertical - East & West ESWPT [g]	Vertical - UHSRS Pipe Chase [g]
0.1	7.54E-03	7.54E-03	5.06E-03	5.06E-03
0.125	1.18E-02	1.19E-02	7.91E-03	7.91E-03
0.15	1.70E-02	1.82E-02	1.14E-02	1.14E-02
0.2	3.07E-02	3.32E-02	2.03E-02	2.17E-02
0.3	5.48E-02	5.58E-02	3.74E-02	3.77E-02
0.4	6.97E-02	6.97E-02	4.74E-02	4.75E-02
0.5	8.37E-02	8.36E-02	5.73E-02	5.73E-02
0.6	9.72E-02	9.72E-02	6.70E-02	6.71E-02
0.7	1.10E-01	1.10E-01	7.65E-02	7.65E-02
0.8	1.23E-01	1.23E-01	8.58E-02	8.58E-02
0.9	1.36E-01	1.36E-01	9.49E-02	9.49E-02
1	1.48E-01	1.48E-01	1.04E-01	1.04E-01
1.25	1.78E-01	1.78E-01	1.26E-01	1.26E-01
1.5	2.07E-01	2.08E-01	1.46E-01	1.47E-01
2	2.64E-01	2.72E-01	1.93E-01	1.89E-01
2.5	3.32E-01	3.15E-01	2.48E-01	2.32E-01
3	4.14E-01	3.10E-01	3.11E-01	2.73E-01
4	6.27E-01	3.49E-01	4.64E-01	3.19E-01
5	8.33E-01	4.30E-01	6.16E-01	3.43E-01
6	9.53E-01	5.33E-01	7.31E-01	4.00E-01
7	1.02E+00	6.36E-01	7.83E-01	4.81 E-01
8	1.06E+00	7.41E-01	8.03E-01	5.65E-01
9	1.08E+00	8.54E-01	8.18E-01	6.49E-01
10	1.12E+00	9.65E-01	8.42E-01	7.34E-01
12.5	1.31E+00	1.21E+00	1.01E+00	9.50E-01
15	1.54E+00	1.42E+00	1.22E+00	1.16E+00
20	1.81E+00	1.77E+00	1.49E+00	1.55E+00

Table 3OO-212 Full-Column Outcrop SSI Input Motions for ESWPT and UHSRS Pipe Chase with Embedded Foundations

Frequency [Hz]	Horizontal - East & West ESWPT [g]	Horizontal - UHSRS Pipe Chase [g]	Vertical - East & West ESWPT [g]	Vertical - UHSRS Pipe Chase [g]
25	1.89E+00	2.00E+00	1.66E+00	1.93E+00
30	1.78E+00	2.12E+00	1.67E+00	2.25E+00
35	1.65E+00	2.06E+00	1.61E+OO	2.39E+00
40	1.53E+00	1.94E+00	1.57E+00	2.45E+00
45	1.41E+00	1.83E+00	1.53E+00	2.46E+00
50	1.29E+00	1.71E+00	1.45E+00	2.34E+00
60	1.06E+00	1.45E+00	1.21E+00	1.92E+00
70	9.23E-01	1.21E+00	1.05E+00	1.58E+00
80	8.35E-01	1.05E+00	9.10E-01	1.27E+00
90	7.68E-01	9.21E-01	8.02E-01	1.07E+00
100	7.35E-01	8.45E-01	7.35E-01	9.30E-01

Table 3OO-213 Zero-lag Cross Correlations for the Spectrum Compatible Acceleration Time Histories for the R/B Complex Case with Embedded Foundation

Components	Zero-Lag Cross Correlation
H1 - H2	0.006
H1 - UP	–0.065
H2 - UP	–0.028

Table 3OO-214 Peak Ground Motion Parameters, Associated Ratios, and 5%–75% Total Cumulative Arias Intensity [AI] Duration for the Spectrum Compatible Time Histories for the R/B Complex case with Embedded Foundation

Parameter	Horizontal H1	Horizontal H2	Vertical
PGA [g]	0.489	0.486	0.488
PGV [cm/sec (inch/sec)]	8.43 (3.32)	7.94 (3.13)	7.00 (2.76)
PGD [cm (inch)]	3.55 (1.40)	6.47(2.55)	3.23(1.27)
V/A [cm/sec/g (inch/sec/g)]	17.22 (6.78)	16.36 (6.44)	14.34 (5.65)
$A*D/V^2$	24.02	48.84	31.56
5%-75% AI Duration (sec)	20.49	22.82	25.95

Figure 3OO-201 Best Estimate Shear Wave Velocity Profile for R/B Complex

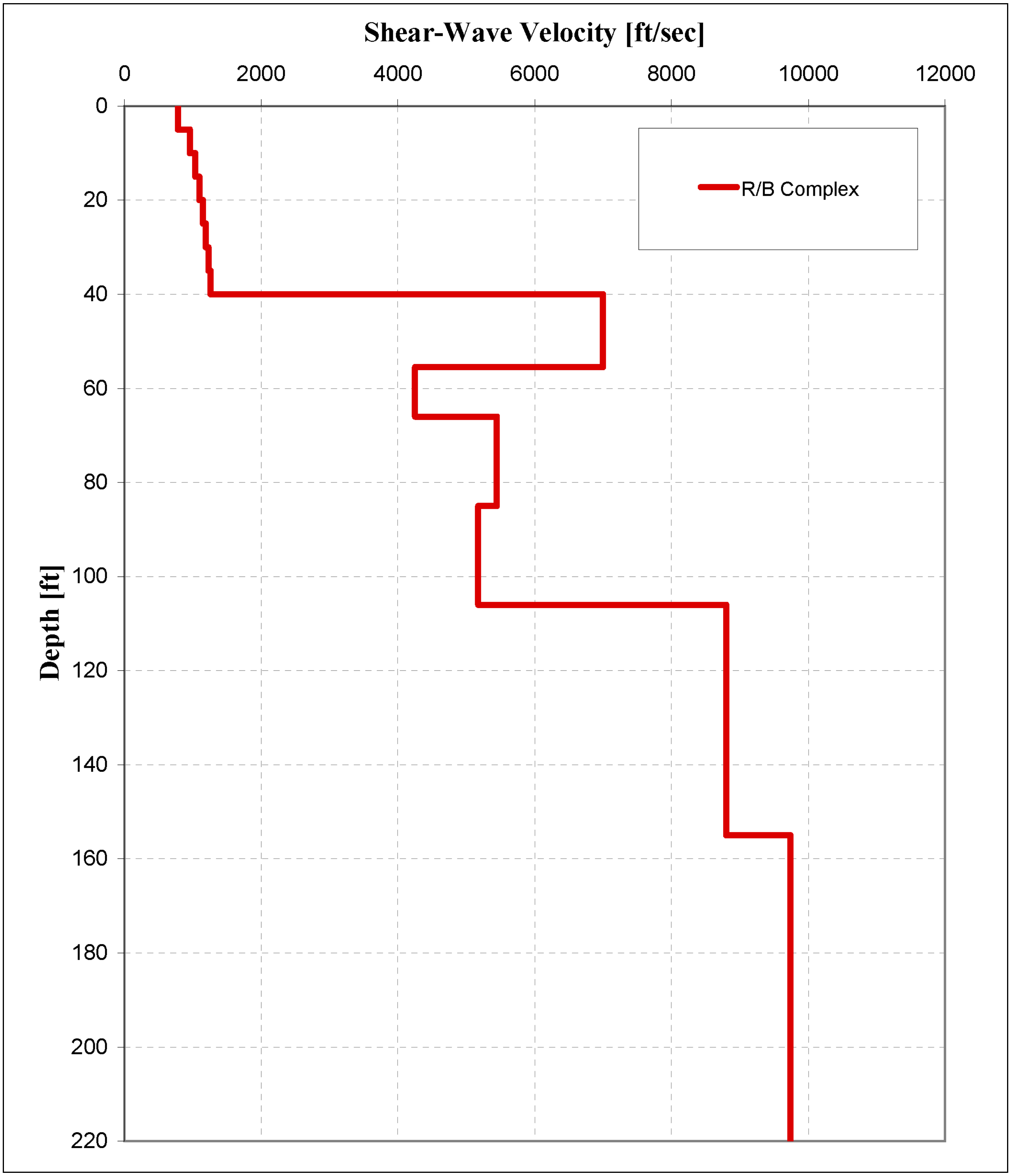


Figure 3OO-202 Low-Strain Shear-Wave Velocity for 60 Simulated Profiles for R/B Complex Not Including Thickness Variation (Halfspace at V_s = 9200 ft/sec)

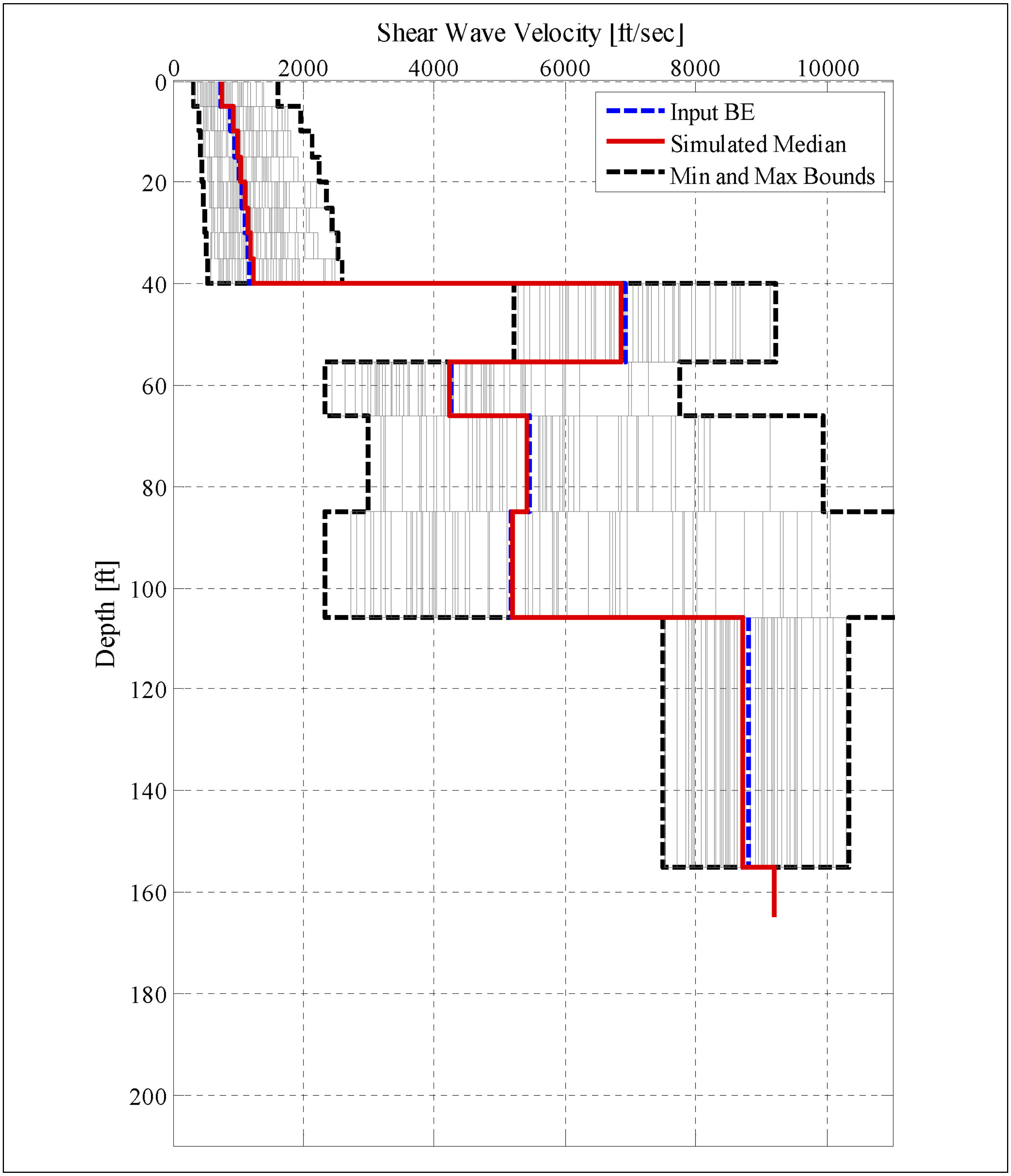


Figure 3OO-203 Low-Strain Shear-Wave Velocity for 60 Simulated Profiles for RJB Complex Including Thickness Variation (Half space at V_s = 9200 ft/sec)

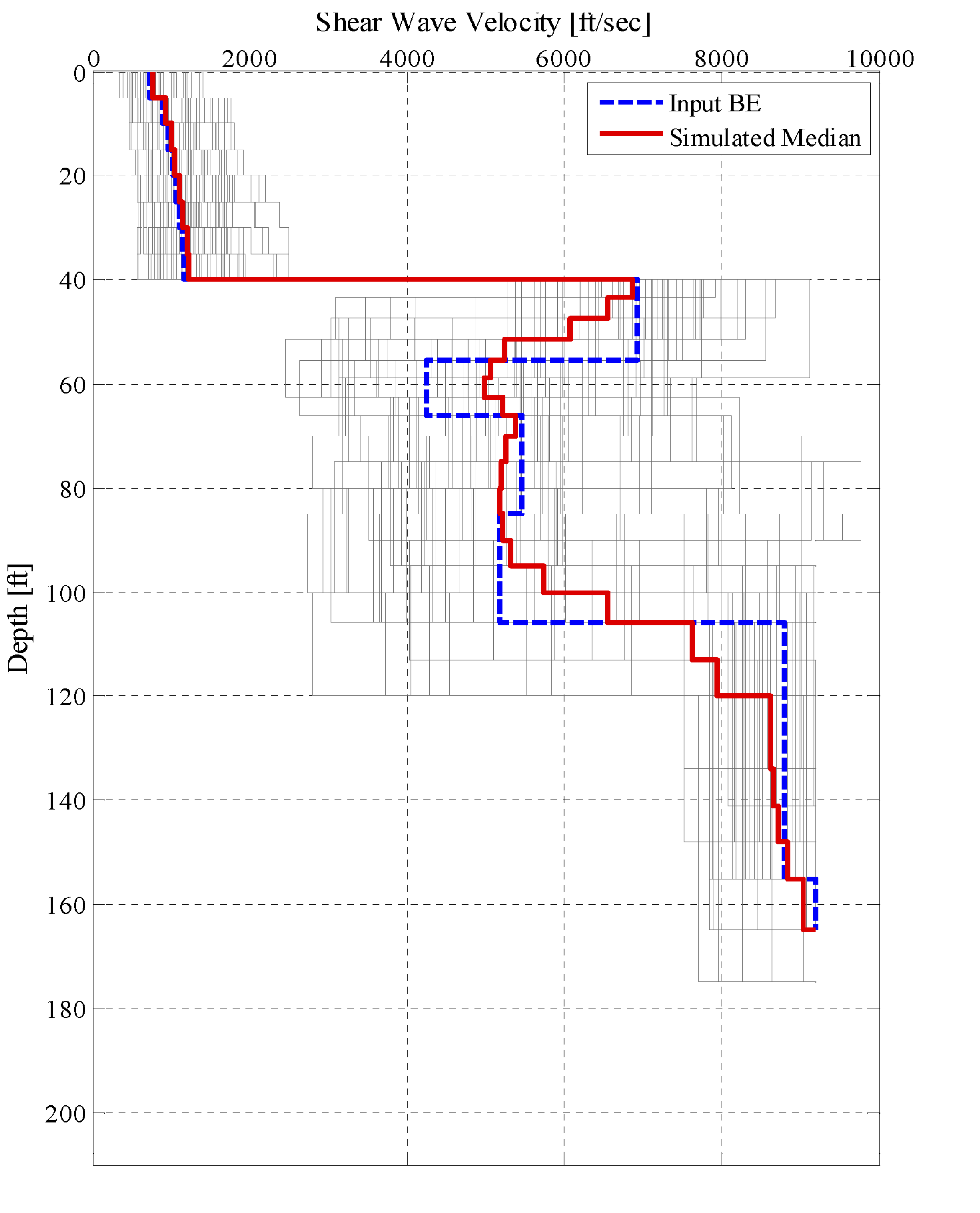


Figure 3OO-204 Strain-Dependent Property Curves for 60 Simulated Profiles for R/B Complex (Fill 1)

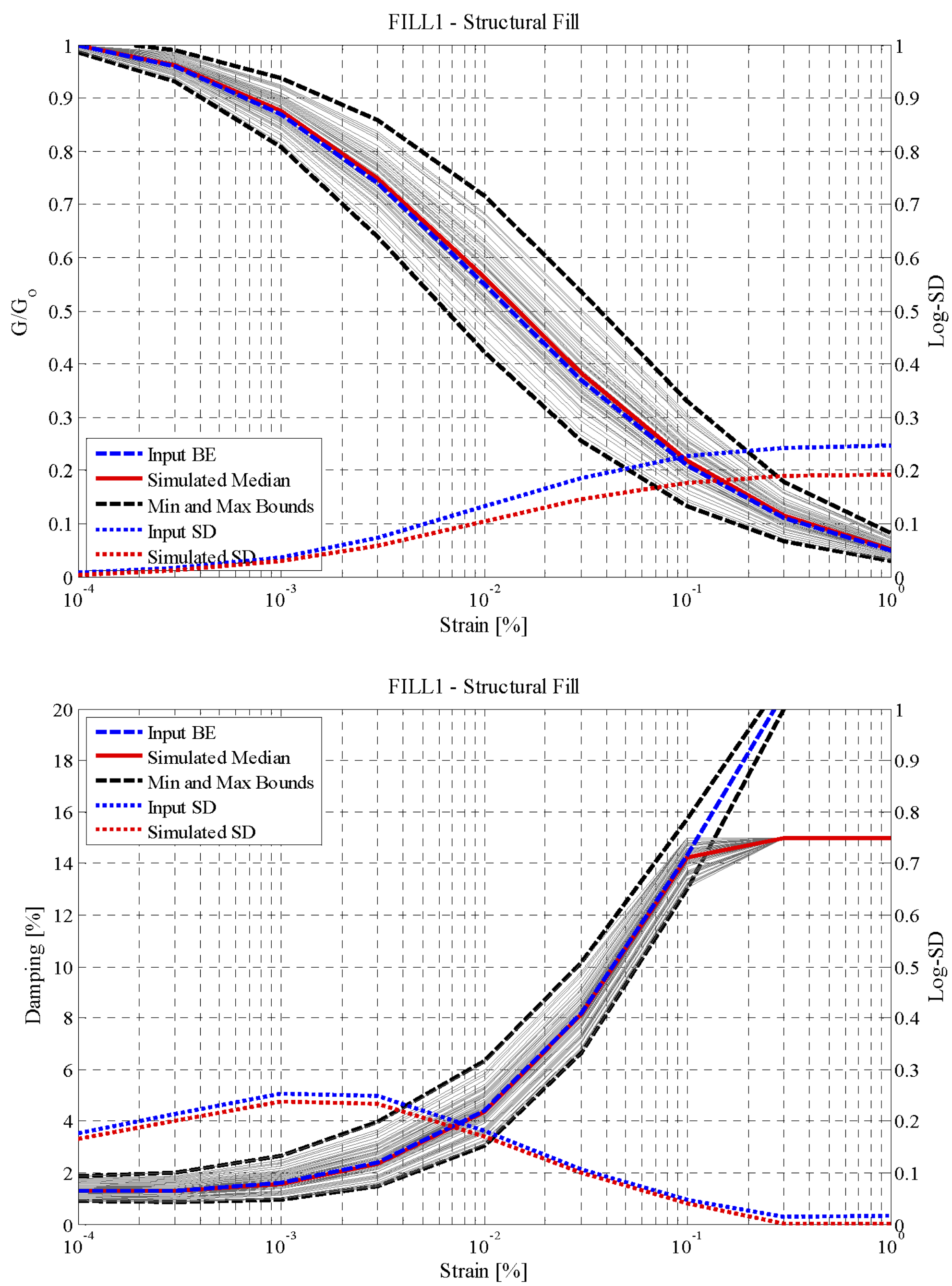


Figure 3OO-205 Low-Strain Damping Ratio for 60 Simulated Profiles for R/B Complex

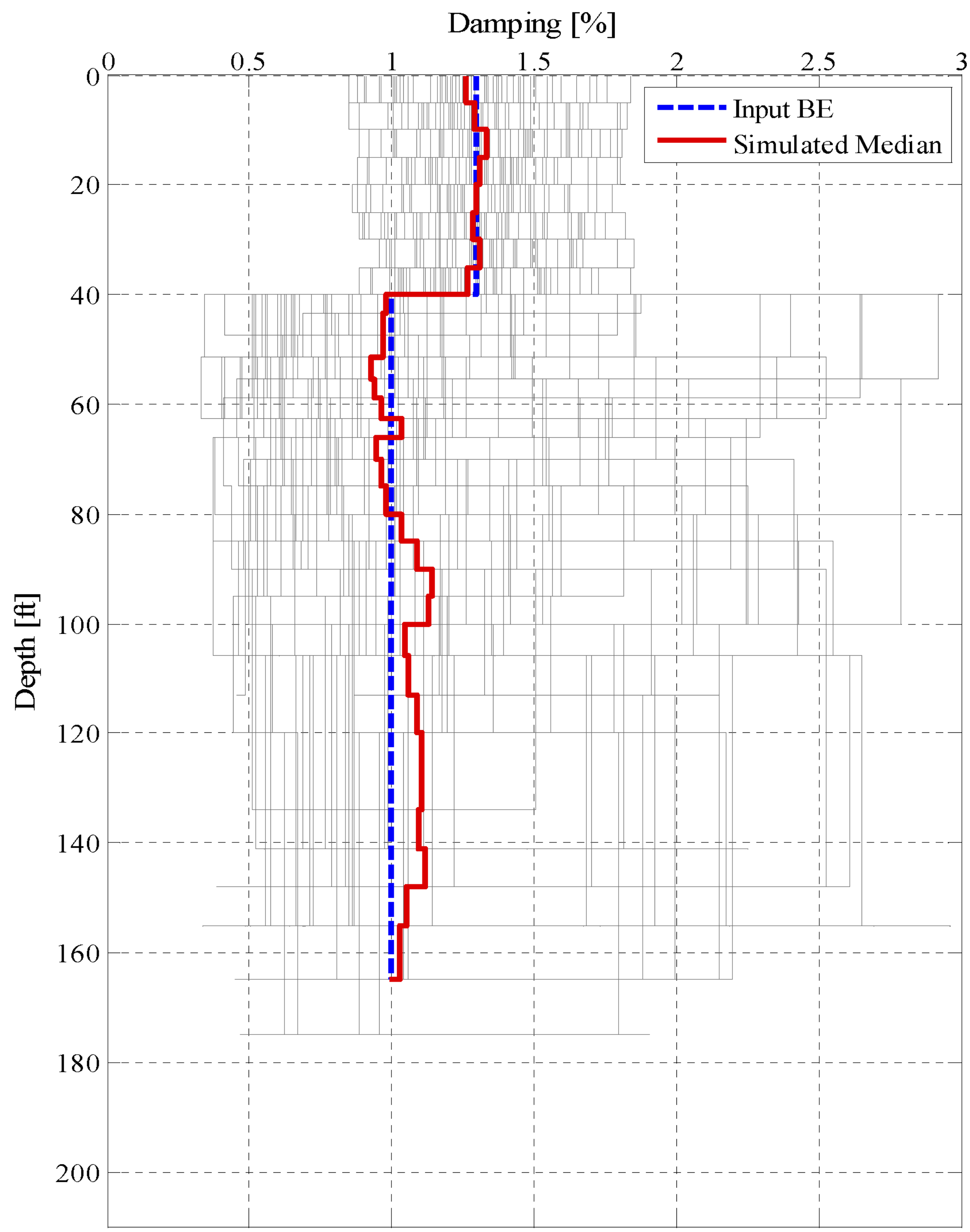


Figure 3OO-206 Best Estimate Shear Wave Velocity Profiles for PS/B

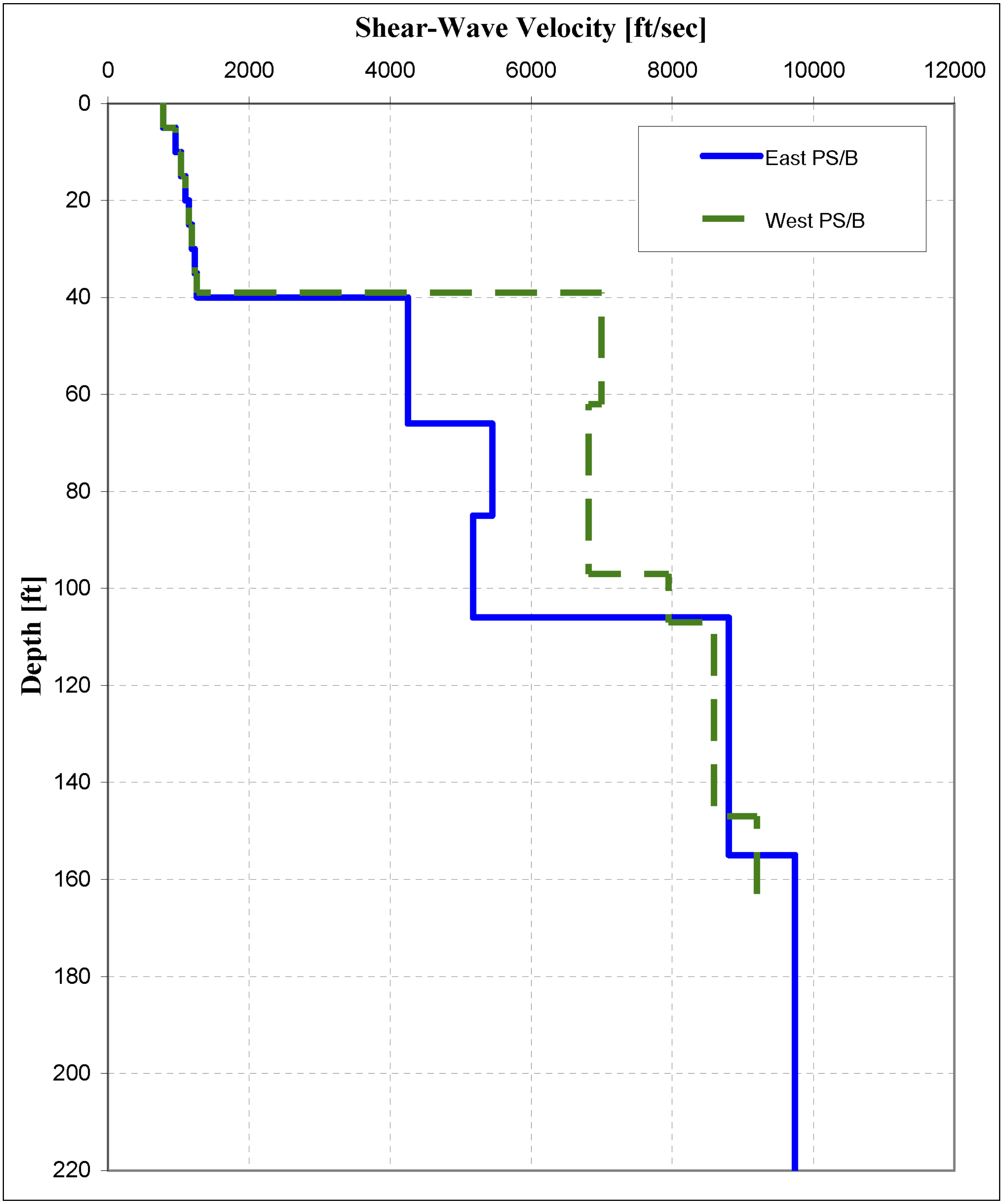


Figure 3OO-207 Best Estimate Shear Wave Velocity Profiles for the Four UHSRS Units

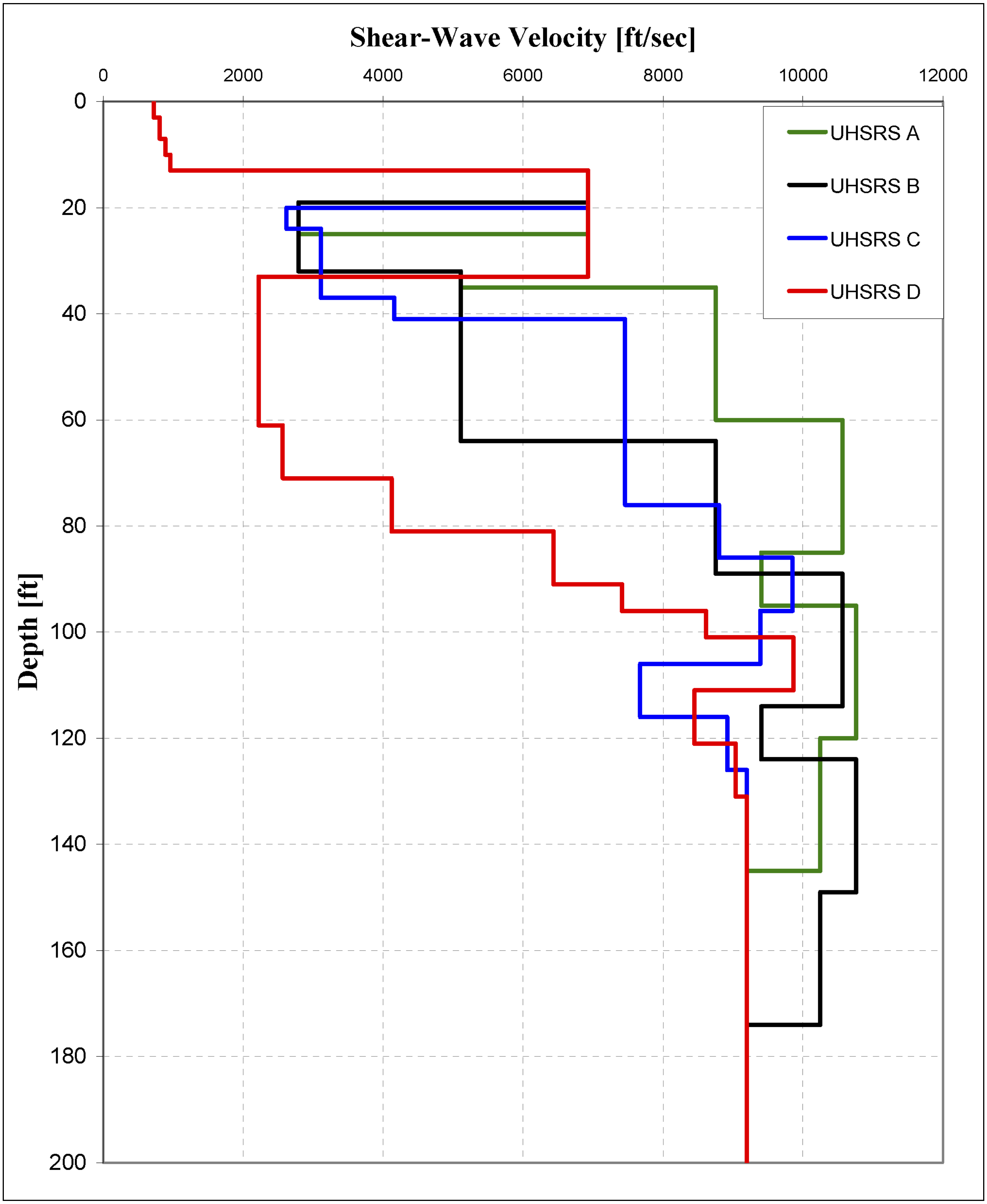


Figure 3OO-208 Best Estimate Shear Wave Velocity Profiles for ESWPT and UHSRS Pipe Chase

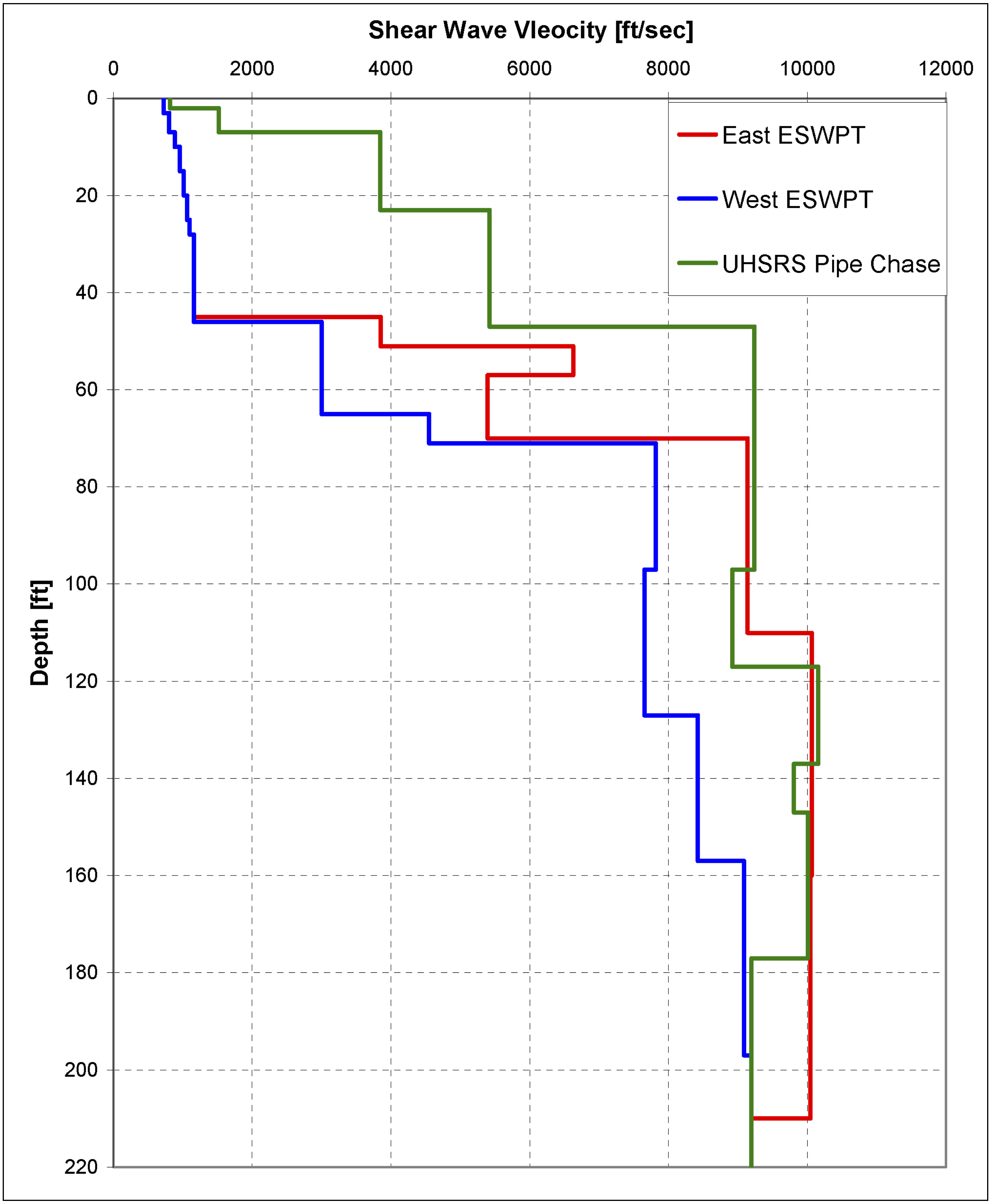


Figure 3OO-209 Full-Column Outcrop ARS Amplification Functions for R/B Complex at Foundation Elevation - LF

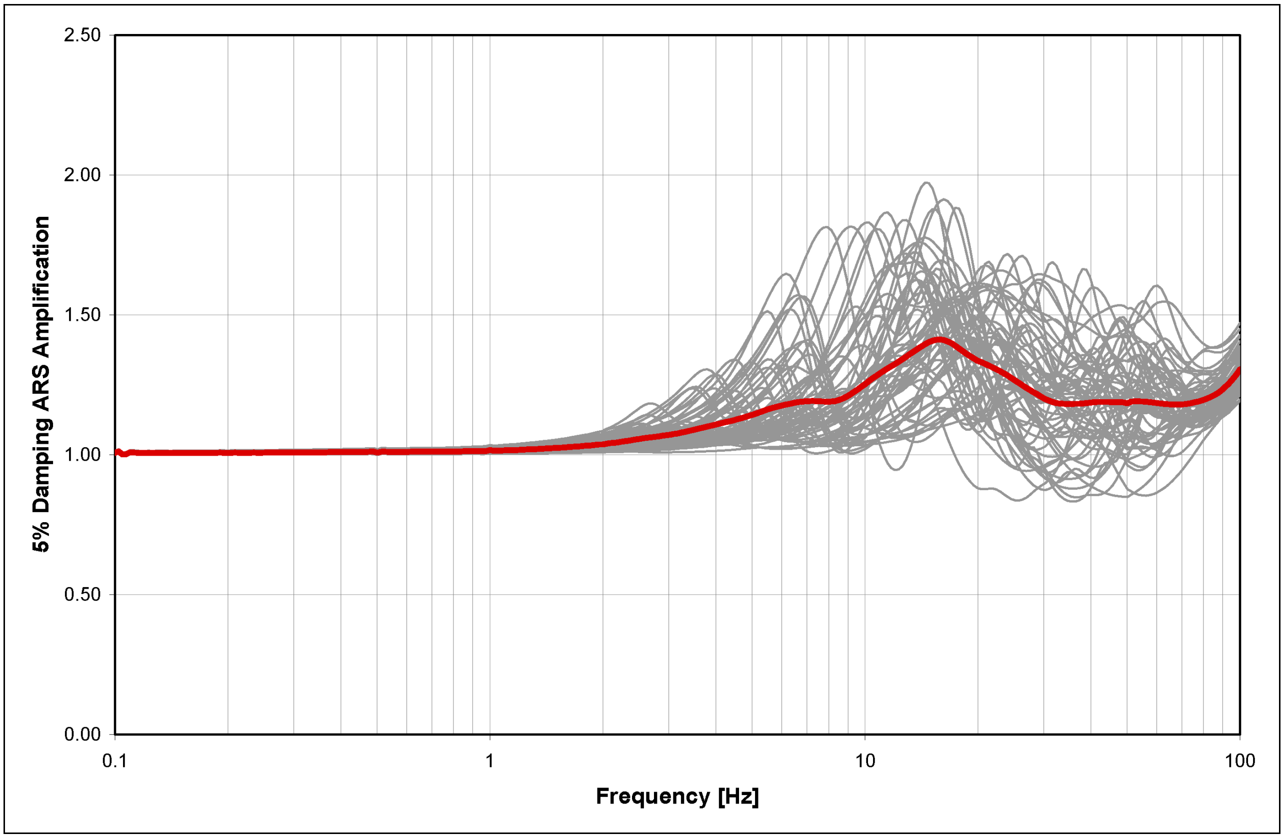


Figure 3OO-210 Full-Column Outcrop ARS Amplification Functions for R/B Complex at Foundation Elevation - HF

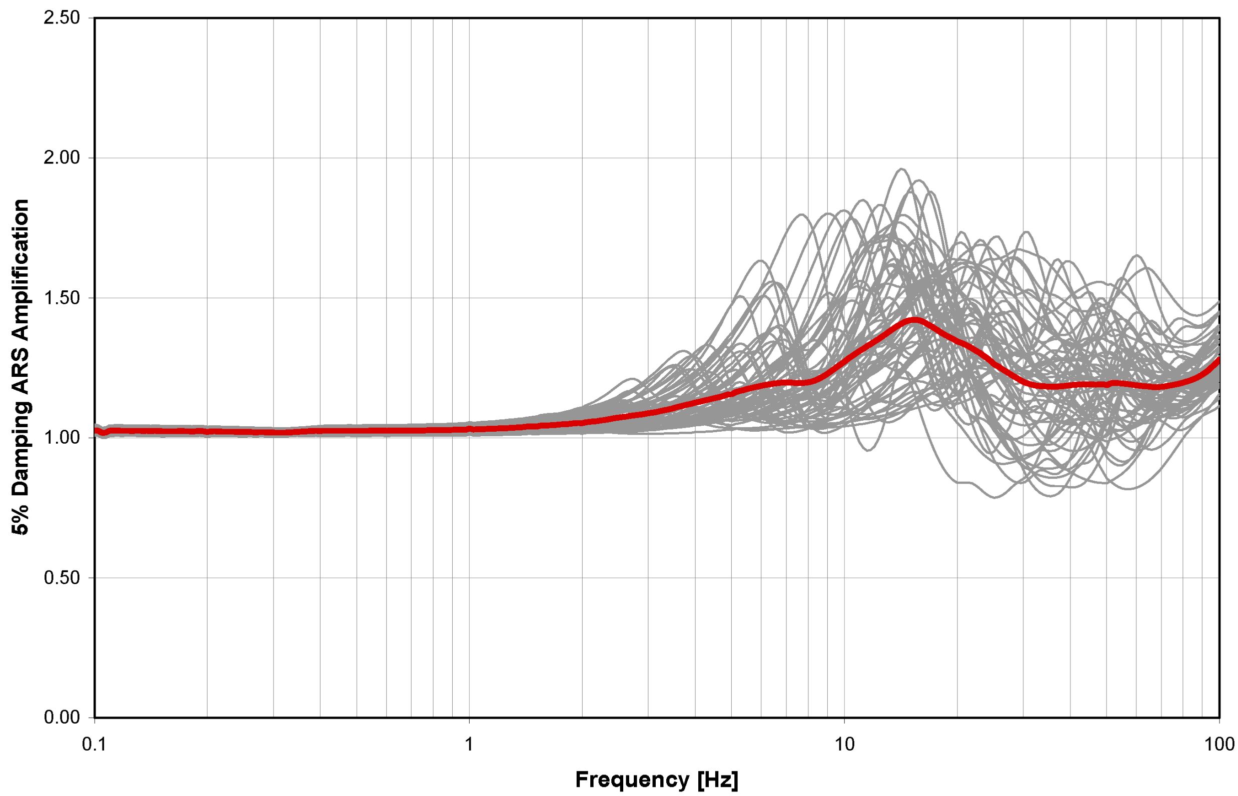


Figure 3OO-211 Geologic Outcrop ARS Amplification Functions for R/B Complex at Foundation Elevation - LF

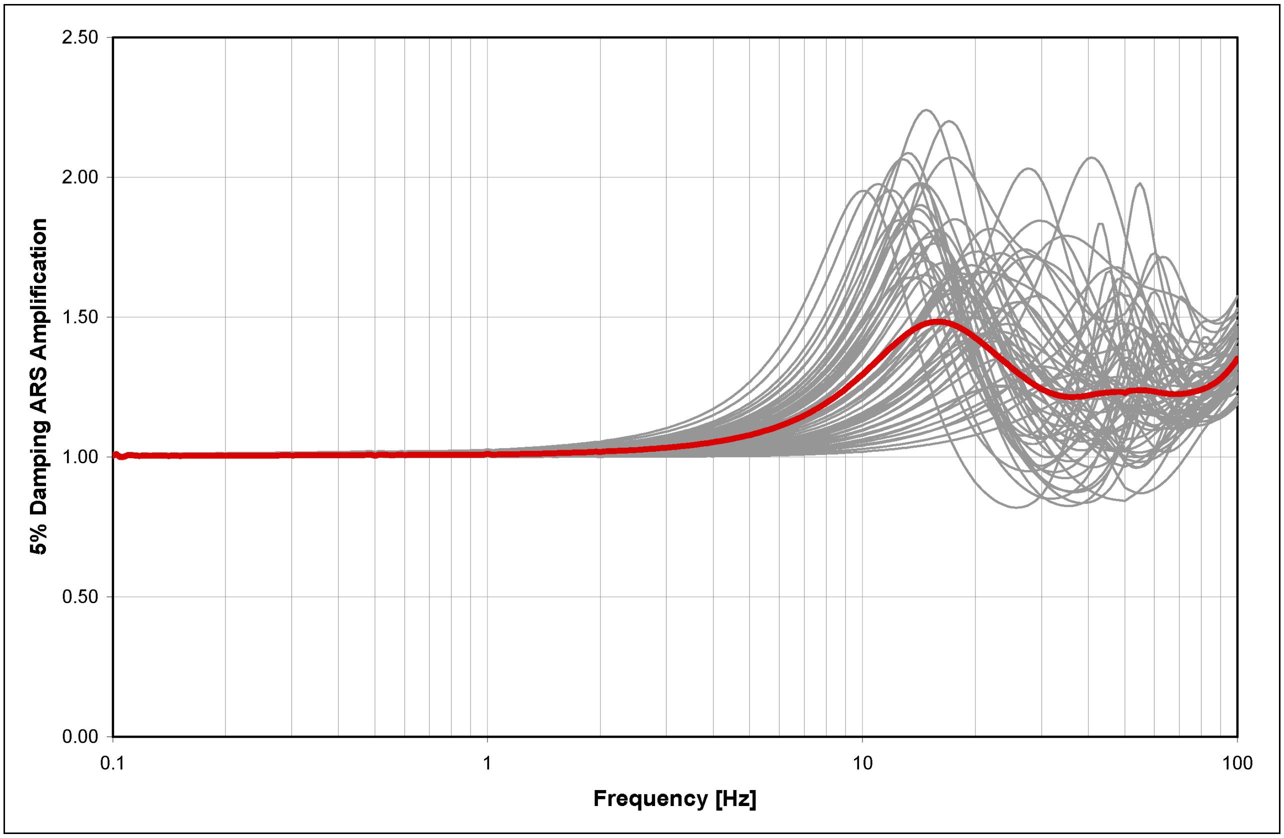


Figure 3OO-212 Geologic Outcrop ARS Amplification Functions for R/B Complex at Foundation Elevation - HF

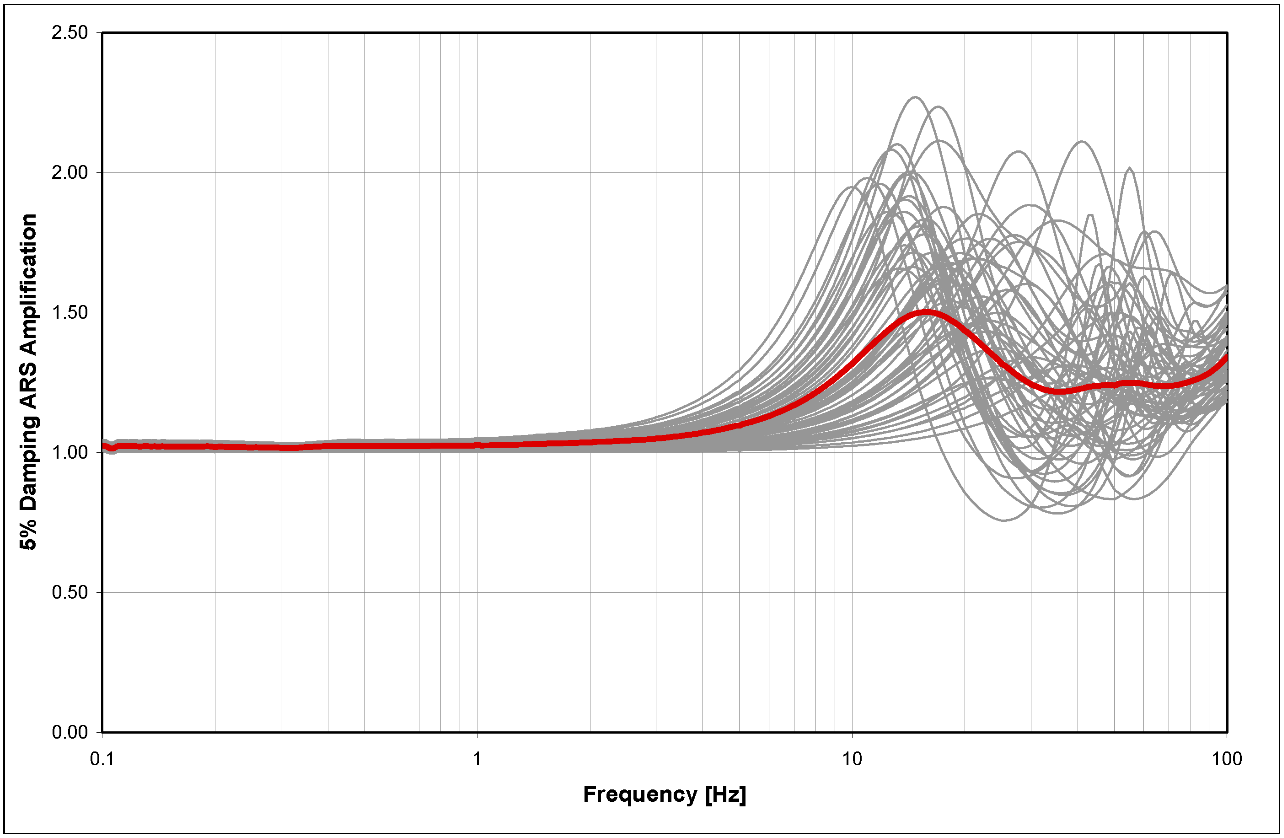


Figure 3OO-213 Full-Column Outcrop Log-mean ARS Amplification Functions for R/B Complex

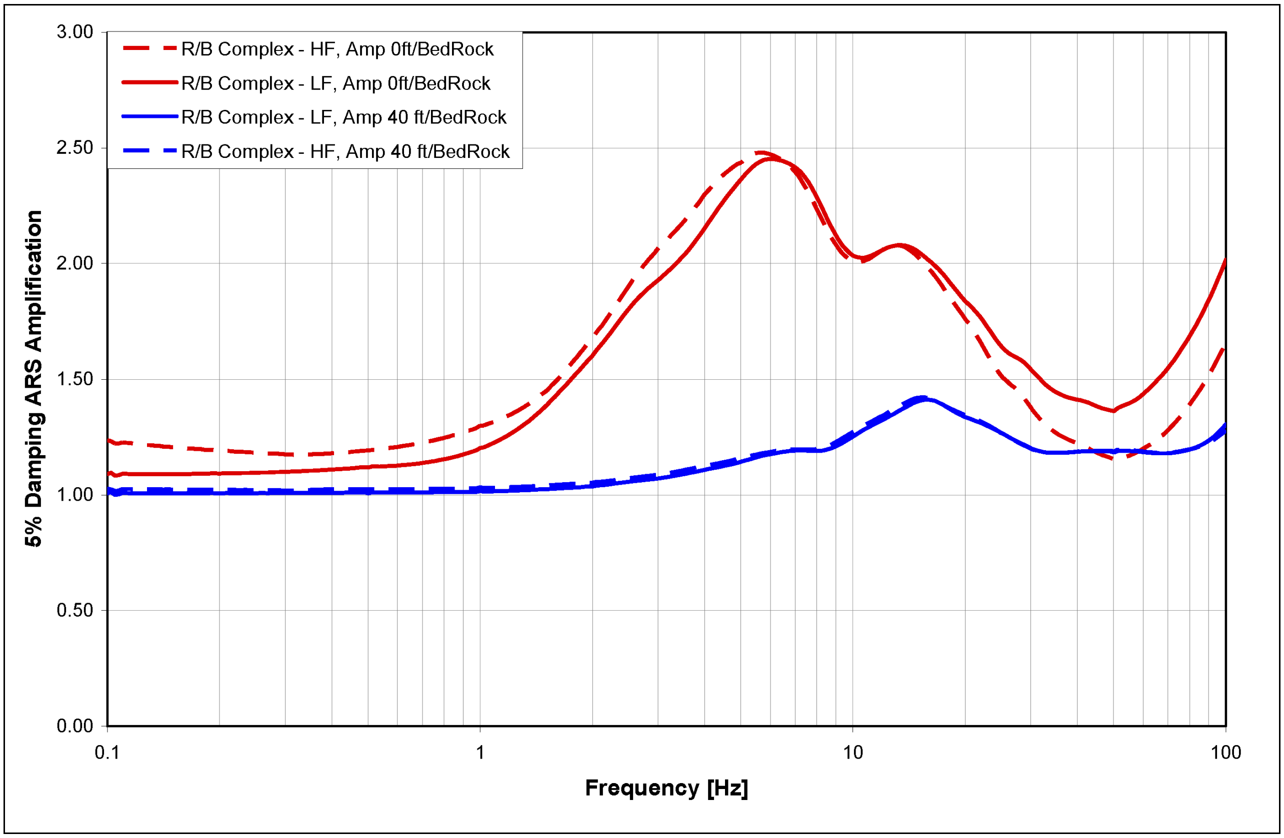


Figure 3OO-214 Geologic Outcrop (TSCR) Log-mean ARS Amplification Functions for R/B Complex

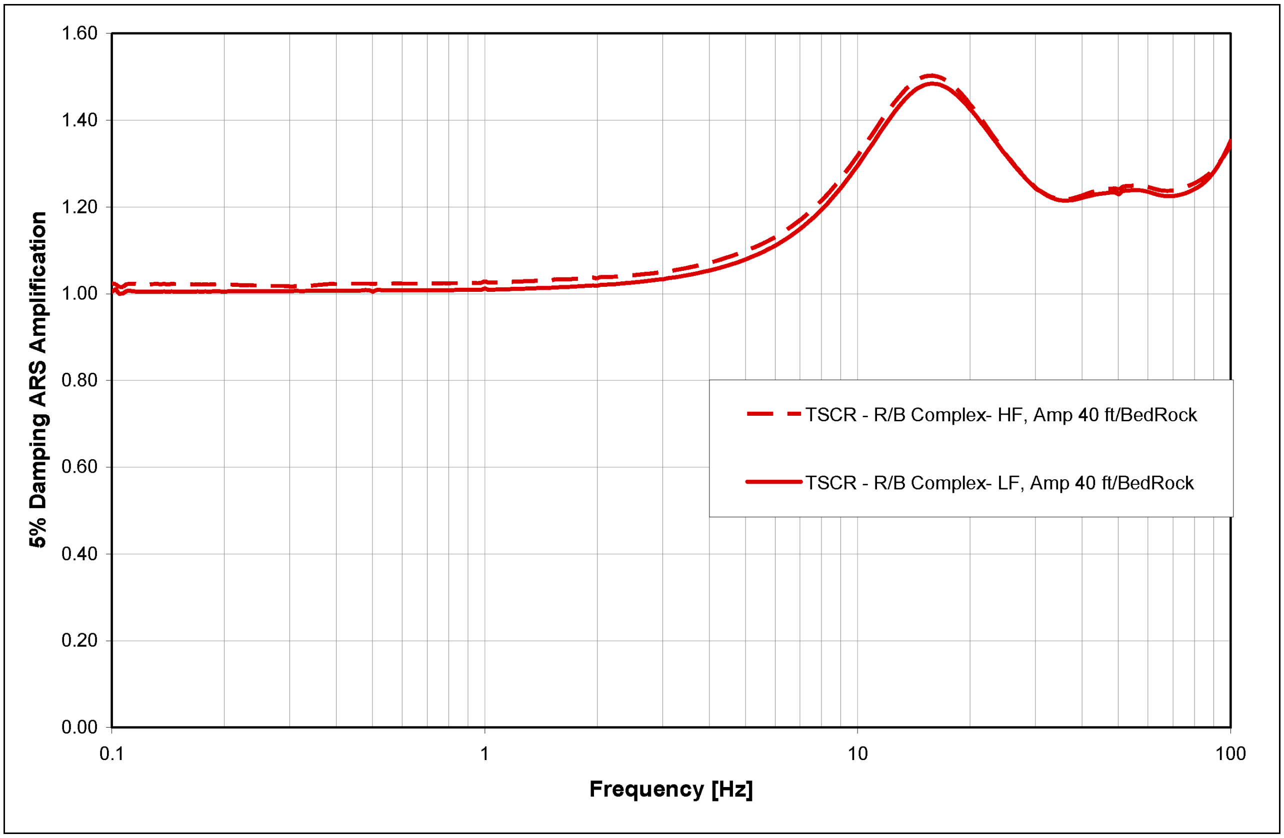


Figure 3OO-215 Full-Column Outcrop Log-mean ARS for R/B Complex

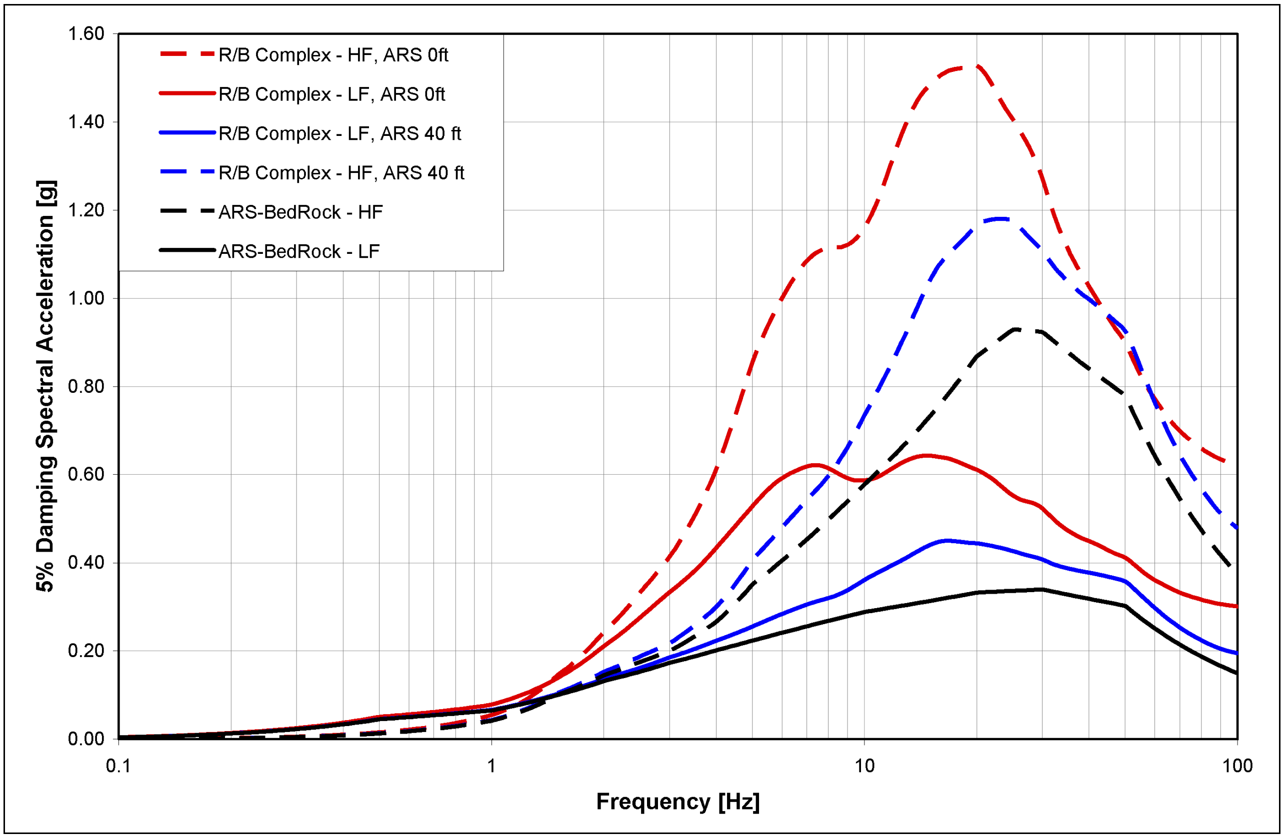


Figure 3OO-216 Geologic Outcrop Log-mean ARS for R/B Complex

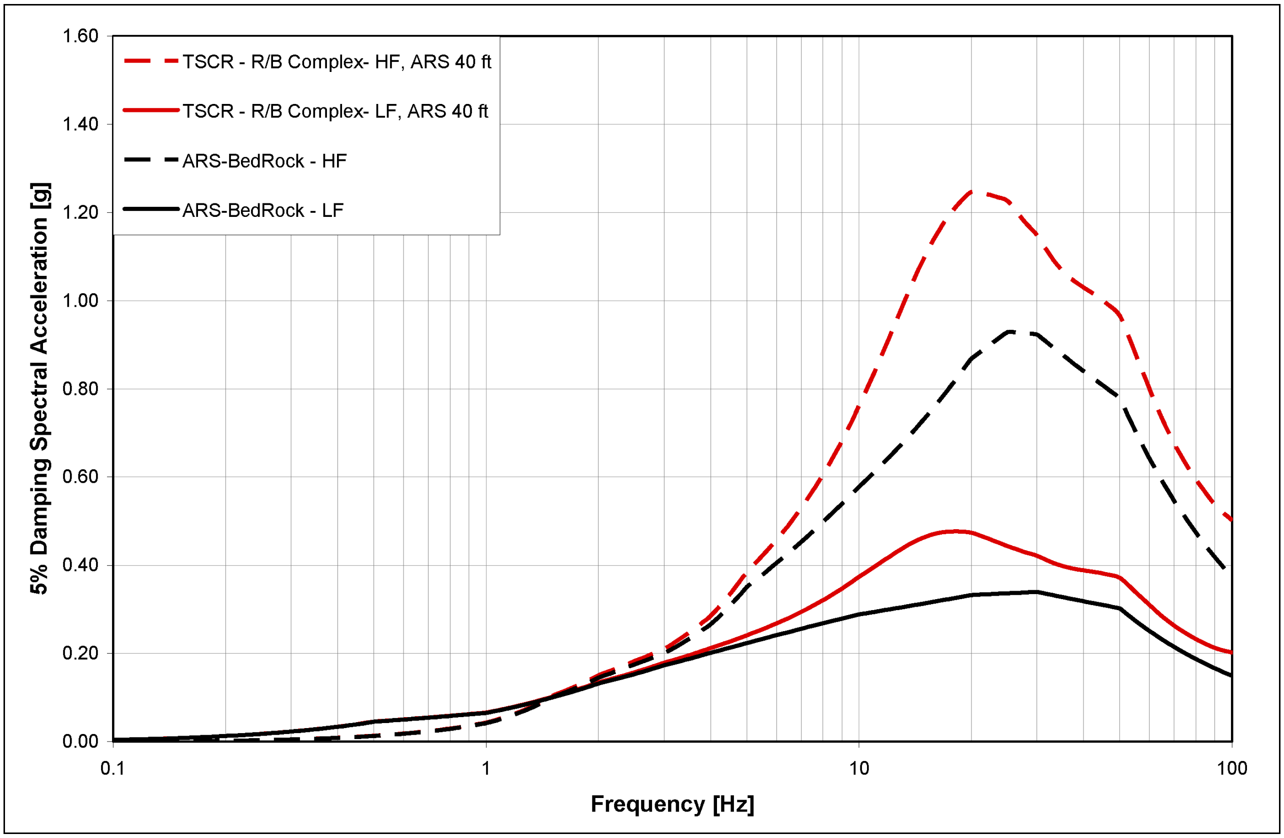


Figure 3OO-217 Full-Column Outcrop Log-mean ARS for East PS/B

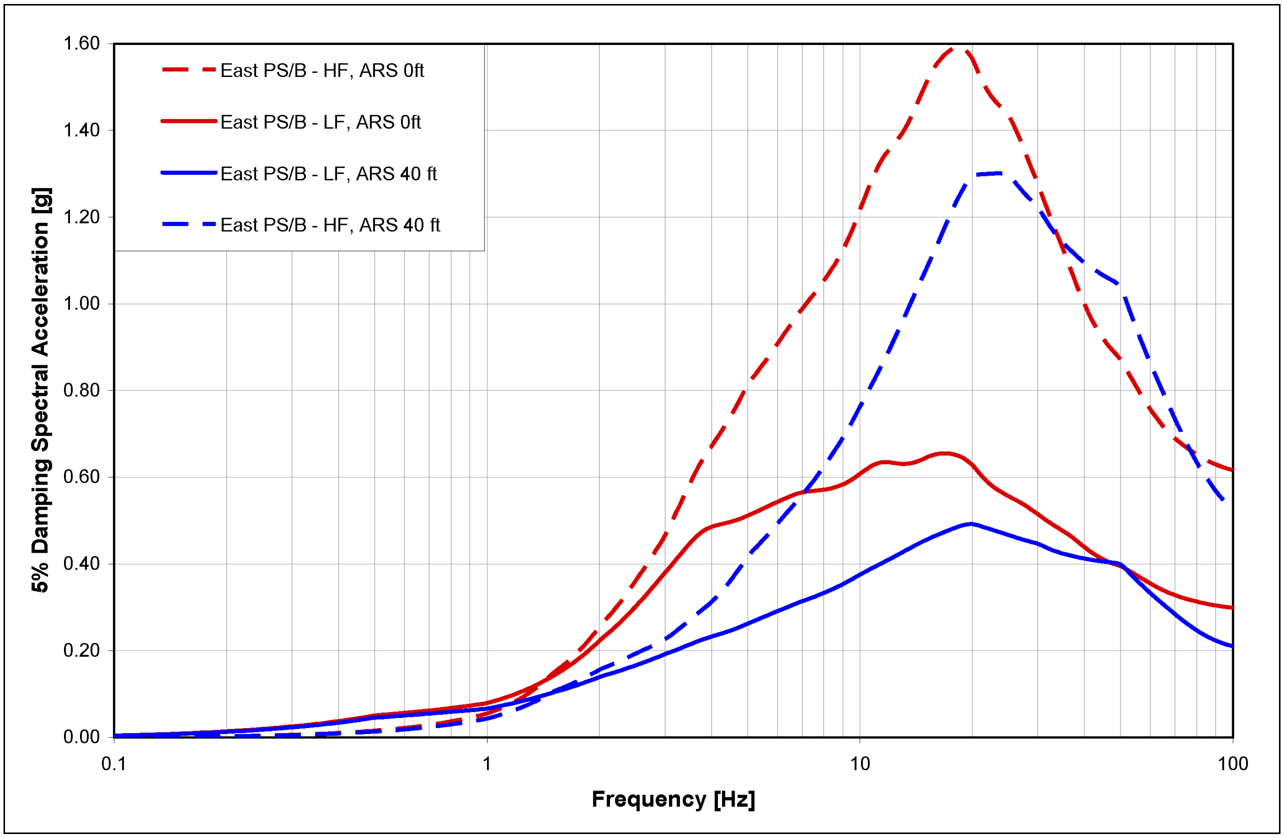


Figure 3OO-218 Geologic Outcrop Log-mean ARS for East PS/B

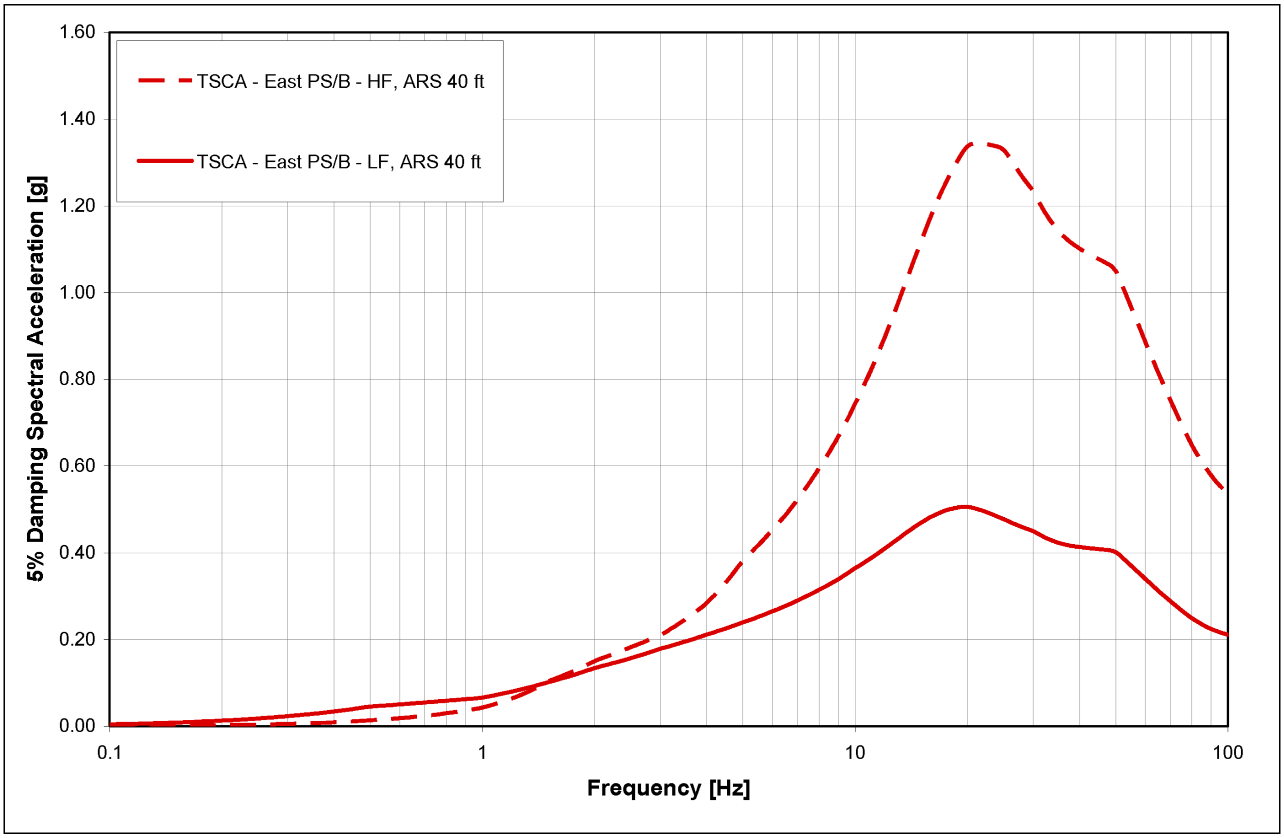


Figure 3OO-219 Full-Column Outcrop Log-mean ARS for West PS/B

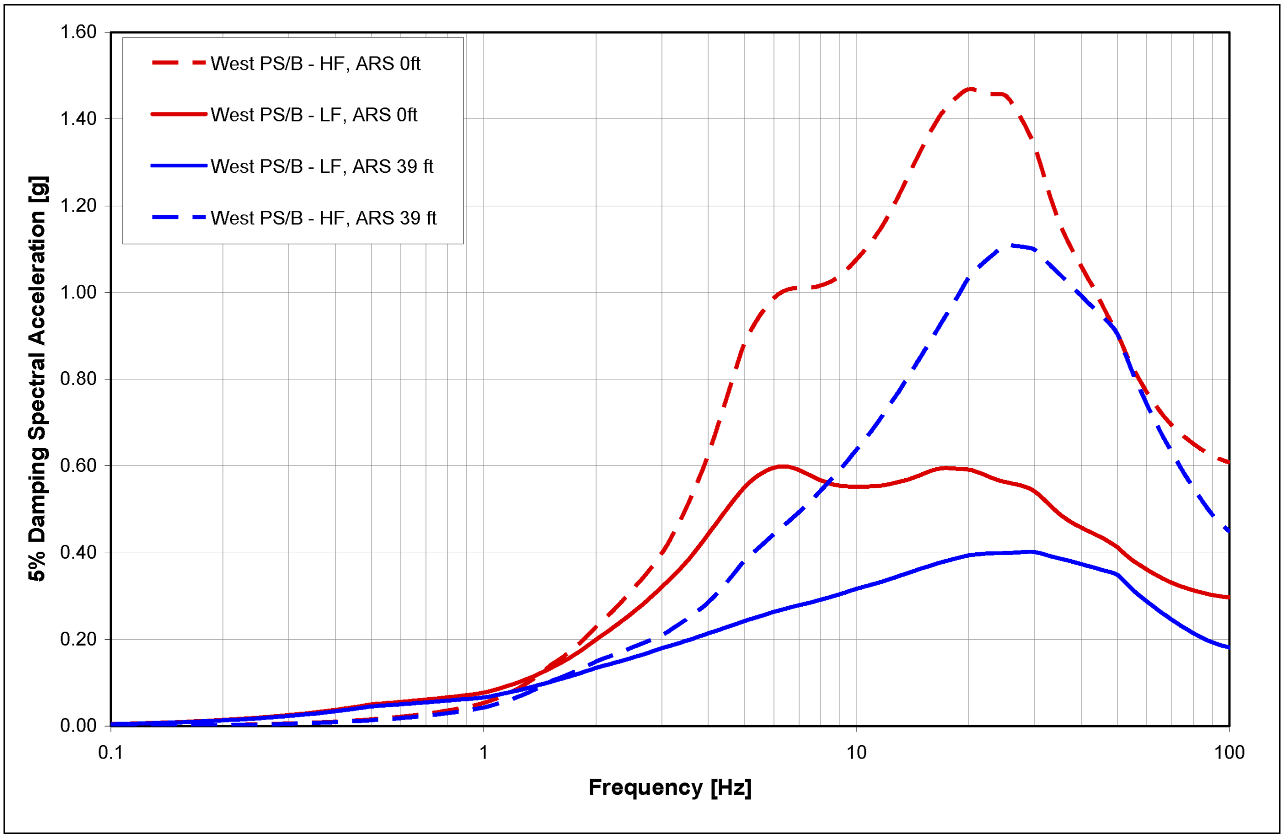


Figure 3OO-220 Geologic Outcrop Log-mean ARS for West PS/B

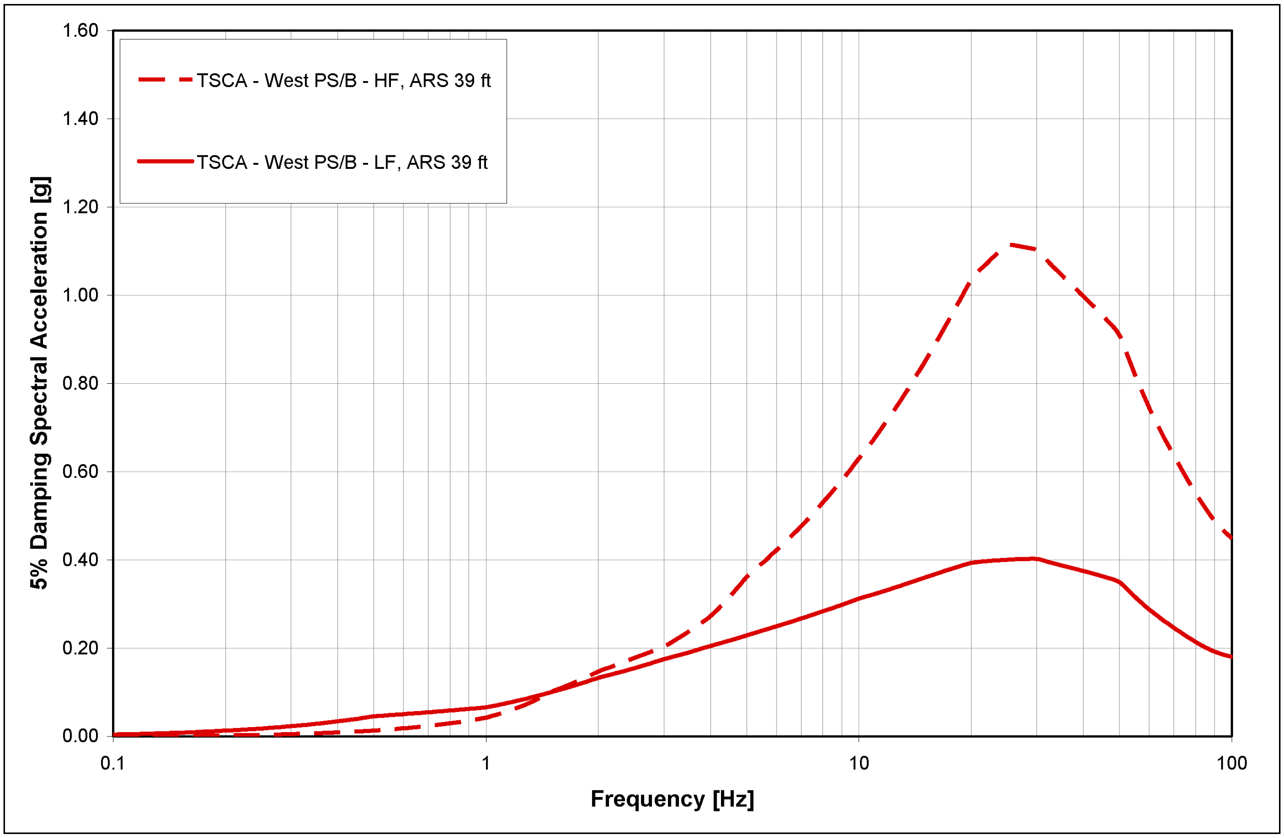


Figure 3OO-221 Geologic Outcrop (TSCR) Log-mean ARS for the Four UHSRS Units

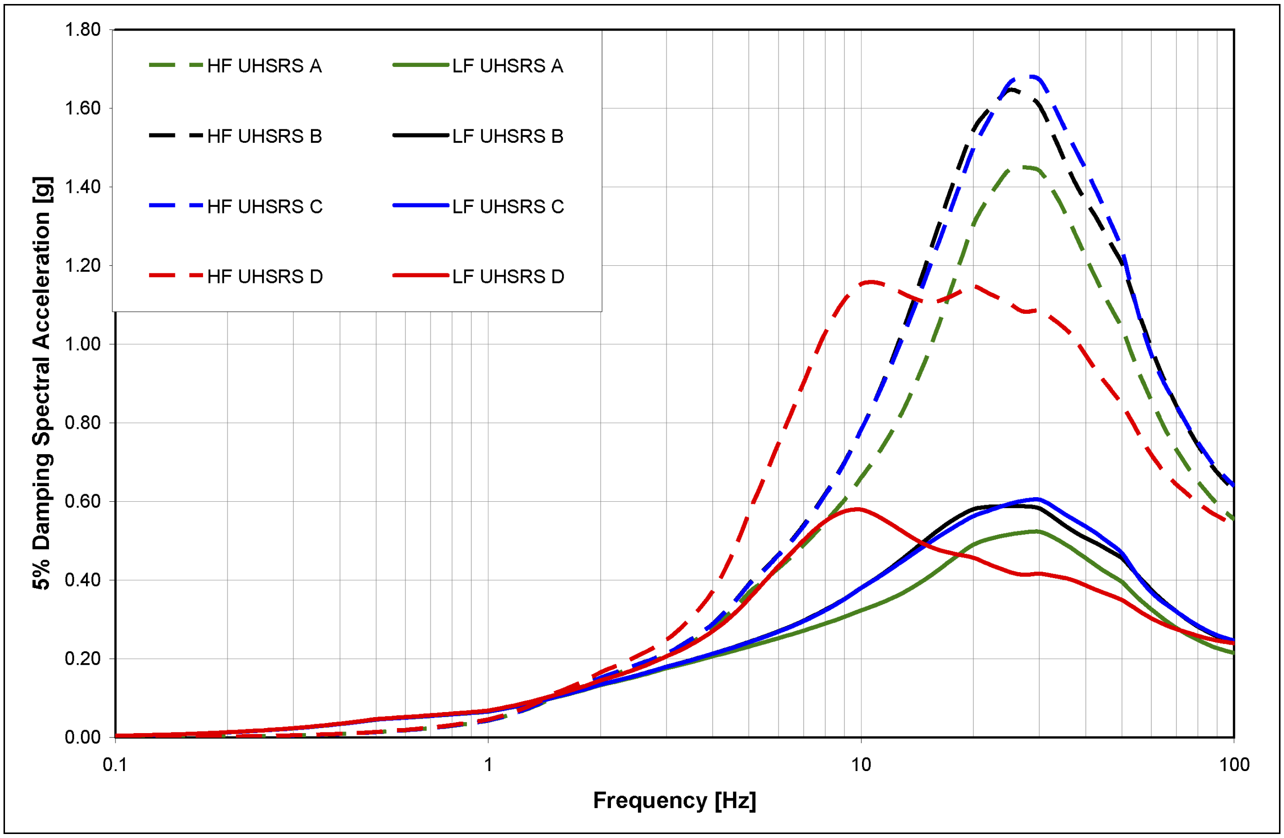


Figure 3OO-222 Full-Column Outcrop Log-mean ARS for East ESWPTs

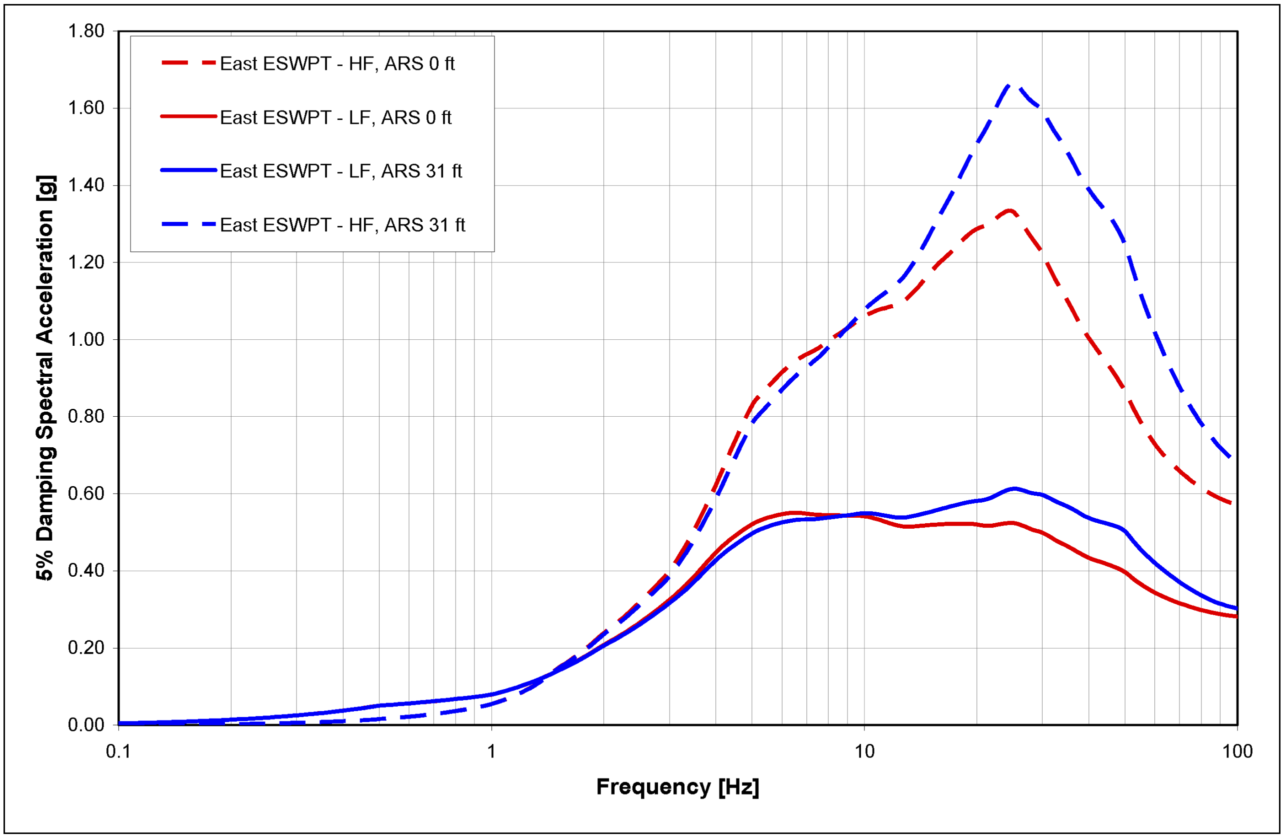


Figure 3OO-223 Full-Column Outcrop Log-mean ARS for West ESWPT

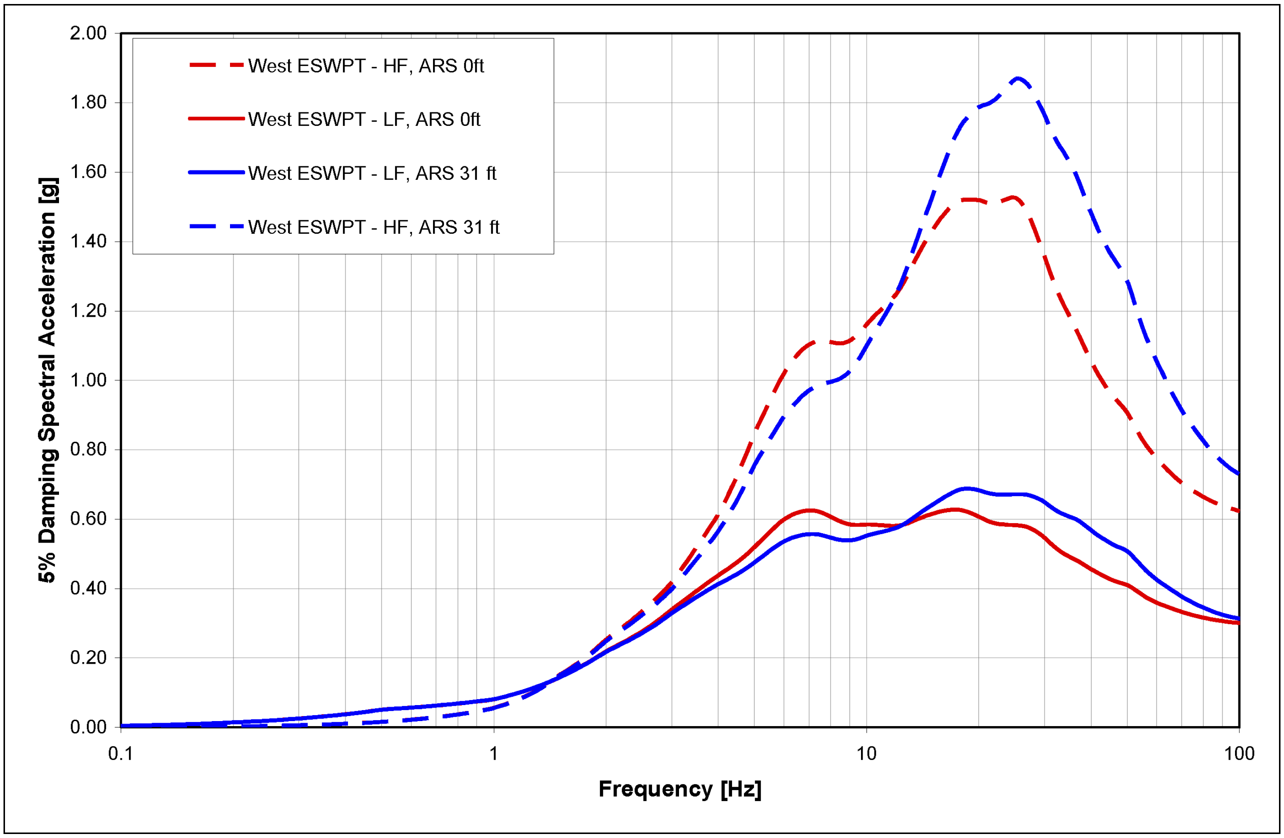


Figure 3OO-224 Full-Column Outcrop Log-mean ARS for UHSRS Pipe Chase

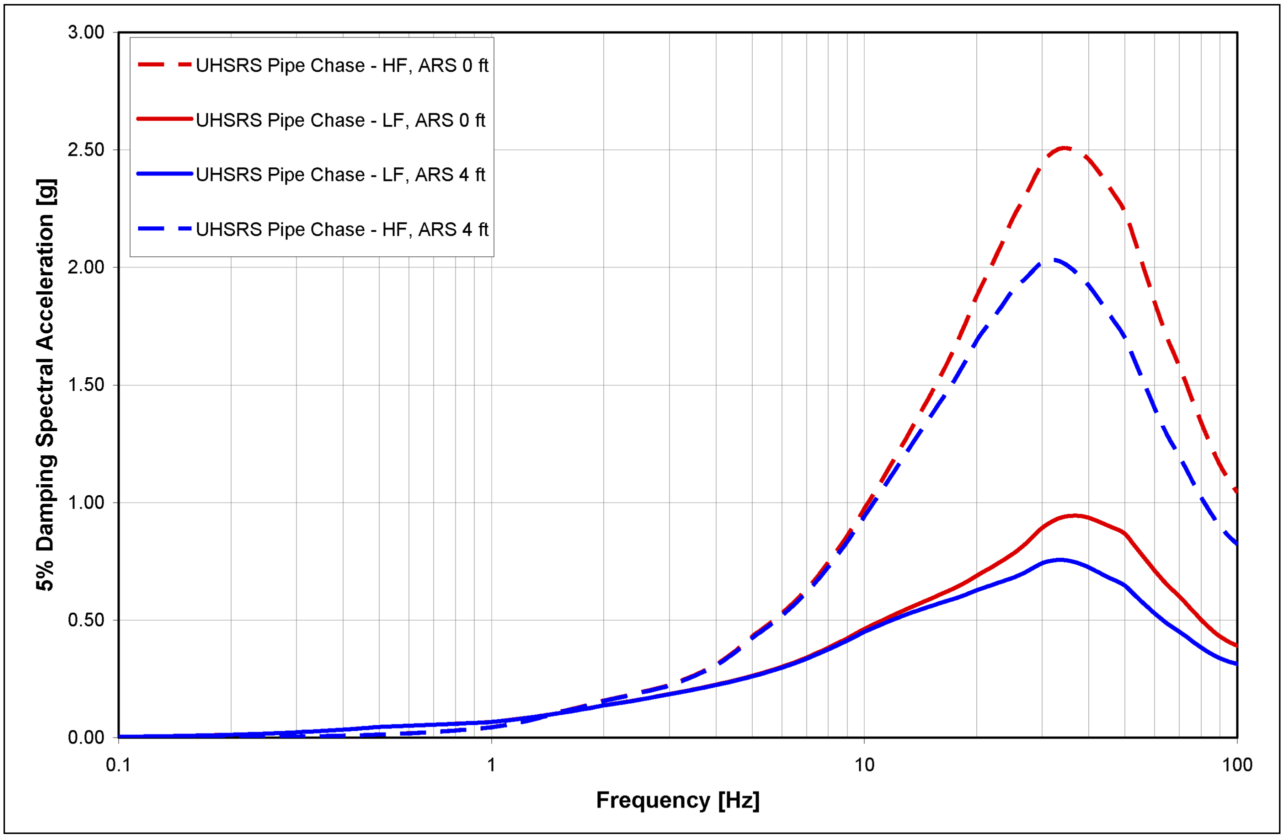


Figure 3OO-225 Log-Mean Strain Profiles for R/B Complex

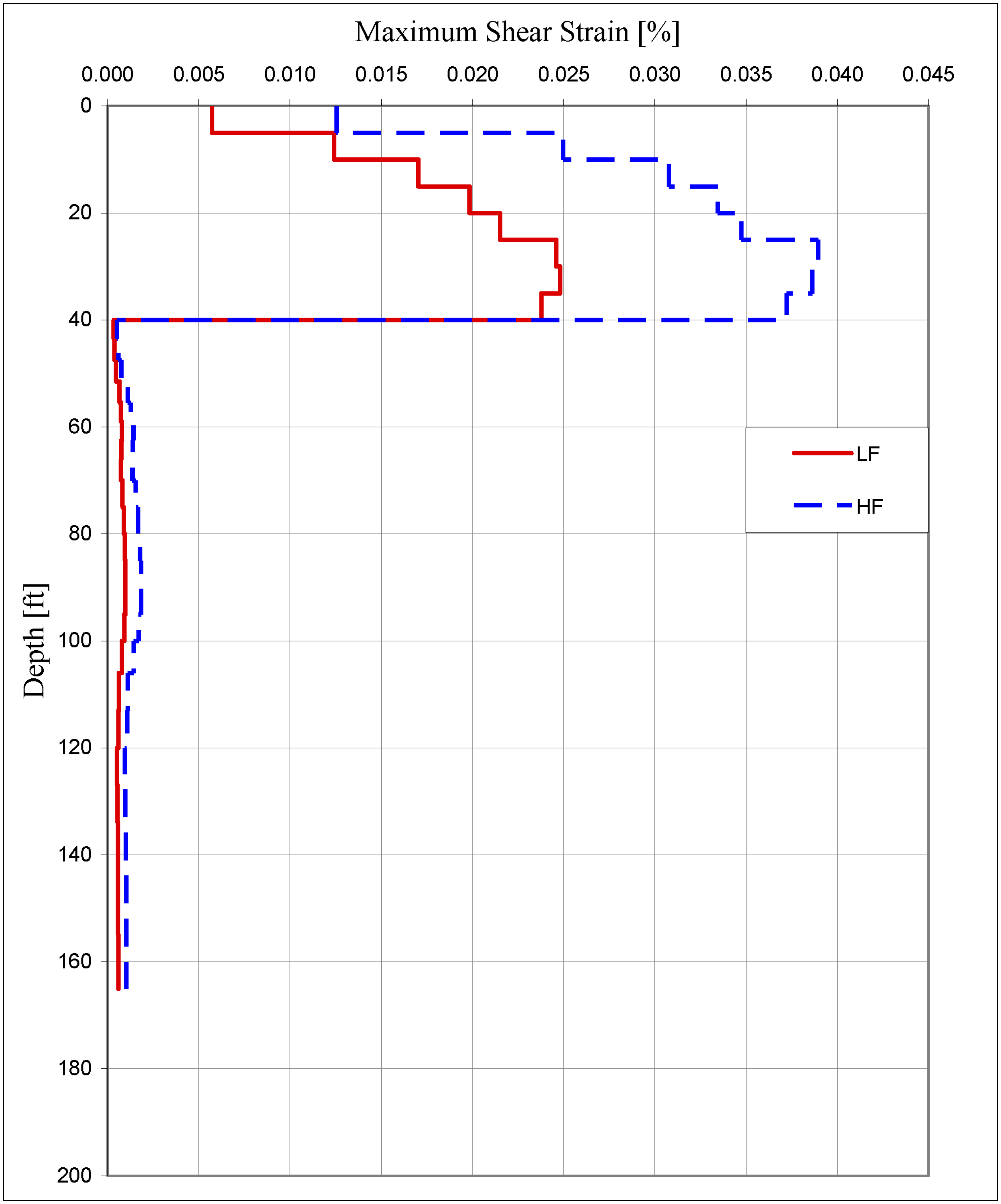


Figure 3OO-226 Full-Column Outcrop Horizontal FIRS for R/B Complex and PS/B

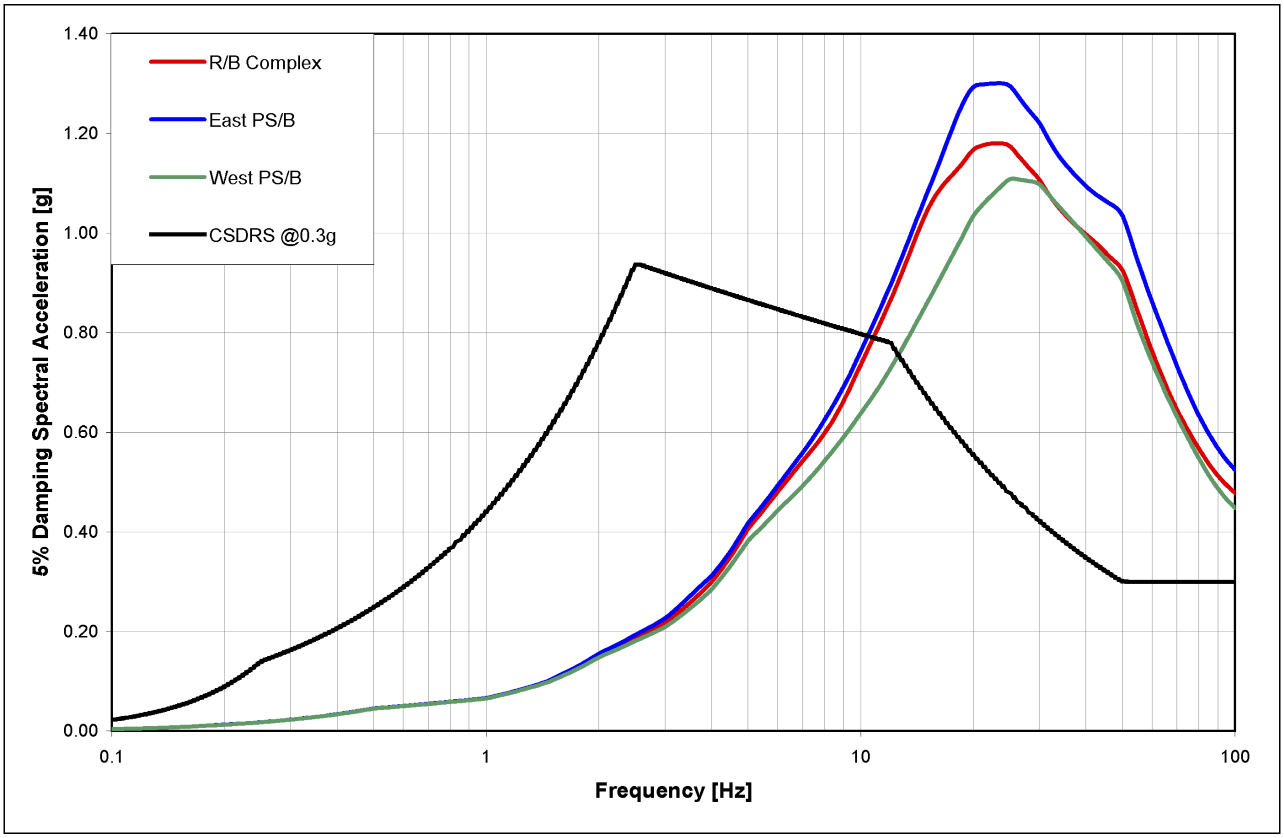


Figure 3OO-227 Full-Column Outcrop Vertical FIRS for R/B Complex and PS/B

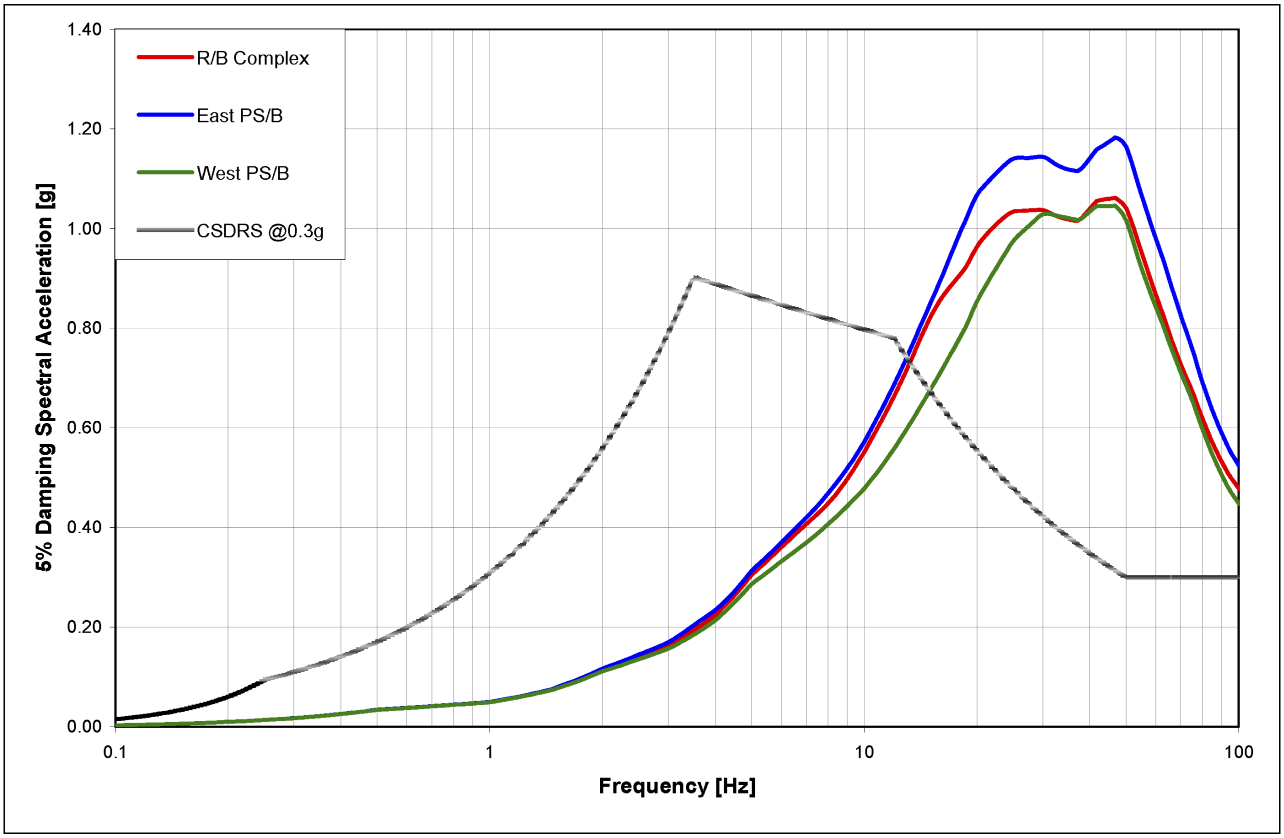


Figure 3OO-228 Geologic Outcrop Horizontal FIRS for R/B Complex and PS/B

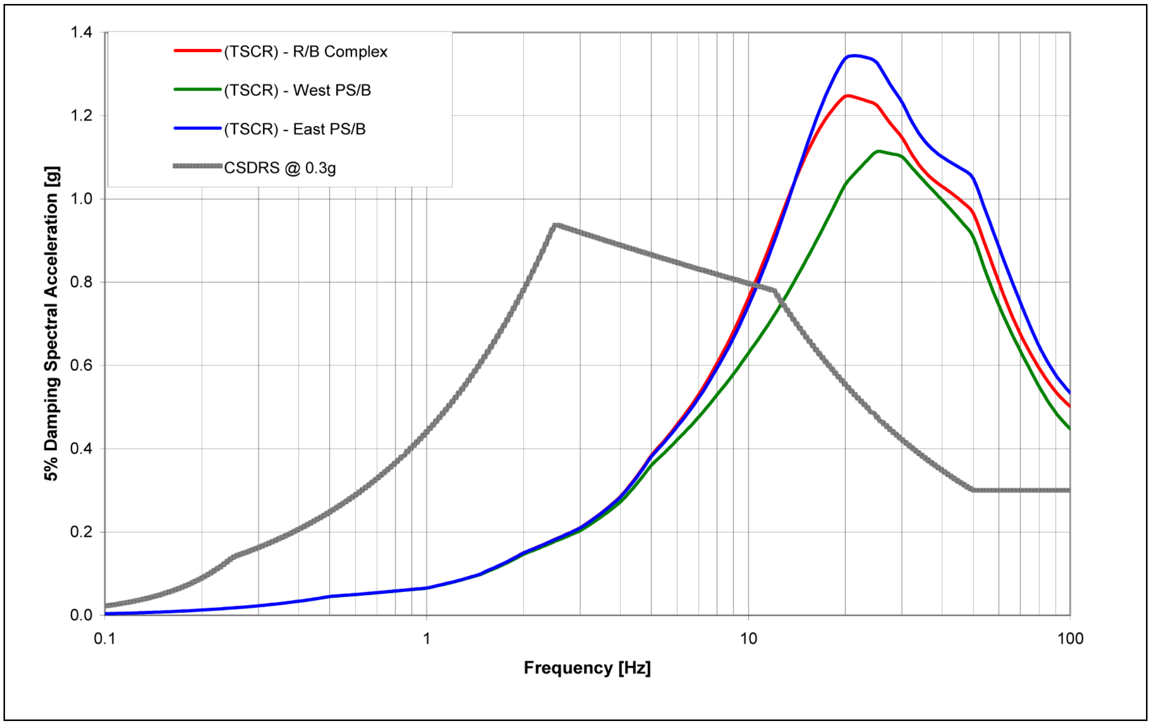


Figure 3OO-229 Geologic Outcrop Vertical FIRS for R/B Complex and PS/B

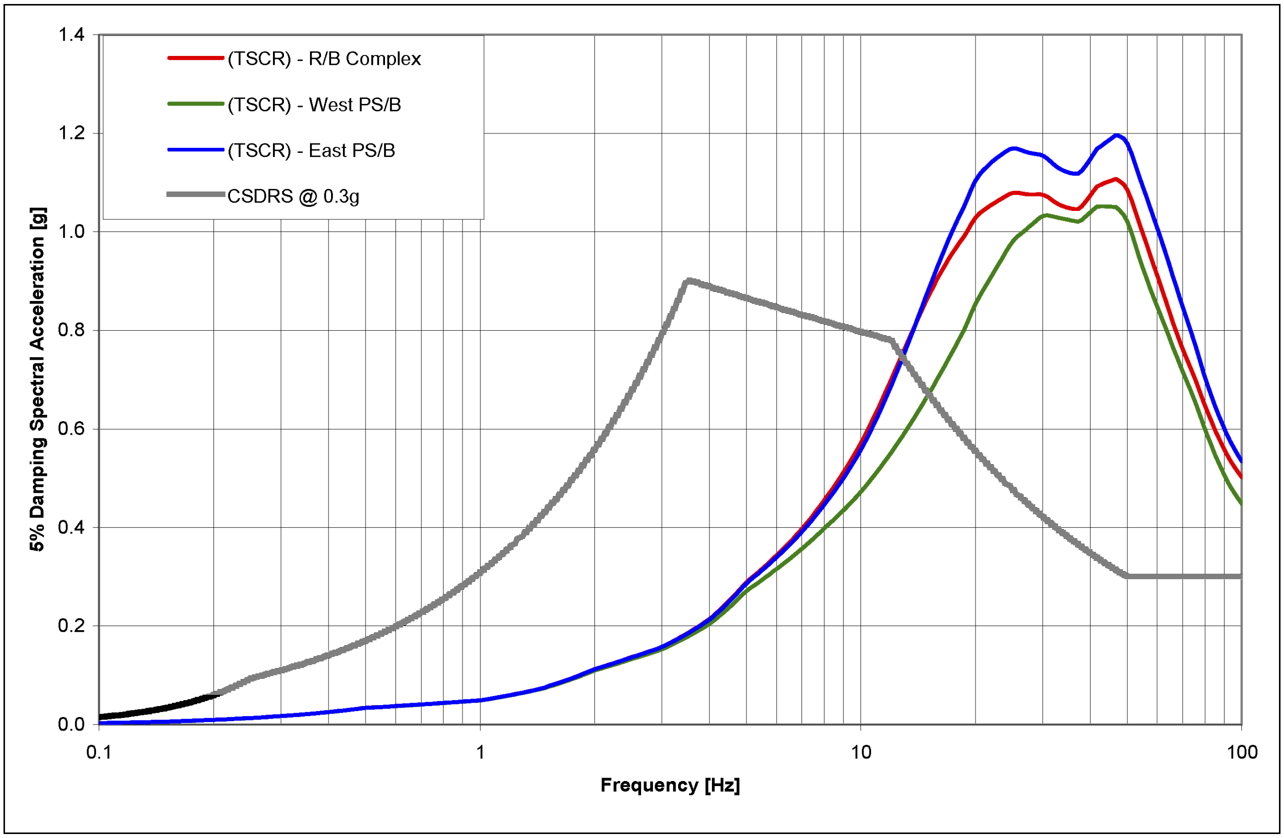


Figure 3OO-230 Geologic Outcrop Horizontal and Vertical FIRS for the Four UHSRS Units

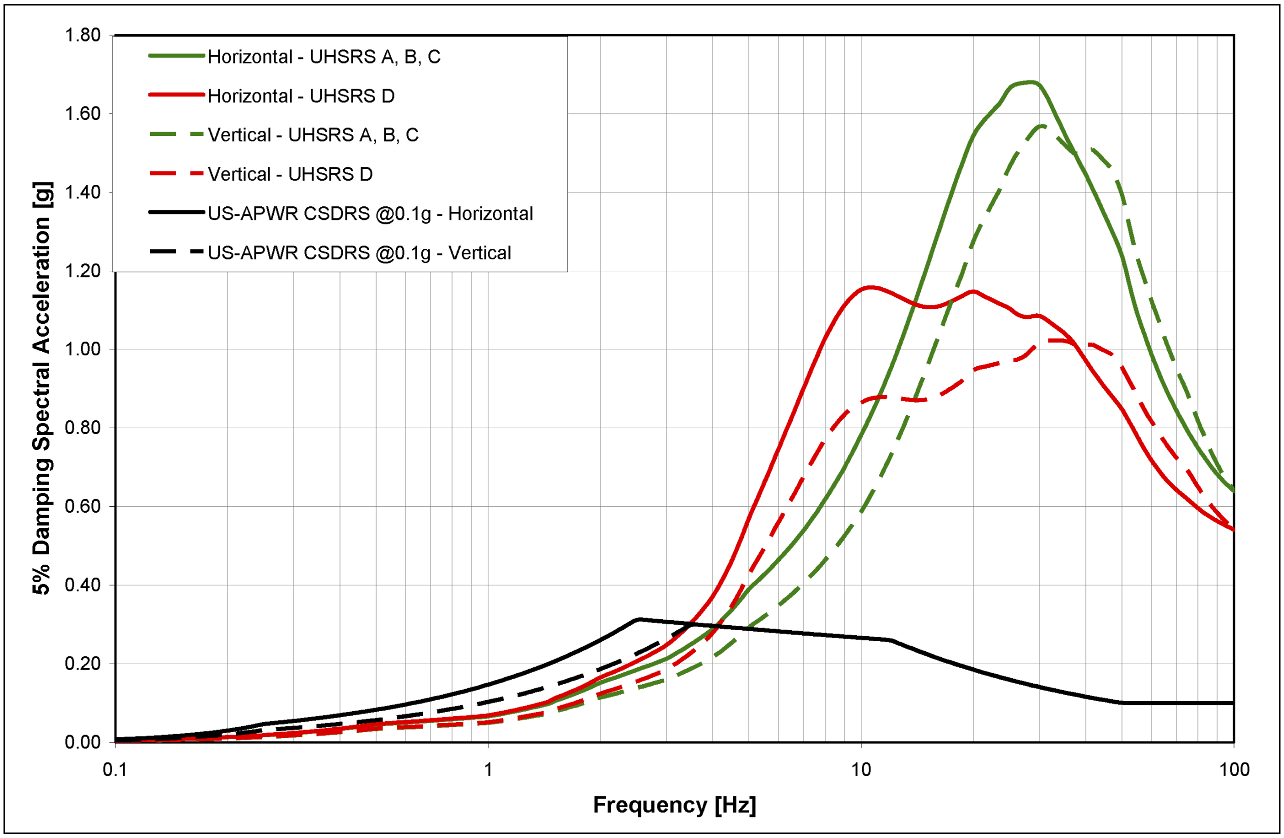


Figure 3OO-231 Full-Column Outcrop Horizontal FIRS for ESWPT and UHSRS Pipe Chase

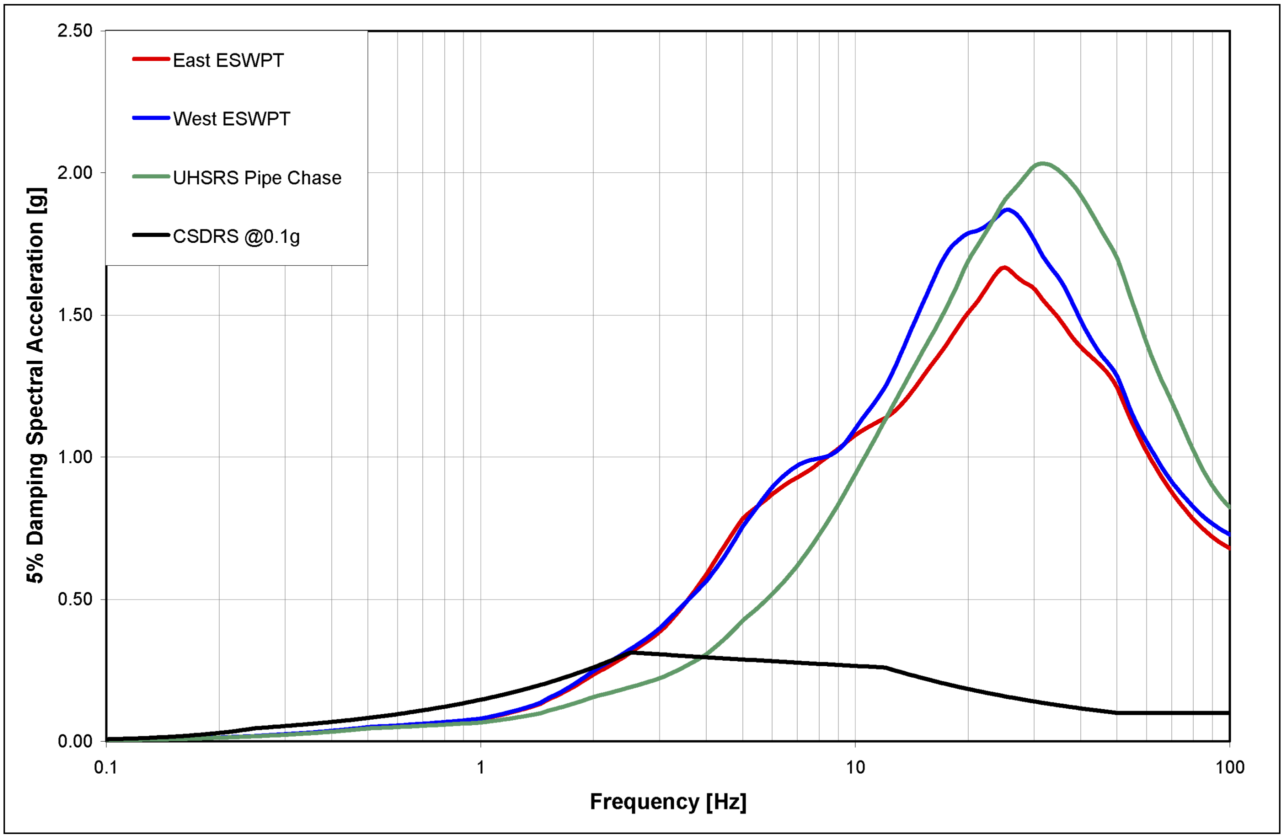


Figure 3OO-232 Full-Column Outcrop Vertical FIRS for ESWPT and UHSRS Pipe Chase

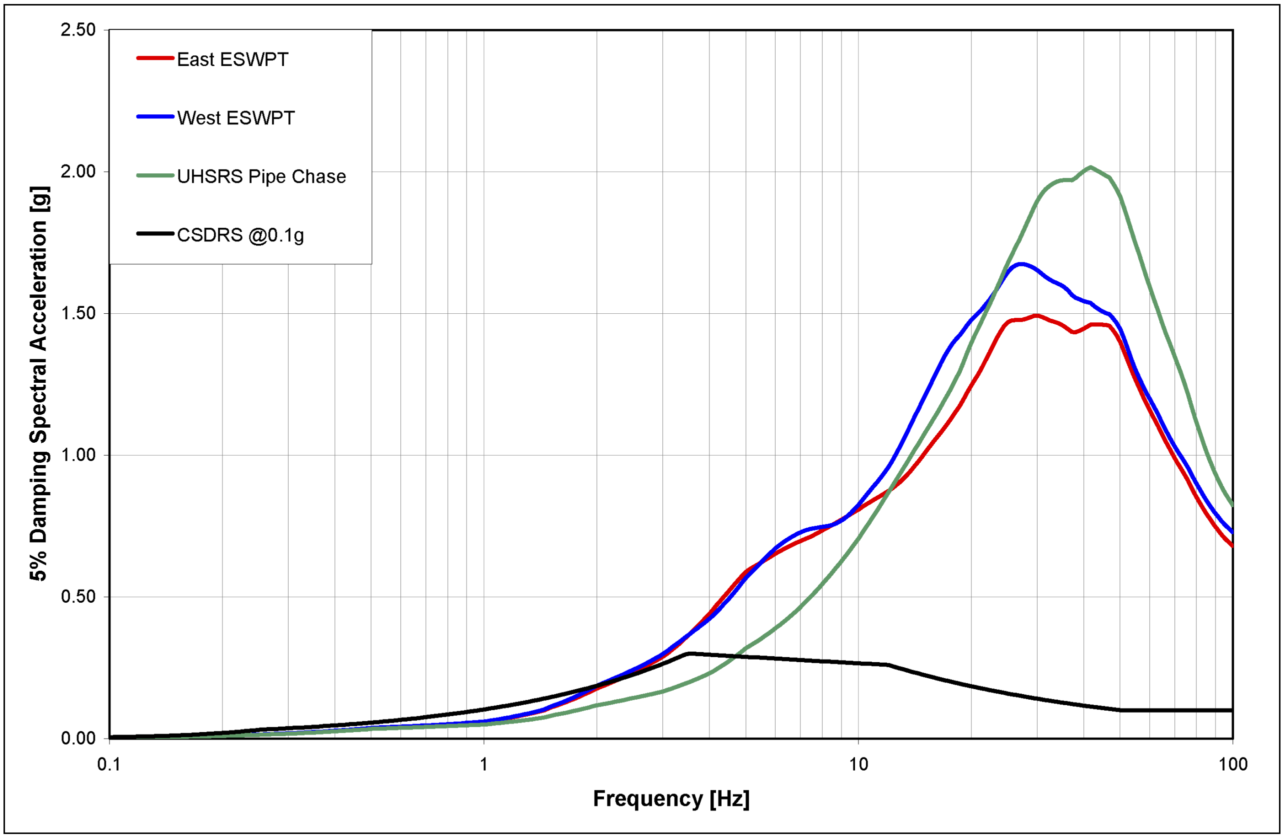


Figure 3OO-233 Horizontal PBSRS at Finished Grade

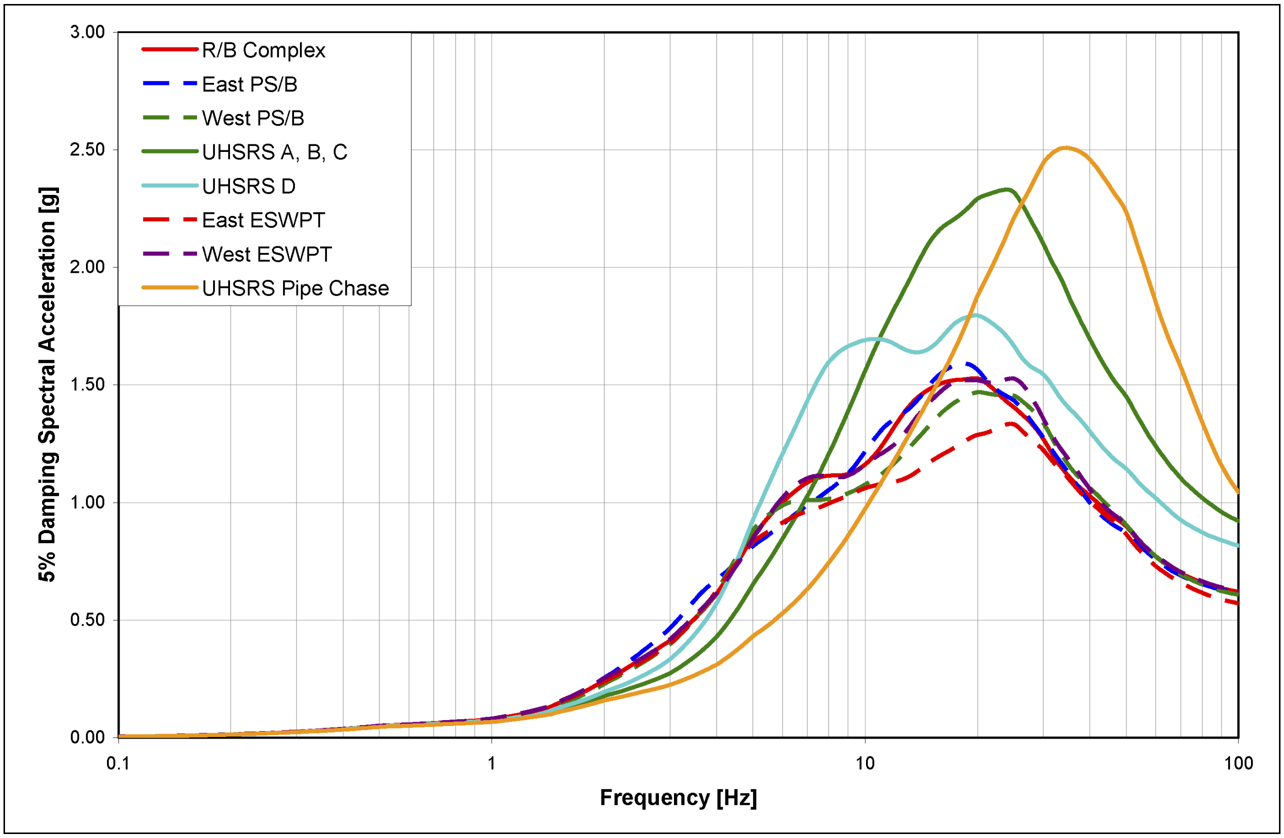


Figure 3OO-234 Vertical PBSRS at Finished Grade

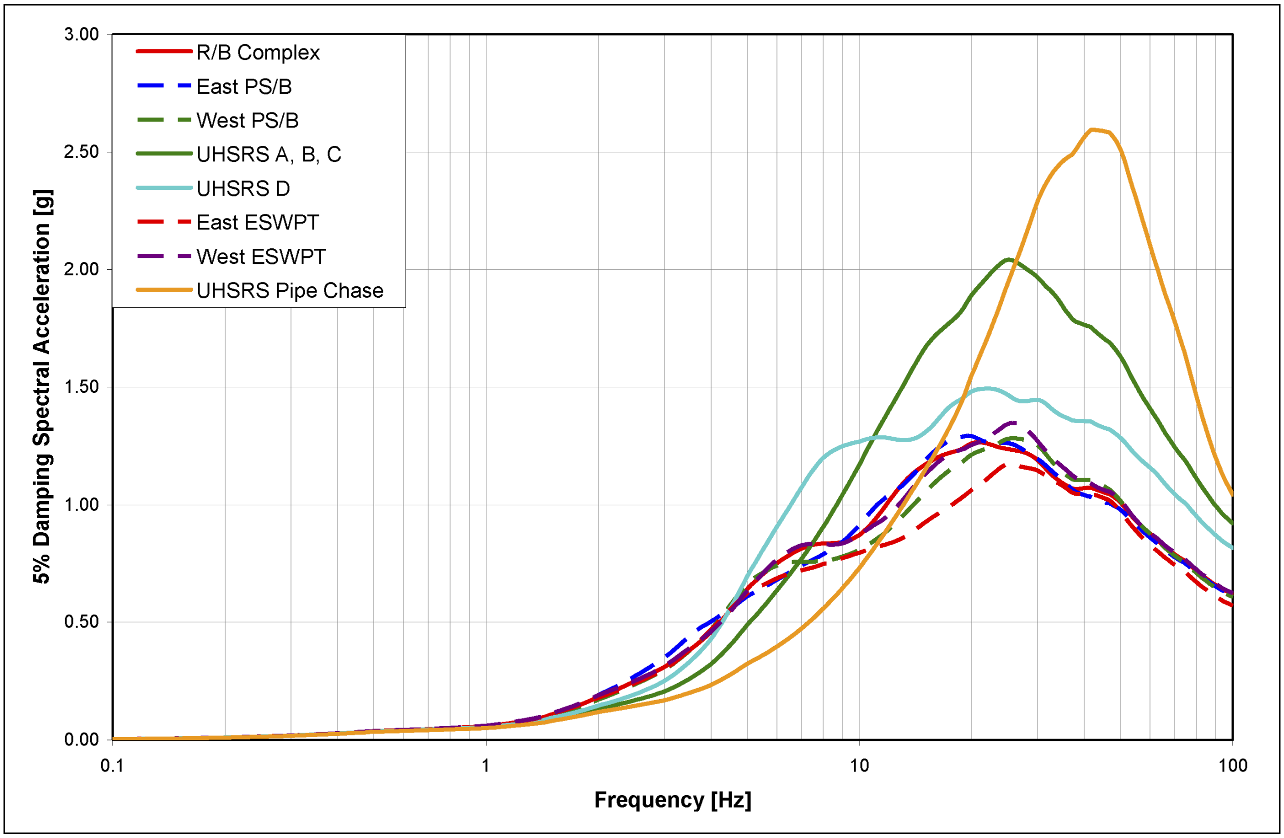


Figure 3OO-235 NEI Check of Horizontal FIRS for R/B Complex

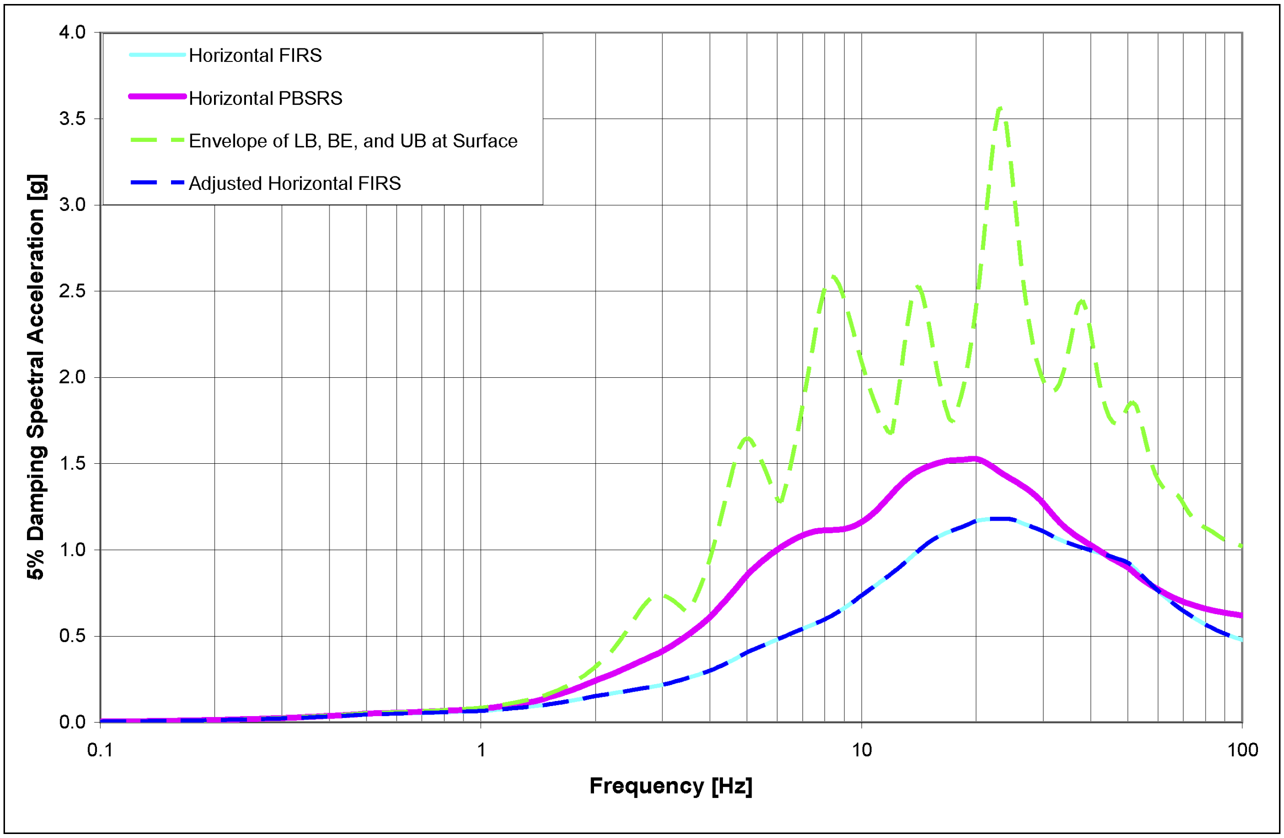


Figure 3OO-236 NEI Check of Vertical FIRS for R/B Complex

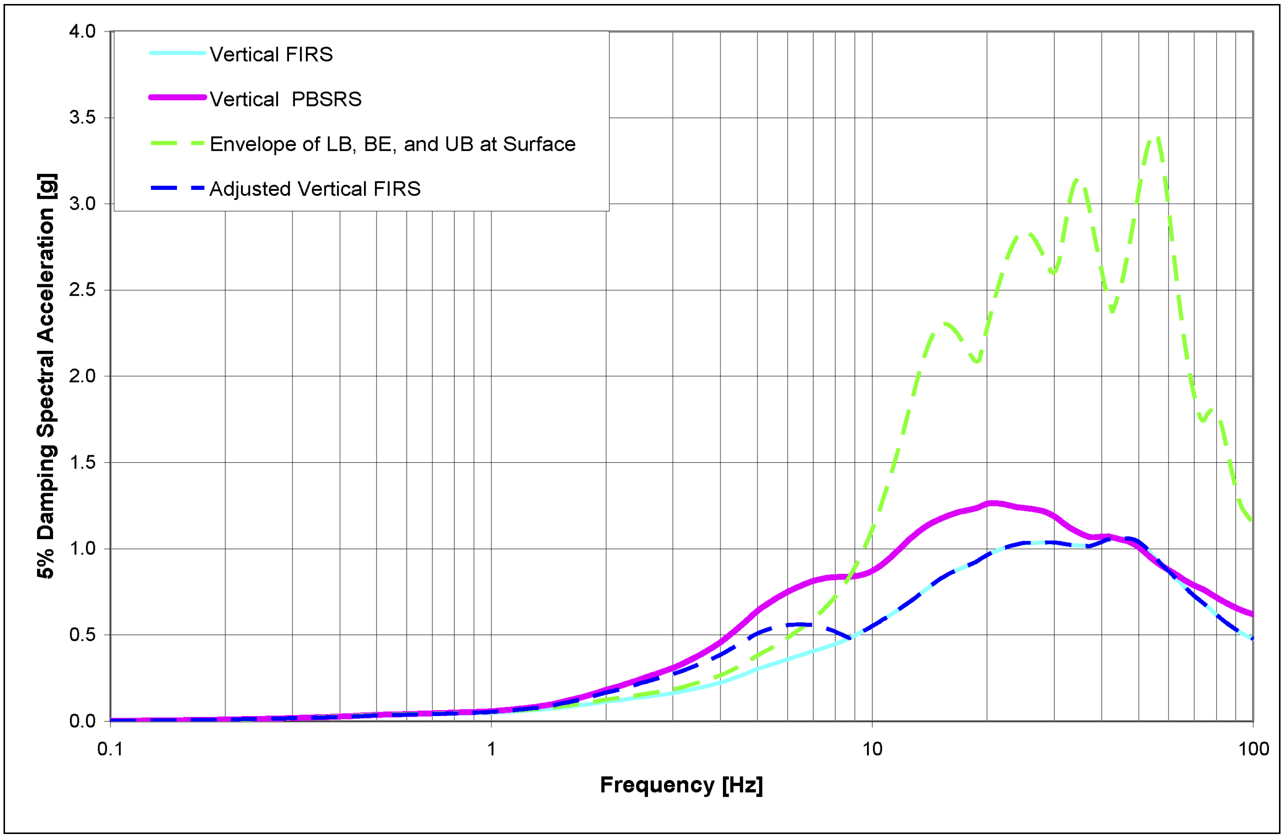


Figure 3OO-237 Full-Column Outcrop SSI Input Motion Spectra for R/B Complex and PS/B

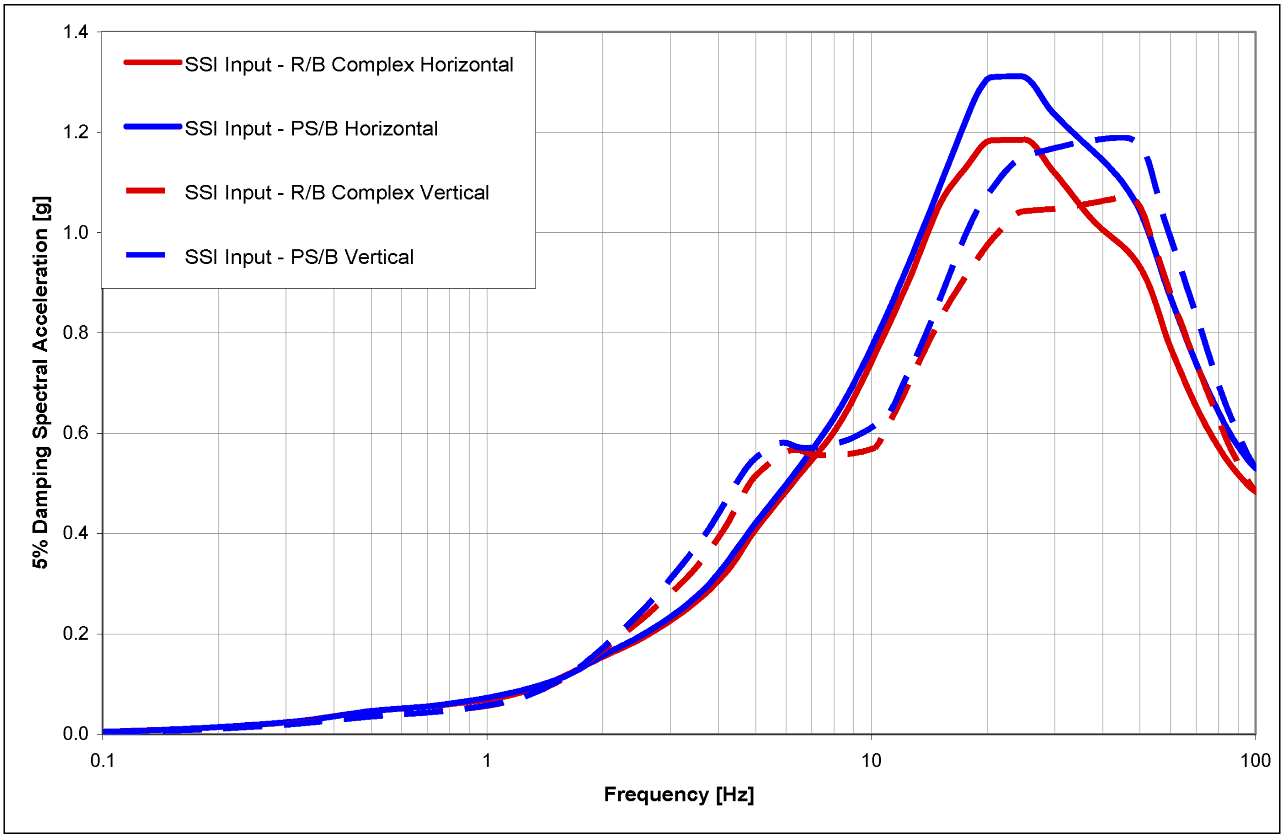


Figure 3OO-238 Geologic Outcrop SSI Input Motion Spectra for R/B Complex and PS/B

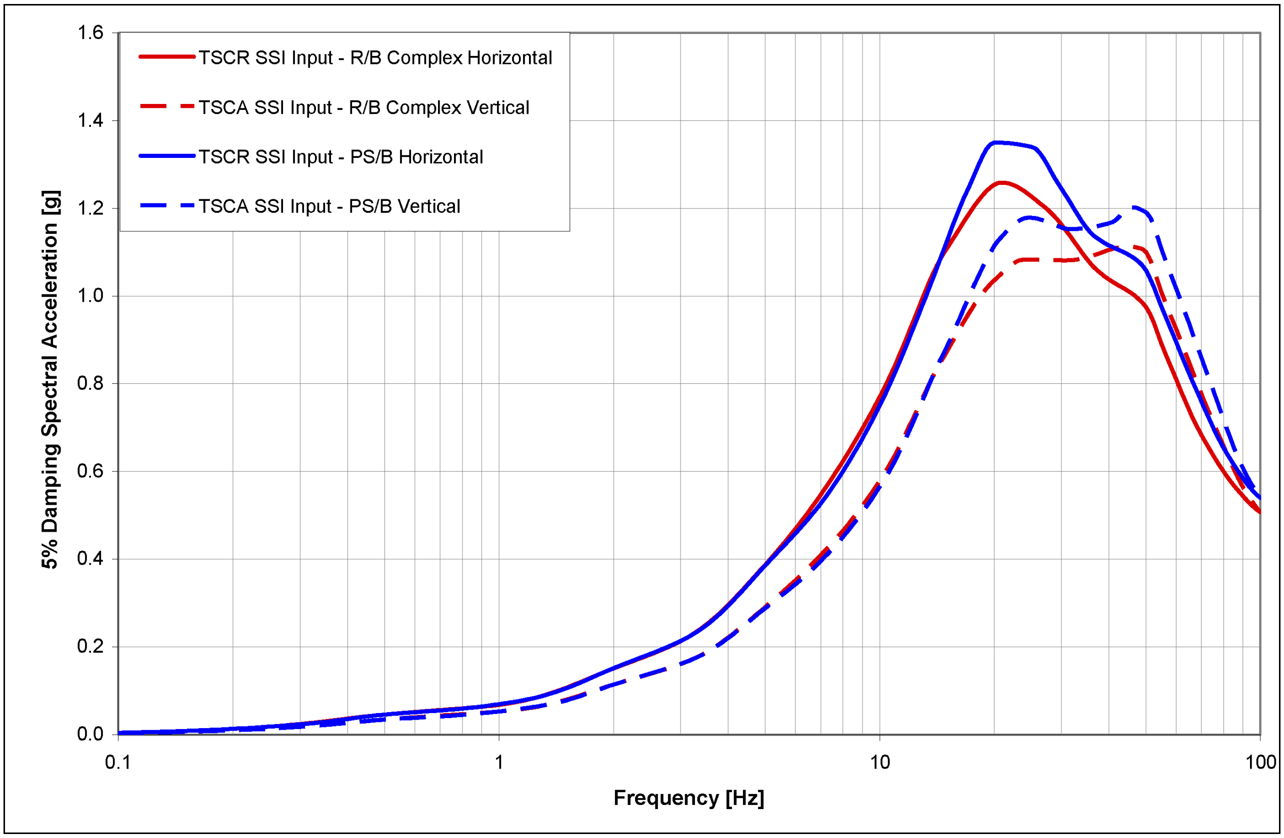


Figure 3OO-239 Geologic Outcrop SSI Input Motion Spectra for the Four UHSRS Units

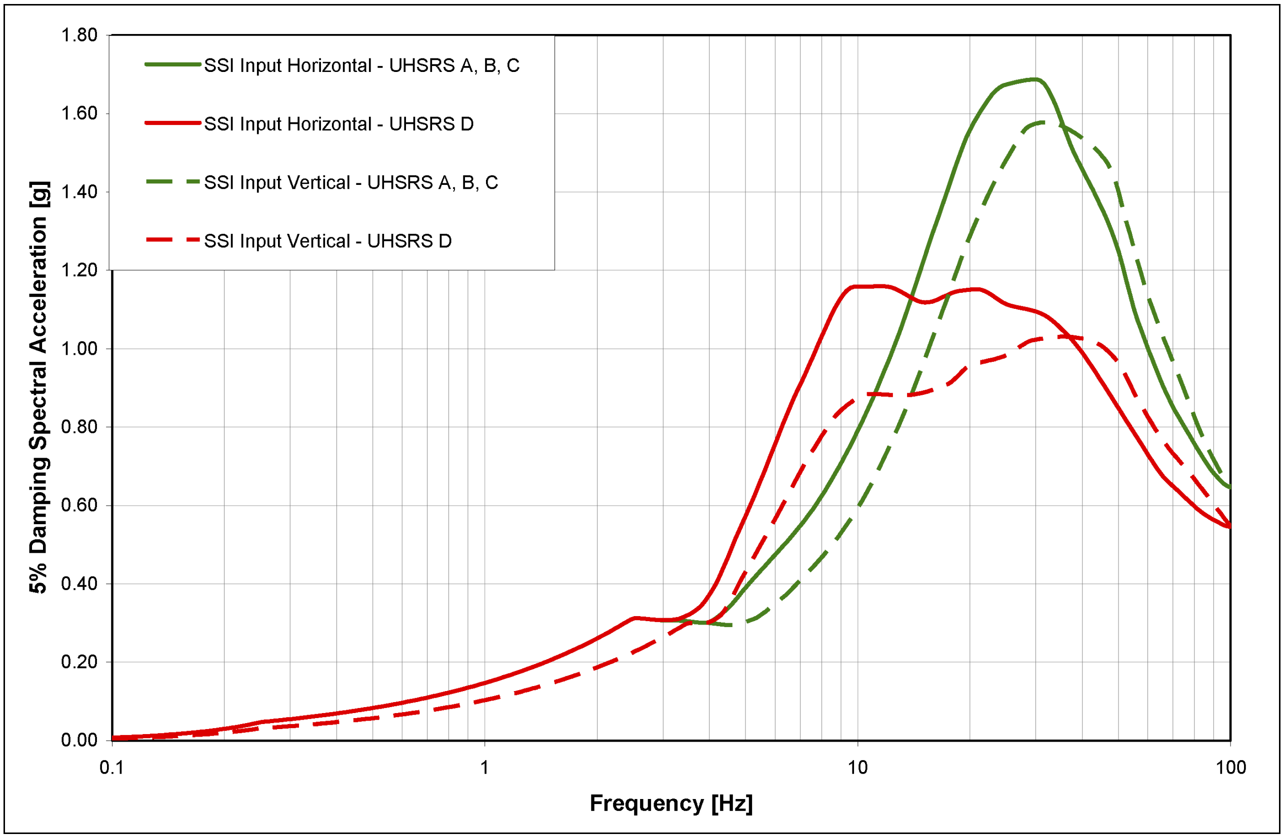


Figure 3OO-240 Full-Column Outcrop SSI Input Motion Spectra for ESWPT and UHSRS Pipe Chase

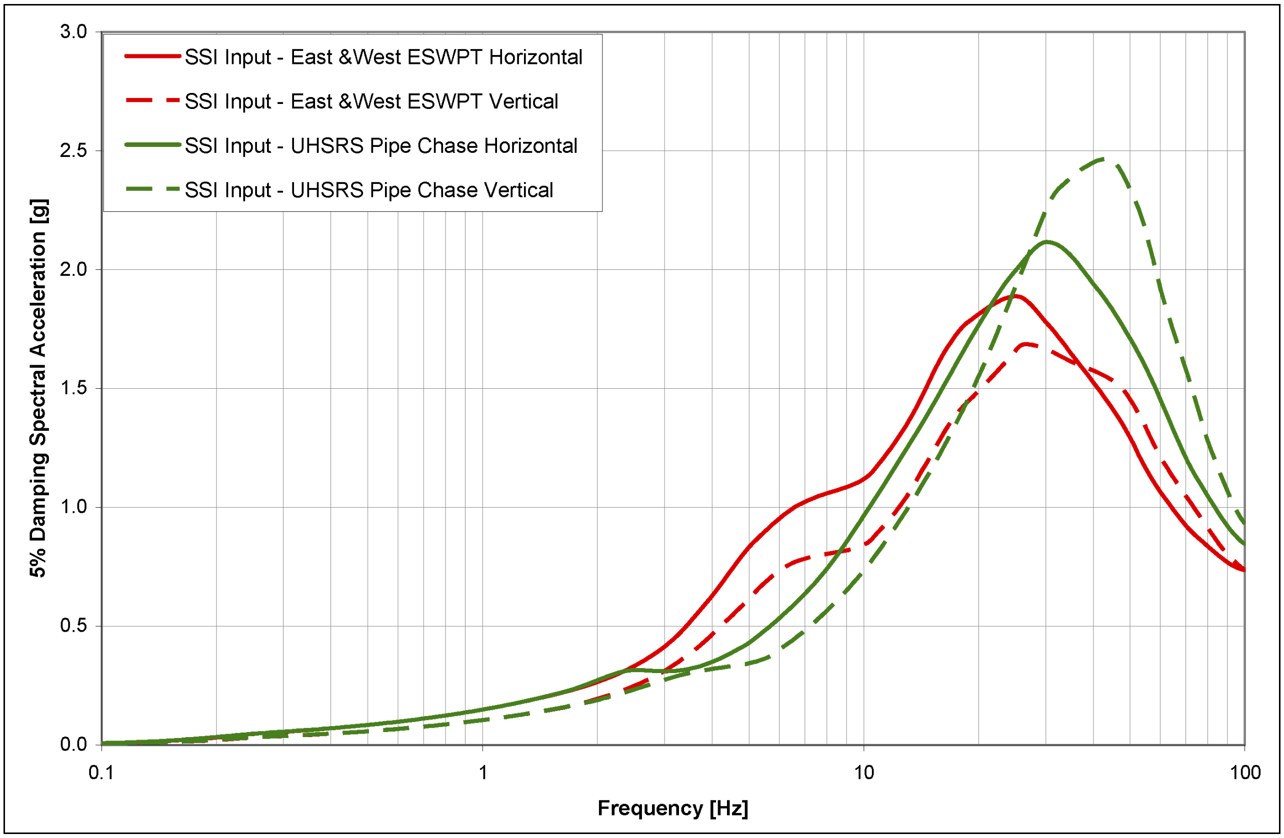


Figure 3OO-241 SSI Shear-Wave Velocity Profiles for R/B Complex (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

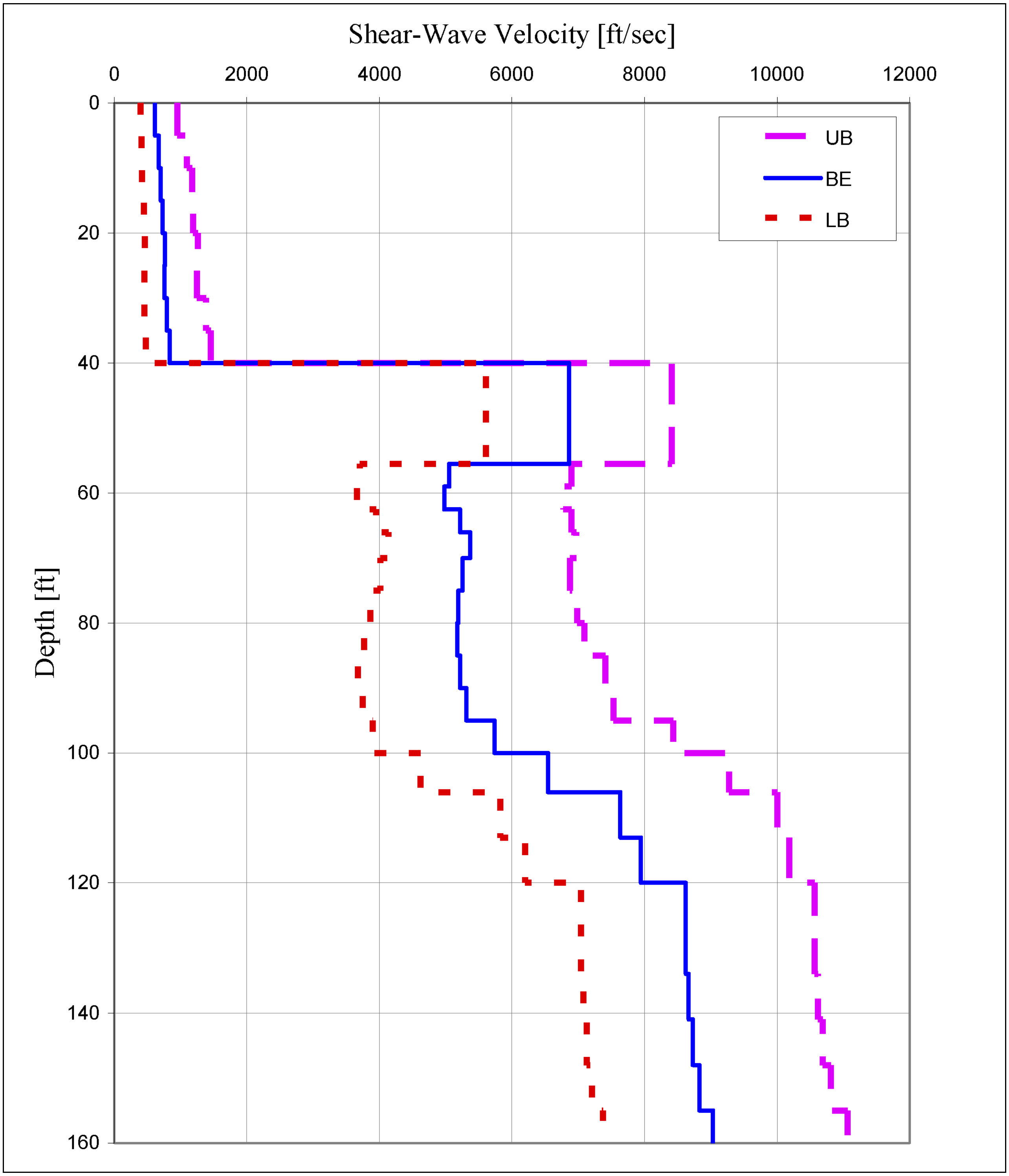


Figure 3OO-242 SSI Damping Ratio Profiles for R/B Complex (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

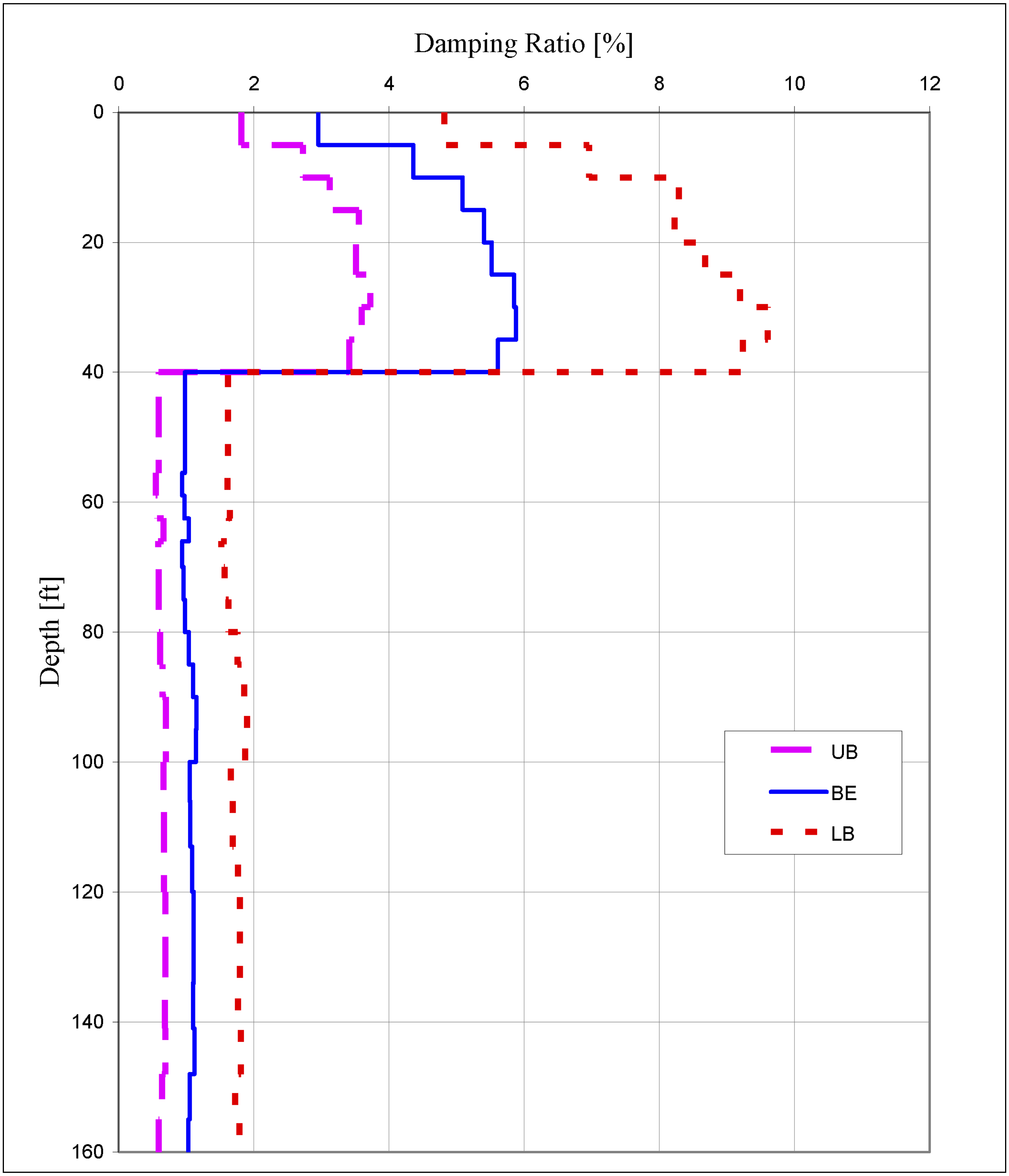


Figure 3OO-243 SSI P-Wave Velocity Profiles for R/B Complex (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

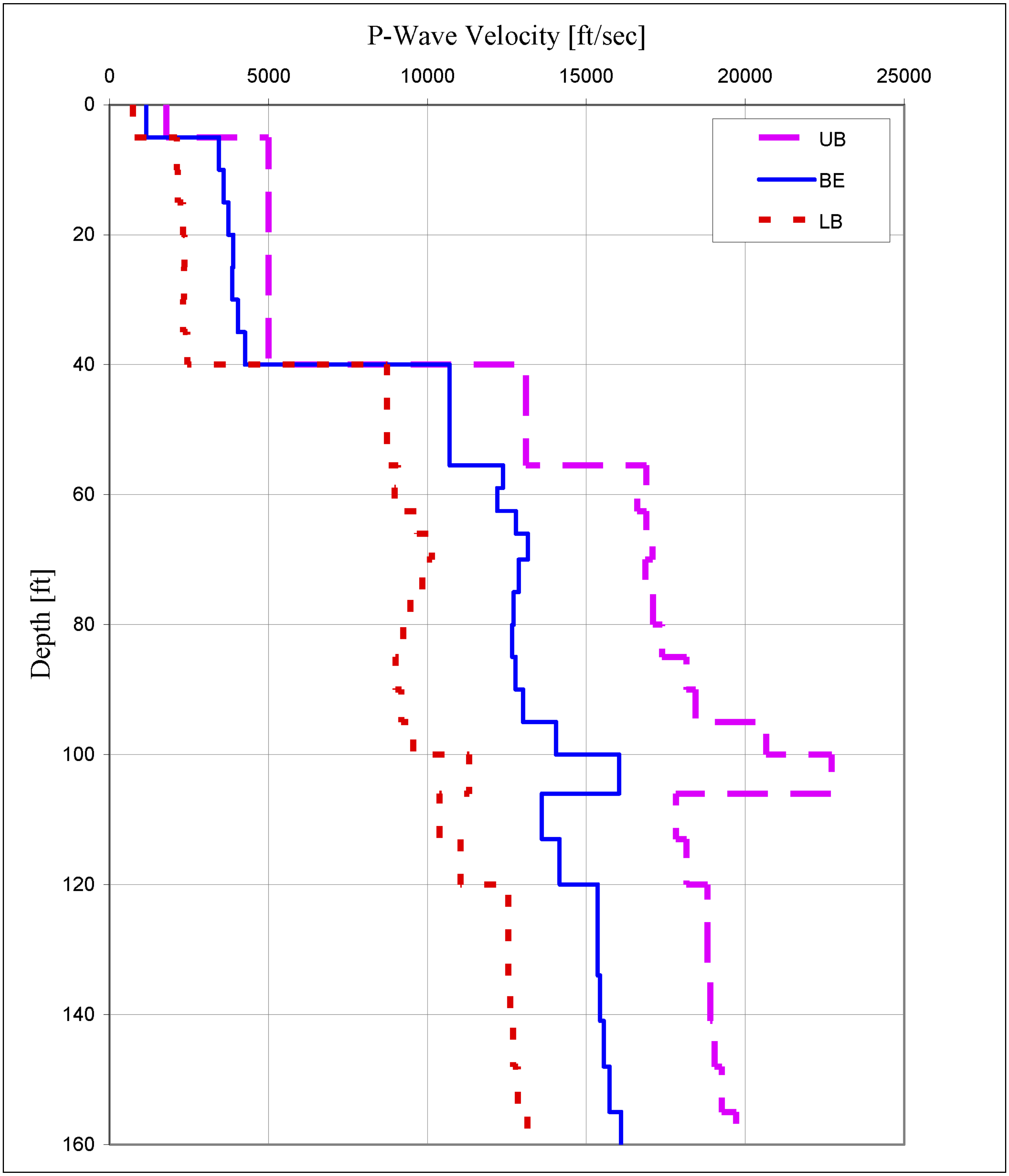


Figure 3OO-244 SSI Shear-Wave Velocity Profiles for PS/B (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

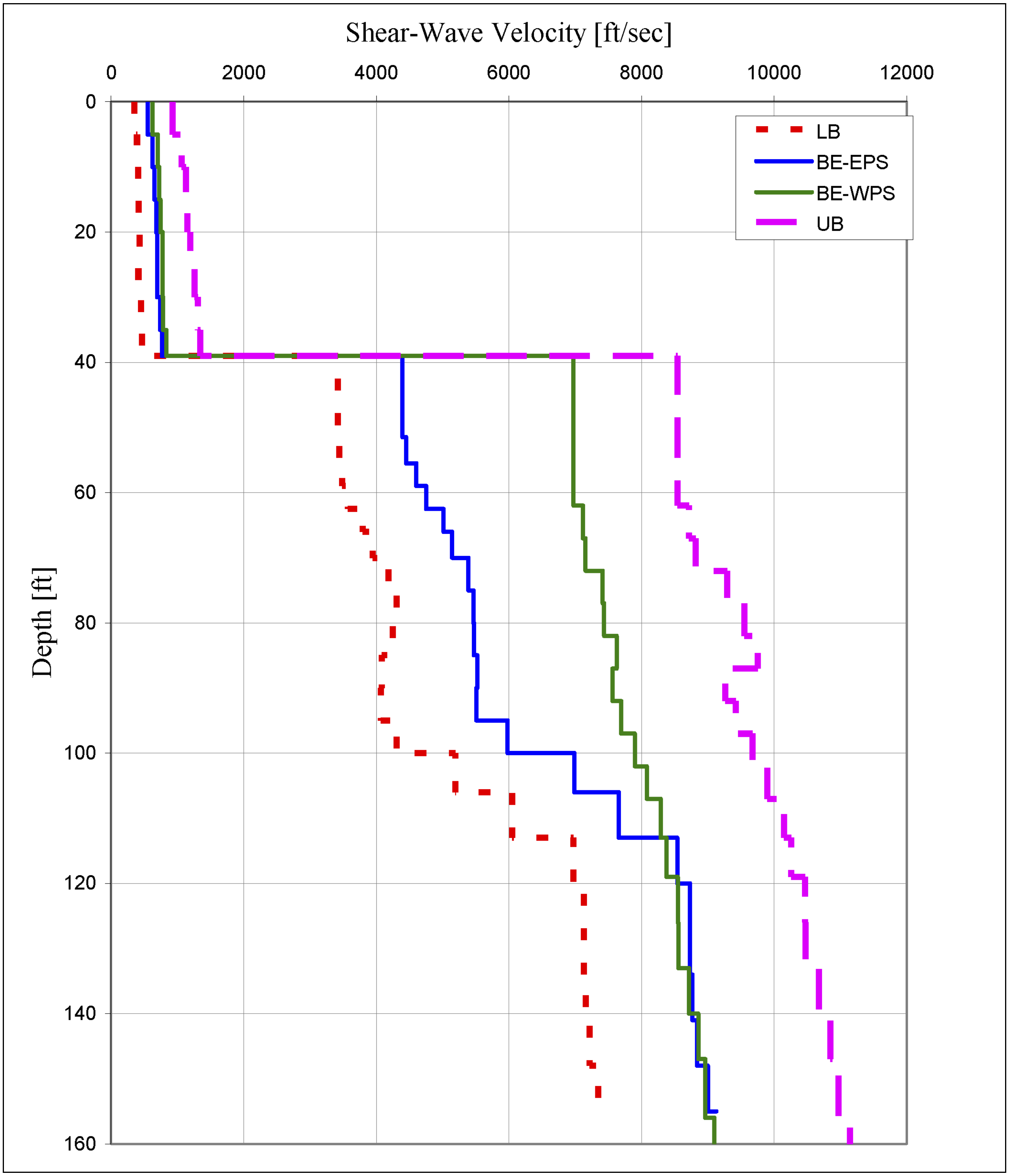


Figure 3OO-245 SSI Damping Ratio Profiles for PS/B (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

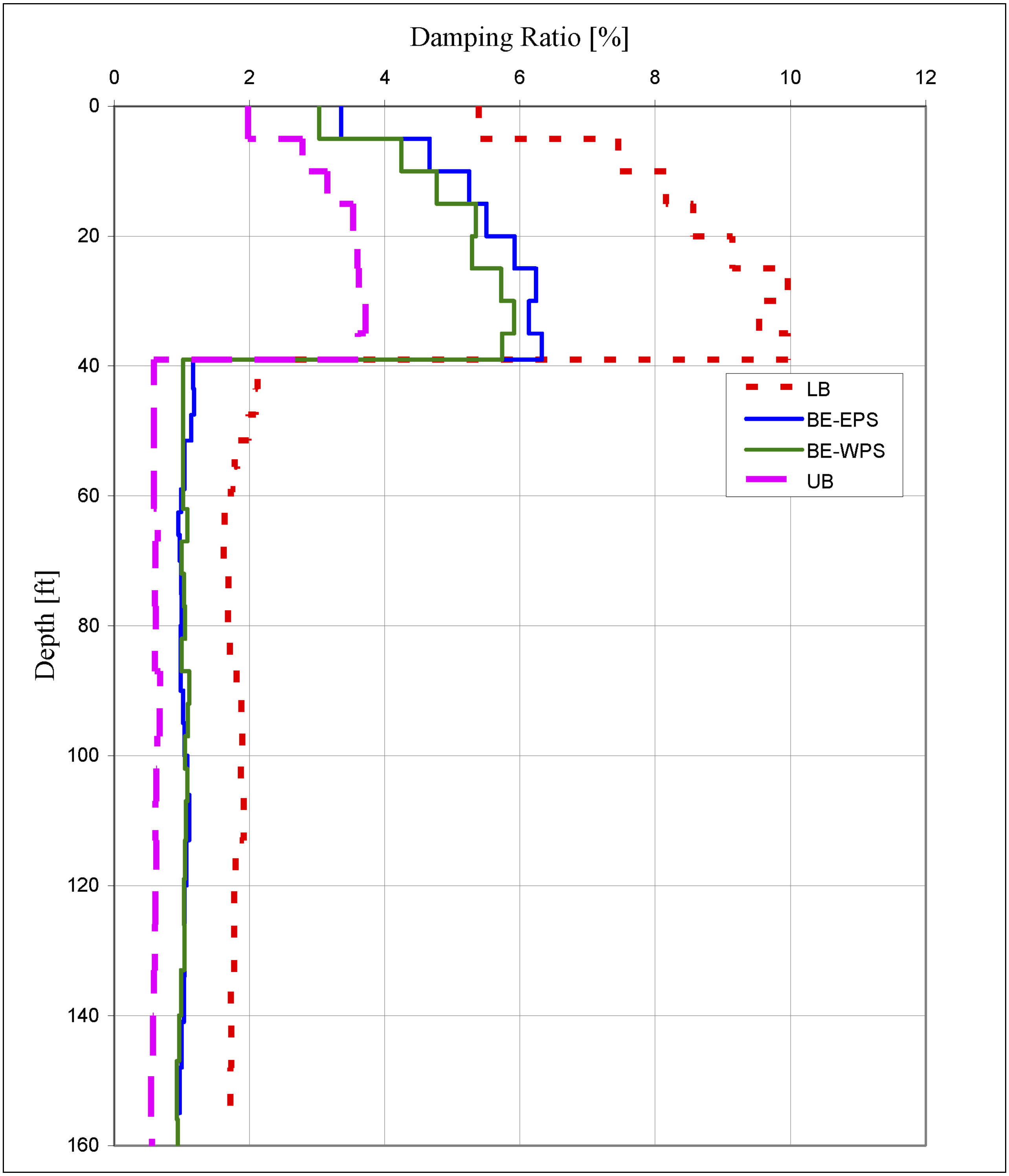


Figure 3OO-246 SSI P-Wave Velocity Profiles for PS/B (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

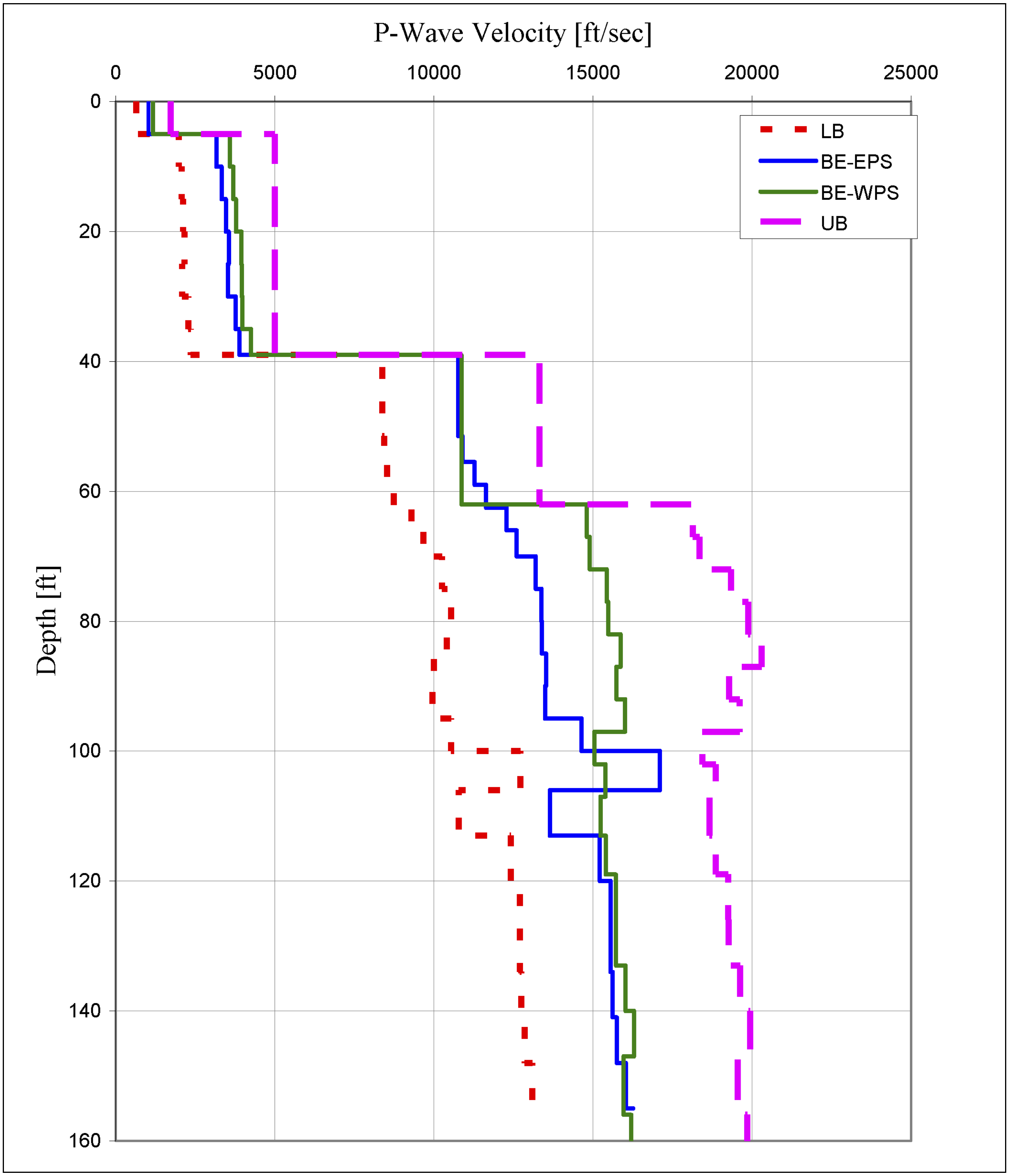


Figure 3OO-247 SSI Shear-Wave Velocity Profiles for UHSRS Unit D (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

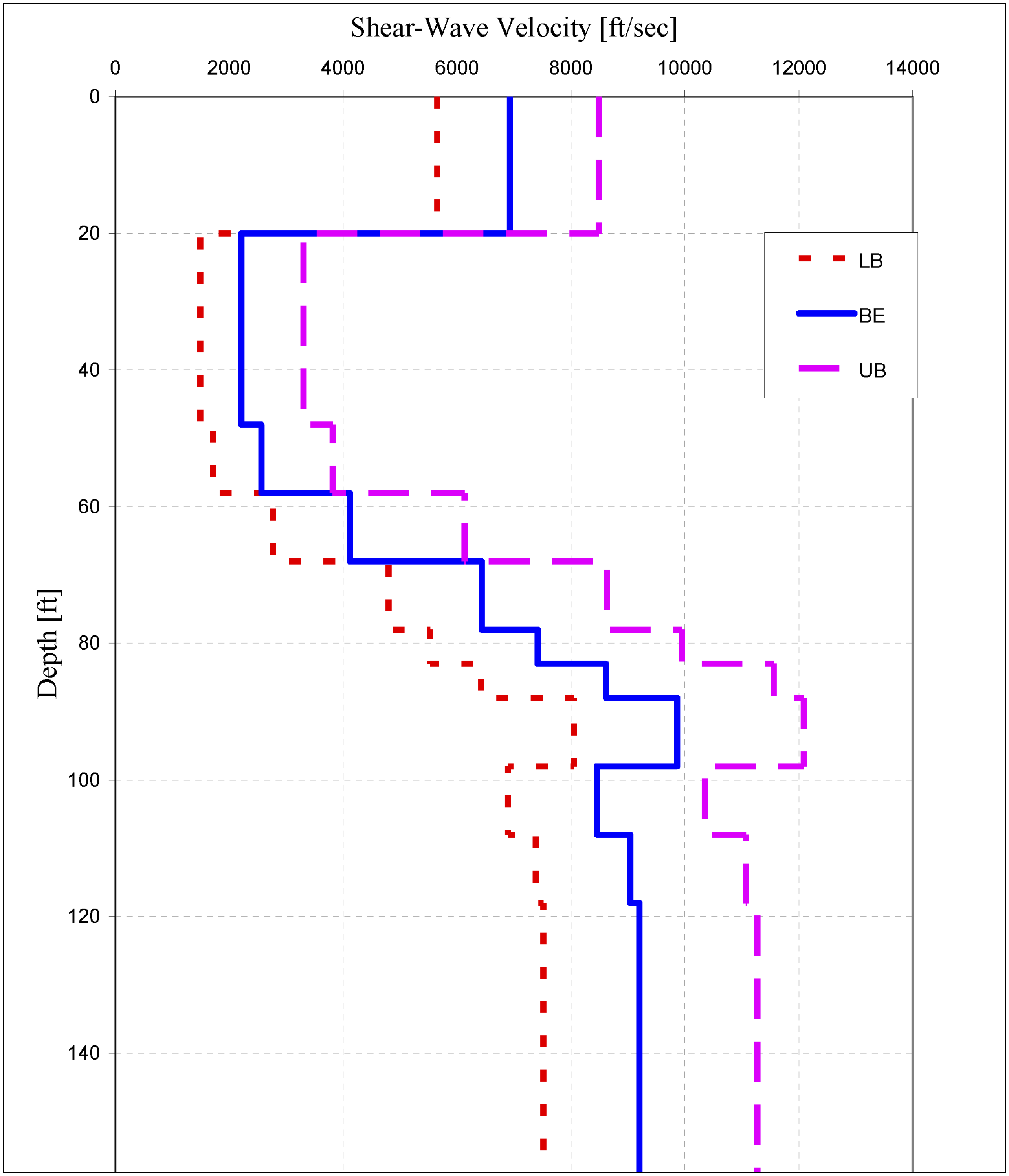


Figure 3OO-248 SSI Damping Ratio Profiles for UHSRS Unit D (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

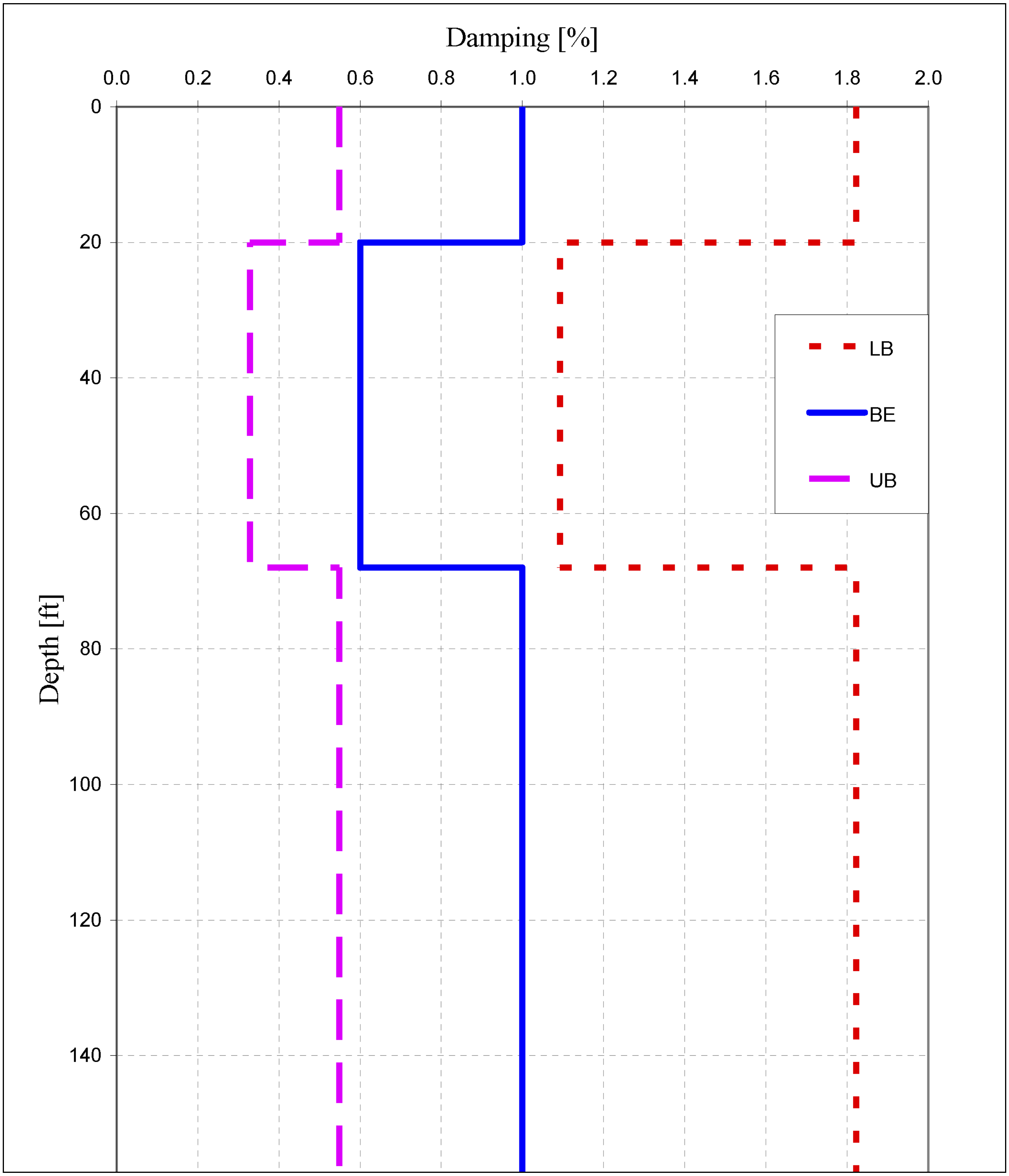


Figure 3OO-249 SSI P-Wave Velocity Profiles for UHSRS Unit D (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

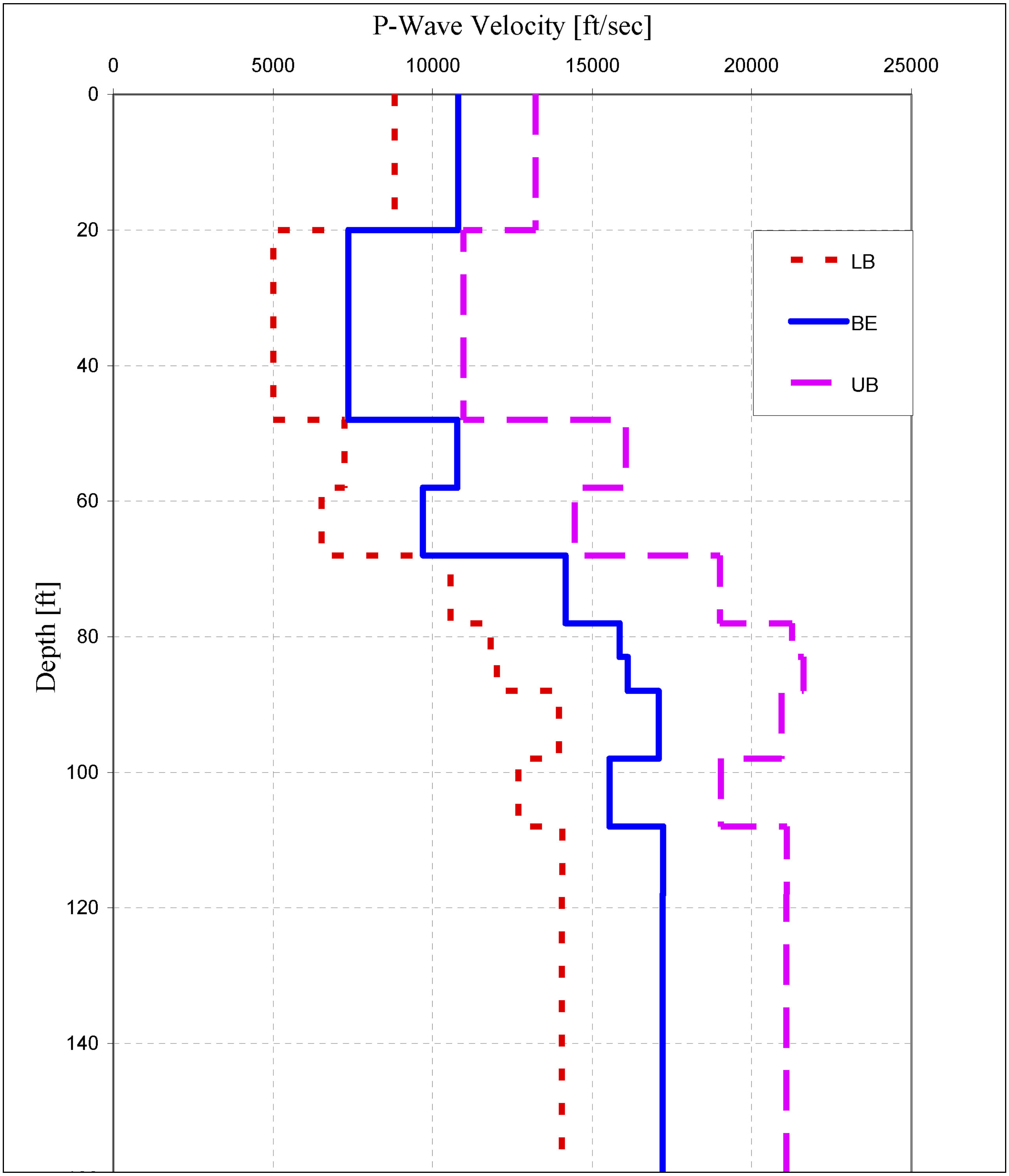


Figure 3OO-250 SSI Shear-Wave Velocity Profiles for UHSRS Units A, Band C (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

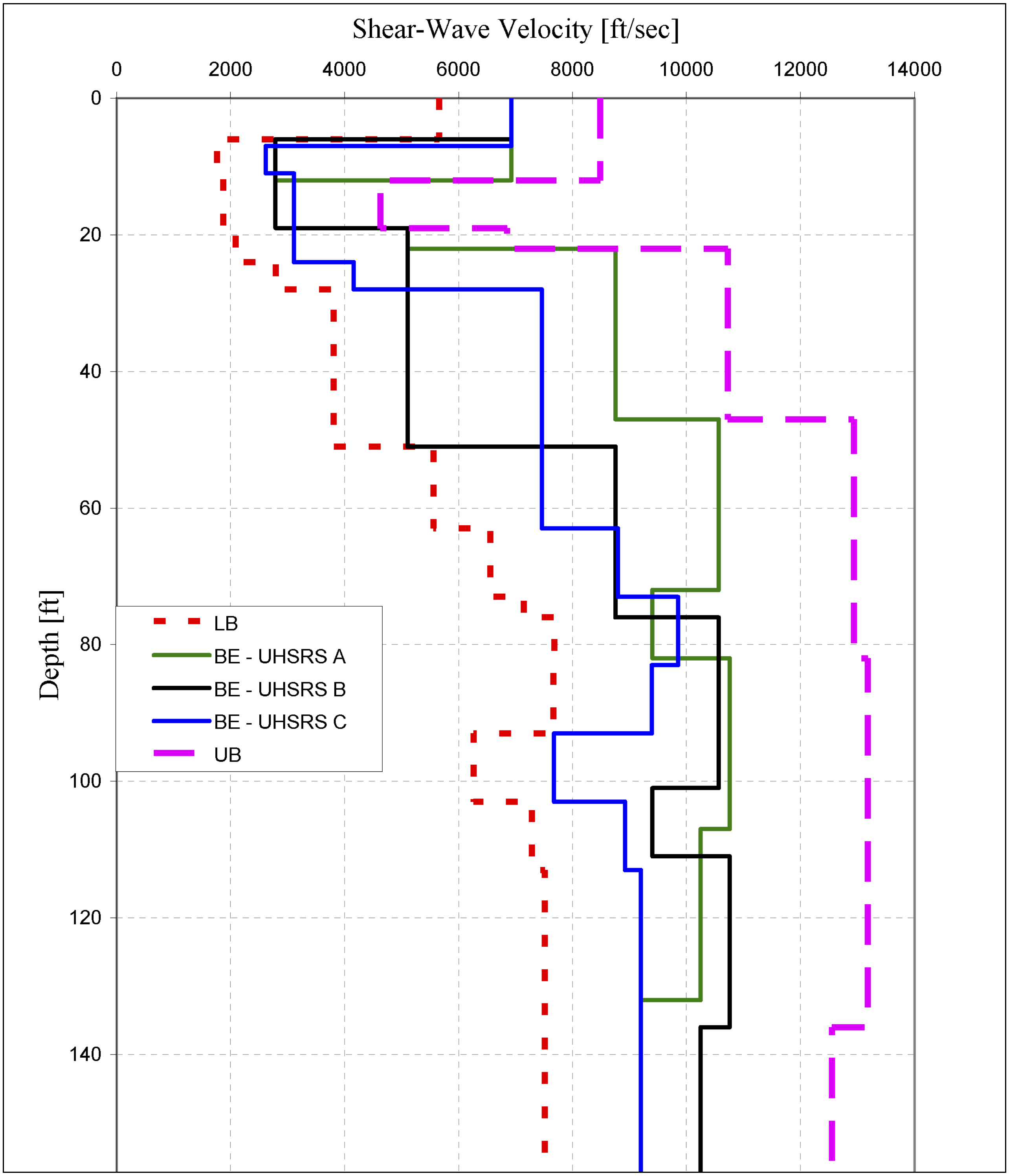


Figure 3OO-251 SSI Damping Ratio Profiles for UHSRS Units A, B and C (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

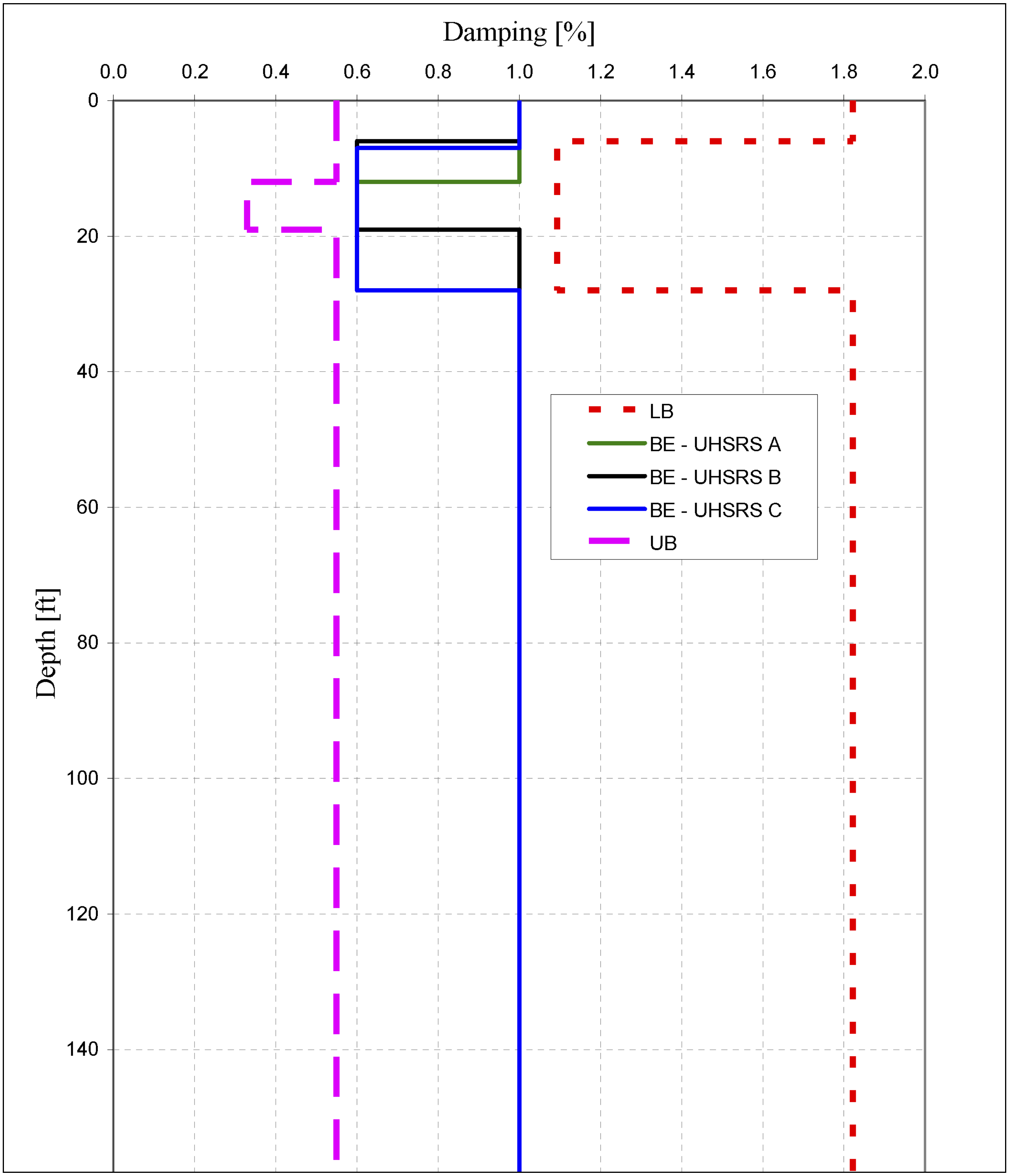


Figure 3OO-252 SSI P-Wave Velocity Profiles for UHSRS Units A, B and C (Depth is measured from Foundation Elevation +277 ft NAVD88 (+277.86 ft NGVD29))

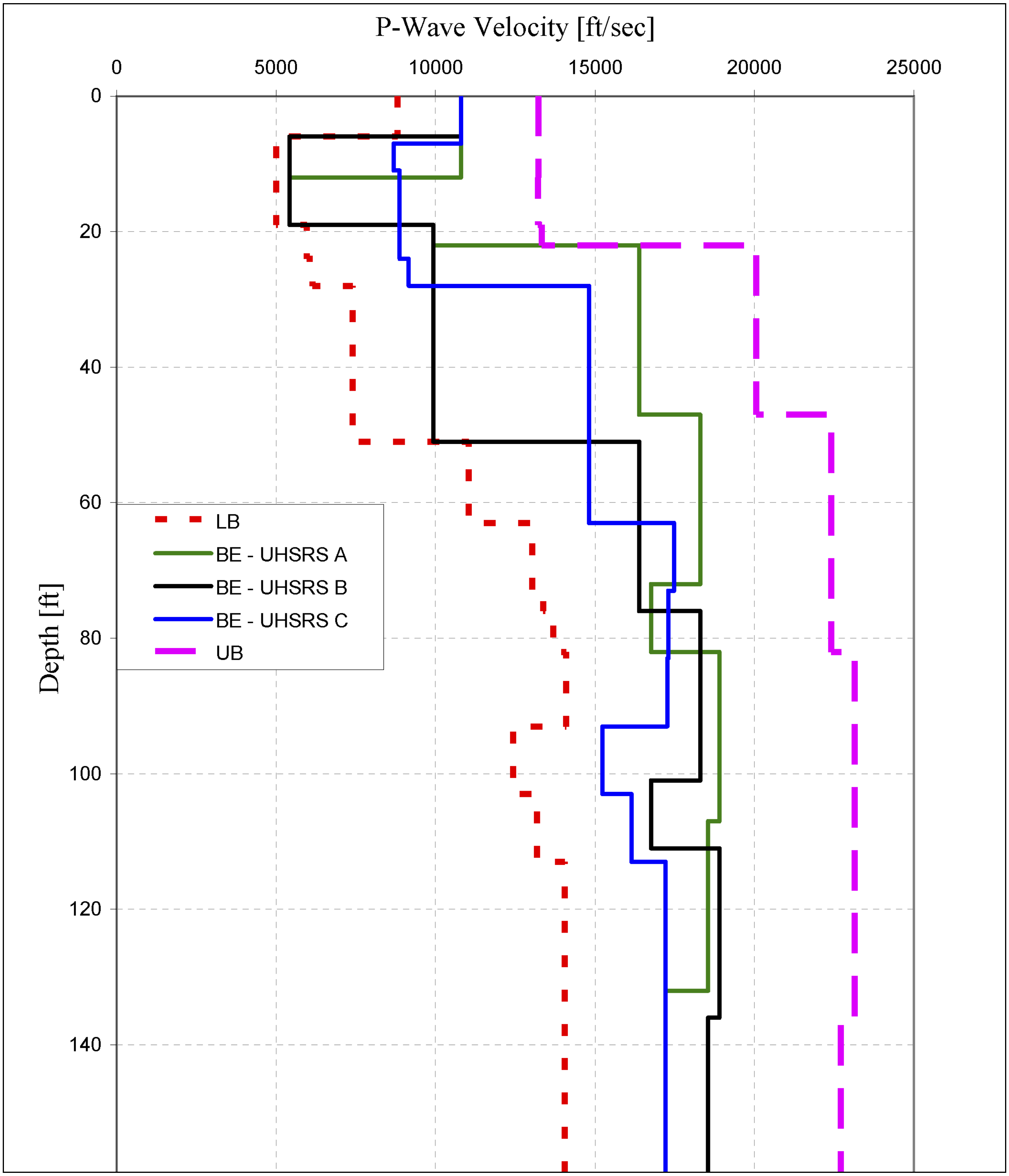


Figure 3OO-253 SSI Shear-Wave Velocity Profiles for East and West ESWPT (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

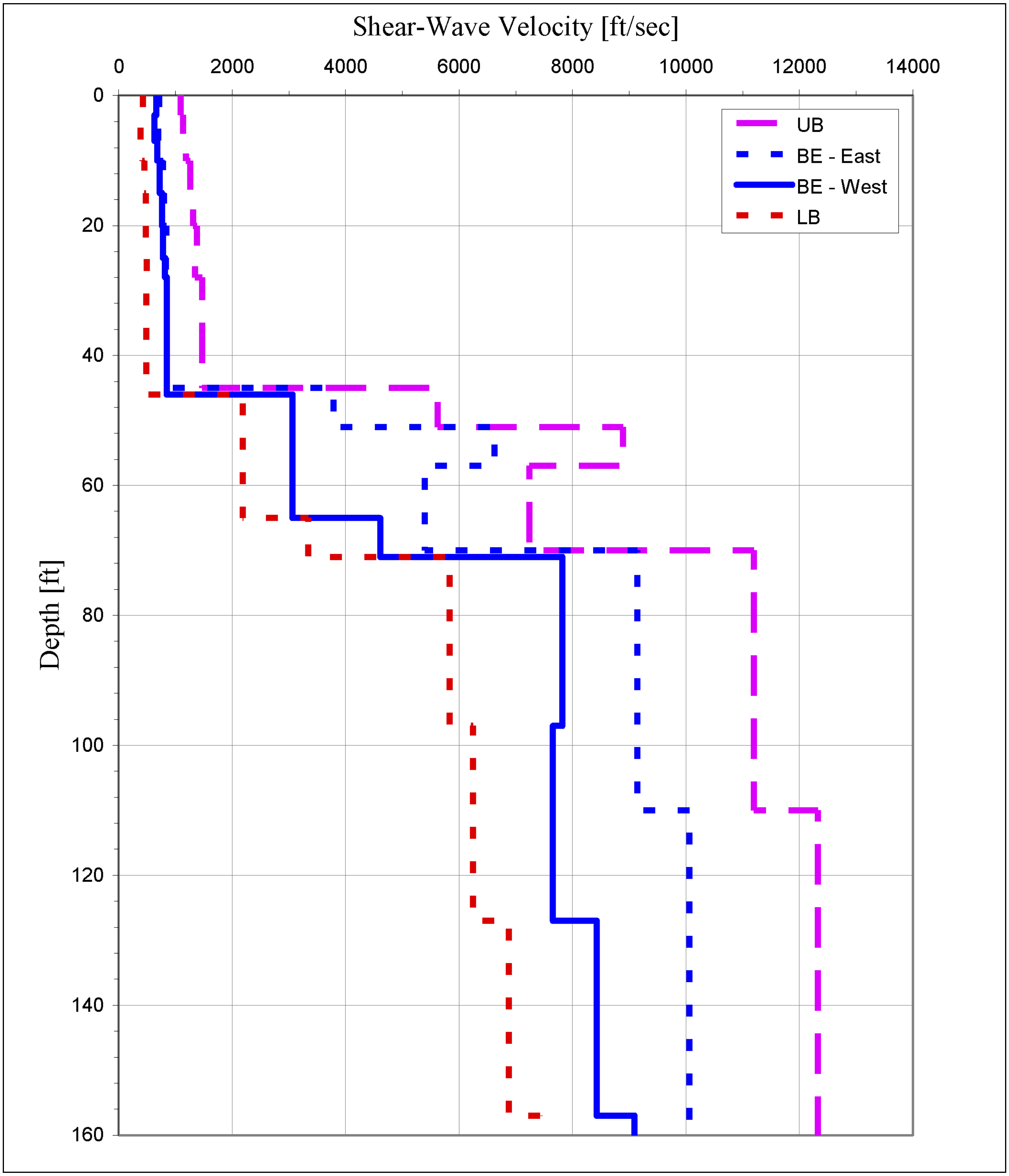


Figure 3OO-254 SSI Damping Ratio Profiles for East and West ESWPT (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

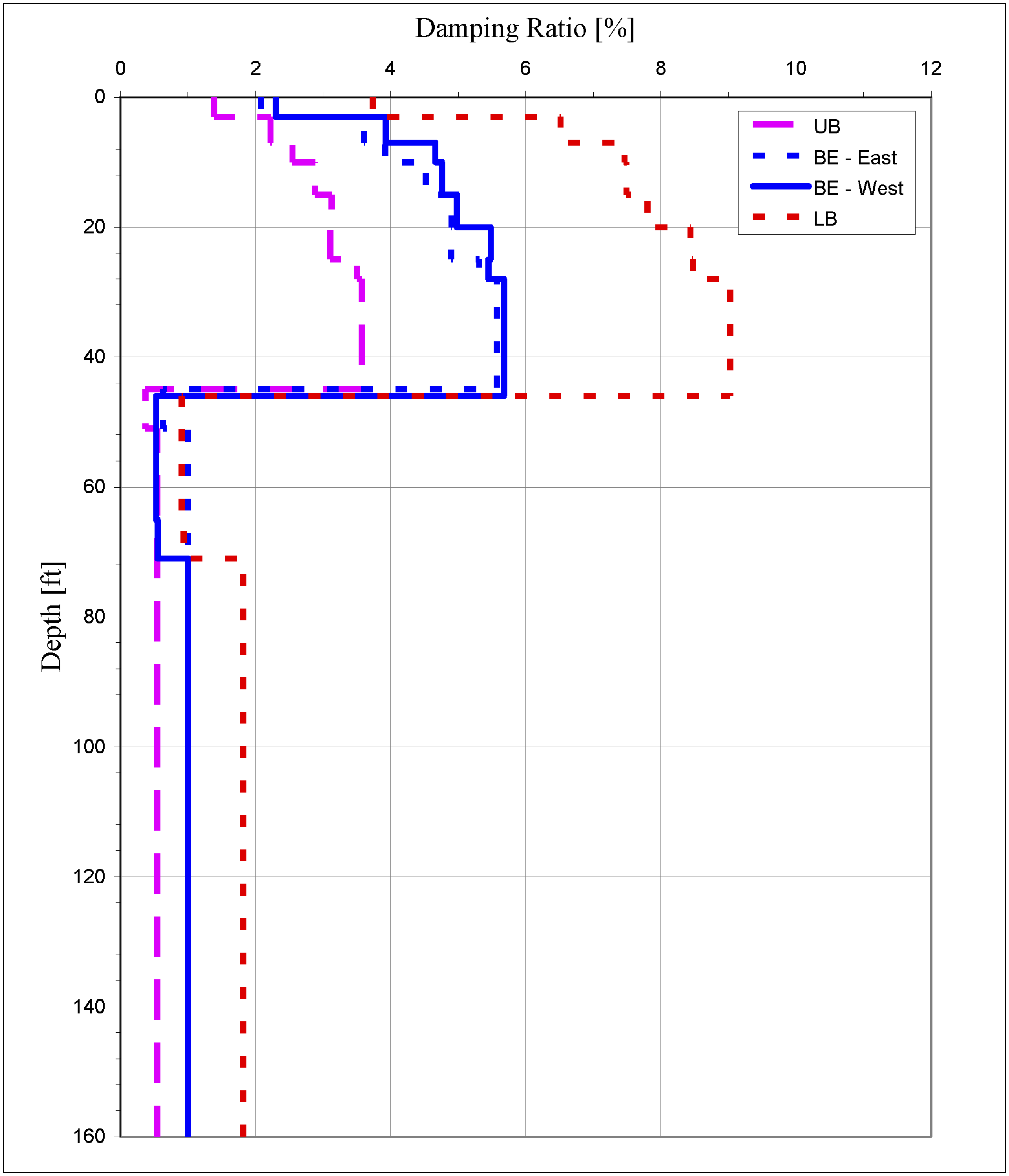


Figure 3OO-255 SSI P-Wave Velocity Profiles for East and West ESWPT (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

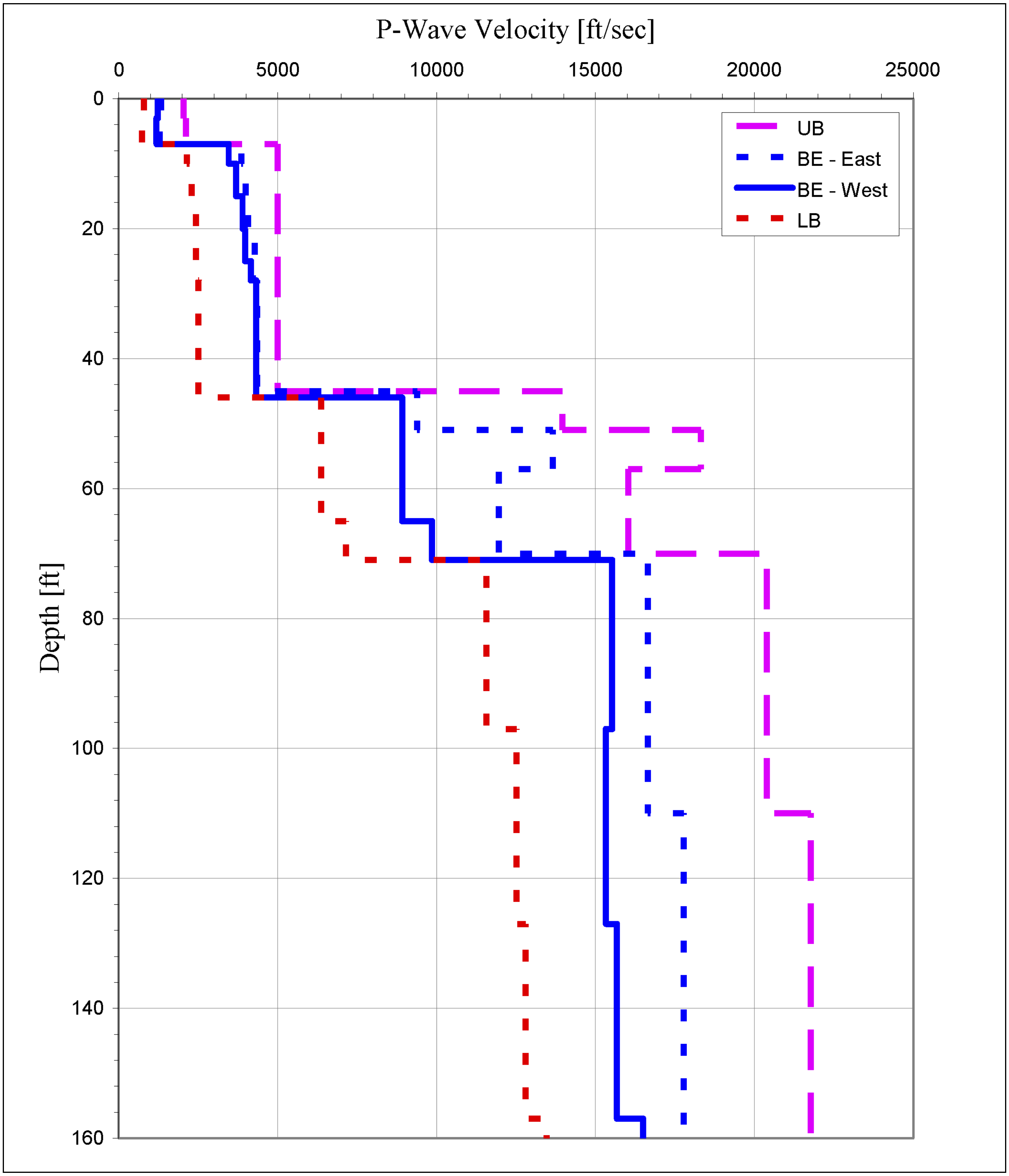


Figure 3OO-256 SSI Shear-Wave Velocity Profiles for UHSRS Pipe Chase (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

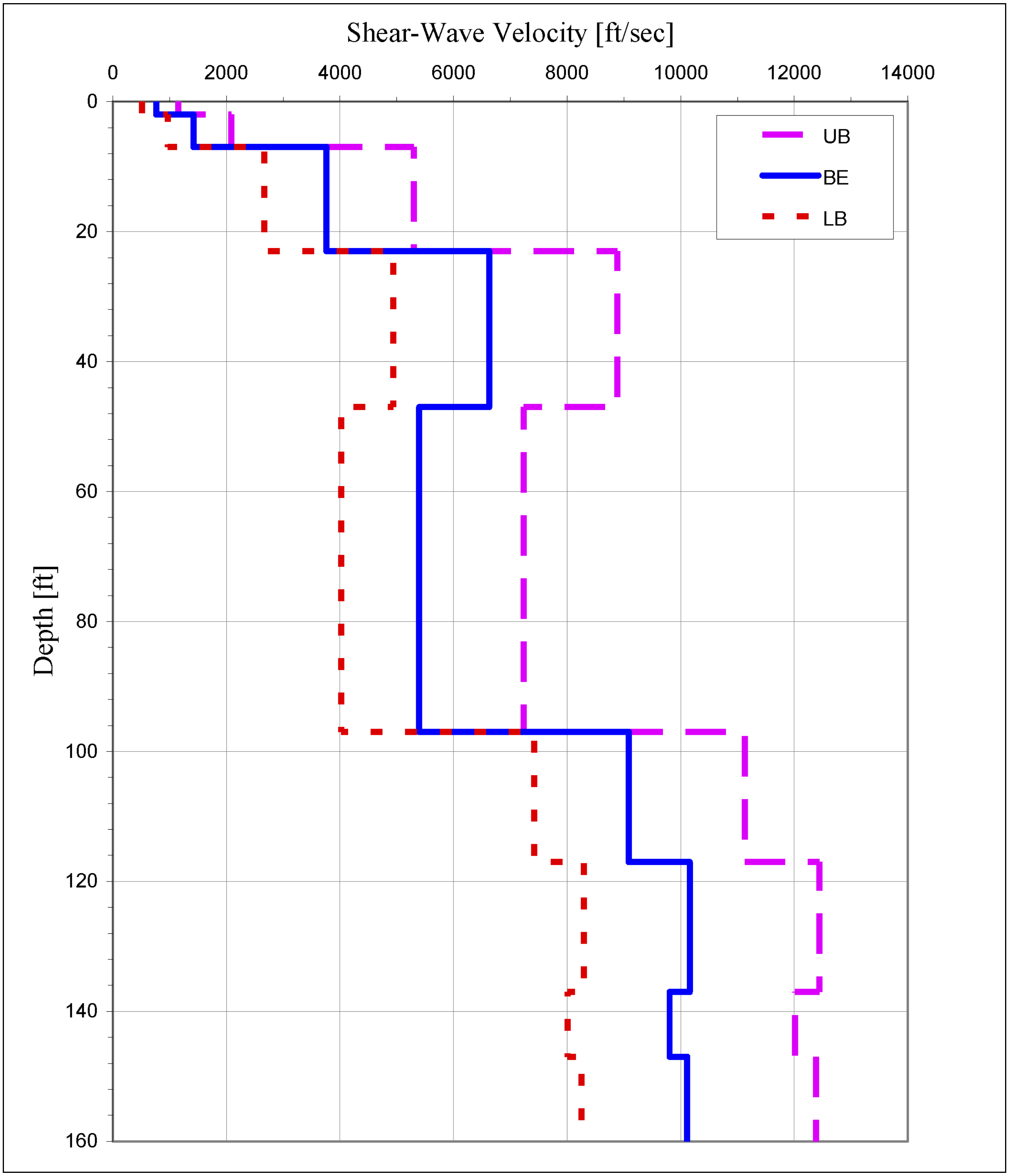


Figure 3OO-257 SSI Damping Ratio Profiles for UHSRS Pipe Chase (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

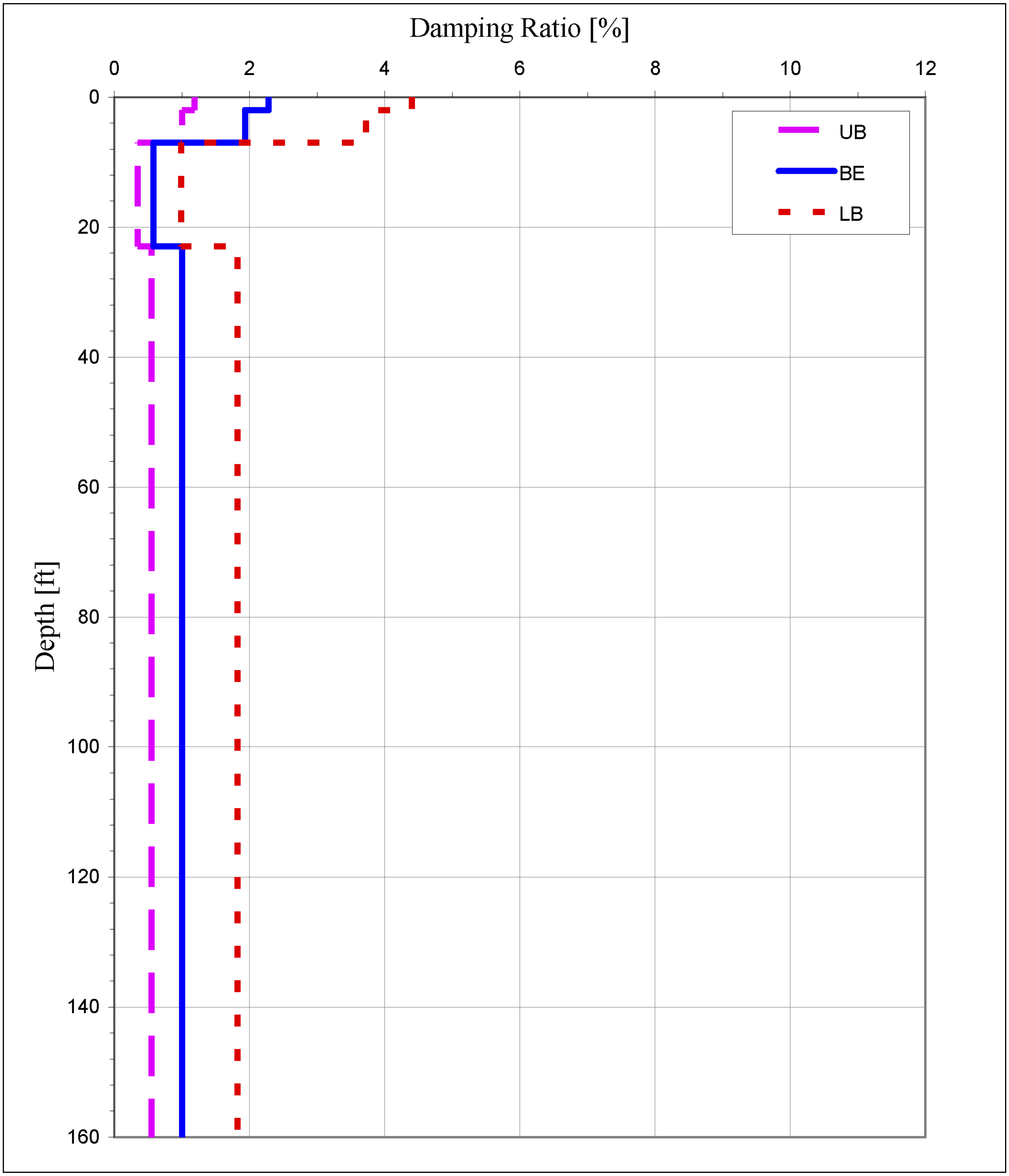


Figure 3OO-258 SSI P-Wave Velocity Profiles for UHSRS Pipe Chase (Depth is measured from Finished Grade Elevation +290 ft NAVD88 (+290.86 ft NGVD29))

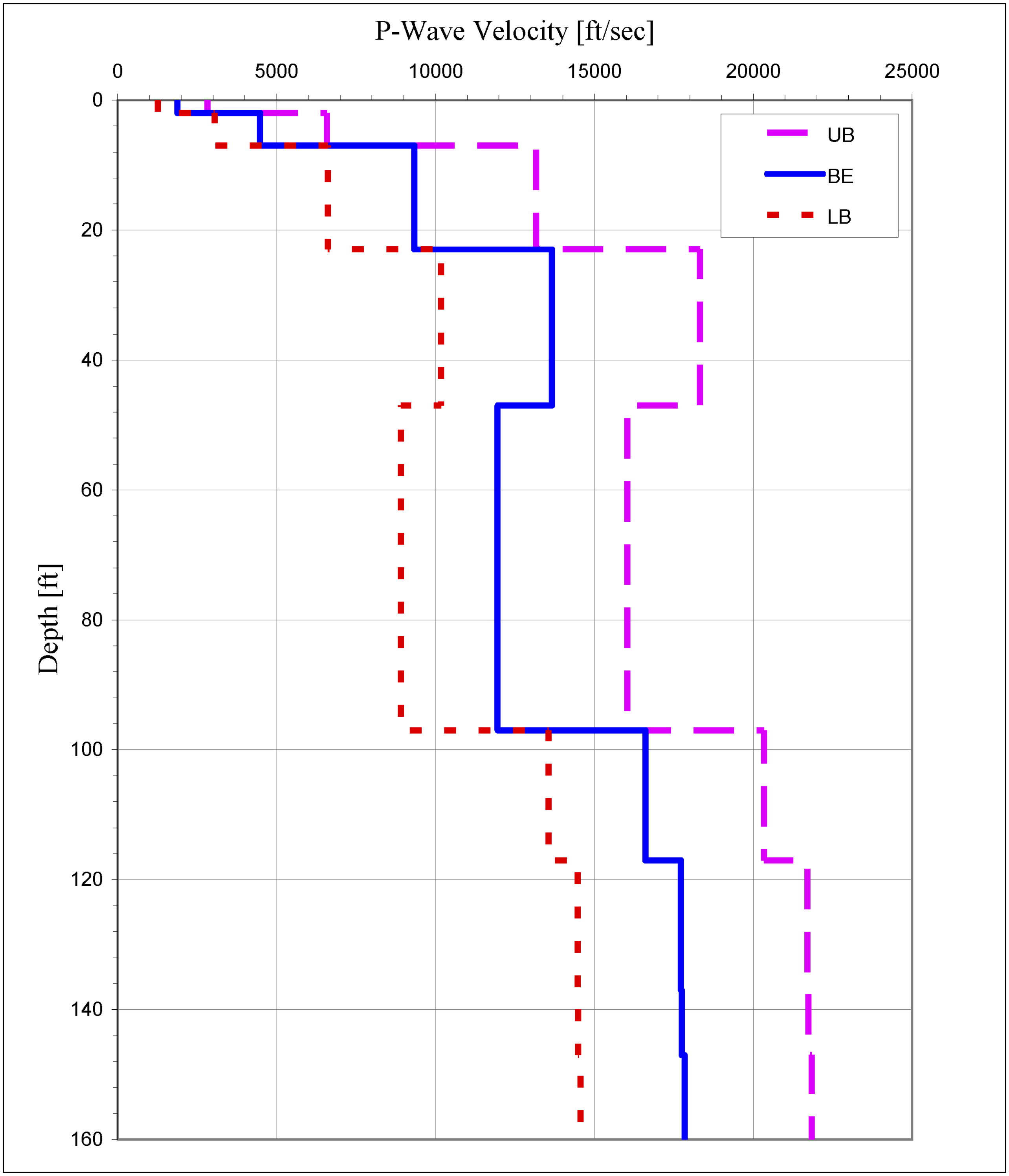


Figure 3OO-259 Comparison Between the Final Spectrum Compatible Response Spectrum, the Target Spectrum, and the Upper and Lower Target Spectrum Bounds for the R/B Complex - H1 Direction

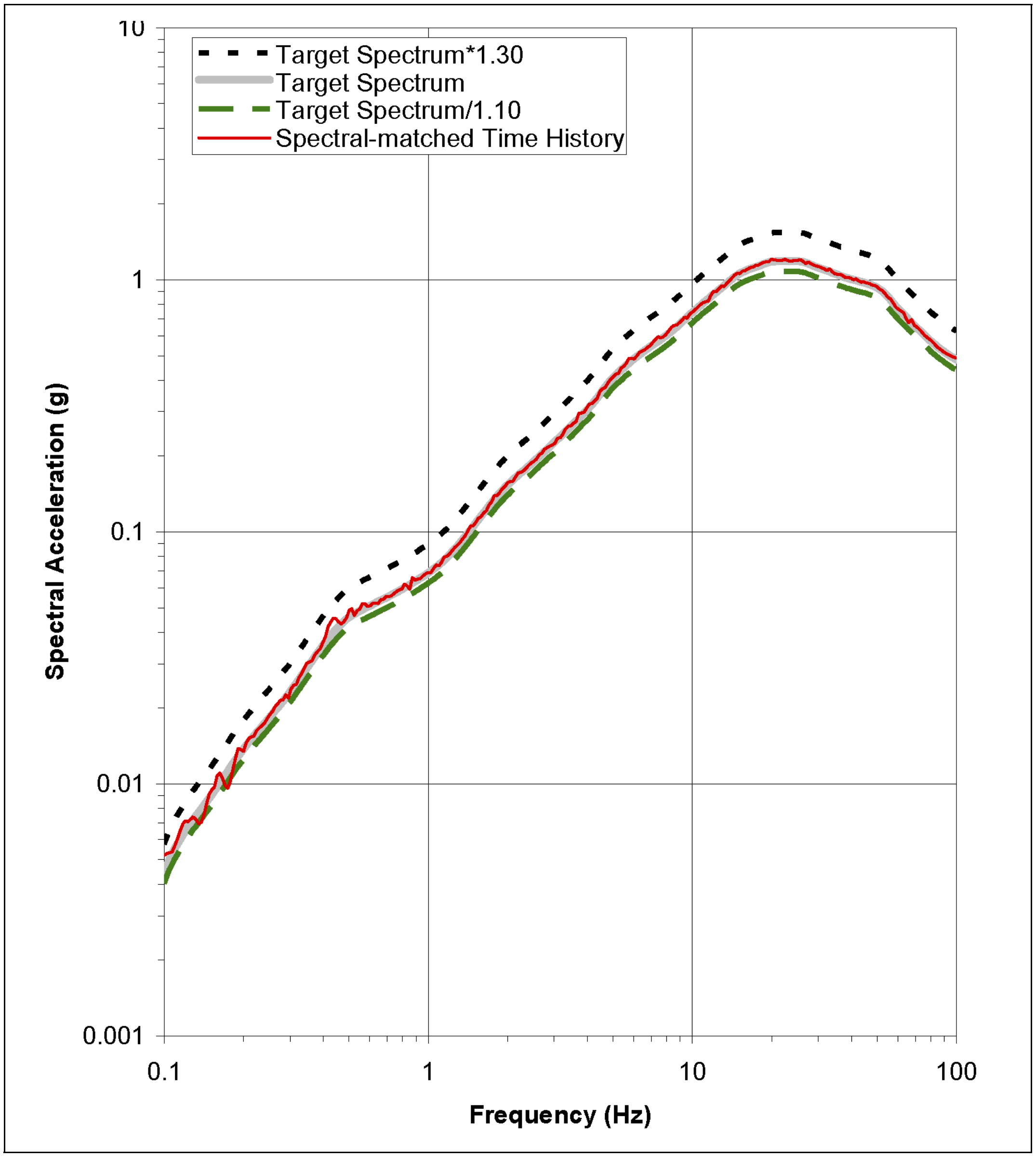


Figure 3OO-260 Comparison Between the Final Spectrum Compatible Response Spectrum, the Target Spectrum, and the Upper and Lower Target Spectrum Bounds for the R/B Complex - H2 Direction

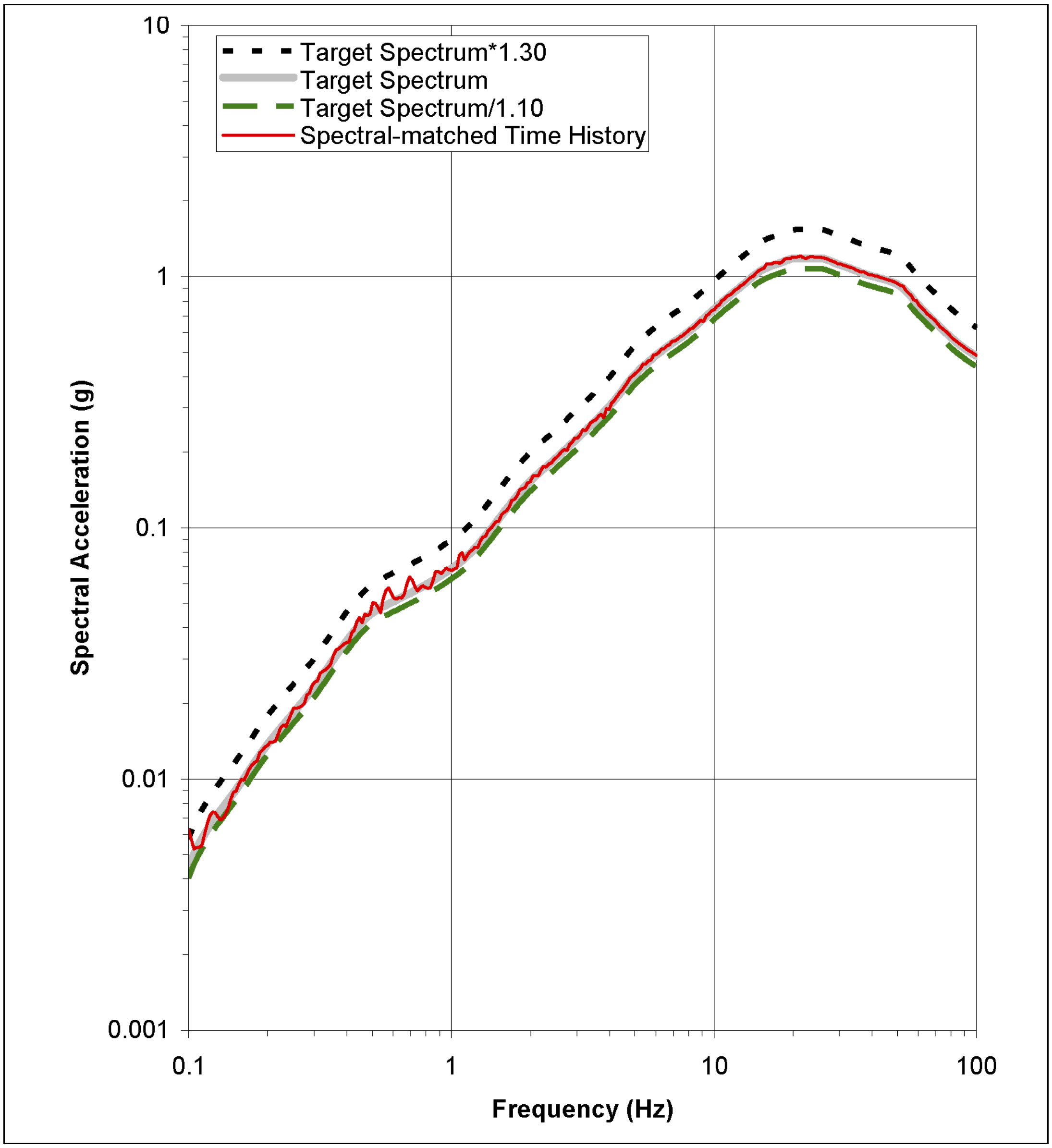


Figure 3OO-261 Comparison Between the Final Spectrum Compatible Response Spectrum, the Target Spectrum, and the Upper and Lower Target Spectrum Bounds for the R/B Complex - UP Direction

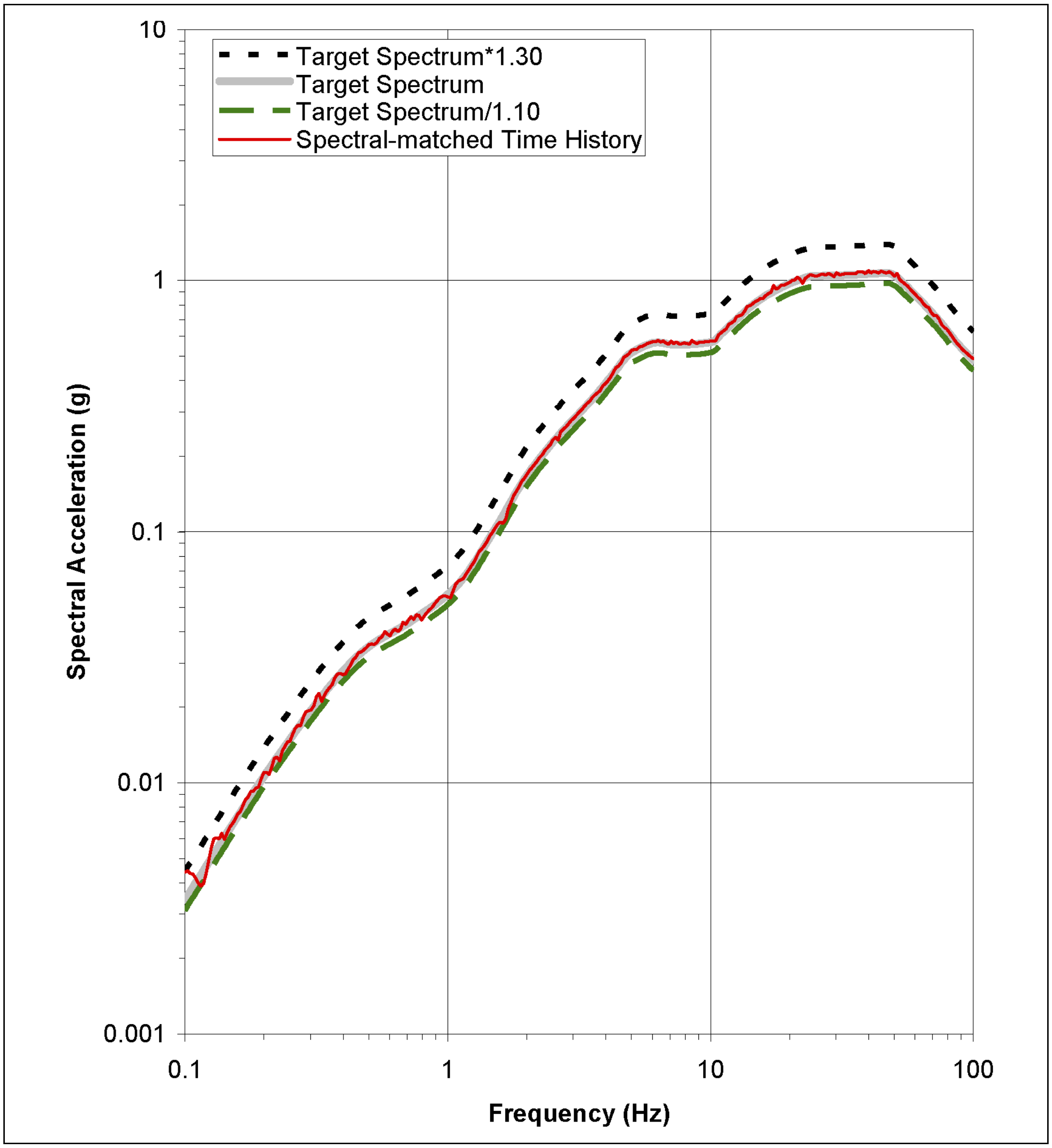


Figure 3OO-262 Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex - H1 Direction

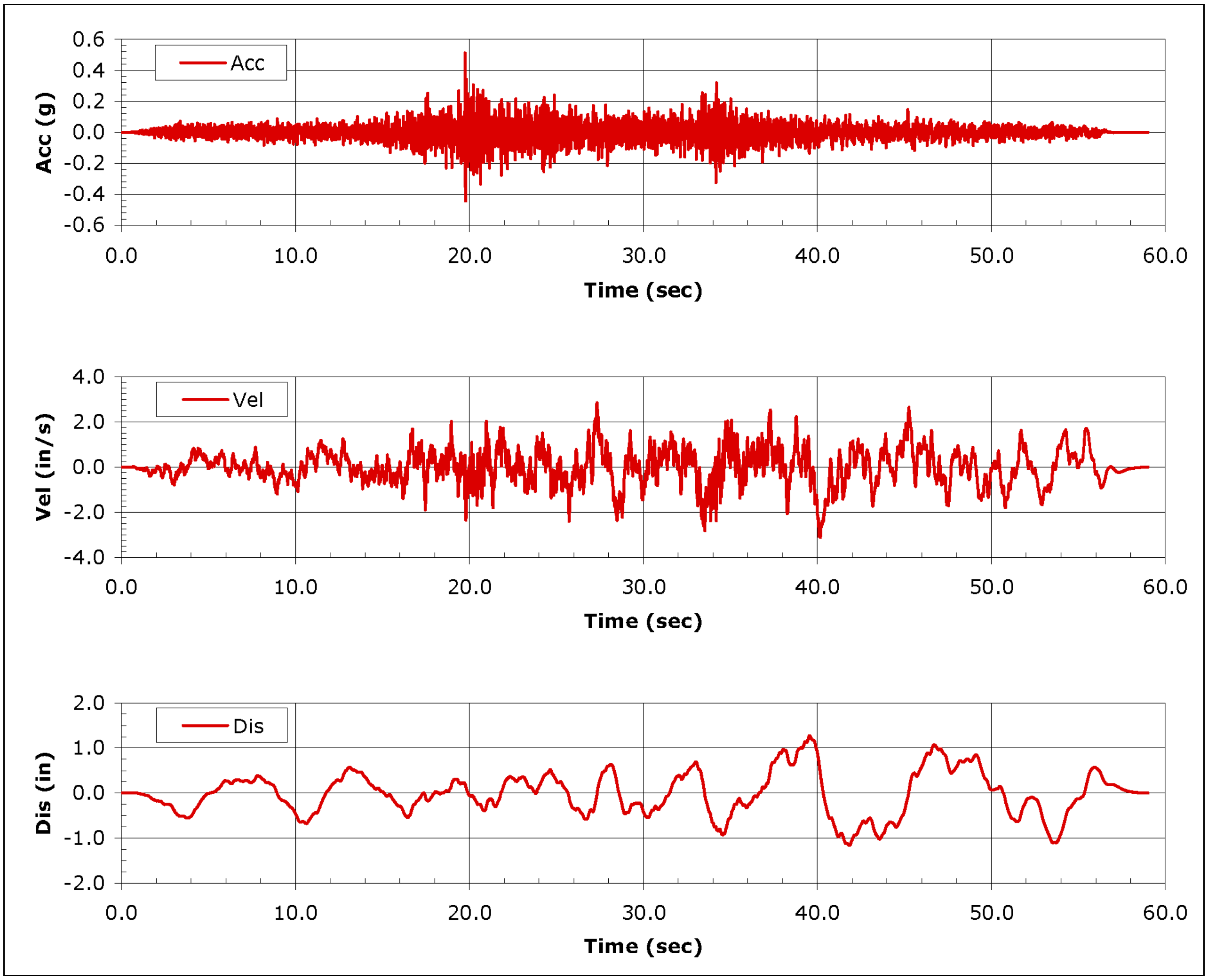


Figure 3OO-263 Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex - H2 Direction

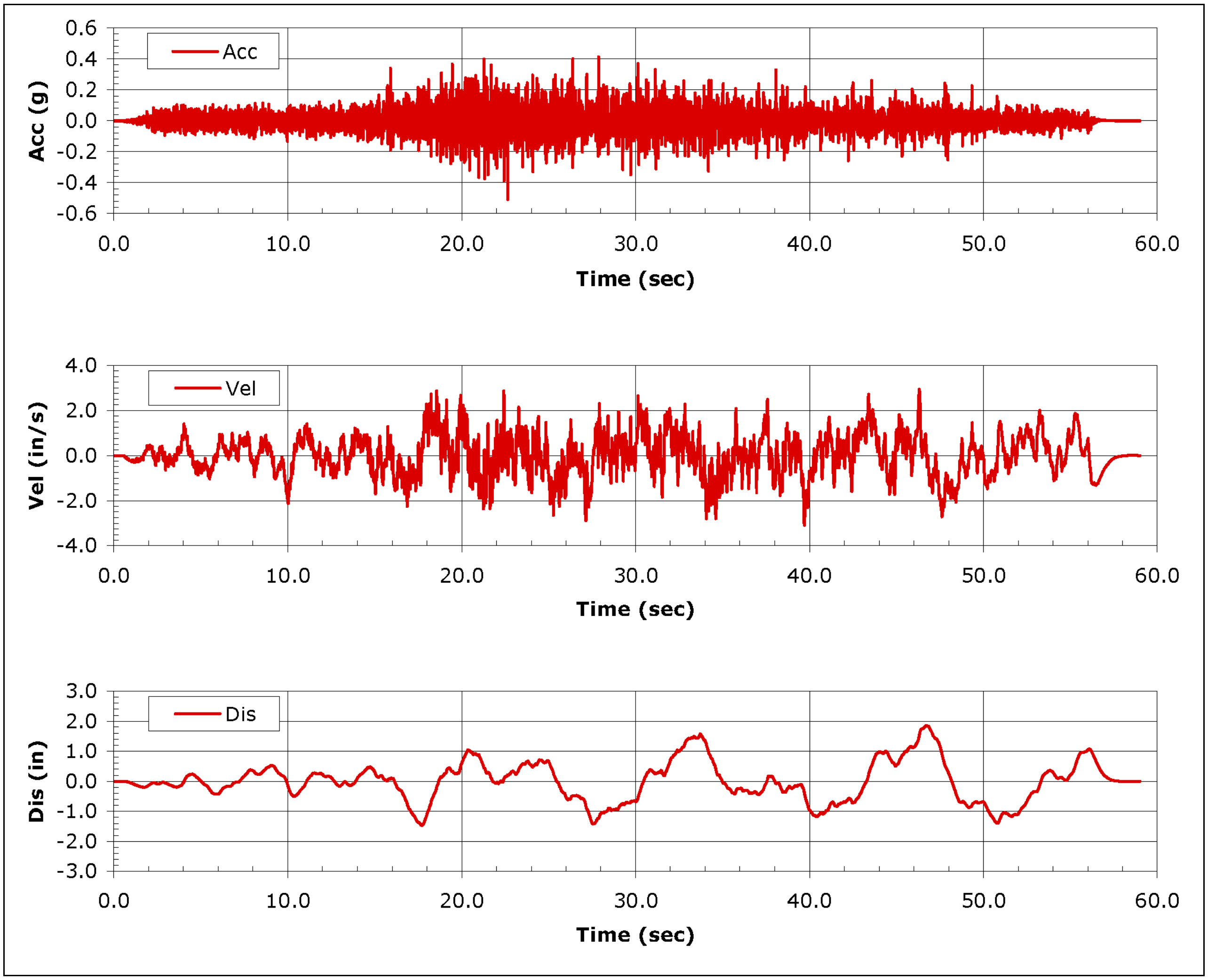


Figure 3OO-264 Spectrally Matched Geologic Outcrop Time-Histories for R/B Complex - UP Direction

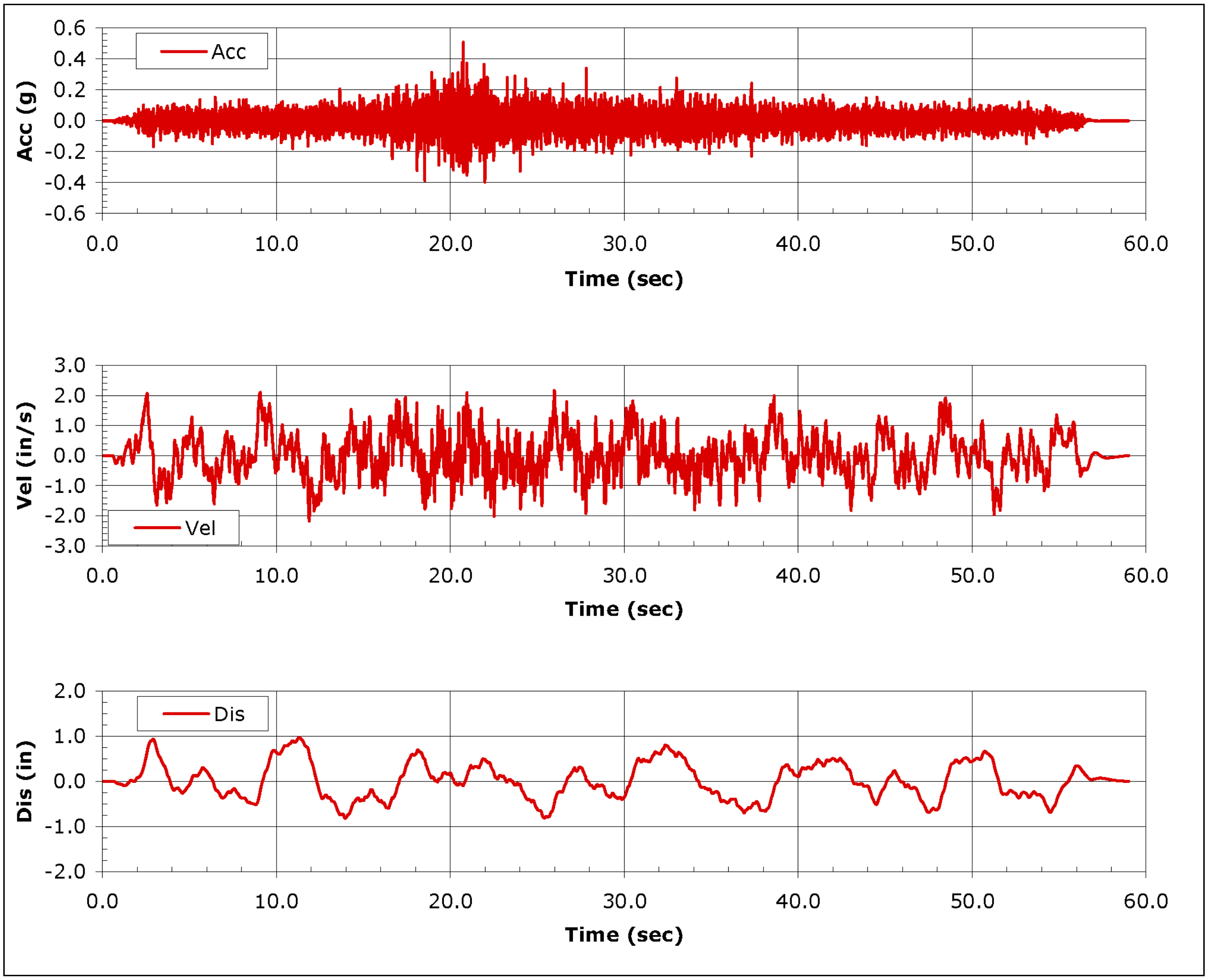


Figure 3OO-265 Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex - H1 direction

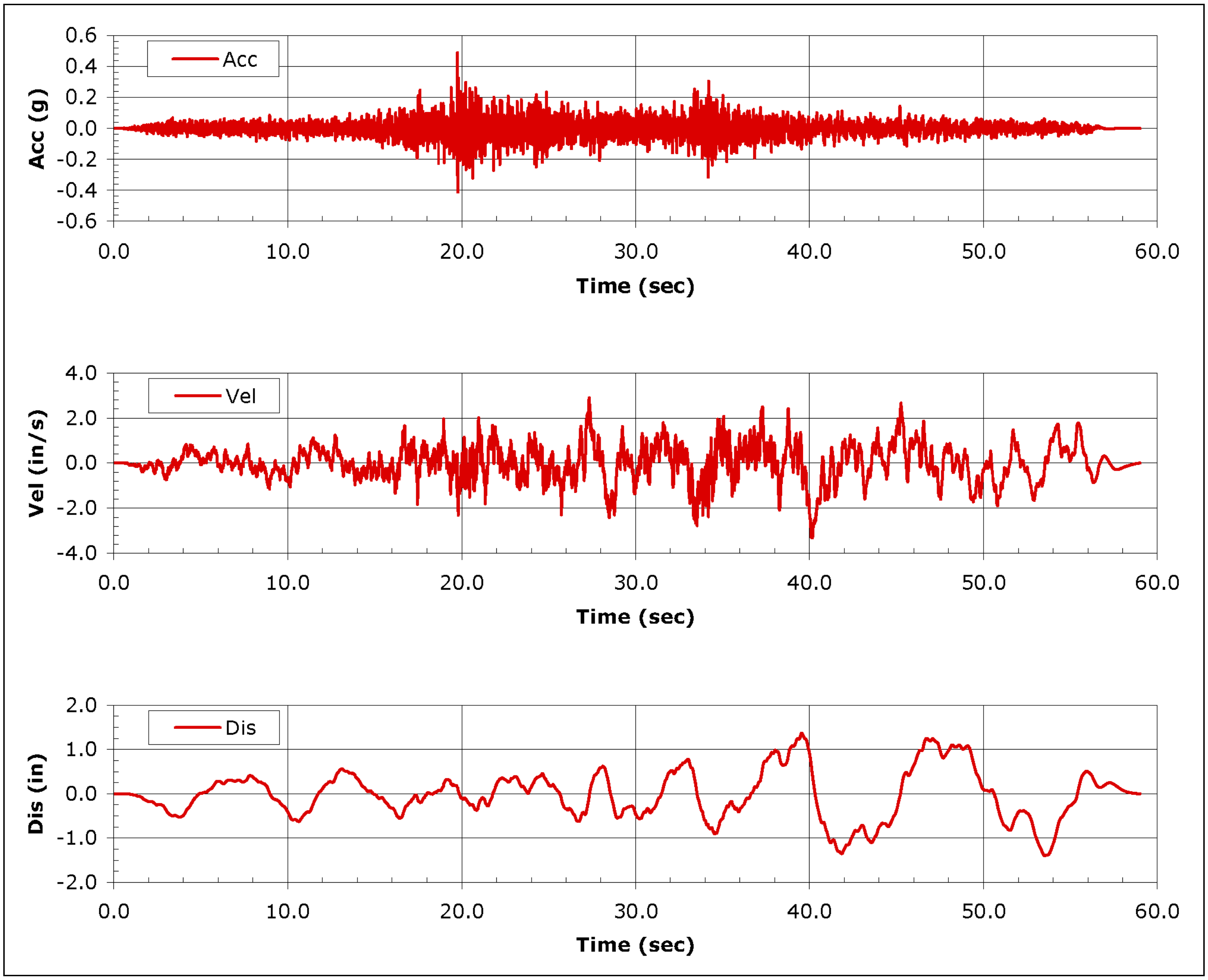


Figure 3OO-266 Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex - H2 direction

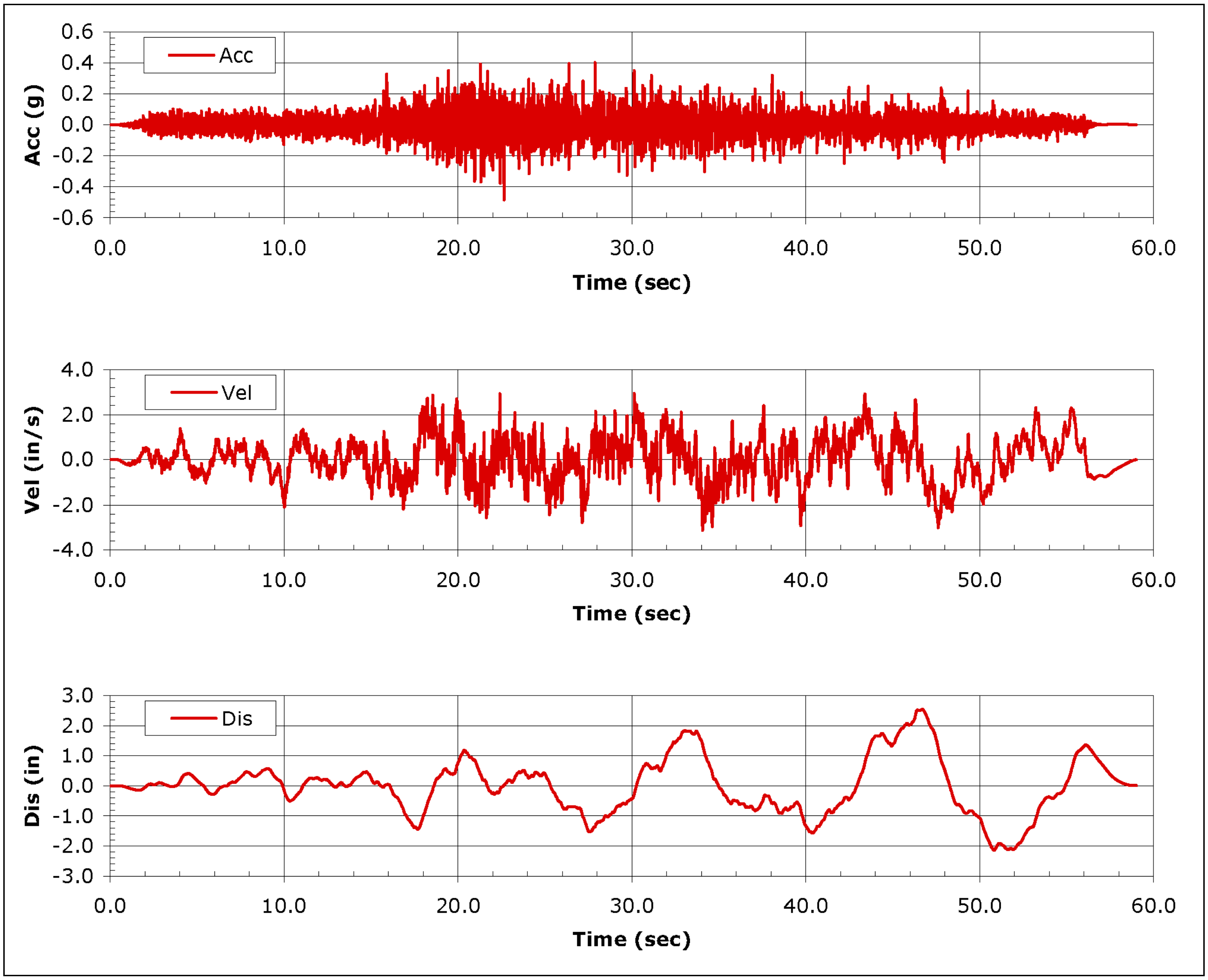


Figure 3OO-267 Spectrally Matched Full-Column Outcrop Time-Histories for R/B Complex - UP direction

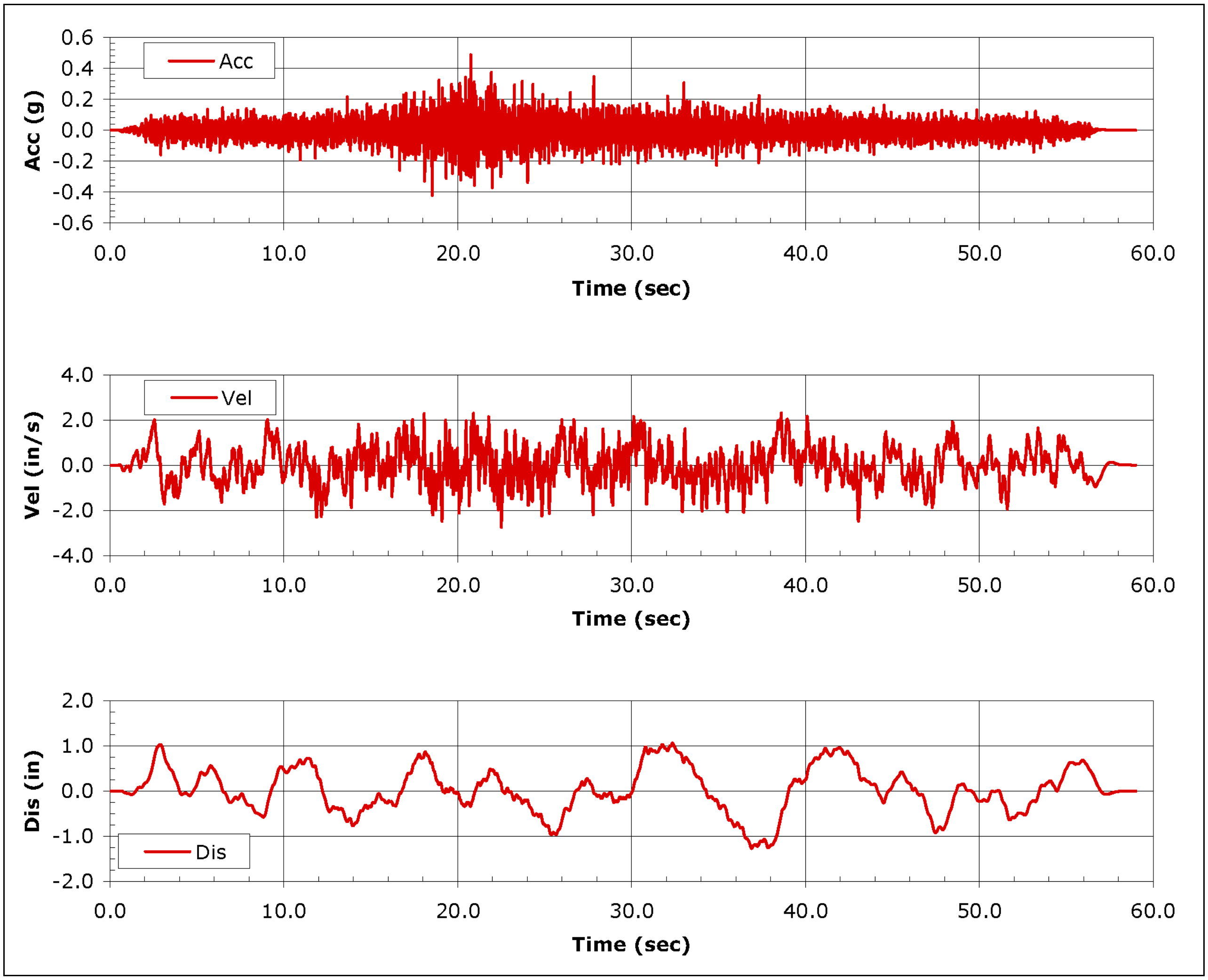
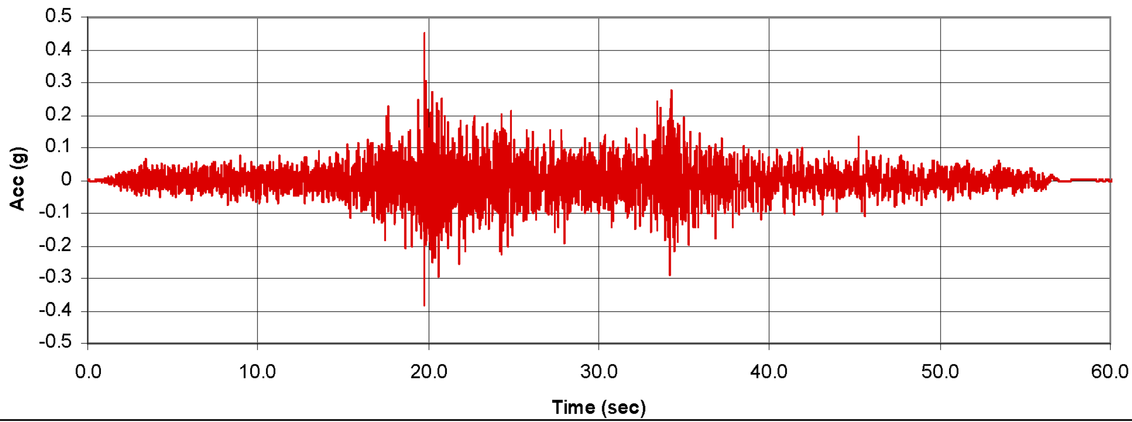
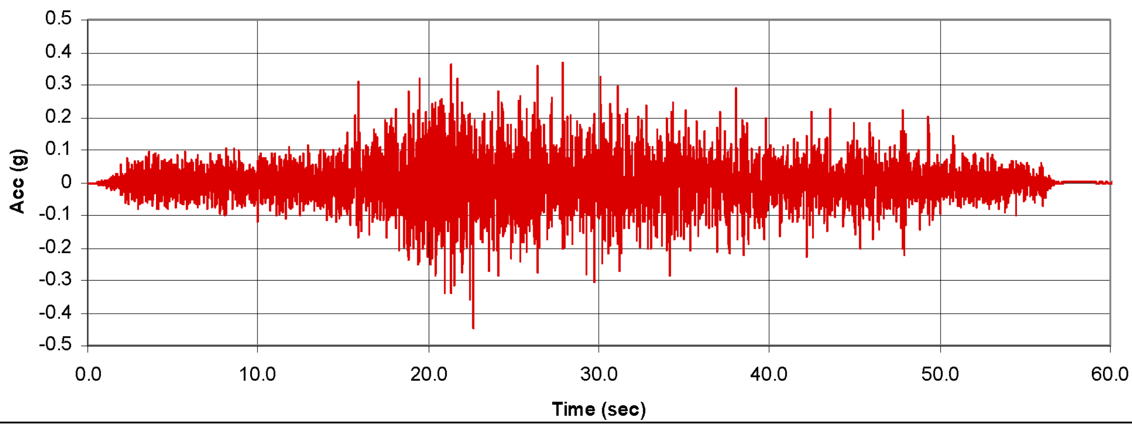


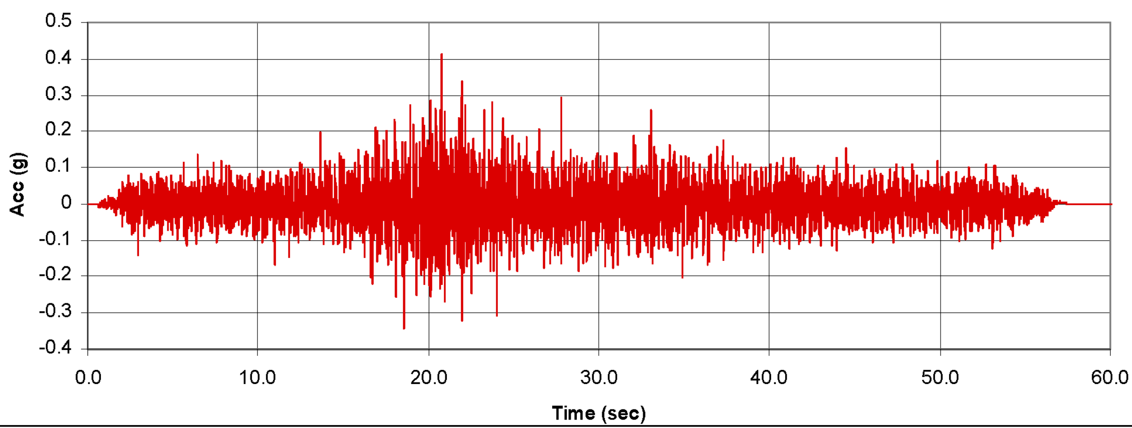
Figure 3OO-268 SSI Within Acceleration Time Histories - Input at R/B Complex Foundation (LB Case)



a) Horizontal Direction - H1

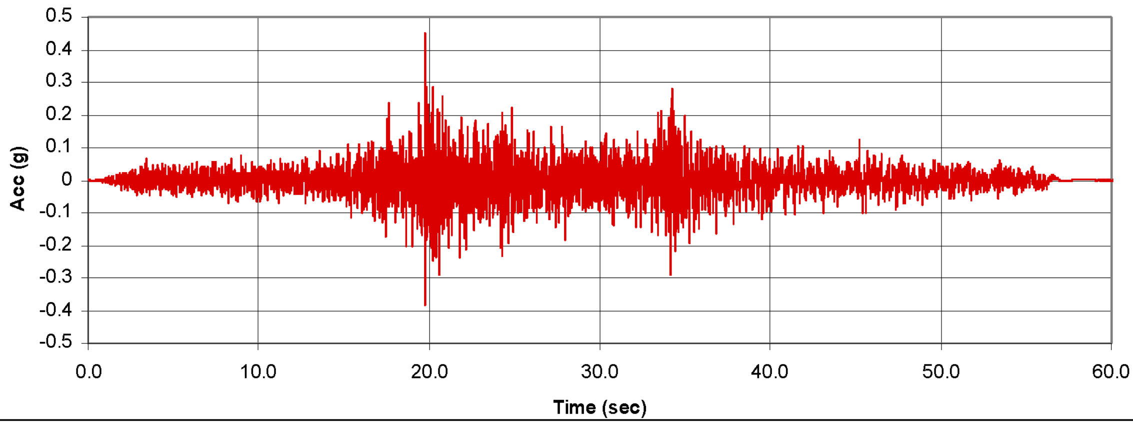


b) Horizontal Direction - H2

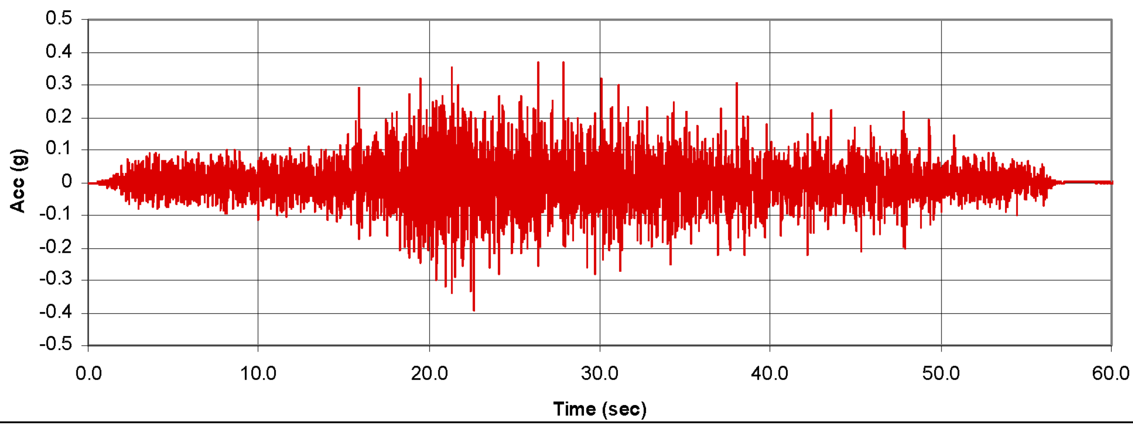


c) Vertical Direction - UP

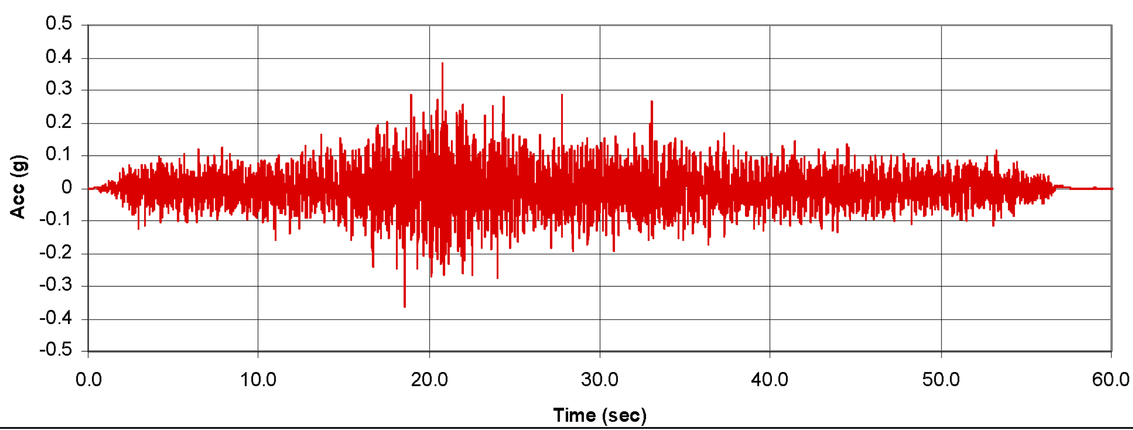
Figure 3OO-269 SSI Within Acceleration Time Histories - Input at R/B Complex Foundation (BE Case)



a) Horizontal Direction - H1

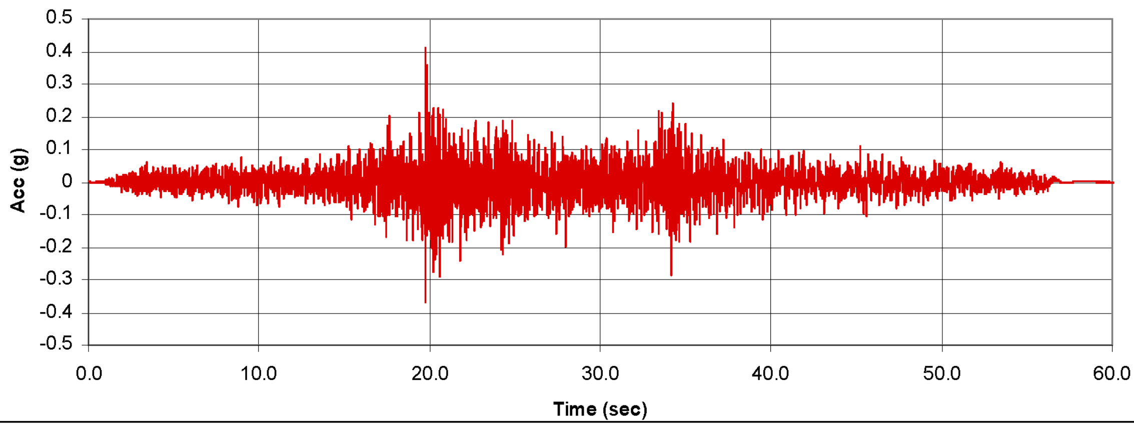


b) Horizontal Direction - H2

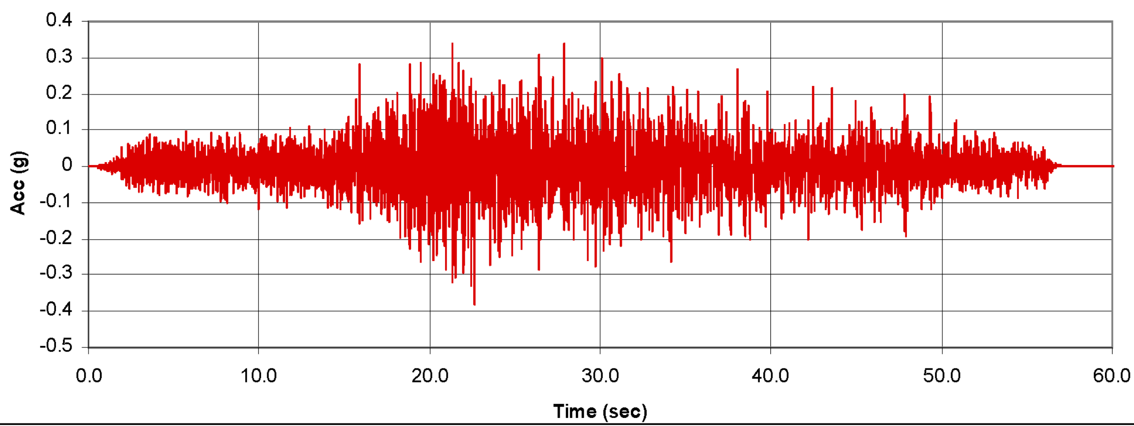


c) Vertical Direction - UP

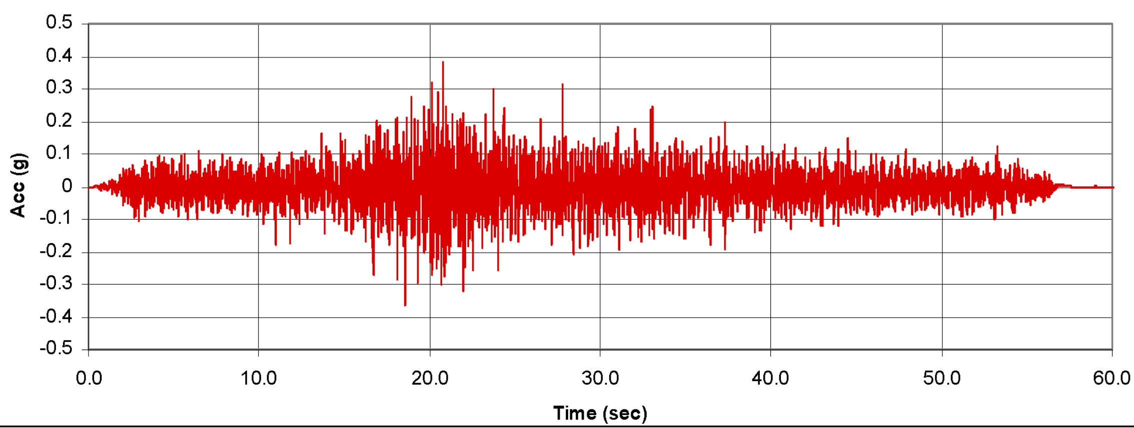
Figure 3OO-270 SSI Within Acceleration Time Histories - Input at R/B Complex Foundation (UB Case)



a) Horizontal Direction - H1



b) Horizontal Direction - H2



c) Vertical Direction - UP