ENCLOSURE 2

Master Engineers and Designer Report

BWX Technologies, Inc.

SEISMIC EVALUATION REPORT
For
BWXT - Mt Athos Facility
Lynchburg, Virginia

MEAD Project No. 260-005-200

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Prepared for:
BWXT
P. O. Box 785
Lynchburg, VA 24505

Prepared by:

MASTER
ENGINEERS & DESIGNERS
904 Lakeside Drive
Lynchburg, VA 24501

COMMONWEALTH OF VIRGINIA
GARY W. LOOMIS
Lic. No. 034383
10 FEB '16
PROFESSIONAL ENGINEER

Revision	Date	Description
0	23 May 2013	Initial Issue of Report for Review and Comment
1	10 Feb 2016	Updated building codes and added bay descriptions

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LIST OF ABBREVIATIONS

AISC	American Institute of Steel Construction
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
BIM	Building Information Model
BOCA	Building Officials Code Administrators International
CMU	Concrete Masonry Unit
EOR	Engineer of record
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
IOPL	Immediate Occupancy Performance Level
LDP	Linear Dynamic Procedure
LFRS	Lateral Force Resisting Systems
LRFD	Load and Resistance Factor Design
LSP	Linear Static Procedure
LSPL	Life Safety Performance Level
MCE	Maximum Credible Earthquake
MEAD	Master Engineers and Designers
NRC	Nuclear Regulatory Commission
SBC	Southern Building Code
SBCC	Southern Building Code Congress
VFRS	Vertical Force Resisting System
VUSBC	Virginia Uniform Statewide Building Code

1.0 EXECUTIVE SUMMARY

Construction of the facility started in the mid-1950's and continues to today with new structures and modifications to existing structures. As a result of earthquakes in 2011, the Nuclear Regulatory Commission is reviewing the seismic requirements for all licensed facilities.

A search and retrieval of design documents was performed to identify the design criteria that was used in the design of the structures. This included search for design drawings, specifications, calculations, and building codes. Drawings were retrieved for all buildings.

All structures were designed in accordance with the building code in effect at the time of the design. Prior to 1973 the building code did not require seismic design however; an analysis of a bay indicates the structure did meet a seismic resistance of approximately 0.03g which is equivalent to the BOCA 1973 building code. The buildings will not collapse and employees should be able to evacuate.

Since the majority of the bays are interconnected, the entire facility was modeled for a more accurate resistance to seismic activity. The analysis was performed in accordance with the American Society of Civil Engineers Standard: Seismic Evaluation of Existing Buildings (ASCE 31-03). The analysis indicates there is some bracing that is overloaded due to the current increased seismic loads. Current seismic loads were used due to the high value of the material.

It is recommended that the bracing in Bays 5, 7, 7A, and 14A be reinforced to provide lateral load paths to meet the current seismic requirements due to the high value of the material in these bays.

2.0 INTRODUCTION

2.1 BACKGROUND

Due to the recent earthquake activity in Japan (March 2011) and in Virginia (August 2011), the Nuclear Regulatory Commission (NRC) is reviewing the seismic requirements for all licensed facilities. As such, the NRC recently performed an audit of the Mt. Athos facilities, which raised question of the structural adequacy to resist seismic activity. The NRC has requested additional information on the design of the facilities.

Initial research of design and construction design documents revealed that some of the oldest structures did not consider seismic loads in their design. This was based on the various codes in effect during the construction. Construction of the facility started in the mid-1950's when Virginia did not have a standardized building code. It was noted by the engineer of record (EOR) of these early buildings in a letter dated March 14, 2012, see Appendix B, that the Southern Building Code (SBC) was utilized during design. The 1965 edition of the SBC did not require seismic effects to be considered, however, there were requirements for wind loads. Copies of the applicable sections of the Building Codes are included in Appendix A.

After the initial research for design information, a simplified equivalent static analysis was performed for Bay 2A/3A and Bay 13A/14A, which were both constructed under the SBC. The analysis was based solely on the record drawings and considered the bays to act independently. This analysis estimated a seismic resistance of approximately 0.03g for both buildings, which is below the required capacity for newly designed buildings under the current codes.

Since the majority of the bays are interconnected, it had been proposed by Master Engineers and Designers, Inc. (MEAD) that a model of the building structures at the NOG-L site be constructed and analyzed to determine a more accurate resistance to seismic activity.

2.2 OBJECTIVE

The objective of this seismic evaluation is to determine the expected performance of the entire facility during a design basis earthquake and to identify deficiencies in the lateral force resisting systems (LFRS) that may require rehabilitation to maintain an acceptable performance level. This assessment is based on the primary and secondary structural components that are part of the LFRS with the understanding that assessment of non-structural elements will be required in the future.

2.3 SCOPE OF WORK

The scope of the project is mainly based on the MEAD Proposal for Engineering Services – Preliminary Seismic Assessment, dated April 18, 2012. Through discussion with the client and over the length of the project some items have been altered.

2.3.1 Items Included in Scope

The scope of work for this project includes the following items:

- Collect and review all available documentation for the bays including structural drawings, architectural drawings, specifications, geotechnical reports, building codes, calculations, etc.
- Develop a design criterion (which is included in this document).
- Perform site walk downs to collect additional information not shown on the drawings. Also, alterations or modifications that affect the LFRS.
- Develop three dimensional computer models of the bays that are interconnected. These models may be used to develop future seismic rehabilitation plans or produce plans for future additions.
- Evaluate the structure for seismic loads and identify deficiencies in the LFRS.
- Make recommendations for addressing deficiencies found.

2.3.2 Items Excluded in Scope

The scope of work does not currently include the following items:

- Design and details for modifications to building components in order to strengthen the LFRS where deficiencies are found.
- Development of a site specific ground motion response spectrum or a probabilistic seismic hazard analysis.
- Analysis of non-structural components and systems including electrical and mechanical systems.

2.4 DESCRIPTION OF STRUCTURES

Facility construction began in the mid-1950's and is still continuing. With the exception of some stand-alone buildings that are not part of this assessment, the buildings are mainly constructed of steel with concentrically braced LFRS. In total there are approximately 35 bays of which most are 50 ft. wide by 250 ft. long. The majority of the bays is interconnected and share LFRS and main columns. Most of the bays are approximately 30 ft. tall with the exception of a few taller bays that house large cranes. There are roof top units, platforms and equipment throughout the entire facility. There are also various mezzanines throughout the facility. Generally the mezzanines are concrete slab on steel beams either resting on steel framing or on concrete masonry unit (CMU) block walls. See Figure 1 for a diagram of the bays and when they were constructed.

2.5 APPROACH

The evaluation was performed in general conformance to the methods of the American Society of Civil Engineers' (ASCE) Standard: *Seismic Evaluation of Existing Buildings* (ASCE 31-03). ASCE 31-03 provides guidance based on performance levels, type of building, and seismicity of the site. A detailed discussion of ASCE 31-03 can be found in the *Codes and Standards* section of this document. A Tier 1 Screening was performed for the entire facility that focused on the structural and geological/foundation checklists. Non-structural items were not a part of this evaluation. Non-compliant items identified in the Tier 1 Screening was further evaluated using the Tier 2 Evaluation as outlined in ASCE 31-03.

The Tier 2 Evaluation is based on three dimensional building models that were developed in REVIT Structure and then exported into RISA Floor and RISA 3D (See Section 2.7 for computer program information) for analysis. The models are based on as-built record drawings and field visits that verified major structural elements as well as the type and location of LFRS elements.

The facility was divided into three primary independent models that consist of various areas of the facility. In an effort to perform a more efficient analysis, two of the models were further divided. The separation point for the models are either where the bays are not physically attached to each other or lack sufficient stiffness in the connecting structural elements that little or no seismic forces are shared between bays. See Figure 2 - 3D Model.

Models:

Model 1: Bays 1M through 17M with Bays 1T, 2T, and 3T along the south side of the facility

Model 1A: Bays 1M-15M

Model 1B: Bays 16M and 17M

Model 1C: Bays 1T and 2T

Model 1D: Bay 3T

Model 2: Bays BC Through 10A along the northeast portion of the facility

Model 2A: Bay 7A - Bay 10A

Model 2B: Bay BC - Bay 2A North

Model 3: Bays 12A through 15A along the northwest portion of the facility

In order to perform an accurate seismic analysis, the total mass of the building needs to be accounted for. RISA 3D automatically calculates the self-weight of the structure which includes beams, columns, braces, roof, and floors and other components that make up the structural system. Gravity loads such as dead and live loads are manually entered into the model. The loads for ducts, lights, raceways, equipment, etc. were estimated on a per bay basis based on field visit observations. In some bays, these loads are fairly uniform across the entire plan area and therefore a uniform equipment dead load was applied to the model. However, in some cases the loads vary in a bay and thus the equipment loads were applied in the general areas that they are actually located. Rooftop and mezzanine equipment were located in the models based on existing documentation as well as field visits that verify location and types of equipment. The weights of standard equipment with unknown data and in-house constructed equipment were estimated based on knowledge of the equipment and/or data from similar equipment where information was available.

Once the models were completed and the gravity loads applied, the models were then analyzed using the Linear Static Procedure from ASCE 31-03 to determine deficiencies in the LFRS. A deficiency is any LFRS element that does not have the required capacity to resist the design earthquake.

2.6 ASSUMPTIONS

The following assumptions were employed during the development and analysis of the models:

- Materials specified in the construction documents are the same as what was used for construction. (No destructive testing of materials was performed.) If materials were not specified or the construction specifications are not available for a typical bay then the minimum properties prescribed by the building code at the time of construction are used in the analysis of the structure.
- The buildings will behave linearly elastic with all pinned connections.
- Connections of main LRFS elements are stronger than the elements themselves (i.e. connections are not modeled or checked during this preliminary assessment).
- All equipment loads supported on the roof or hung from the roof are assumed to act at the roof elevation unless the equipment is located on top of a roof top platform, in which case the platform is modeled and the equipment acts at the elevation of the platform.

2.7 COMPUTER PROGRAMS

A three dimensional computer model was developed to perform the assessment. The buildings were first modeled in REVIT Structure 2012 by Autodesk, which is a building information modeling (BIM) program. The model was exported to RISA Floor 7.0 by RISA Technologies, LLC, to define floor and roof diaphragms and apply gravity loads such as dead and live loads. The model was finally exported to RISA 3D (v. 11.0.0) by RISA Technologies, LLC, which is a three dimensional finite element modeling program, to perform the seismic analysis.

The REVIT Structure model developed can be used to produce drawings for future rehabilitation plans, report deficiencies and for future facility expansion. These drawings can be generated direct from the REVIT model or exported as two dimensional views into AutoCAD to produce drawings.

3.0 CODES AND STANDARDS

3.1 HISTORY OF ORIGINAL DESIGN CODES

Since the early 1900s, the system of building regulations in the United States was based on model building codes developed by three regional model code groups. The codes developed by the Building Officials Code Administrators International (BOCA) were used on the East Coast and throughout the Midwest, while the codes from the Southern Building Code Congress (SBCC) were used in the Southeast and the codes published by the International Conference of Building Officials (ICBO) covered the West Coast. The nation's three model code groups decided to combine their efforts and in 1994 formed the International Code Council (ICC) to develop codes that would have not regional limitations.

3.1.1 Buildings Prior to 1973

The first buildings at the Mt. Athos facility were designed and constructed in 1955. Prior to 1973 Virginia did not adopt a uniform building code and gave the local building officials the authority to define the applicable codes. Campbell County, where the facility is located, did not invoke a building code; however, according to the EOR of the older facilities the SBC was most likely used.

The SBC during this time did not require seismic effects to be considered. The wind load was a uniform 20 psf.

The bays that were constructed during this time period are Bays 1M through 15M, 1T, 2T, BC, 1A, 5A, 6A and 7A. Also portions of bays 2A through 4A, 8A through 10A, 13A and 14A were constructed. The original gate house and some outlying buildings that are not considered during this assessment were also constructed during this time period.

3.1.2 Buildings Between 1973 and 1981

Virginia first formed the Virginia Uniform Statewide Building Code (VUSBC) in 1973 which adopted the BOCA 1970 as the construction standard. The BOCA 1970 required seismic effects to be considered. Seismic loads were determined based on a numerical constant that equated to a percentage of dead load depending on where the structure was in a zone map and the number of stories. For single story bays, this would equate to a design acceleration of 0.033g. BOCA required a wind load of 15 psf.

Virginia adopted the BOCA 1975 in 1976 and BOCA 1978 in 1978. These codes were not available for review at the time of the assessment; however, based on understanding of the progression of codes the design forces were similar to BOCA 1970.

The bays that were constructed during this time period are Bays 4A 2nd North Addition, Bay 10A, and Bay 1A/2A North Addition. The gate house addition was also constructed during this time period but, is not considered in this assessment.

3.1.3 <u>Buildings Between 1982 and 1988</u>

VUSBC adopted the BOCA 1981 in 1982. This code incorporated a similar numerical coefficient as previous codes, except the percent of dead load was based on the zone, fundamental period of vibration and structure type. For single story bays, this would equate to a design acceleration of 0.025g. The design wind pressure for the structures was based on wind speed maps and corresponding tables that equated wind speed and building height to pressure. The design wind load for a typical bay during this time period was 11 psf.

In 1986 the VUSBC adopted BOCA 1984. This code's requirements for seismic and wind did not change.

The bays that were constructed during this time period are Bays 12A and 15A, a portion of Bay 16M, Bay 13 East Addition, and Bay 13/14 South Addition. The Rail Yard Storage Building was also constructed during this time period but is not considered in this assessment.

In 1988 the VUSBC adopted BOCA 1987. There are no bays that were constructed under this code.

3.1.4 <u>Buildings Between 1991 and 1997</u>

VUSBC adopted the BOCA 1990 in 1992. This code incorporated the concept of an acceleration map instead of zones to determine the percent of dead load applied laterally on the structure. This code is also the first to introduce an importance factor for the structures and factors for the type of soil at the site. For typical bays, the determined percentage would equate to a design acceleration of 0.042g. The design wind pressure also incorporated an importance factor in this code. The design wind load for a typical bay during this time period was 10.7 psf.

Bay 2A/3A North Addition was constructed under this code.

In 1993 the VUSBC adopted BOCA 1993. There are no bays that were constructed under this code.

3.1.5 Buildings Between 1997 and 2003

VUSBC adopted the BOCA 1996 in 1997. This code was similar to the previous in that it considered an acceleration map along with a soil profile, type of building construction, and fundamental period to determine a percentage of dead load to be applied in the lateral direction. For typical bays the determined percentage would equate to a design acceleration of 0.066g. The design wind pressure was determined similar to previous codes. The design wind load for a typical bay during this time period was 14.4 psf.

The bays that were constructed during this code are Bays 17M, the RTRT addition, and the overbuild on Bay 15A. Other buildings constructed but not considered in this assessment are the Project 2002 buildings and the ACF Buildings.

3.1.6 Buildings Between 2003 and 2010

VUSBC adopted the IBC 2000 in 2003. This code allowed for multiple methods of seismic analysis. The simplified equivalent static method used the same methodology as previous code editions to determine a percentage of dead load and permanent live load to apply laterally to the structure. The mapped accelerations for both a short and long period were determined and then converted into a design acceleration. The design acceleration was then reduced by a response factor which was based on the building construction type and increased by an importance factor. The resulting coefficient was a percentage that was applied to the dead load and permanent live load of the structure. For the typical bay type this percentage would equate to a design acceleration of 0.066g. The design wind pressure was based on mapped wind speeds, coefficients that took into account surrounding terrain and importance factors based on the use of the building. The resulting design wind load for a typical bay during this time period was 14.8 psf.

In 2005 the VUSBC adopted the IBC 2003 code. The seismic and wind requirements did not change from the IBC 2000 code.

An addition to RTRT was constructed during this time period. Other buildings constructed under the provisions of these codes include Station One (pre-engineered building) and the Container Storage Facility.

In 2008 the VUSBC adopted the IBC 2006 code. The seismic requirements were determined the same way as for IBC 2003; however, the acceleration maps varied slightly. The design wind loads stayed the same. There were no buildings constructed under this code.

3.1.7 Buildings Between 2011 and 2013

In 2011 the VUSBC adopted the IBC 2009 code. The seismic requirements are similar to those that were required in IBC 2006. When using the equivalent static load method the resulting percentage for a typical bay is 0.083g.

The IBC 2006 refers to the ASCE Standard 7-05: *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-05) for gravity and lateral design loads. The current steel design code is the American Institute of Steel Construction (AISC): *Manual of Steel Construction, 13th Edition* which allows the use of either the allowable stress design (ASD) or the load and resistance factor design (LRFD) methodology.

Bay 3T was designed and constructed under this code. Since it is designed under the current code with seismic considerations and has an independent LFRS and has vertical force resisting system (VFRS) it is not part of this assessment.

3.2 CURRENT APPLICABLE DESIGN CODES

Currently the VUSBC references the IBC 2012, which became effective in 2014. The IBC 2012 refers to the ASCE Standard 7-10: *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-10) for gravity and lateral design loads. The current steel design code is the American Institute of Steel Construction (AISC): *Manual of Steel Construction, 13th Edition* which allows the use of either the allowable stress design (ASD) or the load and resistance factor design (LRFD) methodology.

When using the equivalent static load method the resulting percentage for a typical bay is 0.066g and the wind load is 13.7 psf.

3.3 CODES USED FOR ANALYSIS OF EXISTING STRUCTURES

Although the IBC 2009 and ASCE 07-05 codes are applicable for the gravity and wind loads, the seismic design of new structures assumes that detailing per these codes is met and thus incorporated inherent ductility of the system will exist during the design earthquake. Since existing structures may have been detailed differently, the ductility may be different. Therefore, analysis of existing structures for seismic effects must be performed using a different set of guidelines. The ASCE Standard: Seismic Evaluation of Existing Buildings (ASCE 31-03) provides guidance on the seismic evaluation of existing buildings. The ASCE Standard: *Seismic Rehabilitation of Existing Buildings* (ASCE 41-06) also provides some guidance for analysis of existing buildings, but it is meant for the design of rehabilitation and therefore is more limiting in nature than ASCE 31-03.

ASCE 31-03 allows three different levels of complexity, or Tiers, when evaluating an existing building. The three tiers are as follows:

- Tier 1 – Screening
- Tier 2 – Evaluation
- Tier 3 – Detailed Evaluation

The applicability of the tier required for the evaluation depends on the performance level required (either Immediate Occupancy or Life Safety), the seismicity of the site and the type of building construction.

The Immediate Occupancy Performance Level (IOPL) is defined by ASCE 31-03 as a building performance that includes damage to both structural and nonstructural components during a design earthquake, such that the following two criteria are met: (a) the damage is not life-threatening, as to permit immediate occupancy of the building after a design earthquake, and (b) the damage is repairable while the building is occupied. Both of these requirements require a level of judgment as to the exact meaning and level of acceptable repair by the owner. ASCE 31-03 includes in the commentary additional guidance: (1) after a design earthquake, the basic VFRS and LFRS retain nearly all of their pre-earthquake strength, and (2) very limited damage to both structural and nonstructural components is anticipated during the design earthquake that will require some minor repairs, but the critical parts of the building are habitable. The IOPL would be appropriate for essential facilities for which occupancy of the building is required immediately following the design seismic event and/or there are critical materials or processes housed in the building.

The Life Safety Performance Level (LSPL) is defined by ASCE 31-03 as a building performance that includes damage to both structural and non-structural components during a design earthquake, such that the following two criteria are met: (a) partial or total structural collapse does not occur, and (b) damage to nonstructural components is non-life-threatening. ASCE 31-03 includes in the commentary additional guidance: (1) at least some margin against partial or total structural collapse remains, and (b) injuries may occur, but the overall risk of life-threatening injury as a result of structural damage is expected to be low.

Prior to the Tier 1 Screening, an evaluation of the existing construction documents, as-built drawings, submittals, etc. are reviewed of the structure to be assessed. During this evaluation a site visit is to take place to verify the available documents and to gather more information about the structure that may not be available through existing documentation. During this evaluation and site visit stage, enough information should be gathered to perform all the required checks for Tier 1.

The Tier 1 Screening is meant to be used as a mechanism to quickly evaluate structures to determine if there is a potential for a problem. Tier 1 is allowed as the only assessment for IOPL with moderate seismicity for buildings with two or fewer stories, and for LSPL with moderate seismicity for buildings with 6 or fewer stories. According to ASCE 31-03, Tier 1 Screening is not intended to be the sole assessment for buildings requiring an IOPL. Based on the type of building and the performance level checklists for Tier 1 Screening is provided by ASCE 31-03 with criteria to estimate the seismic capabilities of the structures. Some of the criteria are conservative such as the requirement for redundancies in LFRS which the older buildings in the facility lack and would require a Tier 2 be performed for these components.

Tier 1 also allows Benchmark Buildings to be considered. Benchmark buildings are buildings that are of a certain building type and performance level and have been designed, detailed and constructed in accordance with certain Benchmark codes that ASCE considers to be currently acceptable. It is important that it is verified that these structures were actually designed, detailed and constructed using the seismic requirements of these codes, therefore a site visit and evaluation process must still take place to verify conformance prior to being labeled a Benchmark Building. For buildings requiring LSPL with a steel braced frame with a stiff or flexible diaphragm (Type S2 & S2A), the benchmark codes and years for seismic requirements are BOCA 1993, FEMA-178 1992, FEMA-310 1998 or IBC 2000. For buildings requiring LSPL with a steel moment-resisting frame with a stiff or flexible diaphragm (Type S1 & S1A), the benchmark code and years for seismic requirements are IBC 2000 or FEMA-310 1998. The S1 and S1A building types do not have a BOCA benchmark year assigned to them. For buildings requiring IOPL, the only applicable benchmark code is FEMA-310 1998. If a building can be labeled as a Benchmark Building based on these requirements then further assessment is not required based on ASCE 31-03.

For LSPL buildings that do not meet the requirements as a Benchmark Building and have deficiencies based on the Tier 1 Screening, a deficiency only Tier 2 Evaluation will be performed in general conformance with ASCE 31-03. A deficiency only evaluation will only include the evaluation of those items that do not meet the requirements of a Tier 1 screening. If deficiencies still exist, they are either reported in the final report or a more in-depth Tier 3 analysis is performed. For this evaluation, a Tier 2 evaluation will be the last step and deficiencies will be noted for future strengthening and retrofit.

For IOPL buildings a complete Tier 2 evaluation will be performed. Tier 2 Evaluation can be performed either by a Linear Static Procedure (LSP) or by a Linear Dynamic Procedure (LDP). An LSP is acceptable for all types of structures accept those that (a) are taller than 100 ft. or (b) contain mass, stiffness, or geometric irregularities. At this time, no irregularities are anticipated in this assessment and thus a LSP will be utilized.

4.0 PERFORMANCE REQUIREMENTS

The general performance requirement for the site for licensing purposes is that the buildings do not collapse. This requires that all of the facility maintain an LSPL as defined in ASCE 31-03. From an operations goal it is desired that some bays, which are essential to the operation of the owner, be immediately available for reuse.

5.0 LOADS

Design loads used for the analysis was based on design codes as noted in this section.

5.1 GRAVITY LOADS

Gravity loads include structural self-weight, equipment loads, live loads and snow loads. These loads were determined in accordance with ASCE 7-05.

5.1.1 Live Loads

The mezzanine live loads are typically designed for a live load of 200 psf. Mezzanines currently supporting equipment will consider the actual equipment loads in lieu of the 200 psf uniform load.

5.1.2 Roof Live Loads

The roof live load where roof top equipment is not located was taken as 30 psf in accordance with standard facility design requirements. Where roof top equipment is located, the weight of the equipment was applied. Reduction of live load was not considered.

5.1.3 Snow Loads

The design ground snow load for the facility is 25 psf. The importance factor for snow on essential facilities was 1.2. The roof snow loads considered drifts and unbalanced loads in accordance with Chapter 7 of ASCE 7-05.

5.13 Equipment Loads

Equipment loads was estimated based on the type and size of equipment unless actual data for the unit was available. Where equipment loads are located, live loads and snow loads were disregarded.

Crane loads were considered as moving loads along the length of existing runways. Normally a vertical impact of 25% is considered in these facilities. A lateral allowance of 10% and a longitudinal allowance of 20% of the total weight were also applied to the structure.

5.2 WIND LOADS

Wind loads were determined in accordance with Chapter 6 of ASCE 7-05. The basic wind speed for the facility is 90 mph. The importance factor for wind on essential facilities is 1.15. Tornado loads are not required at this site by building code.

5.3 FLOOD LOADS

Flood loads are not required in the analysis since the Main and A-Bays are above the 500 year flood plain.

5.3 SEISMIC LOADS

The pseudo lateral force used in the linear static analysis will be based on a design response spectrum in accordance with ASCE 31-03. Since the site is considered an essential facility with an importance factor of 1.5, the design earthquake is the Maximum Credible Earthquake (MCE) with a 2,500 year return period.

The site class as determined from shear wave measurements throughout the majority of the site is Class C.

$S_{DS} = 0.177g$

$S_{D1} = 0.078$

Existing equipment and the weight of the cranes (not including lifting load) will be treated the same as dead load when determining the excitation forces due to seismic activity.

The pseudo lateral force will calculated using the following equation:

$$V = CSaW$$

Where,

C = Modification Factor to relate expected maximum inelastic displacements to displacements

Sa = Response spectral acceleration

W = Effective seismic weight of building

5.4 LOAD COMBINATIONS

The load combinations used in the analysis models followed those outlined in ASCE 31-03.

The component gravity loads were calculated using the following equations:

$Q_G = 1.1(Q_D+Q_L+Q_S)$ (Eqn. 4-6, ASCE 31-03)

or

$Q_G = 0.9Q_D$ (Eqn. 4-7, ASCE 31-03)

Q_D = Dead Load

Q_L = Effective live load, equal to the larger of actual measured live load or 25% of the design live load

Q_S = Effective snow load, equal to 20% of design flat roof (may be neglected if $p_f \leq 30psf$)

LFRS components in ASCE 31-03 are classified as either deformation controlled or forced controlled. A deformation controlled action is an action that has an associated deformation that is allowed to exceed the yield value. An example of a deformation controlled component is a brace in a braced frame. A force controlled action is an action that is not allowed to exceed the yield value. These would include the beams and columns in a braced frame.

For LFRS components that are classified as deformation-controlled the following equation

$Q_{UD} = Q_G \pm Q_E$ (Eqn. 4-8, ASCE 31-03)

$Q_{CE} \geq Q_{UD}/m$ (Eqn. 4-11, ASCE 31-03)

Q_{UD} = Action due to gravity and earthquake loading

Q_{CE} = Expected strength of the component at deformation level

m = Component demand modifier (determined from ASCE 31-03 Table 4-5)

For the LFRS components where the capacity is limited by the force-controlled actions the following equation will apply:

$$Q_{UF} = Q_G \pm Q_E/C \qquad \text{(Eqn. 4-10, ASCE 31-03)}$$

Q_E = Earthquake Force

C = Modification factor (per ASCE 31-03, Table 3-4), for steel braced frames with stiff diaphragms and one story, C=1.4, for steel braced frames with stiff diaphragms and two stories, C=1.2 (Except for diaphragm forces calculated by Eqn. 4-4, which already includes a C factor, than use C=1.0 in this equation).

6.0 BUILDING DESCRIPTION

6.1 MAIN BAYS

6.1.1 Bay 1

This area is office space constructed in 1955; additions were made in 1969 to the south of the building. Bays 1 and 2 were constructed at the same time. The bay is approximately 50' wide and 320' long and 20' in height for Bay 1 and 30' for Bay 2. It is a steel framed structure with vertical cross bracing. The roofing is built-up with ballast supported on metal roof deck and purlins.

There are limited drawings available, structural drawings are available of additions.

6.1.2 Bay 2

This area is office space constructed in 1955; additions were made in 1969 to the south of the building and in 1994 to the north of the building. Bays 1 and 2 were constructed at the same time. The bay is approximately 50' wide and 320' long and 20' in height. It is a steel framed structure with vertical cross bracing. The roofing is built-up with ballast supported on metal roof deck and purlins. There is galbestos siding on the west side.

There are limited drawings available.

There are two overhead bridge cranes – 5-ton and 15-ton.

6.1.3 Bay 3

Bays 3, 4, and 5 were built together in 1955; additions were made in 1969 to the south of the building. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. Bay 3 is a high bay and is a single-story steel framed structure supported by individual column footings and braced vertically with rod cross bracing. The roofing is built-up with ballast. Siding is on the end walls (north and south elevations) only. The area is currently used for production.

Structural drawings are available and are dated June 21, 1955. Design information is provided on the structural drawings.

There are drawings for a modification dated April 15, 1963 showing an enclosure.

There are drawings for a modification dated April 5, 1968 showing equipment foundations.

The building columns are stepped to support overhead bridge cranes.

There are two overhead bridge cranes – 5-ton and 15-ton.

6.1.4 Bay 4

Bays 3, 4, and 5 were built together in 1955; additions were made in 1960 to the south of the building. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. It is a steel framed structure braced supported by individual column footings and braced vertically with rod cross bracing. Bay 4 is a high bay with a partial mezzanine at the south end (between column lines A and F). The original drawings do not indicate a mezzanine. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls (north and south elevations) only. The area is currently used for production.

Structural drawings are available and are dated June 21, 1955. Design information is provided on the structural drawings.

The building columns are stepped to support overhead bridge cranes.

There are two overhead bridge cranes – 5-ton and 15-ton.

6.1.5 Bay 5

Bays 3, 4, and 5 were built together in 1955; additions were made in 1960 to the south of the building. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. Bay 5 is a high bay with a mezzanine the full length of the bay. The mezzanine is supported by steel columns at mid-span. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls (north and south elevations) only. The area is currently used for production and the mezzanine is office space.

Structural drawings are available and are dated June 21, 1955. Design information is provided on the structural drawings.

There is a small utility elevator.

6.1.6 Bay 6

Bays 6, 7, and 8 were built together in 1966. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls (north and south elevations) only. The area is currently used for production.

Structural drawings are available and are dated March 11, 1966. Design information is provided on the structural drawings.

Individual crane columns support two 5-ton overhead bridge cranes.

6.1.7 Bay 7

Bays 6, 7, and 8 were built together in 1966. A mezzanine was added to Bay 7 in 2002. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls (north and south elevations) only. The area is currently used for production.

Structural drawings are available and are dated March 11, 1966. Design information is provided on the structural drawings.

Individual crane columns support two 5-ton overhead bridge cranes.

6.1.8 Bay 8

Bays 6, 7, and 8 were built together in 1966. Each bay is approximately 320'-0" (16 spaces at 20'-0") long by 50'-0" wide and 30' in height. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls (north and south elevations) only. The area is currently used for production.

Structural drawings are available and are dated March 11, 1966. Design information is provided on the structural drawings.

Individual crane columns support two 5-ton overhead bridge cranes.

6.1.9 Bay 9

Bays 9 and 10 were built together in 1963. Each bay is approximately 320'-0" long by 100'-0" wide. Siding is on the end walls (north and south elevations) only. Bay 9 is a high bay with a partial mezzanine. The area is currently used for production and office and the mezzanine is used for offices.

Structural drawings are available.

Individual crane columns support one overhead bridge crane.

6.1.10 Bay 10

Bays 9 and 10 were built together in 1963. Each bay is approximately 320'-0" long by 100'-0" wide. Siding is on the end walls (north and south elevations) only. Bay 10 is a high bay with a partial mezzanine. The area is currently used for production and the mezzanine is used for storage.

Structural drawings are available.

Individual crane columns support one overhead 25-ton bridge crane.

6.1.11 Bay 11

Bays 11, 12, and 13 were built together in 1967. Each bay is approximately 320'-0" long (16 spaces at 20'-0" long) by 100'-0" wide. There is galbestos siding. The area is currently used for production.

Structural drawings are available.

Individual crane columns support one overhead 5-ton bridge crane

6.1.12 Bay 12

Bays 11, 12, and 13 were built together in 1967. Each bay is approximately 320'-0" long (16 spaces at 20--0" long) by 100'-0" wide. The roofing is 20 Gage, #3 type. The floor deck is 22 Gage, QL-3-22 Type. The area is currently used for production.

Structural drawings are available.

Individual crane columns support one overhead bridge crane

6.1.13 Bay 13

Bays 11, 12, and 13 were built together in 1967. Each bay is approximately 320'-0" long (16 spaces at 20--0" long) by 100'-0" wide. The roofing is 20 Gage, #3 type. The floor deck is 22 Gage, QL-3-22 Type. The area is currently used for production.

Structural drawings are available.

Individual crane columns support one overhead bridge crane

6.1.14 Bay 14

Bay 14 was built in 1967. The bay is approximately 320'-0" long by 50'-0" wide. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls. In 2010, a steel framed mezzanine was added. The area is currently used for production.

Structural drawings are available.

Individual crane columns support one overhead bridge crane

6.1.15 Bay 15

Bay 15 was built in 1967. The bay is approximately 320'-0" long by 50'-0" wide. The roofing is built-up with ballast supported by metal deck and purlins. Siding is on the end walls. The area is currently used for production.

Structural drawings are available.

Individual crane columns support one overhead bridge crane

6.1.16 Bay 16

The 100'-0" by 50'-0" wide northern portion of Bay 16 was built in 1991. In 2001, a mezzanine was constructed in this area. A 40'-0" x 50'-0" wide addition to Bay 16 was built in 1999 to the south of the original Bay 16 structure. Another southern addition was later constructed in 2005 that is 120'-0" in length and 50'-0" in width. This latest addition has a bridge crane that is supported by individual crane columns. The original building and the two additions have an average building height of approximately 29'-0".

Structural drawings are available.

6.1.17 Bay 17

Bay 17 was built in 2001 and is approximately 183'-0" x 50'-0" wide. The 60'-0" long northern portion of Bay 17 is steel construction, and the remainder of the structure is reinforced concrete. There is also a mezzanine that is at the same level as the northern Bay 16 mezzanine in the northern 60'-0" portion of Bay 17. The average height of the northern portion of Bay 17 is approximately 29'-0", and the remaining southern part of Bay 17 is approximately 18'-0" in height.

Structural drawings are available.

6.1.18 Bay 1T

Bay 1T was built in 1968. The bay is approximately 225'-0" long by 60'-0" wide by 30' in height. Siding is on the end walls. The area is currently used for office space.

Structural drawings are available.

6.1.19 Bay 2T

Bay 2T was built in 1969. The bay is approximately 225'-0" long by 60'-0" wide by 20' in height. Siding is on the end walls. The area is currently used for office space.

Structural drawings are available.

6.1.20 Bay 3T

Bay 3T was built in 2012. The bay is approximately 253'-0" long by 60'-0" wide by 20' in height and is reinforced steel and concrete. Siding is on the end walls. The bay is currently used for production and the mezzanine is used for storage.

Structural drawings are available. Design criteria is provided on the drawings.

Individual crane columns support two overhead bridge cranes, one 25-ton and one 10-ton. An elevator is also in the bay.

6.2 A BAYS

6.2.1 Bay 1A

Bays 1A and 2A had additions together in 1979 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 107' long by 37' wide by 30' in height. Both Bays are two floors with a Pit and Penthouse. The area is currently used for production. Mill Rail additions were made in 2006.

Structural Drawings are available and are dated August 24, 1979. Design information is provided on the structural drawings.

There is a Lyton Monorail and a 5-ton crane.

6.2.2 Bay 2A

Bays 2A and 3A were built together in 1966 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 162' long by 30' wide by 21' in height. The main floor is production and the mezzanine is office spaces.

Structural Drawings are available and are dated August 5, 1966. Design information is provided on the structural drawings.

Bays 1A and 2A had additions together in 1979 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 107' long by 37' wide by 30' in height. Both Bays are two floors with a Pit and Penthouse. The area is currently used for production. Mill Rail additions were made in 2006.

Structural Drawings are available and are dated August 24, 1979. Design information is provided on the structural drawings.

There is a Lyton Monorail and a 5-ton crane.

6.2.3 Bay 3A

Bays 2A and 3A were built together in 1966 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 162' long by 30' wide by 21' in height. The main floor is production and the mezzanine is office spaces.

Structural Drawings are available and are dated August 5, 1966. Design information is provided on the structural drawings.

6.2.4 Bay 4A

Bay 4A was built in 1957; several additions have been made. Each bay is approximately 123' long by 52' wide by 91' in height. The roofing is built-up with ballast supported by metal deck and purlins. A divider wall was added in 1999. The bay is used for production.

Structural Drawings are available and are dated 1957; drawings are also available for all the additions. Design information is provided on the structural drawings.

There is a 50-ton crane.

6.2.5 Bay 5A

Bay 5A was built in 2001 and consists of 5 floors. The bay is approximately 48' long and 40' wide. In 2008 modifications were made. In 2010 a roof top HVAC unit was added. This bay is used for storage.

Structural Drawings are available and are dated 2001.

There is an elevator.

6.2.6 Bay 6A

Bays 6A and 7A were built together in 1968 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 182' long by 50' wide by 29' in height. This area is used for production. This bay has a mezzanine.

Structural Drawings are available.

Bay 6AA has a mezzanine that was added in 2008, is approximately 60' long by 26' wide and is steel framed.

Structural drawings are available.

6.2.7 Bay 7A

Bays 6A and 7A were built together in 1968 and are a steel framed structure with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 182' long by 50' wide by 29' in height. This area is used for production. This bay has a mezzanine.

Structural Drawings are available.

6.2.8 Bay 7AA

Bay 7AA was built in 1972 and is a steel framed structure with individual column footings and braced vertically with rod cross bracing. The bay is approximately 220' long by 50' wide by 29' in height. The roofing is built-up with ballast supported by metal deck and purlins. Modifications were made to the mezzanine in 2002. The area is used for production.

Structural Drawings are available.

6.2.9 Bay 8A

Bays 8A and 9A were built in 1972. The bay is approximately 180' long by 50' wide by 29' in height. Both bays have a full mezzanine, which is used for office space. The main level is used for production

Structural Drawings are available.

6.2.10 Bay 9A

Bays 8A and 9A were built in 1972. The bay is approximately 180' long by 50' wide by 29' in height. Both bays have a full mezzanine, which is used for office space. The main level is used for production

Structural Drawings are available.

6.2.11 Bay 10A

Bay 9A was built in 1976 and is a steel framed structure with individual column footings and braced vertically with rod cross bracing. The bay is approximately 180' long (16 spaces at 20' long) by 50' wide by 29' in height. The roof deck is a metal roof deck supported with purlins. The main floor is used for production; the second is used for office space.

Structural Drawings are available.

6.2.12 Bay 12A

Bay 12A Roof Top Equipment Platform was built in 1997 and is steel framed. This area measures approximately 50' long by 50' wide. In 1993 an exhaust system was added.

Structural drawings are available for Roof Top Equipment Platform and the Exhaust System.

6.2.13 Bay 13A

Bay 13A and 14A were built together in 1967, with additions in 1988. In 1993 an exhaust system was added. In 2009 a steel framed roof top equipment platform was added. These bays are steel framed structures with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 120' long (6 spaces at 20' long) by 50' wide by 30' in height. The bay is used for production, with a mezzanine that is used for offices.

Structural Drawings are available.

Scrubbers are located in this area.

6.2.14 Bay 14A

Bay 13A and 14A were built together in 1967, with additions in 1988. In 1993 an exhaust system was added. Bay 14A had additional modifications to the mezzanine in 2003.

These bays are steel framed structures with individual column footings and braced vertically with rod cross bracing. Each bay is approximately 120' long (6 spaces at 20' long) by 50' wide by 30' in height. The bay is used for production, with a mezzanine that is used for offices.

Structural Drawings are available.

Scrubbers are located in this area.

6.2.15 Bay 15A

Bay 15 is steel framed with a concrete pad. This bay is approximately 70' long by 50' wide by 30' in height. In 1993 an exhaust system was added. In 2007 an addition was added. This bay is built as the platform for the Anderson 2000. The bay is used for production.

Structural Drawings are available.

7.0 SAFETY FACTORS AND DESIGN MARGINS

The safety factor against yielding in the seismic assessment is 1.0. This is because it is anticipated that some yielding of some components during an extreme event without catastrophic collapse is acceptable. Other more complex assessment methods include plasticity and ductility in the design and analysis of various structural systems. The yield strength values used are the design yield strength of the materials which is generally the lower statistical boundary of the actual yield strength of the material.

The component strength of the LFRS will be taken as the expected strength, Q_{CE}, for deformation controlled action and as, Q_{CN}, for force-controlled actions.

The allowed limit for strength for deformation-controlled actions is the standard allowable stress multiplied by a factor of 1.25 and 1.7. For force controlled action the allowed limit is the standard allowable stress multiplied by a factor of 1.7.

The goal of the ASCE 31-03 lateral static procedure (LSP) is to provide lateral displacement well into the elastic range without causing collapse.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The results of the evaluation are as follows. The results are based on documents retrieved for the structures, review of building codes from 1955 to present, analysis of bays built prior to 1973, and the analysis of the bays in accordance with ASCE 31-03 using the 3-D model.

Documents were identified and retrieved for all the bays at the NOG-L site. These documents included structural drawings (design and fabrication), project specifications, design codes and standards, calculations, and geotechnical reports. Drawings were retrieved for all bays. The other documents varied from bay to bay. For the more recent bays, the structural drawings included the design criteria (building codes; wind, snow, and seismic loads; and material properties on the structural drawings.

All structures were designed in accordance with the building code in effect at the time of the design. Prior to 1973, the structures were design in accordance with the SBC. From 1973 to 1996, the structures were designed to meet BOCA and from 2003 to present the structures were designed in accordance with the IBC. The BOCA and IBC building codes have seismic and wind requirements. The SBC did not have seismic requirements – only wind. However, an analysis of a bay built prior to 1973 indicates the structure did meet a seismic resistance of approximately 0.03g which is similar to the BOCA 1973. The buildings will not collapse and employees should be able to evacuate.

The analysis of the bays in accordance with ASCE 31-03 indicates some of the bracing is overloaded due to the current higher seismic loads. Current seismic loads were used due to the high value of the material.

8.2 RECOMMENDATIONS

It is recommended that the bracing in Bays 5, 7, 7A, and 14A be reinforced to meet the current seismic requirements due to the high value of the material in these bays.

9.0 REFERENCES

1. ASCE Standard 31-03: *Seismic Evaluation of Existing Buildings* (ASCE 31-03)
2. ASCE Standard 41-06: *Seismic Rehabilitation of Existing Buildings* (ASCE 41-06)
3. *Facts for Steel Buildings Number 3: Earthquakes and Seismic Design*, Hamburger (AISC 2009)
4. RISA Floor Training Manual (RISA Technologies, 2011)
5. RISA-3D Training Manual (RISA Technologies, 2011)
6. AISC *Manual of Steel Construction, 13th Edition*

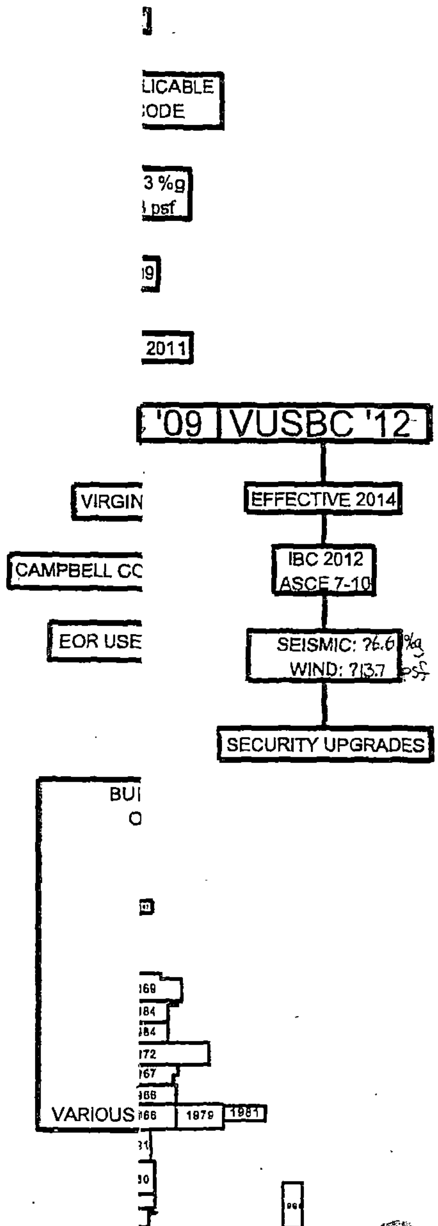


Figure 1

COPY

REVISIONS		
DATE	REV NO	DESCRIPTION

DWN. BY J. GRISHAW, PE
CHKD. BY G. LOOMIS, PE
PASSED BY ED FULCHER
APPVD. BY ED FULCHER

VIRGINIA UNIFORM BUILDING CODE HISTORICAL TIMELINE AND BUILDING DATES

B&W

DO NOT SCALE USE DIMENSIONS ONLY | SCALE N.T.S | SHEET 1 OF 1 | DWG. NO. STEC8_1000 E | REV 0

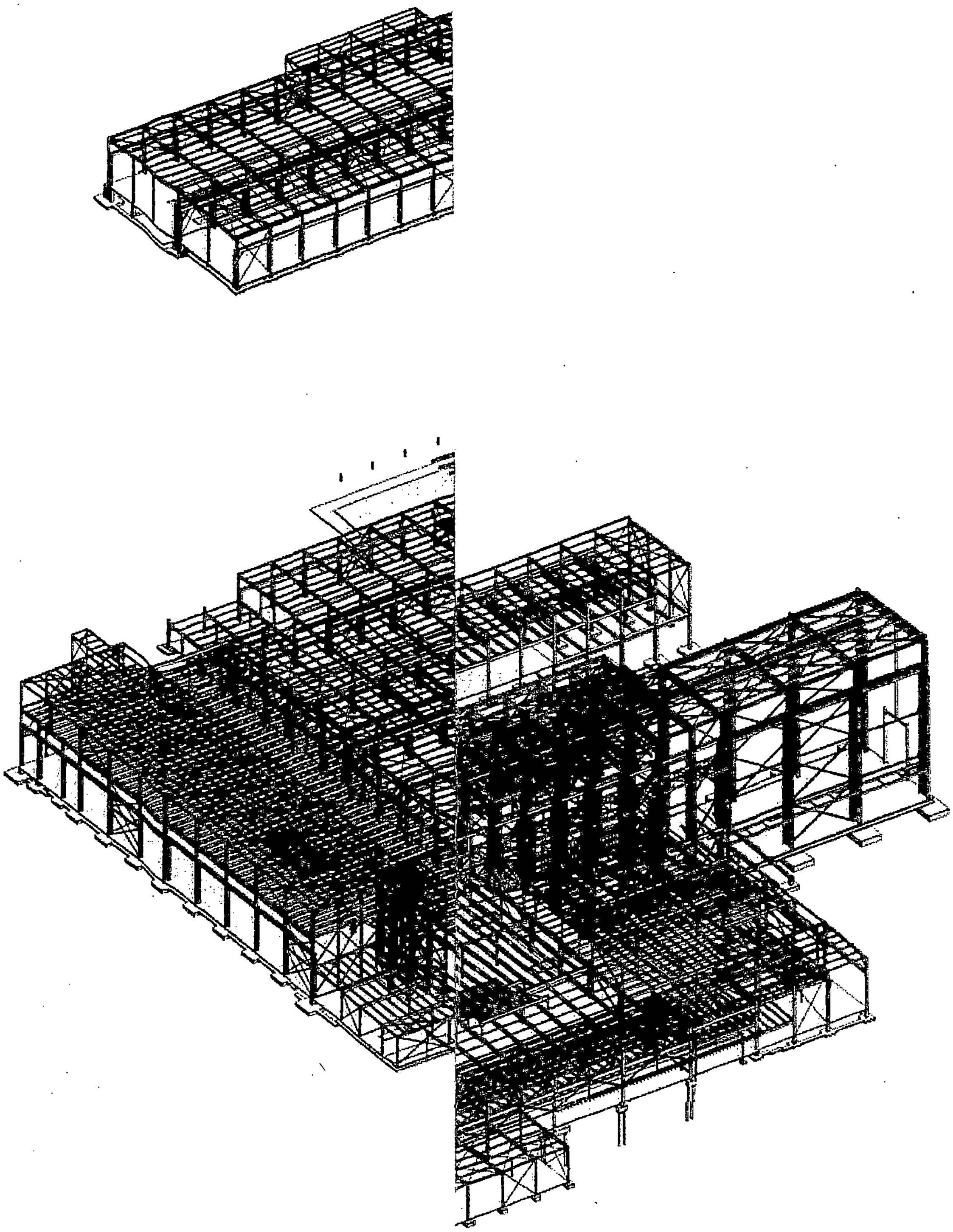


Figure 2

APPENDIX A

CODE INFORMATION

Southern Building Code 1965

(b) Balcony railings, both exterior and interior, shall be designed to resist a horizontal thrust of fifty (50) pounds per linear foot applied at the top of the railing.

1204.3 — SUPPORTS FOR WALKWAYS

Where walkways are to be installed above ceilings, supports shall be designed to carry a load of two hundred (200) pounds occupying a space two and one-half (2½) square feet, so placed as to produce maximum stresses in the affected members.

SECTION 1205 — WIND LOADS

1205.1 — MINIMUM DESIGN LOADS

Buildings or other structures shall be capable of withstanding the horizontal loads shown in the following table and, applied in each zone, allowing for wind from any direction. The first height zone shall be measured above the average level of the ground adjacent to the building and the subsequent height zones shall be added progressively upward to the overall height of the building.

DESIGN WIND PRESSURE FOR VARIOUS HEIGHT ZONES OF BUILDINGS OR OTHER STRUCTURES

Height Zone Ft.	Lb./Sq. Ft. Horizontal Loads	
	For Southern Inland Regions	For Southern Coastal Region*
Less than 30	10	25
31 to 50	20	35
51 to 99	24	45
100 to 199	28	50
200 to 299	30	50
300 to 399	32	50
Over 400	40	50

*Coastal regions is that area lying within 125 miles of the coast and subject to hurricanes, tropical disturbances and occasional winds attaining exceptionally high wind velocities.
(See Appendix "D" for Hurricane Requirements.)

1205.2 — EXTERIOR WALLS

Every exterior wall shall be capable of withstanding the loads specified in the above table, acting either inward or outward.

1205.3 — ROOFS — WIND LOADS

(a) The roofs of all buildings or other structures shall be designed to withstand loads acting outward normal to the surface equal

BOCA 1970 (WIND)

of primary members shall be those prescribed in section 714.1, distributed in accordance with section 714.2.

The wind pressures on vertical surfaces to be considered in the design of secondary members, wall panels, sheathing and girts and their connections shall be those prescribed in section 714.1 distributed in accordance with section 714.2 and as modified by section 714.3.

714.1 **Primary Framing Members:** Except in geographical localities subject to hurricanes, cyclones, tornadoes or similar unusual wind pressures shall be as required in the following section:

714.11 **Height Not More than Fifty Feet:** On buildings or parts thereof that are fifty (50) feet or less in height the wind pressure on exposed vertical surfaces shall be assumed to be fifteen (15) pounds per square foot.

714.12 **Height Not More Than 100 Feet:** On all buildings or parts thereof between fifty (50) and one hundred (100) feet in height, a pressure of twenty (20) pounds per square foot shall be assumed on those exposed vertical surfaces in excess of fifty (50) feet in height.

714.13 **Height Over 100 Feet:** On all buildings or parts thereof over one hundred (100) feet in height the wind pressure shall be assumed to increase twenty-five thousandths (0.025) pounds per square foot for each foot of height in excess of one hundred (100) feet above the one hundred (100) foot level.

714.2 **Distribution of Wind Force:** The wind pressure shall be distributed between opposite walls, two-thirds (⅔) as a normal pressure on the windward side and one-third (⅓) as a normal outward suction on the leeward side.

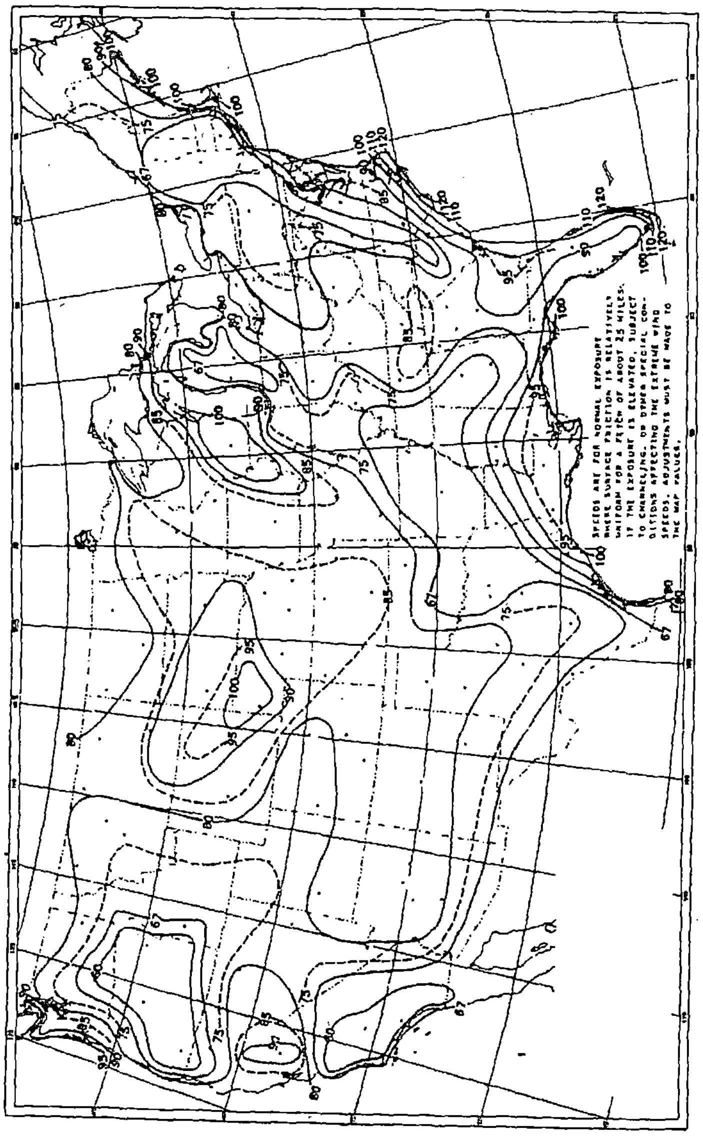
714.3 **Secondary Wall Framing and Wall Panels:** In buildings provided with one-third (⅓) or more wall openings, internal wind forces of ten (10) pounds per square foot shall be assumed to occur simultaneously with the above external forces both in pressure and suction.

714.31 **External Pressures:** External Pressures or suctions to be considered in the design of secondary wall framing and wall panels and sheathing and their connections shall be one and one-half (1½) times those determined in accordance with section 714.2.

714.32 **Internal Pressures:** In buildings having one-third (⅓) or more of any wall surface open, or subject to being opened or broken, an internal pressure of ten (10) pounds per square foot or internal suction of five (5) pounds per square foot, whichever is critical, shall be considered in the design of secondary wall framing and wall panels and sheathing and their connections, in addition to the external pressures or external suction required by section 714.31. For lesser amounts of wall openings the internal pressure or suction assumed shall be one-half (½) of the foregoing values.

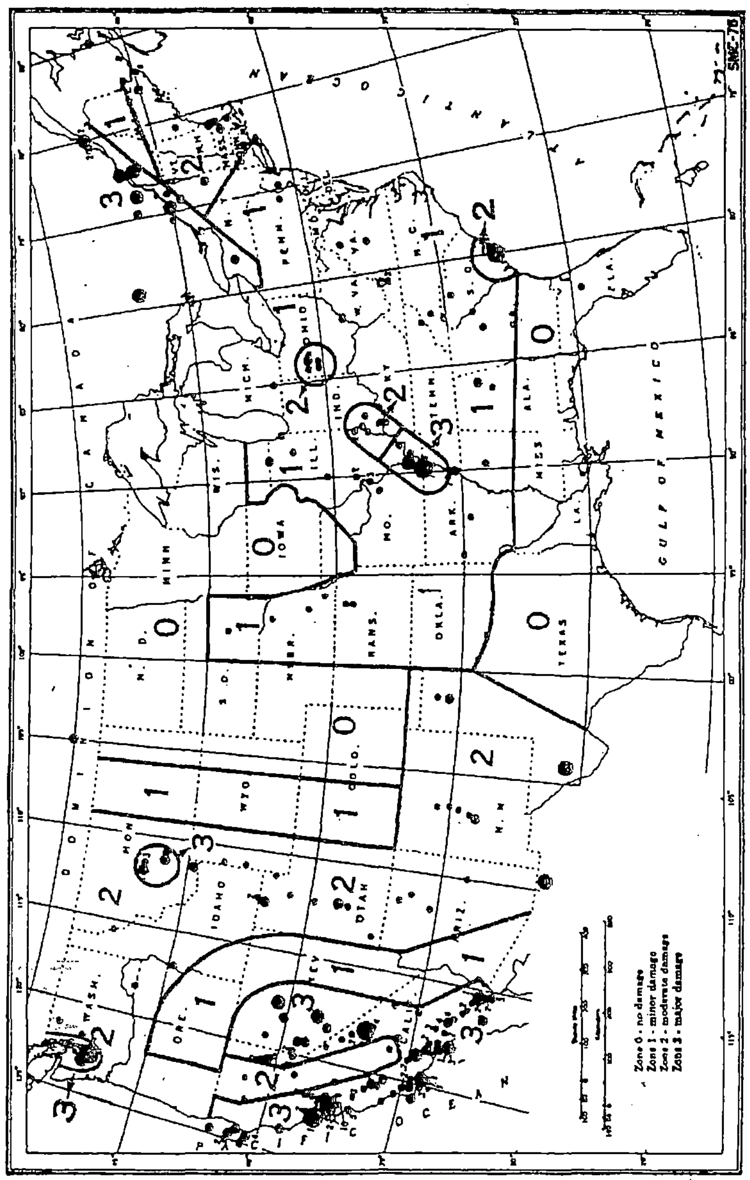
714.4 **Design Wind Load for Glass:** Firmly supported lights of glass of four (4) square feet or more in area installed in a vertical position, or

TABLE B
FASTEST MILE WIND VELOCITY AT 30 FEET ABOVE GROUND,
50 YR. MEAN RECURRENCE.



BOCA 1970 (SEISMIC)

TABLE 14C.—SEISMIC PROBABILITY MAP OF THE UNITED STATES.



BOCA 1970 (SEISMIC)

Section 718.0 Overturning and Sliding

The overturning moment due to the wind load on all structures shall not exceed seventy-five (75) per cent of the moment of stability resulting from the dead load of the building, unless the building or structure is anchored to resist the excess overturning moment and the excess horizontal shear over sliding friction.

Section 719.0 Earthquake Load

In regions where local experience or the records of the U. S. Coast and Geodetic Survey show loss of life or damage of buildings resulting from earthquakes, buildings and structures hereafter erected shall be designed to withstand lateral forces as provided in appendix K-11 of the Basic Code, except as exempted in section 719.1.

719.1 Exemptions: In zone "0" of table 14C in appendix K-11 and where local experience or the records of the U. S. Coast and Geodetic Survey do not show loss of life or damage to property, regardless of zone, or when the building complies with any one or more of the following conditions, no earthquake loading shall be required in calculating the structural frame of the building or structure.

a) is a one- or two-family dwelling;
b) is a minor accessory building;
c) is not over three (3) stories or thirty-five (35) feet in height;
d) is of skeleton frame construction with wind and sway bracing as required by approved engineering practice for the type of frame used, and the least dimension of the building is not less than thirty-five (35) percent of the height.

Section 720.0 Combined Loading

The structural frame of all buildings shall be investigated for the combined effect of lateral and vertical loading and the individual members of the frame shall be proportioned as follows:

720.1 With Earthquake: For combined stresses due to earthquake load together with dead, live and snow loads, the allowable working stress for the structural material may be increased thirty-three and one-third (33⅓) per cent;

720.2 With Wind: For combined stresses due to wind load together with dead, live and snow loads, the allowable working stress for the structural material may be increased thirty-three and one-third (33⅓) percent);

720.3 Minimum Section: The section determined for the combined loadings herein specified shall be compared with that required for dead, live and snow loads only, and the section of greatest strength shall determine that to be used in the structure.

K-9 Formed Steel Construction Stresses

The allowable working stresses for light gage formed steel structural members shall be based on the following grades of flat rolled carbon steel with yield points of 25,000, 30,000 and 33,000 pounds per square inch as specified in the standard specification for the design of light gage steel structural members listed in appendix B, subject to a reduction of ten (10) per cent on all stress values for ordinary materials.

K-10 Lumber Stresses

When the grade of lumber is not identified as provided in section 722 for controlled materials, the maximum allowable working stresses for the species of lumber used shall be determined in accordance with the principles for stress grade lumber as set forth in the National Design Specification for Stress-Grade Lumber and Its Fastenings.

K-11 Earthquake Load Design

When required to withstand lateral forces under section 719.0 buildings and structures shall be designed in accordance with the following sections according to the zone in which they are located on the seismic probability map in table 14C.

K-11-A Application of Provisions: These lateral force requirements are intended to make buildings earthquake-resistive. The provisions apply to the buildings as a unit and also to all parts thereof, including the structural frame or walls, floor and roof systems, and other structural features. In specific cases, they may be interpreted or added to as to detail by rulings of the building official in order that the intent shall be fulfilled.

K-11-A-1 Additions: Where applicable, every addition to an existing building or structure shall be designed and constructed to resist and withstand the forces provided for herein, and in any case where an existing building or structure is increased in height all portions thereof affected by such increased height shall be reconstructed to resist and withstand the forces provided for herein.

K-11-A-2 Alterations: Where applicable, no existing building or structure shall be altered or reconstructed in such a manner that the resistance to the forces provided for herein will be less than that before such alteration of reconstruction was made; provided, however, that this provision shall not apply to non-bearing partitions, and shall not apply to other minor alterations which are made in compliance with all requirements of the Basic Code.

K-11-B Plans and Design Data: Where earthquake loads are applicable, a brief statement of the following items shall be included with each set of plans filed:

a) a summation of the dead and live load of the building, floor by floor, which was used in figuring the shear for which the building is designed.

b) a brief description of the bracing system used, the manner in which the designer expects such system to act and a clear statement of any assumptions used. Assumption as to location of all points of counterflexure in members must be stated.

c) sample calculation of a typical bent or equivalent. For combined stresses due to the lateral forces and other loads, the allowable unit stresses and the allowable load in connections may be increased as provided in section 720.0.

K-11-C **Lateral Force Requirements:** Where earthquake loads are applicable, every building or structure and every portion thereof, except as exempted in section 719.1 shall be designed and constructed to resist stresses produced by lateral forces as provided herein. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the foundation. The force shall be assumed to come from any horizontal direction.

K-11-C-1 **Bracing Systems:** All bracing systems both horizontal and vertical shall transmit all forces to the resisting members and shall be of sufficient extent and detail to resist the horizontal forces provided for herein and shall be located symmetrically about the center of mass of the building or the building shall be designed for the resulting rotational forces about the vertical axis.

K-11-C-2 **Junctures Between Wings:** Junctures between distinct parts of buildings, such as wings which extend more than twenty (20) feet from the main portion of the building, shall be designed at the juncture with other parts of the building for rotational forces, or the juncture may be made by means of sliding fragile joints having a minimum width of not less than eight (8) inches. The details of such joints shall be made satisfactory to the building official.

K-11-D **Horizontal Force Formula:** The horizontal force shall be calculated according to the following formula:

$$F = CW$$

Where

F = the horizontal force in pounds.

W = the total dead load, tributary to the point under consideration, except for warehouses and tanks, in which case W shall equal the total live load tributary to the point under consideration. Machinery or other fixed concentrated loads shall be considered as part of the dead load.

C = a numerical constant as shown in table 14B and section K-11-D-1 to K11-D-3 inclusive.

TABLE NO K-11-A HORIZ FORCE FACTOR "K" FOR BLDG & OTHER STRUCTURES
TABLE NO K-11-B HORIZ FORCE FACTOR "Cp" FOR PARTS OR PORTIONS OF BLDG OR OTHER STRUCTURES

TABLE 14-B.—HORIZONTAL FORCE FACTORS

Part or Portion	Value of C in Zone 1*	Direction of Force
Floors, roofs, columns and bracing in any story of a building or the structure as a whole**	$\frac{0.15^{***}}{N+4\frac{1}{2}}$	Any direction horizontally
Bearing walls, non-bearing walls, partitions, free standing masonry walls over 6 ft. in height	.05 With a minimum of five pounds per sq. ft.	Normal to surface of wall
Cantilever parapet and other cantilever walls, except retaining walls	.25	Normal to surface of wall
Exterior and interior ornamentations and appendages	.25	Any direction horizontally
When connected to or part of a building: towers, tanks, towers and tanks plus contents, chimneys, smokestacks and penthouses	.05	Any direction horizontally
Elevated water tanks and other tower-supported structures not supported by a building	.03	Any direction horizontally

* For zones, see table 14C. For requirements in zones see section K-11-D-1 to K-11-D-3 inclusive.
** Where specified wind load would produce higher stresses, this load shall be used in lieu of the factor shown. (See section 720.0.)
*** N is number of stories above the story under consideration, provided that for floors or horizontal bracing, N shall be only the number of stories contributing loads.

K-11-D-1 Requirements for Zone 1: Where earthquake loads are applicable to buildings or structures in Zone 1 on map in table 14C, the value of "C" shall be as shown in table 14B.

K-11-D-2 Requirements for Zone 2: Where earthquake loads are applicable to buildings or structures in Zone 2 on map in table 14C, the value of "C" shown in table 14B shall be doubled.

K-11-D-3 Requirements for Zone 3: Where earthquake loads are applicable to buildings or structures in Zone 3, on map in table 14C, the value of "C" shown in table 14B shall be multiplied by four (4).

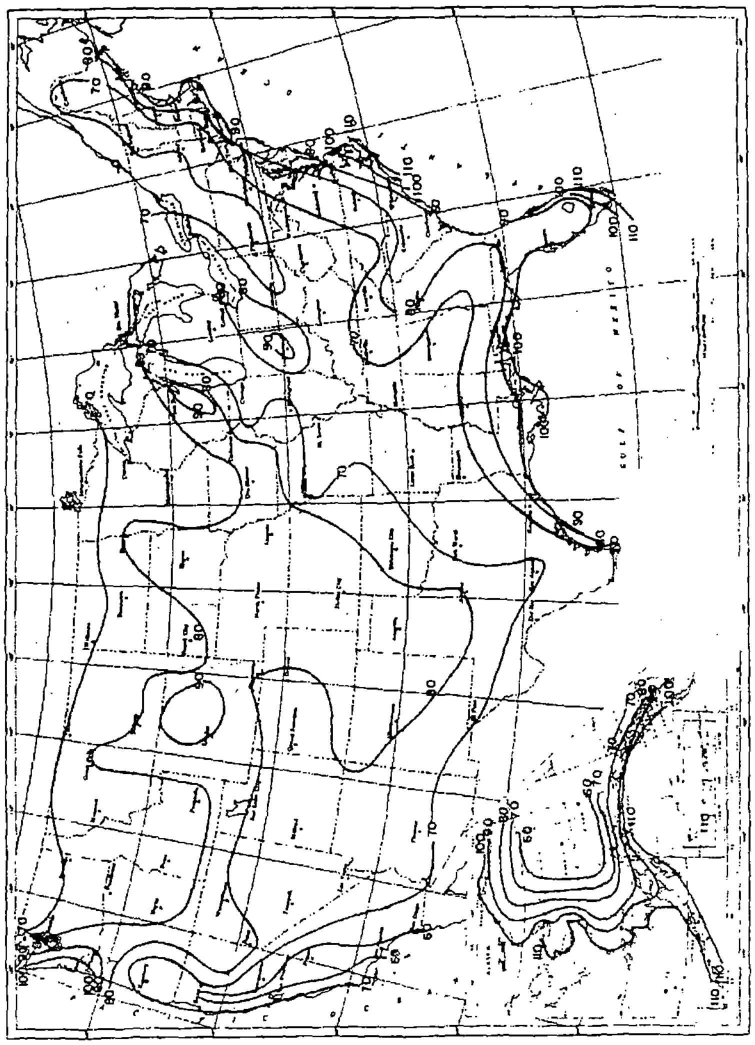
K-11-D-4 Location of Zones: For the purpose of determining the value of "C" in table 14B, the map in table 14C shall govern.

K-11-E Foundation Ties: Where earthquake loads are applicable in the design of buildings, other than lightly loaded structures of type 2 and 4 construction, where the foundations rest on piles or on soil having a safe bearing value of less than two thousand (2000) pounds per square foot, the foundations shall be completely interconnected in two directions approximately at right angles to each other. Each such interconnecting member shall be capable of transmitting by both tension and com-

K-11-E-1 TOTAL LATERAL FORCE & DISTRIBUTION OF LATERAL FORCE:
K-11-E-2 LATERAL FORCE ON PARTS OR PORTIONS OF BUILDINGS AND OTHER STRUCTURES

1981 BOCA (WIND)

Figure 912.1
BASIC WIND SPEED IN MILES PER HOUR
Annual Extreme Fastest Mile Speed 30 Feet Above Ground,
50 Year Mean Recurrence Interval[a]



Note a. This figure applies to all types of storms except tornadoes
Note b. 1 foot = 304.8 mm; ~~1 mph~~ = 0.447 m/s

1981 BOCA (WIND)

SECTION 912.0 WIND LOAD

912.1 Design: All exposed structures or parts of structures shall be designed to resist the pressures due to wind in any direction, as provided in Sections 912.0 to 915.0 inclusive. The basic minimum wind speeds are shown in Figure 912.1 for the geographic location of the structure. The minimum wind pressures corresponding to specific wind speeds and heights are shown in Table 912.1. In all cases, the wind loads shall be considered as acting normal to the surfaces to which they apply. These provisions do not apply to structures of unusual shape, exposure, or structural characteristics which would make them susceptible to unusual stresses. In such cases, special engineering investigations are required.

Table 912.1
EFFECTIVE VELOCITY PRESSURES[a]
FOR ORDINARY BUILDINGS AND STRUCTURES

Height (ft)	Basic wind speed (mph)								
	50	60	70	80	90	100	110	120	130
Less than 30	10	10	10	10	13	16	20	23	27
30-40	10	10	11	14	17	21	27	31	36
40-75	10	10	12	15	19	24	29	34	40
75-125	10	11	15	19	24	30	36	43	51
125-175	10	12	17	22	28	34	41	49	58
175-225	10	14	18	24	31	38	46	54	64
225-275	10	15	20	26	33	41	49	59	69
275-325	11	16	21	28	35	43	52	62	73
325-375	11	16	22	29	37	45	55	65	77
375-425	12	17	23	31	39	48	58	69	81
425-475	12	18	24	32	40	50	60	72	84
475-525	13	18	25	33	42	51	62	74	87
525-575	13	19	26	34	43	53	64	76	90
575-625	14	20	27	35	44	55	66	79	92
625-675	14	20	28	36	46	57	69	82	96
675-725	14	21	28	37	47	58	70	83	98
725-775	15	21	29	38	48	59	72	86	100
775-825	15	22	30	39	49	61	73	87	102

Note a. Pressures, in pounds per square foot, are based on geographic locations such as suburban areas, towns, city outskirts, wooded areas and rolling terrain
Note b. 1 foot = 304 8 mm; 1 mph = 0.447 m/s; 1 psf = 4 882 kg/m².

912.2 Special wind conditions: Special wind conditions shall be provided for in accordance with Sections 912.2.1 and 912.2.2.

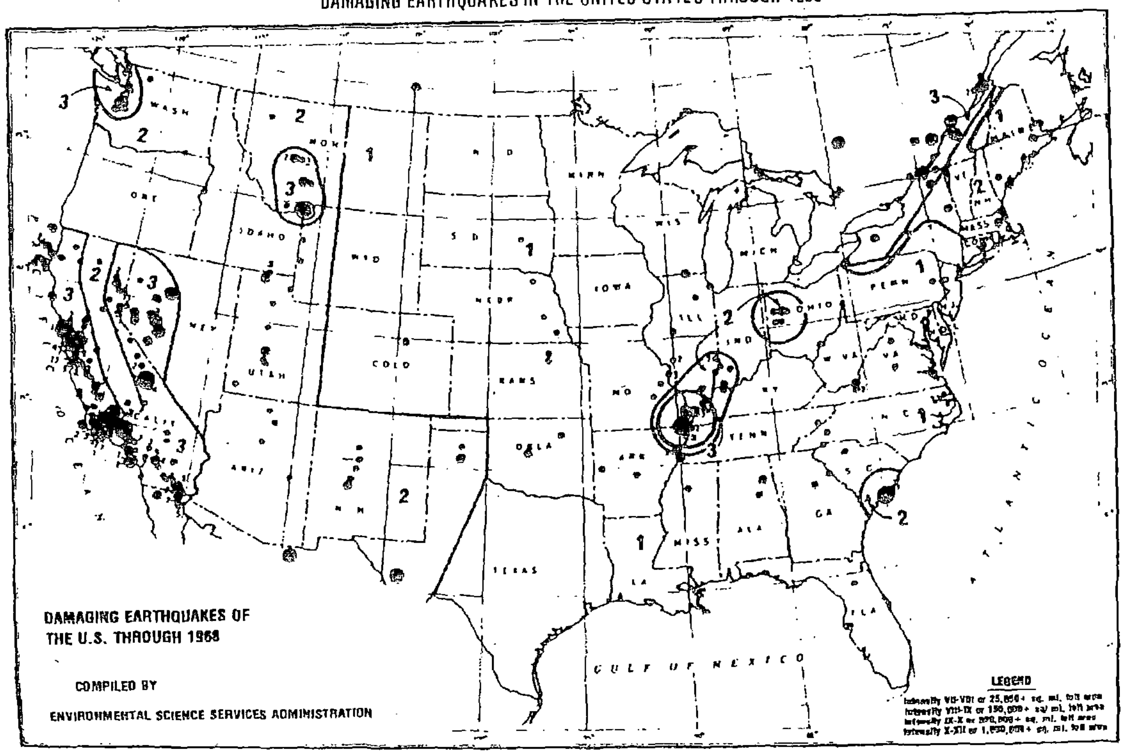
912.2.1 Increased loads: For structures located in flat, open country, open flat coastal belts, grassland, unusually exposed positions or in geographical regions where local records indicate higher wind loads than established in Section 912.1 the higher wind load shall be used.

912.2.2 Decreased loads: For structures located in centers of large cities, very rough, hilly terrain and in geographical regions where substantiating data

BOCA 1981 (Seismic)

Appendix A11

Figure 916
DAMAGING EARTHQUAKES IN THE UNITED STATES THROUGH 1968



915.3 Shielding effect: The shielding effect of one element by another shall not be considered when the distance between them exceeds four times the projected smallest dimension of the windward element.

915.4 Effect of shape: Net pressure coefficients for chimneys, tanks and similar structures are prescribed in Table 915.4. These coefficients apply to the projected area of the structure on a vertical plane normal to the wind direction. For slender structures such as flagpoles, a minimum net pressure coefficient of 1.2 shall be used if $d\sqrt{q} < 2.5$.

SECTION 916.0 EARTHQUAKE LOAD

916.1 General: In regions where local experience or the records of the U.S. Geological Survey (USGS) show loss of life or damage of buildings resulting from earthquakes, buildings and structures hereafter erected shall be designed to withstand lateral forces as provided in Section 916.3, except as exempted in Section 916.2.

916.2 Exemptions: Earthquake loading shall not be required in calculating the structural frame of a building or structure when the building complies with one or more of the following conditions.

1. Is located in Zone 0 of Figure 916.
2. Is located where local experience or the records of the U.S. Geological Survey (USGS) do not show loss of life or damage to property, regardless of zone.
3. Is a building of Use Group R-3.
4. Is a minor accessory building.

916.3 Earthquake load design: The load design criteria provided in this section shall be used to calculate and effectively provide for the loads and stresses acting upon a structure.

916.3.1 General: When required to withstand lateral forces under Section 916.1, buildings and structures shall be designed in accordance with the following provisions of this section according to the zone in which they are located on the seismic probability map in Figure 916.

916.3.1.1 Application of provisions: These lateral force requirements are intended to make buildings earthquake resistive. The provisions apply to the buildings as a unit and also to all parts thereof, including the structural frame or walls, floor and roof systems, and other structural features. In specific cases, they may be interpreted or added to as to detail by approval of the building official in order that the intent shall be fullfilled.

916.3.1.2 Additions: Where applicable, every addition to an existing building or structure shall be designed and constructed to resist and withstand the forces provided for herein, and in any case where an existing building or structure is increased in height all portions thereof affected by such increased height shall be reconstructed to resist and withstand the forces provided for herein.

916.3.1.3 Alterations: Where applicable, an existing building or structure shall not be altered or reconstructed in such a manner that the resistance to the forces provided for herein will be less than that before such alteration or reconstruction was made; provided, however, that this provision shall not apply to nonbearing partitions, and shall not apply to other minor alterations which are made in accordance with Section 103.3.

916.3.2 Plans and design data: Where earthquake loads are applicable, a brief statement of the items indicated in Sections 916.3.2.1 through 916.3.2.3 shall be included with each set of plans filed.

916.3.2.1 Dead and live loads: A summation of the dead and live loads of the building, floor by floor, which was used in figuring the shear for which the building is designed.

916.3.2.2 Bracing: A brief description of the bracing system used, the manner in which the designer expects such system to act and a clear statement of any assumption used. Assumptions as to location of all points of counter flexure in members must be stated.

916.3.2.3 Sample calculation: Sample calculation of a typical bent or equivalent. For combined stresses due to the lateral forces and other loads, the allowable unit stresses and the allowable load in connections may be increased as provided in Section 917.0.

916.3.3 Lateral force requirements: Where earthquake loads are applicable, every building or structure and every portion thereof, except as exempted in Section 916.2, shall be designed and constructed to resist stresses produced by lateral forces as provided in this section. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the foundation. The force shall be assumed to act from any horizontal direction. In those zones where wind, snow, or other loads impose a greater load than those provided herein, such other loads shall be provided for.

916.3.4 Definitions: The definitions listed below apply only to the provisions of this section.

Space frame: A three dimensional structural system composed of interconnected members, other than shear or bearing walls, laterally supported so as to function as a complete self contained unit with or without the aid of horizontal diaphragms or floor bracing systems.

Space frame, vertical load carrying: A space frame designed to carry all vertical loads.

Space frame, moment resisting: A vertical load carrying space frame in which the members and joints are capable of resisting design lateral forces by bending moments and column shears.

Space frame, ductile moment resisting: A space frame which complies with the requirements for a ductile moment resisting space frame as set forth in Section 916.3.11.

Box system: A structural system without a complete vertical load carrying space frame. In this system, the required lateral forces are resisted by shear walls as hereinafter defined.

Shear wall: A wall designed to resist lateral forces parallel to the wall. Braced frames subjected primarily to axial stresses shall be considered as shear walls for the purpose of this definition.

Lateral force resisting system: That part of the structural system to which the lateral forces prescribed in Section 916.3.5.1 are assigned.

916.3.4.1 Symbols and notations: The following symbols and notations apply only to the provisions of this section.

C	= Numerical coefficient for base shear as defined in Section 916.3.5.2.
C_p	= Numerical coefficient as defined in Section 916.3.5.2 and set forth in Table 916.3.5.2.
D	= The dimension of the building in feet in a direction parallel to the applied forces (see also Section 916.3.10).
D_s	= The plan dimension in feet of the vertical lateral force resisting system in the direction of the applied force.
F_i, F_n, F_x	= Lateral force applied to level i, n, or x respectively.
F_p	= Lateral forces on the part of the structure, and in the direction under consideration.
F_t	= That portion of V considered concentrated at the top of the structure, at the level n. The remaining portion of the total base shear (V) shall be distributed over the height of the structure including level n according to the equation for F_x in Section 916.3.5.1.
h_i; h_n, h_x	= The height in feet above the base to level i, n, or x respectively.
J	= Numerical coefficient for base overturning moment as defined in Section 916.3.9.
J_x	= Numerical coefficient for overturning moment at level x.
K	= Numerical coefficient as set forth in Table 916.3.5.1.
Level i	= Level of the structure referred to by the subscript i.
Level n	= That level which is uppermost in the main portion of the structure.
Level x	= That level which is under design consideration.
M	= That overturning moment at the base of the building or structure.
M_x	= The overturning moment at level x.
N	= The total number of stories above exterior grade to level n.
T	= Fundamental period of vibration of the building or structure in seconds in the direction under consideration.
V	= The total lateral force or shear at the base.

$$V = F_t + \sum_{i=1}^{n} F_i$$

where $i = 1$ designates first level above the base.

W =The dead load $W = \sum_{i=1}^{n} W_i$

Exception: W shall be equal to the total dead load plus 25 percent of the floor live load in Use Group S.

W_i, W_x =That portion of W which is located at or is assigned to level i or x respectively.

W_p =The weight of a portion of a structure.

Z =Numerical coefficient dependent upon the zone as determined by the maps in Figure 916. For locations in Zone 1, Z shall be equal to 0.25. For locations in Zone 2, Z shall be equal to 0.50. For locations in Zone 3, Z shall be equal to 1.0.

916.3.5 Minimum earthquake forces for structures: Minimum earthquake forces shall be determined in accordance with Sections 916.3.5.1 through 916.3.5.3.

916.3.5.1 Total lateral force and distribution of lateral force: Every structure shall be designed and constructed to withstand minimum total lateral seismic forces assumed to act nonconcurrently in the direction of each of the main axes of the structure in accordance with the following formula:

$$V = ZKCW$$

The value of K shall be not less than that in Table 916.3.5.1. The value of C shall be determined in accordance with the following formula:

$$C = 0.05 \div \sqrt[3]{T}$$

Exception: C shall be 0.10 for all one and two story buildings.

T is the fundamental period of vibration of the structure in seconds in the direction under consideration. Properly substantiated technical data for establishing the period T for the contemplated structure may be submitted. In the absence of such data, the value T for buildings shall be determined by the following formula:

$$T = 0.05\, h_n \div \sqrt{D}$$

Exception: In all buildings in which the lateral force resisting system consists of a moment resisting space frame which resists 100 percent of the required lateral forces, and which frame is not enclosed by or adjoined by more rigid elements which would tend to prevent the frame from resisting lateral forces:

$$T = 0.10\, N$$

The total lateral force V shall be distributed in the height of the structure in the following manner:

$$F_t = .004\ V (h_n \div D_s)^2$$

F_t need not exceed 0.15 V and may be considered as 0 for values $(h_n \div D_s)$ of 3 or less, and

$$F_x = (V - F_t)\, w_x h_x \div \sum_{i=1}^{n} w_i h_i$$

Exception: One and two story buildings shall have uniform distribution. At each level designated as x, the force F_x shall be applied over the area of the building in accordance with the mass distribution on that level.

Table 916.3.5.1
HORIZONTAL FORCE FACTOR K FOR BUILDINGS OR OTHER STRUCTURES[a]

Type or arrangement of resisting elements	Value of K^b
All building framing systems except as hereinafter classified	1.00
Buildings with a box system as defined in Section 916.3.4	1.33
Buildings with a dual bracing system consisting of a ductile moment resisting space frame and shear walls designed in accordance with the following criteria. 1. The frames and shear walls shall resist the total lateral force in accordance with their relative rigidities considering the interaction of the shear walls and frames. 2. The shear walls acting independently of the ductile moment resisting space frame shall resist the total required lateral force. 3. The ductile moment resisting space frame shall have the capacity to resist not less than 25 percent of the required lateral force.	0.80
Buildings with a ductile moment resisting space frame designed to resist the total required lateral force.	0.67
Elevated tanks plus full contents, on four or more crossbraced legs and not supported by a building[c, d, e]	3.00
Structures other than buildings and other than those set forth in Table 916.3.5.2	2.00

Note a. Where wind load would produce higher stresses, these loads shall be used in lieu of the loads resulting from earthquake forces.
Note b. See maps in Figure 916 for seismic probability zones and definitions of Z as specified in Section 916.3.4.1.
Note c. The minimum value of KC shall be 0.12 and the maximum value of KC need not exceed 0.25.
Note d. For overturning, the factor J as specified in Section 916.3.9 shall be 1.00.
Note e. The torsional requirements of Section 916.3.8 shall apply.

916.3.5.2 Lateral forces on parts or portions of buildings and other structures: Parts or portions of buildings or structures and their anchorage shall be designed for lateral forces in accordance with the following formula:

$$F_p = ZC_pW'_p$$

The values of C_p are in Table 916.3.5.2. The distribution of these forces shall be according to the gravity loads pertaining thereto.

916.3.5.3 Pile foundations and caisson footings: Individual pile and caisson footings of every building or structure shall be interconnected by ties, each of which can carry by tension and compression a horizontal force equal to 10 percent of the larger pile cap loading, unless it can be demonstrated that equivalent restraint can be provided by other means.

916.3.6 Distribution of horizontal shear: Total shear in any horizontal plane shall be distributed to the various elements of the lateral force resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements that are assumed not to be part of the lateral force resisting system may be incorporated into buildings provided that their effect on the action of the system is considered and provided for in the design.

916.3.7 Drift: Lateral deflections or drift of a story relative to its adjacent stories shall be considered.

916.3.8 Horizontal torsional moments: Provisions shall be made for the increase in shear resulting from the horizontal torsion due to an eccentricity between the center of mass and the center of rigidity. Negative torsional shears shall be neglected. Where the vertical resisting elements depend on diaphragm action for shear distribution at any level, the shear resisting elements shall be capable of resisting a torsional moment assumed to be equivalent to the story shear acting with an eccentricity of not less than 5 percent of the maximum building dimension at that level.

916.3.9 Overturning: Every building or structure shall be designed to resist the overturning effects caused by wind forces and the related requirements, or the earthquake forces specified in this section, whichever governs.

Exception: The axial loads from earthquake force on vertical elements and footings in every building or structure may be modified in accordance with the following provisions.

Table 916.3.5.2
HORIZONTAL FORCE FACTOR C_p FOR PARTS OR PORTIONS OF BUILDINGS OR OTHER STRUCTURES

Part or portion of building	Direction of force	Value of C_p
Exterior bearing and nonbearing walls, interior bearing walls and partitions, interior nonbearing walls and partitions over 10 feet in height, masonry fences over 6 feet in height.	Normal to flat surface	0.20
Cantilever parapet and other cantilever walls, except retaining walls.	Normal to flat surface	1.00
Exterior and interior ornamentations and appendages	Any direction	1.00
When connected to or part of a building: towers, tanks, towers and tanks plus contents, chimneys, smokestacks, and penthouses	Any direction	0.20[a]
When resting on the ground, tank plus effective mass of its contents	Any direction	0.10
Floors and roofs acting as diaphragms[b]	Any direction	0.10
Connections for exterior panels or for elements complying with Section 916.3.12.5	Any direction	2.00

Note a. When $\frac{h_n}{D}$ of any building is equal to or greater than five to one, increase value by 50 percent.

Note b. Floors and roofs acting as diaphragms shall be designed for a minimum value of C_p of 10 percent applied to loads tributary from that story unless a greater value of C_p is required by the basic seismic formula $V = ZKCW$.

Note c. 1 foot = 304.8 mm.

1. Overturning moment (M) at the base of the building or structure shall be determined in accordance with the following formula:

$$M = J(F_t h_n = \sum_{i=1}^{n} F_i h_i)$$

where $J = 0.6 \div \sqrt[3]{T^2}$

The value of J need not be more than 1.00.

2. For structures other than buildings, the value of J shall not be less than 0.45, and the overturning moment (M_x) at any level designated as x shall be determined in accordance with the following formula:

$$M_x = J_x\,[F_t(h_n - h_x) + \sum_{i=1}^{n} F_i\,(h_i - h_x)]$$

where $J_x = J + (1 - J)\,(h_x \div h_n)^3$

916.3.9.1 Overturning moment distribution: At any level, the incremental changes of the design overturning moment in the story under consideration shall be distributed to the various resisting elements in the same proportion as the distribution of the shears in the resisting system. Where other vertical members are provided which are capable of partially resisting the overturning moments, a redistribution may be made to these members if framing members of sufficient strength and stiffness to transmit the required loads are provided.

Where a vertical resisting element is discontinuous, the overturning moment carried by the lowest story of that element shall be carried down as a load to the foundation.

916.3.10 Setbacks: Buildings having setbacks wherein the plan dimension of the tower in each direction is at least 75 percent of the corresponding plan dimension of the lower part may be considered as a uniform building without setbacks for the purpose of determining seismic forces.

For other conditions of setbacks, the tower shall be designed as a separate building using the larger of the seismic coefficients at the base of the tower determined by considering the tower as either a separate building for its own height or as part of the overall structure. The resulting total shear from the tower shall be applied at the top of the lower part of the building which shall be otherwise considered separately for its own height.

916.3.11 Structural systems: Buildings more than 160 feet (48768 mm) in height shall have ductile moment resisting space frames which (including connections) are capable of resisting not less than 25 percent of the required seismic force for the structure as a whole. All buildings designed with a horizontal force factor K of 0.67 or 0.80 shall be ductile moment resisting space frames.

Exceptions

1. Buildings more than 160 feet (48768 mm) in height in Zone 1 may have shear walls or braced frames in lieu of a ductile moment resisting space frame, provided a K value of 1.00 or 1.33 is utilized in the design.

2. Other structural systems may be approved by the building official when evidence is submitted showing that adequate energy absorption and ductility are provided to withstand the anticipated earthquakes based on a seismological evaluation for the location.

Moment resisting space frames and ductile moment resisting space frames may be enclosed or adjoined by more rigid elements which would tend to prevent the space frame from resisting lateral forces where it can be shown that the action or failure of the more rigid elements will not impair the vertical and lateral load resisting ability of the space frame.

The necessary ductility for a ductile moment resisting space frame shall be provided by a frame which will incorporate approved criteria for achieving ductility in the elastic and inelastic range. Shear walls in buildings where K = 0.80 shall be constructed to achieve ductile systems in accordance with approved criteria.

916.3.12 Design requirements: The design requirements of Sections 916.3.12.1 through 916.3.12.5 shall apply to the earthquake design required by this section.

916.3.12.1 Building separations: All portions of structures shall be designed and constructed to act as an integral unit in resisting horizontal forces unless separated structurally by a distance sufficient to avoid contact under deflection from seismic action or wind forces.

916.3.12.2 Minor alterations: Minor structural alterations may be made in existing buildings and other structures; but the resistance to lateral forces shall be not less than that before such alterations were made, unless the building as altered meets the requirements of this section.

916.3.12.3 Structural elements: All elements within the structure which are considered to resist seismic forces or movement, or are connected so as to participate with the structural system, shall be designed in accordance with approved structural practice.

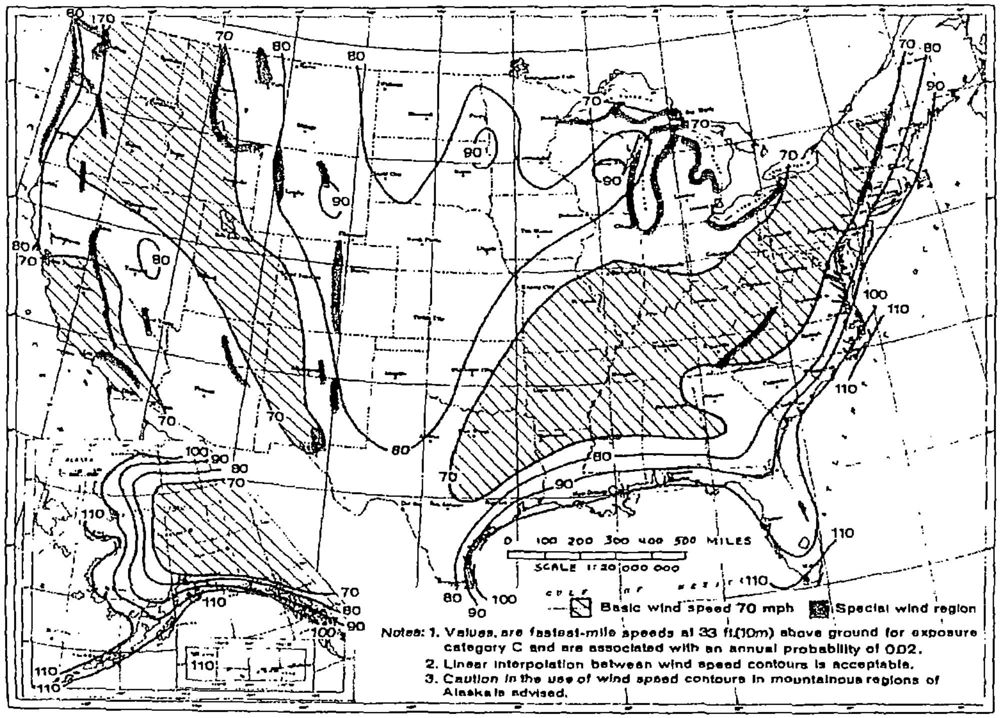
916.3.12.4 Combined vertical and horizontal forces: In computing the effect of seismic force in combination with vertical loads, gravity load stresses induced in members by dead load plus design live load, except roof live load and snow load, shall be considered.

916.3.12.5 Exterior elements: Nonbearing nonshear wall panels, or other elements which are attached to or enclose the exterior, shall accommodate movements of the structure resulting from lateral forces or temperature changes. These panels or other elements shall be supported by approved means or by mechanical fasteners in accordance with the provisions of Sections 916.3.12.5.1 through 916.3.12.5.3.

916.3.12.5.1 Movement between stories: Connections and panel joints shall allow for a relative movement between stories of not less than two times story drift caused by wind or seismic forces, or ¼ inch (6 mm), whichever is greater.

1990 BOCA (WIND)

Figure 1112.3.2
BASIC WIND SPEED (miles per hour)[a]



Note a. 1 mile per hour = 0.447 m/s.

Appendix A20

Table 1112.3.3a
EFFECTIVE VELOCITY PRESSURES P_e (lb/ft^2) FOR BUILDINGS AND STRUCTURES (EXPOSURE B)[a]

Height above grade (ft)	Basic wind speed (mph)				
	70	80	90	100	110
0-20	9	12	15	18	22
20-40	10	13	17	21	25
40-60	13	16	21	26	31
60-100	14	18	23	28	34
100-150	16	21	27	33	40
150-200	18	23	29	36	43
200-300	20	26	33	41	50
300-400	23	30	37	46	56
> 400	Per ASCE 7 listed in Appendix A.				

Note a. 1 pound per square foot = 47.88 P; 1 mile per hour = 0.447 m/s; 1 foot = 304.8 mm.

Table 1112.3.3b
EFFECTIVE VELOCITY PRESSURES P_e (lb/ft^2) FOR BUILDINGS AND STRUCTURES (EXPOSURE C)[a]

Height above grade (ft)	Basic wind speed (mph)				
	70	80	90	100	110
0-20	15	20	25	31	37
20-40	16	21	27	33	40
40-60	19	25	31	38	47
60-100	20	26	33	41	50
100-150	23	30	37	46	56
150-200	24	31	39	49	59
200-300	25	33	42	51	62
300-400	28	36	46	56	68
> 400	Per ASCE 7 listed in Appendix A.				

Note a. 1 pound per square foot = 47.88 P; 1 mile per hour = 0.447 m/s; 1 foot = 304.8 mm.

1112.3.4 Special wind conditions: Special wind conditions shall be provided for in accordance with Sections 1112.3.4.1 and 1112.3.4.2.

1112.3.4.1 Increased loads: For structures located on flat, unobstructed coastal areas directly exposed to wind flowing over large bodies of water, within 1,500 feet (457 m) of the shoreline, the increased *wind loads* of Exposure D shall be used in accordance with ASCE 7 listed in Appendix A.

1112.3.4.2 Decreased loads: For structures located in centers of large cities with at least 50 percent of the buildings having a *height* in excess of 70 feet (21336 mm) and where these conditions prevail in the upwind direction for a distance of at least one-half mile or ten times the *height* of the structure,

1112.2 Symbols, notations and definitions: The following symbols, notations and definitions shall apply to the provisions of this section.

$P_d = p_z + p_h$ = design pressure to be used in determination of *wind loads* for the main windforce-resisting system

p_z = windward design pressure evaluated at height above grade (z), in pounds per square foot

p_h = leeward or sidewall pressure evaluated at height $z = h$, in pounds per square foot

z = height above grade, in feet

h = the mean roof height of a building, the height of other structures or the eave height for buildings with roof slope of less than 10 degrees (0.17 rad), in feet

P_e = effective velocity pressure, including gust effect as tabulated in Table 1112.3.3a(1) for Exposure B and Table 1112.3.3b for Exposure C.

I = importance factor of the building or other structure as indicated in Tables 1112.2a(1) and 1112.2b

C_p = external pressure coefficient to be used in determination of *wind loads* for buildings or for other structures (see Figure 1112.2a and Tables 1112.2c through 1112.2h)

Components and cladding: Structural elements that are either directly *loaded* by the wind or receive *wind loads* originating at relatively close locations and that transfer those *loads* to the main windforce-resisting system.

Main windforce-resisting system: An assemblage of major structural elements designed to provide support for secondary members and cladding. The system primarily receives *wind loading* from relatively remote locations.

Table 1112.2a(1)
IMPORTANCE FACTOR, I (WIND LOADS)

	Importance factor, I [b]	
Category[a]	100 miles (161 km) from hurricane oceanline, and in other areas	At hurricane oceanline[c]
I	1.00	1.05
II	1.07	1.11
III	1.07	1.11
IV	0.95	1.00

Note a. For building and structure classification categories, see Table 1112.2b.
Note b. For regions between the hurricane oceanline and 100 miles (161 km) inland, the importance factor (I) shall be determined by linear interpolation.
Note c. Hurricane oceanlines are the Atlantic and Gulf of Mexico coastal areas.

Table 1112.2b
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR WIND LOADS

Nature of occupancy	Category
All buildings and structures except those listed below	I
Buildings and structures of Use Group A in which more than 300 people congregate in one area	II
Buildings and structures designated as essential facilities including, but not limited to: 1. I-2 uses having surgery or emergency treatment areas 2. Fire or rescue and police stations 3. Primary communication facilities and disaster operation centers 4. Power stations and other utilities required in an emergency 5. Structures having critical national defense capabilities 6. Designated shelters for hurricanes	III
Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, production greenhouses, certain temporary facilities and minor storage facilities	IV

Table 1112.2c
EXTERNAL PRESSURE COEFFICIENTS FOR ARCHED ROOFS, C_p[a]

Condition	Rise-to-span ratio, r	C_p[b] Windward quarter	Center half	Leeward quarter
Roof on elevated structure	$0 < r < 0.2$	-0.9	$-0.7-r$	-0.5
	$0.2 \leq r < 0.3$[c]	$1.5r - 0.3$	$-0.7-r$	-0.5
	$0.3 \leq r$ 0.6	$2.75r - 0.7$	$-0.7-r$	-0.5
Roof springing from ground level	$0 < r \leq 0.6$	$1.4r$	$-0.7-r$	-0.5

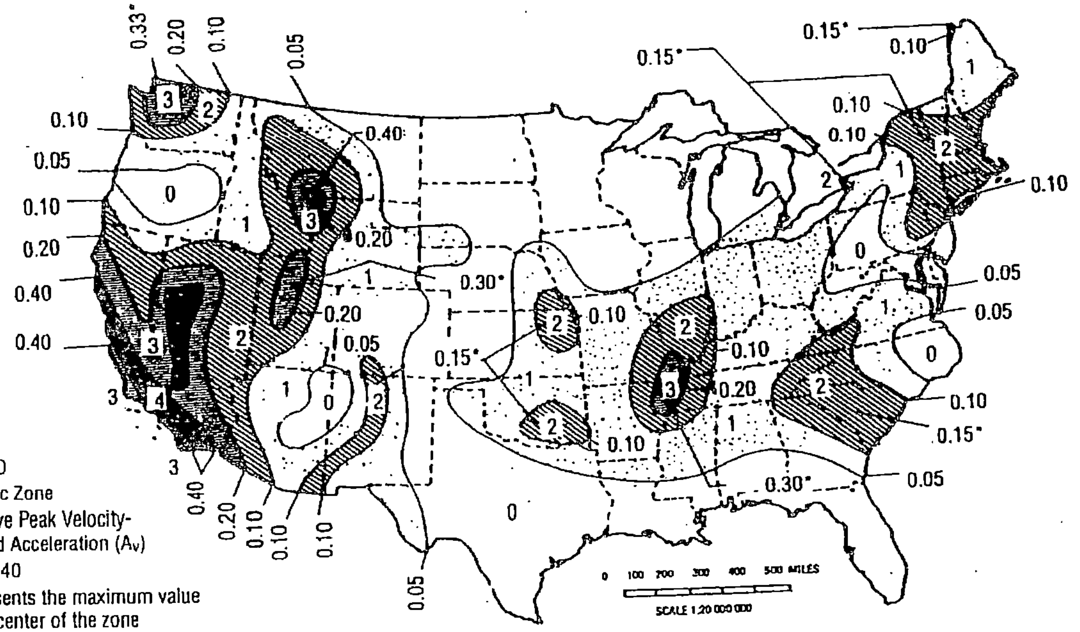
Note a. Values listed are for the determination of average loads on the main windforce-resisting system.

Note b. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

Note c. When the rise-to-span is 0.2 $r \leq 0.3$, alternate coefficients given by $6r - 2.1$ shall also be used for the windward quarter.

Figure 1113.1
MAP OF SEISMIC ZONES AND EFFECTIVE PEAK VELOCITY-RELATED ACCELERATION (A_v)
CONTIGUOUS 48 STATES

Linear interpolation between contours is acceptable



LEGEND
- x Seismic Zone
- x.xx Effective Peak Velocity-Related Acceleration (A_v)
- $A_v \geq 0.40$
- * Represents the maximum value in the center of the zone

1990 BOCA (SEISMIC)

1996 BOCA (wind)

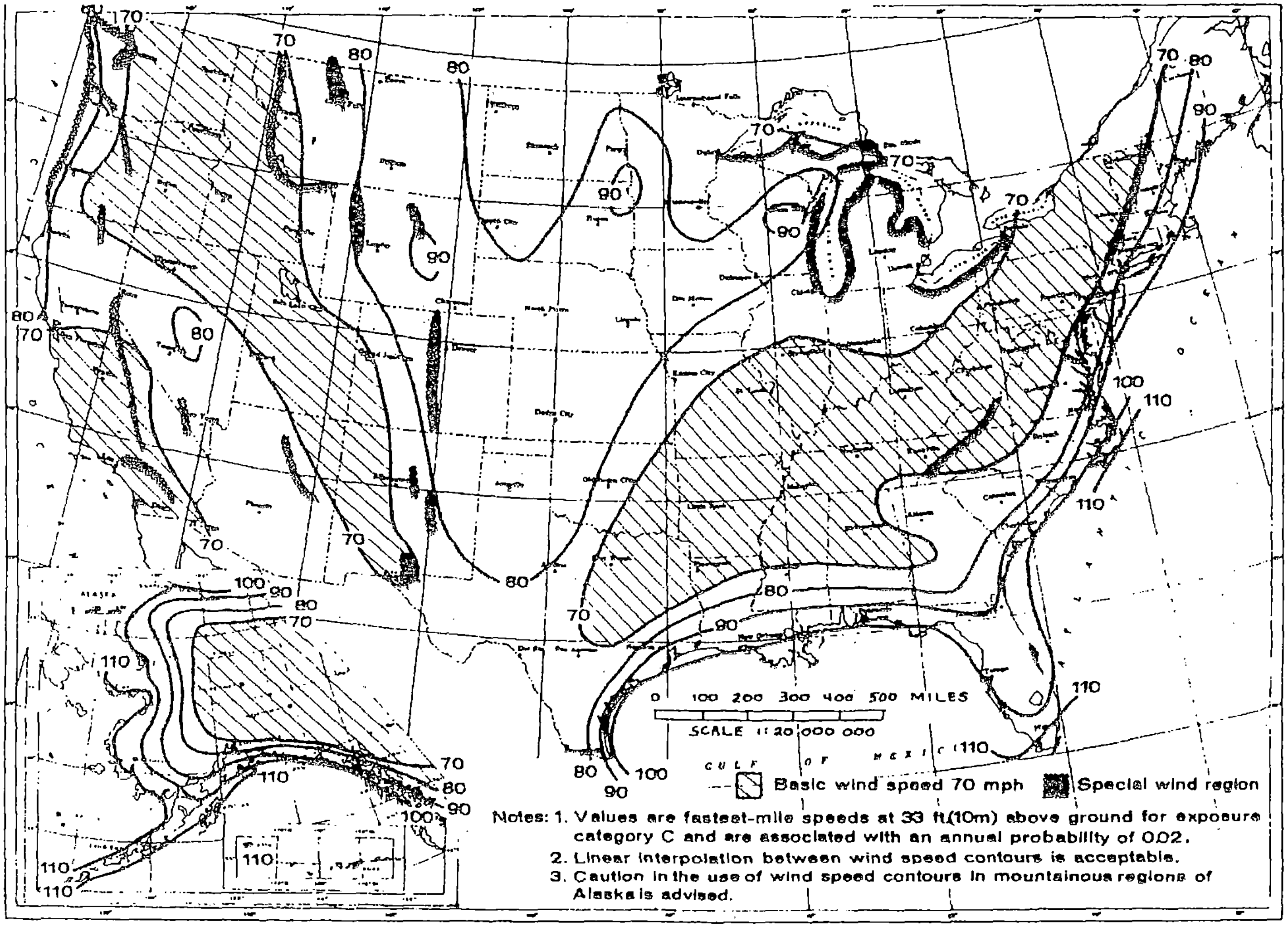


Figure 1609.3
BASIC WIND SPEED, V (miles per hour)[a]

Note a. 1 mile per hour = 1.6 Km/hr.

1609.6 Minimum design wind load: The design *wind load* shall be determined in accordance with Sections 1609.7 through 1609.10 or the minimum design *wind load* in this section, whichever is greater. The *wind load* utilized in the design of the main windforce-resisting system for buildings and other structures shall not be less than 10 psf (479 Pa) multiplied by the area of the building or structure projected on a vertical plane that is normal to the wind direction.

In the calculation of design *wind loads* for components and cladding for buildings, the pressure difference between opposite faces shall be taken into consideration. The combined design pressure shall be not less than 10 psf (479 Pa) acting in either direction normal to the surface.

The *wind load* used in the design of components and cladding for other structures shall be not less than 10 psf (479 Pa) multiplied by the projected area of the component or cladding.

1609.7 Building main windforce-resisting system: The building's main windforce-resisting system shall be designed for external and internal pressure effects caused by the basic wind speed from any direction, as determined in this section. The design pressure shall be applied simultaneously on windward and leeward walls, and on roof surfaces as shown in Figure 1609.7. Positive pressure shall be considered to act toward the surface and negative pressure shall be considered to act away from the surface. The external and internal pressures shall be combined to determine the most critical *load*. The calculated pressures are in pounds per square foot.

Windward wall design pressure, P:

$$P = P_v \; I \; [K_z \, G_h \, C_p - K_h \, (GC_{pi})]$$

Leeward wall, side walls and roof design pressure, P:

$$P = P_v \; I \; [K_h \, G_h \, C_p - K_h \, (GC_{pi})]$$

where:

P_v = Basic velocity pressure in Table 1609.7(3).

I = *Wind load* importance factor in Table 1609.5.

K_z = Velocity pressure exposure coefficient, at the height of interest (z) in Table 1609.7(4).

G_h = Gust response factor in Table 1609.7(5), evaluated at height (h). The gust response factor for buildings which have a height to least horizontal dimension ratio greater than 5 or a fundamental frequency less than one cycle per second (period greater than 1 second) shall be calculated by an approved rational analysis that incorporates the dynamic properties of the main windforce-resisting system.

C_p = External pressure coefficient in Table 1609.7(1), Table 1609.7(2) and Table 1609.7(7).

K_h = Velocity pressure exposure coefficient, evaluated at the mean roof height (h) in Table 1609.7(4).

GC_{pi} = Product of internal pressure coefficient and gust response factor in Table 1609.7(6).

h = Mean roof height: the distance from grade to the average height of the roof or to the eave height for buildings or other structures having a roof slope equal to or less than 10 degrees (0.17 rad).

Table 1609.7(1)
WALL PRESSURE COEFFICIENTS (C_p)

Surface	L/B	C_p	For use with
Windward wall	All values	0.8	K_z
Leeward wall	0 to 1 2 ≥ 4	-0.5 -0.3 -0.2	K_h
Side walls	All values	-0.7	K_h

Table 1609.7(2)
ROOF PRESSURE COEFFICIENTS[a, b, c, d] (C_p), FOR USE WITH K_h

Wind Direction	Windward								Leeward
	h/L	Angle, θ, (degrees)[f]							
		0	10-15	20	30	40	50	>60	
Normal to ridge	≤ 0.3	-0.7	0.2[e] -0.9[e]	0.2	0.3	0.4	0.5	0.01θ	-0.7 for all values of h/L and θ
	0.5	-0.7	-0.9	-0.75	-0.2	0.3	0.5	0.01θ	
	1.0	-0.7	-0.9	-0.75	-0.2	0.3	0.5	0.01θ	
	≥1.5	-0.7	-0.9	-0.9	-0.9	-0.35	0.2	0.01θ	
Parallel to ridge	h/B or h/L < 2.5	-0.7							-0.7
	h/B or h/L > 2.5	-0.8							-0.8

Note a. Refer to Table 1609.7(7) for arched roofs.

Note b. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

Note c. Linear interpolation is permitted for values of θ, h/L and h/B ratios other than shown.

Note d. Notation:

z = Height above ground, in feet.

h = Mean roof height, in feet, or the eave height is permitted for $\theta < 10$ degrees.

B = Horizontal dimension of building, in feet, measured normal to wind direction.

L = Horizontal dimension of building, in feet, measured parallel to wind direction.

θ = Roof slope from horizontal, in degrees (See Figure 1609.7).

Note e. Both values of C_p shall be utilized in assessing load effects

Note f. 1 degree = 0.01745 rad

Table 1609.7(3)
BASIC VELOCITY PRESSURE (P_v)

Basic Wind Speed[a] (V) (miles per hour)[c]	70	75	80	85	90	100	110	120	130
Basic Velocity Pressure[b] P_v (lb./ft.^{2})[c]	12.5	14.4	16.4	18.5	20.7	25.6	31.0	36.9	43.3

Note a. Basic wind speed to be determined in accordance with Section 1609.3.

Note b. The Basic Velocity Pressure (P_v) is permitted to be determined in accordance with the following formula: $P_v = 0.00256V^2$.

where: V = Basic wind speed (miles per hour) determined in accordance with Section 1609.3.

Note c. 1 mile per hour = 1.6 km/hr; 1 pound per square foot = 47.9 Pa

Mean roof height (*h*): The distance from grade to the average height of the roof or to the eave height for buildings or other structures having a roof slope equal to or less than 10 degrees (0.17 rad).

Wind tributary area (*A*): That portion of the surface area receiving *wind loads* supported by the element considered. For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.

1609.3 Basic wind speed: The basic wind speed, in miles per hour, for the design of a structure shall be based on location of the structure determined by Figure 1609.3 or Table 1609.3. Basic wind speed for the special wind regions indicated on Figure 1609.3 or in Note a of Table 1609.3 shall be in accordance with local jurisdiction requirements. Basic wind speeds determined by the local jurisdiction shall be based on fastest-mile wind speeds at 33 feet (10058 mm) above the ground, Exposure C, with an annual probability of 0.02. Measurements taken at locations not meeting these criteria shall be adjusted accordingly. Reductions in the basic wind speed due to direct shielding afforded by adjacent buildings, structures or terrain features shall not be permitted.

Table 1609.3
BASIC WIND SPEED (*V*) [a]

Location	*V* (miles per hour)[b]
Hawaii	80
Puerto Rico	95

Note a. Basic wind speed near mountainous terrain, gorges and ocean promontories shall be in accordance with local jurisdiction requirements.
Note b. 1 mile per hour = 1.6 km/hr

1609.4 Exposure category: The appropriate wind exposure shall be determined for each side of the building or structure consistent with the site terrain as required by this section. *Wind loads* for the design of the main windforce-resisting system shall be based on the site exposure category, as follows:

Exposure A: Large city centers with at least 50 percent of the buildings having a height in excess of 70 feet (21336 mm). Use of this exposure category shall be limited to those areas for which terrain representative of Exposure A prevails in the upwind direction for a distance of at least one-half mile or ten times the height of the building or structure, whichever is greater. Possible channeling effects or increased velocity pressures due to the building or structure being located in the wake of adjacent buildings shall be taken into account in the determination of the design wind pressures.

Exposure B: Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of *single-family dwellings* or larger. This exposure category shall be limited to those areas for which terrain representative of Exposure B prevails in the upwind direction for a distance of at least 1,500 feet (457 m) or ten times the *height* of the building or structure, whichever is greater.

Exposure C: Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat, open country and grasslands.

Exposure D: Flat, unobstructed areas exposed to wind flowing over large bodies of water which are greater than 1 mi (1.6 km) in width in the upwind direction. This exposure shall apply only to those buildings and other structures exposed to wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet (457 m) or ten times the height of the building or structure, whichever is greater.

1609.4.1 Exposure category for design of components and cladding: Components and cladding for buildings with mean roof height of 60 feet (18288 mm) or less shall be designed on the basis of Exposure C. Components and cladding for buildings with a mean roof height in excess of 60 feet (18288 mm) and for other structures shall be designed on the basis of the exposure categories in Section 1609.4, except that Exposure B shall be assumed for buildings and other structures sited in terrain representative of Exposure A.

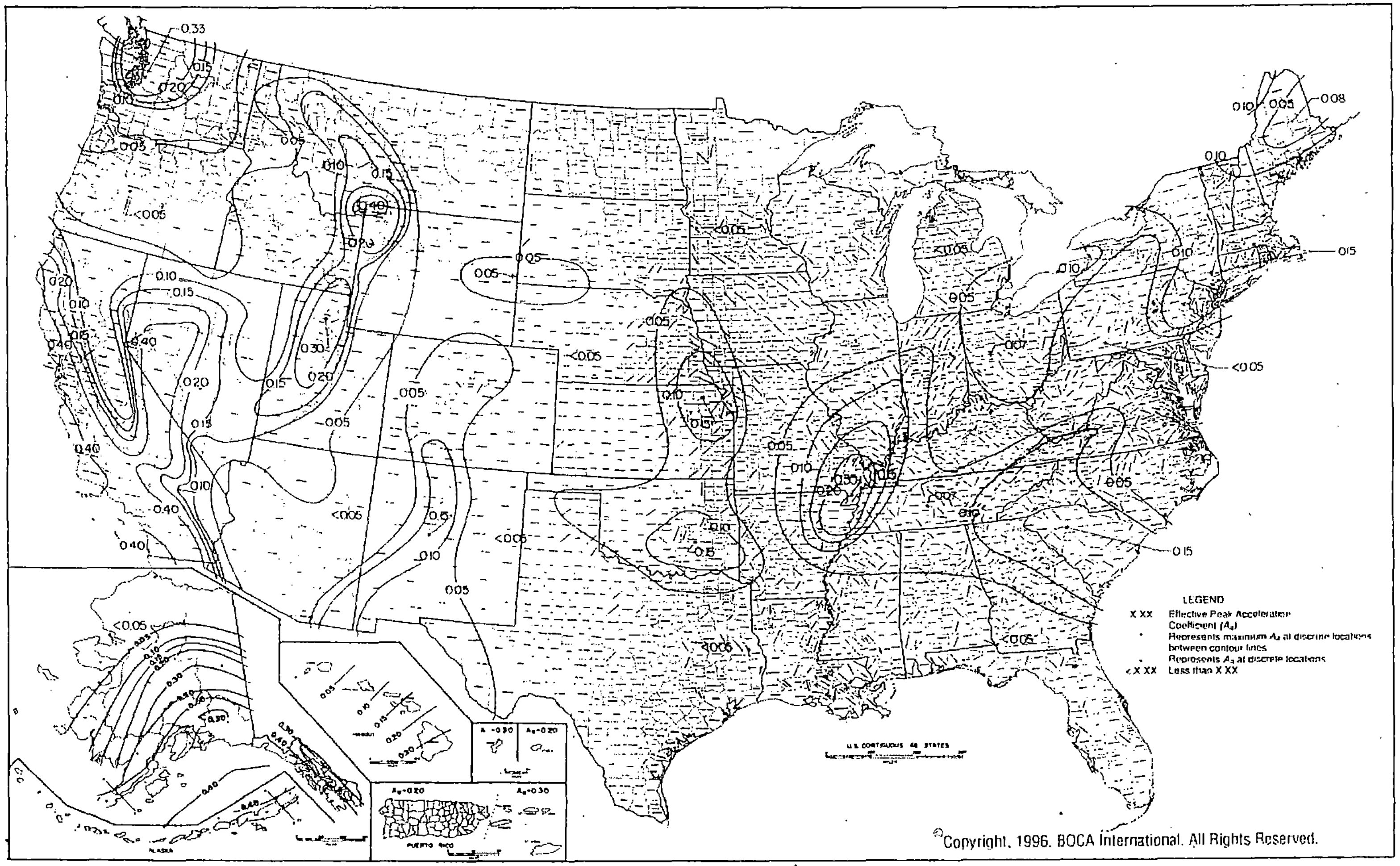
1609.5 Importance factor: Buildings and other structures shall be assigned a *wind load* importance factor (*I*) in accordance with Table 1609.5.

Table 1609.5
IMPORTANCE FACTOR (*I*)

Nature of occupancy	Wind Load Importance Factor (*I*)[a]		Snow load importance factor (*I*)
	100 miles[c] from hurricane oceanline, and in other areas	At hurricane oceanline[b]	
All buildings and structures except those listed below	1.00	1.10	1.0
Occupancies in Use Group A in which more than 300 people congregate in one area	1.15	1.23	1.1
Buildings and structures having essential facilities, including buildings containing any one or more of the indicated occupancies 1. Fire, rescue and police stations 2. Use Group I-2 having surgery or emergency treatment facilities. 3. Emergency preparedness centers 4. Designated shelters for hurricanes. 5. Power generating stations and other utilities required as emergency backup facilities 6. Primary communication facilities.	1.15	1.23	1.2
Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, production greenhouses, certain temporary facilities and minor storage facilities	0.90	1.00	0.8

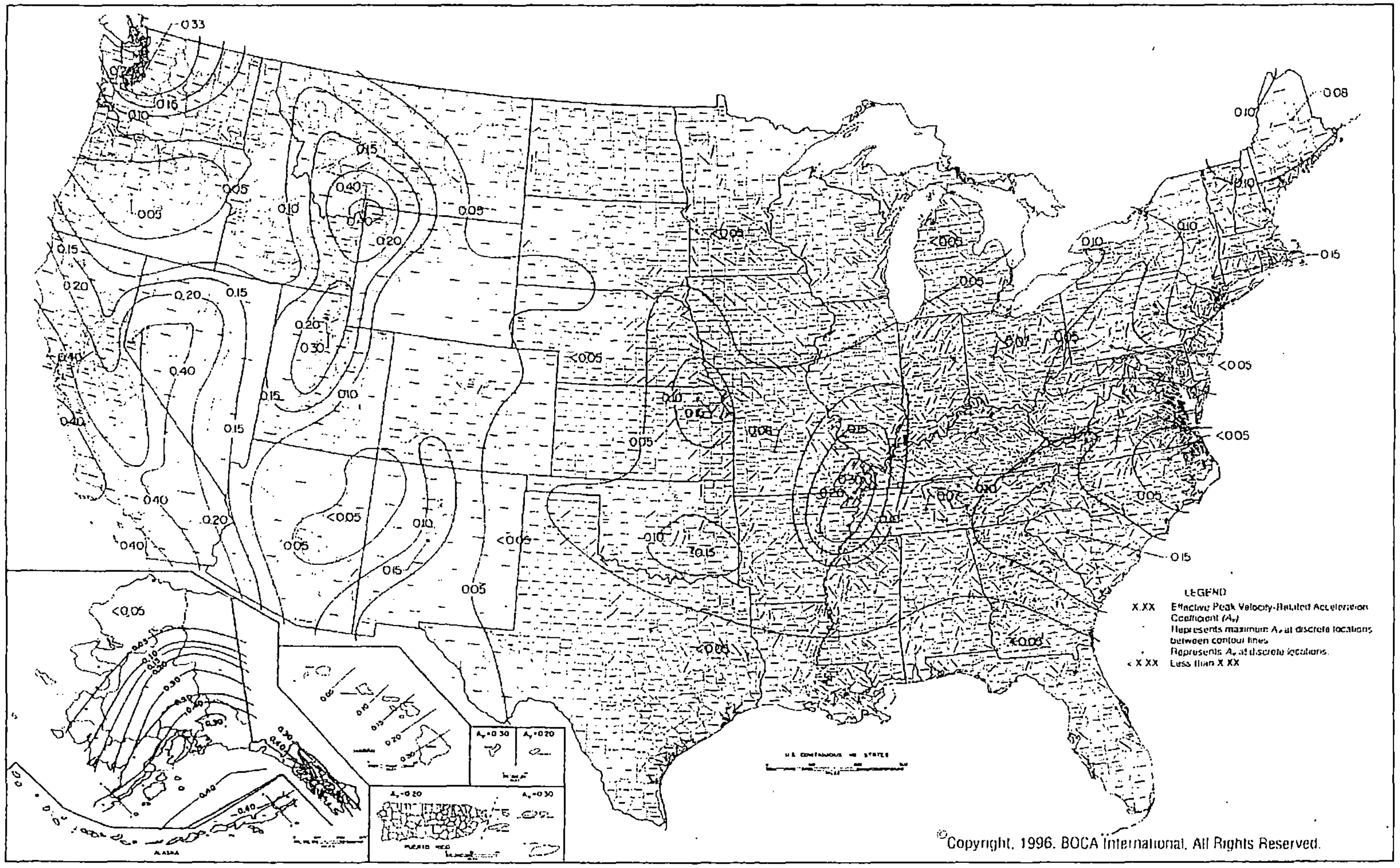
Note a. For regions between the hurricane oceanline and 100 miles inland, the importance factor (*I*) shall be determined by linear interpolation.
Note b. Hurricane oceanlines are the Atlantic and Gulf of Mexico coastal areas.
Note c. 1 mile = 1.6 km

Figure 1610.1.3(2)
CONTOUR MAP OF EFFECTIVE PEAK ACCELERATION COEFFICIENT (*Aa*)



1996 BOCA (Seismic)

Figure 1610.1.3(1)
CONTOUR MAP OF EFFECTIVE PEAK VELOCITY-RELATED ACCELERATION COEFFICIENT (A_v)



Exceptions

1. Detached *one-* and *two-family dwellings* that are located in seismic map areas having an effective peak velocity-related acceleration (A_v) value less than 0.15, in accordance with Section 1610.1.3, are exempt from the requirements of this section.
2. Agricultural storage buildings which are intended only for incidental human occupancy are exempt from the requirements of this section.
3. Buildings or structures located where the seismic coefficient representing the effective peak velocity-related acceleration (A_v) is less than 0.05, are only required to comply with Section 1610.3.6.1.
4. The seismic force-resisting system of wood frame buildings that conform to the provisions of Section 2305.8 and are constructed in accordance with Section 2305.0 and Section 1610.3.6.1 are not required to be analyzed as specified in Sections 1610.3 through 1610.5.
5. Category B → See VUSBC

1610.1.1 Additions to existing buildings: An *addition* that is structurally independent from an existing building shall be designed and constructed in accordance with the seismic requirements for new buildings. An *addition* that is not structurally independent from an existing building shall be designed and constructed such that the entire building conforms to the seismic requirements for new buildings unless the following three provisions are complied with:

1. The *addition* complies with the seismic requirements for new buildings;
2. The *addition* shall not increase the seismic forces in any structural element of the existing building by more than 5 percent unless the increased forces on the element are still in compliance with these provisions; and
3. The *addition* shall not decrease the seismic resistance of any structural element of the existing building below that required for new buildings.

1610.1.2 Change of occupancy: Where a *change of occupancy* results in an existing building being reclassified to a higher Seismic Hazard Exposure Group, the building shall conform to the seismic requirements for new buildings.

Exception: Upgrading the building for the seismic requirements of this section is not required for buildings located in seismic map areas having an effective peak velocity-related acceleration (A_v) value of less than 0.15 where the *change of occupancy* results in a building being reclassified from Seismic Hazard Exposure Group I to Seismic Hazard Exposure Group II.

1610.1.3 Seismic ground acceleration maps: The effective peak velocity-related acceleration (A_v) and the effective peak acceleration (A_a) shall be determined from Figures 1610.1.3(1) and 1610.1.3(2), respectively. Interpolation shall be permitted in the determination of the effective peak velocity-related acceleration (A_v) and the effective peak acceleration (A_a). For the application of the formulas in Sections 1610.4 and 1610.5 which incorporate the effective peak acceleration coefficient (A_a), the value of A_a shall be determined from Figure 1610.1.3(2) or shall be 0.05, whichever is greater.

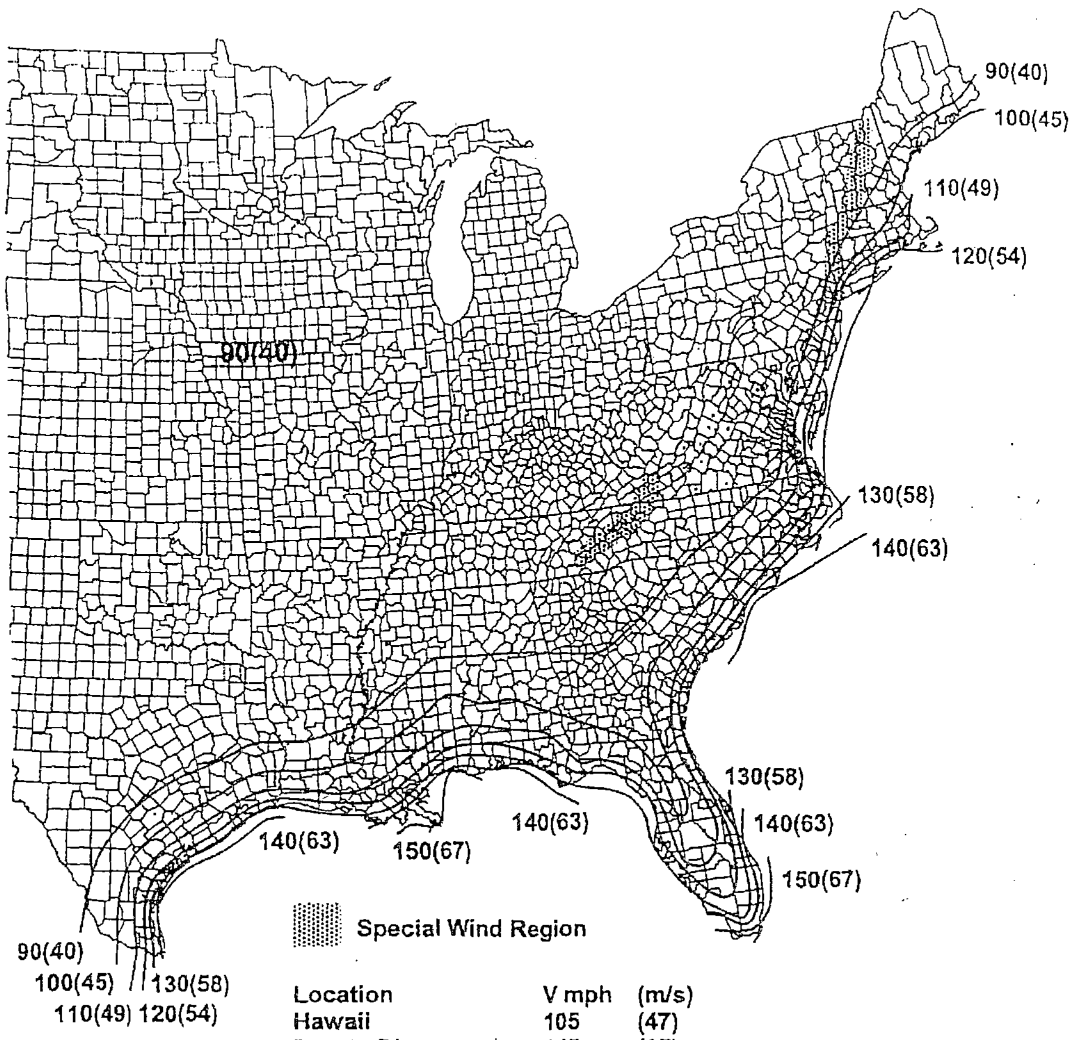
1610.1.4 Site-specific response spectra: Where site-specific response spectra are required for buildings assigned to Seismic Performance Categories D and E, in accordance with Table 1610.3.5.3, the site-specific response spectra shall be developed based on ground motions which have a 90-percent probability of not being exceeded in 50 years.

1610.1.5 Seismic Hazard Exposure Groups: All buildings shall be assigned to one of the Seismic Hazard Exposure Groups in accordance with Table 1610.1.5.

1610.1.5.1 Multiple occupancies: Where a building is occupied for two or more occupancies not included in the same Seismic Hazard Exposure Group, the building shall be assigned the classification of the highest Seismic Hazard Exposure Group occupancy.

Table 1610.1.5
SEISMIC HAZARD EXPOSURE GROUP

Seismic Hazard Exposure Group type and description	Nature of occupancy
Group I	All occupancies except those listed below
Group II Seismic Hazard Exposure Group II buildings are those which have a substantial public hazard due to occupancy or use, including buildings containing any one or more of the indicated occupancies.	1. Use Group A in which more than 300 people congregate in one area. 2. Use Group E with an occupant load greater than 250 3. Use Group B used for college or adult education with an occupant load greater than 500. 4. Use Group I-2 with an occupant load greater than 50, not having surgery or emergency treatment facilities. 5. Use Group I-3. 6. Power-generating stations and other public utility facilities not included in Seismic Hazard Exposure Group III. 7. Any other occupancy with an occupant load greater than 5,000.
Group III Seismic Hazard Exposure Group III buildings are those having essential facilities which are required for post-earthquake recovery, including buildings containing any one or more of the indicated occupancies.	1. Fire, rescue and police stations. 2. Use Group I-2 having surgery or emergency treatment facilities. 3. Emergency preparedness centers. 4. Post-earthquake recovery vehicle garages. 5. Power-generating stations and other utilities required as emergency backup facilities. 6. Primary communication facilities. 7. Highly toxic materials as defined by Section 307.0 where the quantity of the material exceeds the exempt amounts of Section 307.8.



Location	V mph	(m/s)
Hawaii	105	(47)
Puerto Rico	145	(65)
Guam	170	(76)
Virgin Islands	145	(65)
American Samoa	125	(56)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear interpolation between wind contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

FIGURE 1609—continued
BASIC WIND SPEED (3-SECOND GUST)

Appendix A32

TABLE 1604.5
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR IMPORTANCE FACTORS

CATEGORY[a]	NATURE OF OCCUPANCY	SEISMIC FACTOR I_E	SNOW FACTOR I_S	WIND FACTOR I_w
I	Buildings and other structures except those listed in Categories II, III and IV	1.00	1.0	1.00
II	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with elementary school, secondary school or day-care facilities with capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities • Jails and detention facilities • Any other occupancy with an occupant load greater than 5,000 • Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Category III • Buildings and other structures not included in Category III containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released	1.25	1.1	1.15
III	Buildings and other structures designated as essential facilities including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue and police stations and emergency vehicle garages • Designated earthquake, hurricane or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power-generating stations and other public utility facilities required as emergency back-up facilities for Category III structures • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantity of Table 307.7(2) • Aviation control towers, air traffic control centers and emergency aircraft hangars • Buildings and other structures having critical national defense functions • Water treatment facilities required to maintain water pressure for fire suppression	1.50	1.2	1.15
IV	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	1.00	0.8	0.87[b]

a. "Category" is equivalent to "Seismic Use Group" for the purposes of Section 1616.2.

b. In hurricane-prone regions with $V > 100$ miles per hour, I_w shall be 0.77

structures and portions thereof shall resist the most critical effects from the following combinations of factored loads:

$1.4D$ (Formula 16-1)

$1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$ (Formula 16-2)

$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (f_1 L \text{ or } 0.8W)$ (Formula 16-3)

$1.2D + 1.6W + f_1 L + 0.5(L_r \text{ or } S \text{ or } R)$ (Formula 16-4)

$1.2D + 1.0E + f_1 L + f_2 S$ (Formula 16-5)

$0.9D + (1.0E \text{ or } 1.6W)$ (Formula 16-6)

where:

$f_1 = 1.0$ for floors in places of public assembly, for live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and for parking garage live load.

$f_1 = 0.5$ for other live loads.

 2000 IBC (SEISMIC)

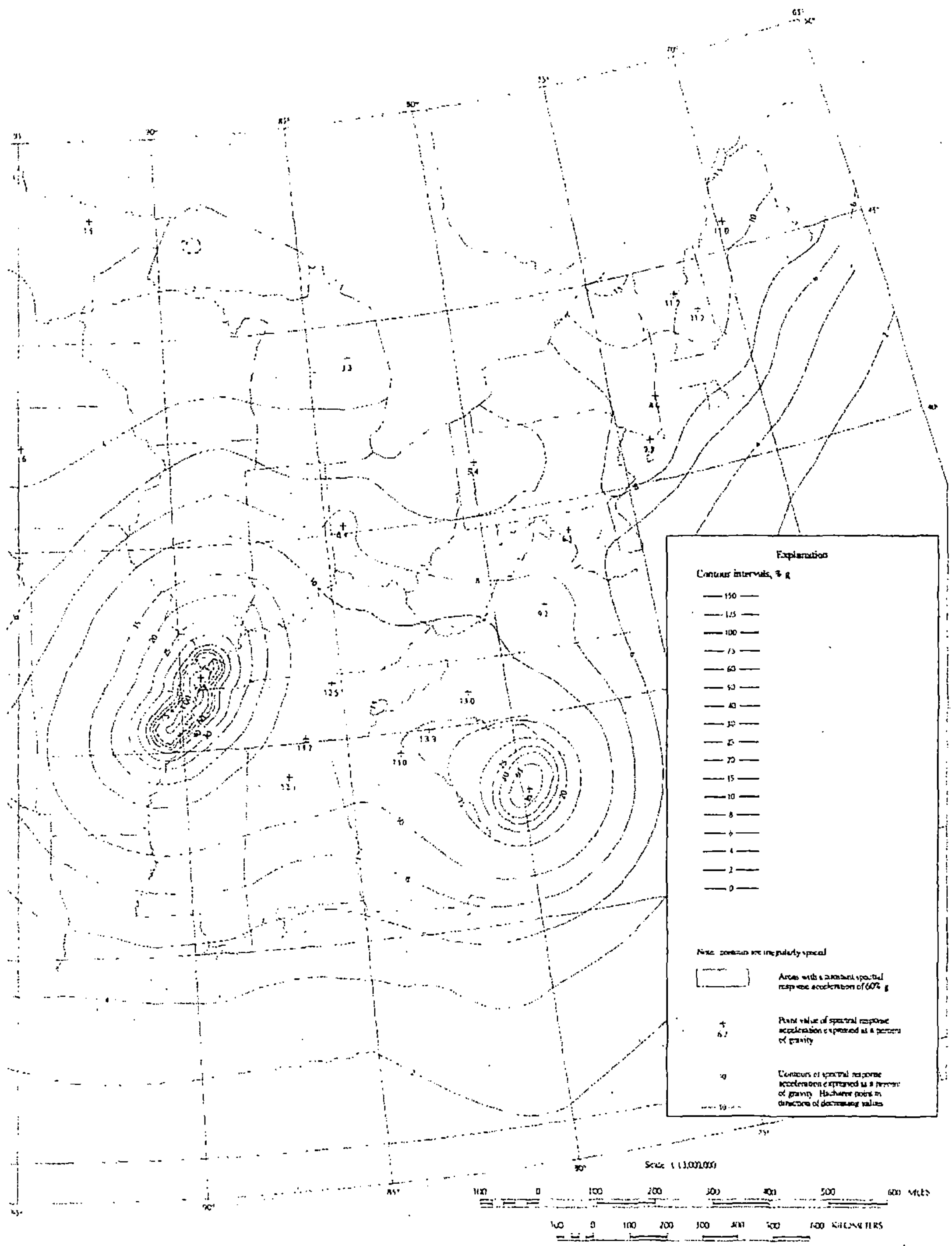


FIGURE 1615(2)—continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR
THE CONTERMINOUS UNITED STATES OF 1.0 SEC SPECTRAL RESPONSE
ACCELERATION (5 PERCENT OF CRITICAL DAMPING), SITE CLASS B

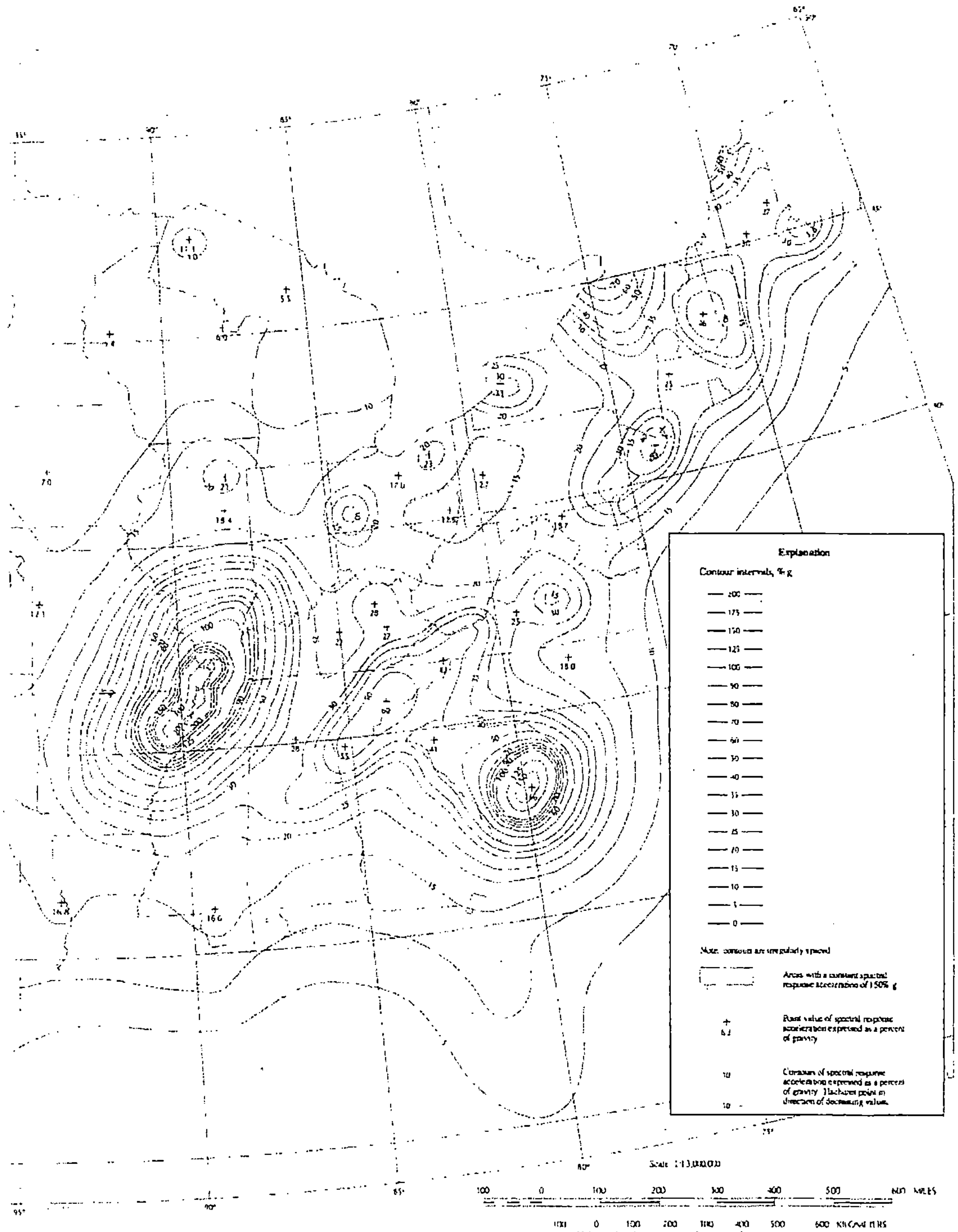


FIGURE 1615(1)—continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR
THE CONTERMINOUS UNITED STATES OF 0.2 SEC SPECTRAL RESPONSE
ACCELERATION (5 PERCENT OF CRITICAL DAMPING), SITE CLASS B

TABLE 1604.5
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR IMPORTANCE FACTORS

CATEGORY[a]	NATURE OF OCCUPANCY	SEISMIC FACTOR I_E	SNOW FACTOR I_S	WIND FACTOR I_w
I	Buildings and other structures except those listed in Categories II, III and IV	1.00	1.0	1.00
II	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with elementary school, secondary school or day-care facilities with capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities • Jails and detention facilities • Any other occupancy with an occupant load greater than 5,000 • Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Category III • Buildings and other structures not included in Category III containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released	1.25	1.1	1.15
III	Buildings and other structures designated as essential facilities including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue and police stations and emergency vehicle garages • Designated earthquake, hurricane or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power-generating stations and other public utility facilities required as emergency back-up facilities for Category III structures • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantity of Table 307.7(2) • Aviation control towers, air traffic control centers and emergency aircraft hangars • Buildings and other structures having critical national defense functions • Water treatment facilities required to maintain water pressure for fire suppression	1.50	1.2	1.15
IV	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	1.00	0.8	0.87[b]

a "Category" is equivalent to "Seismic Use Group" for the purposes of Section 1616.2.
b In hurricane-prone regions with $V > 100$ miles per hour, I_w shall be 0.77.

structures and portions thereof shall resist the most critical effects from the following combinations of factored loads:

$1.4D$ (Formula 16-1)

$1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$ (Formula 16-2)

$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (f_1L \text{ or } 0.8W)$ (Formula 16-3)

$1.2D + 1.6W + f_1L + 0.5(L_r \text{ or } S \text{ or } R)$ (Formula 16-4)

$1.2D + 1.0E + f_1L + f_2S$ (Formula 16-5)

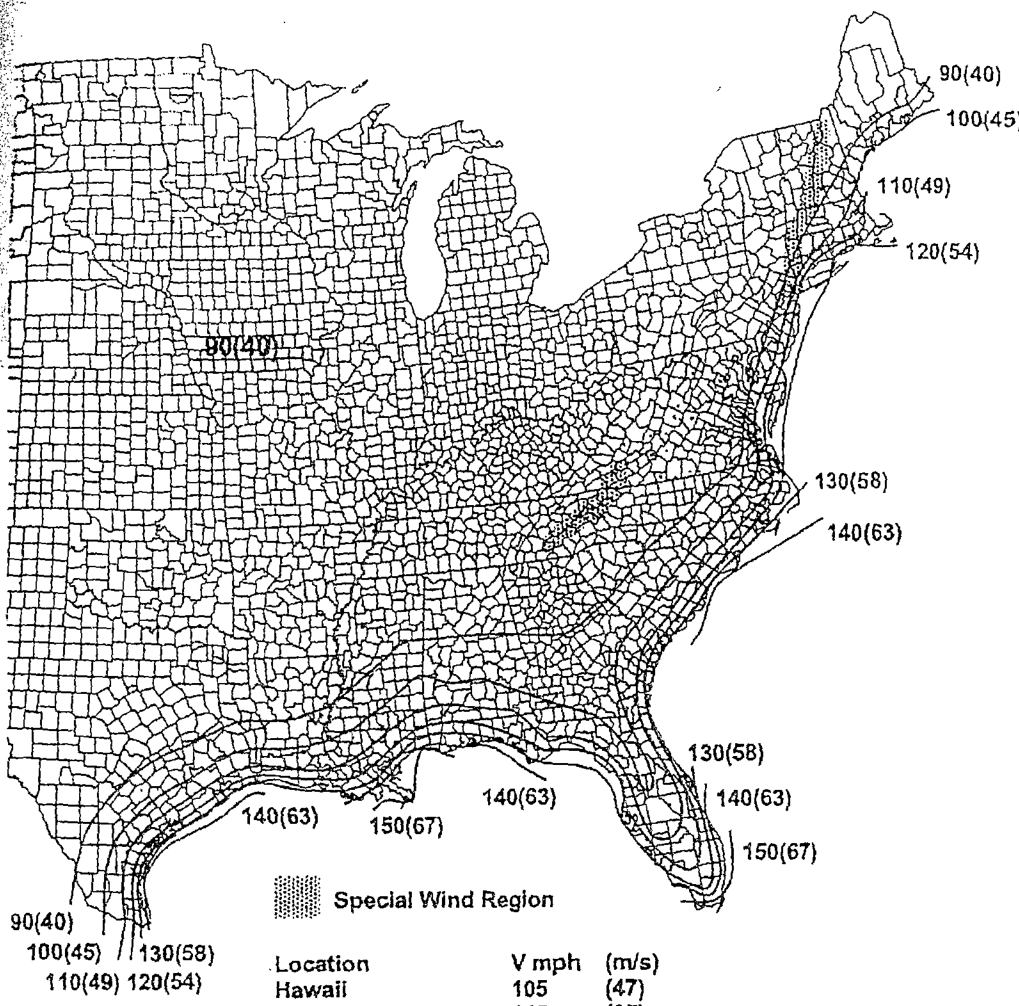
$0.9D + (1.0E \text{ or } 1.6W)$ (Formula 16-6)

where:

$f_1 = 1.0$ for floors in places of public assembly, for live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and for parking garage live load.

$f_1 = 0.5$ for other live loads.

2003 IBC (WIND)



Location	V mph	(m/s)
Hawaii	105	(47)
Puerto Rico	145	(65)
Guam	170	(76)
Virgin Islands	145	(65)
American Samoa	125	(56)

Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear interpolation between wind contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

FIGURE 1609—continued
BASIC WIND SPEED (3-SECOND GUST)

TABLE 1604.5
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR IMPORTANCE FACTORS

CATEGORY[a]	NATURE OF OCCUPANCY	SEISMIC FACTOR I_E	SNOW FACTOR I_S	WIND FACTOR I_W
I	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	1.00	0.8	0.87[b]
II	Buildings and other structures except those listed in Categories I, III and IV	1.00	1.0	1.00
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with elementary school, secondary school or day care facilities with an occupant load greater than 250 • Buildings and other structures with an occupant load greater than 500 for colleges or adult education facilities • Health care facilities with an occupant load of 50 or more resident patients but not having surgery or emergency treatment facilities • Jails and detention facilities • Any other occupancy with an occupant load greater than 5,000 • Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Category IV • Buildings and other structures not included in Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released	1.25	1.1	1.15
IV	Buildings and other structures designated as essential facilities including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue and police stations and emergency vehicle garages • Designated earthquake, hurricane or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power-generating stations and other public utility facilities required as emergency backup facilities for Category IV structures • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.7(2) • Aviation control towers, air traffic control centers and emergency aircraft hangars • Buildings and other structures having critical national defense functions • Water treatment facilities required to maintain water pressure for fire suppression	1.50	1.2	[illegible]

a. For the purpose of Section 1616.2, Categories I and II are considered Seismic Use Group I, Category III is considered Seismic Use Group II and [illegible] equivalent to Seismic Use Group III.

b. In hurricane-prone regions with $V > 100$ miles per hour, I_w shall be 0.77

2003 IBC (SEISMIC)

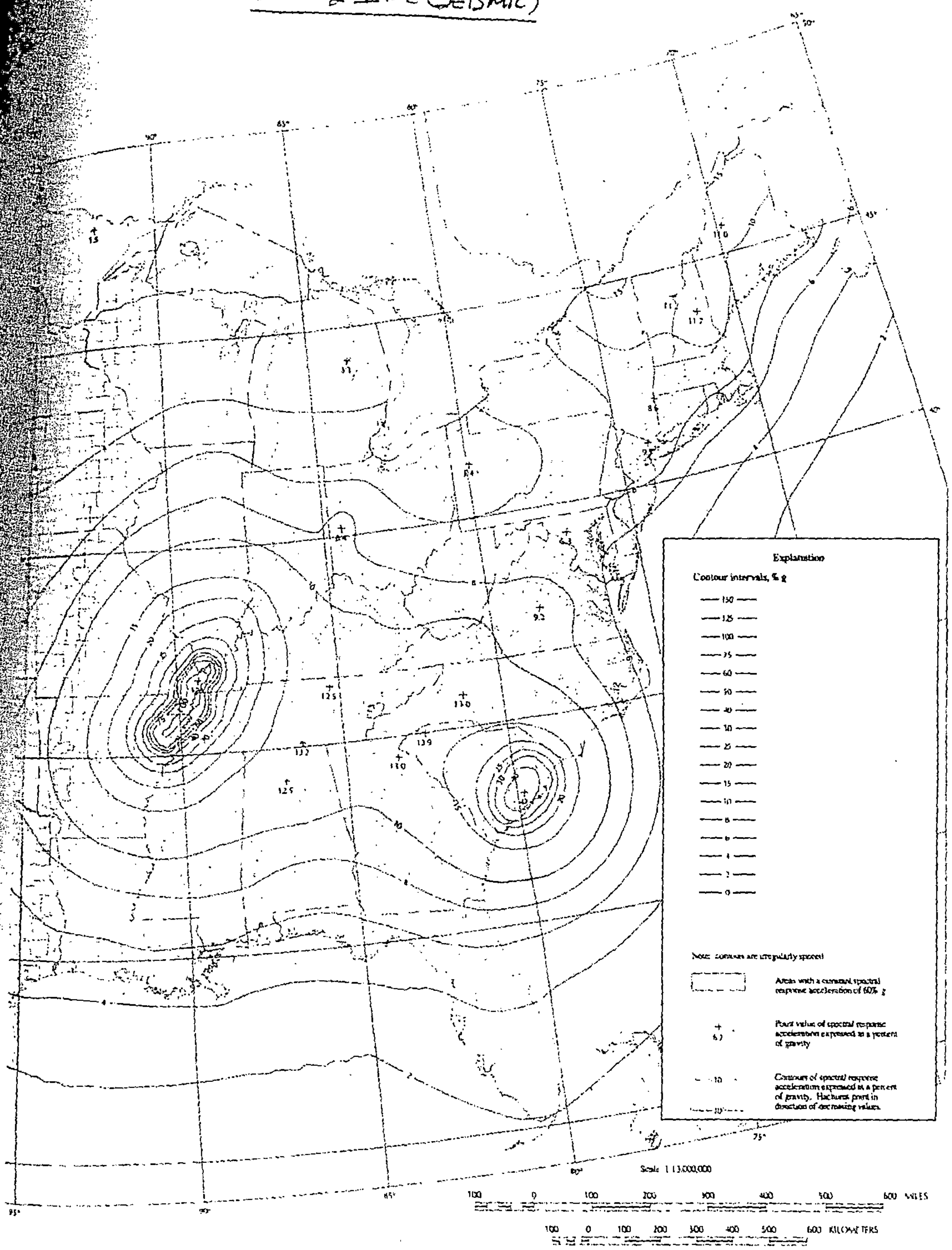


FIGURE 1615(2)—continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES
OF 1.0 SEC SPECTRAL RESPONSE ACCELERATION (5 PERCENT OF CRITICAL DAMPING), SITE CLASS B

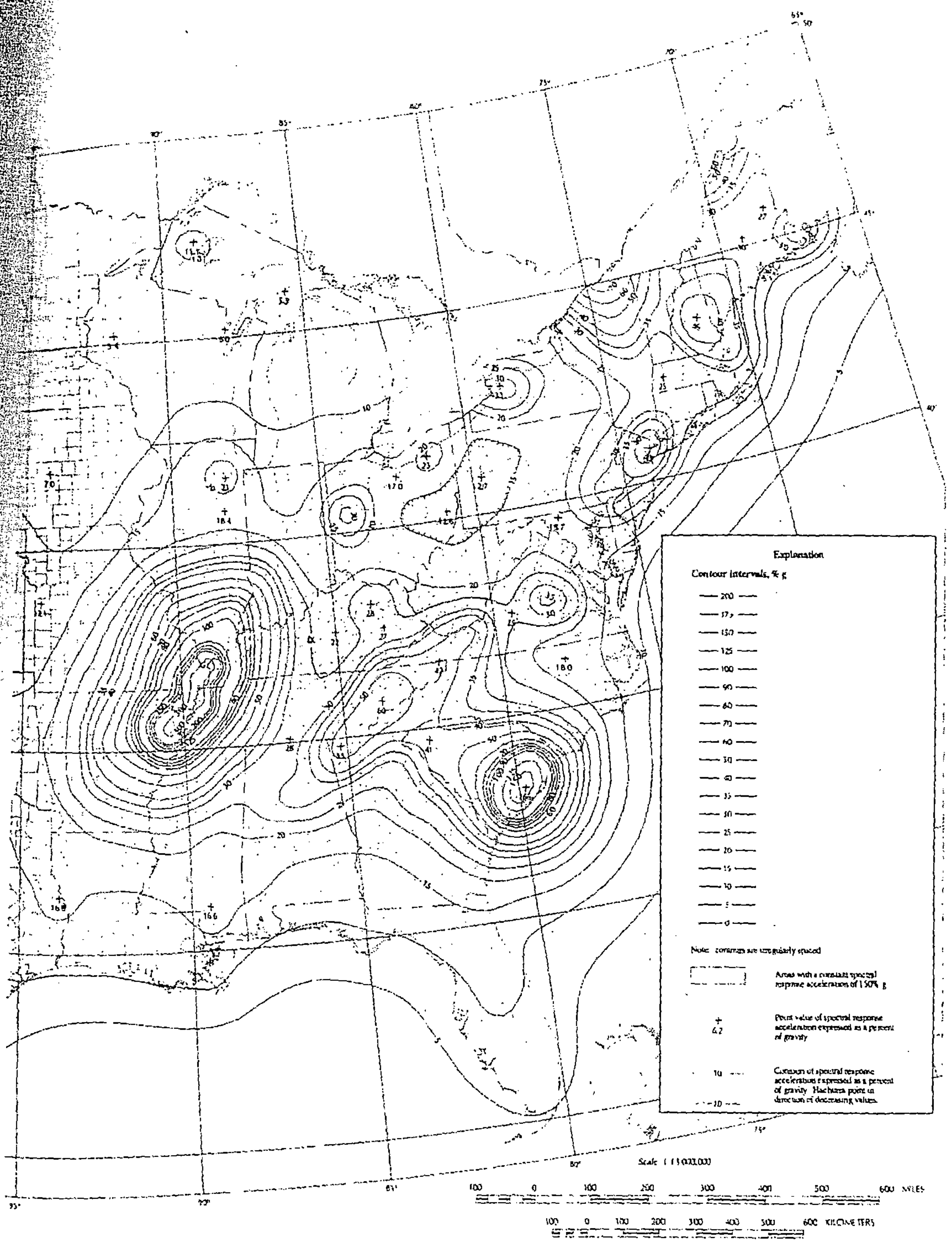


FIGURE 1615(1)—*continued*
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES OF 0.2 SEC SPECTRAL RESPONSE ACCELERATION (5 PERCENT OF CRITICAL DAMPING), SITE CLASS B

TABLE 1604.5
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR IMPORTANCE FACTORS

CATEGORY[a]	NATURE OF OCCUPANCY	SEISMIC FACTOR I_E	SNOW FACTOR I_S	WIND FACTOR I_W
I	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	1.00	0.8	0.87[b]
II	Buildings and other structures except those listed in Categories I, III and IV	1.00	1.0	1.00
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with elementary school, secondary school or day care facilities with an occupant load greater than 250 • Buildings and other structures with an occupant load greater than 500 for colleges or adult education facilities • Health care facilities with an occupant load of 50 or more resident patients but not having surgery or emergency treatment facilities • Jails and detention facilities • Any other occupancy with an occupant load greater than 5,000 • Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Category IV • Buildings and other structures not included in Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released	1.25	1.1	1.15
IV	Buildings and other structures designated as essential facilities including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue and police stations and emergency vehicle garages • Designated earthquake, hurricane or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power-generating stations and other public utility facilities required as emergency backup facilities for Category IV structures • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.7(2) • Aviation control towers, air traffic control centers and emergency aircraft hangars • Buildings and other structures having critical national defense functions • Water treatment facilities required to maintain water pressure for fire suppression	1.50	1.2	[illegible]

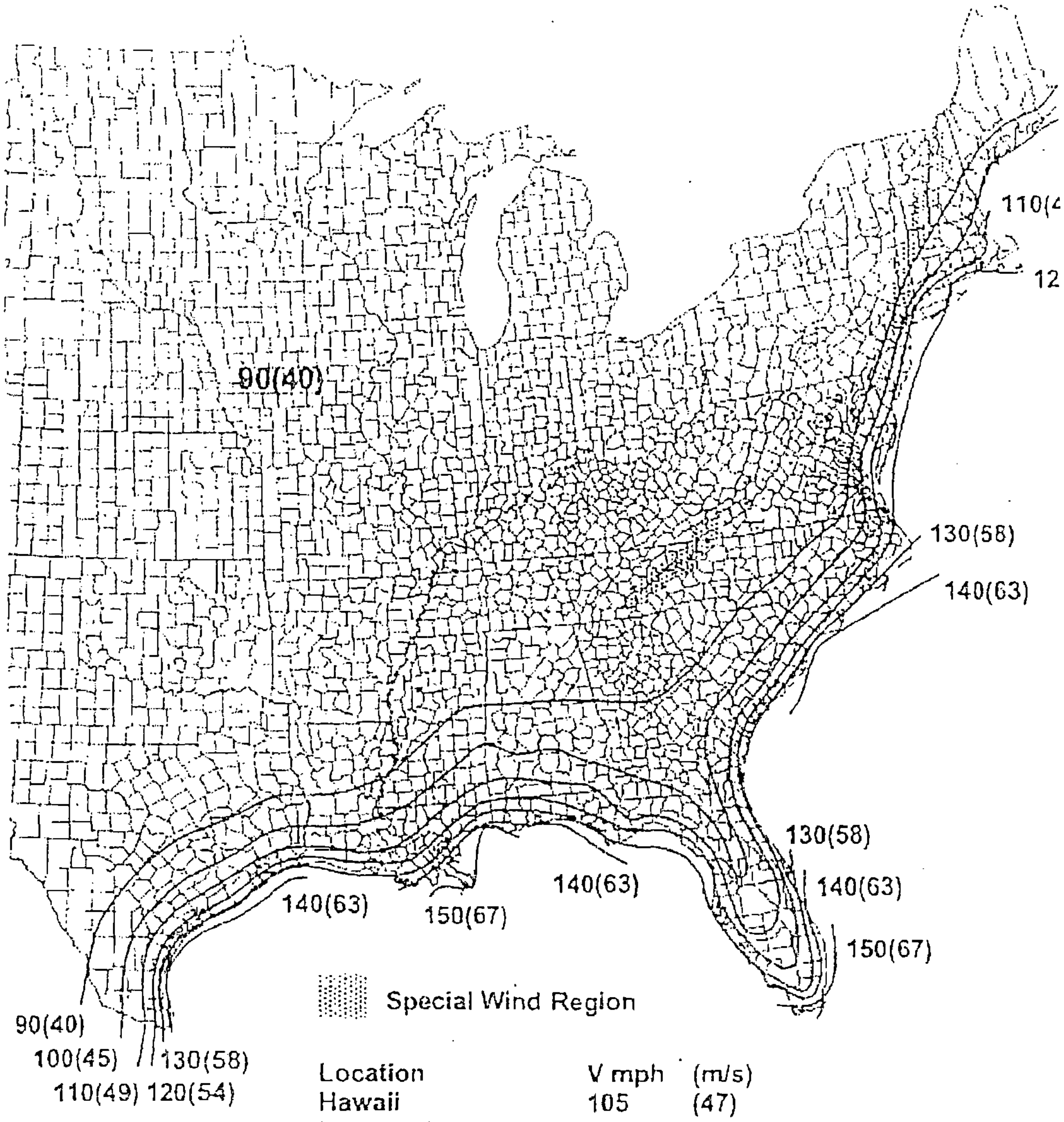
a. For the purpose of Section 1616.2, Categories I and II are considered Seismic Use Group I. Category III is considered Seismic Use Group II and Category [illegible] equivalent to Seismic Use Group III.

b. In hurricane-prone regions with $V > 100$ miles per hour, I_w shall be 0.77.

IBC 2009 (WIND)

SECTION 1609 WIND LOADS

FIGURE 1609 BASIC WIND SPEED (3-SECOND GUST)



Location	V mph	(m/s)
Hawaii	105	(47)
Puerto Rico	145	(65)
Guam	170	(76)
Virgin Islands	145	(65)
American Samoa	125	(56)

IBC 2009 (SEISMIC)

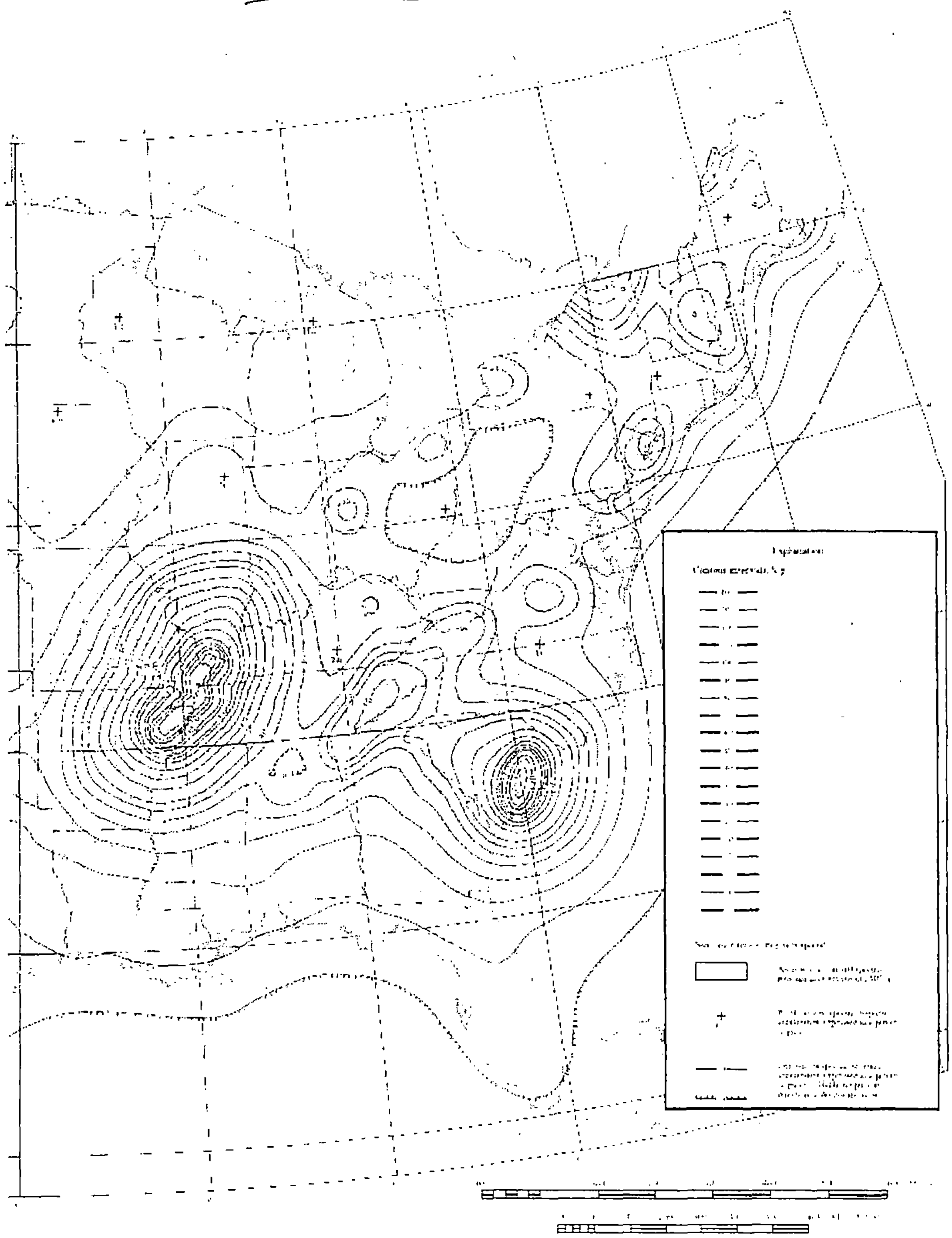


FIGURE 1613.5(1)-continued MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES OF 0.2 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

IBC 2009 (SEISMIC)

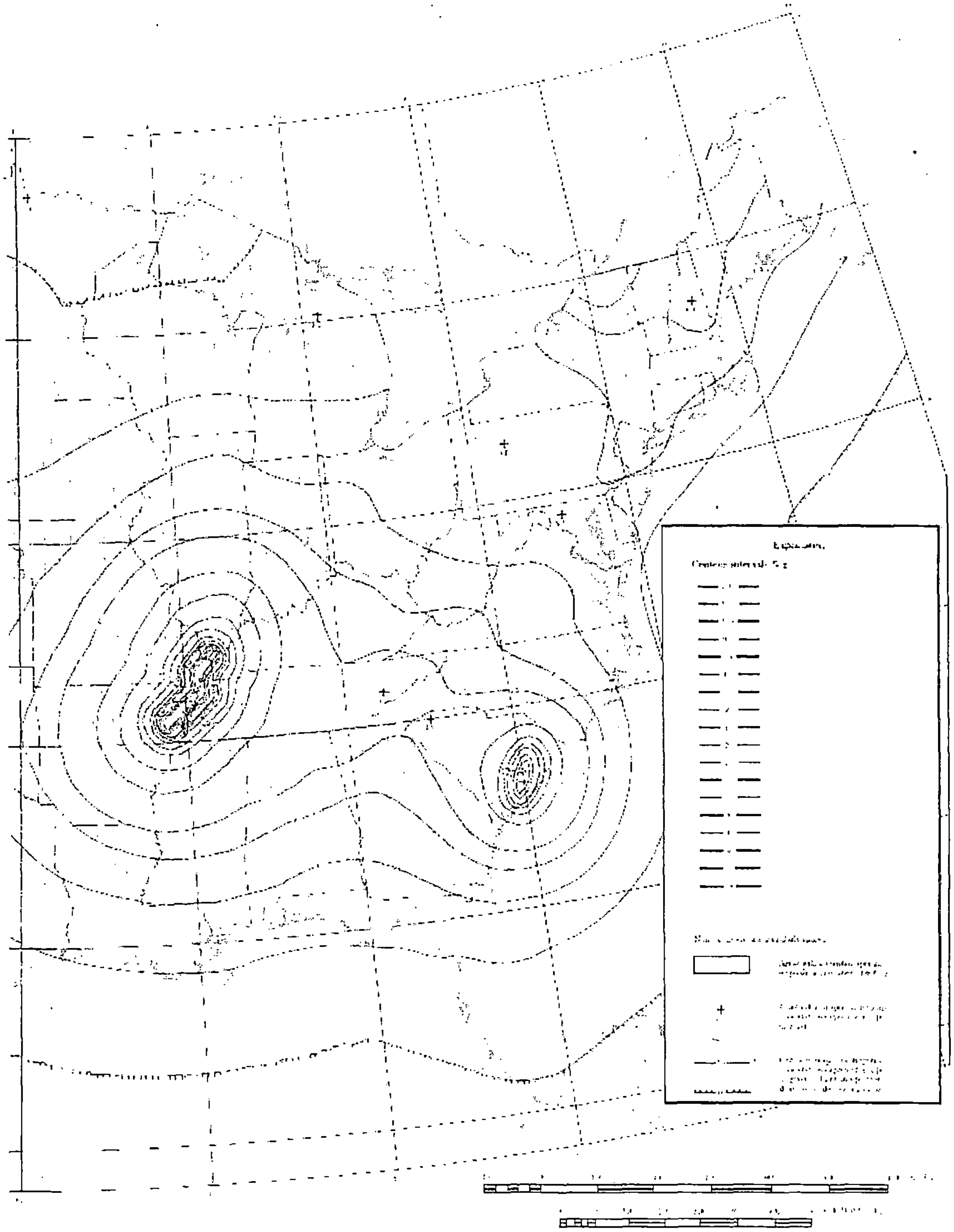


FIGURE 1613.5(2)-continued MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES OF 1.0 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

SECTION 1613 EARTHQUAKE LOADS

1613.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A. The *seismic design category* for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7.

Exceptions:

1. Detached one- and two-family dwellings, assigned to *Seismic Design Category* A, B or C, or located where the mapped short-period spectral response acceleration, S_S, is less than 0.4 g.
2. The seismic-force-resisting system of wood-frame buildings that conform to the provisions of Section 2308 are not required to be analyzed as specified in this section.
3. Agricultural storage structures intended only for incidental human occupancy.
4. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.

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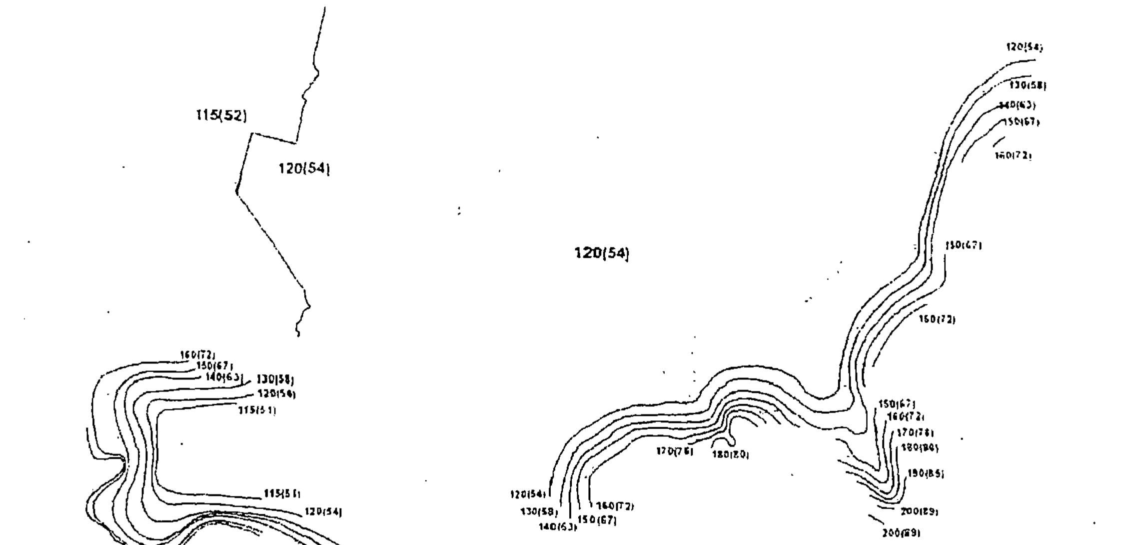
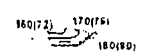
IBC2012 (WIND)

ULTIMATE DESIGN SPEEDS FOR CATEGORY III AND IV BUILDINGS



Special Wind Region

Location	Vmph	(m/s)
Guam	210	(94)
Virgin Islands	175	(78)
American Samoa	170	(76)
Hawaii – Special Wind Region Statewide	145	(65)



Puerto Rico

Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years)

1604.5 Occupancy category. Each building and structure shall be assigned an *occupancy category* in accordance with Table 1604.5.

TABLE 1604.5 OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES

OCCUPANCY CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Occupancy Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident patients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000[a]. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Occupancy Category IV. • Buildings and other structures not included in Occupancy Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released.
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Occupancy Category IV structures. • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.1(2). • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions.

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1609.3 Basic wind speed.

The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609A, 1609B and 1609C. The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609A. The ultimate design wind speed, V_{ult}, for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609B. The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609C. The ultimate design wind speed, V_{ult}, for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult}, determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7.

In nonhurricane-prone regions, when the ultimate design wind speed, V_{ult}, is estimated from regional climatic data, the ultimate design wind speed, V_{ult}, shall be determined in accordance with Section 26.5.3 of ASCE 7.

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IBC 2012 Seismic

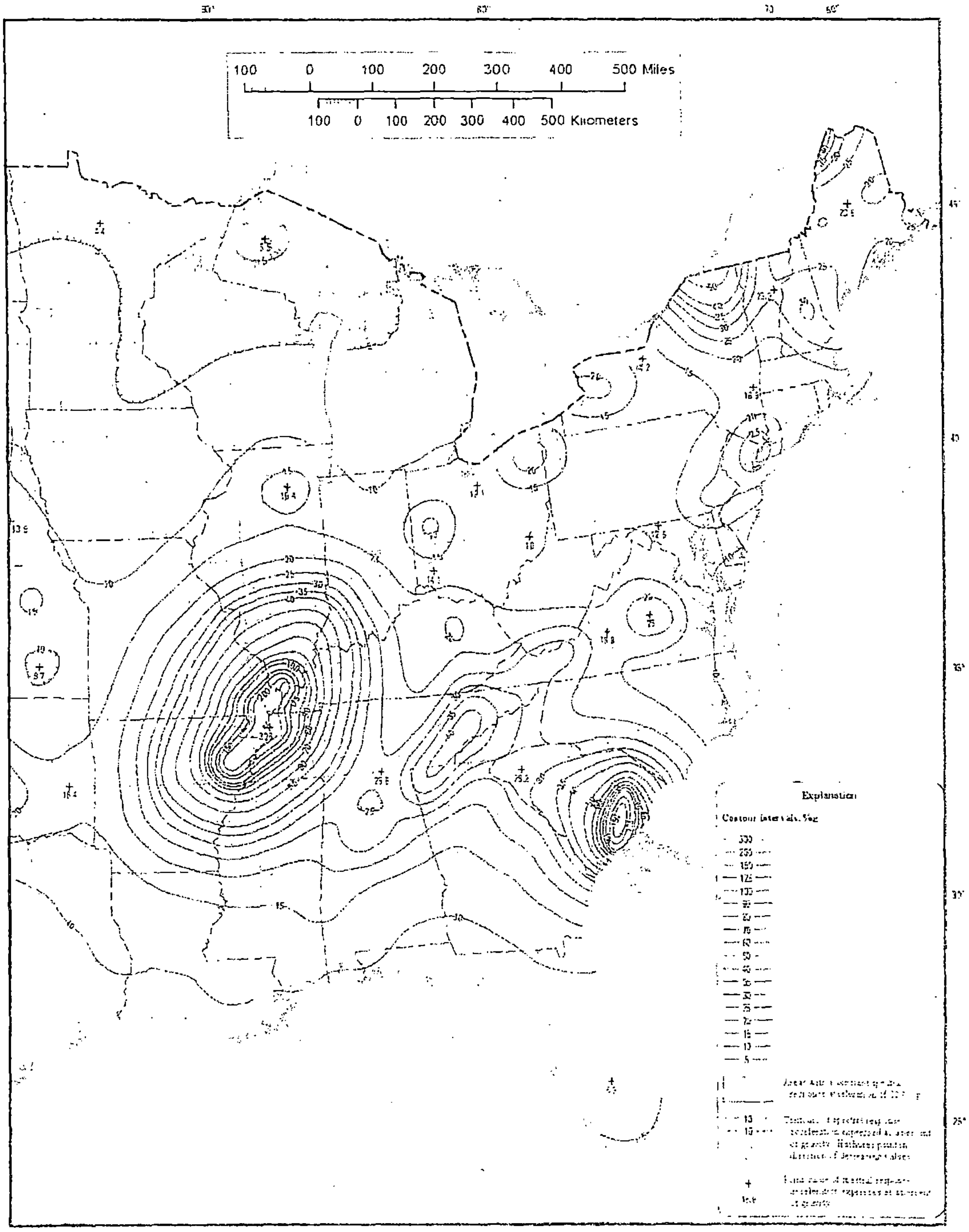

FIGURE 1613.3.1(1)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

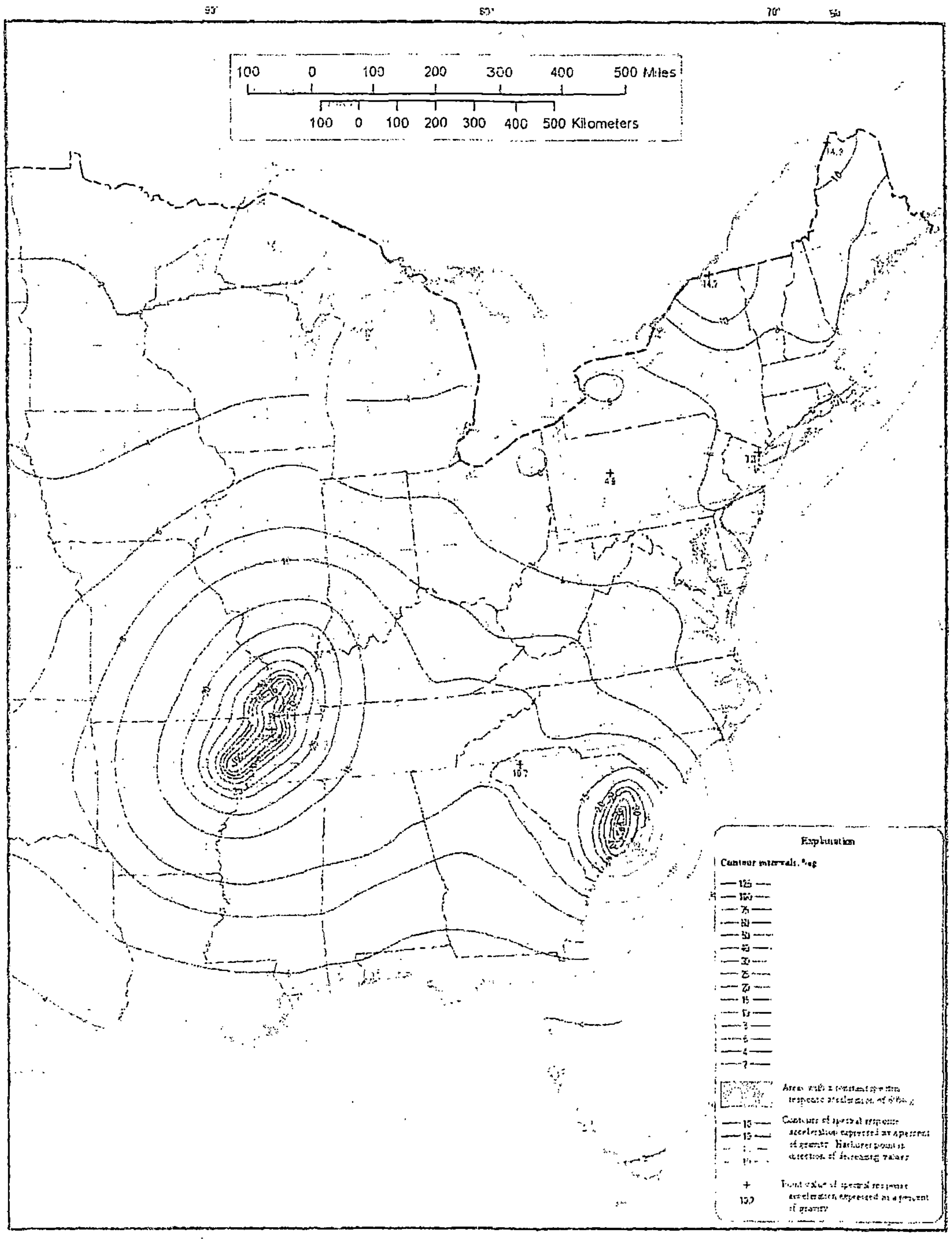

FIGURE 1613.3.1(2)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

to resist flotation, collapse and lateral movement due to the effects of wind and flood loads acting simultaneously on all building components, and other load requirements of Chapter 16.

2.3. For breakaway walls designed to have a resistance of more than 20 psf (0.96 kN/m^2) determined using allowable stress design, *construction documents* shall include a statement that the breakaway wall is designed in accordance with ASCE 24.

SECTION 1613
EARTHQUAKE LOADS

1613.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7, excluding Chapter 14 and Appendix 11A. The *seismic design category* for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7.

Exceptions:

1. Detached one- and two-family dwellings, assigned to *Seismic Design Category* A, B or C, or located where the mapped short-period spectral response acceleration, S_S, is less than 0.4 g.
2. The seismic force-resisting system of wood-frame buildings that conform to the provisions of Section 2308 are not required to be analyzed as specified in this section.
3. Agricultural storage structures intended only for incidental human occupancy.
4. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.

1613.2 Definitions. The following terms are defined in Chapter 2:

DESIGN EARTHQUAKE GROUND MOTION.

MECHANICAL SYSTEMS.

ORTHOGONAL.

RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE$_R$) GROUND MOTION RESPONSE ACCELERATION.

SEISMIC DESIGN CATEGORY.

SEISMIC FORCE-RESISTING SYSTEM.

SITE CLASS.

SITE COEFFICIENTS.

1613.3 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

1613.3.1 Mapped acceleration parameters. The parameters S_s and S_1 shall be determined from the 0.2 and 1-second spectral response accelerations shown on Figures 1613.3.1(1) through 1613.3.1(6). Where S_1 is less than or equal to 0.04 and S_s is less than or equal to 0.15, the structure is permitted to be assigned to *Seismic Design Category* A. The parameters S_S and S_1 shall be, respectively, 1.5 and 0.6 for Guam and 1.0 and 0.4 for American Samoa.

1613.3.2 Site class definitions. Based on the site soil properties, the site shall be classified as *Site Class* A, B, C, D, E or F in accordance with Chapter 20 of ASCE 7. Where the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official or geotechnical data determines Site Class E or F soils are present at the site.

1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. The maximum considered earthquake spectral response acceleration for short periods, S_{MS}, and at 1-second period, S_{M1}, adjusted for *site class* effects shall be determined by Equations 16-37 and 16-38, respectively:

$$S_{MS} = F_a S_s \quad \textbf{(Equation 16-37)}$$

$$S_{M1} = F_v S_1 \quad \textbf{(Equation 16-38)}$$

where:

F_a = Site coefficient defined in Table 1613.3.3(1).

F_v = Site coefficient defined in Table 1613.3.3(2).

S_S = The mapped spectral accelerations for short periods as determined in Section 1613.3.1.

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a [a]

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD				
	$S_s \le 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s.
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

S_1 = The mapped spectral accelerations for a 1-second period as determined in Section 1613.3.1.

1613.3.4 Design spectral response acceleration parameters. Five-percent damped design spectral response acceleration at short periods, S_{DS}, and at 1-second period, S_{D1}, shall be determined from Equations 16-39 and 16-40, respectively:

$$S_{DS} = \frac{2}{3}S_{MS} \quad \text{(Equation 16-39)}$$

$$S_{D1} = \frac{2}{3}S_{M1} \quad \text{(Equation 16-40)}$$

where:

S_{MS} = The maximum considered earthquake spectral response accelerations for short period as determined in Section 1613.3.3.

S_{M1} = The maximum considered earthquake spectral response accelerations for 1-second period as determined in Section 1613.3.3.

1613.3.5 Determination of seismic design category. Structures classified as *Risk Category* I, II or III that are located where the mapped spectral response acceleration parameter at 1-second period, S_1, is greater than or equal to 0.75 shall be assigned to *Seismic Design Category* E. Structures classified as *Risk Category* IV that are located where the mapped spectral response acceleration parameter at 1-second period, S_1, is greater than or equal to 0.75 shall be assigned to *Seismic Design Category* F. All other structures shall be assigned to a *seismic design category* based on their *risk category* and the design spectral response acceleration parameters, S_{DS} and S_{D1}, determined in accordance with Section 1613.3.4 or the site-specific procedures of ASCE 7. Each building and structure shall be assigned to the more severe *seismic design category* in accordance with Table 1613.3.5(1) or 1613.3.5(2), irrespective of the fundamental period of vibration of the structure, T.

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_V [a]

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD				
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1.
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

EXCEPTIONS:

a. Where the inclusion of storage loads adds no more than 5% to the effective seismic weight at that level, it need not be included in the effective seismic weight.

b. Floor live load in public garages and open parking structures need not be included.

2. Where provision for partitions is required by Section 4.2.2 in the floor load design, the actual partition weight or a minimum weight of 10 psf (0.48 kN/m²) of floor area, whichever is greater.
3. Total operating weight of permanent equipment.
4. Where the flat roof snow load, P_f, exceeds 30 psf (1.44 kN/m²), 20 percent of the uniform design snow load, regardless of actual roof slope.
5. Weight of landscaping and other materials at roof gardens and similar areas.

12.7.3 Structural Modeling

A mathematical model of the structure shall be constructed for the purpose of determining member forces and structure displacements resulting from applied loads and any imposed displacements or P-delta effects. The model shall include the stiffness and strength of elements that are significant to the distribution of forces and deformations in the structure and represent the spatial distribution of mass and stiffness throughout the structure.

In addition, the model shall comply with the following:

a. Stiffness properties of concrete and masonry elements shall consider the effects of cracked sections.

b. For steel moment frame systems, the contribution of panel zone deformations to overall story drift shall be included.

Structures that have horizontal structural irregularity Type 1a, 1b, 4, or 5 of Table 12.3-1 shall be analyzed using a 3-D representation. Where a 3-D model is used, a minimum of three dynamic degrees of freedom consisting of translation in two orthogonal plan directions and rotation about the vertical axis shall be included at each level of the structure. Where the diaphragms have not been classified as rigid or flexible in accordance with Section 12.3.1, the model shall include representation of the diaphragm's stiffness characteristics and such additional dynamic degrees of freedom as are required to account for the participation of the diaphragm in the structure's dynamic response.

EXCEPTION: Analysis using a 3-D representation is not required for structures with flexible diaphragms that have Type 4 horizontal structural irregularities.

12.7.4 Interaction Effects

Moment-resisting frames that are enclosed or adjoined by elements that are more rigid and not considered to be part of the seismic force-resisting system shall be designed so that the action or failure of those elements will not impair the vertical load and seismic force-resisting capability of the frame. The design shall provide for the effect of these rigid elements on the structural system at structural deformations corresponding to the design story drift (Δ) as determined in Section 12.8.6. In addition, the effects of these elements shall be considered where determining whether a structure has one or more of the irregularities defined in Section 12.3.2.

12.8 EQUIVALENT LATERAL FORCE PROCEDURE

12.8.1 Seismic Base Shear

The seismic base shear, V, in a given direction shall be determined in accordance with the following equation:

$$V = C_s W \qquad (12.8\text{-}1)$$

where

C_s = the seismic response coefficient determined in accordance with Section 12.8.1.1

W = the effective seismic weight per Section 12.7.2

12.8.1.1 Calculation of Seismic Response Coefficient

The seismic response coefficient, C_s, shall be determined in accordance with Eq. 12.8-2.

$$C_s = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)} \qquad (12.8\text{-}2)$$

$I_e = 1.5$ ↓ Check 12.8-3 / 12.8-4 Too

where

S_{DS} = the design spectral response acceleration parameter in the short period range as determined from Section 11.4.4 or 11.4.7

R = the response modification factor in Table 12.2-1

I_e = the importance factor determined in accordance with Section 11.5.1

The value of C_s computed in accordance with Eq. 12.8-2 need not exceed the following:

$$C_s = \frac{S_{D1}}{T\left(\frac{R}{I_e}\right)} \quad \text{for} \quad T \le T_L \qquad (12.8\text{-}3)$$

$$C_s = \frac{S_{D1} T_L}{T^2\left(\frac{R}{I_e}\right)} \quad \text{for} \quad T > T_L \qquad (12.8\text{-}4)$$

APPENDIX B

Code Compliance by EOR

MASTER
ENGINEERS & DESIGNERS

March 22, 2012

Mr. Josh Grishaw
Babcock & Wilcox
P. O. Box 785
Lynchburg, VA 24505

Reference: Building Codes
B&W Mt. Athos Facility
Lynchburg, VA
MEAD Project No. 260-005-200

Dear Mr. Grishaw:

The facilities at Mt. Athos were constructed from 1956 to present. In 1973 Virginia issued the Virginia Uniform Statewide Building Code (VUSBC) which references the Building Officials and Code Administrators (BOCA) until 2003 when it references the International Building Code (IBC).

Prior to 1973, the local building authority had jurisdiction for code compliance. Campbell County did not invoke a building code. However, in discussions with local building authoriities, engineers, and architects practicing at that time, the Southern Building Code (SBC) was generally used.

From 1973 to 2003, the VUSBC references BOCA. Buildings designed by Master Engineers during that timeframe were designed in accordance with the VUSBC and BOCA.

From 2003 to present, the VUSBC references the IBC. Buildings designed by Master Engineers during this timeframe were designed in accordance with the VUSBC and IBC.

If there is any additional information required or questions please, do not hesitate to call me.

Sincerely,

MASTER ENGINEERS AND DESIGNERS, INC.

Gary W Loomis

Gary W. Loomis, P.E.
Senior Structural Engineer

127 Nationwide Dr., Lynchburg, VA 24502-4272 | 434.947.1901 | wileywilson.com

Wiley|Wilson
Constant Progress

March 14, 2012
John Compher, P.E., CPE
Manager, Facilities Engineering, Maintenance, & Construction
Babcock & Wilcox Company - NOG
PO Box 785
Lynchburg, VA 24505

Re: Code Research – B&W Mt. Athos Facilities Design

Dear John:

At your request, we have researched what codes were used as the basis for the structural design of several of the facilities constructed at the Mt. Athos facility in the 1960s. This letter serves as a summary of our findings.

Facilities:

We focused our research on the period between 1965 and 1969 which encompasses the design and construction of the following facilities: 2A, 3A, 4A, 13A, and 14A.

Historic Documentation:

Our company policy is to retain design files for a period of 10 (ten) years for projects in Virginia. While the above time frame is outside of the retention period defined by this policy, we were able to find some design files for projects 2A, 3A, 4A, 13A, and 14A. These files were being stored at a facility owned by a previous majority owner of Wiley|Wilson, who retained these records as personal property. Our records indicate these facilities to have been designed in the 1966 and 1967 time periods.

Building Codes in Effect at This Time:

The Commonwealth of Virginia adopted the Uniform Statewide Building Code (USBC) based on the BOCA Basic Codes in 1973. Prior to 1973, local governments were free to adopt codes as they saw fit. The B&W Mt. Athos facilities are located in Campbell County, Virginia. At the time of the design of the above referenced projects, Campbell County had not yet adopted any building codes. It was up to the architect or engineer of record to perform the design using the requirements of the code they deemed to be appropriate.

Review of Historic Documentation Relative to Building Codes in Effect When the Buildings Were Designed:

I was structural engineering of record for the design of the referenced projects. My personal recollection is that the structural design loads used for these facilities were as follows:

- Dead Load: Calculated dead load based on the weights of the various facility components
- Live Load: As mutually agreed upon by discussions between Wiley|Wilson and Babcock & Wilcox
- Wind Load: With no specific Campbell County code requirement, our default at that time would have been the Southern Building Code.
- Snow Load: With no specific Campbell County code requirement, our default at that time would have been the Southern Building Code.

The design files we found are by no means complete and the information we found does not reference any specific design code. However, there is enough information present to determine with some confidence the design loads we used for the above referenced structures. We have made a comparison of the design loads used for both wind and snow and the applicable load requirements of the Southern Building Code in effect at the time of the design of these facilities.

Conclusions:

Our research did not produce specific reference to any design code. However, our review of the historic documentation available relative to the building codes of that time period indicates that these facilities, and any other facilities designed by Wiley|Wilson for the B&W Mt. Athos facility prior to 1973 when Virginia adopted the USBC based on the BOCA Basic Codes, were designed in accordance with the wind load and snow load requirements of the Southern Building Code in effect at the time of the designs.

Please let us know if there is anything else you need from us to resolve this matter.

Sincerely,

Wiley|Wilson

William A. Stuart, PE (Retired)

Reviewed and approved for transmittal by:

T. A. (Tim) Groover, PE
President & COO

APPENDIX C

BUILDING DATA SHEETS

BUILDING DATA

Bay No.: 2

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: ____________

Year Designed/Built: 4-1-1976 4-10-1964 Overall Dimensions: ____________

Construction Type: ____________

No. Floors: ____________ Basement: ____________

Applicable Codes: ____________

Drawing No: STRUCTURAL - LP1481E, LP2800D

Specifications: ____________

Geotechnical Report: ____________

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: ____________

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____________ 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: ____________ Floor Deck: ____________

Anchor Bolts: ____________

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

BUILDING DATA

Bay No.: 3

General Information (as provided by the drawings and specifications)

Engineer of Record: ______ Project (commission) No.: ______

Year Designed/Built: 4-15-1963 Overall Dimensions: 16'-6" x 70'-5½"

Construction Type: ______

No. Floors: ______ Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL - LP 1316E

Specifications: ______

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______ Roof Snow: ______

Roof Live Load: ______ 2nd Floor Live Load: ______

Wind: ______ Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______ 2nd Floor Concrete: ______

Structural Steel: ______ Bracing: ______

Roof Deck: ______ Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 3 - EXPANSION

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON
Project (commission) No.: 8037

Year Designed/Built: 4-5-1968
Overall Dimensions: 9'-6" x 22'-0"

Construction Type: ____

No. Floors: ____
Basement: ____

Applicable Codes: ____

Drawing No: STRUCTURAL - PD-24866

Specifications: ____

Geotechnical Report: ____

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____
Roof Snow: ____

Roof Live Load: ____
2nd Floor Live Load: ____

Wind: ____
Seismic: ____

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500 PSI - 28 DAY (MIN)
2nd Floor Concrete: ____

Structural Steel: ____
Bracing: ____

Roof Deck: ____
Floor Deck: ____

Anchor Bolts: ____
REINFORCING A15

Equipment:

Cranes: ____

Mechanical: ____

Electrical: ____

Additions: ____

BUILDING DATA

Bay No.: 3-4-5

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: ____________

Year Designed/Built: 6/21/1956 Overall Dimensions: 156'-0" x 320'-0" ±

HEIGHT 31'-4" ±

Construction Type: ____________

No. Floors: + MEZZANINE Basement: ____________

Applicable Codes: ____________

Drawing No: STRUCTURAL - LS-1-E; LS-2-E, LS-10-E, LS-11-E, LA-4-E, LA-5-E

Specifications: No

Geotechnical Report: ALLOWABLE SOIL PRESSURE 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: ____________

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,000 PSI 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: ____________ Floor Deck: ____________

Anchor Bolts: ____________ REINFORCING 20,000 PSF

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

(SEE BACK)

DWG - LS-1-E - FOUNDATIONS (REFERENCES DWG #29207-E)

DWG - LS-10-E - MEZZ FLOOR SLAB (REFERENCES R.C. MAHON DWG # L.O.2)

BUILDING DATA

Bay No.: 6/7/8

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 60014

Year Designed/Built: 3/18/1966

Overall Dimensions: 150' x 322' ±

Construction Type: ______

HEIGHT 30' ±

No. Floors: ______

Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL - PD 21451, PD 21452, PD21453

Specifications: ______

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 9/10

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: 9236-51-03

Year Designed/Built: 1/10/1963 Overall Dimensions: 100' x 320' ±

Construction Type: ____________

No. Floors: ____________ Basement: ____________

Applicable Codes: ____________

Drawing No: STRUCTURAL - LP 1271 E

Specifications: ____________

Geotechnical Report: ____________

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: ____________

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____________ 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: ____________ Floor Deck: ____________

Anchor Bolts: ____________

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

BUILDING DATA

Bay No.: 11-12-13

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON   Project (commission) No.: 70750

Year Designed/Built: 12/20/1967   Overall Dimensions: ____

Construction Type: ____

No. Floors: ____   Basement: ____

Applicable Codes: ACI 318, ASTM, AISI

Drawing No: STRUCTURAL - PD 21832, PD21833, PD21834

Specifications: YES

Geotechnical Report: ____

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____   Roof Snow: ____

Roof Live Load: ____   2nd Floor Live Load: ____

Wind: ____   Seismic: ____

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500 PSI   2nd Floor Concrete: ____

Structural Steel: ASTM A36   Bracing: ____

Roof Deck: 20 GAGE, #3 TYPE   Floor Deck: 22 GAGE, QL-3-22 TYPE

Anchor Bolts: ____   REINFORCING ASTM A15, DEFORMED A305

WWF ASTM A185

Equipment:

Cranes: ____

Mechanical: ____

Electrical: ____

Additions: ____

BUILDING DATA

Bay No.: 14

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON   Project (commission) No.: 8069

Year Designed/Built: 12/23/1967   Overall Dimensions: 50'x320'

Construction Type:

No. Floors: Basement:

Applicable Codes:

Drawing No: STRUCTURAL - PD 21872

*SEE BACK

Specifications:

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: Roof Snow:

Roof Live Load: 2nd Floor Live Load:

Wind: Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 2nd Floor Concrete:

Structural Steel: Bracing:

Roof Deck: Floor Deck:

Anchor Bolts:

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

* - REFERENCE DRAWINGS
PD 21832 - PD 21833 - PD 21834

BUILDING DATA

Bay No.: 15

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 8131

Year Designed/Built: 11-01-1968

Overall Dimensions: 50' x 323' ±

Construction Type:

No. Floors:

Basement:

Applicable Codes: ACI 318, ASTM, AISC

Drawing No: STRUCTURAL - PD25021, PD25022, PD25023

Specifications: YES

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load:

2nd Floor Live Load:

Wind:

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500 PSI

2nd Floor Concrete:

Structural Steel: ASTM A36

Bracing:

Roof Deck: 20 GAGE, #3 TYPE

Floor Deck: 22 GAGE, TYPE 3-22

Anchor Bolts: ASTM A325

REINFORCING: ASTM A15, DEFORMED A305

WWF: ASTM A185

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: BAY 1T

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 8129

Year Designed/Built: 04-04-1969

Overall Dimensions: 60'-0" x 225'-0"

HEIGHT 28'-6 1/2" ±

Construction Type: ______

No. Floors: ______

Basement: ______

Applicable Codes: AISC, ASTM

Drawing No: STRUCTURAL - PD26107, PD26108, PD26109

Specifications: YES

Geotechnical Report: ALLOWABLE SOIL PRESSURE OF 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500 PSI

2nd Floor Concrete: ______

Structural Steel: ASTM A36

Bracing: ______

Roof Deck: 20 GAGE, #3 TYPE

Floor Deck: 20 GAGE, QL-3 TYPE

Anchor Bolts: ASTM A325

REINFORCING ASTM A15, DEFORMED A305

WWF ASTM A185

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 1-6 (SOUTH ADDITION)

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 8129

Year Designed/Built: 1-7-1969

Overall Dimensions: 55'-0" x 225'-0"

Construction Type: ______

HEIGHT 28'-6 1/2"

No. Floors: (1) FLOOR + MEZZANINE

Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL - LP-3296E, LP-3297E, LP-3298E

Specifications: ______

Geotechnical Report: ALLOWABLE SOIL PRESSURE OF 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 2T

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 8130

Year Designed/Built: 01-10-1969

Overall Dimensions: ____

Construction Type: ____

No. Floors: ____

Basement: ____

Applicable Codes: ASTM, 63'

Drawing No: STRUCTURAL- PD 26121, PD26122, PD26123, PD26124

Specifications: YES

Geotechnical Report: ALLOWABLE SOIL PRESSURE OF 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____

Roof Snow: ____

Roof Live Load: 25 PSF

MEZZ ~~2nd Floor~~ Live Load: 200 PSF

Wind: 20 PSF

Seismic: ____

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: FTGS/3,000 PSI OTHER/3,500 PSI

2nd Floor Concrete: ____

Structural Steel: ASTM A36

Bracing: ____

Roof Deck: 20 GAGE, #3 TYPE

Floor Deck: 20 GAGE, QL-3 TYPE

Anchor Bolts: ASTM A325

REINFORCING ASTM A15, DEFORMED A305

WWF ASTM A185

Equipment:

Cranes: ____

Mechanical: ____

Electrical: ____

Additions: ____

BUILDING DATA

Bay No.: 1A/2A NORTH ADDITION

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 79053

Year Designed/Built: 1979

Overall Dimensions: 107' x 78'

HEIGHT T/2nd FLOOR ROOF 30'-8"

Construction Type:

No. Floors: (2) FLOORS & PENTHOUSE

~~Basement:~~ PIT: PIT/LOW PIT

Applicable Codes:

Drawing No: STRUCTURAL - LP 3555E, LP 3556E, LP 3557E, LP3551E, LP3552E, LP 3558E, LP 3559E, LP3560E

Specifications: YES - PROJECT MANUAL FOR NNFD - NORTH ADDITION 1A & 2A

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load: 30 PSF, EQUIP 40 PSF; PENTHOUSE FLOOR - LL 250 PSF

2nd Floor Live Load: 200 PSF

Wind:

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 4,000 PSI NORMAL WT.

2nd Floor Concrete: 3,000 PSI LT. WT.

Structural Steel: ASTM A36

Bracing: REF. "MANUAL OF STEEL CONST."

Roof Deck: ASTM A611, GRADE C OR ASTM A446 GRADE A

Floor Deck: ASTM A446

Anchor Bolts: ASTM A36 / HIGH STR. A325 OR A490

REINFORCING ASTM A615 GRADE 60

WWF ASTM A185

Equipment:

Cranes: LYTON MONORAIL & 5 TON CRANE

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: 2A & 3A

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON
Project (commission) No.: 60016

Year Designed/Built: 8/05/1966
Overall Dimensions: 160' x 101' ±

Construction Type: ______
HEIGHT 21'-6"

No. Floors: 1
Basement: ______

Applicable Codes: ACI 318, ASTM,

Drawing No: STRUCTURAL - PD21802, PD21803, PD21804, PD21806

Specifications: YES

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______
Roof Snow: ______

Roof Live Load: ______
2nd Floor Live Load: ______

Wind: ______
Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500 PSI, EXCEPT FLOOR 5,000 PSI
2nd Floor Concrete: ______

Structural Steel: A36, ASTM A7
Bracing: AISC SPECS

Roof Deck: 20 GAGE, #3 TYPE
Floor Deck: 18 GAGE, #21 TYPE

Anchor Bolts: ASTM A325
WWF ASTM A185

REINFORCING ASTM A15, DEFORMED A305

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 4A

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: ____________

Year Designed/Built: 7/17/57 Overall Dimensions: ____________

Construction Type: ____________

No. Floors: ____________ Basement: ____________

Applicable Codes: ____________

Drawing No: ____________

____

Specifications: ____________

Geotechnical Report: ____________

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: ____________

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____________ 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: ____________ Floor Deck: ____________

Anchor Bolts: ____________

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

BUILDING DATA

Bay No.: 4A - NORTH ADDITION

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 79106, 79115, 79123

Year Designed/Built: 4/30/1979

Overall Dimensions: 123' x 52' ±

Construction Type:

No. Floors:

Basement:

Applicable Codes: ACI 318, ACI 301, AISC, AWS, SSPC, ASTM, NAAMM

Drawing No: ARCH/STRUCTURAL - LP3530E, LP3531E, LP3532E, LP3533E, LP3534E, LP3535E

Specifications: YES

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load:

2nd Floor Live Load:

Wind:

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: SLAB/4,000 PSI OTHER/3,500 PSI

2nd Floor Concrete:

Structural Steel: ASTM A36, ASTM A511, GRADE C

Bracing:

Roof Deck: ASTM A445, GRADE A - MIN 20 GAGE

Floor Deck:

Anchor Bolts: ASTM A325 OR A490

REINFORCING ASTM A615, GRADE 60

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: 4A & 5A – ADDITION

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 60010

Year Designed/Built: 06-17-1966

Overall Dimensions: 120' x 52'

Construction Type: ______

HEIGHT 91'-0" ±

No. Floors: 3

Basement: ______

Applicable Codes: ACI 318, AISC SPECS

Drawing No: STRUCTURAL – PD 21473, PD21474, PD21475, PD21476, PD21480, PD21481, PD21492, PD21477, PD 21478, PD21479

Specifications: YES

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,500, EXCEPT FLOOR 5,000 PSI

2nd Floor Concrete: ______

Structural Steel: ASTM A7 & A36

Bracing: AISC SPECS

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

REINFORCING ASTM A15, DEFORMED A305

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 4A & 5A SOUTH ADDITION

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON
Project (commission) No.: 8099

Year Designed/Built: 9/5/68
Overall Dimensions: 115' x 100' ±

Construction Type: ______
HEIGHT 45'-0" ±

No. Floors: 1
Basement: ______

Applicable Codes: AISC, STEEL DECK INSTITUTE

Drawing No: STRUCTURAL – PD 25005, PD 25006, PD 25007, PD 25008, PD 25009

Specifications: YES

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______
Roof Snow: ______

Roof Live Load: 30 PSF
2nd Floor Live Load: ______

Wind: 20 PSF
Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: "A" 3,500 PSI
2nd Floor Concrete: ______

Structural Steel: ASTM A36
Bracing: ______

Roof Deck: 20 GAGE #3 TYPE
Floor Deck: ASTM A245 & ASTM A446

Anchor Bolts: ASTM A-325
REINFORCING ASTM A15, DEFORMED A305
WWF ASTM A185

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 5A - STORAGE FACILITY

General Information (as provided by the drawings and specifications)

Engineer of Record: MEAD

Project (commission) No.: ____

Year Designed/Built: 1/12/2001

Overall Dimensions: 33' x 44' ±

Construction Type: ____

No. Floors: 5

Basement: ____

Applicable Codes: BOCA 96', AISC, AWS D1.1, ACI 318

Drawing No: STRUCTURAL - 5AS_1001E, 5AS2_1001E, 5AS3_1001E, 5AS4_1001E

Specifications: ON DRAWING (5AS_1001E)

Geotechnical Report: ____

Specified Design Loads (as provided by the drawings and specifications) FLOOR 80 PSF

Ground Snow: ____

Roof Snow: ____

Roof Live Load: ____

2nd Floor Live Load: ____

Wind: ____

Seismic: ____

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3,000 PSI

2nd Floor Concrete: ____

Structural Steel: ASTM A36

Bracing: ____

Roof Deck: ____

Floor Deck: ____

Anchor Bolts: ASTM A325-N

REINFORCING ASTM A615, GRADE 60

Equipment:

Cranes: ____

Mechanical: ____

Electrical: ____

Additions: ____

BUILDING DATA

Bay No.: 6A & 7A

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 8127 (6A) 8128 (7A)

Year Designed/Built: 12-02-1968

Overall Dimensions: 6A – 182'-6" x 50' ± 7A – 182'-6" x 50' ±

Construction Type: ______

HEIGHT 29'-4" ±

No. Floors: ______

Basement: ______

Applicable Codes: ACI 318, ASTM, AISC

Drawing No: STRUCTURAL – PD25035, PD25037, PD25038, PD25039, PD25036 (ALSO MONTAGUE-BETTS)

Specifications: YES

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: 30 PSF

2nd Floor Live Load: ______

Wind: 20 PSF

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 3500 PSI

2nd Floor Concrete: ______

Structural Steel: ASTM A36

Bracing: AISC SPECS

Roof Deck: 20 GAGE ASTM A525 ASTM A446

Floor Deck: ______

Anchor Bolts: ASTM A325

REINFORCING ASTM A15, DEFORMED A305

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 7AA

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 2038

Year Designed/Built: 4/7/1972

Overall Dimensions: 220' x 50'

HEIGHT 29'-0" ±

Construction Type: ______

No. Floors: ______

Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL – LP2954E, LP2955E, LP2956E, LP2957E

Specifications: ______

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: 50 PSF

2nd Floor Live Load: ______

Wind: 30 PSF

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

FLOOR SLAB LL= 200 PSF

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 7AA

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON
Project (commission) No.: 2038

Year Designed/Built: 4/24/1972
Overall Dimensions: 50' x 220' ±

HEIGHT 28'-6"

Construction Type: ______

No. Floors: ______
Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL – LP2954E, LP2955E, LP2956E, LP2957E

Specifications: ______

Geotechnical Report: ASSUMED 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______
Roof Snow: ______

Roof Live Load: LL + DL = 50 PSF
2nd Floor Live Load: ______

Wind: 30 PSF
Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 4,000 PSI / LL 200 PSF
2nd Floor Concrete: ______

Structural Steel: ______
Bracing: ______

Roof Deck: [illegible]
Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: 7A - MEZZANINE

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: ____________

Year Designed/Built: 12/31/01 Overall Dimensions: 50' x 120' ±

Construction Type: ____________

No. Floors: ____________ Basement: ____________

Applicable Codes: ____________

Drawing No: PIEDMONT METALS - E1

Specifications: ____________

Geotechnical Report: ____________

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: ____________

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____________ 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: ____________ Floor Deck: ____________

Anchor Bolts: ____________

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

BUILDING DATA

Bay No.: 8A & 9A

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 2038

Year Designed/Built: 4/24/1972

Overall Dimensions: 8A – 180' x 50' ± 9A – 180' x 50' ±

HEIGHT 29'-10" ±

Construction Type:

No. Floors: 8A – (2) MAIN, MEZZ 9A –

Basement:

Applicable Codes:

Drawing No: STRUCTURAL – LP2966E, LP2967E, LP2968E, LP2969E, LP2970E

Specifications:

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load: 50 PSF

2nd Floor Live Load:

Wind: 30 PSF

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength:

2nd Floor Concrete:

Structural Steel:

Bracing:

Roof Deck:

Floor Deck:

Anchor Bolts:

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: 8A & 9A NORTH ADDITION

General Information (as provided by the drawings and specifications)

Engineer of Record: B&W

Project (commission) No.:

Year Designed/Built: 8/13/1984

Overall Dimensions: 100' x 85' ±

HEIGHT 16'-6" ±

Construction Type:

No. Floors:

Basement:

Applicable Codes:

Drawing No: STRUCTURAL – LP 3815E, LP3816E

Specifications:

Geotechnical Report: AUGUST 3, 1984 4,000 PSF

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load: 50 PSF

2nd Floor Live Load:

Wind: 20 PSF

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 4,000 PSI

2nd Floor Concrete:

Structural Steel: ASTM A36

Bracing:

Roof Deck:

Floor Deck:

Anchor Bolts:

REINFORCING ASTM A615, GRADE 60

FLOOR SLAB LL = 200 PSF

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: 10 A

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 6064

Year Designed/Built: 2-20-1976

Overall Dimensions: 180' x 50'

HEIGHT 29'-0" ±

Construction Type:

No. Floors: 2

Basement: NO

Applicable Codes: ACI 318, ACI 301, ASTM, AWS, SSPC

Drawing No: STRUCTURAL – LP3404E, LP3405E, LP3406E

Specifications: ACI 318-71, AISC 1969

Geotechnical Report: SOIL DESIGN BEARING CAPACITY – 6,000 PSF

Specified Design Loads (as provided by the drawings and specifications) CALCULATIONS

Ground Snow:

Roof Snow: 30 PSF

Roof Live Load: 30 PSF

2nd Floor Live Load: 200 PSF

Wind: 25.6 PSF

Seismic: ZONE 1, PER BOCA SECTION 719.0

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 4,000 PSI

2nd Floor Concrete: 4,000 PSI LWT

Structural Steel: A36

Bracing:

Roof Deck: 18 GAGE SHEAR 300 PLF

Floor Deck: 1 1/2 TYPE B, 18 GAGE SHEAR 250 PLF

Anchor Bolts: ASTM A325 OR A490

REINFORCING ASTM A615 GRADE 60

Equipment:

Cranes:

Mechanical:

Electrical:

Additions:

BUILDING DATA

Bay No.: J

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 9001

Year Designed/Built: 5/9/1969

Overall Dimensions: 53' x 42' ±

HEIGHT 17'-0" ±

Construction Type: ____

No. Floors: ____

Basement: ____

Applicable Codes: ____

Drawing No: ARCH/STRUCTURAL - PD26133, PD26134, PD26135

Specifications: ____

Geotechnical Report: ____

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____

Roof Snow: ____

Roof Live Load: ____

2nd Floor Live Load: ____

Wind: ____

Seismic: ____

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____

2nd Floor Concrete: ____

Structural Steel: ____

Bracing: ____

Roof Deck: ____

Floor Deck: ____

Anchor Bolts: ____

Equipment:

Cranes: ____

Mechanical: ____

Electrical: ____

Additions: ____

BUILDING DATA

Bay No.: 13A & 14A

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: 70410

Year Designed/Built: 08-15-67

Overall Dimensions: 103' × 129' × 30' HT

Construction Type:

No. Floors: 1 w/ MEZZANINE

Basement: NO

Applicable Codes:

Drawing No: PD21818, PD 218189, PD 21820

PD 21821

Specifications:

Geotechnical Report:

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow:

Roof Snow:

Roof Live Load:

2nd Floor Live Load:

Wind:

Seismic:

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength:

2nd Floor Concrete:

Structural Steel:

Bracing:

Roof Deck:

Floor Deck:

Anchor Bolts:

Equipment:

Cranes:

Mechanical: SCRUBBER

Electrical:

Additions:

BUILDING DATA

Bay No.: 13A/14A – SOUTH ADDITION – MEZZANINE

General Information (as provided by the drawings and specifications)

Engineer of Record: ____________ Project (commission) No.: ____________

Year Designed/Built: 1/11/1988 Overall Dimensions: 103' x 95' ±

Construction Type: ____________

No. Floors: ____________ Basement: ____________

Applicable Codes: ____________

Drawing No: STRUCTURAL – LP4034E, LP4033E

____

Specifications: ____________

Geotechnical Report: ____________

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ____________ Roof Snow: ____________

Roof Live Load: ____________ 2nd Floor Live Load: 3,500 PSI

Wind: ____________ Seismic: ____________

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ____________ 2nd Floor Concrete: ____________

Structural Steel: ____________ Bracing: ____________

Roof Deck: 20 GAGE, TYPE B Floor Deck: ____________

Anchor Bolts: ____________

Equipment:

Cranes: ____________

Mechanical: ____________

Electrical: ____________

Additions: ____________

BUILDING DATA

Bay No.: BC

General Information (as provided by the drawings and specifications)

Engineer of Record: WILEY & WILSON

Project (commission) No.: A&I 3003/2038

Year Designed/Built: 6/16/1972 6/6/1955

Overall Dimensions: 80'x40'± 160'x39'-4"±

Construction Type: ______

No. Floors: ______

Basement: ______

Applicable Codes: ASTM

Drawing No: STRUCTURAL - 29808E, 29809E, LP2981E, LP2982E, LP2983E, LP2989E,

Specifications: ______

Geotechnical Report: 4,000 (ASSUMED)

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: 30 PSF

2nd Floor Live Load: ______

Wind: 20 PSF

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: 4,000 PSI

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

REINFORCING ASTM A615, GRADE 40

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: BC- MEZZANINE

General Information (as provided by the drawings and specifications)

Engineer of Record: MEAD

Project (commission) No.: 260-005-029

Year Designed/Built: 10/23/2002

Overall Dimensions: 244' x 32' ±

Construction Type: ______

HEIGHT HIGH/16'-7 LOW/9'-0"

No. Floors: ______

Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL - (S-2) BCS2-1000E

Specifications: ______

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______

BUILDING DATA

Bay No.: NN

General Information (as provided by the drawings and specifications)

Engineer of Record: MEAD

Project (commission) No.: ______

Year Designed/Built: 1/3/1994

Overall Dimensions: 107' x 35' ±

Construction Type: ______

No. Floors: ______

Basement: ______

Applicable Codes: ______

Drawing No: STRUCTURAL - S1-LP4420E, S1A-LP4420E, S2-LP4420E, S3-LP4420E, S4-LP4420E

Specifications: ______

Geotechnical Report: ______

Specified Design Loads (as provided by the drawings and specifications)

Ground Snow: ______

Roof Snow: ______

Roof Live Load: ______

2nd Floor Live Load: ______

Wind: ______

Seismic: ______

Material Properties/Structural Properties (as provided by the drawings and specifications)

Concrete Strength: ______

2nd Floor Concrete: ______

Structural Steel: ______

Bracing: ______

Roof Deck: ______

Floor Deck: ______

Anchor Bolts: ______

Equipment:

Cranes: ______

Mechanical: ______

Electrical: ______

Additions: ______