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Docket No.: 50-305
License No.: DPR-43

DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
LICENSE AMENDMENT REQUEST 239 – REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

Pursuant to 10 CFR 50.90 Dominion Energy Kewaunee, Inc. (DEK) requests Nuclear Regulatory Commission (NRC) approval of a proposed license amendment request (LAR) for the Kewaunee Power Station (KPS). The proposed amendment would allow the use of a methodology to determine the seismic loads on the recently upgraded Auxiliary Building (AB) crane. The AB crane has recently been upgraded to a single-failure-proof design through replacement of the crane trolley and modification of the existing crane bridge. The proposed new methodology is not currently described in the KPS Updated Safety Analysis Report (USAR) or the codes of reference applicable to the upgraded AB crane.

Specifically, DEK requests NRC approval to use a nonlinear analysis method to determine the response of the AB crane structure during a design basis seismic event. This nonlinear analysis method includes consideration of the crane trolley and bridge drive wheels rolling under seismic loads. The consideration of wheel rolling, which makes the analysis nonlinear, occurs when the seismic load exceeds the trolley and bridge drive wheel brake resisting force. The proposed nonlinear analysis method constitutes a departure from a method of evaluation as described in the KPS USAR because the method is not described in the USAR or in applicable NRC-endorsed guidance. Use of the proposed nonlinear analysis method would be limited to the AB crane seismic analysis.

Additional information and documents to support this LAR are provided as attachments to this letter. Attachment 1 provides a detailed description of the proposed amendment, background and technical analysis, and a no significant hazards consideration determination, and an environmental review consideration. Attachment 2 provides marked-up USAR pages showing proposed changes. Attachment 3 provides a

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depiction of the crane mathematical model used in the nonlinear analysis. Also enclosed are non-proprietary general arrangement drawings of the upgraded KPS AB crane bridge and trolley (enclosure 1) and the calculation documenting the development of the seismic time histories used in the nonlinear analysis (enclosure 2).

The AB crane modification and functional testing have been successfully completed and the crane has been turned-over to Operations for limited use, pending approval of this LAR. The AB crane is currently available for use under administrative controls that restrict the lifted load to no more than 50 tons on the main hoist. The modified AB crane has been seismically analyzed using the current linear analysis method to confirm its structural adequacy with a load of up to 50 tons suspended from the main hoist.

As previously discussed with the NRC staff, this LAR will consist of two letters. This letter constitutes the first letter, and describes the approach, inputs, assumptions, and modeling used in the nonlinear analysis to develop the seismic response of the crane structure. It is this methodology for which NRC approval is requested. The second letter, scheduled for August 8, 2008, will be confirmatory in nature, providing the results of the AB crane seismic analyses using the nonlinear method. This two-letter approach is necessary to allow sufficient time for the NRC staff review of this amendment request. The proposed amendment needs to be approved in order to begin using the crane to lift and handle spent fuel storage casks in the summer of 2009.

The KPS Facility Safety Review Committee has approved the proposed amendment and a copy of this request has been provided to the State of Wisconsin in accordance with 10 CFR 50.91(b).

DEK requests approval of the proposed amendment by April 30, 2009 in order to support the dry spent fuel storage loading schedule and to allow restoration of full core offload capability in the KPS spent fuel pool. Upon NRC staff approval of this amendment request, the KPS USAR will be revised, similar to that shown in attachment 2, pursuant to 10 CFR 50.71(e).

If you have any questions or require any additional information, please contact Mr. Gerald Riste at (920) 388-8424.

Very truly yours,

Gerald T. Bischof
Vice President-Nuclear Engineering

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid today by Gerald T. Bischof, who is the Vice President–Nuclear Engineering of Dominion Energy Kewaunee, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 7th day of July, 2008.

My Commission Expires: August 31, 2008.

Margaret B. Bennett
Notary Public

MARGARET B. BENNETT
Notary Public 354302
Commonwealth of Virginia
My Commission Expires Aug 31, 2008

Attachments:

1. Evaluation of License Amendment Request 239
2. USAR Mark-up Pages for License Amendment Request 239 (Information Only)
3. KPS AB Crane Seismic Analysis Mathematical Model

Enclosures:

1. General Arrangement Drawings of Upgraded Auxiliary Building Crane
2. ABS Consulting Calculation No. 1886592-C-001, "Generation of Artificial Seismic Time Histories for the Fuel Cask Bridge Crane at Kewaunee Power Station," Revision 1

Commitments made by this letter:

1. DEK will submit the results of the analyses performed using the nonlinear seismic analysis methodology described in this LAR.
2. DEK will perform a "push" test to provide empirical data documenting the force required to induce crane trolley and bridge drive wheel rolling with the brakes applied. The results of the test will be provided to the NRC.
3. DEK will have an independent peer review performed of the nonlinear structural model and outputs of the nonlinear analysis to confirm the methodology is appropriate for the application and provide a summary of the review to the NRC.

cc: Regional Administrator
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ATTACHMENT 1

LICENSE AMENDMENT REQUEST 239
REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

EVALUATION OF LICENSE AMENDMENT REQUEST 239

KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEEE, INC.

EVALUATION OF LICENSE AMENDMENT REQUEST 239
Request for Review and Approval of Seismic Analysis Methodology Regarding Auxiliary Building Crane

1.0 DESCRIPTION

This submittal is a request to amend Operating License No. DPR-43 for the Kewaunee Power Station (KPS). KPS has implemented modifications to the Auxiliary Building (AB) crane that have made the crane a single-failure-proof design. In accordance with 10 CFR 50.90 and 10 CFR 50.59, Nuclear Regulatory Commission (NRC) staff review and approval is required for the proposed changes to the design and licensing basis as described in the KPS Updated Safety Analysis Report (USAR). Specifically, Dominion Energy Kewaunee, Inc. (DEK) proposes to revise the KPS USAR to allow the use of a nonlinear analysis methodology for determining the seismic response of the upgraded AB crane.

This nonlinear analysis methodology is not part of the KPS current licensing basis or in NRC-approved guidance for such analyses. KPS plans to use the AB crane for spent fuel cask loading operations in the spent fuel pool. A separate license amendment request (LAR) 227 (reference 12) was previously submitted to the NRC to modify and relocate a Technical Specification (TS) pertaining to handling of heavy loads in and around the spent fuel pools. LAR 227 is currently under review by the NRC staff. Approval of both LAR 227 and this LAR are needed to allow use of the upgraded AB crane for spent fuel cask loading operations. The following provides a description, purpose, and detailed justification for the proposed amendment; an evaluation of no significant hazards consideration; and an environmental impact evaluation.

As previously discussed with the NRC staff, this LAR will consist of two letters. This letter is the first of the two and describes the approach, inputs, assumptions, and modeling used in the nonlinear analysis to develop the seismic response of the crane structure. It is this methodology for which NRC approval is requested. The second letter will be confirmatory in nature, providing the results of the AB crane seismic analyses using the nonlinear method.

2.0 PROPOSED CHANGE

The purpose of this amendment request is to modify the KPS design and licensing basis to allow the use of a nonlinear analysis methodology to determine the response of the modified AB crane to a design basis seismic event. This methodology would consider the AB crane bridge and trolley free to roll if seismic forces overcome the brake resisting forces acting on their respective drive wheels. A modification has recently been completed to replace the existing non-single-failure-proof crane trolley with a single-failure-proof design. The load rating of the crane main hoist remains unchanged at 125 tons and the auxiliary hoist load rating has been increased from 10 tons to 15 tons.

Although the AB crane bridge was not replaced, it is being re-analyzed because the new bridge-and-trolley combination is different than the original.

The upgraded AB crane meets applicable NRC and industry guidance for single-failure-proof-cranes provided in NUREG-0612 (reference 1) and NUREG-0554 (reference 2). However, the seismic analysis of the upgraded AB crane requires the use of a nonlinear analysis methodology not previously approved for this application at KPS. The scope of this amendment request is limited to the nonlinear analysis method proposed for use in determining the seismic response of the crane support structure.

The proposed nonlinear analysis methodology considers rolling of the trolley and bridge drive wheels as described in detail later in this attachment. The nonlinear analysis methodology will be used to simulate drive wheel rolling when calculating the seismic response of the crane and support structure. A capacity check of the crane trolley using the loads created by these forces and displacements will be performed in accordance with current NRC-endorsed codes and standards. The capacity check for the AB crane bridge and crane support structure will be performed in accordance with the applicable codes and standards in the KPS current licensing basis. Therefore, NRC approval is not requested for the capacity check work. More specific discussion of the licensing basis and applicable codes and standards for the crane is provided in Sections 3.0 and 4.1. Following NRC approval of this amendment request, the KPS USAR will be modified in accordance with 10 CFR 50.71(e) to include appropriate changes to reflect the new methodology. Attachment 2 provides information only mark-ups of the proposed USAR changes.

3.0 BACKGROUND

DEK intends to operate an Independent Spent Fuel Storage Installation (ISFSI) at the KPS site starting in mid-2009 under the general license provisions of 10 CFR 72, Subpart K. DEK will be using the Transnuclear, Inc. Standard NUHOMS dry spent fuel storage system in accordance with 10 CFR 72 Certificate of Compliance 1004. The Standard NUHOMS System requires the use of a transfer cask weighing up to 125 tons during cask loading operations in the AB. The KPS AB crane will be used to lift and move transfer casks between the cask loading area of the spent fuel pool and the truck bay. The original AB crane was a 125-ton capacity, non-single-failure-proof, Whiting Corporation bridge and trolley design of late-1960s vintage. To facilitate its use in dry spent fuel storage system loading operations, the AB crane has been upgraded to a single-failure-proof design by replacing the trolley with a single-failure-proof design and modifying the existing bridge. The design rated load (DRL) and maximum critical load (MCL) for the AB crane remains unchanged at 125 tons for the main host. The auxiliary hoist DRL has been increased from 10 tons to 15 tons. The AB crane requires re-analysis of its ability to withstand a design basis seismic event due to a 20-ton increase in trolley weight and differences in the design and arrangement of the new trolley compared to the original trolley.

The KPS AB crane is designated Service Class A in accordance with Crane Manufacturer's Association of America Standard 70 (CMAA 70) (reference 7), Section 2.2. The AB crane has a Class I* nuclear safety design classification in accordance with KPS USAR Appendix B, Section B.2.1. Components designated as Class I* are designed to Class I Design Basis Earthquake (DBE) loading and treated as Class III in all other respects[1]. In short, the Class I* designation means that under all credible operating conditions and failure modes, the AB crane must not experience uncontrolled lowering of the load, and the trolley and bridge wheels must remain on their respective rails under a seismic event. It is not required that the crane remain operational.

In order to comply with the requirements for a single-failure-proof crane, the AB crane must be able to withstand the loads induced by the safe shutdown earthquake (SSE) with full rated load suspended from the crane hook. In NUREG-0800, Section 9.1.5 (reference 6), the NRC staff endorsed ASME NOG-1-2004, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)," (reference 5) as an acceptable methodology for performing seismic analyses of crane systems. ASME NOG-1-2004 allows the use of either linear response spectrum seismic analysis or linear time history seismic analysis.

For the linear analysis methods, the crane mathematical model for seismic analysis of cranes is set forth in ASME NOG-1-2004, Figure 4154.3-1. This model imposes restraints at the interface between the bridge and trolley drive wheels and their respective rails. However, in reality the drive wheels are driven and stopped by suitably designed motors, drive shaft gearing, and drive shaft brakes. If the braking systems have less capacity than the applied seismic loads, then the drive wheels will roll with a constant brake resisting force. The rolling of the trolley drive wheels and/or the bridge drive wheels constitutes a nonlinear behavior of the crane system during a seismic event. The methodology used to capture this nonlinear behavior during the seismic event is the subject of this LAR.

The methods used to calculate other required loads (dead and live loads), combine seismic loads with the other loads, and the acceptance criteria used in the structural capacity checks will be in accordance with applicable industry standards that have been endorsed by the NRC or are part of the KPS current licensing basis.

Two basic tasks are required to perform the nonlinear seismic analysis of the AB crane system. The first required task is development of the nonlinear element in the mathematical model that simulates the limited resistance of the braking system on the trolley and bridge drive wheel shafts. This nonlinear model element allows movement

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[1] As stated in KPS USAR, Section B.2.1, Class I structures and components are those whose failure might cause or increase the severity of a loss-of-coolant accident or result in an uncontrolled release of substantial amounts of radioactivity, and those structures and components vital to safe shutdown and isolation of the reactor. Class III structures and components are not directly related to reactor operation or containment.

of the trolley and/or bridge along the rails after known level of force (the breakaway force) on the brakes is achieved. A push test will be conducted to validate the forces in the model associated with the wheel-rolling phenomenon.

The second required task is generation of artificial seismic time histories at the top of the AB crane rail for the SSE. The DBE for the upgraded AB crane design is the SSE. The artificial seismic time histories represent the accelerations at the AB crane rail over the duration of the design basis earthquake. There are special requirements for the development of seismic time histories used in nonlinear analyses. These special requirements are above and beyond those typically used for linear time history analyses. These special requirements primarily pertain to the uncertainty associated with nonlinear analyses. The seismic time histories used in the nonlinear analysis of the KPS AB crane were prepared in accordance with "Option II" described in NUREG-0800, Section 3.7.1 (reference 9).

In summary, DEK is requesting review and approval of the nonlinear seismic analysis methodology to be used for the seismic analysis of the AB crane. The specific nonlinear behavior considered in the proposed methodology is the rolling of the trolley and bridge drive wheels along their respective rails when the applied seismic load exceeds the brake resisting force. This submittal proposes to eliminate the overly conservative assumption that the AB crane trolley and bridge drive wheel brakes have an unlimited capability to resist seismic-induced forces by using a nonlinear seismic analysis methodology to represent the limited capacity of the drive wheel brakes.

4.0 TECHNICAL ANALYSIS

4.1 Applicable Codes and Standards

The AB crane is described in KPS USAR Section 9.5.2.12, "Auxiliary Building Crane." The original crane was non-safety-related and non-single-failure-proof. It was designed and procured as a commercial grade item during initial plant construction in accordance with EOCI Standard 61; ANSI B30.2.0, 1967 Edition; and Pioneer Service and Engineering Company Specification for Powerhouse Overhead Electric Traveling Cranes.

KPS Safety Design Classification I* for the AB crane ensures that the seismic design of the crane is such that a DBE will not result in an uncontrolled lowering of the lifted load and the bridge and trolley wheels will not leave their rails with a load suspended, up to and including the 125-ton rated load of the crane. The crane upgrade project has enhanced the design of the AB crane by replacing the existing trolley with a single-failure-proof trolley constructed in accordance with the guidance in NUREG-0554.

NUREG-0554 is the governing NRC guidance document for the design of single-failure-proof cranes for nuclear power plant service, including upgrades of existing cranes. In general, NUREG-0554 either provides specific guidance or invokes the guidance in CMAA-70 for design work. CMAA-70 is a commercial crane code and does not provide guidance in all areas necessary for nuclear plant service. ASME NOG-1 provides guidance for cranes in nuclear plant service.

The choice of governing codes and standards for the KPS crane upgrade project was based on replacing the trolley and using the existing bridge. The design phase of the project was initiated and the applicable codes governing the upgraded crane's design were selected prior to the NRC's March 2007 endorsement of NOG-1-2004 in Standard Review Plan 9.1.5, Revision 1. Therefore, the primary design code used for the KPS AB crane upgrade was CMAA-70 rather than ASME NOG-1-2004. However, in areas where detailed guidance is not provided in NUREG-0554 or CMAA-70, such as for the seismic analysis, the guidance in ASME NOG-1-2004 was used. In summary, the NRC has endorsed the principal codes and standards used in the project.

4.2 Upgraded AB Crane Seismic Analysis

This section describes the response spectra, damping, time histories, computer models, crane/hoist load combinations, and analysis work that are being used to perform the seismic analyses of the crane. These analyses will produce the seismic-induced forces and displacements on the AB crane and its support structure. These seismic-induced forces and displacements, when combined with the appropriate dead and live load combinations, will be used to compute the loads used for the structural capacity checks of those components for the seismic load condition.

4.2.1 Background and General Overview of Approach

The KPS AB crane is designated Class I* as stated in the KPS USAR, Appendix B, Table B.2-1. In accordance with USAR, Section B.2.1, Class I* components are designed to Class I DBE dynamic loading and are treated as Class III in all other respects. This includes the trolley, bridge, and AB crane support system. In general, the response spectra for seismic analysis performed for the Kewaunee plant are documented in a report developed by John A. Blume and Associates for Pioneer Service and Engineering Company in 1971 (reference 8), hereafter referred to as the "Blume Report." The Blume Report, however, does not include horizontal response spectra for a mass point at the location of the AB crane rails. Therefore, new horizontal response spectra and horizontal and vertical time histories were developed for this analysis, as discussed in the sections that follow.

In performing the seismic analysis of the crane, a nonlinear time history analysis methodology is being used. This analysis uses a computer model of the crane in representative trolley and bridge positions and hook load configurations consistent with ASME NOG-1-2004. The nonlinear time history analysis of the upgraded AB crane is being performed using the SAP 2000 computer program, Version 11. A peer review of the seismic inputs for the nonlinear analysis has been performed by an independent consultant, Dr. Robert Kennedy of RPK Structural Mechanics Consulting. Dr. Kennedy will also perform a peer review of the nonlinear structural model and the outputs of the nonlinear analysis.

An overview of the AB crane seismic analysis is provided below as a series of tasks:

- Task 1: Develop horizontal DBE amplified response spectra at the AB crane rail using the Blume Report as the design input. Vertical response spectra are taken directly from the Blume Report.

- Task 2: Develop artificial seismic time histories at the AB crane rail that are suitable for nonlinear seismic time history analysis.

- Task 3: Develop the crane structural computer model that simulates the nonlinear behavior of the bridge and trolley drive wheel brake system.

- Task 4: Conduct the nonlinear seismic analysis of the crane structure to obtain forces and displacements to be used in combination with other load cases for capacity checks.

4.2.2 Modeling the Behavior of the Braking System

The mathematical model used in the nonlinear seismic analysis of the AB crane is consistent with Figure 4154.3-1 of NOG-1-2004. See attachment 3 for a depiction of the KPS AB crane seismic analysis mathematical model. The restraint conditions at the nodes are consistent with Table 4154.3-1 of NOG-1-2004, with one exception. The one exception is that the nodes representing the trolley and bridge drive wheels are free to move in the direction parallel to their rails after the drive wheel brake force in that direction has been exceeded. Using NOG-1-2004, Figure 4154.3-1 as a reference, the modeling exception applies to bridge wheel Nodes A and C in the "Y" direction and trolley wheel nodes E and F in the "X" direction.

Nodes A, C, E, and F in the mathematical model of the AB crane are restrained in the directions parallel to the rail until the seismic forces in that direction overcome the drive wheel brake force. When the brake forces are exceeded, the wheels are allowed to translate in the dynamic model. This phenomenon represents the nonlinear nature of the analysis. A push test will be conducted to validate the brake resisting forces used in the nonlinear analysis. The push test will be performed for both the trolley and the bridge girder.

4.2.3 DBE Response Spectra and Damping (Task 1)

New horizontal response spectra at the AB crane rails were developed for use in the seismic analyses. Vertical response spectra were taken directly from the Blume Report. A separate response spectrum was developed for each horizontal direction of seismic input (i.e., north-south and east-west). Two percent damping was used in all three spectra in accordance with the criteria for steel structures in the KPS USAR. Horizontal response spectra were developed for the frequency range of 0.1 to 40 Hertz in accordance with NUREG-0800, Section 3.7.1 (reference 9) and Regulatory Guide 1.122 (reference 10).

4.2.4 DBE Acceleration Time Histories at the Crane Rails (Task 2)

The overall approach and acceptance criteria used to generate the needed acceleration time histories is consistent with the basic guidance described in NUREG-0800, Section 3.7.1, Revision 3. This section of the Standard Review Plan (SRP) is mainly focused on the development of the design ground motion time histories for the seismic analysis of structures. Thus, it is used herein with the understanding that some of the guidelines may not be directly applicable for seismic time history generation where the target motion has already been amplified and filtered by the dynamic characteristics of the supporting Auxiliary Building structure. However, the intent of SRP 3.7.1, Revision 3 is met.

Because the analysis of the crane structure is a nonlinear time history seismic analysis, five sets of artificial time histories, each containing three directional components, were developed. This is consistent with SRP 3.7.1, Section II.1.B, Option II, and meets the intent of paragraph 3.3.2 of ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities," (reference 13). Each of the fifteen artificial time histories generated uses an actual recorded earthquake motion as the starting seed. The seed records were selected from available recorded earthquake ground motions obtained from the U.S. Geological Survey database. The criteria used for selecting the earthquake seed records was based on the earthquake magnitude, duration and the required low and high frequency content characteristics.

SRP 3.7.1, Section II.1.B, Option II, "Multiple Sets of Time Histories," was used as guidance for the acceptance criteria for the generation of the artificial time history sets. In addition to the criteria stated in the SRP, each time history developed was baseline corrected (except for one, see enclosure 2, sheet D14) for peak acceleration at high and low frequency consistent with RG 1.122 (reference 10). The statistical independence of the three acceleration components from each of the five sets was validated by calculating the correlation coefficients. The absolute value of the correlation coefficients are all less than 0.16, consistent with the acceptance criteria in SRP 3.7.1, Section II.1.B. The strong motion duration meets or exceeds the guidance contained in Section 2.3 of ASCE 4-98, "Seismic Analysis of Safety-Related Nuclear Structures," (reference 14).

Enclosure 2 provides a detailed description of the methodology that was used to generate the artificial time histories that will be used for the nonlinear analysis of the AB crane. The report also contains plots of all fifteen generated time history accelerations, velocities and displacements. In addition, plots are provided for comparison of the calculated two percent damped response spectra to the target spectra for each direction.

4.2.5 Crane Configurations for Analysis

Table 4.2.5-1 below lists the crane configurations to be analyzed. These configurations were chosen in accordance with the guidance in NOG-1-2004. The trolley is assumed to be at the mid-span, quarter-span, and end-span trolley locations to encompass the entire travel path.

Table 4.2.5-1
Seismic Analysis Crane Configurations

Case No.	Trolley Position	Main Hoist		Auxiliary Hoist	
		Load (tons)	Block	Load (tons)	Block
01	mid-span	125	Raised	0	Raised
02	quarter-span	125	Raised	0	Raised
03	end-span	125	Raised	0	Raised
04	mid-span	0	Raised	0	Raised
05	quarter-span	0	Raised	0	Raised
06	end-span	0	Raised	0	Raised
07	mid-span	125	Lowered	0	Raised
08	quarter-span	125	Lowered	0	Raised
09	end-span	125	Lowered	0	Raised
10	mid-span	0	Raised	15	Raised
11	quarter-span	0	Raised	15	Raised
12	end-span	0	Raised	15	Raised
13	mid-span	0	Raised	15	Lowered
14	quarter-span	0	Raised	15	Lowered
15	end-span	0	Raised	15	Lowered

Each of the configurations above will be analyzed for the five different time history sets (i.e., a north-south, east-west, and vertical time history in each set).

4.2.6 Seismic Model (Task 3)

A three-dimensional (3-D) crane model was developed for use with the SAP 2000, Version 11 computer program, including the bridge girders, bridge end trucks, bridge end ties, trolley structure, wire ropes, and lifted loads. The stiffness and weight properties of the crane components are consistent with the as-built crane. The crane model attributes include:

1. Fundamental crane systems, structures, and components:
    a. Crane bridge, consisting of girders, end trucks and end ties.

b. A simplified trolley assembly, representing the frequency of the trolley in three directions.

2. Simplified pendulum lifted load. The wire rope is modeled as an elastic link element hinged at the top connection to the trolley with the weight of the lower block and lifted load modeled at the bottom. The lower block and wire rope models will be tuned to model the vertical elastic stiffness and the two horizontal direction pendulum frequencies.

3. Trolley travel limits and pre-set nodal points for establishing trolley end, quarter-span, and mid-span locations.

4. Restraint conditions in accordance with ASME NOG-1-2004, Section 4154, except that nonlinear resistance elements will be modeled at the interface between the bridge and trolley drive wheels and their respective rails to model the rolling phenomenon.

The finite element model of the crane that was used for the nonlinear seismic analysis is consistent with the guidance in Sections 4154.1 through 4154.4 of ASME NOG-1-2004. The exception taken from NOG-1-2004 involves modeling of the restraint conditions at the drive wheels for both the trolley and the bridge girder. NOG-1-2004, Table 4154.3-1 requires that these nodes be modeled as restrained in all three translational directions. For the bridge girder, the restrained boundary condition in the transverse direction (Y direction as shown in Figure 4154.3-1 of ASME NOG-1-2004) was replaced with a nonlinear element. This nonlinear element restrains movement in the transverse direction until the maximum brake force is reached. After the maximum brake force is exceeded, the nonlinear element allows the bridge drive wheels to roll with a constant brake resisting force. In a similar manner, the restrained boundary condition for the trolley drive wheels in the transverse direction (X direction as shown in Figure 4154.3-1 of ASME NOG-1-2004) was replaced with a nonlinear element. The nonlinear element restrains the trolley from movement in the transverse direction until the maximum trolley brake force is achieved. Thereafter, the trolley is allowed to roll with a constant brake resisting force.

Attachment 3 shows an SAP 2000 model depicting the eight-wheel crane having the trolley at mid-span with the main hoist hook lowered and the auxiliary hook in the raised position. The figure is provided for information purposes to show the level of detail used in the model of the AB crane for the nonlinear analysis. Other similar models have the trolley located at the quarter-span and at the end of the bridge and have different hook positions. Greater analysis detail, including geometry, weights, member properties, trolley and bridge wheel boundary/interface conditions, and descriptions of the non-linear elements associated with drive wheel rolling will be included in the detailed seismic analysis package.

4.2.7 Analysis Outputs (Task 4)

The seismic-induced forces and displacements on the AB crane will be the outputs of the nonlinear analyses. The results of each seismic analysis set will be added together (e.g., element forces, nodal point motions), and then the summed values averaged. The averaged seismic analysis results will then be combined with the corresponding dead load and live load non-time history analysis results in accordance with the NOG-1-2004 combinations and used in the structural capacity checks of the trolley, bridge, and AB crane support structure.

4.2.8 Summary

The nonlinear seismic analysis for the AB crane structure is being performed in accordance with applicable industry codes and standards. The seismic input time histories were developed consistent with SRP 3.7.1 for nonlinear analysis. The basic mathematical model of the crane is consistent with the guidance in ASME NOG-1-2004 with the exception of the nonlinear boundary conditions. A push test of the crane trolley and bridge will be performed to validate the nonlinear boundary condition in the structural model.

Based on the above, the nonlinear analysis methodology used to determine the seismic response of the upgraded Kewaunee AB crane is acceptable because:

- Seismic time history inputs used in the analysis were developed in accordance with the applicable requirements of SPR 3.7.1
- The nonlinearity is limited to the interface between the drive wheels and the rails. The behavior of the nonlinear element will be validated by testing
- The analysis methods used to solve the nonlinear problem are well established and have been benchmarked to demonstrate that they converge to the correct solution

5.0 REGULATORY SAFETY ANALYSIS

5.1 No Significant Hazards Consideration

Dominion Energy Kewaunee, Inc. (DEK) proposes to modify the Kewaunee Power Station (KPS) licensing basis by adding a new method for the seismic analysis of the KPS Auxiliary Building (AB) crane. This new method of analysis is a nonlinear seismic analysis of the crane that considers trolley and bridge drive wheel rolling after the brake resisting force is exceeded. The proposed new methodology is otherwise consistent with the recommended methods for seismic analysis of cranes in ASME NOG-1-2004, which is silent regarding consideration of rolling. The proposed methodology is consistent with NRC and industry guidance for such analyses.

DEK has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of Amendment," as discussed below:

1. **Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?**

   Response: No.

   This amendment request pertains solely to a nonlinear seismic analysis method supporting the upgrade of the KPS AB crane from a non-single-failure-proof design to a single-failure proof design. Specifically, the existing AB crane trolley has been replaced with a state-of-the-art design that is single-failure-proof. The AB crane does not interface with operating plant equipment. The crane will continue to be able to withstand a design basis seismic event without an uncontrolled lowering of the load. The probability of a load drop is not increased by the proposed change in methodology.

   The seismic analysis methodology proposed for use recognizes the inherent propensity for structures not fixed to one another (e.g., steel wheels on steel rails) to roll if sufficient lateral force is applied. This seismic analysis method is proposed for use solely on the AB crane upgrade and not for any other plant structures, systems, or components. The recognition of wheel rolling between the AB crane trolley and bridge and their respective rails reflects the true nature of the installed equipment and its response to horizontal forces generated by a seismic event.

   Therefore, the proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. **Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?**

   Response: No.

   This amendment request pertains to an analysis method supporting the upgrade of an existing plant component. Specifically, the existing AB crane trolley has been replaced with a state-of-the-art design that is single-failure-proof. The AB crane does not interface with operating plant equipment. This seismic analysis methodology is proposed for use solely on the AB crane upgrade and not for any other plant structures, systems, or components.

   The design rated load of the AB crane main hoist remains the same at 125 tons. This load bounds the design and supporting analysis. The auxiliary hook design rated load has been increased from 10 tons to 15 tons. The proposed amendment does not change the currently acceptable heavy load handling practices in use at KPS. The number and types of lifts made using this crane in support of KPS plant operations will not significantly change from those contemplated during original plant licensing. Furthermore, the basic operations of the crane (i.e., hoisting and horizontal travel) remain the same.

Therefore, the proposed amendment does not create a new or different kind of accident from any accident previously evaluated.

3. **Does the proposed amendment involve a significant reduction in a margin of safety?**

Response: No.

Although the proposed new methodology supports the upgrade of the KPS AB crane from a non-single-failure-proof to a single-failure-proof design, the margin of safety under consideration in this evaluation is based on that contained within the safety analysis (seismic analysis).

The purpose of this methodology is to determine the design loads (forces and moments), accelerations, and displacements on the AB crane and building support structure. These loads will subsequently be used to perform the structural analysis of these components to confirm that the design meets all applicable acceptance criteria using previously approved industry codes and standards for such analyses, including ASME NOG-1-2004 and CMAA-70 (2004). If the stresses computed in the structural components as a result of a seismic event are less than the limits contained in these codes, the structural integrity of the crane is maintained and a suspended load will remain suspended during a seismic event. Meeting these code limits maintains an acceptable margin of safety for the individual components and the crane as a whole.

Therefore, the proposed amendment does not involve a significant reduction in a margin of safety.

5.2 Applicable Regulatory Requirements/Criteria

The U.S. Atomic Energy Commission (AEC) issued their Safety Evaluation (SE) of Kewaunee on July 24, 1972 with supplements dated December 18, 1972 and May 10, 1973. Section 3.1, "Conformance with AEC General Design Criteria," of the AEC's SE described the conclusions the AEC reached associated with the General Design Criteria in effect at the time. The AEC SE stated:

"The Kewaunee plant was designed and constructed to meet the intent of AEC's General Design Criteria, as originally proposed in July 1967. Construction of the plant was about 50% complete and the Final Safety

Analysis Report (Amendment 7) had been filed with the Commission before publication of the revised General Design Criteria in February 1971 and the present version of the criteria in July 1971. As a result, we did not require the applicant to reanalyze the plant or resubmit the FSAR. However, our technical review did assess the plant against the General Design Criteria now in effect and we are satisfied that the plant design generally conforms to the intent of these criteria."

As such, the appropriate General Design Criteria KPS is licensed to, per the Final Safety Analysis Report (Amendment 7), which has now been updated and is entitled the Updated Safety Analysis Report (USAR), are listed below.

5.3 Kewaunee Design Criteria

1. <u>Criterion 2 – Performance Standards</u>

   Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand without loss of the capability to protect the public. The additional forces that might be imposed by natural phenomena include those such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects. The design bases so established shall reflect:

   a) appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and surrounding area, and

   b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as the basis for design.

5.4 Conclusion

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

6.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amount of any effluent that may be released offsite, or (iii) a significant increase in the individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 REFERENCES

1. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," dated July 1980.
2. NUREG-0554, "Single Failure Proof Cranes for Nuclear Power Plants," dated May 1979.
3. NRC Bulletin 96-02, "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment," dated April 11, 1996.
4. NRC Regulatory Issue Summary 2005-25, "Clarification of NRC Guidelines for Control of Heavy Loads," dated October 31, 2005; and Supplement 1 dated May 29, 2007.
5. ASME NOG-1, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)," 2004 Edition.
6. NUREG-0800, "Standard Review Plan," Section 9.1.5, "Overhead Heavy Load Handling Systems," Revision 1.
7. Crane Manufacturers Association of America (CMAA) Specification 70, "Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes," 2004.
8. "Kewaunee Nuclear Power Plant Earthquake Analysis: Reactor-Auxiliary-Turbine Building Response Acceleration Spectra" John A. Blume and Associates Report to Pioneer Service & Engineering Company, April 1971.
9. NUREG-0800, "Standard Review Plan," Section 3.7.1, "Seismic Design Parameters," Revision 3.
10. USNRC Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components," Revision 1.

11. ABS Consulting Calculation No. 1886592-C-001, "Generation of Artificial Seismic Time Histories for the Fuel Cask Bridge Crane at Kewaunee Power Station," Revision 0.

12. Letter from G. T. Bischof (DEK) to NRC Document Control Desk, "License Amendment Request 227, Relocation of Spent Fuel Pool Crane Technical Specification to Technical Requirements Manual," dated November 9, 2007 (ADAMS Accession No. ML073170705).

13. ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities. "

14. ASCE 4-98, "Seismic Analysis of Safety-Related Nuclear Structures."

Serial No. 08-0211

ATTACHMENT 2

LICENSE AMENDMENT REQUEST 239
REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

USAR MARK-UP PAGES FOR LICENSE AMENDMENT REQUEST 239

(For Information Only)

Section B.8

KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEEE, INC

B.8 PROTECTION AGAINST CRANE TOPPLING AND CONTROL OF HEAVY LOADS

The Auxiliary Building crane and the Turbine Building crane are located in areas where they are subject to possible damage from tornado and earthquake. These crane bridges and trolleys are protected against tipping, derailment, and uncontrolled movements that could possibly create damage.

To assure stability of the crane, the bridge and trolley are equipped with fixed, fitted rail yokes that allow free rolling movement but prevent the wheels from being lifted or derailed. The bridge and trolley wheels are equipped with electrically activated, spring set brakes. Upon loss of power or when the crane or trolley are not under operator control, the springs activate the brakes, locking the wheels firmly in place to prevent rolling out of position. The positive wheel stops and bumpers provided to prevent over-travel of the trolley and bridge will prevent the trolley and bridge from leaving the rails, even in the unlikely event of brake failure.

As a result of Generic Task A-36, "Control of Heavy Loads Near Spent Fuel," the NRC issued NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." NUREG-0612 was to be implemented in two phases. Phase I addressed Section 5.1 of NUREG-0612 and established seven basic guidelines for all nuclear power plants, which detailed provisions for the handling of heavy loads in the area of the reactor vessel near stored spent fuel, in other areas where an accidental load drop could damage equipment required for safe shutdown or decay heat removal. Phase II (Sections 5.1.2 through 5.1.6) was intended to cover the need for electrical interlocks/mechanical stops, or alternatively, single failure-proof cranes or load drop analyses.

In Reference 15 the NRC concluded that satisfaction of the Phase I guidelines would provide adequate assurance that, due to improvements in heavy load handling procedures and training, and crane and handling tool inspection and testing, the potential for a load drop is extremely small. Reference 15 also included a cost-benefit analysis for Phase II of NUREG-0612 which concluded that, because of the reduced potential of a load handling accident provided by Phase I, the high cost of implementing Phase II could not be justified by the comparatively small associated increase in plant safety.

Therefore, since Kewaunee has satisfied the requirements of Phase I and since Phase II compliance is no longer required, the NRC has determined that Kewaunee has adequately addressed NUREG-0612 and has significantly reduced the probability of a heavy load handling accident to an acceptably small value (see NRC SER in Reference 16).\

The Auxiliary Building (AB) crane was upgraded in support of dry spent fuel storage cask loading operations. This upgrade involved the replacement of the original trolley with a single-failure-proof design, replacement of the trolley controls, and an upgrade to the existing AB crane bridge. The upgrade of the AB crane meets the guidance in Section 5.1.6 of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," and NUREG-0554, "Single Failure Proof Cranes for Nuclear Power Plants," as applicable.

Design Criteria for Upgraded Auxiliary Building Crane

The AB crane is designated as Class I* per Table B.2-1 and therefore is designed to meet Class I seismic standards. The crane is designed to stay on its rails and not allow an uncontrolled lowering of the load as a result of a seismic event. It is not required to be operational during or after a seismic event. The AB crane is also designed to withstand the crane design basis accident events described in NUREG-0554: two-blocking, load hang-up, and wire rope failure.

Because the replacement AB crane trolley is a new component and the crane bridge is an existing component, the construction codes applicable to the two are not identical. The construction codes for the trolley and bridge are as follows:

<u>AB Crane Trolley Codes and Standards</u>

Construction is in accordance with NUREG-0554 and, where NUREG-0554 does not offer specific guidance (e.g., normal condition load combinations and stress acceptance criteria), construction is in accordance with Crane Manufacturers Association of America Specification 70 (CMAA-70), 2004 Edition is used. ASME NOG-1-2004 is used where CMAA-70 does not offer specific construction guidance, such as for seismic design and faulted conditions. Seismic load combinations and stress analysis acceptance criteria, as well as guidance used to address two blocking, load hang-up, and wire rope failure are, therefore, taken from ASME NOG-1-2004.

<u>AB Crane Bridge Codes and Standards</u>

Construction is in accordance with NUREG-0554 and Electrical Overhead Crane Institute Standard 61 (EOCI-61). CMAA-70 (2004) and ASME NOG-1-2004 are used, in that hierarchy, where NUREG-0554, and EOCI-61 do not offer specific construction guidance such as for seismic design and faulted conditions. Seismic load combinations and stress analysis acceptance criteria, therefore, taken from ASME NOG-1-2004.

<u>Upgraded AB Crane Seismic Response Spectra, Damping, and Accelerations</u>

The seismic analysis of the AB crane considers trolley and bridge drive wheel rolling when the seismic forces exceed the drive wheel brake resisting force. This nonlinear boundary condition required seismic time history inputs to be developed consistent with SRP 3.7.1, Revision 3, Option II. With the exception of the nonlinear boundary condition at the trolley and bridge drive wheels, the seismic analysis of the upgraded AB crane is consistent with ASME NOG-1-2004.

The Blume Report, which forms the basis for seismic analyses at the Kewaunee Power Station, does not include horizontal response spectra data for a mass point at the location of the AB crane rail, appropriate for use in analyzing the upgraded crane. Therefore, a lumped-mass stick model of the Auxiliary Building steel structure was used to generate additional horizontal response spectra applicable for use at the AB crane rail. A 2 percent damping for the Safe Shutdown Earthquake condition was applied to both the vertical and horizontal response spectra at the crane rail elevation.

A set of 5 time histories consisting of two horizontal and one vertical time history were developed from the crane rail response spectra. The time histories were developed in accordance with the requirements of the NRC Standard Review Plan, Section 7.3.1. The time histories were used in conjunction with a 3-D model of the crane to perform the non-linear seismic analysis.

Serial No. 08-0211

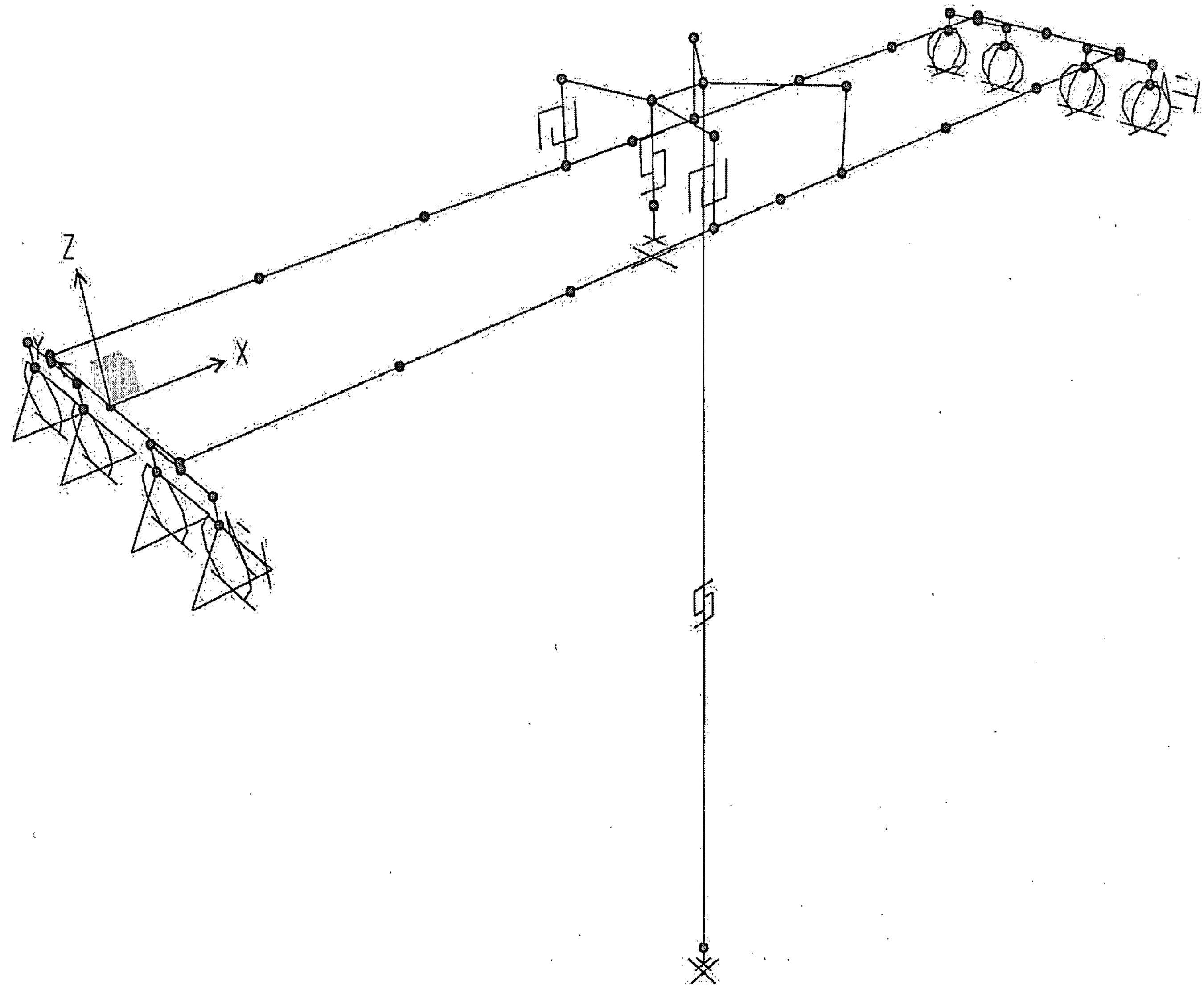
ATTACHMENT 3

LICENSE AMENDMENT REQUEST 239
REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

KPS AB CRANE SEISMIC ANALYSIS MATHEMATICAL MODEL

KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEEE, INC.

KPS AB CRANE SEISMIC ANALYSIS MATHEMATICAL MODEL



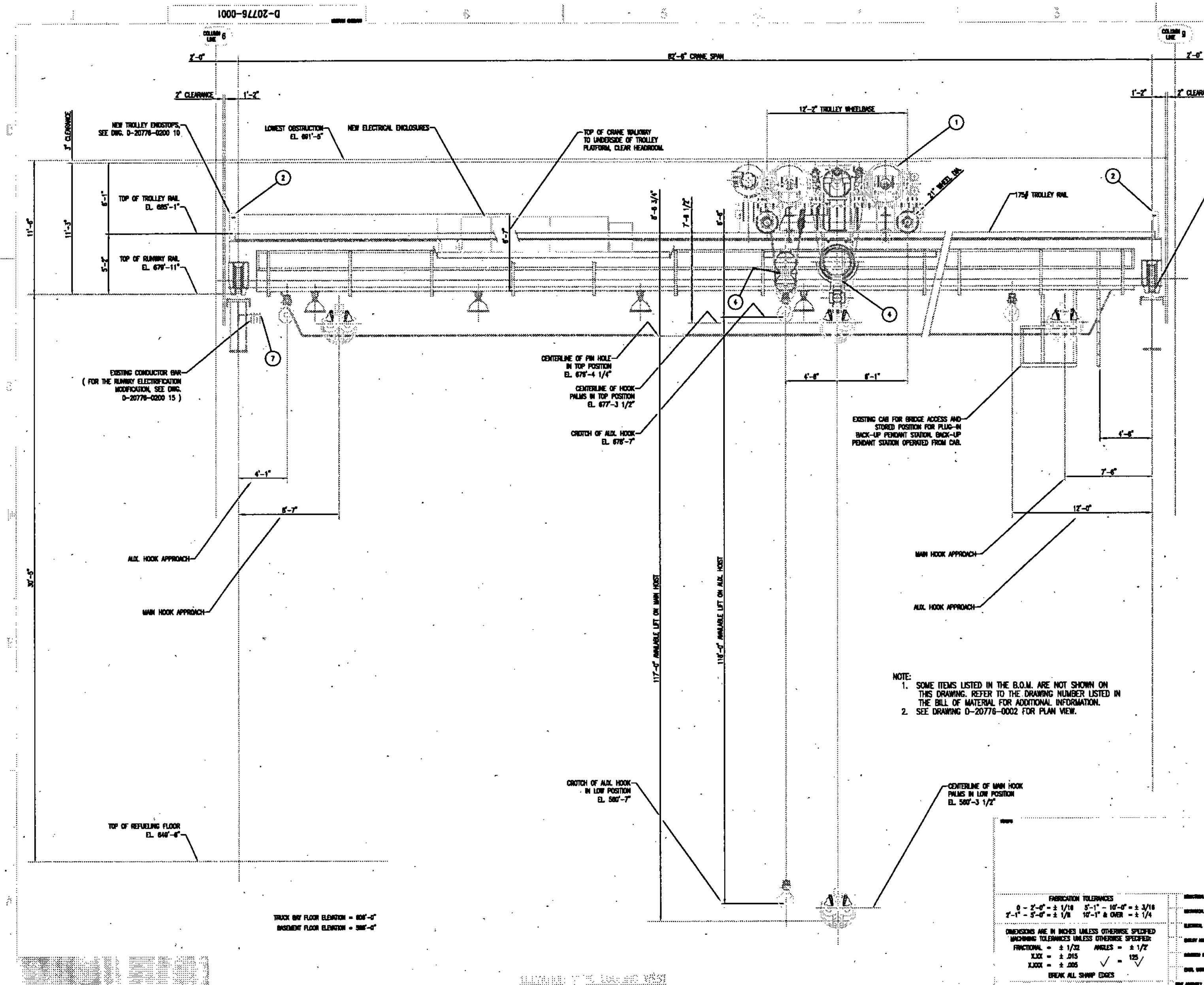
Serial No. 08-0211

ENCLOSURE 1

LICENSE AMENDMENT REQUEST 239
REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

GENERAL ARRANGEMENT DRAWINGS OF UPGRADED AUXILIARY BUILDING CRANE

KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEEE, INC.



NOTE:
1. SOME ITEMS LISTED IN THE B.O.M. ARE NOT SHOWN ON THIS DRAWING. REFER TO THE DRAWING NUMBER LISTED IN THE BILL OF MATERIAL FOR ADDITIONAL INFORMATION.
2. SEE DRAWING D-20776-0002 FOR PLAN VIEW.

REVISIONS

CRANE DATA

TROLLEY NO.	2949
CAPACITIES	MAIN HOIST: DRL = MCL = 125 TONS AUX. HOIST: DRL = MCL = 15 TONS TROLLEY: DRL = MCL = 125 TONS BRIDGE: 125 TONS
MAIN HOIST SPEED	0.25-5 F.P.M. VARIABLE (CRITICAL LOAD) 0.25-7.5 F.P.M. VARIABLE (NON CRITICAL LOAD)
AUX. HOIST SPEED	0.25-20 F.P.M. VARIABLE (CRITICAL LOAD) 0.25-30 F.P.M. VARIABLE (NON CRITICAL LOAD)
TROLLEY SPEED	1-40 F.P.M. VARIABLE
BRIDGE SPEED	1.25-50 F.P.M. VARIABLE
TROLLEY WEIGHT	112,000 LBS.
BRIDGE WEIGHT	EXISTING
MAXIMUM BRIDGE WHEEL LOAD (WITHOUT IMPACT)	98,500 LBS. @ 125 TON CAPACITY (TO BE CONFIRMED)
APPLICATION	NUREG 0554, CMAA CLASS A, INDOORS
POWER SUPPLY	460-3-60 AC
OPERATOR CONTROLS	RADIO REMOTE CONTROL WITH BACK-UP PENDANT STATION
CONTROL ENCLOSURE	NEMA 4 (FOR NEW ENCLOSURES)
RUNWAY COLLECTORS	CONDUCTOR BAR - 3 EXISTING ACECO TO ADD 4TH FOR GROUND
RUNWAY LENGTH	150 FT. APPROX.
SURFACE PREPARATION	SSPC-SP6
PAINT	PRIMER: 2.5-6.0 MILS DFT, KEELER & LONG KL3200, WHITE FINISH: 1.5-2.5 MILS DFT, KEELER & LONG POLY-SILICONE ENAMEL- SAFETY ORANGE TO MATCH EXISTING.

DOMINION ELECTRIC KEWAUNEE
KEWAUNEE POWER STATION
CUSTOMER P.O. NO. 70153249 SAFETY RELATED

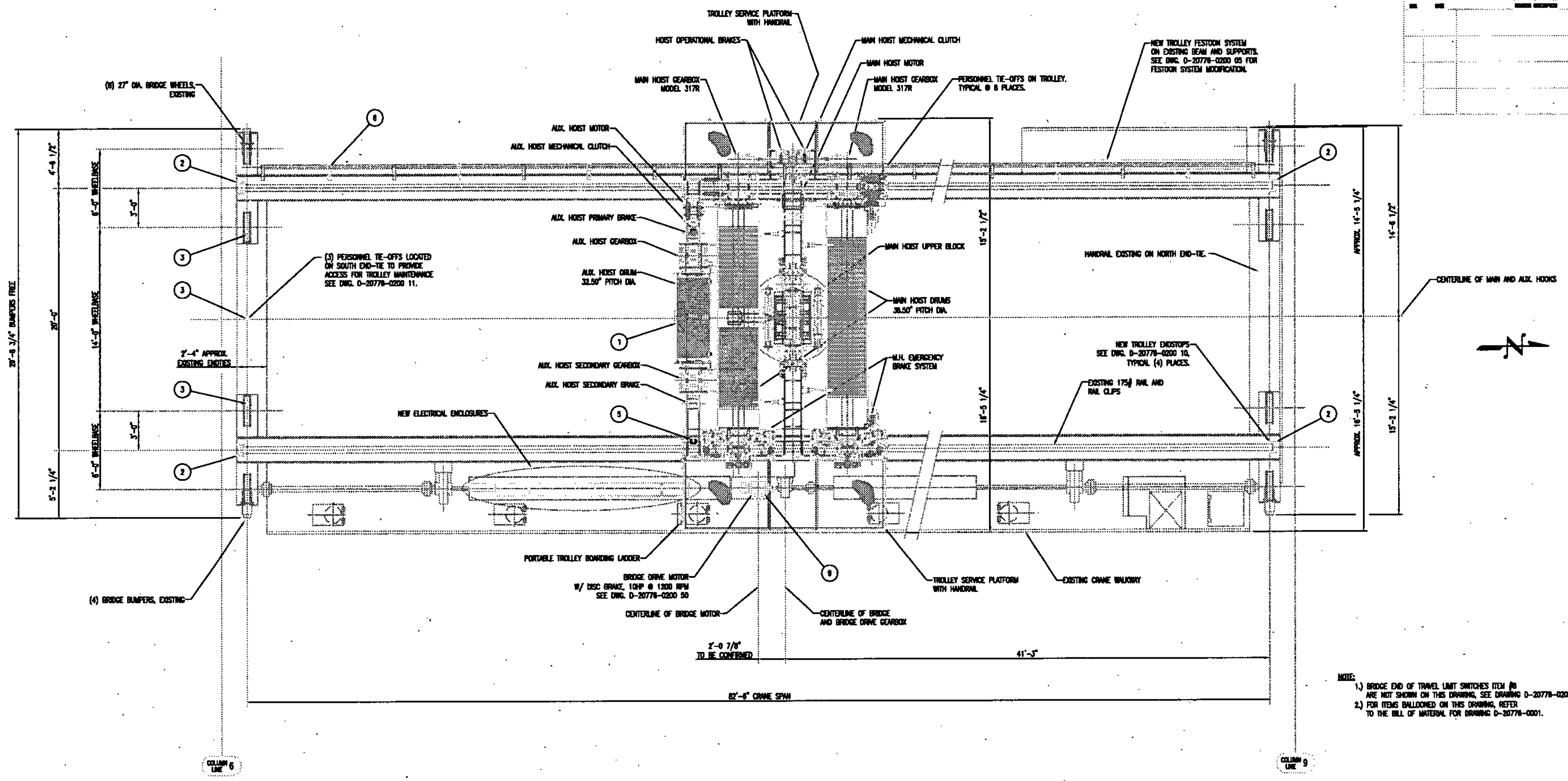
FABRICATION TOLERANCES
0 - 2'-0" = ± 1/16   5'-1" - 10'-0" = ± 3/16
2'-1" - 5'-0" = ± 1/8   10'-1" & OVER = ± 1/4

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
MACHINING TOLERANCES UNLESS OTHERWISE SPECIFIED:
FRACTIONAL = ± 1/32   ANGLES = ± 1/2°
X.XX = ± .015
X.XXX = ± .005   √ = 125√
BREAK ALL SHARP EDGES

SINGLE FAILURE PROOF TROLLEY #2949
GENERAL ARRANGEMENT, ELEVATION VIEW

UPGRADE OF KPS AUX. BUILDING CRANE

J. PENTZ   3/20/08   1/4" = 1' - 0"
20776 0001 000000RD
20776
N/A
D-20776-0001



NOTE:

1.) BRIDGE END OF TRAVEL LIMIT SWITCHES ITEM #8 ARE NOT SHOWN ON THIS DRAWING, SEE DRAWING D-20776-0200 80.

2.) FOR ITEMS BALLOONED ON THIS DRAWING, REFER TO THE BILL OF MATERIAL FOR DRAWING D-20776-0001.

FABRICATION TOLERANCES
0 - 2'-0" = ± 1/16 5'-1" - 10'-0" = ± 3/16
2'-1" - 5'-0" = ± 1/8 10'-1" & OVER = ± 1/4

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
MACHINING TOLERANCES UNLESS OTHERWISE SPECIFIED:
FRACTIONAL = ± 1/32 ANGLES = ± 1/2°
X.XX = ± .015
X.XXX = ± .005 √ = 125√
BREAK ALL SHARP EDGES

D-20776-0001

DOMINION ELECTRIC ...
KEWAUNEE POWER STATION
CUSTOMER P.O. NO. 70153249 SAFETY RELATED

AMERICAN CRANE & EQUIPMENT CORPORATION
DOUGLASSVILLE, PA. 19518 U.S.A.

SINGLE FAILURE PROOF TROLLEY #2949
GENERAL ARRANGEMENT, PLAN VIEW

UPGRADE OF KPS AUX. BUILDING CRANE

J. PENTZ	3/20/08	1/4" = 1' - 0"
		20776 0002 00000RO
		20776

D-20776-0002 C

ENCLOSURE 2

LICENSE AMENDMENT REQUEST 239
REQUEST FOR REVIEW AND APPROVAL OF SEISMIC ANALYSIS METHODOLOGY FOR AUXILIARY BUILDING CRANE

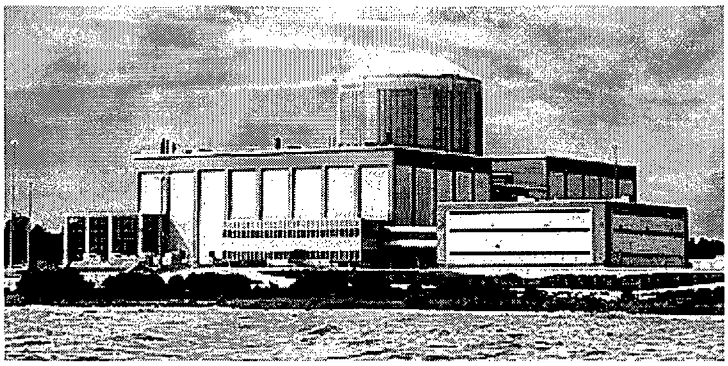
ABS CONSULTING CALCULATION NO. 1886592-C-001, "GENERATION OF ARTIFICIAL SEISMIC TIME HISTORIES FOR THE FUEL CASK BRIDGE CRANE AT KEWAUNEE POWER STATION," REVISION 1

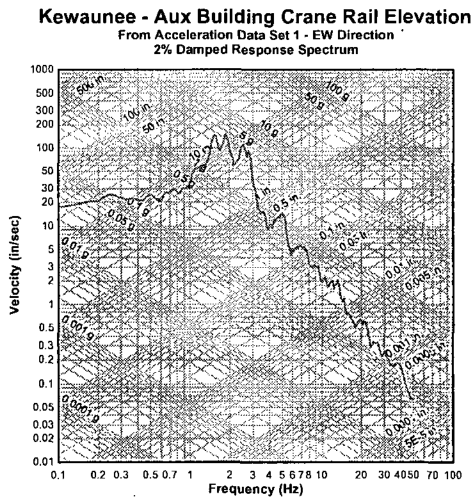
KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEEE, INC.

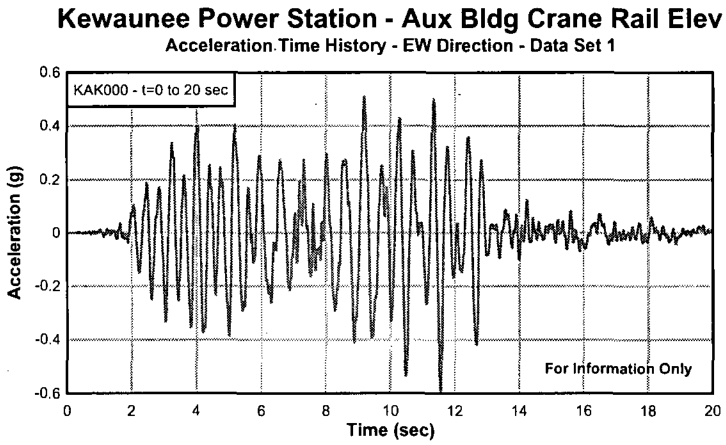
ABS Consulting
RISK CONSULTING DIVISION

Calculation
1886592-C-001
Revision 1
May 2008

Generation of Artificial Seismic Time Histories for the Fuel Cask Bridge Crane at the Kewaunee Power Station







Prepared for:
American Crane and Equipment Corporation
Douglassville, PA

Prepared by:
ABS Consulting

ABS Consulting

CALCULATION COVER SHEET

Calculation No.	**1886592-C-001**
Project:	**1886592**
Calculation Title:	**Generation of Artificial Seismic Time Histories for the Fuel Cask Bridge Crane at the Kewaunee Power Station**
Client:	**American Crane and Equipment Corporation**
Computer Software Used[1]:	☐ **No** ☒ **YES[2]: Code/Version:** See sheet 2 to 5
Quality Assurance:	☐ **ISO 9001 Program (QMS)** ☒ **Nuclear QA Program (NQA)**
Client PO No:	**010153**
References:	See Section 6 of this calculation
Attachments:	As noted on Table of Contents

Total Number of Pages (Including Cover Sheet): **119**

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
0	05-May-08	Original Issue	F.Elsabee/M.C.Ozbey	W.Sawruk	W.Sawruk
1	27-May-08	Total Revision	F. Elsabee M. C. Ozbey	Walter Sawruk W. Sawruk Independent Verifier: P. Streeter	Walter Sawruk W. Sawruk

[1] Check NO box when Excel, MathCAD, and/or similar programs are used since algorithms are explicitly displayed.
[2] For each use of computer software, include a Computer Software Use form before the Table of Contents.

COMPUTER SOFTWARE USE

>> INCLUDE SEPARATE SHEET FOR EACH SOFTWARE USED <<

1	**Computer Software Used** (Code/Version)	RSPEC Version 1.2P	
2	**Software Supplier**	ABS Consulting	
3	**Software Update Review**	☐ Error notices; describe: ☒ Other; describe: Not available	
4	**Nuclear Safety Related Software**	☐ NO ☒ YES	Hardware identification # used for execution: Compaq Desktops: SN: 6X23-JYFZ-X21E SN: 6X28-KN8Z-70M2 Basis for Verification is Ref. [2] – Validation of software on above two machines is provided in Ref. [4].
5	**Input Listing(s)**	☐ Input listing(s) attached: ☒ Not attached; identify File/Disc ID: Input files provided separately on disc (see identified input files in Attachment A)	
6	**Output Data**	☐ Output results attached: ☒ Not attached; identify File/Disc ID: Output files provided separately on disc. (see identified output files in Attachment A)	
7	**Output Identifier(s)***	See listings in Attachment A.	
	*e.g., run date/time; use for reference, as appropriate, within body of calculation		
8	**Comments**	Only Acceleration Response Spectra option of the software is QA certified (see page 11 of manual)	
9	**Keywords****	Not Applicable.	
	**For use in describing software features used in this calculation; use common terms based on software user manual.		

COMPUTER SOFTWARE USE

>> INCLUDE SEPARATE SHEET FOR EACH SOFTWARE USED <<

1	**Computer Software Used** (Code/Version)	RSPLT Version 1.6P	
2	**Software Supplier**	ABS Consulting	
3	**Software Update Review**	☐ Error notices; describe: ☒ Other; describe: Not available	
4	**Nuclear Safety Related Software**	☐ NO ☒ YES	Hardware identification # used for execution: Compaq Desktops: SN: 6X23-JYFZ-X21E SN: 6X28-KN8Z-70M2 Basis for Verification is Ref. [3] – Validation of software on above two machines is provided in [4].
5	**Input Listing(s)**	☐ Input listing(s) attached: ☒ Not attached; identify File/Disc ID: Input files provided separately on disc (see identified input files in Attachment A)	
6	**Output Data**	☐ Output results attached: ☒ Not attached; identify File/Disc ID: Output files provided separately on disc. (see identified output files in Attachment A)	
7	**Output Identifier(s)***	See listings in Attachment A.	
	*e.g., run date/time; use for reference, as appropriate, within body of calculation		
8	**Comments**		
9	**Keywords****	Not Applicable.	
	**For use in describing software features used <u>in this calculation</u>; use common terms based on software user manual.		

COMPUTER SOFTWARE USE
>> INCLUDE SEPARATE SHEET FOR EACH SOFTWARE USED <<

1	**Computer Software Used** (Code/Version)	RspMatch2005
2	**Software Supplier**	University of California, Berkeley, CA
3	**Software Update Review**	☐ Error notices; describe: ☒ Other; describe: Not available
4	**Nuclear Safety Related Software**	☒ NO ☐ YES — Hardware identification # used for execution: Non-QA
5	**Input Listing(s)**	☐ Input listing(s) attached: ☒ Not attached; identify File/Disc ID: N/A (See discussion in Section 3.1)
6	**Output Data**	☐ Output results attached: ☒ Not attached; identify File/Disc ID: N/A. (See discussion in Section 3.1)
7	**Output Identifier(s)***	N/A (See discussion in Section 3.1)
	*e.g., run date/time; use for reference, as appropriate, within body of calculation	
8	**Comments**	COMMERCIALLY AVAILABLE SOFTWARE - Not Verified/Validated in accordance with the ABS Consulting Nuclear Quality Assurance manual (NQAM) and Procedure RCD-NQP-00-P03 (Ref. 10 and 11 respectively). Refer to discussion in Section 3.1 for use of results generated by this software.
9	**Keywords****	Not Applicable.
	**For use in describing software features used in this calculation; use common terms based on software user manual.	

COMPUTER SOFTWARE USE

>> INCLUDE SEPARATE SHEET FOR EACH SOFTWARE USED <<

1	**Computer Software Used** (Code/Version)	Dplot version 2.1.4.9
2	**Software Supplier**	HydeSoft Computing, LLC
3	**Software Update Review**	☐ Error notices; describe: ☒ Other; describe: Not available
4	**Nuclear Safety Related Software**	☒ NO ☐ YES Hardware identification # used for execution: Non-QA
5	**Input Listing(s)**	☐ Input listing(s) attached: ☒ Not attached; identify File/Disc ID: N/A (See discussion in Section 3.1)
6	**Output Data**	☐ Output results attached: ☒ Not attached; identify File/Disc ID: N/A. (See discussion in Section 3.1)
7	**Output Identifier(s)***	N/A (See discussion in Section 3.1)
	*e.g., run date/time; use for reference, as appropriate, within body of calculation	
8	**Comments**	COMMERCIALLY AVAILABLE SOFTWARE - Not Verified/Validated in accordance with the ABS Consulting Nuclear Quality Assurance manual (NQAM) and Procedure RCD-NQP-00-P03 (Ref. 10 and 11 respectively). Refer to discussion in Section 3.1 for use of results generated by this software.
9	**Keywords****	Not Applicable.
	**For use in describing software features used in this calculation; use common terms based on software user manual.	

RECORD OF REVISION

Revision	Description of Change	Reason For Change
0	Original Issue	N/A
1	Total revision of entire calculation.	To address Client's comments.

Table of Contents

ATTACHMENTS

Attachment	Description	No of Sheets
A	Log of Computer Software Runs	7
B	Design Input Data	14
C	Plots of Generated Time Histories & Response Spectra and Tabulation of Generated ARS Data	50
D	Plots of Seed Time Histories	16
E	NQP-02 Review Guidelines	1

The Input and Output computer files are on attached CD.

Calculation Summary Page

Calculation Objective

The purpose of this calculation is to develop artificial acceleration time histories representing the response of the Kewaunee auxiliary building at the base of the fuel cask bridge crane rails. Since these time histories are to be used as input for a non-linear time history analysis of the crane system, a set of five time histories are developed with each set consisting of two horizontal and one vertical time histories.

Conclusions

The required fifteen time histories are developed and evaluated in this calculation to show that they meet the requirements specified in the Standard Review Plan section 7.3.1 [5] which is used as a guide for the development effort.

Assumptions

Assumptions, where utilized, are justified within the text and body of this calculation. No assumptions require verification to validate the conclusions and results of this calculation. Refer to Section 2.0 for more detailed listing of input and assumptions considered in the calculation.

Design Input Documents

Refer to Sections 2 and 6 for a complete listing of design inputs and references used in this calculation. Refer to Attachment B for a copy of ACECO's Design Information Transmittal to ABS Consulting that provides the target spectra data.

1 Introduction

American Crane and Equipment Corporation (ACECO) is to perform a non-linear time history analysis, as part of the seismic qualification, of the 125/15 Ton Single Failure Proof Fuel Cask Bridge crane located in the auxiliary building of the Kewaunee Power Station. The seismic input to be used for the analysis was defined by Dominion as the 2% damped acceleration response spectra (ARS) at the base of the crane rails [1][3]. These curves, consisting of two horizontal (NS and EW) and one vertical, incorporate the amplification and filtering effect of the site Design Basis Earthquake (DBE) through the supporting structure(s). However, since the crane analysis is to consist of a non-linear time history analysis, the input to the analysis needs to be in the form of acceleration time histories. Thus, this calculation develops the required acceleration time histories such that their 2% damped ARS curves match the design target ARS curves provided by Dominion in [1].

The methodology and acceptance criteria used in the development of the time histories are described in Section 3 and are based on the requirements of the U.S. Nuclear Regulatory Commission (NRC) Standard Review Plan (SRP) Section 3.7.1 [5] which is used as a guide for this effort.

[3] Numbers identified in brackets [] refer to the associated reference number listed in Section 6.

2 Inputs and Assumptions

1. Some calculations herein are done using the commercially available Microsoft Excel and Mathcad computer software. The significant numbers of digits shown in the results are rounded off values. Values calculated by these software are independently verified and specifically described in this calculation.
2. The target ARS curves for the motion defined at the crane rails are obtained from [1] and modified as described in Section 4.1.
3. This calculation develops five sets of acceleration time histories, with a duration of 20 seconds for each time history, to be used for the non-linear seismic analysis of the subject crane. The required number of sets and the duration of each time history have been deemed acceptable for the non-linear analysis and no further justification is provided herein.
4. The acceleration response spectra calculated from the determined time histories are compared to the provided/modified response spectra using a damping value of 2%. This damping value has been deemed acceptable and no further justification is provided herein.
5. The fifteen selected earthquake record seeds used in this calculation were obtained from the UC Berkeley (public) web site at this address:

   http://peer.berkeley.edu/smcat

3 Methodology

3.1 Overall Time History Generation Approach

The overall approach and acceptance criteria used to generate the needed acceleration time histories follows the basic requirements described in the U.S. NRC SRP Section 3.7.1 [5]. Note that this Section of the SRP discusses mostly the development of design ground motion time histories for the seismic analysis of the structures. Thus, it is used herein as a guide with the understanding that some of the guidelines may not be directly applicable for the time history generation at hand where the target motion has already been amplified and filtered by the dynamic characteristics of the supporting auxiliary building.

Since the crane analysis will be a non-linear time history analysis, five sets of time histories, each containing three directional components, are developed here in.

Each of the fifteen generated acceleration time histories uses a real earthquake record as a starting seed. The seed earthquake records chosen for this task are identified below in Section 4.2. The development of the needed acceleration time histories and iterations used on the seed records are based on a state-of-the-art improved method of matching response spectra using wavelets described in [7]. This methodology is programmed into a computer software named RspMatch2005. This software has not been Verified and Validated (V&V) in accordance with the requirements of the ABS Consulting Nuclear Quality Assurance Manual (NQAM) [10] and QA Procedure RCD-NQP-00-P03 [11]. As such this software is considered a commercially available non V&V software. However, the final time history records developed with this software are verified to meet all the criteria requirements, described in Section 3.2, using in-house ABS Consulting QA software (using RSPEC[4] and RSPLT) and publicly available standard packages such as Excel where the algorithms and equations are explicitly displayed and verified by the checker.

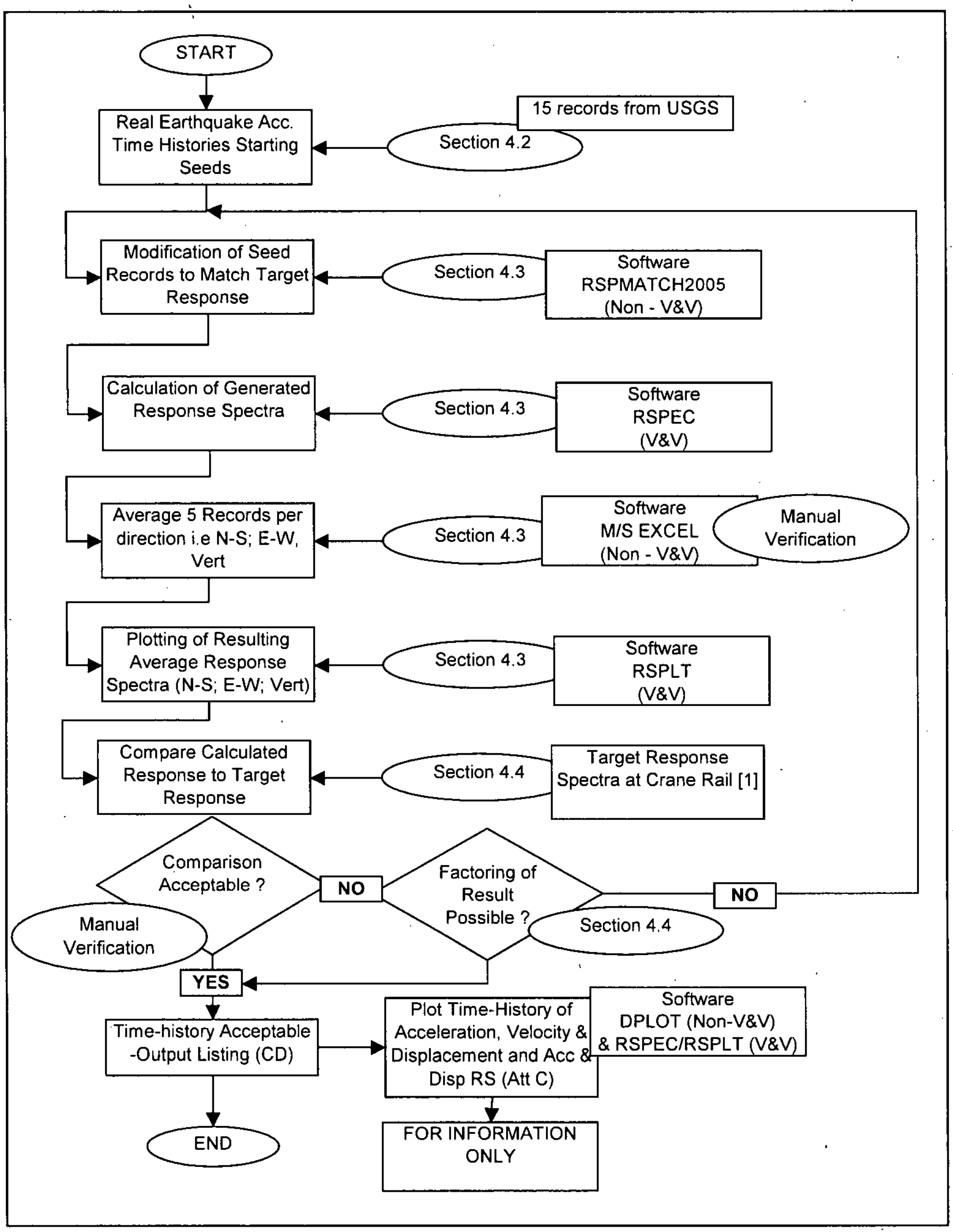
The commercially available plotting software DPLOT is also used for displaying some of the data in this calculation. This software package has not been Verified and Validated in accordance with the requirements of [10] and [11]. As such, the time history data

[4] Note that only the acceleration response spectrum calculation option in RSPEC has been QA verified in [2]. Therefore, the displacement response spectra calculated using RSPEC is thus identified <u>For Information Only</u> in Attachment C.

displayed with this software is provided For Information Only. These plots, contained in Attachment C, are so marked (For Information Only), and thus specific V&V of the DPLOT software is not required. However, when comparing the calculated spectra of the developed time histories to the target spectra, the in-house ABS Consulting software package RSPLT is utilized. This software package has been V&V in accordance with the ABS NQAM [10] and ABS RCD-NQP-00-P03 procedure for software [11]. The overall analysis approach is depicted in the Figure 3.1 flowchart.

Thus, based on the above discussion, none of the input or output files from RspMatch2005 or Dplot are identified or listed in this calculation.

Figure 3.1: Calculation Methodology Flowchart



3.2 Criteria for the Generation of Artificial TH's

As discussed above, the SRP 3.7.1 [5] is used as a guide for the acceptance criteria of the generated artificial time histories. Since multiple sets of time histories are being generated, the requirements of "Option 2," on page 3.7.1-12 of [5] are used. Thus based on the SRP requirements, the following are the criteria needed to be met for each of the five sets of time histories:

1. For each of the five sets, each of the three directional acceleration time histories must be shown to be statistically independent from the others. Statistical independence between two time histories is shown when the absolute value of their correlation coefficient does not exceed 0.16.
2. Each set of three directional time histories shall be selected from real recorded historical earthquake time histories (NS, EW & vertical). The amplitude of these records may be scaled but the phasing of Fourier components must be maintained. Each time history should be defined at intervals of 0.01 sec, with a minimum of 6 seconds of strong motion and a total duration of at least 20 seconds. A target objective of 6 to 10 seconds of strong motion duration with at least 11 seconds of vibratory duration followed by trailing zeros will be used for this criterion.
3. Spectral accelerations at 2% damping shall be computed at a minimum of 100 frequency points per decade, uniformly spaced over the log frequency scale from 0.1Hz to 40Hz (i.e. a total of 240 frequency points). Comparison of the calculated absolute acceleration response spectrum to the target spectrum shall be performed at each computed frequency point. Note that the range up to 40 Hz is used since the target spectra are provided up to 40 Hz and the response past this frequency is of little interest in seismic analysis.
4. The absolute acceleration response spectrum for each individual time history need not envelop the associated target response spectrum. However, the set of five time histories (for each direction) is acceptable if the **average calculated response spectrum** generated from these time histories meets the two enveloping criteria defined below.
5. The following two enveloping criteria shall be met:
   - The computed average 2% damped acceleration response spectrum shall not fall more than 10% below the corresponding target spectrum at any one frequency. To prevent spectral values in large frequency windows from falling below the target spectrum, the frequency window for the comparison is not larger than $\pm$10% centered on the frequency point of interest. This corresponds to spectral values at no more than **9 adjacent frequency points** defined in 3 above from falling below the target response spectrum.
   - The computed average 2% damped acceleration response spectrum shall not exceed the target response spectrum by more than 30% (a factor of

1.3) at any frequency in the frequency range of interest. If this level is exceeded at any frequency range, the power spectrum density of the acceleration time history needs to be computed and shown to not have significant gaps in energy at any frequency over this frequency range.

6. Each acceleration time history developed shall be baseline corrected and the corresponding integrated velocity and displacement time histories shall be plotted.
7. For each acceleration time history developed, the associated 2% damped displacement response spectra shall also be calculated and plotted.

4 Calculation Details

4.1 Modification of Target Spectra

The target spectra provided in [1] are quite conservative in the low frequency region below 1 Hz. Furthermore, these curves do not go down to the 0.1 Hz value needed for the anticipated extremely low frequency response of the loaded hook and rope of the crane. Thus, the following corrections are made to each of the three target spectra.

Reduce Conservatism below 1 Hz:

Per Reg. Guide 1.122 [6], peak broadening of floor response spectra is required around the structural frequencies. The broadening effect is generally eliminated in the region of the lower tail of the curve. This is indicated in Figure 1 of the Reg. Guide. The target curves provided in [1] carry the broadening way below 1 Hz.

Thus, to aid in the non-linear analysis in the low frequency range, the target curves are modified such that the unbroadened curves provided in [1] are used below 1 Hz. A smooth transition region between the broadened and unbroadened portions of the curves is also provided such that no abrupt change in the ARS results.

Extrapolate Down to 0.1 Hz: Per Reg Guide 1.60 [8], the ground motion is normally defined with constant displacement from 0.25 Hz to 0.1 Hz for all three directions. Thus, considering the ARS at the crane rail in this low frequency region to have the same shape as that defined in the Reg Guide, we get the following values at 0.1 Hz:

EW:
a = 0.021g at 0.2 Hz as discussed above
$\delta = a / \omega^2$ = 5.14" at 0.2 Hz
Therefore, use δ = 5.14" also at 0.1 Hz and
$a = \delta \omega^2$ = 0.0053g at 0.1 Hz

NS:
a = 0.047g at 0.25 Hz as discussed above
$\delta = a / \omega^2$ = 7.36" at 0.25 Hz
Therefore, use δ = 7.36" also at 0.1 Hz & 0.2 Hz
$a = \delta \omega^2$ = 0.0075g at 0.1 Hz
$a = \delta \omega^2$ = 0.0301g at 0.2 Hz

Vert:
a = 0.062g at 0.5 Hz as discussed above
Per [8], the amplification of the 2% damped spectral acceleration between 0.25Hz and 0.5Hz is approximately: 0.7g / 0.38g = 1.84, therefore,

$a = 0.062g / 1.84 = 0.034g$ at 0.25Hz
$\delta = a / \omega^2 = 5.32"$ at 0.25 Hz
Therefore, use $\delta = 5.32"$ also at 0.1 Hz and
$a = \delta \omega^2 = 0.0054g$ at 0.1 Hz

Combined Modifications: The total combined modifications, based on the above discussions, result in the 2% damped target spectral acceleration values provided in Table 4.1 for the low frequency range below 1 Hz. The modified target response spectrum curves are compared to the original target curves in Figure 4.1 and Figure 4.2.

Table 4.1: Modified Target Response Spectrum Curves in Low Frequency

2% Damped EW		2% Damped NS		2% Damped Vert	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
0.10	0.0053	0.10	0.0075	0.10	0.0054
0.20	0.021	0.20	0.030	0.5	0.062
0.40	0.045	0.25	0.047	0.597	0.084
0.60	0.103	0.5	0.166	0.8	0.133
0.80	0.205	0.75	0.39	1.00	0.17
1.02	0.507	0.85	0.883		
		1.000	1.955		

Note that the target spectral acceleration values for frequencies higher than 1 Hz are as provided in Attachment B under the "Broadened" columns of ET-CEM-8-0004 [1].

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Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08

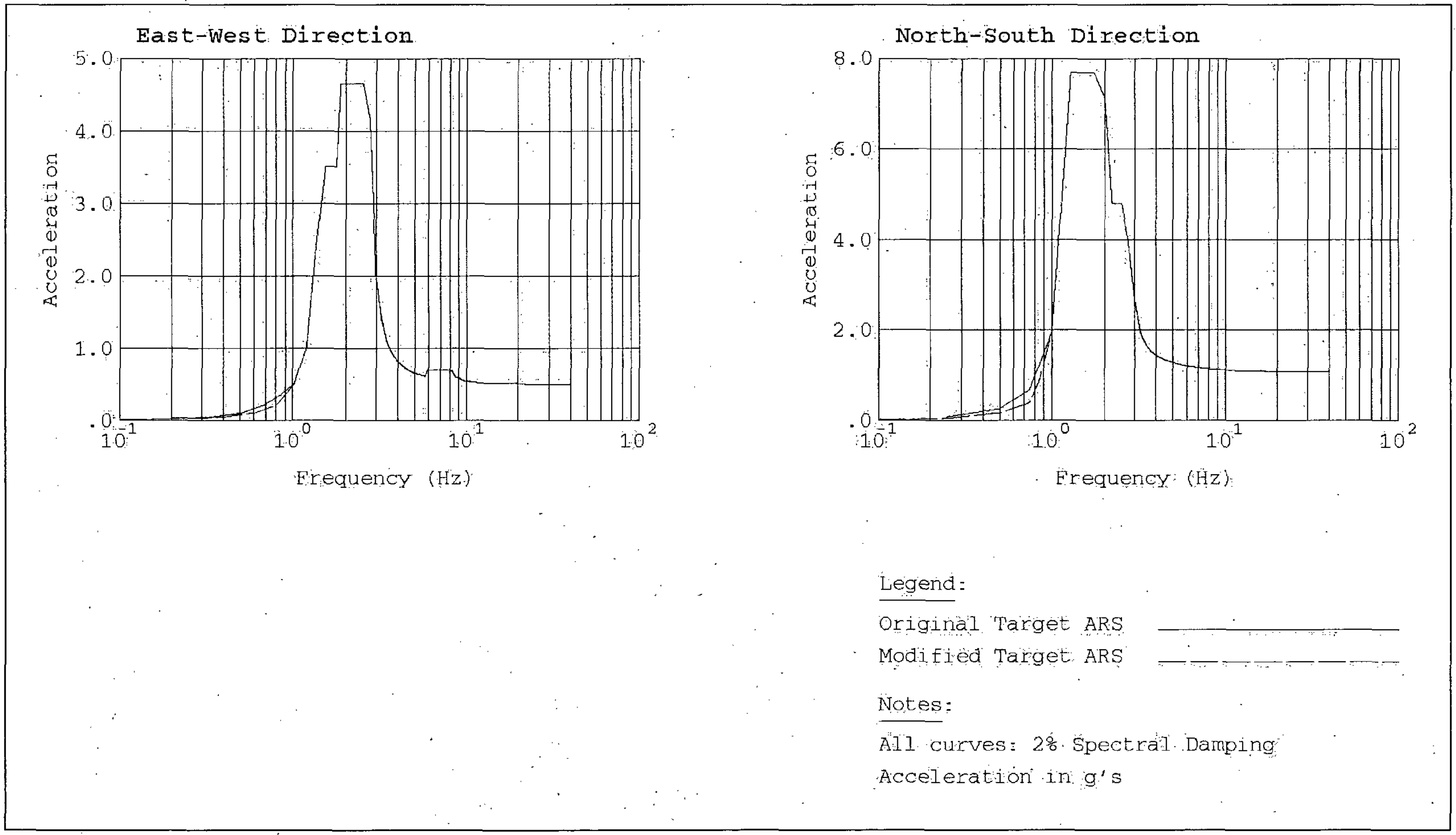

Figure 4.1: Kewaunee Power Station – Aux Building Crane Rail Elevation
Comparison of Original and Modified Target Spectra
East/West and North/South Directions

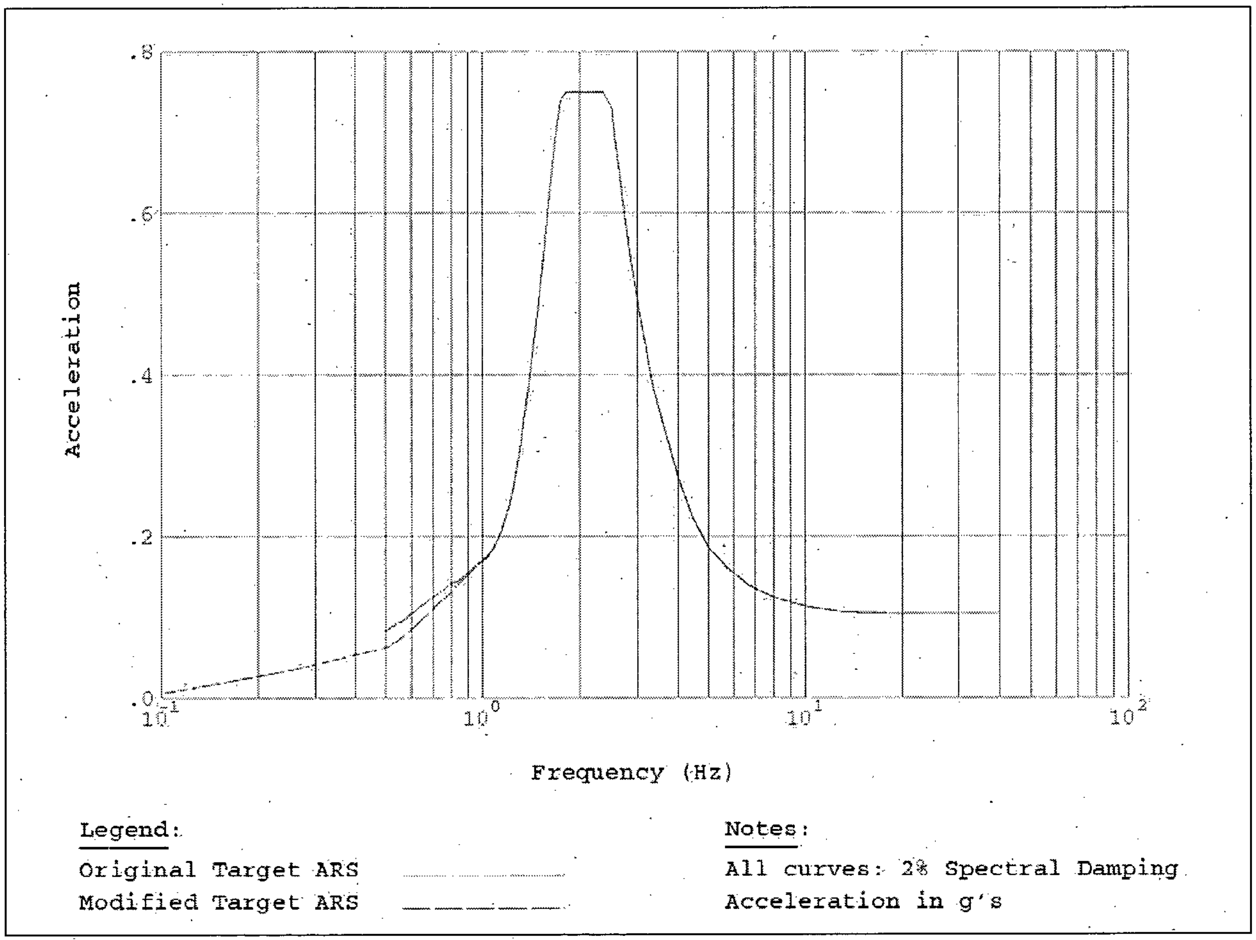

**Figure 4.2: Kewaunee Power Station – Aux Building Crane Rail Elevation
Comparison of Original and Modified Target Spectra
Vertical Direction**

4.2 Description of Seed Earthquake Records

The development of the needed acceleration time histories starts with the selection of appropriate seed earthquake records. The seed records have been selected from available recorded real earthquake ground motion acceleration time histories obtained from the US Geological Survey database located at the UC Berkeley PEER center website (http://peer.berkeley.edu/smcat). The criteria used for selecting the seed records are based on the earthquake characteristics (i.e. high magnitude Mw), the duration requirements described in Section 3.2, and the needed low and high frequency content characteristics of the earthquake. After several iteration trials, the five sets of earthquake signals identified in Table 4.2 were selected, with each set containing three directional components. Note that to accommodate the needed frequency contents and the statistical independence requirement of each of the three directions, the directional components within each set of the seed records need not be from the same measured earthquake recording station. The earthquakes from which the seed records were selected are also described in Table 4.2 while the composition of the five sets of time histories used for this project is provided in Table 4.3. The seed record time histories are plotted in Attachment D.

Table 4.2: Description of Selected Earthquake Seed Records

Earthquake Description				Recording Station			Record ID		
Name	EQ Mag. (M_w)	Location	Date	Name	Site Condition (USGS)	Closest Distance (Km)	N-S	E-W	Vert
Kobe	6.9	Japan	1/16/95	Kakogawa	D	26.4	--	KAK000	--
Duzce	7.1	Turkey	11/12/99	Sakarya	B	49.9	--	--	SKR-UP
Kern County	7.4	US	7/21/52	Santa Barbara Courthouse	B	87.0	--	SBA042	--
				Taft Lincoln School	B	41.0	TAF021	--	TAF-UP
Landers	8.3	US	6/29/92	Silent Valley	A	51.7	--	--	SIL-UP
Borrego Mountain	6.8	US	4/9/68	Borrego Mt	C	46.0	--	--	A-ELC-UP
				Borrego Mt	C	217.4	A-PEL090	--	A-PEL-UP
Cape Mendocino	7.1	US	4/25/92	Shelter Cove Airp	B	33.8	--	SHL000 SHL090	--
Livermore	5.8	US	1/24/80	Sewage Treatment Plant	C	37.3	A-STP093	--	--
Morgan Hill	6.2	US	4/24/84	Hollister City Hall	C	32.5	HCH001 HCH271	HCH271	--

4.3 Generation of Required Time Histories

The actual earthquake acceleration seed records are first corrected to provide a time step interval of 0.01 second. Each seed record is then systematically modified to match the associated modified target response spectrum using the state-of-the-art improved wavelet method of matching response spectra described in [7]. This process is implemented using the software RspMatch2005. The resulting acceleration time history is then adjusted through a low pass filter and the end noise in the record is subsequently eliminated. Trailing zeros are finally added, when needed, to achieve a total duration of 20 seconds. This modified record is then base line corrected and the end result is finally plotted in Attachment C. The associated velocity and displacement time histories (calculated using DPLOT) are also provided in Attachment C along with the 2% damped acceleration and displacement response spectra (calculated using RSPEC) for each of the fifteen generated time histories.

4.4 Check of Acceptance Criteria

Statistical Independence: The correlation coefficients of the three acceleration components (EW, NS, & vert) from each of the five time history sets are calculated and shown to be statistically independent. The correlation coefficient between two time histories is defined as the ratio of the covariance of the two series over the product of the standard deviations. Thus, the coefficient for two time history data series (x_i and y_i) is calculated in Excel using the following equation:

$$Correl\ Coef = \frac{\sum_{i=1}^{N}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{N}(x_i-\bar{x})^2\sum_{i=1}^{N}(y_i-\bar{y})^2}}$$ Where $\bar{x}$ *and* $\bar{y}$ are the sample means of the series.

For series with large number of data points, the above equation is identical to the covariance of the two series divided by the product of the standard deviation of each. The calculated correlation coefficient for the three directions associated with each of the five time history sets are provided in Table 4.3. As can be seen, the absolute value of all correlation coefficients is less than 0.16 and thus all three (3) signals in each of the five (5) data sets are considered statistically independent per the criteria of Section 3.2.

Time Durations: Each of the fifteen acceleration time histories had been initially reviewed for the total duration and the various time requirements of each signal. As can be seen from Table 4.3 and the figures in Attachment C, all time histories meet the total duration requirement of at least 20 seconds. The rise time, decay time and steady state are visually verified by reviewing the time histories of Attachment C.

The strong motion duration is defined in the SRP [5] as the duration where the Arias Intensity rises from 5% to 75%. The Arias Intensity is proportional to the cumulative sum of the square of the acceleration value at each time step. This duration, denoted as $T_{5\text{-}75}$, is provided in Table 4.3. The duration associated with an alternate calculation, based on the rise time from 5% to 95% is also provided in the table. This is further discussed in Section 5.

Comparison of Response Spectra: The 2% damped acceleration response spectra (ARS) curves are calculated using RSPEC. The spectra are calculated at 240 frequencies using a uniform logarithmic increment between 0.1 Hz and 40 Hz. These curves are plotted using RSPLT and provided in Attachment C.

The average of the five ARS curves, in each of the three directions, is then calculated. The resulting three curves, in each of the three directions, are plotted using RSPLT and compared to each of the associated modified target acceleration spectrum described in Section 4.1. The resulting comparison curves are provided in Figure 4.3, Figure 4.4 and Figure 4.5. Data used in generating these averaged ARS are tabulated in Attachment C. The target spectra data are obtained from ACECO's DIT included in Attachment B.

A visual comparison of the curves shows that in each case, the generated acceleration response spectra (ARS) generally follow the target ARS. A more detailed comparison of the curves in the peak region is provided in Figure 4.6, Figure 4.7 and Figure 4.8 for the EW, NS and Vertical directions, respectively. Note that all of the generated ARS points are within +30%/-10% of the target ARS values and no more than 9 consecutive points of the generated ARS fall below the target ARS.

Table 4.3: Composition of the Five Artificial TH Data Sets and Associated Record Properties

Artificial TH Set #	Target Direction	Seed Record	Seed Record Strong Motion Duration $T_{5\text{-}75}$ (sec)	Final Record Vibratory Duration (sec)	Final Record Strong Motion Duration		Calculated Correlation Coefficient	
					$T_{5\text{-}75}$ (sec)	$T_{5\text{-}95}$ (sec)	Direction	Value
1	E/W	KAK000	8.2	15	7.19	9.57	E/W & N/S	0.035
	N/S	HCH001	13.2	20	6.53	12.34	E/W & Vert	0.151
	Vert	A-ELC-UP	13.8	14	7.81	10.21	N/S & Vert	0.038
2	E/W	SBA042	12.4	18	10.03	14.46	E/W & N/S	0.040
	N/S	HCH271	11.1	18	7.04	9.62	E/W & Vert	0.041
	Vert	TAF-UP	14.1	16	7.47	11.33	N/S & Vert	0.078
3	E/W	SHL000	13.6	16	10.34	11.03	E/W & N/S	0.065
	N/S	TAF021	10.7	14	6.28	9.68	E/W & Vert	0.128
	Vert	SKR-UP	17.4	17	7.19	8.89	N/S & Vert	0.045
4	E/W	HCH271	11.1	16	10.05	11.52	E/W & N/S	-0.007
	N/S	A-STP093	14.6	18	7.15	11.23	E/W & Vert	-0.100
	Vert	SIL-UP	19.7	17	7.89	12.04	N/S & Vert	0.003
5	E/W	SHL090	14.8	15	7.90	9.37	E/W & N/S	-0.034
	N/S	A-PEL090	17.5	14	6.00	7.99	E/W & Vert	0.031
	Vert	A-PEL-UP	30.6[1]	17	6.00	8.31	N/S & Vert	0.050

Note: 1. The original seed record had a total duration of 50 secs.

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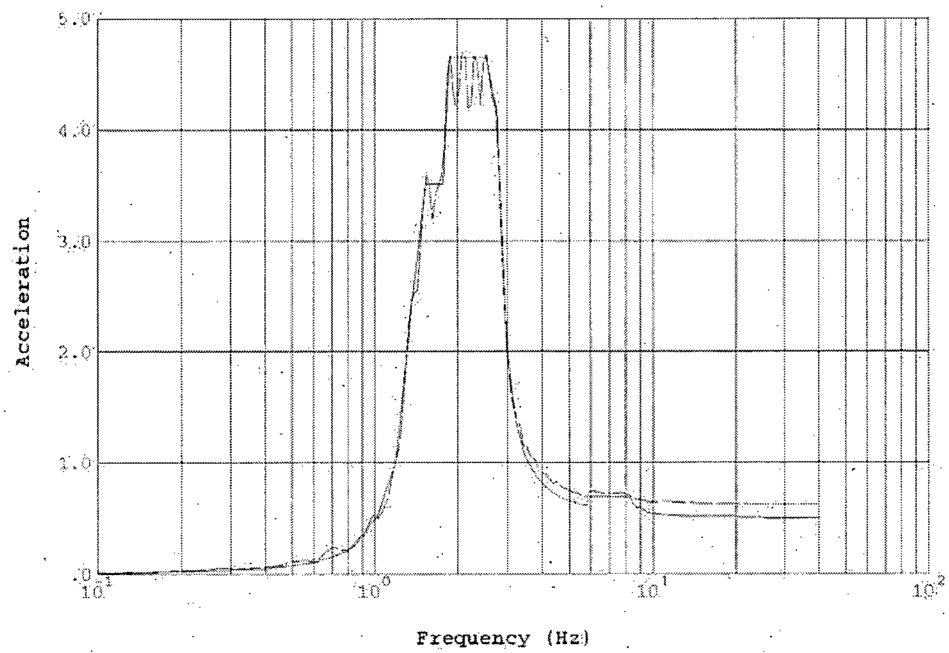
Figure 4.3: Comparison of the Average Calculated 2% Damped Response Spectra to the Modified Target Spectrum – EW Direction



Legend:

Modified Target ARS

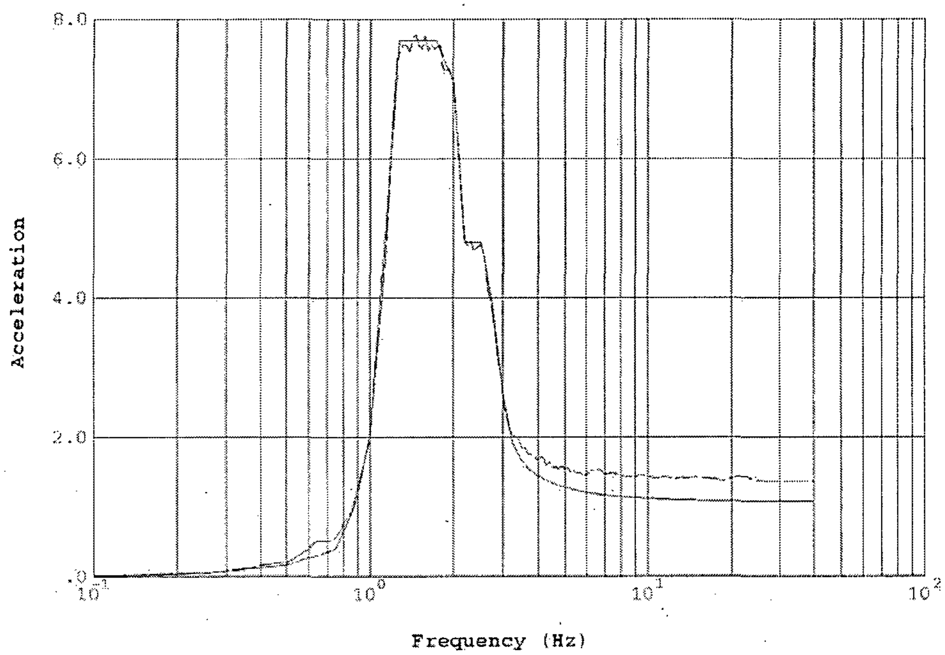
Average Five Seeds

Notes:

All curves: 2% Spectral Damping

Acceleration in g's

Figure 4.4: Comparison of the Average Calculated 2% Damped Response Spectra to the Modified Target Spectrum - NS Direction



Legend:

Modified Target ARS

Average Five Seeds

Notes:

All curves: 2% Spectral Damping

Acceleration in g's

RSPLT INTEL386 VERS 1.6P COMPILED 03/13/97 09:53:27 EXECUTED 05/23/08 13:18:46

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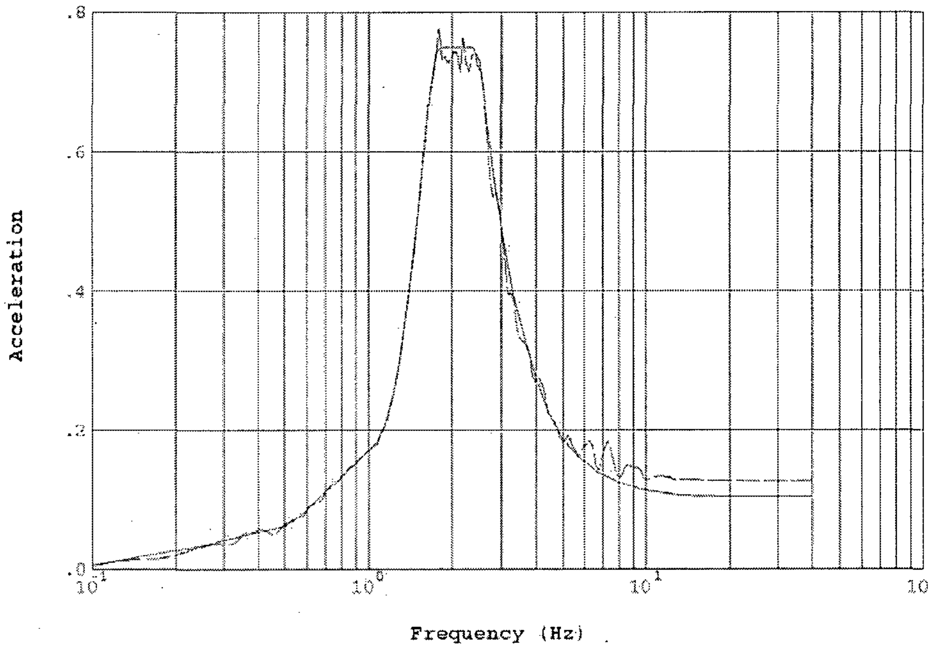
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Figure 4.5: Comparison of the Average Calculated 2% Damped Response Spectra to the Modified Target Spectrum - Vertical Direction



Legend:

Modified Target ARS

Average Five Seeds

Notes:

All curves: 2% Spectral Damping

Acceleration in g's

Figure 4.6:
Kewaunee Power Station - Aux Bldg Crane Rail Elevation
Comparison of Achieved Average ARS and Broadened Target Spectra
2% Damping - East/West Direction
(For Information Only)

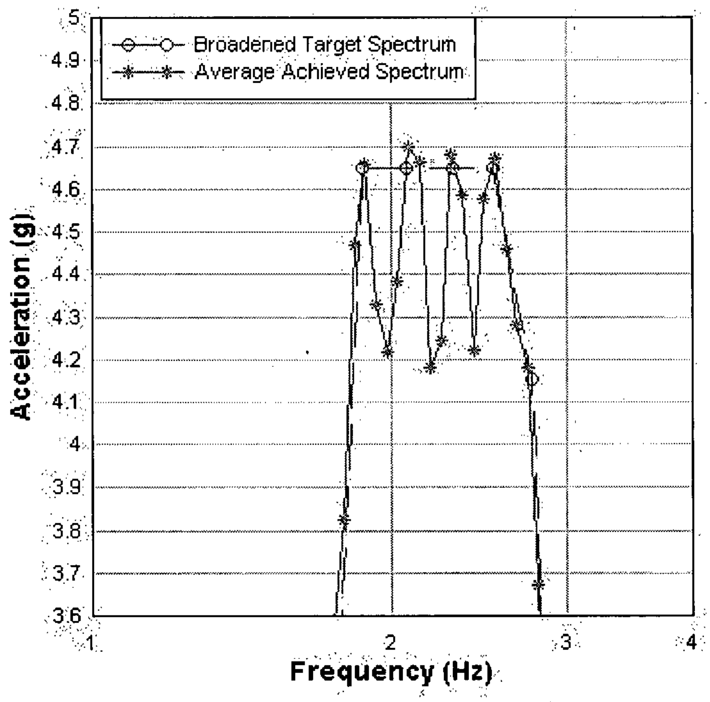


Figure 4.7:
Kewaunee Power Station - Aux Bldg Crane Rail Elevation
Comparison of Achieved Average ARS and Broadened Target Spectra
2% Damping - North/South Direction
(For Information Only)

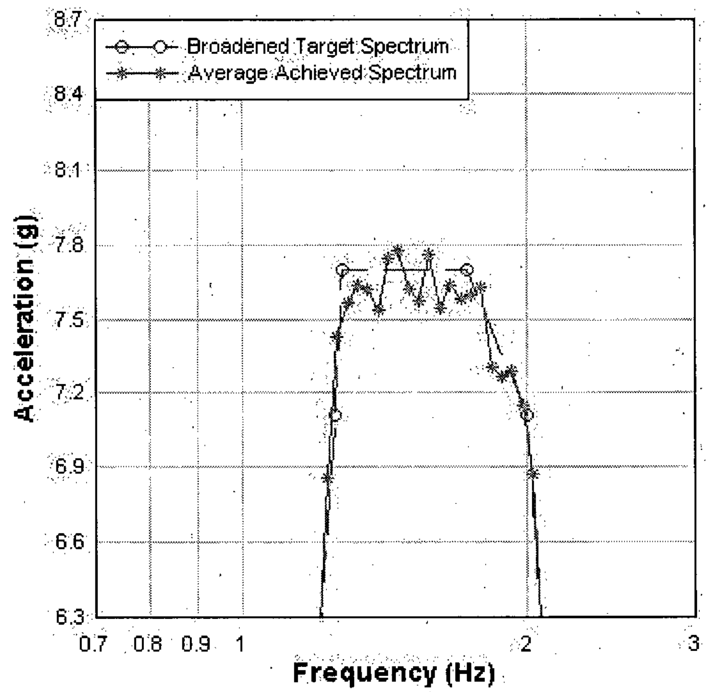
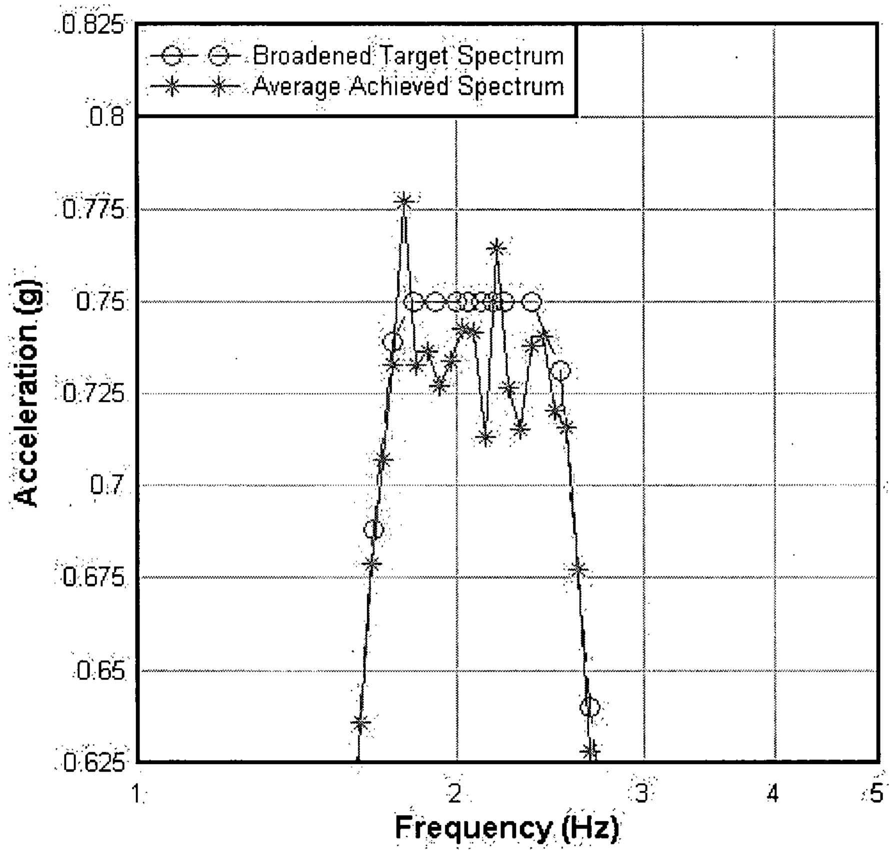


Figure 4.8:

Kewaunee Power Station - Aux Bldg Crane Rail Elevation Comparison of Achieved Average ARS and Broadened Target Spectra 2% Damping - Vertical Direction (For Information Only)



5 Analysis of Results

The five sets of acceleration time histories, needed for the non-linear analysis of the 125/15 Ton Single Failure Proof Fuel Cask Bridge crane located in the auxiliary building of the Kewaunee Power Station, are provided in the attached CD and plotted in Attachment C. The three-direction acceleration time histories, in each of the five sets, have been shown in Table 4.3 to be statistically independent with the absolute value of all correlation coefficients below 0.16.

The various duration requirements associated with each signal were reviewed and evaluated. As can be seen from the time histories in Attachment C, all acceleration time histories meet the minimum duration requirement of 20 seconds with at least 11 seconds of vibratory motion. The requirement of at least 6 seconds of strong motion duration is shown to have been met as indicated by the $T_{5\text{-}75}$ parameter tabulated in Table 4.3. Furthermore, since numerous other alternatives have been suggested for the definition of the strong motion duration, one alternate definition is the time required for the Arias Intensity to rise from 5% to 95% [9], designated by $T_{5\text{-}95}$. Based on this alternate definition, the developed signals have at least 7.99 seconds of strong motion duration.

The average of the 2% damped ARS curves is compared to the target spectra in Figure 4.3 to Figure 4.8 for each of the three directions. The ARS curves are calculated using 240 frequencies uniformly spaced on a logarithmic scale between 0.1 Hz and 40 Hz. An analysis of these comparisons concludes the following:

1. None of the calculated average spectral values fall more than 10% below the target response spectra.
2. No more than 9 consecutive points are found in any one curve where the calculated average spectral value falls below the target value per the requirement of Section 3.2.
3. None of the calculated average spectral values, at the peak of the curves, exceed the target curve by more than 30%.
4. At a few locations, the calculated average spectral values exceed the target value by as much as 40% on the right side of the peak. Even though the maximum value of 30% specified in [5] is slightly exceeded at a few locations, it can be seen from the curves provided that the processed acceleration signals are adequate and contain enough energy in the frequency region of interest such that there is no need to calculate the Power Spectral Density curves for these signals.

Based on the above evaluations, it is concluded that the fifteen acceleration time histories provided in Attachment C meet the intent of the SRP [5] requirements and are considered adequate for the non-linear analysis of the Kewaunee Auxiliary Building Fuel Cask Bridge Crane.

6 References

1. Dominion Engineering Transmittal, "Seismic Amplified Response Spectra for the Analysis of Aux Building Crane," ET-CEM-08-0004, Rev. 0. (see Attachment B).
2. RSPEC, ABS Consulting Quality Assurance Documentation, Document AA-QA-002, DOC-001 & MAN-001, Program Verification and User's Manual for Version 1.2P, December 8, 1993.
3. RSPLT, ABS Consulting Quality Assurance Documentation, Document AA-QA-014, DOC-002 & MAN-002, Program Verification and User's Manual for Version 1.6P, April 9, 1997.
4. ABS Consulting Calculation 1817851-C-002, "Validation of SASSI and Related Software on Specific Computers," Rev. 0.
5. U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800, Section 3.7.1, "Seismic Design Parameters," Rev. 3 – March 2007.
6. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components," Rev. 1, February 1978.
7. Hancock, J., et al. [2006] "An Improved Method of Matching Response Spectra of Recorded Earthquake Ground Motion Using Wavelets," *Journal of Earthquake Engineering,* Vol. 10, Special Issue 1, 67-89.
8. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.60, "Design Response Spectra For Seismic Design of Nuclear Power Plants," Rev. 1, December 1973.
9. Dorby, R., Idriss, I.M., and Ng, E., "Duration Characteristics of Horizontal Components of Strong-Motion Earthquake Records," Bulletin of the Seismological Society of America, October 1978, v.68, no.5, p.1487-1520.
10. ABS Consulting Nuclear Quality Assurance Manual (NQAM), Revision 7. Dated Dec. 8th, 2004.
11. ABS Consulting "NQA Procedure for Software Verification and Control" RCD-NQP-00-P03, Revision 2. Dated January 31st, 2007.

ATTACHMENT A

Log of Computer Software Runs

This attachment contains a log of the QA computer runs executed for this calculation. Associated input and output files are located on the attached CD, in the directories and subdirectories identified in the following tables.

ABS Consulting

Attachment A

			Rev 1	**Sheet No.**	A2
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** F.Elsabee	**Date** 5/22/08	
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08	

Target ARS Directory

Pgm/Module Name	Input File Name	Input File Date/Time	Output File Name	Output File Date/Time
RSPLT	rsplth.in	4/14/08 10:07AM	RSPLTH.LOG	4/14/08 10:47AM
			TARGET_H.PS	4/14/08 10:47AM
	rspltv.in	4/14/08 10:55AM	RSPLTV.LOG	4/14/08 10:57AM
			TARGET_V.PS	4/14/08 10:57AM

Artificial Records Directory
Data Set 1 subdirectory

Subdirectory Name	Pgm/Module Name	Input File Name	Input File Date/Time	Output File Name	Output File Date/Time
EW	RSPEC	rspeca.in	5/20/08 2:49PM	ACC1EW.LOG	5/20/08 2:54PM
				ACC1EW.ARS	5/20/08 2:54PM
		rspecd.in	5/22/08 8:24AM	DIS1EW.LOG	5/22/08 8:24AM
				DIS1EW.ARS	5/22/08 8:24AM
	RSPLT	rsplta.in	5/20/08 1:56PM	RSPLTA.LOG	5/20/08 3:56PM
				COMP_EW.PS	5/20/08 3:56PM
		rspltd.in	5/22/08 8:22AM	RSPLTD.LOG	5/22/08 8:24AM
				DISP_EW.PS	5/22/08 8:24AM
NS	RSPEC	rspeca.in	5/23/08 12:14PM	ACC1NS.LOG	5/23/08 12:16PM
				ACC1NS.ARS	5/23/08 12:16PM
		rspecd.in	5/23/08 12:15PM	DIS1NS.LOG	5/23/08 12:25PM
				DIS1NS.ARS	5/23/08 12:25PM
	RSPLT	rsplta.in	5/20/08 1:56PM	RSPLTA.LOG	5/23/08 12:17PM
				COMP_NS.PS	5/23/08 12:17PM
		rspltd.in	5/22/08 9:43AM	RSPLTD.LOG	5/23/08 12:26PM
				DISP_NS.PS	5/23/08 12:26PM
Vertical	RSPEC	rspeca.in	5/20/08 2:50PM	ACC1UP.LOG	5/20/08 2:54PM
				ACC1UP.ARS	5/20/08 2:54PM
		rspecd.in	5/22/08 9:59AM	DIS1UP.LOG	5/22/08 10:02AM
				DIS1UP.ARS	5/22/08 10:02AM
	RSPLT	rsplta.in	5/20/08 1:55PM	RSPLTA.LOG	5/20/08 3:57PM
				COMP_VER	5/20/08 3:57PM
		rspltd.in	5/22/08 10:02AM	RSPLTD.LOG	5/22/08 10:03AM
				DISP_UP.PS	5/22/08 10:03AM

ABS Consulting

Attachment A

				Rev	1	**Sheet No.**	*A3*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	F.Elsabee	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Artificial Records Directory
Data Set 2 subdirectory

Subdirectory Name	Pgm/Module Name	Input File		Output File	
		Name	Date/Time	Name	Date/Time
EW	RSPEC	rspeca.in	5/20/08 2:50PM	ACC2EW.LOG	5/20/08 2:55PM
				ACC2EW.ARS	5/20/08 2:55PM
		rspecd.in	5/22/08 10:20AM	DIS2EW.LOG	5/22/08 10:21AM
				DIS2EW.ARS	5/22/08 10:21AM
	RSPLT	rsplta.in	5/20/08 1:57PM	RSPLTA.LOG	5/20/08 3:58PM
				COMP_EW.PS	5/20/08 3:58PM
		rspltd.in	5/22/08 10:20AM	RSPLTD.LOG	5/22/08 10:21AM
				DISP_EW.PS	5/22/08 10:21AM
NS	RSPEC	rspeca.in	5/20/08 2:50PM	ACC2NS.LOG	5/20/08 2:55PM
				ACC2NS.ARS	5/20/08 2:55PM
		rspecd.in	5/22/08 10:28AM	DIS2NS.LOG	5/22/08 10:29AM
				DIS2NS.ARS	5/22/08 10:29AM
	RSPLT	rsplta.in	5/20/08 1:57PM	RSPLTA.LOG	5/20/08 3:58PM
				COMP_NS.PS	5/20/08 3:58PM
		rspltd.in	5/22/08 10:29AM	RSPLTD.LOG	5/22/08 10:30AM
				DISP_NS.PS	5/22/08 10:30AM
Vertical	RSPEC	rspeca.in	5/20/08 2:44PM	ACC2UP.LOG	5/20/08 3:52PM
				ACC2UP.ARS	5/20/08 3:52PM
		rspecd.in	5/22/08 10:37AM	DIS2UP.LOG	5/22/08 10:38AM
				DIS2UP.ARS	5/22/08 10:38AM
	RSPLT	rsplta.in	5/20/08 1:58PM	RSPLTA.LOG	5/20/08 3:59PM
				COMP_VER	5/20/08 3:59PM
		rspltd.in	5/22/08 10:38AM	RSPLTD.LOG	5/22/08 10:39AM
				DISP_UP.PS	5/22/08 10:39AM

ABS Consulting

Attachment A

		Rev	1	Sheet No.	A4
Job No. 1886592	Job ACECO – Kewaunee Aux Bldg Bridge Crane	By	F.Elsabee	Date	5/22/08
Calc. No. 1886592-C-001	Subj Generation of Artificial Seismic Time Histories	Checked	W.Sawruk	Date	5/23/08

Artificial Records Directory
Data Set 3 subdirectory

Subdirectory Name	Pgm/Module Name	Input File		Output File	
		Name	Date/Time	Name	Date/Time
EW	RSPEC	rspeca.in	5/20/08 2:51PM	ACC3EW.LOG	5/20/08 3:09PM
				ACC3EW.ARS	5/20/08 3:09PM
		rspecd.in	5/22/08 10:52AM	DIS3EW.LOG	5/22/08 10:53AM
				DIS3EW.ARS	5/22/08 10:53AM
	RSPLT	rsplta.in	5/20/08 1:59PM	RSPLTA.LOG	5/20/08 4:08PM
				COMP_EW.PS	5/20/08 4:08PM
		rspltd.in	5/22/08 10:52AM	RSPLTD.LOG	5/22/08 10:53AM
				DISP_EW.PS	5/22/08 10:53AM
NS	RSPEC	rspeca.in	5/20/08 2:51PM	ACC3NS.LOG	5/20/08 3:10PM
				ACC3NS.ARS	5/20/08 3:10PM
		rspecd.in	5/22/08 11:02AM	DIS3NS.LOG	5/22/08 11:03AM
				DIS3NS.ARS	5/22/08 11:03AM
	RSPLT	rsplta.in	5/20/08 2:00PM	RSPLTA.LOG	5/20/08 4:09PM
				COMP_NS.PS	5/20/08 4:09PM
		rspltd.in	5/22/08 11:08AM	RSPLTD.LOG	5/22/08 11:08AM
				DISP_NS.PS	5/22/08 11:08AM
Vertical	RSPEC	rspeca.in	5/20/08 2:51PM	ACC3UP.LOG	5/20/08 3:10PM
				ACC3UP.ARS	5/20/08 3:10PM
		rspecd.in	5/22/08 11:12AM	DIS3UP.LOG	5/22/08 11:13AM
				DIS3UP.ARS	5/22/08 11:13AM
	RSPLT	rsplta.in	5/20/08 2:01PM	RSPLTA.LOG	5/20/08 4:10PM
				COMP_VER	5/20/08 4:10PM
		rspltd.in	5/22/08 11:13AM	RSPLTD.LOG	5/22/08 11:14AM
				DISP_UP.PS	5/22/08 11:14AM

Artificial Records Directory
Data Set 4 subdirectory

Subdirectory Name	Pgm/Module Name	Input File Name	Input File Date/Time	Output File Name	Output File Date/Time
EW	RSPEC	rspeca.in	5/20/08 2:51PM	ACC4EW.LOG	5/20/08 3:10PM
				ACC4EW.ARS	5/20/08 3:10PM
		rspecd.in	5/22/08 11:19AM	DIS4EW.LOG	5/22/08 11:20AM
				DIS4EW.ARS	5/22/08 11:20AM
	RSPLT	rsplta.in	5/20/08 2:02PM	RSPLTA.LOG	5/20/08 4:11PM
				COMP_EW.PS	5/20/08 4:11PM
		rspltd.in	5/22/08 11:19AM	RSPLTD.LOG	5/22/08 11:20AM
				DISP_EW.PS	5/22/08 11:20AM
NS	RSPEC	rspeca.in	5/23/08 12:46PM	ACC4NS.LOG	5/23/08 12:47PM
				ACC4NS.ARS	5/23/08 12:47PM
		rspecd.in	5/23/08 12:46PM	DIS4NS.LOG	5/23/08 12:47PM
				DIS4NS.ARS	5/23/08 12:47PM
	RSPLT	rsplta.in	5/20/08 2:05PM	RSPLTA.LOG	5/23/08 12:48PM
				COMP_NS.PS	5/23/08 12:48PM
		rspltd.in	5/22/08 11:25AM	RSPLTD.LOG	5/23/08 12:48PM
				DISP_NS.PS	5/23/08 12:48PM
Vertical	RSPEC	rspeca.in	5/20/08 2:52PM	ACC4UP.LOG	5/20/08 3:11PM
				ACC4UP.ARS	5/20/08 3:11PM
		rspecd.in	5/22/08 11:30AM	DIS4UP.LOG	5/22/08 11:37AM
				DIS4UP.ARS	5/22/08 11:37AM
	RSPLT	rsplta.in	5/22/08 11:32AM	RSPLTA.LOG	5/22/08 11:32AM
				COMP_VER	5/22/08 11:32AM
		rspltd.in	5/22/08 11:31AM	RSPLTD.LOG	5/22/08 11:37AM
				DISP_UP.PS	5/22/08 11:37AM

Artificial Records Directory
Data Set 5 subdirectory

Subdirectory Name	Pgm/Module Name	Input File		Output File	
		Name	Date/Time	Name	Date/Time
EW	RSPEC	rspeca.in	5/20/08 2:52PM	ACC5EW.LOG	5/20/08 3:12PM
				ACC5EW.ARS	5/20/08 3:12PM
		rspecd.in	5/22/08 11:43AM	DIS5EW.LOG	5/22/08 11:45AM
				DIS5EW.ARS	5/22/08 11:45AM
	RSPLT	rsplta.in	5/20/08 2:06PM	RSPLTA.LOG	5/20/08 4:14PM
				COMP_EW.PS	5/20/08 4:14PM
		rspltd.in	5/22/08 11:45AM	RSPLTD.LOG	5/22/08 11:45AM
				DISP_EW.PS	5/22/08 11:45AM
NS	RSPEC	rspeca.in	5/20/08 2:52PM	ACC5NS.LOG	5/20/08 3:12PM
				ACC5NS.ARS	5/20/08 3:12PM
		rspecd.in	5/22/08 11:49AM	DIS5NS.LOG	5/22/08 11:51AM
				DIS5NS.ARS	5/22/08 11:51AM
	RSPLT	rsplta.in	5/20/08 2:07PM	RSPLTA.LOG	5/20/08 4:15PM
				COMP_NS.PS	5/20/08 4:15PM
		rspltd.in	5/22/08 11:51AM	RSPLTD.LOG	5/22/08 11:51AM
				DISP_NS.PS	5/22/08 11:51AM
Vertical	RSPEC	rspeca.in	5/20/08 2:52PM	ACC5UP.LOG	5/20/08 3:12PM
				ACC5UP.ARS	5/20/08 3:12PM
		rspecd.in	5/22/08 11:56AM	DIS5UP.LOG	5/22/08 11:57AM
				DIS5UP.ARS	5/22/08 11:57AM
	RSPLT	rsplta.in	5/20/08 2:08PM	RSPLTA.LOG	5/20/08 4:16PM
				COMP_VER	5/20/08 4:16PM
		rspltd.in	5/22/08 11:57AM	RSPLTD.LOG	5/22/08 11:58AM
				DISP_UP.PS	5/22/08 11:58AM

Artificial Records Directory

Pgm/Module Name	Input File		Output File	
	Name	Date/Time	Name	Date/Time
RSPLT	rsplt.in	4/29/08 4:08PM	RSPLT.LOG	5/23/08 1:18PM
			COMPEAVE.PS	5/23/08 1:18PM
			COMPNAVE.PS	5/23/08 1:18PM
			COMPVAVE.PS	5/23/08 1:18PM

ATTACHMENT B

Design Input Data

ACECO Design Information Transmittal

DIT No. DCR-3629-11 25-Mar-08

(included on following pages)

Kewaunee Modification Process	**Design Information Transmittal (DIT)**

From: David Lohman, Dominion

To : Jami Rubendall, ACECO

Mod or Tracking Number: DCR 3629 Date: 03/25/08 DIT No: DCR-3629-11

Mod Title: Upgrade Auxiliary Building Crane to Single Failure Proof

Plant: Kewaunee Unit 1 ☒ Unit 2 ☐ Common ☐ Quality Classification: QA-2

SUBJECT:Design Basis Earthquake Response Spectra

Check if applicable:

☐ **This DIT confirms information previously transmitted orally on _______ by _________________.**

☐ **This information is preliminary. See explanation below.**

SOURCE OF INFORMATION (Source documents should be uniquely identified)

Engineering Transmittal ET-CEM-08-0004 Rev. 0

DESCRIPTION OF INFORMATION (Write the information being transmitted or list each document being transmitted)

DBE Response spectra at the crane rail for use in the non-linear seismic evaluation of the crane

DISTRIBUTION (Recipients should receive all attachments unless otherwise indicated. All attachments are uncontrolled unless otherwise indicated)

Electronic Distribution to Jami Rubendall, ACECO

PREPARED BY (The Preparer and Approver may be the same person.)

Lori Christensen	Nuc Tech Spec III	Lori Christensen	3/25/08
Preparer Name	Position	Signature	Date

APPROVED BY (The cognizant Engineering Supervisor has release authority. Consult the Design Interface Agreement or local procedures to determine who else has release authority.)

David Lohman	Project Mgr.	[signature]	4/2/2008
Approver Name	Position	Signature	Date

A copy of the DIT (along with any attachments not on file) should be sent to the modification file.

Dominion

Engineering Transmittal

STD-GN-0041 Page 1 of 3

1. Transmittal Number:	2. Revision:	3. Station(s)	4. Unit(s):
ET-CEM-08-0004	0	☒ Kewaunee	☒ Unit 1 ☐ Unit 2 ☐ ISFSI

5. Title:	6. Quality Classification:
Seismic Amplified Response Spectra for the Analysis of Aux Building Crane	SR

7. ET Type	8. Required Actions?	9. SNSOC Approval Req.?
☐ Implementing ☒ Non-Implementing	☐ Yes ☒ No	☐ Yes ☒ No

10. Preparation, Review, and Approval Signatures		
Prepared By / Affiliation: (Print) Divakar Bhargava / Corporate Engineering Mechanics	Signature: DBhargava	Date: 3-24-08
Reviewed By / Affiliation: (Print) Daniel J. Vasquez / Corporate Engineering Mechanics	Signature: [signature]	Date: 3/24/08
Programs / Other Reviewer / Affiliation: (Print)	Signature: N/A	Date:
Supervisor Approval / Affiliation: (Print) John D. MACCRIMMON / Supervisor – Corporate Civil Engineering	Signature: [signature]	Date: 3/24/08
Design Control Engineer (DCE) Approval / Site: (Print)	Signature: N/A	Date:
Project Engineer Approval / Affiliation: (Print)	Signature: N/A	Date:
Manager Operations Approval / Site: (Print)	Signature: N/A	Date:
Manager Site Engineering Approval / Site: (Print)	Signature: N/A	Date:
SNSOC Approval / Site: (Print)	Signature: N/A	Date:

Standard Attachments		Reviewed & No Impact	Not Required
11. ☐ Activity Checklist Included as attachment	______		☒
12. ☐ Safety Review included as attachment	______		☒
13. ☐ 50.59/72.48 Screen included as attachment	______		☒
14. ☐ PRC & PRCS included as Attachment:	______	☐	☒
15. ☐ CDS included as Attachment:	______	☐	☒

16. Controlled Document Review and Revision (CDRR) Requirements

☒ CDRR is NOT required.

☐ requested to initiate CDRR upon receipt of this ET.

☐ CDRR will be required at a later date. The affected DCE(s) will be notified following to initiate CDRR.

17. Additional Attachments

No.	Description
1.	Source Document Email Request (1 pages)
2.	Amplified Response Spectra and digitized data for Kewaunee Aux. Bldg Crane rail level (8 pages)

18. *Distribution (Original is transmitted to Records. Copies shall be sent to Primary Recipient and others identified below.)*			
Primary Recipient(s):	*David C. Lohman – Kewaunee Power Station*		
Copy To?	Other Recipient / Department or Location	Copy To?	Other Recipient / Department or Location
X	Daniel J. Vasquez / IN3NW		System Engineer
X	Divakar Bhargava / IN3NW	X	Records Management (Copy)
X	Eric W. May / IN3NW		Affected CDS Points-of-Contact
	Site DCE		Nuclear Training (Simulator)
	Affected organization		
	Program Owners	X	John D. MacCrimmon / IN3NW

Source Document

Email Request from D. Lohman to D. Bhargava / J. MacCrimmon dated 3/12/08, "Crane Seismic Evaluation" (Attachment 1)

Record of Revision

Original Issue.

Purpose & Applicability

The purpose of this ET is to provide design basis earthquake (DBE) amplified response spectra for the seismic analysis of 125/15 Ton Single Failure Proof Aux Building Crane.

This ET is provided as information only. It is categorized as a non-implementing ET. Any configuration change must be implemented by an approved change process (such as DCP, IEER, implementing ET, procedure change, etc.) that may reference or use the information in this ET, as appropriate.

References

1. Report JAB-PS-03 - "Earthquake Analysis of the Reactor-Auxiliary-Turbine Building", Pioneer Services & Engineering Co./John A. Blume & Associates, Engineers, dated February 16, 1971.
2. Calculation KPS-70155344-S01, Rev. 1, July 30, 2007, "Development of Response spectra at Aux. Building Crane Rail Level", Prepared by AES.
3. Calculation KPS-70155344-S01, Rev. 1, Addendum A, March 20, 2008, "Development of Response spectra at Aux. Building Crane Rail Level".
4. Calculation KPS-70155344-S01, Rev. 1, Addendum B, "Development of Response spectra at Aux. Building Crane Rail Level".
5. Standard Review Plan 3.7.1, Rev. 2 (NUREG 0800)

Design Inputs

1. Amplified response spectra (ARS) for the Kewaunee Auxiliary Building were developed in References 1 and 2.

2. Reference 3, which provides updated shear areas for the stick model of the Aux Building for seismic analysis in the E-W direction.

3. Reference 4, which develops response spectrum at the Crane rail elevation for the E-W direction for the updated shear areas developed in Reference 3. Reference 4 also envelops/peak-broadens spectra in the N-S (from Reference 2) and vertical directions (from Reference 1).

Discussion

Design Basis Earthquake (DBE) amplified response spectra curves are provided in Attachment 2 of this ET for each of the three orthogonal directions to support the analysis of the Kewaunee Aux. Building Crane. Digitized data for these curves are also provided. These spectra are at the Crane rail location, elevation 679'-11" and are peak-broadened +-15%. They are at 2% spectral damping which is considered appropriate for the crane analysis and is consistent with Kewaunee Station's licensing basis. The development of these spectra meets the guidance provided in Reference 5.

The E-W spectrum is obtained from reference 4 which used dynamic time-history analysis (four cases) with an updated model of the Aux. Building obtained from Reference 3. Reference 4 also peak- broadened the vertical response spectrum, which was obtained from reference 1. Additionally, in the N-S direction, the un-broadened spectrum was obtained from Reference 2 for two cases: crane at mid-span and crane at any location. These two cases were peak-broadened +- 15% in Reference 4 again and were enveloped. The resulting N-S spectrum is provided in Attachment 2. It is noted that the peak broadening may be slightly conservative and may over-predict responses in the low frequency range for some of the orientations. If needed, the users may, at their discretion, refine the response spectrum broadening in the low frequency range provided the guidance of NRC RG 1.122 is met.

Conclusion

The peak-broadened ARS curves and digitized data for seismic analysis of the Kewaunee Aux. Building Crane are transmitted via this ET in Attachment 2.

Precautions and Limitations

None.

Recommendations

None.

Required Actions

None.

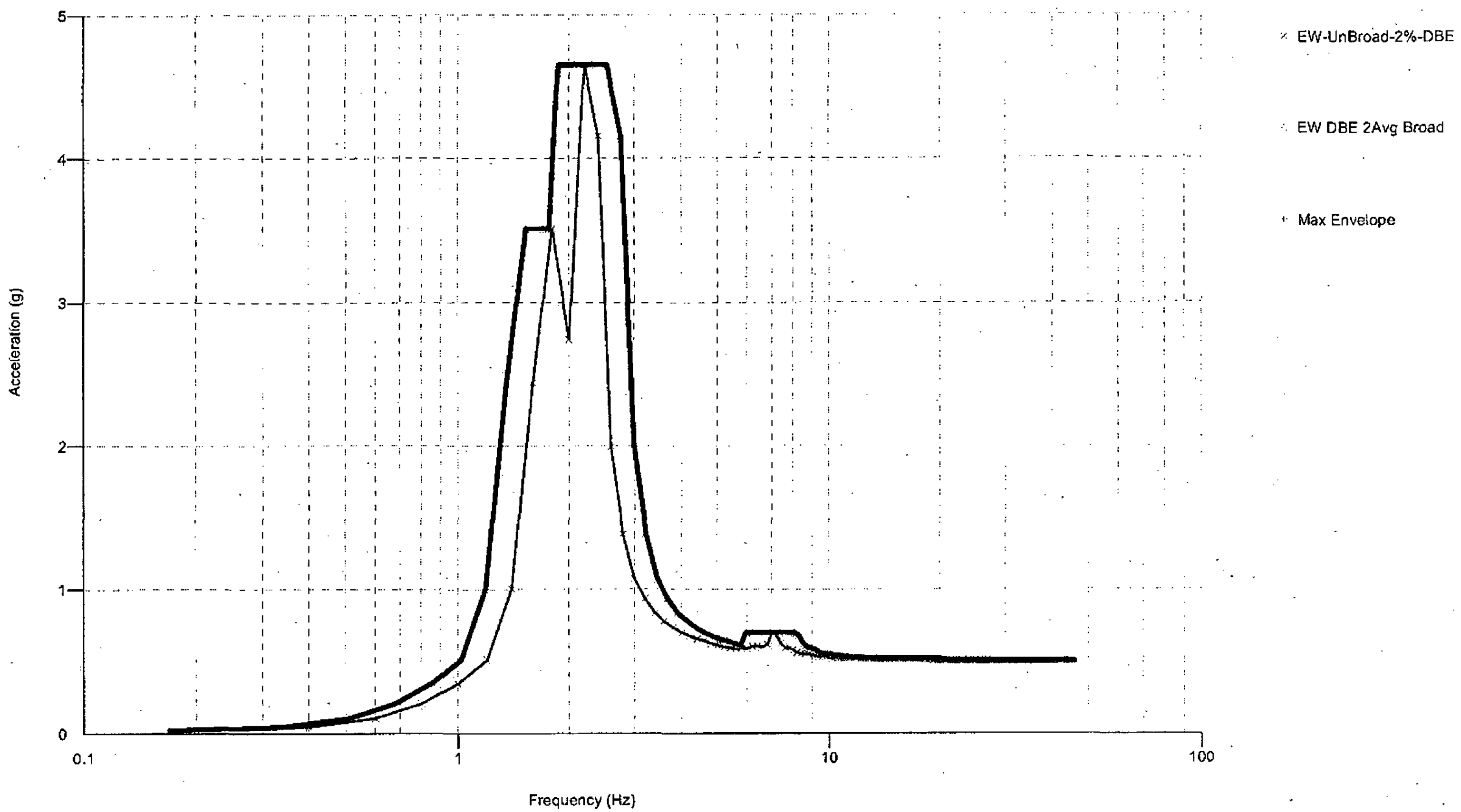
ET CEM-08-0004, Revision 0

Attachment 1, Page 1 of 1

David C
Lohman/Generation/4/Dom
03/12/2008 08:21 AM
To Divakar Bhargava/Generation/6/Dom@VANCPOWER, John
Maccrimmon/Generation/6/Dom@VANCPOWER
cc
bcc
Subject Crane Seismic Evaluation
History: This message has been replied to.

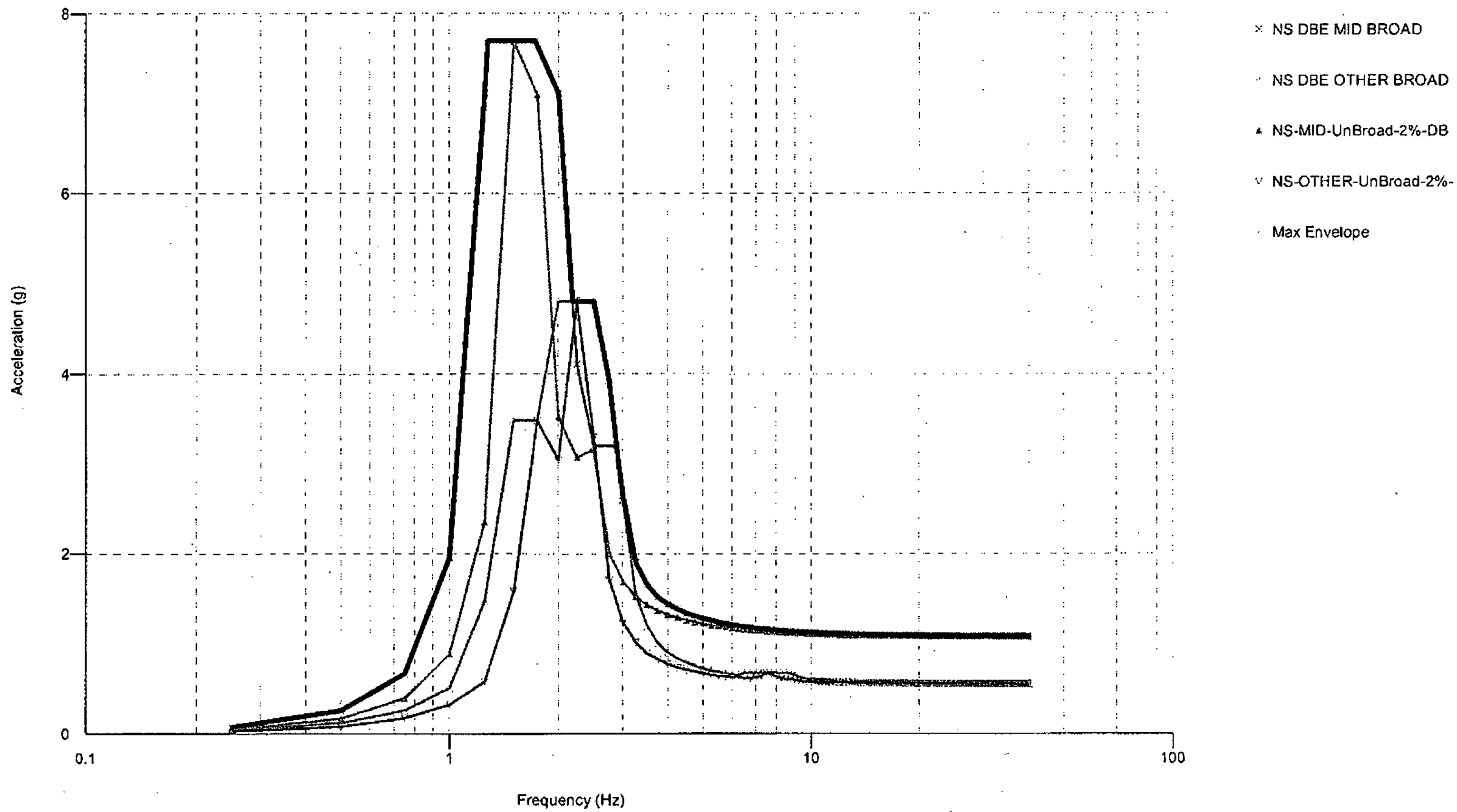
John and Divakar, the requisition for ACECO to do the seismic analysis has been approved and they are starting work. Are we still on track to provide them the Response Spectra by 3/24? John, the PO will list you as the technical contact for this activity and me the station point of contact

KEWAUNEE POWER STATION
AUX BUILDING CRANE RAIL ELEVATION
EAST-WEST DIRECTION



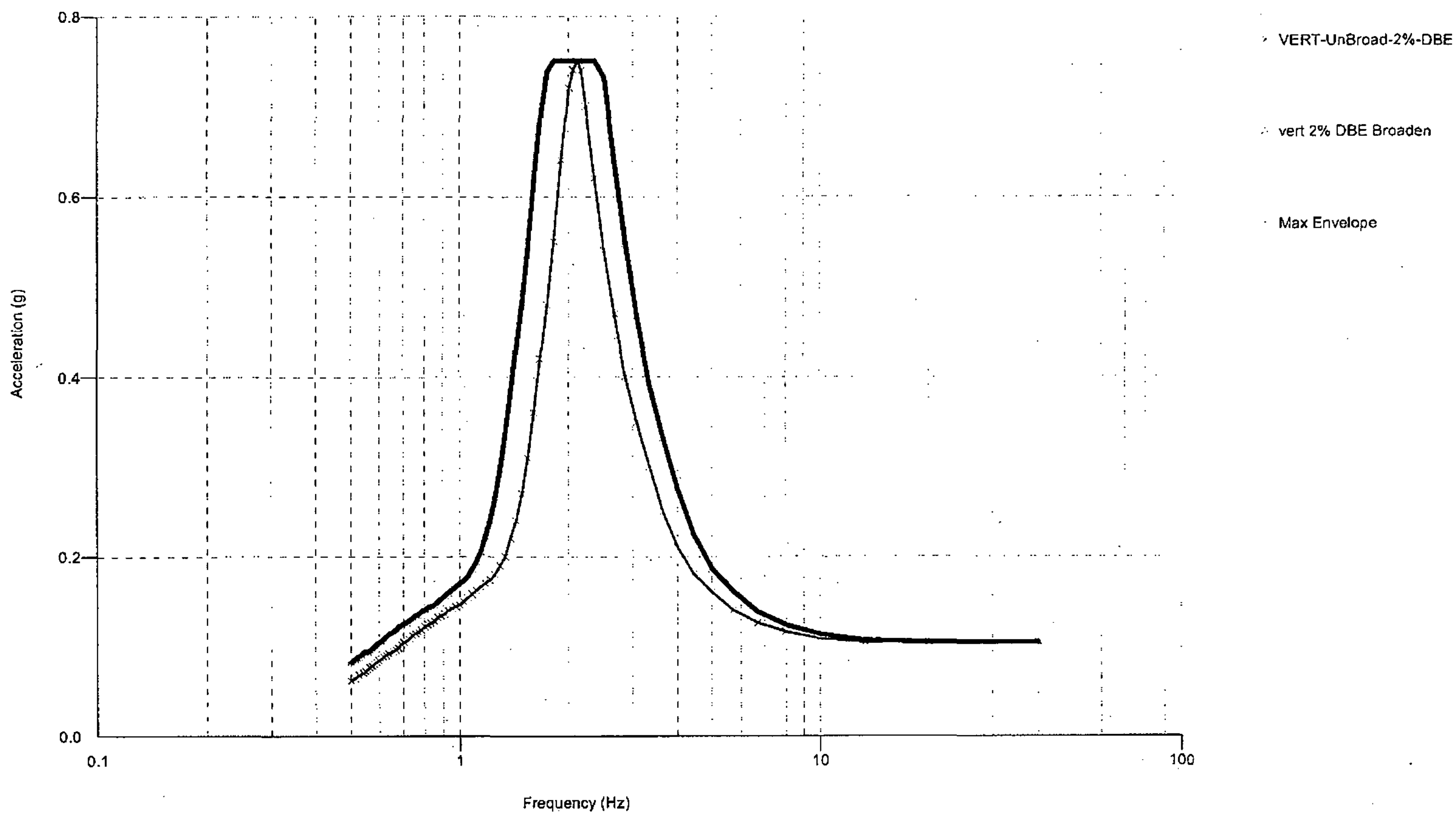
EW-UNBROAD-2%-DBE AUX BUILDING - CRANE ELEV 679-11" EAST-WEST UNBROADENED 2% EQUIPMENT DAMPING KEWAUNEE POWER STATION
EW_DBE_2AVG_BROAD AUX BUILDING - CRANE ELEV 679-11" EAST-WEST BROADENED 2% EQUIPMENT DAMPING KEWAUNEE POWER STATION

KEWAUNEE POWER STATION
AUX BUILDING CRANE RAIL ELEVATION
NORTH-SOUTH DIRECTION




```
NS_DBE_MID_BROAD      AUX BUILDING - CRANE ELEV 679'-11" (CRANE AT MID SPAN)  NORTH-SOUTH BROADENED   2% EQUIPMENT DAMPING
NS_DBE_OTHER_BROAD    AUX BUILDING - CRANE ELEV 679'-11" (CRANE AT OTHER LOC) NORTH-SOUTH BROADENED   2% EQUIPMENT DAMPING
NS-MID-UNBROAD-2%-DB  AUX BUILDING - CRANE ELEV 679'-11" (CRANE AT MID SPAN)  NORTH-SOUTH UNBROADENED 2% EQUIPMENT DAMPING
NS-OTHER-UNBROAD-2%-  AUX BUILDING - CRANE ELEV 679'-11" (CRANE AT OTHER LOC) NORTH-SOUTH UNBROADENED 2% EQUIPMENT DAMPING
```

KEWAUNEE POWER STATION
AUX BUILDING CRANE RAIL ELEVATION
VERTICAL DIRECTION



VERT-UNBROAD-2%-DBE AUX BUILDING - CRANE ELEV 679-11" VERTICAL UNBROADENED 2% EQUIPMENT DAMPING KEWAUNEE POWER STATION
VERT_2%_DBE_BROADEN AUX BUILDING - CRANE ELEV 679-11" VERTICAL BROADENED 2% EQUIPMENT DAMPING KEWAUNEE POWER STATION

Structure: **KPS Aux Building - Crane Elevation 679'-11"**
EQ Type: **Design Basis Earthquake**
Damping: **2% Equipment Damping**
Direction:

East-West			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
0.170	0.021	0.200	0.021
0.340	0.045	0.400	0.045
0.510	0.103	0.600	0.103
0.680	0.205	0.800	0.205
0.850	0.344	1.000	0.344
1.020	0.507	1.200	0.507
1.190	1.003	1.400	1.003
1.360	2.439	1.600	2.439
1.530	3.513	1.800	3.513
1.700	3.513	2.000	2.739
1.767	3.513	2.200	4.650
1.870	4.650	2.400	4.155
2.070	4.650	2.600	1.995
2.300	4.650	2.800	1.385
2.530	4.650	3.000	1.073
2.760	4.155	3.200	0.934
2.990	1.995	3.400	0.833
3.220	1.385	3.600	0.778
3.450	1.073	3.800	0.732
3.680	0.934	4.000	0.697
3.910	0.833	4.200	0.678
4.140	0.778	4.400	0.652
4.370	0.732	4.600	0.639
4.600	0.697	4.800	0.623
4.760	0.680	5.000	0.611
4.830	0.673	5.200	0.599
4.930	0.664	5.400	0.590
5.060	0.652	5.600	0.586
5.100	0.649	5.800	0.589
5.270	0.640	6.000	0.585
5.290	0.639	6.200	0.601
5.440	0.628	6.400	0.604
5.520	0.623	6.600	0.595
5.610	0.618	6.800	0.617
5.739	0.612	7.000	0.697
5.750	0.613	7.200	0.677
5.780	0.617	7.400	0.621
5.885	0.667	7.600	0.593
5.950	0.697	7.800	0.592
5.980	0.697	8.000	0.578
6.210	0.697	8.200	0.558
6.275	0.697	8.400	0.549
6.440	0.697	8.600	0.546

North-South					
BROADENED *		UNBROADENED			
		Crane @ MidSpan		Crane @ Other	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
0.250	0.076				
0.500	0.256	0.250	0.047	0.250	0.0258
0.750	0.669	0.500	0.166	0.500	0.0808
1.000	1.955	0.750	0.390	0.750	0.1736
1.250	7.114	1.000	0.883	1.000	0.3224
1.275	7.694	1.250	2.354	1.250	0.5742
1.725	7.694	1.500	7.693	1.500	1.582
2.000	7.114	1.750	7.090	1.750	3.4798
2.190	4.800	2.000	3.516	2.000	3.0392
2.500	4.800	2.250	3.068	2.250	4.8006
2.750	3.927	2.500	3.159	2.500	3.2908
2.927	2.963	2.750	1.999	2.750	1.7084
3.000	2.641	3.000	1.689	3.000	1.2258
3.250	1.902	3.250	1.519	3.250	1.0118
3.500	1.658	3.500	1.428	3.500	0.8884
3.750	1.516	3.750	1.367	3.750	0.8226
4.000	1.436	4.000	1.323	4.000	0.7698
4.250	1.381	4.250	1.287	4.250	0.733
4.500	1.338	4.500	1.260	4.500	0.7068
4.750	1.304	4.750	1.237	4.750	0.6904
5.000	1.277	5.000	1.219	5.000	0.6722
5.250	1.254	5.250	1.204	5.250	0.6578
5.500	1.236	5.500	1.191	5.500	0.6406
5.750	1.220	5.750	1.181	5.750	0.6358
6.000	1.206	6.000	1.171	6.000	0.6254
6.250	1.195	6.250	1.163	6.250	0.6286
6.500	1.185	6.500	1.156	6.500	0.617
6.750	1.176	6.750	1.150	6.750	0.6162
7.000	1.168	7.000	1.145	7.000	0.622
7.250	1.161	7.250	1.139	7.250	0.6388
7.500	1.155	7.500	1.135	7.500	0.6782
7.750	1.150	7.750	1.131	7.750	0.659
8.000	1.145	8.000	1.128	8.000	0.6338
8.250	1.141	8.250	1.125	8.250	0.6188
8.500	1.137	8.500	1.121	8.500	0.603
8.750	1.133	8.750	1.119	8.750	0.6058
9.000	1.131	9.000	1.116	9.000	0.5922
9.250	1.127	9.250	1.113	9.250	0.5858
9.500	1.124	9.500	1.112	9.500	0.581
9.750	1.122	9.750	1.110	9.750	0.579
10.000	1.120	10.000	1.108	10.000	0.579
10.250	1.117	10.250	1.107	10.250	0.5772
10.500	1.114	10.500	1.105	10.500	0.5742

Vertical			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
0.500	0.082	0.500	0.062
0.506	0.084	0.513	0.064
0.513	0.085	0.526	0.068
0.519	0.087	0.541	0.070
0.526	0.089	0.548	0.072
0.533	0.090	0.556	0.074
0.541	0.093	0.563	0.076
0.556	0.094	0.571	0.078
0.563	0.095	0.580	0.080
0.571	0.097	0.588	0.082
0.580	0.099	0.597	0.084
0.588	0.102	0.606	0.086
0.597	0.104	0.615	0.088
0.606	0.106	0.625	0.090
0.615	0.107	0.635	0.092
0.625	0.110	0.656	0.094
0.635	0.113	0.667	0.096
0.656	0.116	0.678	0.098
0.667	0.118	0.690	0.102
0.678	0.121	0.702	0.104
0.690	0.123	0.714	0.106
0.702	0.125	0.727	0.108
0.714	0.127	0.741	0.112
0.727	0.129	0.755	0.114
0.741	0.132	0.769	0.116
0.755	0.134	0.784	0.118
0.769	0.136	0.800	0.122
0.784	0.139	0.816	0.124
0.800	0.141	0.833	0.126
0.816	0.143	0.851	0.128
0.833	0.144	0.870	0.132
0.851	0.146	0.889	0.134
0.870	0.150	0.909	0.136
0.889	0.153	0.930	0.140
0.909	0.156	0.952	0.142
0.930	0.160	0.976	0.144
0.952	0.163	1.000	0.146
0.976	0.167	1.026	0.150
1.000	0.170	1.053	0.154
1.026	0.173	1.081	0.158
1.053	0.178	1.111	0.162
1.081	0.185	1.143	0.166
1.111	0.194	1.176	0.170

Structure: **KPS Aux Building - Crane Elevation 679'-11"**
EQ Type: **Design Basis Earthquake**
Damping: **2% Equipment Damping**
Direction:

East-West

BROADENED Freq (Hz)	BROADENED Accel (g)	UNBROADENED Freq (Hz)	UNBROADENED Accel (g)
6.670	0.697	8.800	0.547
6.900	0.697	9.000	0.540
7.310	0.697	9.200	0.536
7.360	0.697	9.400	0.530
7.480	0.697	9.600	0.531
7.590	0.697	9.800	0.530
7.990	0.697	10.000	0.524
8.050	0.697	10.200	0.519
8.160	0.687	10.400	0.523
8.280	0.677	10.600	0.524
8.510	0.621	10.800	0.520
8.670	0.601	11.000	0.519
8.740	0.593	11.200	0.519
8.840	0.593	11.400	0.520
8.970	0.592	11.600	0.519
9.010	0.590	11.800	0.518
9.200	0.578	12.000	0.517
9.350	0.565	12.200	0.516
9.430	0.558	12.400	0.514
9.520	0.554	12.600	0.515
9.660	0.549	12.800	0.516
9.690	0.548	13.000	0.514
9.765	0.547	13.200	0.512
9.890	0.547	13.400	0.511
10.120	0.547	13.600	0.511
10.350	0.540	13.800	0.510
10.540	0.536	14.000	0.509
10.580	0.536	14.200	0.510
10.710	0.533	14.400	0.510
10.767	0.531	14.600	0.511
10.810	0.531	14.800	0.512
10.880	0.531	15.000	0.512
11.040	0.531	15.200	0.511
11.270	0.530	15.400	0.510
11.493	0.524	15.600	0.509
11.730	0.524	15.800	0.509
11.900	0.524	16.000	0.510
12.070	0.524	16.200	0.511
12.190	0.524	16.400	0.512
12.240	0.523	16.600	0.513
12.408	0.520	16.800	0.514
12.420	0.520	17.000	0.516
12.580	0.520	17.200	0.517

North-South

BROADENED * Freq (Hz)	BROADENED * Accel (g)	UNBROADENED Crane @ MidSpan		UNBROADENED Crane @ Other	
10.750	1.112	10.750	1.104	10.750	0.5718
11.000	1.111	11.000	1.103	11.000	0.5684
11.250	1.110	11.250	1.102	11.250	0.5666
11.500	1.108	11.500	1.101	11.500	0.5688
11.750	1.106	11.750	1.100	11.750	0.5688
12.000	1.106	12.000	1.099	12.000	0.5686
12.250	1.105	12.250	1.098	12.250	0.569
12.750	1.103	12.500	1.097	12.500	0.5692
13.250	1.100	12.750	1.096	12.750	0.567
13.500	1.100	13.000	1.095	13.000	0.5652
13.750	1.098	13.250	1.095	13.250	0.5642
14.000	1.098	13.500	1.094	13.500	0.5638
14.250	1.097	13.750	1.093	13.750	0.5634
14.500	1.096	14.000	1.093	14.000	0.5636
14.750	1.096	14.250	1.092	14.250	0.5648
15.000	1.096	14.500	1.092	14.500	0.5658
15.250	1.094	14.750	1.091	14.750	0.5654
15.750	1.094	15.000	1.091	15.000	0.5642
16.000	1.093	15.250	1.090	15.250	0.562
16.250	1.092	15.500	1.090	15.500	0.5574
16.750	1.092	15.750	1.089	15.750	0.5568
17.000	1.092	16.000	1.089	16.000	0.5618
17.250	1.090	16.250	1.089	16.250	0.5642
18.000	1.090	16.500	1.088	16.500	0.5654
18.500	1.088	16.750	1.088	16.750	0.5646
19.750	1.088	17.000	1.088	17.000	0.562
20.000	1.087	17.250	1.087	17.250	0.5586
20.250	1.086	17.500	1.087	17.500	0.5578
21.750	1.086	17.750	1.086	17.750	0.5578
22.250	1.084	18.000	1.086	18.000	0.5572
25.250	1.084	18.250	1.086	18.250	0.5572
25.500	1.083	18.500	1.086	18.500	0.5572
25.750	1.082	18.750	1.085	18.750	0.557
30.250	1.082	19.000	1.085	19.000	0.5574
30.500	1.082	19.25	1.08496	19.25	0.5576
30.750	1.080	19.5	1.08476	19.5	0.5572
40.000	1.080	19.75	1.08456	19.75	0.5568
		20	1.08436	20	0.5564
		20.25	1.08416	20.25	0.5562
		20.5	1.08398	20.5	0.556
		20.75	1.0838	20.75	0.5558
		21	1.08364	21	0.5558
		21.25	1.0835	21.25	0.5558

* Envelop of 2 Conditions: Crane at Mid-Span & Crane at Any Other Location

Vertical

BROADENED Freq (Hz)	BROADENED Accel (g)	UNBROADENED Freq (Hz)	UNBROADENED Accel (g)
1.143	0.205	1.212	0.174
1.176	0.222	1.250	0.180
1.212	0.239	1.290	0.190
1.250	0.264	1.333	0.200
1.290	0.296	1.379	0.220
1.333	0.335	1.429	0.240
1.379	0.380	1.481	0.270
1.429	0.432	1.538	0.310
1.481	0.483	1.600	0.360
1.538	0.543	1.667	0.420
1.600	0.617	1.739	0.480
1.667	0.688	1.818	0.550
1.739	0.739	1.905	0.640
1.818	0.750	2.000	0.720
1.905	0.750	2.049	0.740
2.000	0.750	2.105	0.750
2.049	0.750	2.160	0.740
2.105	0.750	2.222	0.700
2.160	0.750	2.353	0.620
2.222	0.750	2.500	0.540
2.353	0.750	2.667	0.470
2.500	0.731	2.857	0.400
2.667	0.640	3.077	0.350
2.857	0.548	3.333	0.300
3.077	0.467	3.636	0.250
3.333	0.390	4.000	0.210
3.636	0.333	4.444	0.180
4.000	0.275	5.000	0.160
4.444	0.224	5.714	0.140
5.000	0.186	6.667	0.126
5.714	0.161	8.000	0.116
6.667	0.139	10.000	0.108
8.000	0.124	13.333	0.104
10.000	0.113	20.000	0.104
13.333	0.106	40.000	0.104
20.000	0.104		
40.000	0.104		

Structure: **KPS Aux Building - Crane Elevation 679'-11"**
EQ Type: **Design Basis Earthquake**
Damping: **2% Equipment Damping**
Direction:

East-West			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
12.650	0.520	17.400	0.515
13.110	0.520	17.600	0.510
13.340	0.519	17.800	0.508
13.430	0.519	18.000	0.508
13.570	0.518	18.200	0.507
13.600	0.518	18.400	0.506
13.770	0.517	18.600	0.505
13.800	0.517	18.800	0.505
13.940	0.516	19.000	0.504
14.001	0.516	19.200	0.504
14.030	0.516	19.400	0.504
14.110	0.516	19.600	0.504
14.260	0.516	19.800	0.504
14.280	0.516	20.000	0.504
14.431	0.516	20.200	0.504
14.450	0.516	20.400	0.504
14.620	0.517	20.600	0.504
14.720	0.517	20.800	0.504
14.950	0.517	21.000	0.504
15.130	0.517	21.200	0.504
15.180	0.517	21.400	0.504
15.300	0.517	21.600	0.504
15.410	0.517	21.800	0.504
15.640	0.517	22.000	0.504
15.870	0.517	22.200	0.504
16.100	0.517	22.400	0.503
17.020	0.517	22.600	0.503
17.250	0.517	22.800	0.503
17.340	0.517	23.000	0.503
17.480	0.517	23.200	0.503
17.510	0.517	23.400	0.503
17.680	0.517	23.600	0.503
17.710	0.517	23.800	0.503
17.850	0.517	24.000	0.503
17.940	0.517	24.200	0.503
18.020	0.517	24.400	0.503
18.170	0.517	24.600	0.503
19.780	0.517	24.800	0.503
20.010	0.515	25.000	0.503
20.240	0.510	25.200	0.503
20.449	0.508	25.400	0.503
20.470	0.508	25.600	0.503
20.700	0.508	25.800	0.503

North-South					
BROADENED *		UNBROADENED			
Freq (Hz)	Accel (g)	Crane @ MidSpan		Crane @ Other	
		21.5	1.08334	21.5	0.5558
		21.75	1.08318	21.75	0.5558
		22	1.08304	22	0.5556
		22.25	1.0829	22.25	0.5554
		22.5	1.08276	22.5	0.5552
		22.75	1.08262	22.75	0.5552
		23	1.08248	23	0.555
		23.25	1.08236	23.25	0.555
		23.5	1.08224	23.5	0.5548
		23.75	1.08212	23.75	0.5548
		24	1.082	24	0.5548
		24.25	1.0819	24.25	0.5546
		24.5	1.08178	24.5	0.5544
		24.75	1.08168	24.75	0.5542
		25	1.08158	25	0.5542
		25.25	1.08148	25.25	0.5542
		25.5	1.08138	25.5	0.554
		25.75	1.0813	25.75	0.554
		26	1.0812	26	0.554
		26.25	1.08112	26.25	0.5538
		26.5	1.08104	26.5	0.5538
		26.75	1.08094	26.75	0.5538
		27	1.08086	27	0.5536
		27.25	1.0808	27.25	0.5536
		27.5	1.08072	27.5	0.5536
		27.75	1.08064	27.75	0.5536
		28	1.08056	28	0.5534
		28.25	1.0805	28.25	0.5534
		28.5	1.08042	28.5	0.5534
		28.75	1.08036	28.75	0.5532
		29	1.0803	29	0.5532
		29.25	1.08024	29.25	0.5532
		29.5	1.08018	29.5	0.5532
		29.75	1.08012	29.75	0.5532
		30	1.08006	30	0.553
		30.25	1.08	30.25	0.553
		30.5	1.07996	30.5	0.553
		30.75	1.0799	30.75	0.553
		31	1.07984	31	0.5528
		31.25	1.0798	31.25	0.5528
		31.5	1.07974	31.5	0.5528
		31.75	1.0797	31.75	0.5528
		32	1.07964	32	0.5528

Vertical			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)

Structure: **KPS Aux Building - Crane Elevation 679'-11"**
EQ Type: **Design Basis Earthquake**
Damping: **2% Equipment Damping**
Direction:

East-West			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
20.930	0.507	26.000	0.502
21.160	0.506	26.200	0.502
21.390	0.505	26.400	0.502
21.620	0.505	26.600	0.502
21.850	0.504	26.800	0.502
22.080	0.504	27.000	0.502
22.310	0.504	27.200	0.502
22.540	0.504	27.400	0.502
22.770	0.504	27.600	0.502
23.000	0.504	27.800	0.502
23.230	0.504	28.000	0.502
23.460	0.504	28.200	0.502
24.380	0.504	28.400	0.502
24.610	0.504	28.600	0.502
24.840	0.504	28.800	0.502
25.070	0.504	29.000	0.502
25.300	0.504	29.200	0.502
25.530	0.504	29.400	0.502
25.760	0.503	29.600	0.502
25.990	0.503	29.800	0.502
26.220	0.503	30.000	0.502
26.450	0.503	30.200	0.502
26.680	0.503	30.400	0.502
26.910	0.503	30.600	0.502
27.140	0.503	30.800	0.502
27.370	0.503	31.000	0.502
27.600	0.503	31.200	0.502
27.830	0.503	31.400	0.502
28.060	0.503	31.600	0.502
28.290	0.503	31.800	0.502
28.520	0.503	32.000	0.502
28.750	0.503	32.200	0.501
28.980	0.503	32.400	0.501
29.210	0.503	32.600	0.501
29.440	0.503	32.800	0.501
29.670	0.503	33.000	0.501
29.900	0.502	33.200	0.501
30.130	0.502	33.400	0.501
30.360	0.502	33.600	0.501
30.590	0.502	33.800	0.501
30.820	0.502	34.000	0.501
31.050	0.502	34.200	0.501
31.280	0.502	34.400	0.501

North-South					
BROADENED *		UNBROADENED			
Freq (Hz)	Accel (g)	Crane @ MidSpan		Crane @ Other	
		32.25	1.0796	32.25	0.5528
		32.5	1.07956	32.5	0.5526
		32.75	1.07952	32.75	0.5526
		33	1.07948	33	0.5526
		33.25	1.07944	33.25	0.5526
		33.5	1.0794	33.5	0.5526
		33.75	1.07936	33.75	0.5524
		34	1.07932	34	0.5524
		34.25	1.07926	34.25	0.5524
		34.5	1.07922	34.5	0.5524
		34.75	1.07918	34.75	0.5524
		35	1.07916	35	0.5524
		35.25	1.07912	35.25	0.5524
		35.5	1.07908	35.5	0.5524
		35.75	1.07904	35.75	0.5522
		36	1.07902	36	0.5522
		36.25	1.07898	36.25	0.5522
		36.5	1.07896	36.5	0.5522
		36.75	1.07892	36.75	0.5522
		37	1.0789	37	0.5522
		37.25	1.07886	37.25	0.5522
		37.5	1.07884	37.5	0.5522
		37.75	1.0788	37.75	0.552
		38	1.07878	38	0.552
		38.25	1.07874	38.25	0.552
		38.5	1.07872	38.5	0.552
		38.75	1.0787	38.75	0.552
		39	1.07866	39	0.552
		39.25	1.07864	39.25	0.552
		39.5	1.07862	39.5	0.552
		39.75	1.07858	39.75	0.552
		40	1.07856	40	0.5518

Vertical			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)

ABS Consulting Calc 1886592-C-001 R0
Attachment B - Page B-13 of 14

Structure: **KPS Aux Building - Crane Elevation 679'-11"**
EQ Type: **Design Basis Earthquake**
Damping: **2% Equipment Damping**
Direction:

East-West			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
31.510	0.502	34.600	0.501
31.740	0.502	34.800	0.501
31.970	0.502	35.000	0.501
32.200	0.502	35.200	0.501
32.430	0.502	35.400	0.501
32.660	0.502	35.600	0.501
32.890	0.502	35.800	0.501
33.120	0.502	36.000	0.501
33.350	0.502	36.200	0.501
33.580	0.502	36.400	0.501
33.810	0.502	36.600	0.501
34.040	0.502	36.800	0.501
34.270	0.502	37.000	0.501
34.500	0.502	37.200	0.501
34.730	0.502	37.400	0.501
34.960	0.502	37.600	0.501
35.190	0.502	37.800	0.501
35.420	0.502	38.000	0.501
35.650	0.502	38.200	0.501
35.880	0.502	38.400	0.501
36.110	0.502	38.600	0.501
36.340	0.502	38.800	0.501
36.570	0.502	39.000	0.501
36.800	0.502	39.200	0.501
37.030	0.501	39.400	0.501
37.260	0.501	39.600	0.501
37.490	0.501	39.800	0.501
37.720	0.501	40.000	0.501
37.950	0.501		
38.180	0.501		
38.410	0.501		
38.640	0.501		
38.870	0.501		
39.100	0.501		
39.330	0.501		
39.560	0.501		
39.790	0.501		
40.000	0.501		

North-South			
BROADENED *		UNBROADENED	
Freq (Hz)	Accel (g)	Crane @ MidSpan	Crane @ Other

Vertical			
BROADENED		UNBROADENED	
Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)

ATTACHMENT C

Plots of Generated

Time Histories & Response Spectra

and

Tabulation of Generated ARS Data

This attachment contains plots of the fifteen generated acceleration time histories. Digitized data for these curves are provided in ASCII text format files included on the enclosed CD. All acceleration values are in units of 'g'. All curves are digitized at 0.01 seconds interval for 2000 time steps with the first value starting at t = 0 second.

Also, included in this attachment are plots of the associated velocity and displacement time histories as well as the associated 2% damped acceleration and displacement response spectra. Note that all the plots shown in this attachment are "For Information Only" since they were developed and plotted using non-QA software (See Section 3.1 for discussion).

Spectral values are calculated at 240 frequencies equally spaced logarithmically between 0.1Hz and 40 Hz. These frequency values are listed on sheet C2. Also listed immediately following the spectral frequencies are tabulations of the averaged acceleration response spectra (ARS) for each of the three directional components (EW, NS and vertical). These averaged spectral accelerations, together with the spectral frequencies comprise the data used to generate the ARS provided in Figure 4.3, Figure 4.4 and Figure 4.5 located in Section 4.4.

List of Spectral Frequency values (in Hz) used for calculating all response spectra.

0.1	0.1025	0.1051	0.1078	0.1105
0.1134	0.1162	0.1192	0.1222	0.1253
0.1285	0.1318	0.1351	0.1385	0.142
0.1456	0.1493	0.1531	0.157	0.161
0.1651	0.1693	0.1736	0.178	0.1825
0.1871	0.1919	0.1968	0.2018	0.2069
0.2121	0.2175	0.223	0.2287	0.2345
0.2405	0.2466	0.2528	0.2592	0.2658
0.2726	0.2795	0.2866	0.2939	0.3013
0.309	0.3168	0.3249	0.3331	0.3416
0.3502	0.3591	0.3682	0.3776	0.3872
0.397	0.4071	0.4174	0.428	0.4389
0.45	0.4614	0.4732	0.4852	0.4975
0.5101	0.5231	0.5363	0.55	0.5639
0.5782	0.5929	0.608	0.6234	0.6392
0.6555	0.6721	0.6892	0.7067	0.7246
0.743	0.7619	0.7812	0.801	0.8214
0.8422	0.8636	0.8855	0.908	0.931
0.9547	0.9789	1.0038	1.0292	1.0554
1.0822	1.1096	1.1378	1.1667	1.1963
1.2267	1.2578	1.2897	1.3225	1.3561
1.3905	1.4258	1.462	1.4991	1.5371
1.5762	1.6162	1.6572	1.6993	1.7424
1.7866	1.832	1.8785	1.9262	1.9751
2.0252	2.0766	2.1294	2.1834	2.2388
2.2957	2.354	2.4137	2.475	2.5378
2.6022	2.6683	2.736	2.8055	2.8767
2.9497	3.0246	3.1014	3.1801	3.2609
3.3436	3.4285	3.5156	3.6048	3.6963
3.7901	3.8864	3.985	4.0862	4.1899
4.2963	4.4053	4.5172	4.6318	4.7494
4.87	4.9936	5.1204	5.2504	5.3837
5.5203	5.6605	5.8042	5.9515	6.1026
6.2575	6.4164	6.5792	6.7463	6.9175
7.0931	7.2732	7.4578	7.6471	7.8413
8.0403	8.2444	8.4537	8.6683	8.8884
9.114	9.3454	9.5826	9.8259	10.075
10.331	10.593	10.862	11.138	11.421
11.711	12.008	12.313	12.625	12.946
13.275	13.611	13.957	14.311	14.675
15.047	15.429	15.821	16.223	16.634
17.057	17.49	17.934	18.389	18.856
19.334	19.825	20.328	20.845	21.374
21.916	22.473	23.043	23.628	24.228
24.843	25.474	26.12	26.783	27.463
28.16	28.875	29.608	30.36	31.131
31.921	32.731	33.562	34.414	35.288
36.184	37.102	38.044	39.01	40

ABS Consulting

Attachment C

				Rev	1	**Sheet No.**	C 3
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

EW Averaged ARS:

5.508060E-03	5.785560E-03	6.054200E-03	6.385020E-03	6.742900E-03
7.123240E-03	7.502460E-03	7.875400E-03	8.237860E-03	8.781460E-03
9.371420E-03	9.999540E-03	1.071142E-02	1.142406E-02	1.222848E-02
1.306448E-02	1.400880E-02	1.496660E-02	1.601760E-02	1.701080E-02
1.785080E-02	1.930400E-02	2.084140E-02	2.209960E-02	2.333980E-02
2.433500E-02	2.500340E-02	2.550640E-02	2.708420E-02	2.879460E-02
3.026660E-02	3.153060E-02	3.277020E-02	3.384040E-02	3.567960E-02
3.797220E-02	4.072760E-02	4.291600E-02	4.524880E-02	4.743340E-02
4.979060E-02	5.061580E-02	5.155900E-02	5.187560E-02	5.129480E-02
5.169180E-02	5.308740E-02	5.345040E-02	5.289380E-02	5.280280E-02
5.299620E-02	5.395120E-02	5.429220E-02	5.417420E-02	5.675180E-02
5.937520E-02	6.277200E-02	6.451280E-02	6.520440E-02	7.071260E-02
7.524740E-02	8.249460E-02	9.504740E-02	1.040924E-01	1.066800E-01
1.104814E-01	1.145300E-01	1.179928E-01	1.213176E-01	1.183460E-01
1.155420E-01	1.165580E-01	1.203180E-01	1.364880E-01	1.602300E-01
1.808660E-01	2.037040E-01	2.257960E-01	2.397100E-01	2.302860E-01
2.195760E-01	2.100180E-01	2.122480E-01	2.220760E-01	2.381180E-01
2.537700E-01	2.852780E-01	3.256220E-01	3.415840E-01	3.779140E-01
4.541840E-01	5.158920E-01	5.290440E-01	5.009360E-01	5.426400E-01
6.012220E-01	6.715620E-01	8.037320E-01	9.355880E-01	1.048440E+00
1.167680E+00	1.459100E+00	1.846180E+00	2.205720E+00	2.466000E+00
2.532560E+00	2.552860E+00	2.959160E+00	3.347600E+00	3.583380E+00
3.500820E+00	3.201180E+00	3.411840E+00	3.496440E+00	3.583000E+00
3.824980E+00	4.470420E+00	4.659480E+00	4.328160E+00	4.215080E+00
4.383520E+00	4.696820E+00	4.663700E+00	4.179480E+00	4.243380E+00
4.679420E+00	4.588040E+00	4.219540E+00	4.577680E+00	4.672520E+00
4.459180E+00	4.281320E+00	4.181980E+00	3.669940E+00	2.947660E+00
2.299300E+00	1.936460E+00	1.599940E+00	1.476060E+00	1.397000E+00
1.328200E+00	1.144860E+00	1.148794E+00	1.078384E+00	1.031634E+00
1.026460E+00	9.382120E-01	9.108540E-01	9.010160E-01	8.735500E-01
8.429620E-01	8.124440E-01	8.308200E-01	8.003000E-01	7.801880E-01
7.675620E-01	7.526980E-01	7.365980E-01	7.304840E-01	7.276620E-01
7.050920E-01	6.984120E-01	6.925580E-01	7.396160E-01	7.476000E-01
7.318820E-01	7.309160E-01	7.275320E-01	7.281880E-01	7.243240E-01
7.195800E-01	7.239340E-01	7.204160E-01	7.320800E-01	7.279340E-01
7.206940E-01	7.024620E-01	6.828460E-01	6.693820E-01	6.662620E-01
6.593660E-01	6.526000E-01	6.465100E-01	6.461840E-01	6.489280E-01
6.436660E-01	6.452140E-01	6.487880E-01	6.478700E-01	6.483340E-01
6.471220E-01	6.428800E-01	6.417560E-01	6.425480E-01	6.392020E-01
6.359160E-01	6.362040E-01	6.354740E-01	6.333740E-01	6.324720E-01
6.319120E-01	6.314380E-01	6.330960E-01	6.337340E-01	6.342640E-01
6.337820E-01	6.323300E-01	6.300660E-01	6.309200E-01	6.307080E-01
6.305480E-01	6.302640E-01	6.293060E-01	6.290600E-01	6.289420E-01
6.286700E-01	6.278820E-01	6.282200E-01	6.280540E-01	6.277140E-01
6.275320E-01	6.272660E-01	6.271740E-01	6.266020E-01	6.266040E-01
6.268980E-01	6.264460E-01	6.260260E-01	6.258340E-01	6.257200E-01
6.254420E-01	6.254440E-01	6.251960E-01	6.251360E-01	6.250360E-01
6.249440E-01	6.249840E-01	6.248420E-01	6.248000E-01	6.246680E-01

NS Averaged ARS:

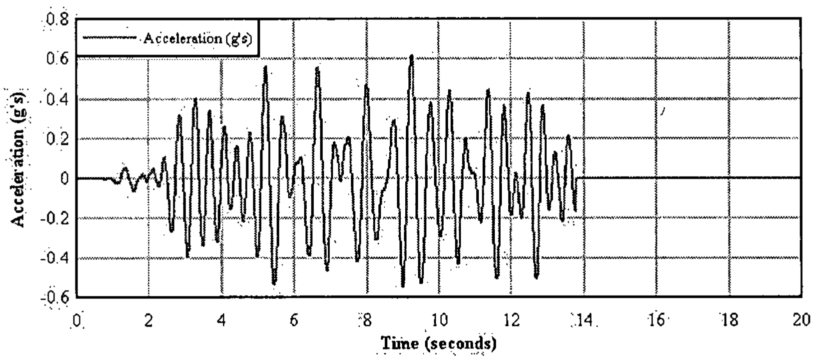
9.457340E-03	1.008580E-02	1.076194E-02	1.148928E-02	1.226920E-02
1.310100E-02	1.398320E-02	1.491100E-02	1.587740E-02	1.687380E-02
1.794460E-02	1.905600E-02	2.020320E-02	2.137900E-02	2.287960E-02
2.449140E-02	2.625260E-02	2.802320E-02	3.001840E-02	3.226700E-02
3.428660E-02	3.592420E-02	3.842000E-02	4.025780E-02	4.195940E-02
4.364040E-02	4.583760E-02	4.819220E-02	4.998480E-02	5.116840E-02
5.173620E-02	5.231580E-02	5.371140E-02	5.491320E-02	5.550140E-02
5.541180E-02	5.616000E-02	5.737760E-02	5.945160E-02	6.226980E-02
6.558600E-02	6.915120E-02	7.342100E-02	7.907360E-02	8.347740E-02
8.926220E-02	9.599800E-02	1.008554E-01	1.034024E-01	1.112124E-01
1.167760E-01	1.207860E-01	1.207070E-01	1.317134E-01	1.432440E-01
1.536240E-01	1.618340E-01	1.656920E-01	1.683700E-01	1.759840E-01
1.829920E-01	1.899440E-01	1.926680E-01	1.967240E-01	2.001920E-01
2.093600E-01	2.383180E-01	2.701860E-01	2.956240E-01	3.137680E-01
3.470160E-01	3.765100E-01	4.125060E-01	4.655980E-01	4.949940E-01
5.046080E-01	5.016460E-01	5.058480E-01	4.996000E-01	5.089880E-01
5.385860E-01	5.931860E-01	6.596720E-01	7.536300E-01	8.126160E-01
8.851740E-01	9.392540E-01	1.055264E+00	1.210780E+00	1.416160E+00
1.618500E+00	1.807260E+00	2.080140E+00	2.516680E+00	2.998040E+00
3.477040E+00	3.904460E+00	4.525360E+00	5.220320E+00	6.010600E+00
6.731240E+00	7.289100E+00	7.421100E+00	7.496580E+00	7.479680E+00
7.390600E+00	7.593180E+00	7.628400E+00	7.477480E+00	7.430220E+00
7.610520E+00	7.399640E+00	7.495380E+00	7.436800E+00	7.455880E+00
7.486380E+00	7.163580E+00	7.129160E+00	7.152940E+00	7.015580E+00
6.741140E+00	6.013200E+00	5.337300E+00	4.732000E+00	4.641740E+00
4.720980E+00	4.592560E+00	4.627740E+00	4.671160E+00	4.586740E+00
4.323320E+00	4.003400E+00	3.830420E+00	3.505240E+00	3.083420E+00
2.814980E+00	2.416300E+00	2.224180E+00	2.054140E+00	1.994480E+00
1.950620E+00	1.913620E+00	1.798500E+00	1.803760E+00	1.724600E+00
1.710080E+00	1.676640E+00	1.635900E+00	1.677400E+00	1.651520E+00
1.560540E+00	1.602360E+00	1.528060E+00	1.535120E+00	1.508560E+00
1.546120E+00	1.509080E+00	1.525620E+00	1.454160E+00	1.488820E+00
1.447140E+00	1.458480E+00	1.428600E+00	1.422740E+00	1.459780E+00
1.489780E+00	1.485400E+00	1.496700E+00	1.494660E+00	1.439380E+00
1.435320E+00	1.444800E+00	1.456980E+00	1.434280E+00	1.427420E+00
1.420560E+00	1.391140E+00	1.401040E+00	1.396060E+00	1.390660E+00
1.401940E+00	1.429160E+00	1.420800E+00	1.404280E+00	1.400120E+00
1.392000E+00	1.378300E+00	1.385160E+00	1.389920E+00	1.400320E+00
1.392600E+00	1.380920E+00	1.375160E+00	1.377260E+00	1.385980E+00
1.390720E+00	1.383320E+00	1.383100E+00	1.392180E+00	1.397120E+00
1.394260E+00	1.394900E+00	1.387880E+00	1.384260E+00	1.381420E+00
1.375060E+00	1.369540E+00	1.362600E+00	1.347220E+00	1.342400E+00
1.364000E+00	1.378740E+00	1.389180E+00	1.396300E+00	1.401260E+00
1.406060E+00	1.403820E+00	1.391480E+00	1.371060E+00	1.352640E+00
1.343380E+00	1.341800E+00	1.339160E+00	1.335980E+00	1.337200E+00
1.336420E+00	1.334180E+00	1.333240E+00	1.333320E+00	1.331760E+00
1.331340E+00	1.331640E+00	1.331060E+00	1.329720E+00	1.329780E+00
1.329020E+00	1.329620E+00	1.328560E+00	1.328420E+00	1.328480E+00

Vertical Averaged ARS:

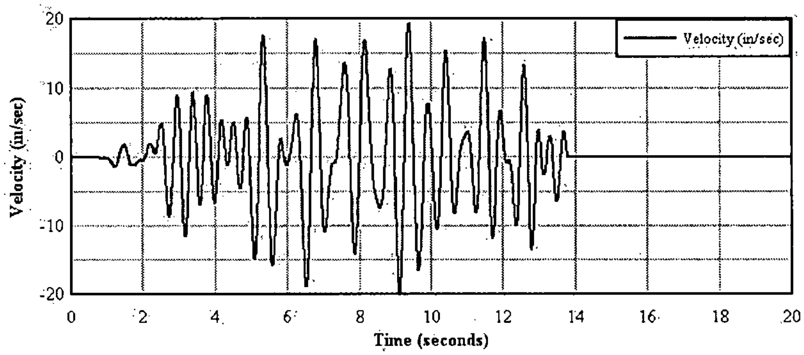
5.904800E-03	6.424340E-03	6.951460E-03	7.468120E-03	7.961700E-03
8.500100E-03	9.076480E-03	9.718640E-03	1.035116E-02	1.095282E-02
1.146740E-02	1.208400E-02	1.266600E-02	1.327840E-02	1.392500E-02
1.446180E-02	1.488978E-02	1.516084E-02	1.522934E-02	1.518764E-02
1.518336E-02	1.513154E-02	1.538970E-02	1.590662E-02	1.658206E-02
1.751818E-02	1.851624E-02	1.989940E-02	2.149760E-02	2.298560E-02
2.415360E-02	2.537260E-02	2.660840E-02	2.848220E-02	2.995120E-02
3.107160E-02	3.227420E-02	3.306380E-02	3.395100E-02	3.527060E-02
3.624000E-02	3.634240E-02	3.663820E-02	3.656260E-02	3.626600E-02
3.560300E-02	3.600820E-02	3.739640E-02	3.936860E-02	4.430080E-02
4.877260E-02	5.192260E-02	5.352480E-02	5.391300E-02	5.305240E-02
5.555860E-02	5.706060E-02	5.676880E-02	5.489480E-02	5.222360E-02
4.936580E-02	5.062400E-02	5.408980E-02	5.955640E-02	6.386460E-02
6.681000E-02	6.844320E-02	7.104980E-02	7.441360E-02	7.505260E-02
7.648080E-02	8.125840E-02	8.993640E-02	9.359040E-02	9.509020E-02
9.531680E-02	9.748200E-02	1.048430E-01	1.129280E-01	1.181280E-01
1.241460E-01	1.253060E-01	1.270260E-01	1.329220E-01	1.367480E-01
1.429480E-01	1.466620E-01	1.487300E-01	1.529580E-01	1.592500E-01
1.624220E-01	1.673000E-01	1.697960E-01	1.765240E-01	1.760900E-01
1.814480E-01	1.948920E-01	2.041540E-01	2.098400E-01	2.328580E-01
2.516780E-01	2.684720E-01	2.925180E-01	3.225920E-01	3.561920E-01
3.871160E-01	4.243580E-01	4.569120E-01	5.023180E-01	5.378960E-01
5.936580E-01	6.357380E-01	6.784360E-01	7.069940E-01	7.329180E-01
7.770540E-01	7.326480E-01	7.363000E-01	7.271120E-01	7.340080E-01
7.425320E-01	7.417820E-01	7.132680E-01	7.644520E-01	7.267740E-01
7.151580E-01	7.380620E-01	7.404920E-01	7.205380E-01	7.154360E-01
6.770940E-01	6.280980E-01	5.586920E-01	5.357000E-01	5.403020E-01
5.201260E-01	4.791440E-01	4.422540E-01	3.947400E-01	3.959400E-01
3.815480E-01	3.420580E-01	3.299500E-01	3.272000E-01	3.198280E-01
3.086660E-01	2.796440E-01	2.685000E-01	2.761680E-01	2.667700E-01
2.530080E-01	2.264680E-01	2.194680E-01	2.136960E-01	2.054940E-01
1.892380E-01	1.819580E-01	1.874580E-01	1.929700E-01	1.791460E-01
1.723540E-01	1.612200E-01	1.648280E-01	1.763760E-01	1.794900E-01
1.848960E-01	1.743720E-01	1.497440E-01	1.417440E-01	1.608860E-01
1.748740E-01	1.838560E-01	1.718860E-01	1.524520E-01	1.346420E-01
1.312700E-01	1.379720E-01	1.481200E-01	1.496700E-01	1.438240E-01
1.464040E-01	1.460940E-01	1.403960E-01	1.307980E-01	1.282120E-01
1.302180E-01	1.310940E-01	1.324900E-01	1.331900E-01	1.327400E-01
1.325360E-01	1.321880E-01	1.310540E-01	1.288320E-01	1.277400E-01
1.287380E-01	1.282500E-01	1.277420E-01	1.281780E-01	1.281060E-01
1.277580E-01	1.279040E-01	1.275900E-01	1.272580E-01	1.273300E-01
1.272700E-01	1.272220E-01	1.271240E-01	1.268000E-01	1.267540E-01
1.268040E-01	1.267920E-01	1.266440E-01	1.265180E-01	1.265920E-01
1.265900E-01	1.265180E-01	1.264240E-01	1.264180E-01	1.263780E-01
1.263040E-01	1.262660E-01	1.262360E-01	1.262000E-01	1.261740E-01
1.261500E-01	1.261200E-01	1.260980E-01	1.260860E-01	1.260640E-01
1.260460E-01	1.260180E-01	1.260020E-01	1.259820E-01	1.259660E-01
1.259500E-01	1.259320E-01	1.259140E-01	1.259040E-01	1.258900E-01

Final Generated Time History – Data Set 1 EW Direction

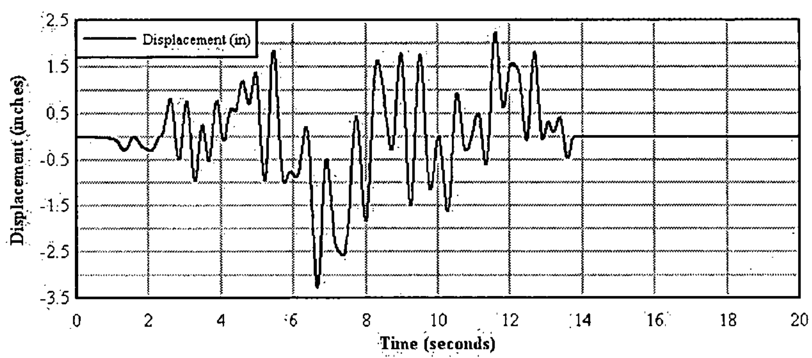
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record KAK000 EW (For Information Only)



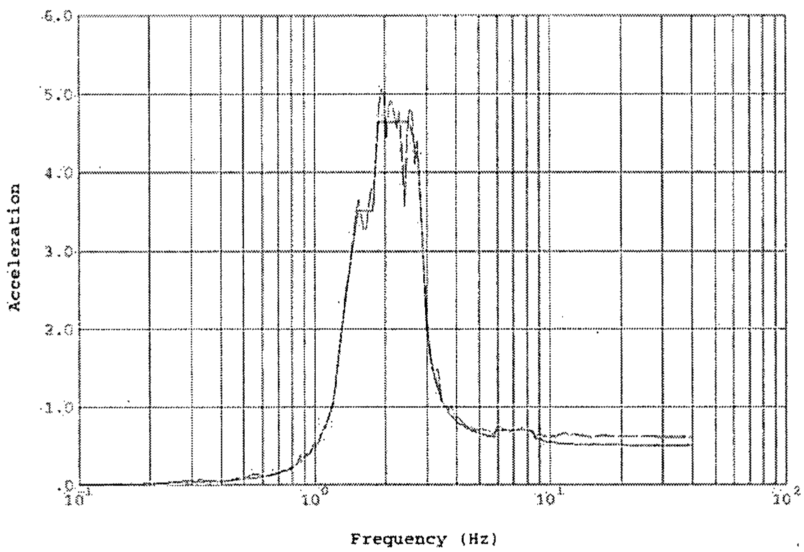
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record KAK000 EW (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record KAK000 EW (For Information Only)



ABS Consulting				**Attachment C**	
				Rev 1	**Sheet No.** C 7
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08



Legend:

Modified Target ARS ————

From KAK000 Seed — — — —

Notes:

All curves: 2% Spectral Damping

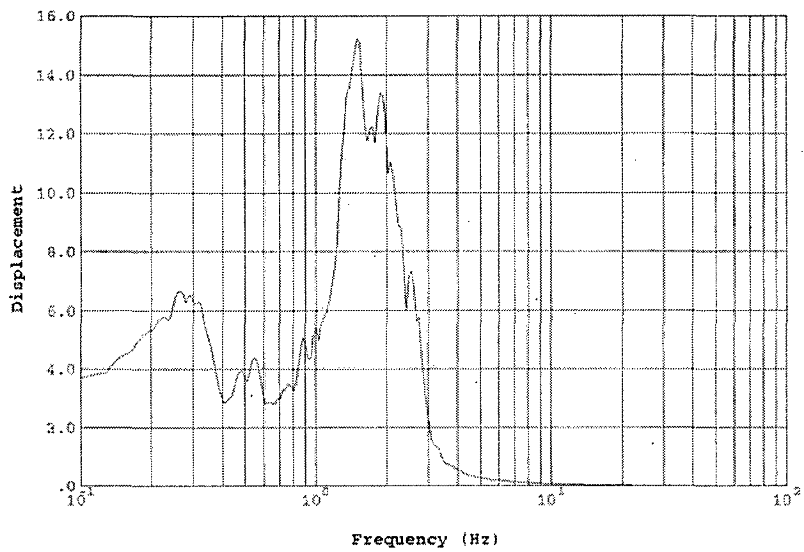
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
East/West Direction

ABS Consulting

Attachment C

			Rev	1	**Sheet No.** *C 8*
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



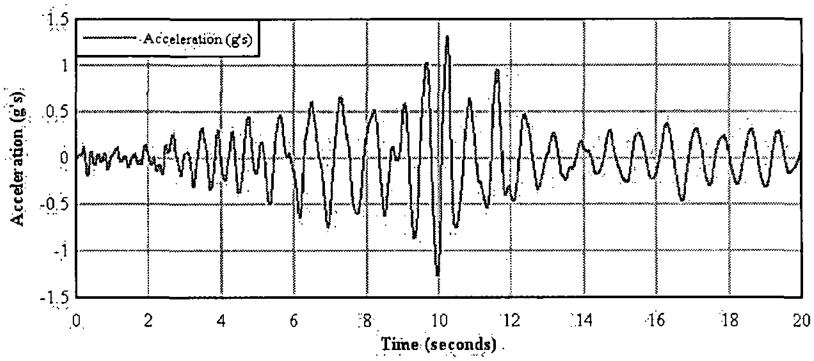
Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum East/West Direction
Data Set 1 - From KAK000 Seed

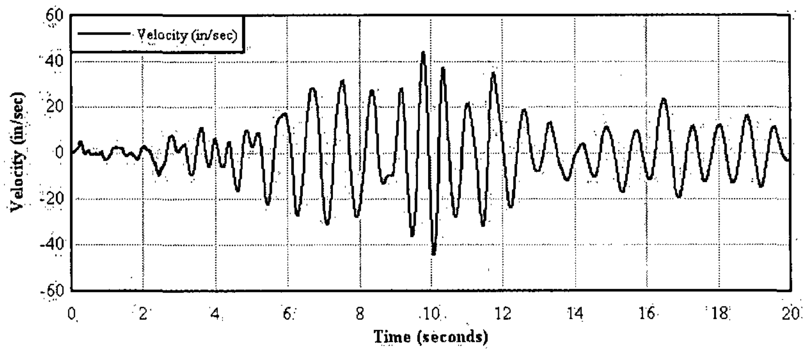
(For Information Only)

Final Generated Time History – Data Set 1 NS Direction

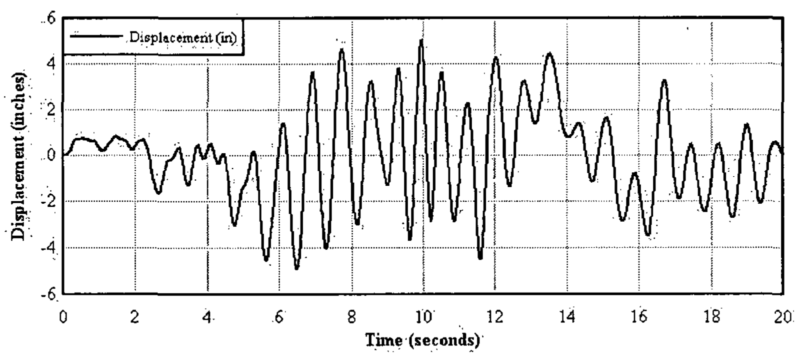
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record HCH001 NS (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record HCH001 NS (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record HCH001 NS (For Information Only)



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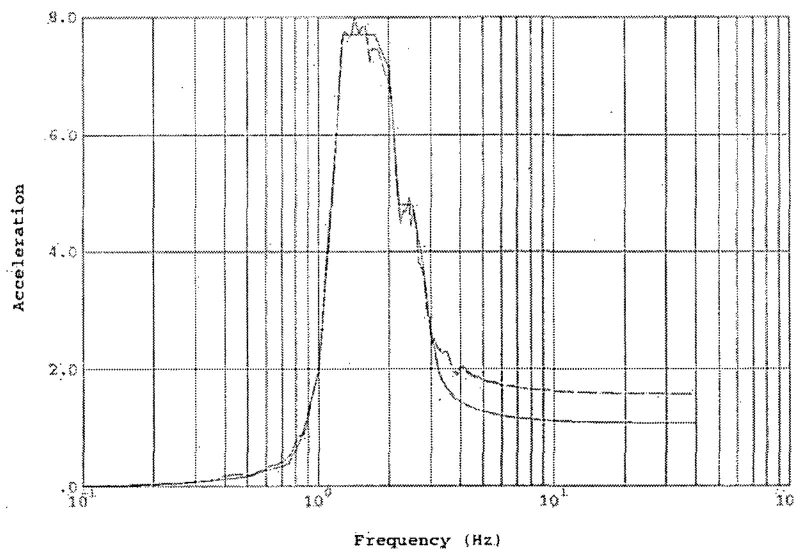
Attachment C

			Rev 1	**Sheet No.**	*C 10*
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



Legend:

Modified Target ARS

From A-STP093 Seed

Notes:

All curves: 2% Spectral Damping

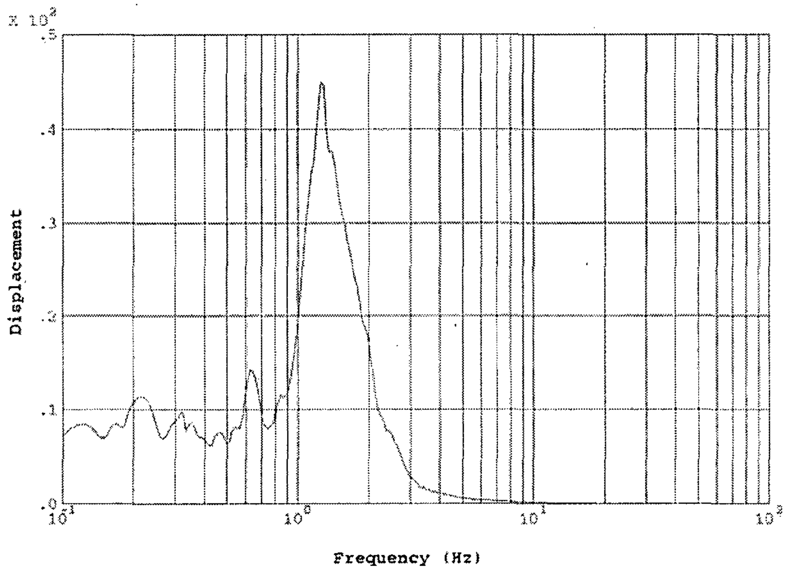
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
North/South Direction

ABS Consulting

Attachment C

				Rev 1	**Sheet No.** C 11
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08



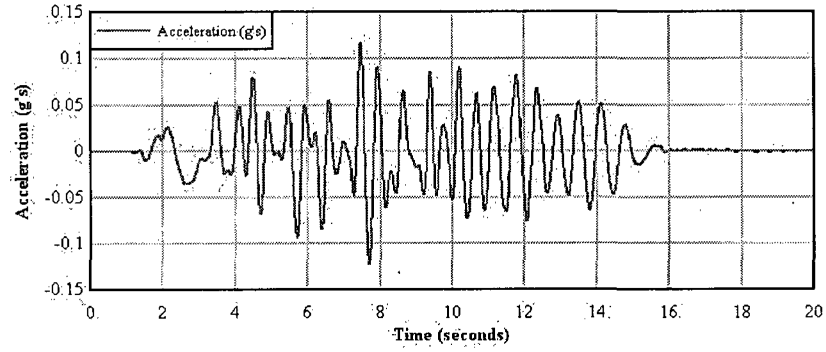
Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum North/South Direction
Data Set 1 - From HCH001 Seed

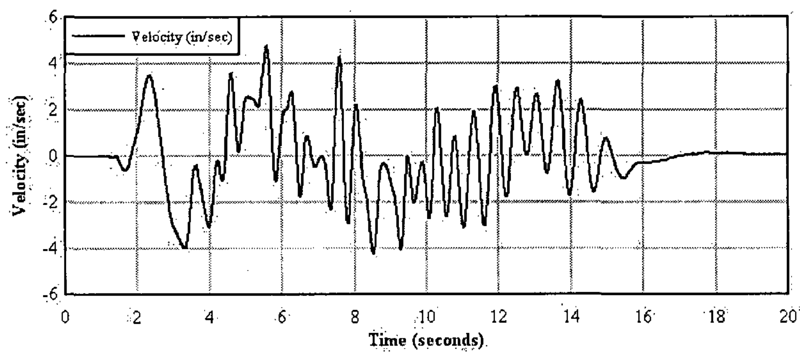
(For Information Only)

Final Generated Time History – Data Set 1 Vertical Direction

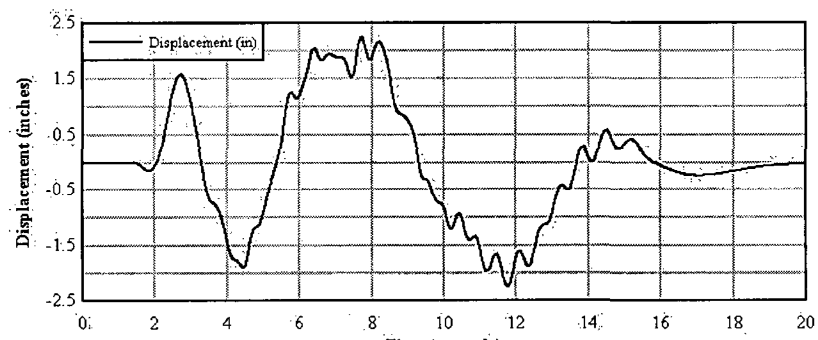
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record A-ELC-UP.UD (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record A-ELC-UP.UD (For Information Only)



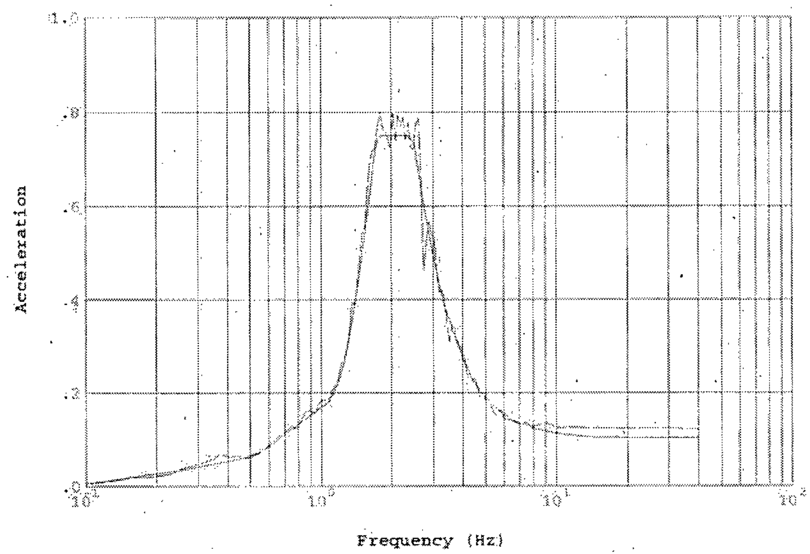
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 1 - Record A-ELC-UP.UD (For Information Only)



ABS Consulting

Attachment C

				Rev 1	**Sheet No.** C 13
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08



Legend:
Modified Target ARS
From A-ELC-UP Seed

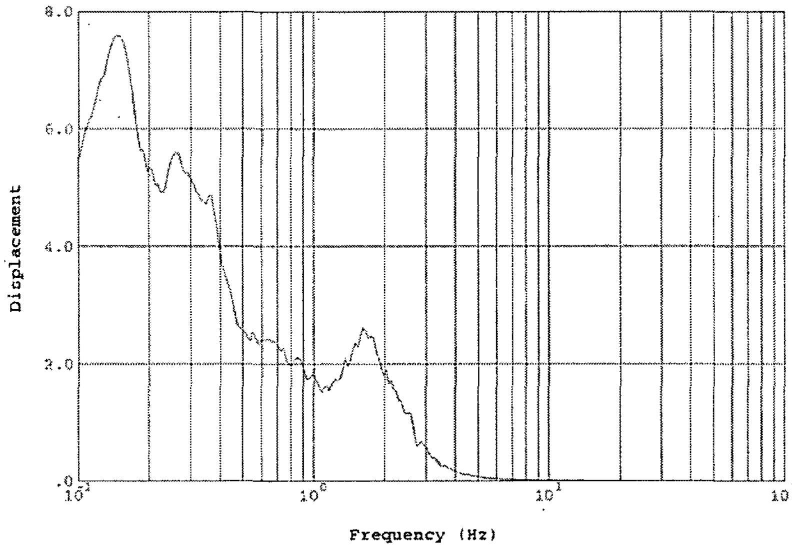
Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
Vertical Direction

ABS Consulting

Attachment C

			Rev 1	**Sheet No.**	*C 14*
Job No.	1886592	**Job** ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj** Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum Vertical Direction
Data Set 1 - From A-ELC-UP Seed

(For Information Only)

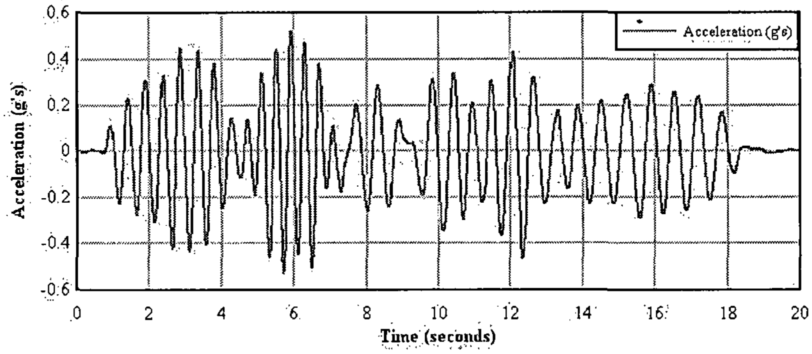
ABS Consulting

Attachment C

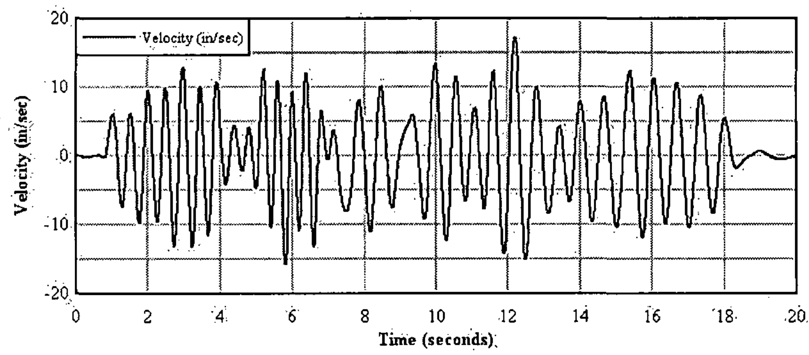
			Rev 1	**Sheet No.**	C 15
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08

Final Generated Time History – Data Set 2 EW Direction

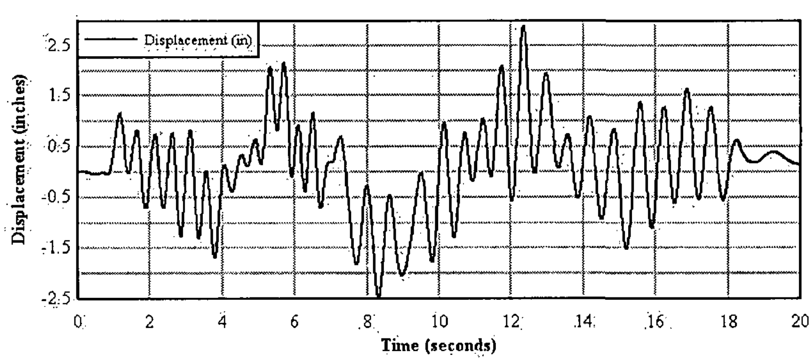
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record SBA042 EW (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record SBA042 EW (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record SBA042 EW (For Information Only)



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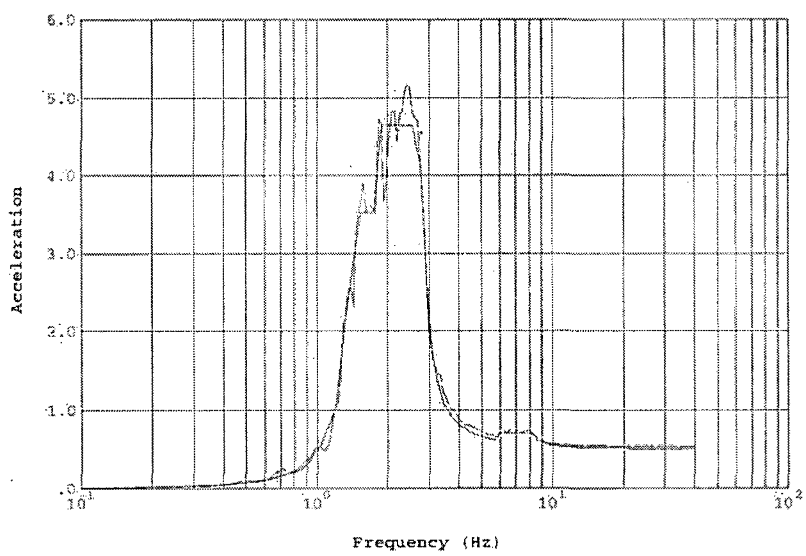
Attachment C

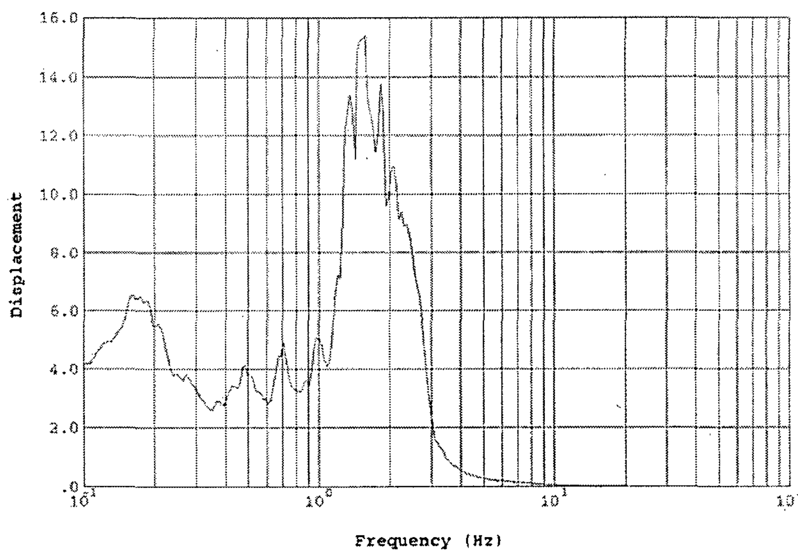
			Rev 1	Sheet No.	C 16
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date**	5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date**	5/23/08



Legend:
Modified Target ARS
From SBA042 Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
East/West Direction



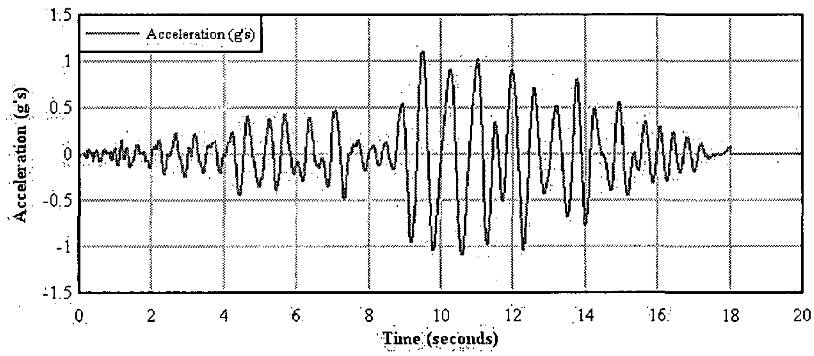
Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum East/West Direction
Data Set 2 - From SBA042 Seed

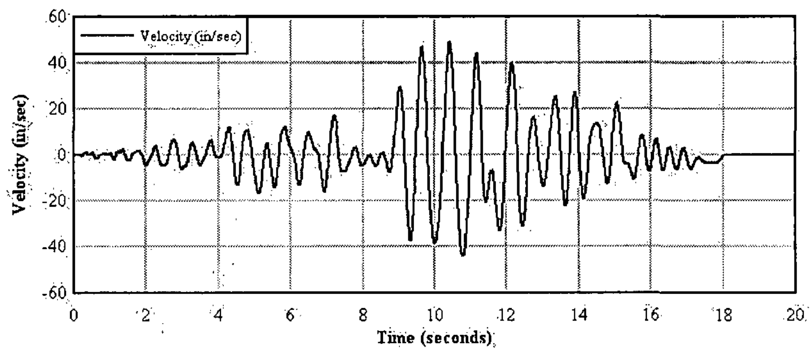
(For Information Only)

Final Generated Time History – Data Set 2 NS Direction

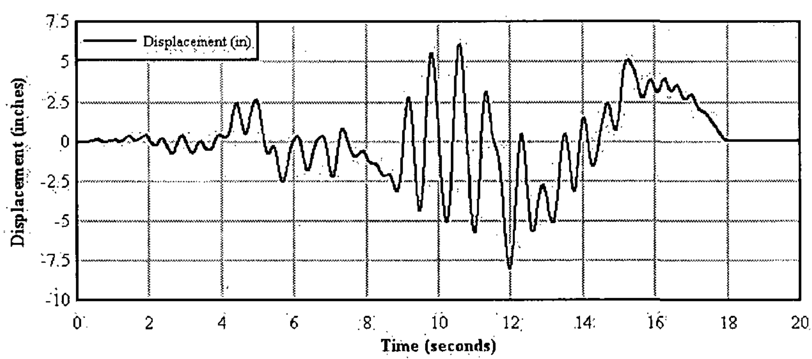
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record HCH271 NS (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record HCH271 NS (For Information Only)



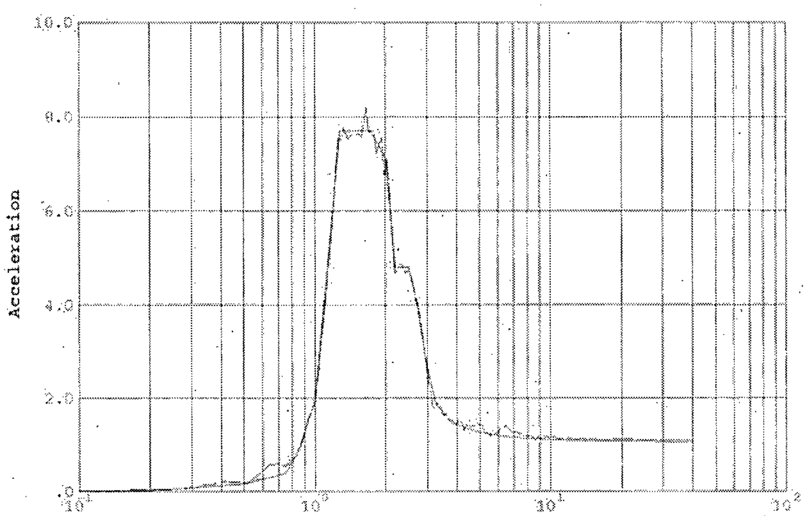
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record HCH271 NS (For Information Only)



ABS Consulting

Attachment C

				Rev	1	**Sheet No.**	C 19
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

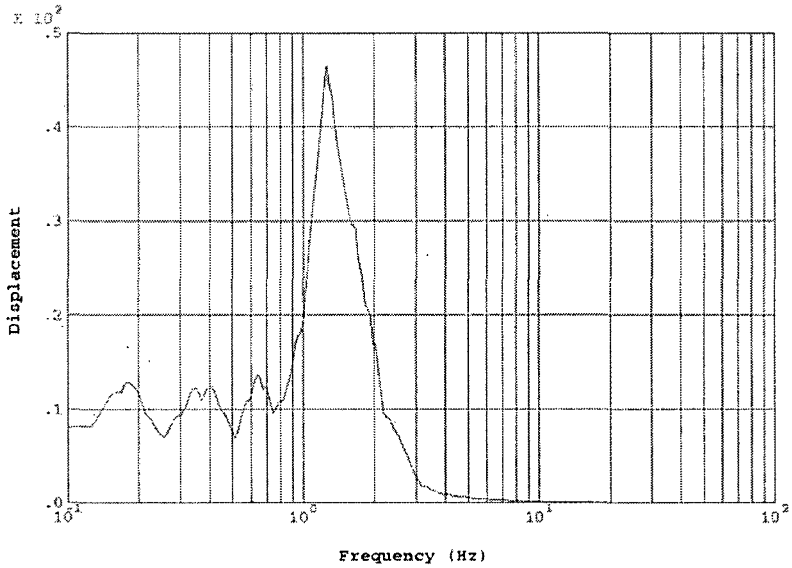


Legend:
Modified Target ARS
From HCH271 Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
North/South Direction

ABS Consulting			**Attachment C**			
			Rev	1	**Sheet No.**	C 20
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum North/South Direction
Data Set 2 - From HCH271 Seed

(For Information Only)

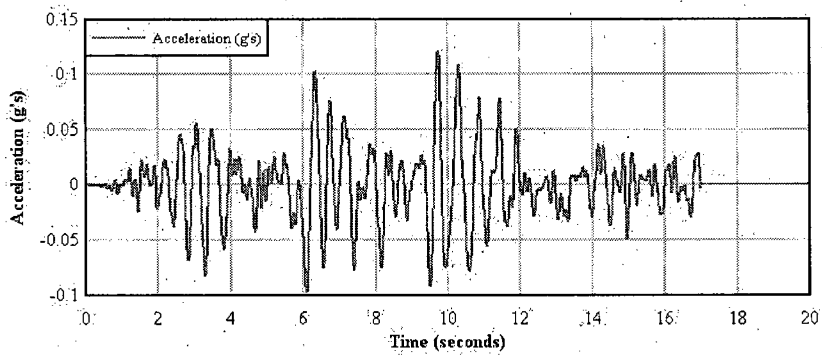
ABS Consulting

Attachment C

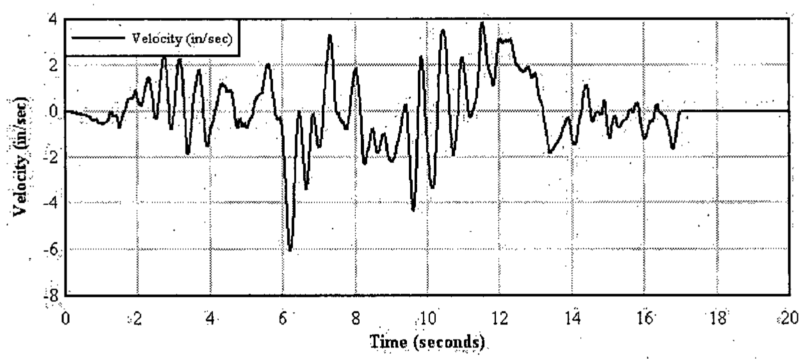
				Rev	1	**Sheet No.**	C 21
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Final Generated Time History – Data Set 2 Vertical Direction

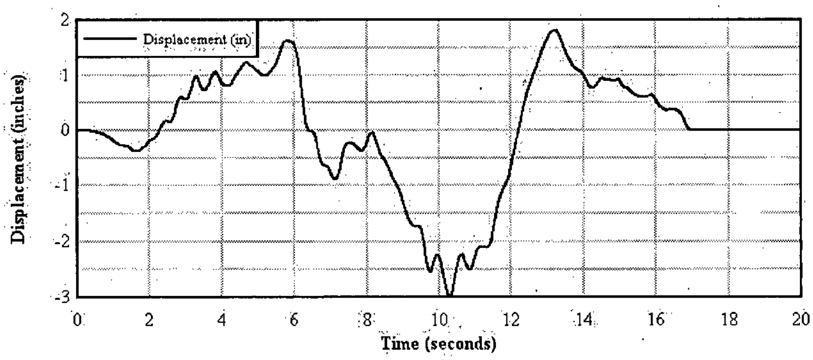
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record TAF-UP UD (For Information Only)



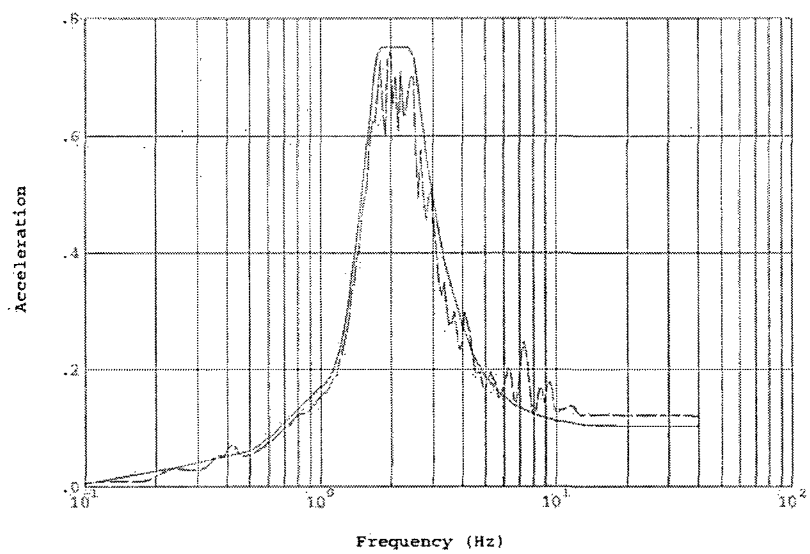
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record TAF-UP UD (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 2 - Record TAF-UP UD (For Information Only)



ABS Consulting				**Attachment C**	
			Rev 1	**Sheet No.**	C 22
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



Legend:
Modified Target ARS
From TAF-UP Seed

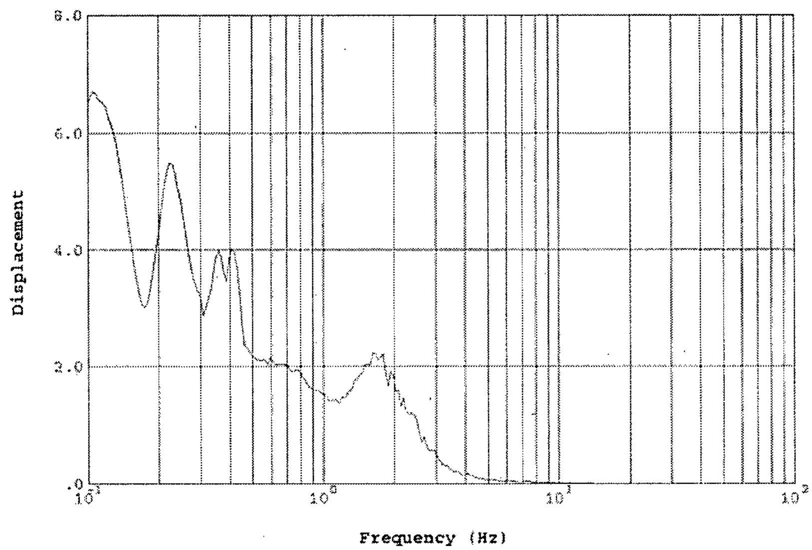
Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
Vertical Direction

ABS Consulting

Attachment C

			Rev 1	**Sheet No.** C 23	
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08

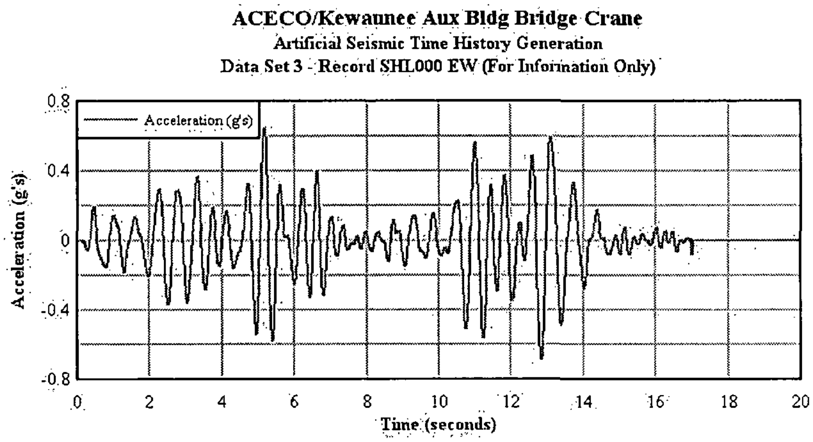


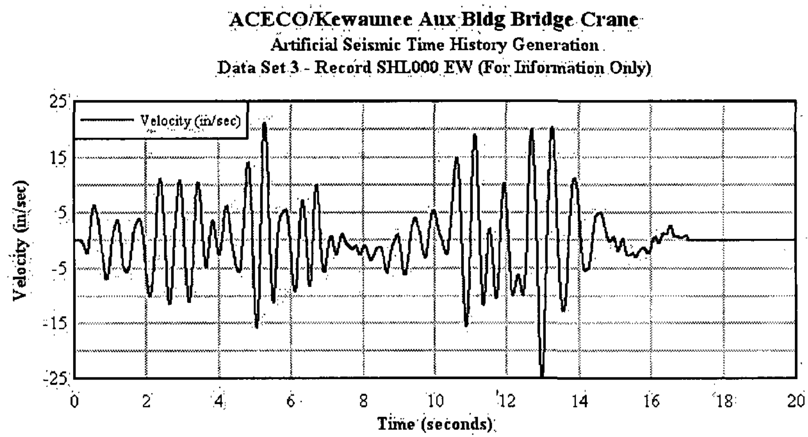
Notes:
All curves: 2% Spectral Damping
Displacement in inches

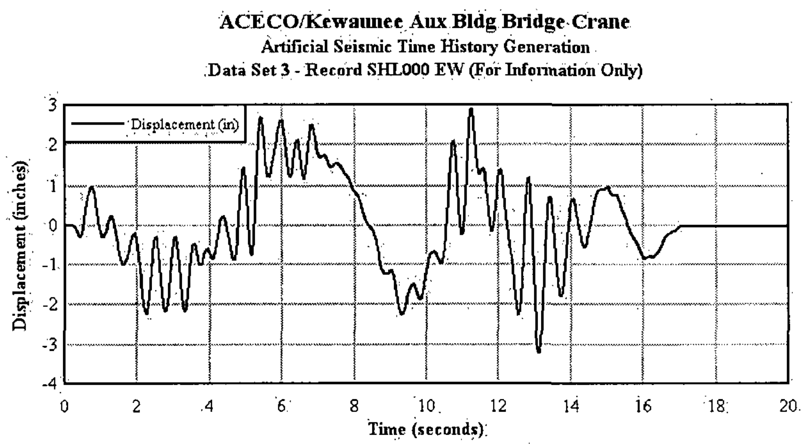
Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum Vertical Direction
Data Set 2 - From TAF-UP Seed

(For Information Only)

Final Generated Time History – Data Set 3 EW Direction







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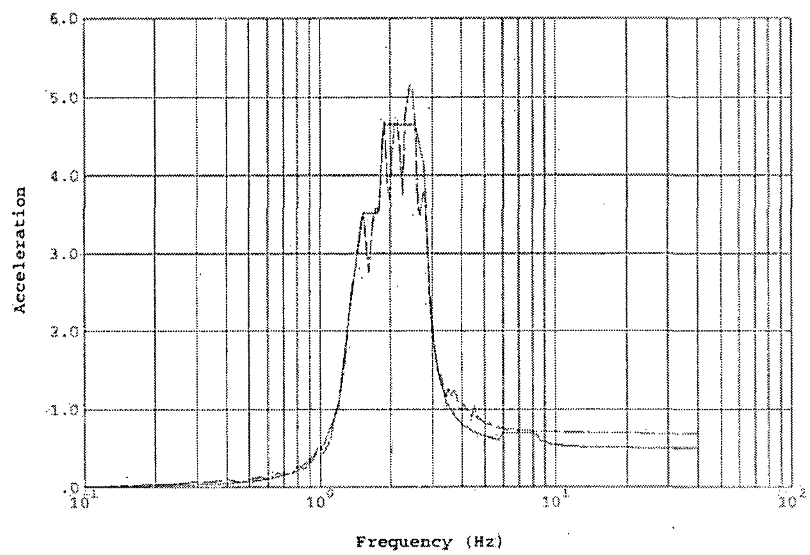
Attachment C

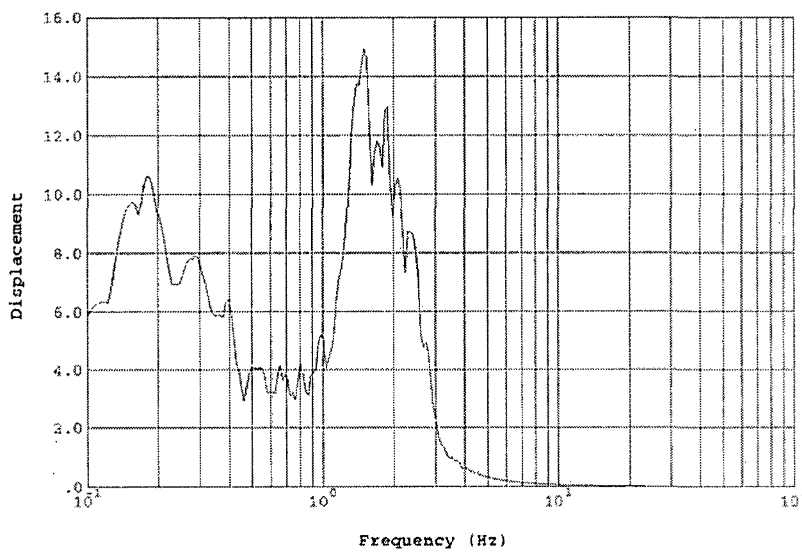
			Rev 1	**Sheet No.**	C 25
Job No.	1886592	**Job** ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj** Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



Legend:
Modified Target ARS
From SHL000 Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
East/West Direction



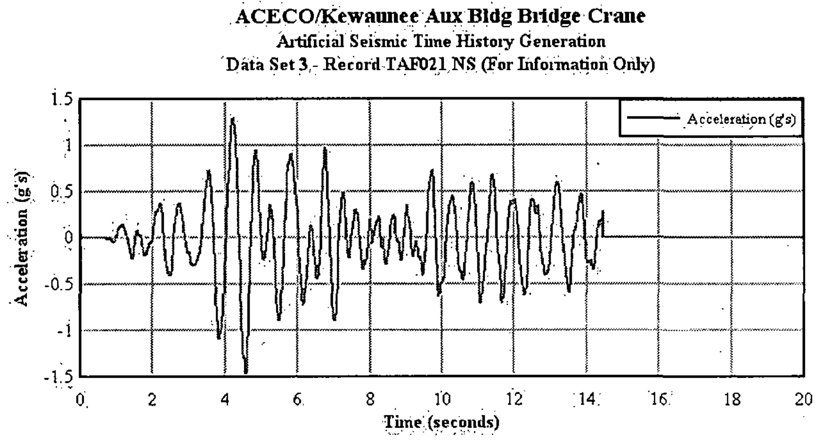
Notes:
All curves: 2% Spectral Damping
Displacement in inches

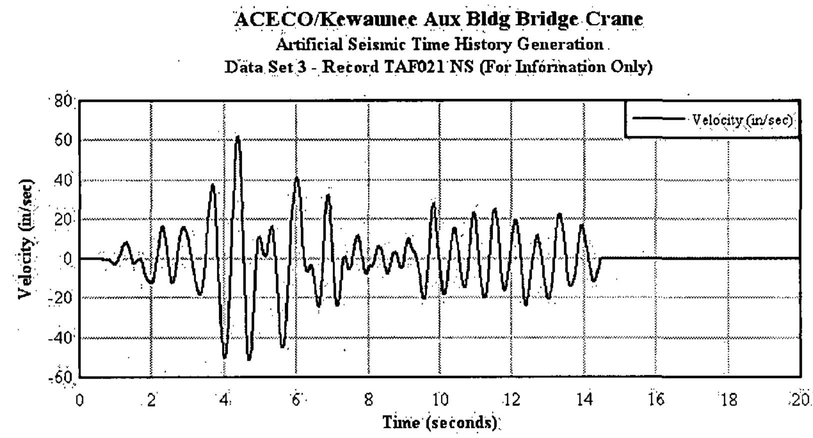
Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum East/West Direction
Data Set 3 - From SHL000 Seed

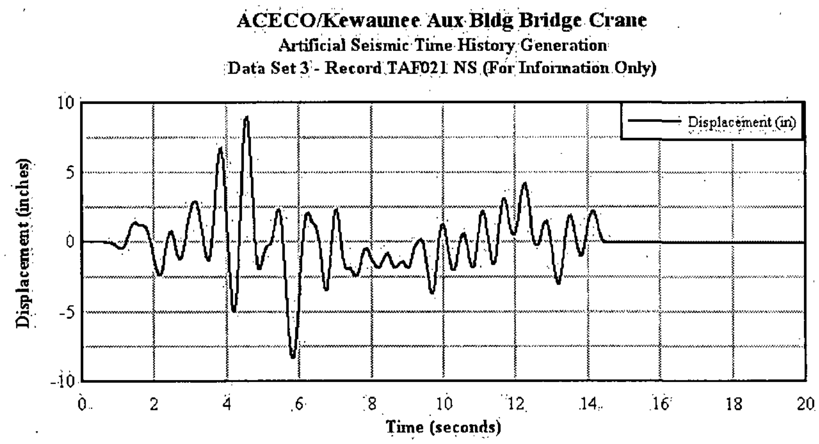
(For Information Only)

ABS Consulting			Attachment C	
			Rev 1	Sheet No. C 27
Job No. 1886592	Job	ACECO – Kewaunee Aux Bldg Bridge Crane	By M.C.Ozbey	Date 5/22/08
Calc. No. 1886592-C-001	Subj	Generation of Artificial Seismic Time Histories	Checked W.Sawruk	Date 5/23/08

Final Generated Time History – Data Set 3 NS Direction



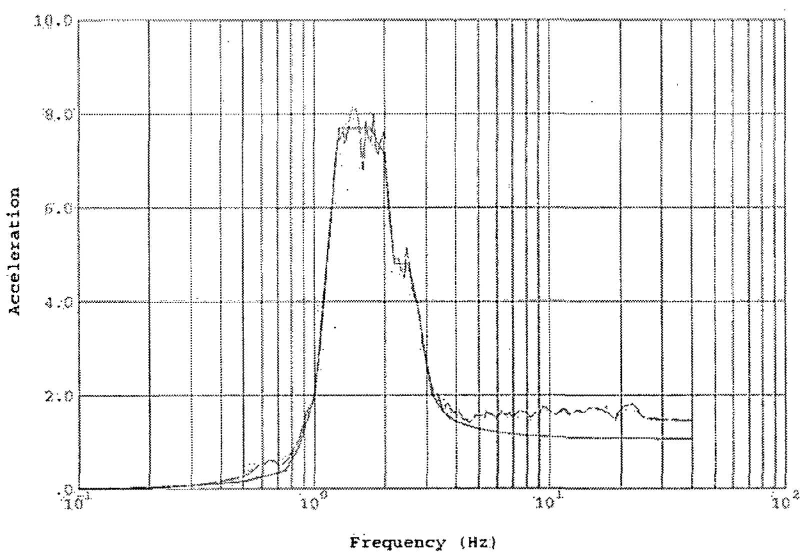




ABS Consulting

Attachment C

			Rev 1	**Sheet No.**	*C 28*
Job No.	1886592	**Job** ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj** Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



Legend:

Modified Target ARS

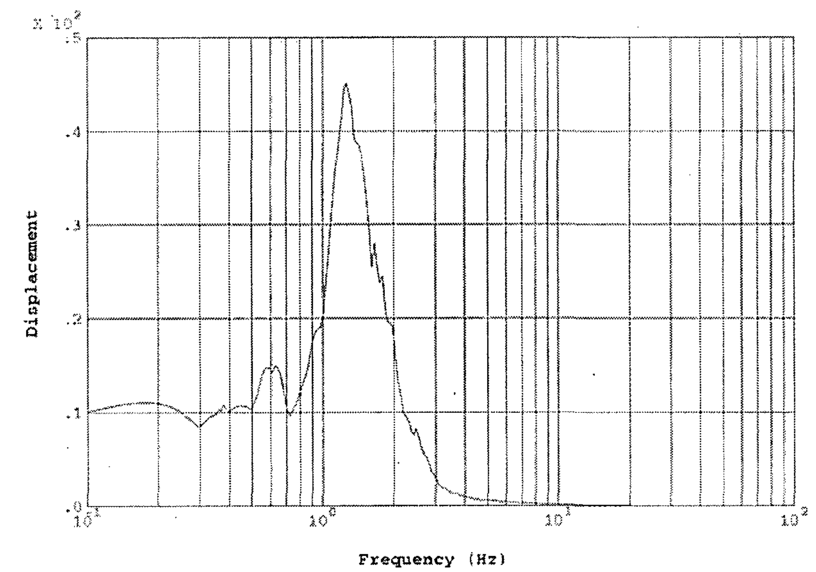
From TAF021 Seed

Notes:

All curves: 2% Spectral Damping

Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
North/South Direction



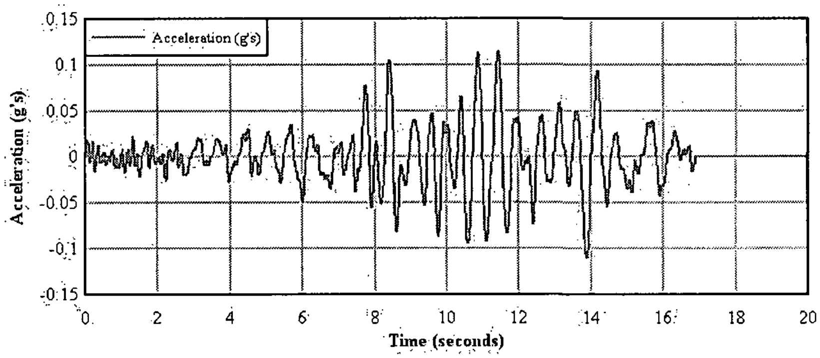
Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum North/South Direction
Data Set 3 - From TAF021 Seed

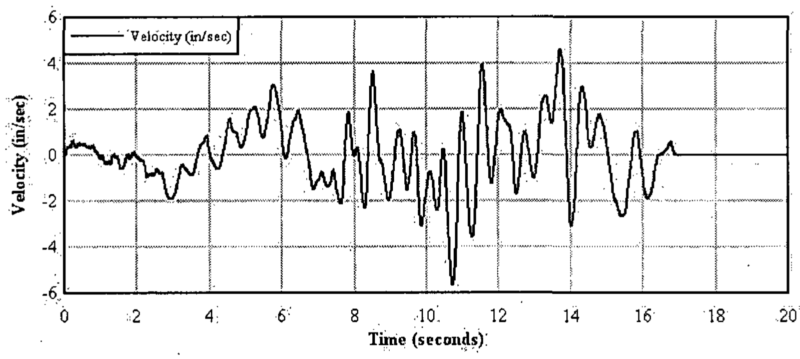
(For Information Only)

Final Generated Time History – Data Set 3 Vertical Direction

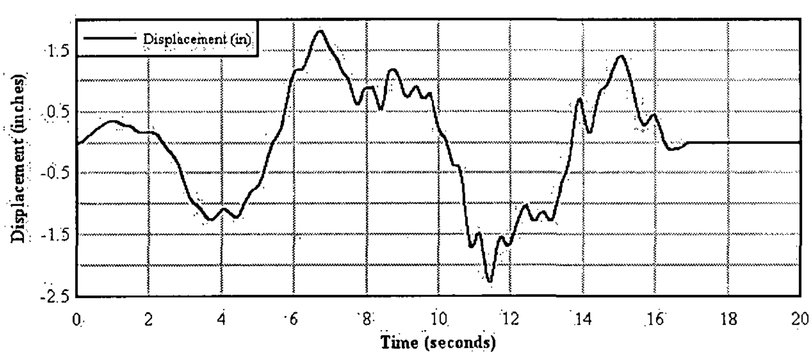
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 3 - Record SKR-UP UD (For Information Only)



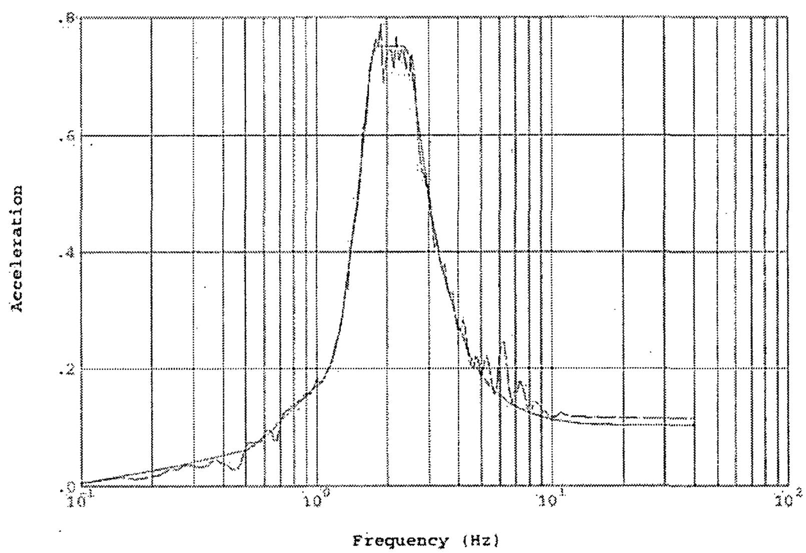
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 3 - Record SKR-UP UD (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 3 - Record SKR-UP UD (For Information Only)



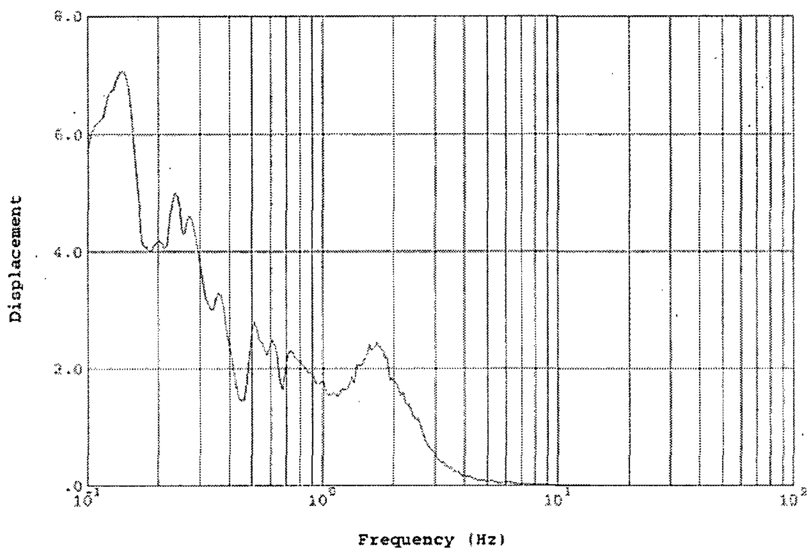
ABS Consulting			Attachment C			
			Rev	1	**Sheet No.**	C 31
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Legend:
Modified Target ARS ————
From SKR-UP Seed - - - - -

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
Vertical Direction



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum Vertical Direction
Data Set 3 - From SKR-UP Seed

(For Information Only)

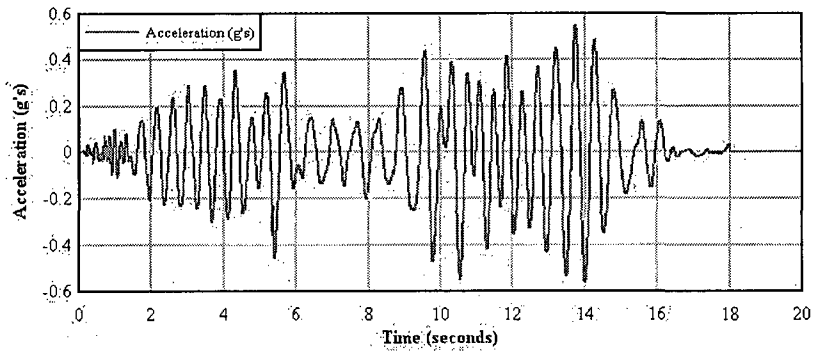
ABS Consulting

Attachment C

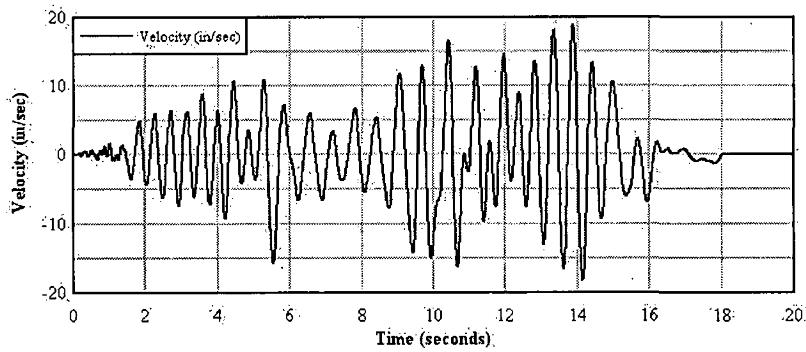
				Rev	1	**Sheet No.**	C 33
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Final Generated Time History – Data Set 4 EW Direction

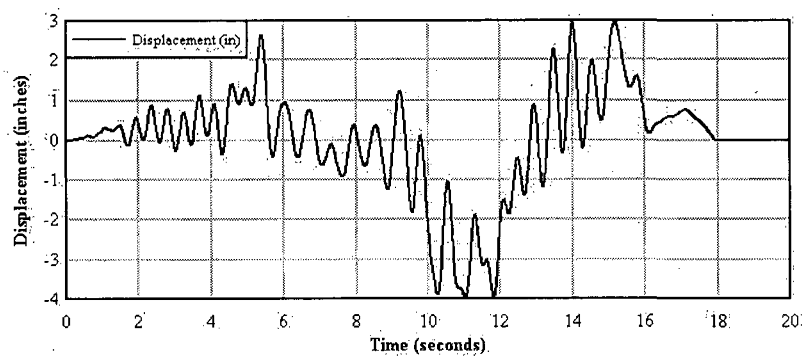
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record HCH271 EW (For Information Only)

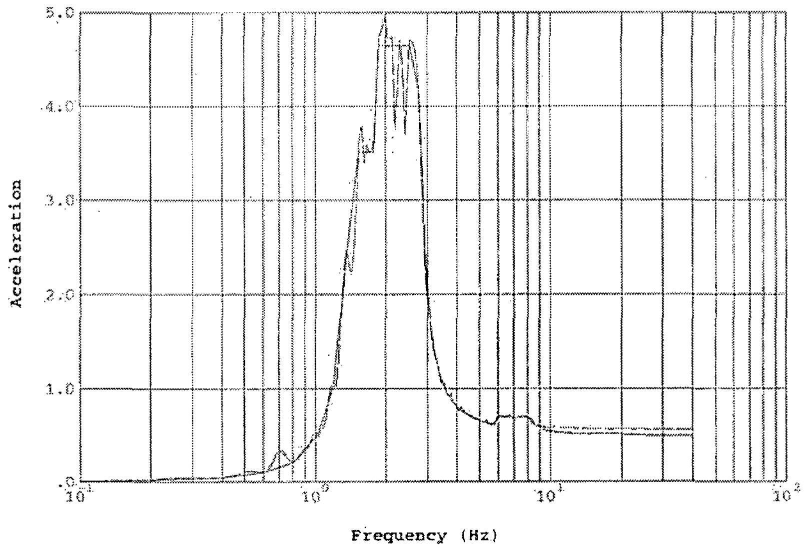


ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record HCH271 EW (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record HCH271 EW (For Information Only)



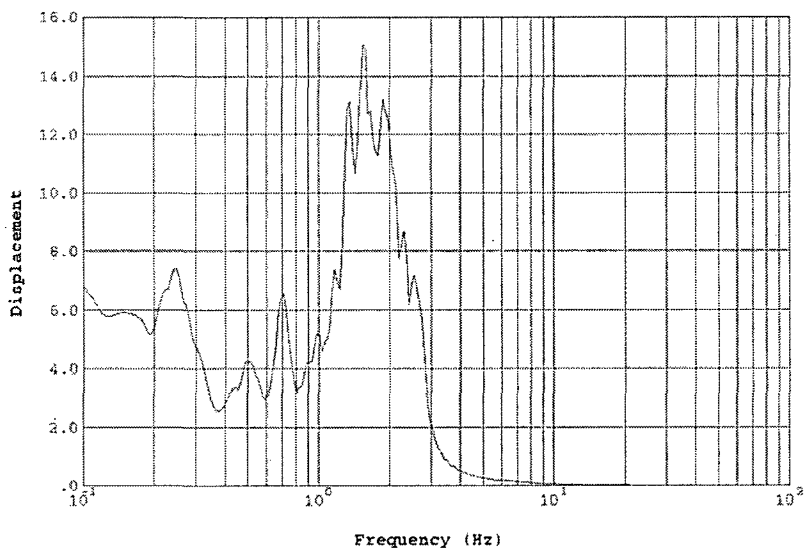


Legend:
Modified Target ARS
From HCH271 Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
East/West Direction

ABS Consulting				Attachment C	
				Rev 1	**Sheet No.** C 35
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

BSPLT INTEL386 VERS 1.6P COMPILED 03/13/97 09:52:27 EXECUTED 05/22/08 11:20:35

Disp_EW.ps

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum East/West Direction
Data Set 4 - From HCH271 Seed

(For Information Only)

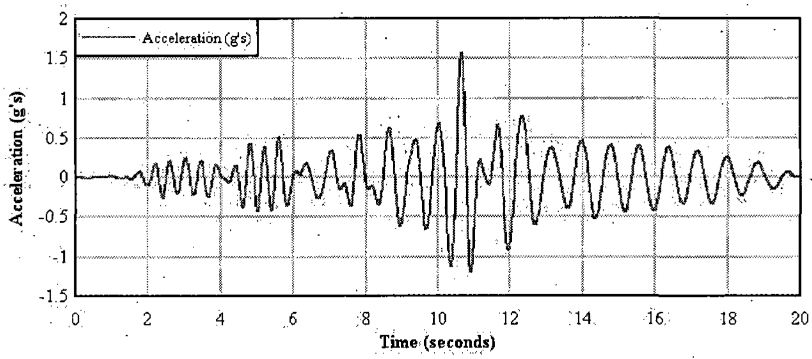
ABS Consulting

Attachment C

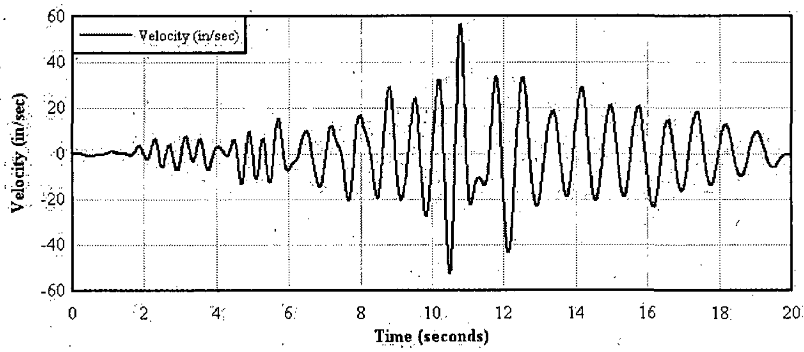
				Rev	1	Sheet No.	C 36
Job No.	1886592	Job	ACECO – Kewaunee Aux Bldg Bridge Crane	By	M.C.Ozbey	Date	5/22/08
Calc. No.	1886592-C-001	Subj	Generation of Artificial Seismic Time Histories	Checked	W.Sawruk	Date	5/23/08

Final Generated Time History – Data Set 4 NS Direction

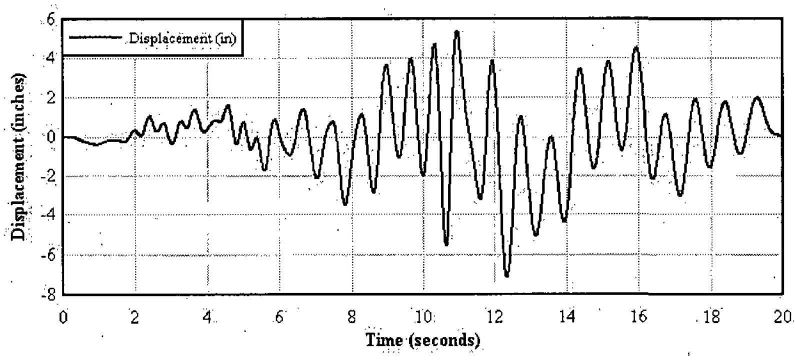
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record A-STP093 NS (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record A-STP093 NS (For Information Only)



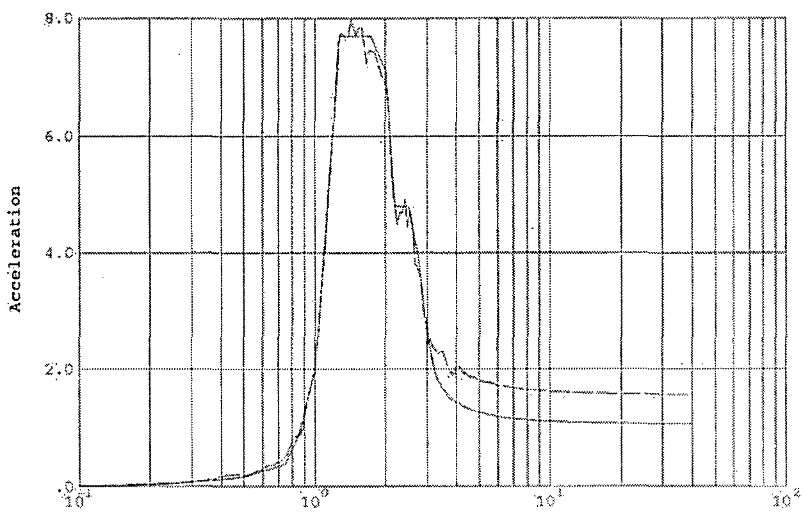
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record A-STP093 NS (For Information Only)



ABS Consulting

Attachment C

				Rev	1	Sheet No.	C 37
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Legend:
Modified Target ARS
From A-STP093 Seed

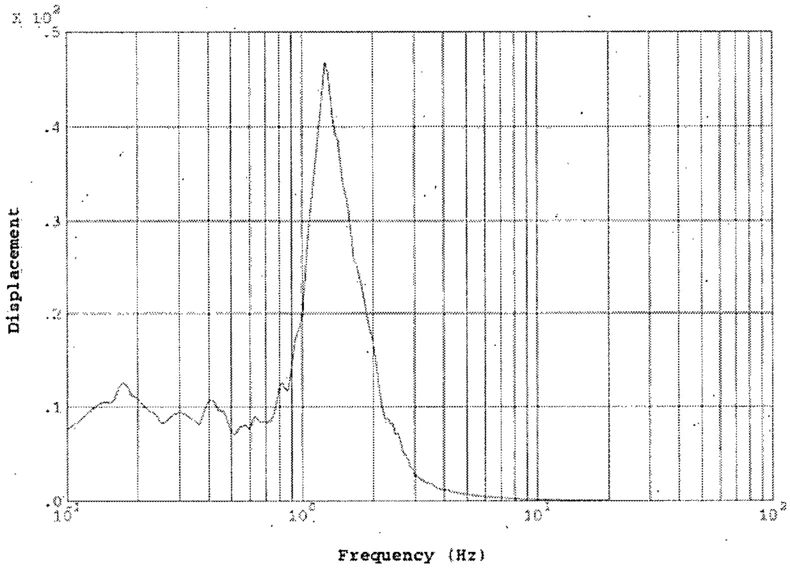
Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
North/South Direction

ABS Consulting

Attachment C

				Rev	1	**Sheet No.**	C 38
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum North/South Direction
Data Set 4 - From A-STP093 Seed

(For Information Only)

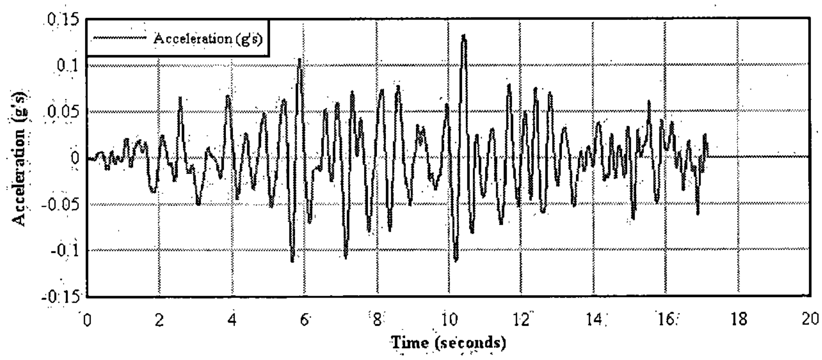
ABS Consulting

Attachment C

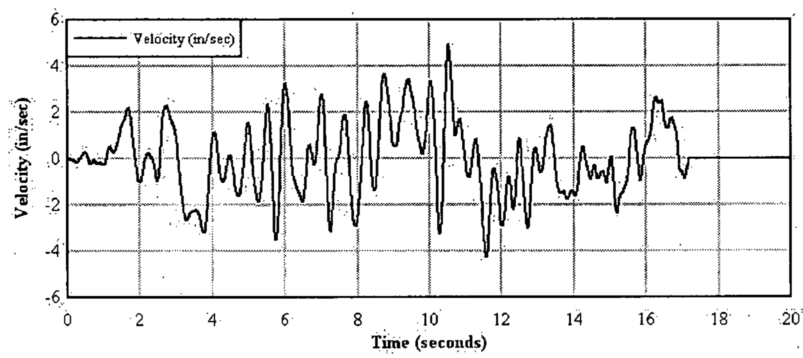
			Rev 1	**Sheet No.**	C 39
Job No.	1886592	**Job** ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj** Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08

Final Generated Time History – Data Set 4 Vertical Direction

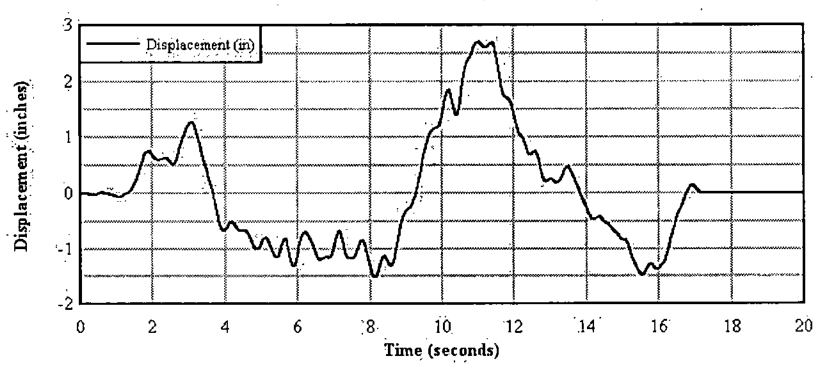
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record SIL-UP UD (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record SIL-UP UD (For Information Only)



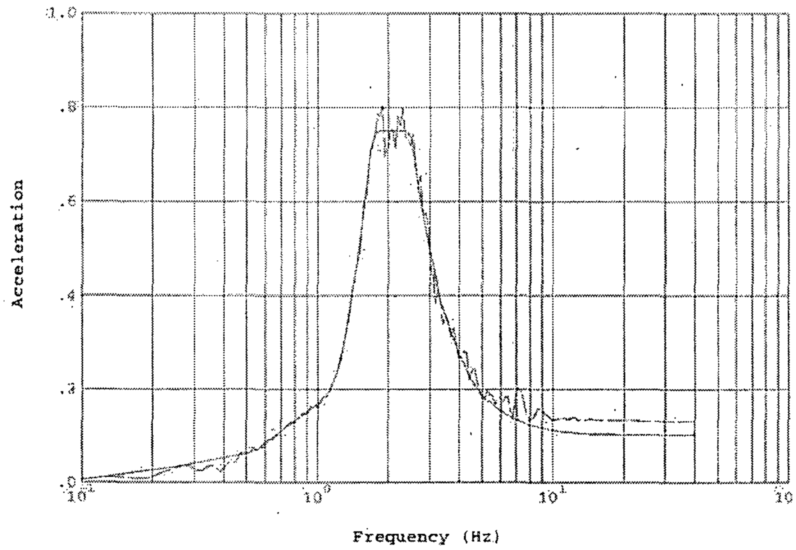
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 4 - Record SIL-UP UD (For Information Only)



ABS Consulting

Attachment C

				Rev 1	**Sheet No.** C 40
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date** 5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date** 5/23/08



Legend:
Modified Target ARS
From SIL-UP Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
Vertical Direction

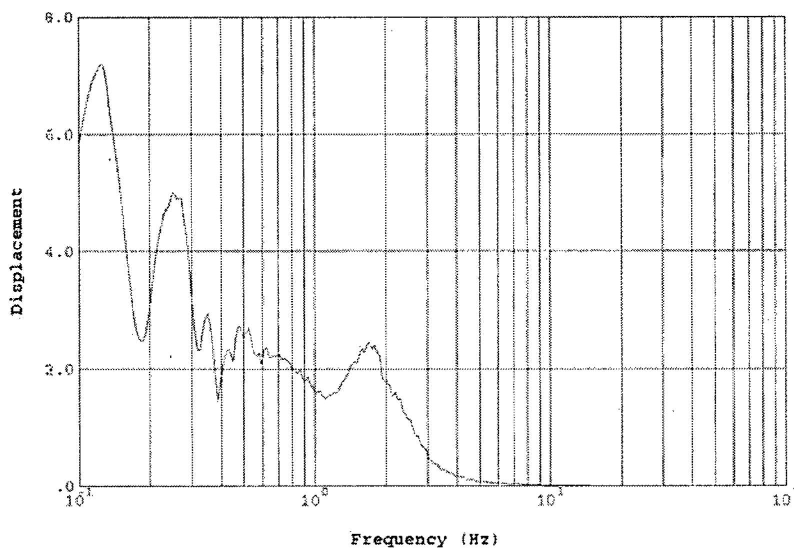
ABS Consulting

Attachment C

Rev 1 **Sheet No.** *C 41*

Job No. 1886592 **Job** ACECO – Kewaunee Aux Bldg Bridge Crane **By** M.C.Ozbey **Date** 5/22/08

Calc. No. 1886592-C-001 **Subj** Generation of Artificial Seismic Time Histories **Checked** W.Sawruk **Date** 5/23/08

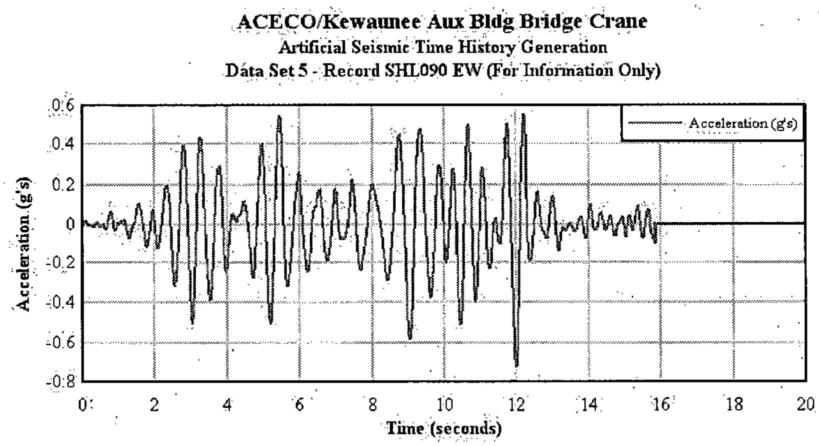


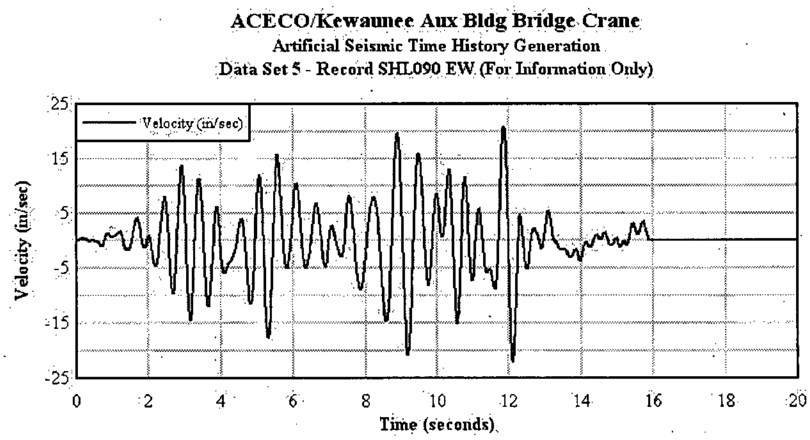
Notes:
All curves: 2% Spectral Damping
Displacement in inches

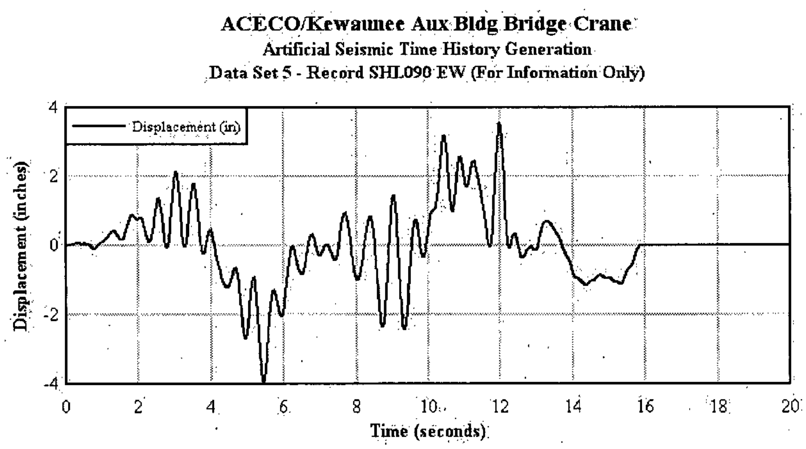
Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum Vertical Direction
Data Set 4 - From SIL-UP Seed

(For Information Only)

Final Generated Time History – Data Set 5 EW Direction



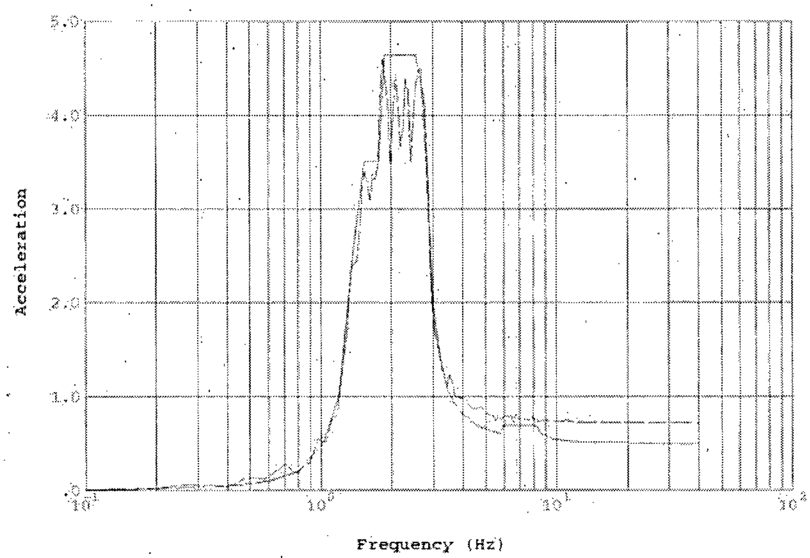




ABS Consulting

Attachment C

				Rev	1	**Sheet No.**	*C 43*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

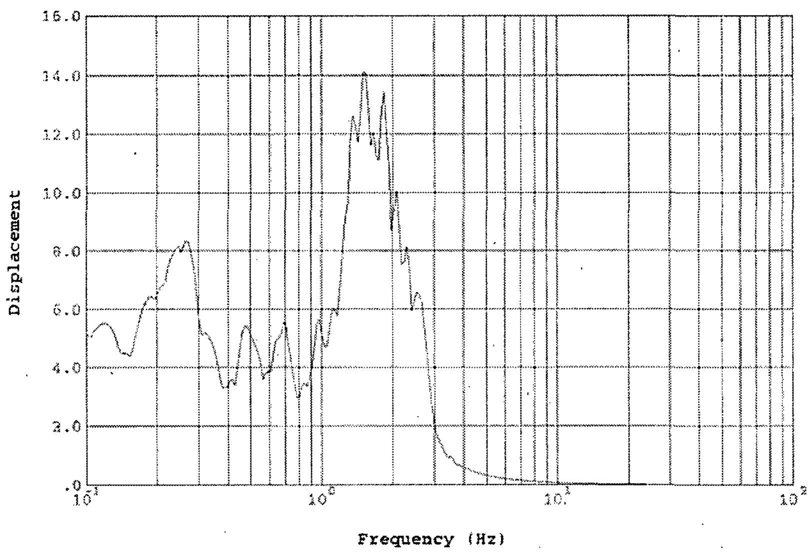


Legend:
Modified Target ARS
From SHL090 Seed

Notes:
All curves: 2% Spectral Damping
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
East/West Direction

ABS Consulting				Attachment C	
				Rev 1	**Sheet No.** C 44
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08



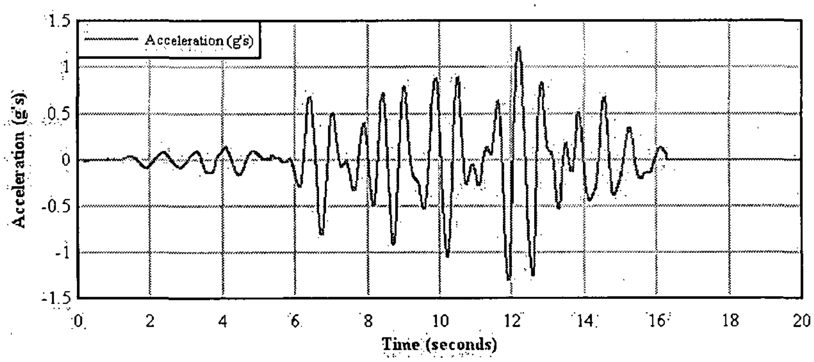
Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum East/West Direction
Data Set 5 - From SHL090 Seed

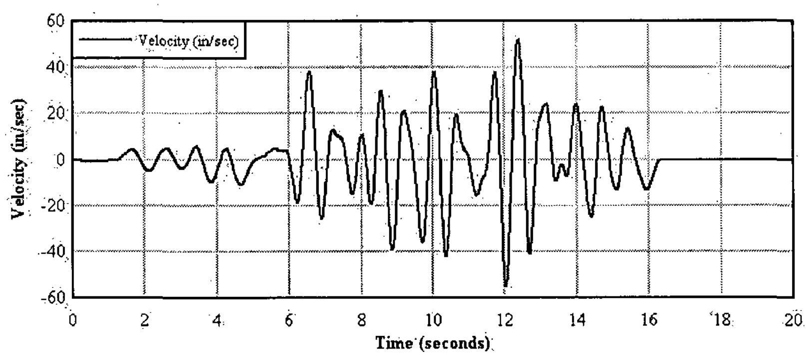
(For Information Only)

Final Generated Time History – Data Set 5 NS Direction

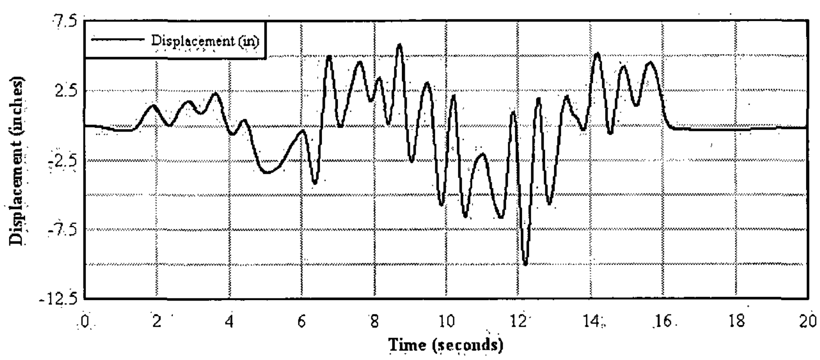
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 5 - Record A-PEL090 NS (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 5 - Record A-PEL090 NS (For Information Only)



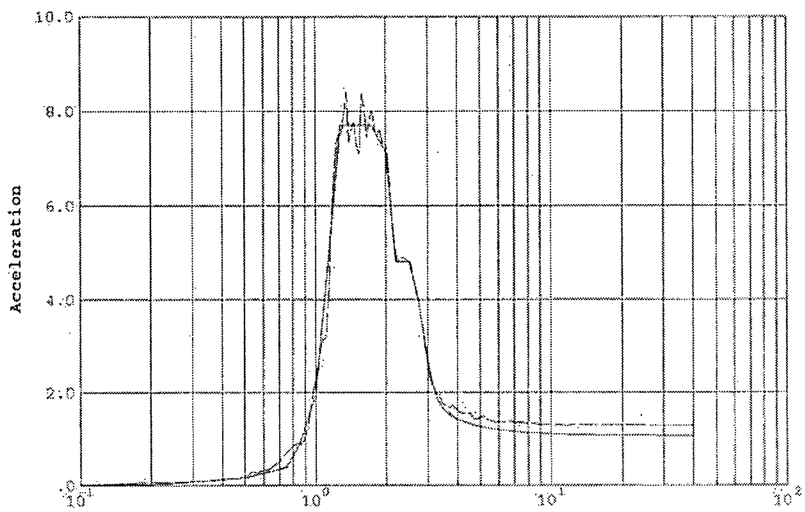
ACECO/Kewaunee Aux Bldg Bridge Crane
Artificial Seismic Time History Generation
Data Set 5 - Record A-PEL090 NS (For Information Only)



![ABS Consulting]

Attachment C

				Rev	1	**Sheet No.**	*C 46*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Legend:

Modified Target ARS

From A-PEL090 Seed

Notes:

All curves: 2% Spectral Damping

Acceleration in g's

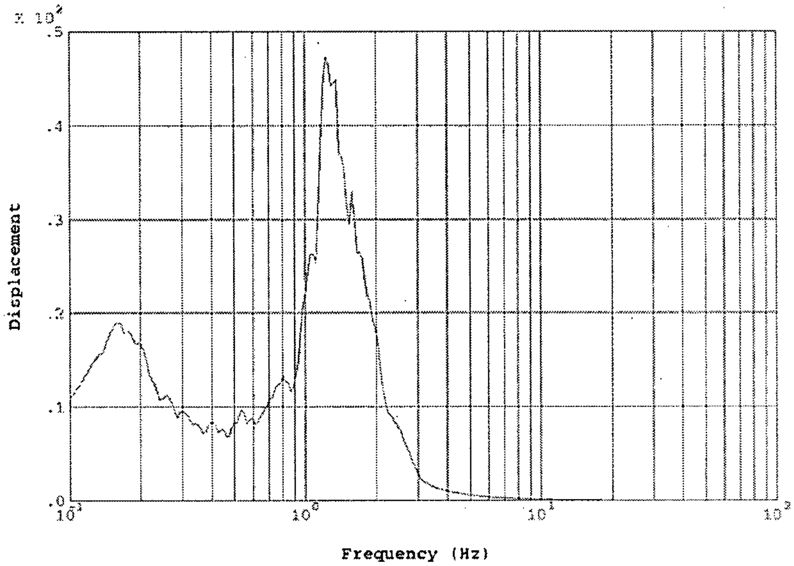
Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
North/South Direction

ABS Consulting

Attachment C

Rev 1 **Sheet No.** *C 47*

Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum North/South Direction
Data Set 5 - From A-PEL090 Seed

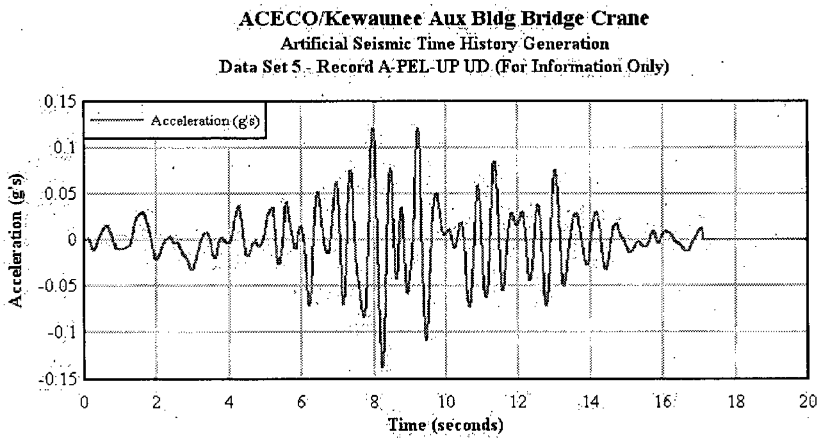
(For Information Only)

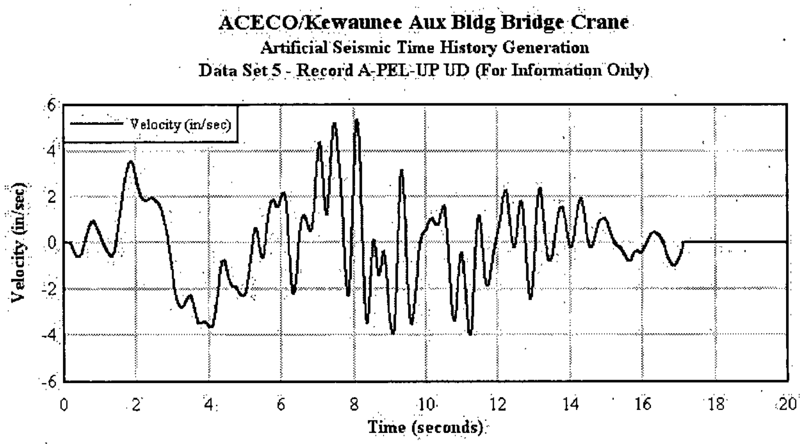
ABS Consulting

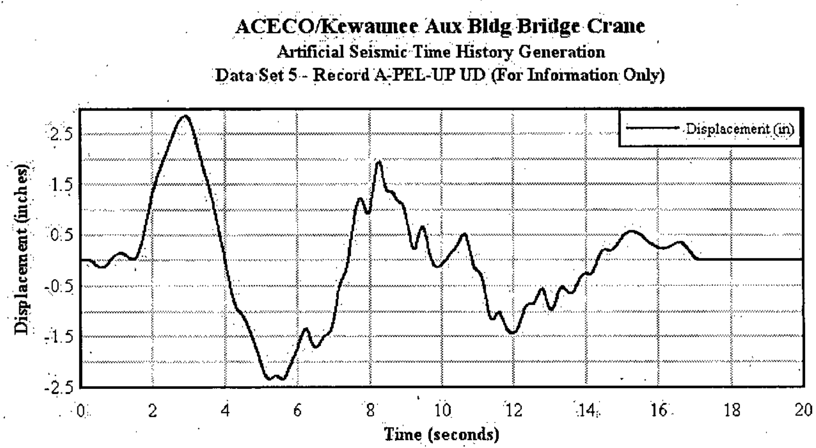
Attachment C

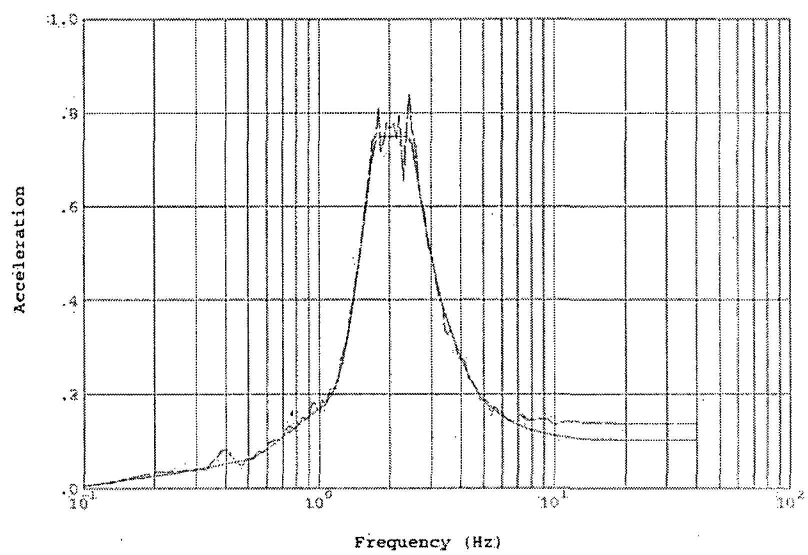
				Rev	1	**Sheet No.**	C 48
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Final Generated Time History – Data Set 5 Vertical Direction









Legend:

Modified Target ARS

From A-PEL-UP Seed

Notes:

All curves: 2% Spectral Damping

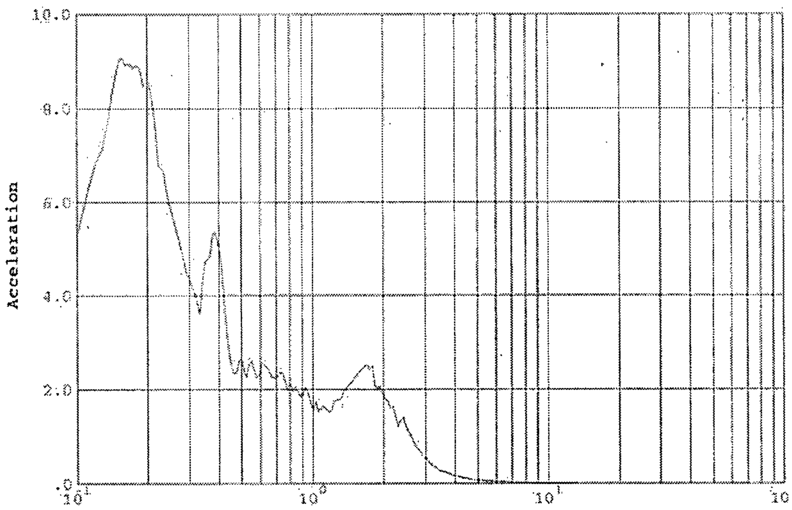
Acceleration in g's

Kewaunee Power Station - Aux Building Crane Rail Elevation
Comparison of Achieved and Target Spectra
Vertical Direction

ABS Consulting

Attachment C

			Rev 1	**Sheet No.**	*C 50*
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By** M.C.Ozbey	**Date**	5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked** W.Sawruk	**Date**	5/23/08



Notes:
All curves: 2% Spectral Damping
Displacement in inches

Kewaunee Power Station - Aux Building Crane Rail Elevation
Displacement Response Spectrum Vertical Direction
Data Set 5 - From A-PEL-UP Seed

(For Information Only)

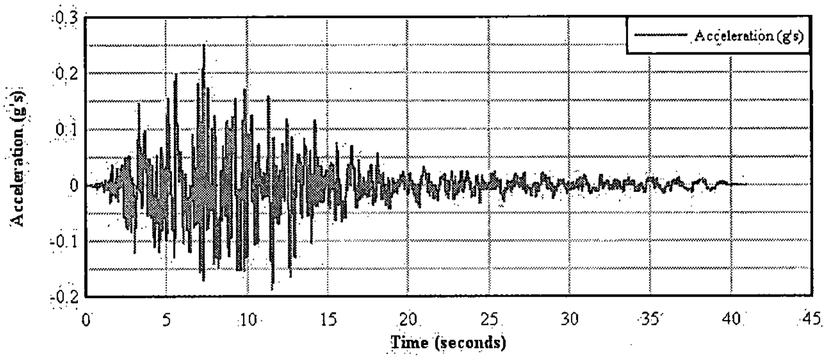
ATTACHMENT D

Plots of Seed Time Histories

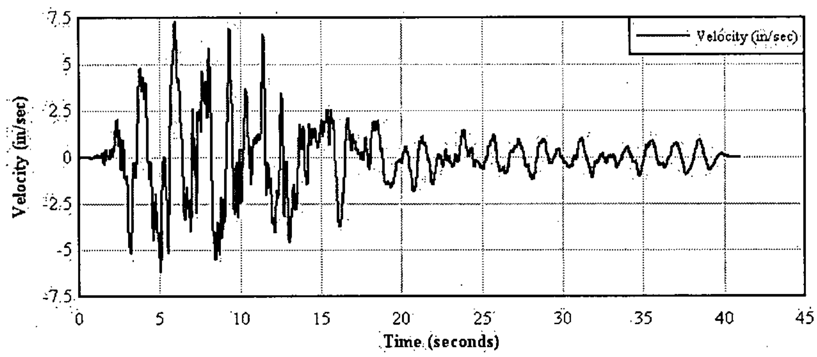
This attachment contains plots of the fifteen seed acceleration time histories obtained from (http://peer.berkeley.edu/smcat). The associated velocity and displacement time histories are calculated using DPLOT without any corrections being applied. Note that all the plots shown in this attachment are "For Information Only" since they were plotted using non-QA software (See Section 3.1 for discussion).

Seed Time History Data Set #1 – EW Direction

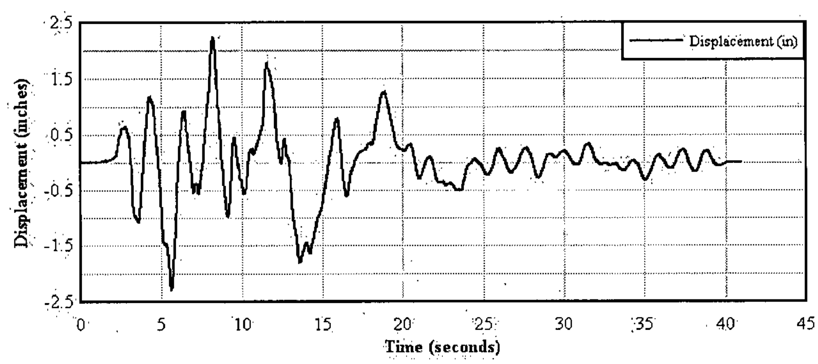
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record KAK000 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record KAK000 (For Information Only)

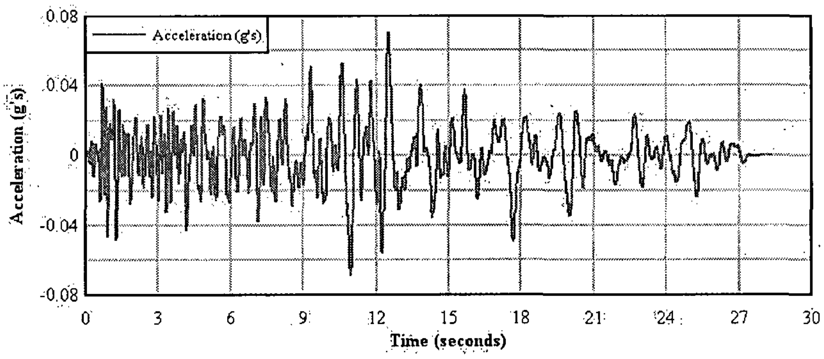


ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record KAK000 (For Information Only)

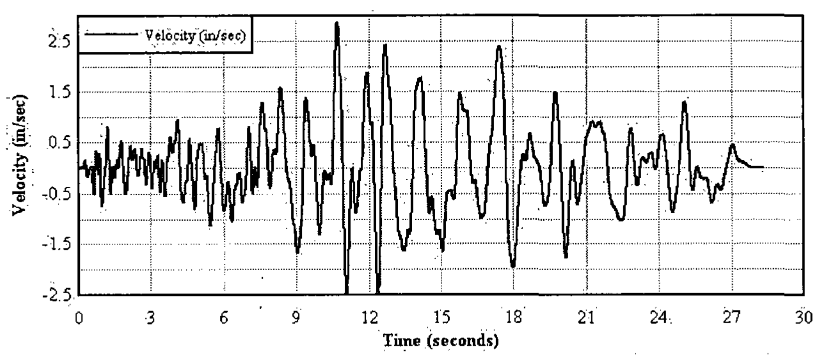


Seed Time History For Data Set #1 – NS Direction

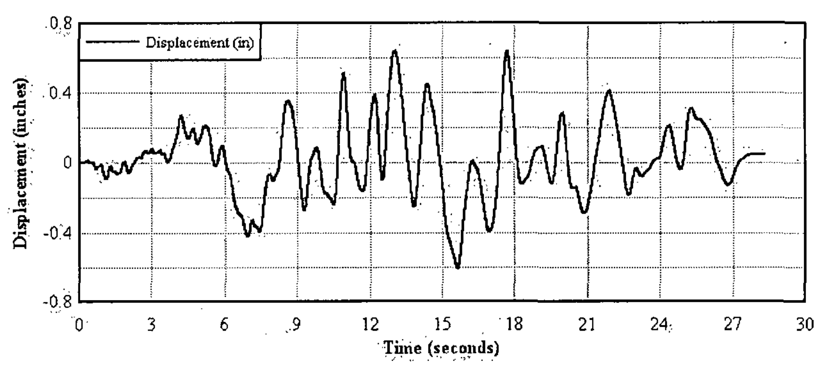
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record HCH001 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record HCH001 (For Information Only)

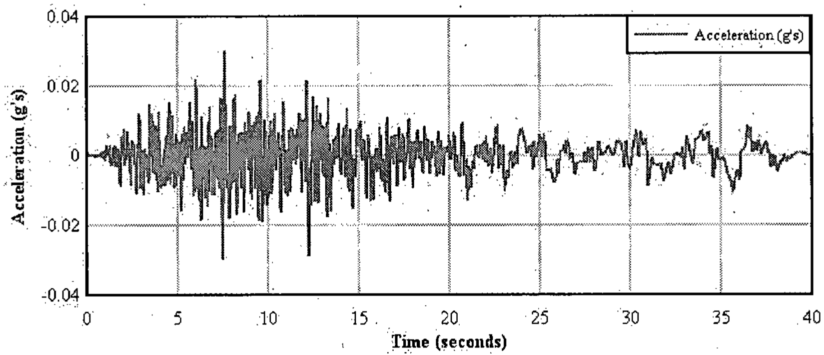


ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record HCH001 (For Information Only)

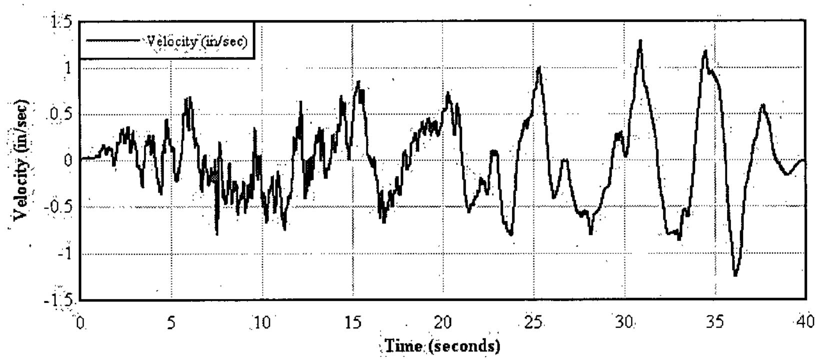


Seed Time History For Data Set #1 – Vert Direction

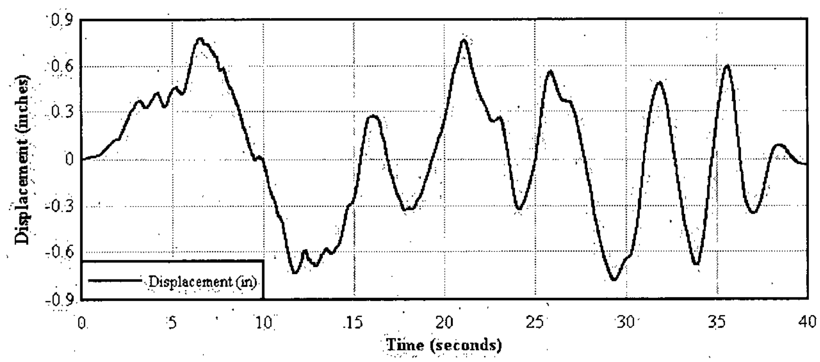
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Data
Record A-ELC-UP (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record A-ELC-UP (For Information Only)

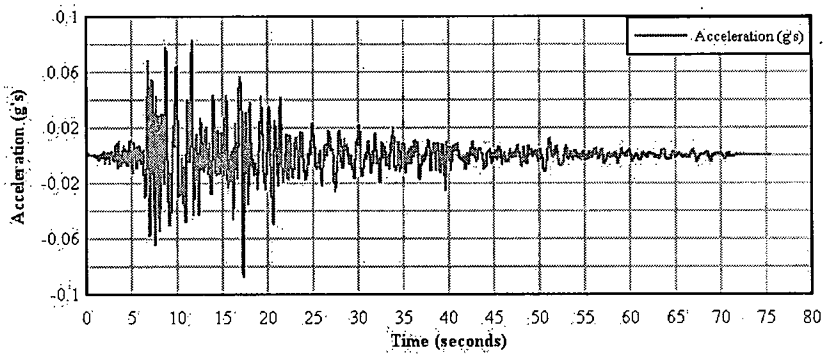


ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record A-ELC-UP (For Information Only)

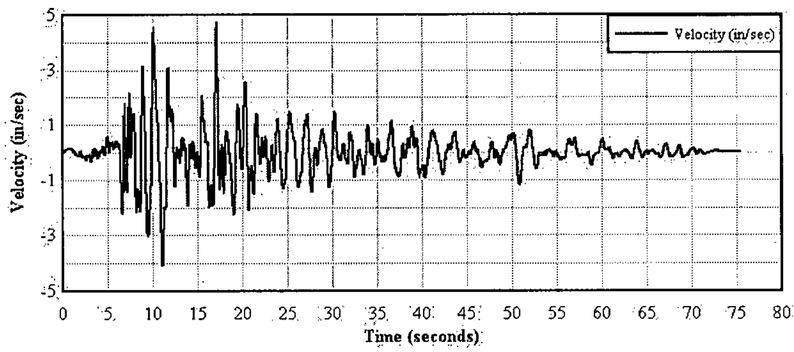


Seed Time History Data Set #2 – EW Direction

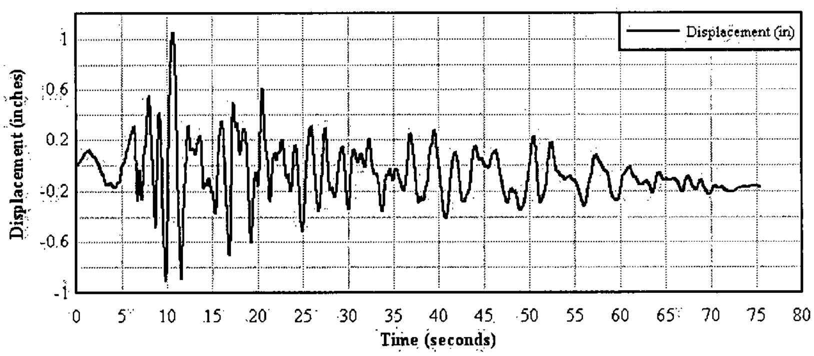
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SBA-042 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SBA-042 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record SBA-042 (For Information Only)

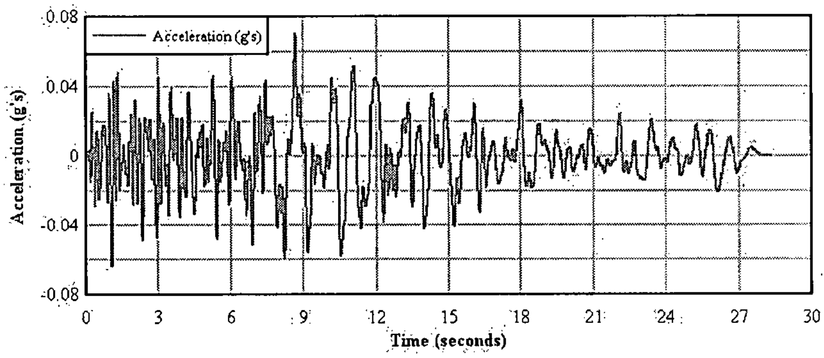


ABS Consulting | **Attachment D**

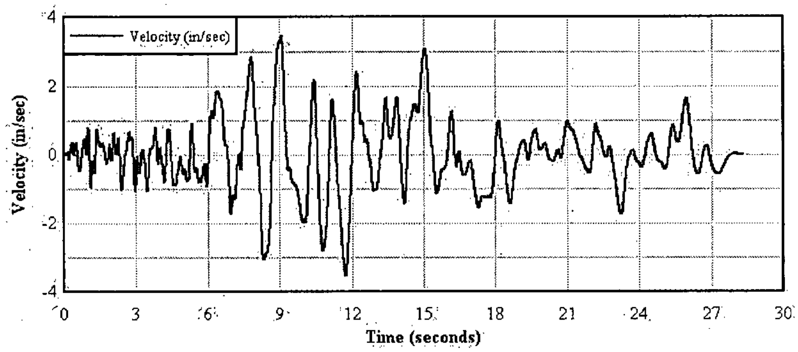
				Rev 1	**Sheet No.** D6
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08

Seed Time History Data Set #2 – NS Direction

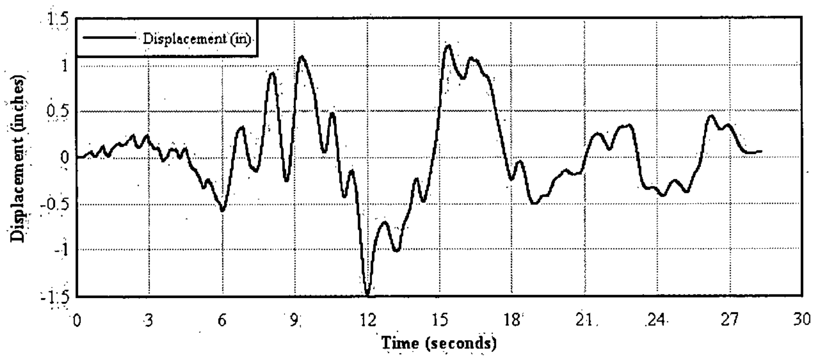
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record HCH271 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record HCH271 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record HCH271 (For Information Only)



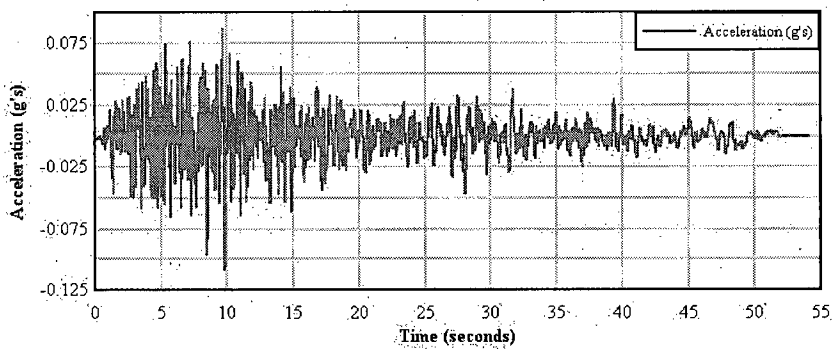
ABS Consulting

Attachment D

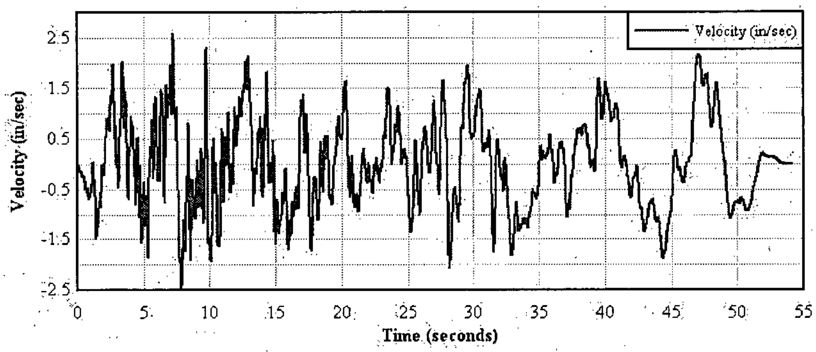
				Rev	1	**Sheet No.**	*D7*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Seed Time History Data Set #2 – Vert Direction

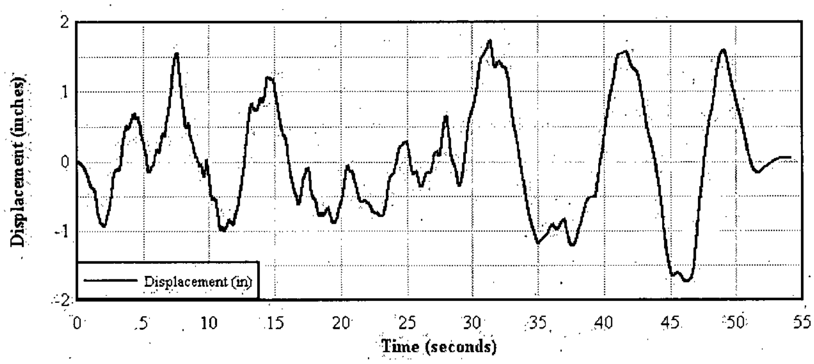
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record TAF-UP (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record TAF-UP (For Information Only)

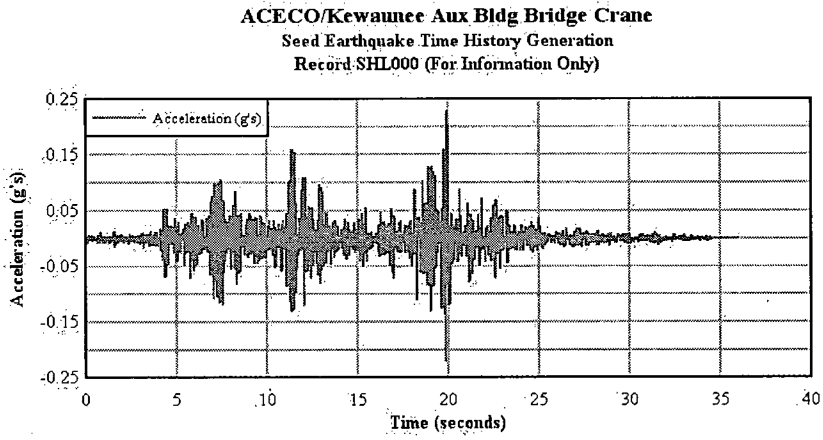


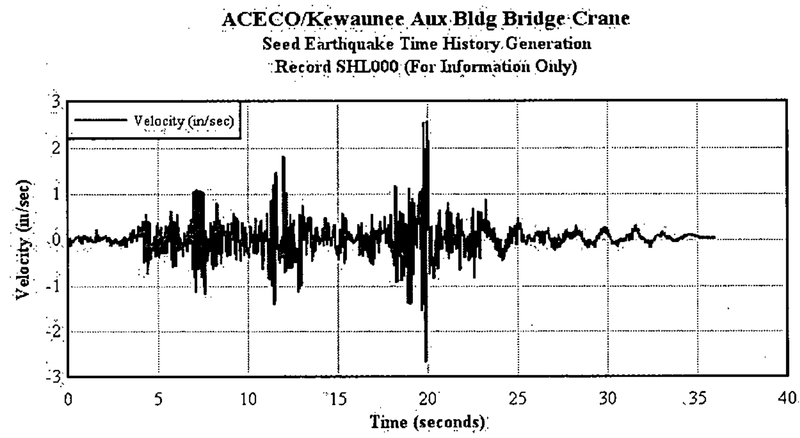
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record TAF-UP (For Information Only)

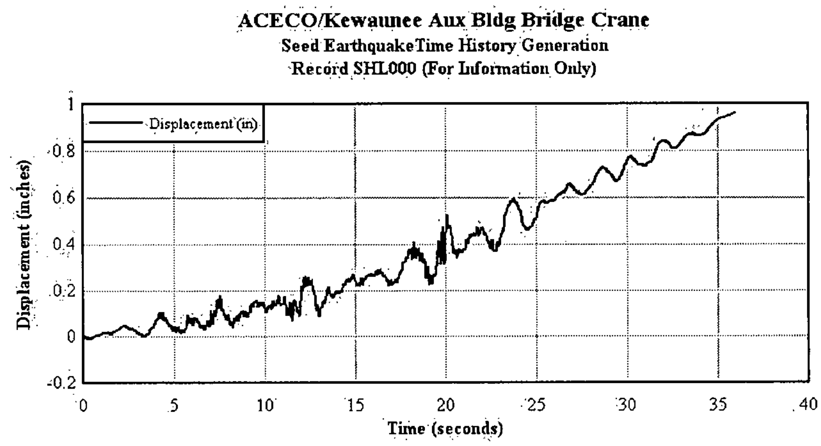


ABS Consulting				Attachment D			
				Rev	1	Sheet No.	D8
Job No.	1886592	Job	ACECO – Kewaunee Aux Bldg Bridge Crane	By	M.C.Ozbey	Date	5/22/08
Calc. No.	1886592-C-001	Subj	Generation of Artificial Seismic Time Histories	Checked	W.Sawruk	Date	5/23/08

Seed Time History Data Set #3 – EW Direction*

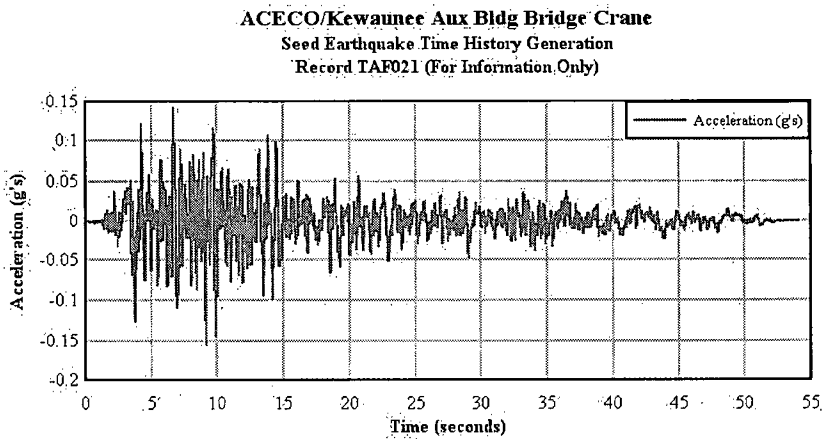


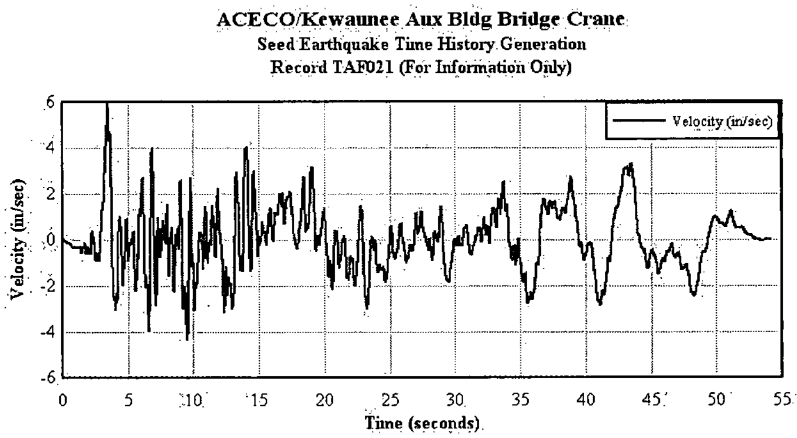


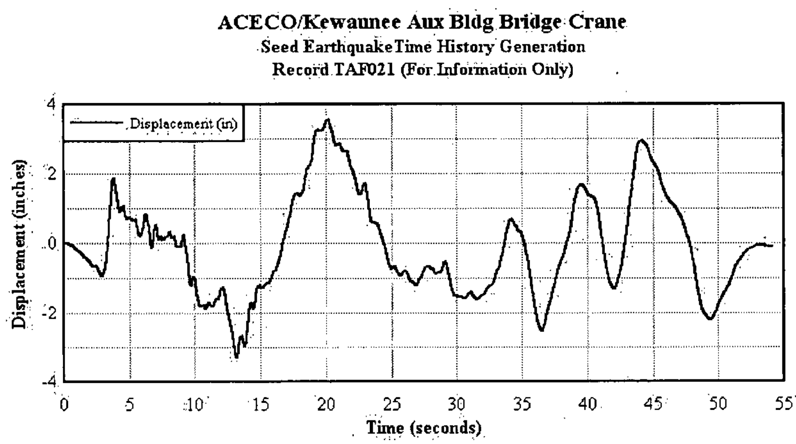


* Note: The seed acceleration data obtained from the referenced site did not include the required signal correction for this time history and thus the displacement time history is not base line corrected.

Seed Time History Data Set #3 – NS Direction

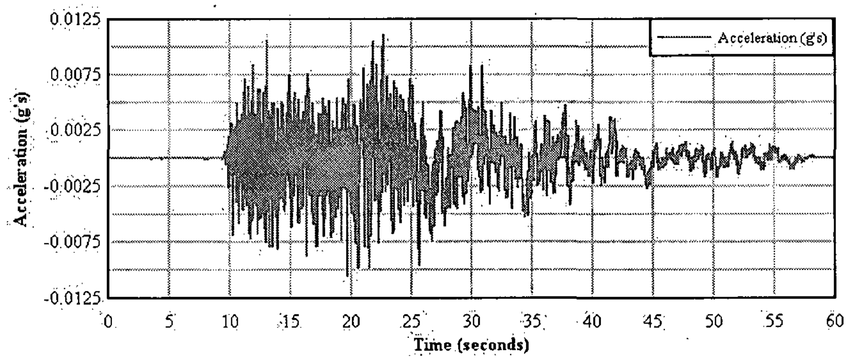




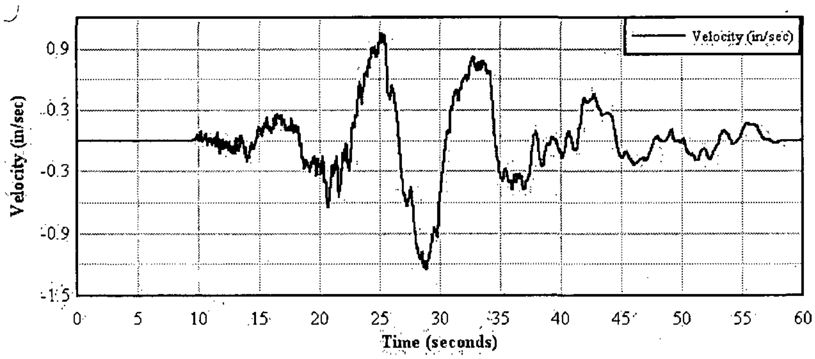


Seed Time History Data Set #3 – Vert Direction

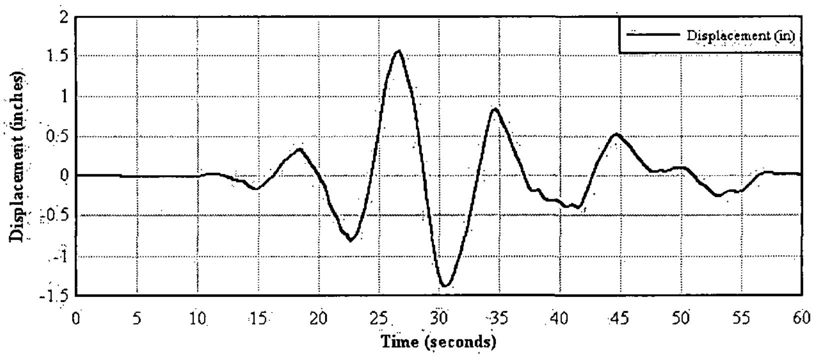
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SKR-UP (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SKR-UP (For Information Only)

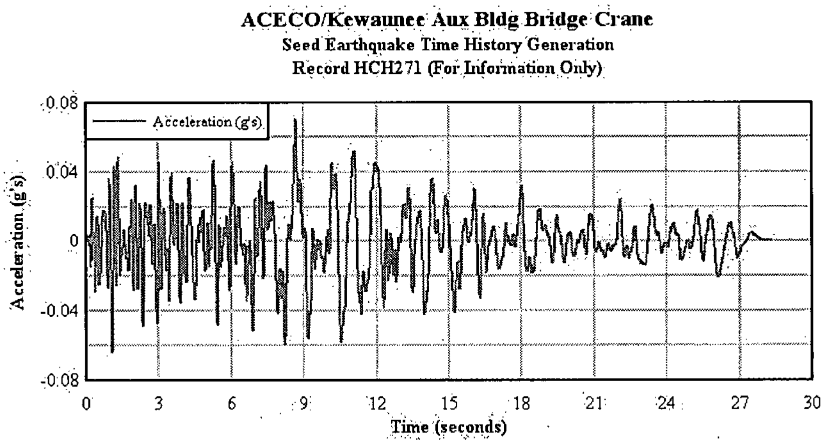


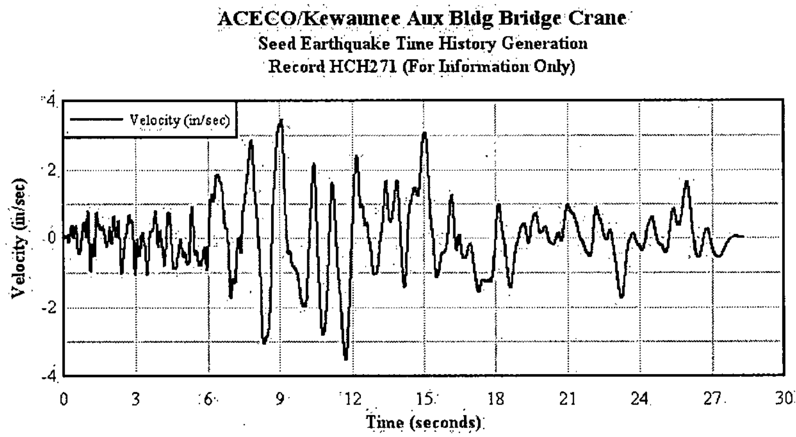
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record SKR-UP (For Information Only)

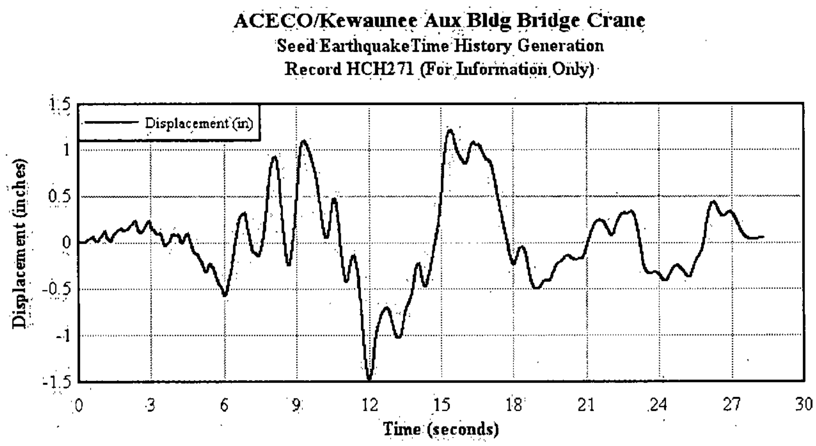


ABS Consulting			**Attachment D**		
			Rev 1	**Sheet No.**	*D11*
Job No. 1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date** 5/22/08
Calc. No. 1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date** 5/23/08

Seed Time History **Data Set #4 – EW Direction**







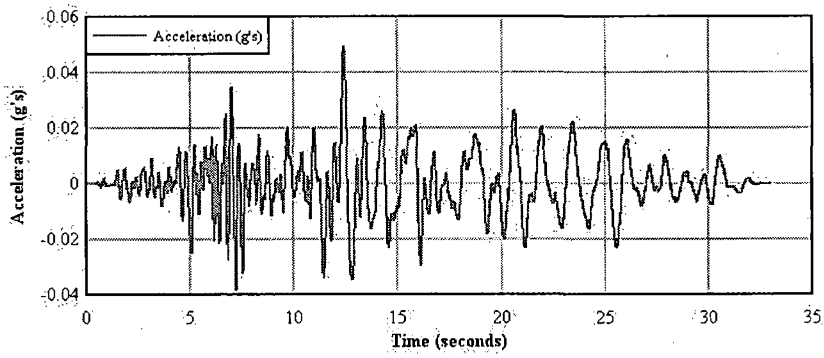
ABS Consulting

Attachment D

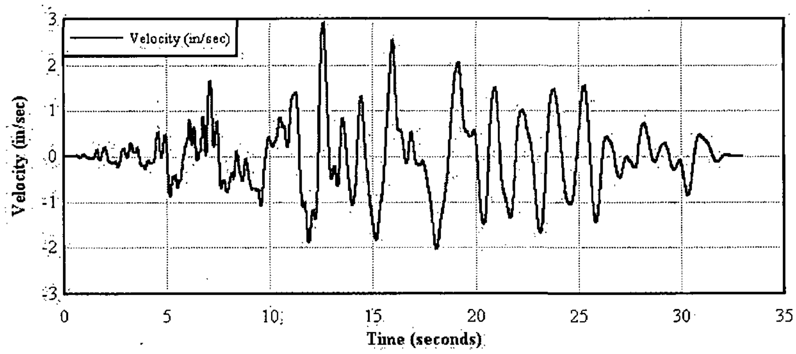
				Rev	1	**Sheet No.**	*D12*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	M.C.Ozbey	**Date**	5/22/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**	W.Sawruk	**Date**	5/23/08

Seed Time History Data Set #4 – NS Direction

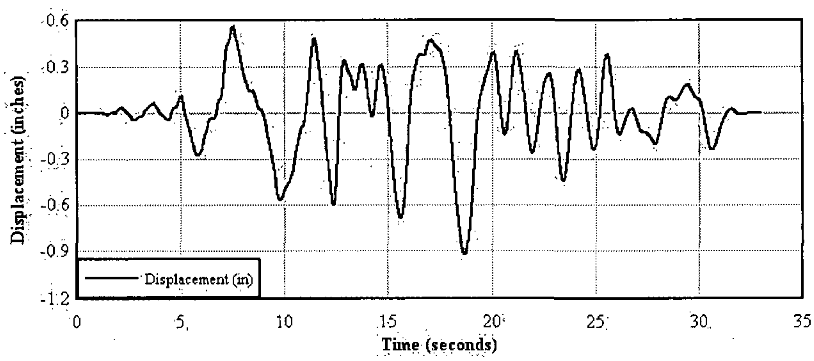
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record A-STP093 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record A-STP093 (For Information Only)

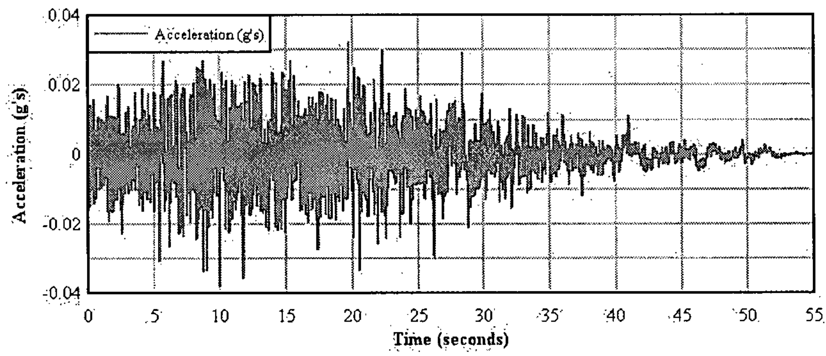


ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record A-STP093 (For Information Only)

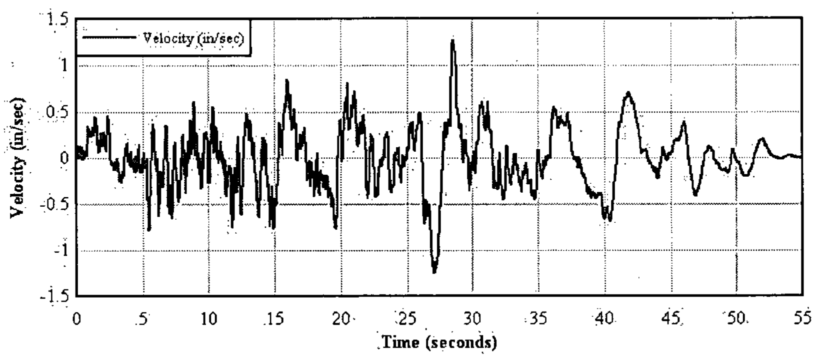


Seed Time History Data Set #4 – Vert Direction

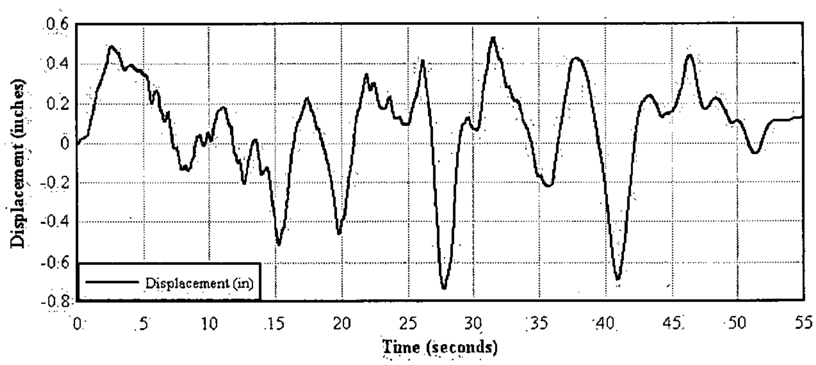
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SIL-UP (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SIL-UP (For Information Only)

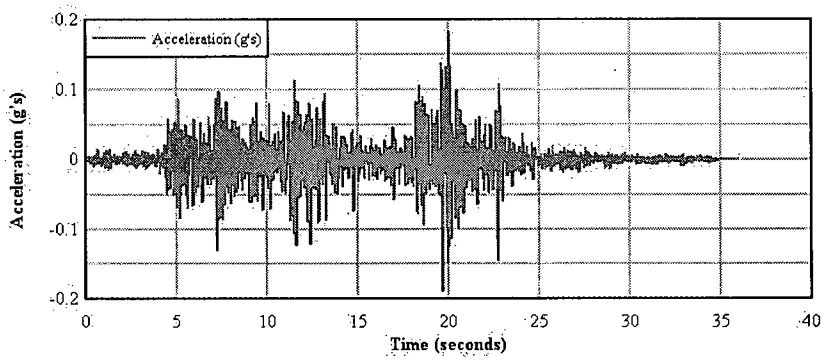


ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record SIL-UP (For Information Only)

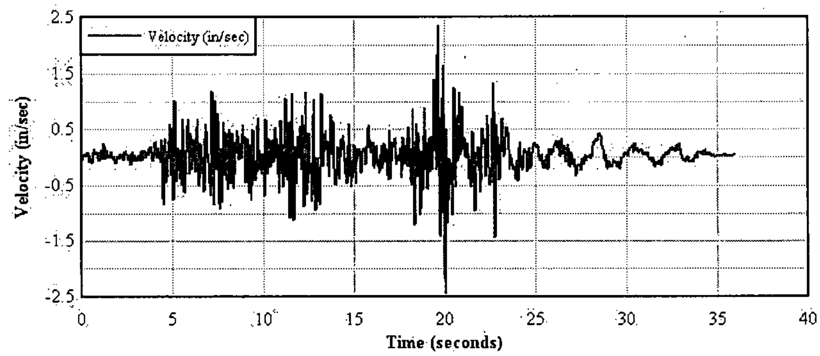


Seed Time History Data Set #5 – EW Direction*

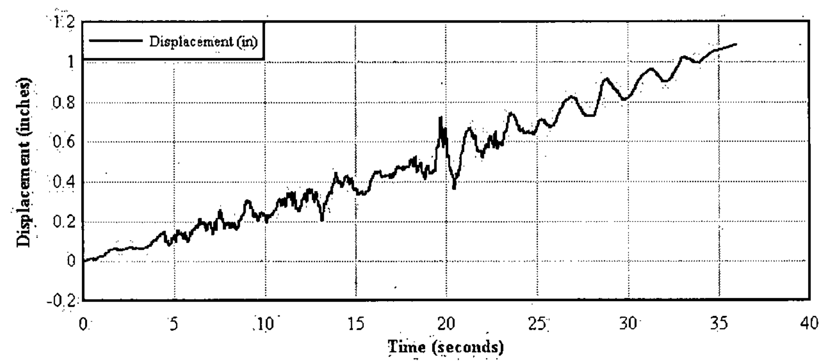
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SHL090 (For Information Only)



ACECO/Kewaunee Aux Bldg Bridge Crane
Seed Earthquake Time History Generation
Record SHL090 (For Information Only)

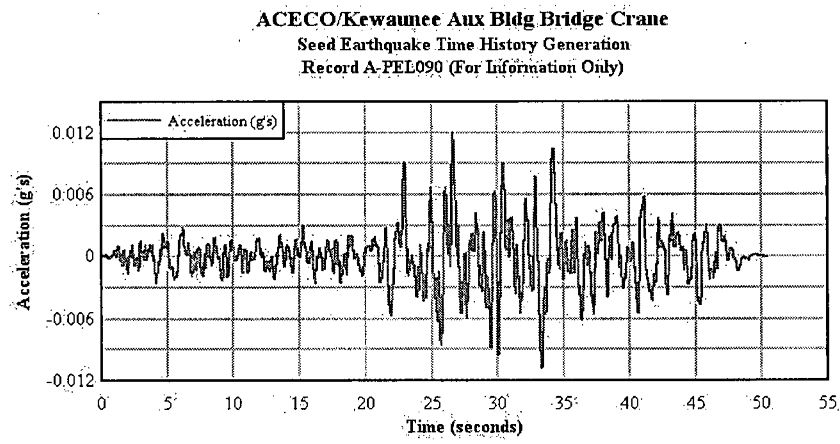


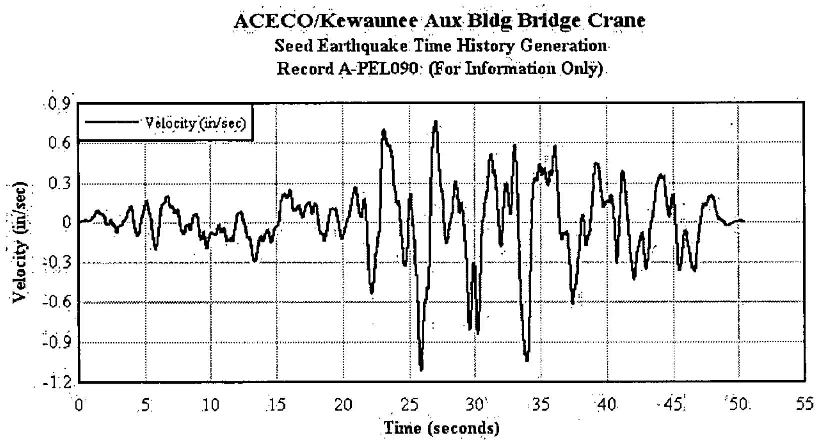
ACECO/Kewaunee Aux Bldg Bridge Crane
Seed EarthquakeTime History Generation
Record SHL090 (For Information Only)

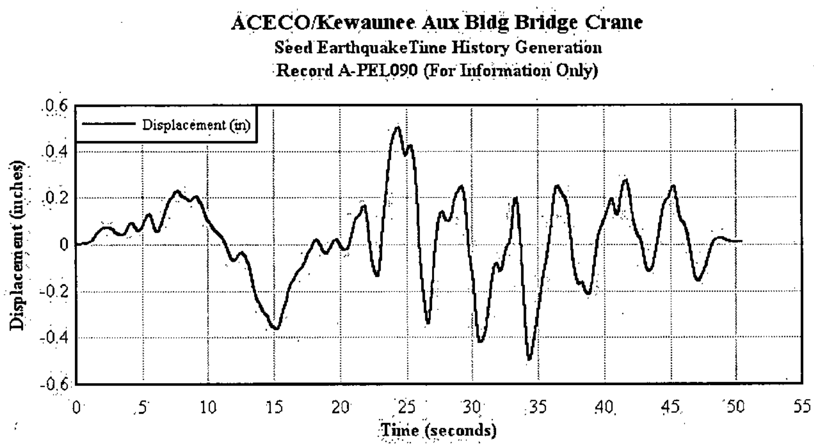


* Note: The seed acceleration data obtained from the referenced site did not include the required signal correction for this time history and thus the displacement time history is not base line corrected.

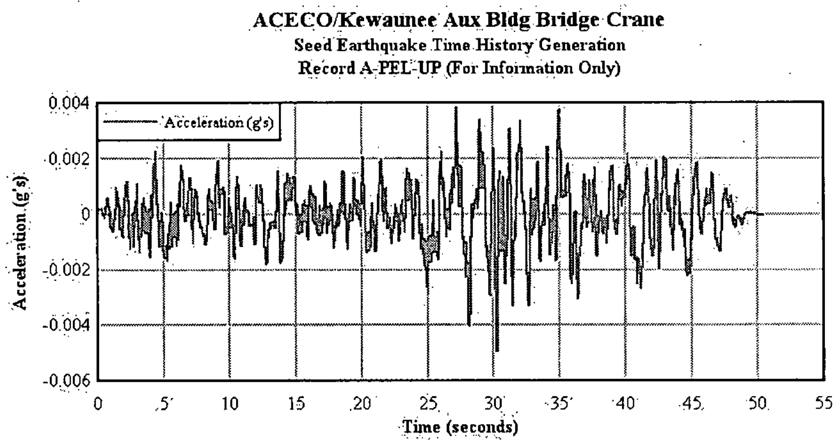
Seed Time History Data Set #5 – NS Direction

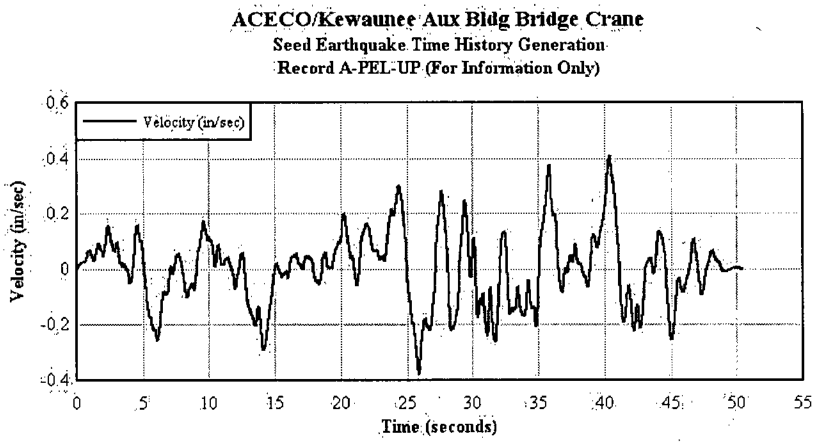


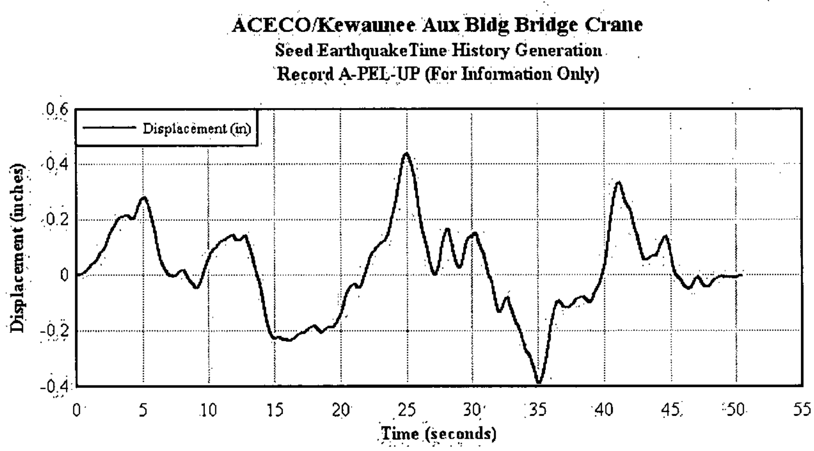




Seed Time History Data Set #5 – Vert Direction







ABS Consulting

Attachment E

				Rev	1	**Sheet No.**	*E1*
Job No.	1886592	**Job**	ACECO – Kewaunee Aux Bldg Bridge Crane	**By**	P. Streeter	**Date**	5/27/08
Calc. No.	1886592-C-001	**Subj**	Generation of Artificial Seismic Time Histories	**Checked**		**Date**	

NQP-02 Review Guidelines
Review Checklist

Document Number: ***1886592-C-001***
Review Scope: ***Entire Calculation***

Review Method: ☑ **X** Design Review ☐ Alternate Calculation ☐ Test

Criteria		**Checker**
1	Were the inputs correctly selected and incorporated into design?	Yes
2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	Yes
3.	Are the appropriate quality and quality assurance requirements specified?	Yes
4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?	Yes
5.	Have applicable construction and operating experience been considered?	Yes
6.	Have the design interface requirements been satisfied?	Yes
7.	Was an appropriate design method used?	Yes
8.	Is the output reasonable compared to inputs?	Yes
9.	Are the specified parts, equipment, and processes suitable for the required application?	N/A
10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	N/A
11.	Have adequate maintenance features and requirements been specified?	N/A
12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	N/A
13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	N/A
14.	Has the design properly considered radiation exposure to the public and plant personnel?	N/A
15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	Yes
16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	N/A
17.	Are adequate handling, storage, cleaning and shipping requirements specified?	N/A
18.	Are adequate identification requirements specified?	N/A
19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?	Yes

Checker shall initial indicating review and mark N/A where not applicable

Review Completed by: [signature] Date: 27-May-08

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