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MECHANICAL AND HYDRAULIC
SNUBBERS FOR NUCLEAR
APPLICATIONS

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U. S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY PROGRAMS

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		<p>Revisions were primarily editorial. Definitions are now alphabetized and all applicable codes and standards have been revised to list all those in the body of the standard, and other references now appear in a new Appendix X2.</p> <p>Use of this standard, coupled with the Nuclear Regulatory Commission "Draft Regulatory Guide SC-708-4" and the "ANSI/ASME OM4" standard, should result in a consistent approach to the construction of components that utilize snubbers. This, in turn, will lead to reduction in costs and schedules.</p>	
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FOREWORD

This standard was developed primarily for application in the U.S. Department of Energy (DOE) nuclear energy programs. It is one of a series of nuclear energy program standards developed under a "limited coordination" procedure designed to achieve a technical coordination among individuals of recognized authority from affected DOE programs in a relatively short period of time and, where appropriate, from suppliers, purchasers, users, and technical experts. The procedure utilizes a writing group to prepare the standard and a technical review committee to provide a formal review and comment. Participants in the writing and review of this standard are listed below.

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MECHANICAL AND HYDRAULIC SNUBBERS FOR NUCLEAR APPLICATIONS

1. INTRODUCTION

1.1 Scope. This standard covers the material, design, analysis, application, fabrication, testing, examination, quality assurance, certification, delivery, installation and inservice inspection of safety-related hydraulic and mechanical shock suppressors (snubbers) for nuclear reactors.

These devices permit thermal expansion motion of components during normal plant service, but provide restraint to dynamic loads.

1.2 Applicability. This standard applies to all (Seismic Category I) snubbers which otherwise would be classified as American Society of Mechanical Engineers (ASME) Section III, Division 1, Class 1, 2, 3, or MC component supports, including supports required to restrain high-temperature components which are designed and manufactured in accordance with the requirements of the ASME Boiler and Pressure Vessel Code (hereinafter referred to as the Code), Section III, Nuclear Power Plant Components, Division 1.

A complete shock suppression support assembly might include: an attachment between component being restrained and one end of the snubber; an attachment between the other end of the snubber and an anchor such as structural steel of a building; and any hardware or extension members needed to make these connections. The support assembly shall be constructed to the requirements of ASME, Subsection NF applicable to the Code Class of the component being supported. Any items which affect the adequacy of the load transfer mechanism should be considered in the design of the assembly and some guidelines are given in this standard. However, this standard focuses on the snubber and its performance.

This standard does not address the adequacy of the component (vessel, pipe, pump, or valve) or intervening element to sustain the gross or local deformations due to the type of loadings encountered. For example, the interaction of snubber and pipe cross-section should be evaluated. If there is an intervening element, there shall also be a component support or means of attachment constructed to the requirements of Subsection NF in the component support load path.

1.3 Definitions. The definitions included here are intended only to furnish clarification of the subjects mentioned and are neither detailed nor complete.

(a) Acceptance Test. A test to monitor the adequacy of the manufacturing process and quality assurance program to ensure that each finished snubber will function as specified.

(b) Activation Level. The activation level is that velocity or acceleration at which free motion of the snubber actuator or piston ceases and restricted motion begins. Some snubber designs do not have a distinct activation level.

(c) Anchor. A rigid restraint providing substantially full fixation (permitting neither translatory nor rotational displacement of the attached structure on any of the three reference axes).

(d) Breakaway Force. Is the minimum applied force required to begin extension or retraction of the snubber in its motion mode. This quantity is often specified as a percentage of the rated load of the snubber.

(e) Component Standard Support. A support assembly consisting of one or more units usually referred to as catalog items and generally mass produced.

(f) Construction. The all inclusive term comprises material, design, fabrication and installation, examination, testing, inspection, and certification required in the manufacture and installation of component supports.

(g) Constructor. The organization which contracts to build the facility, including installing the component supports (snubber).

(h) Dead Band. The dead band is the extent of free axial movement of the snubber when changing from compressive to tensile loading. It includes the installation clearance, the manufacturer's mechanical clearance and the additional movement accommodated by the snubber under loadings before the activation takes place. It is therefore a function of the installation, manufacturing process, interaction of the applied loading, and activation level (Sec. 2.2.4 for detailed discussion).

(i) Drag. The drag is the frictional resistance of the snubbers to an axial movement at a given velocity before activation. The force required for initial axial movement, or the breakaway load, is the maximum drag at zero velocity. The drag force is normally specified as a percentage of the rated load of the snubber.

(j) Flexibility. For small deflection theory, the deflection produced by a unit load applied on the structure (snubber) in the direction of the loading.

(k) Integral Attachments. These attachments are welded to, or forged on, the component and include lugs, shoes, and rings which transmit loads induced by the component.

(l) Intervening Element. Those items not constructed to the rules of Subsection NF in the component support load path such as diesel motors, load-bearing insulation, electric motors, valve operators, and access structures.

(m) Linear Type Supporting Elements. Those that act under essentially a single component of direct stress, but may also be subjected to shear stress.

(n) Loads. See Section 3.2 for definition of possible loads.

(o) Nonintegral Attachments. These attachments mechanically connect to the component. There is a physical interface between the component and its support. These attachments include clamps, saddles or straps which transmit loads induced by the component.

(p) Owner. The organization which owns and operates the facility in which the component support (snubber) is used.

(q) Purchaser. The organization which contracts to have the vendor manufacture the component support (snubber). The owner may act as the purchaser; or he may subcontract these functions to another properly qualified organization.

(r) Qualification Test. A test to verify the functional capability of a specific snubber design and to demonstrate the ability of the snubber as constructed to perform properly in the operating environment.

(s) Release Rate. The axial velocity of snubber movement under a specified load after activation takes place.

(t) Spring Rate. This is a simplified expression of the load displacement relationship of the structure (snubber) under the action of a cyclically applied load in both tension and compression. This rate may vary as a function of the frequency and the magnitude of the applied load (Sec. 2.2.5 for detailed description).

(u) Swing Clearance. The movement envelope in which the snubber must operate without restriction, from the cold installed position to the hot operating position.

(v) Vendor. The organization which contracts to design and manufacture component supports (snubbers).

1.4 Applicable Codes and Standards. Where the term Code is used in this standard, this means the edition of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers as specified in the design specification for the system, component, support or all.

The following documents should be referenced in the design specification. Consideration should also be given to the reference documents in Appendix X2. Where the standard appears to conflict with the requirements of a reference document, such conflict shall be brought to the attention of the purchaser for resolution.

The issue of a document in effect on the date of the invitation to bid, including any amendments also in effect on that date, should apply unless otherwise specified. Under the rules of Section III of the Code, the owner or his designee shall establish the Code edition and addenda to be included in the design specification.

1.4.1 American National Standards Institute (ANSI).

ANSI/ASME NQA-1	Quality Assurance Program Requirements for Nuclear Power Plants
ANSI/ASME OM4-1982	Examination and Performance Testing of Nuclear Power Plant Dynamic Restraints (Snubbers)
ANSI/ASME N45.2.2	Packaging, Shipping, Receiving, Storage and Handling of the Items for Nuclear Power Plants
ANSI/ASME B46.1	Surfaces and Surfacing

1.4.2 American Society of Mechanical Engineers (ASME). The ASME Boiler and Pressure Vessel Code including applicable Addenda.

Section II Material Specifications

Section II, Part C, SFA 5.1, Specification for Covered Carbon Steel Arc Welding Electrodes

Section II, Part C, SFA 5.4, Specification for Covered Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Electrodes

Section II, Part C, SFA 5.9, Specification for Corrosion Resisting Chromium and Chromium-Nickel Steel Bare and Composite Metal Cored and Stranded Welding Electrodes and Welding Rods.

Section III Division 1, Nuclear Power Plant Components

Section XI Rules for Inservice Inspection of Nuclear Power Plant Components

Code Case N-71	Additional Materials for Component Supports Fabricated by Welding
Code Case N-122	Stress Indices for Integral Structural Attachments, Section III, Division 1, Class 1
Code Case N-249	Additional Materials for Component Supports Fabricated Without Welding
Code Case N-318	Procedure for Evaluation of the Design of Rectangular Cross Section Attachments on Class 2 or 3 Piping, Section III, Division 1
Code Case N-391	Procedures for Evaluation of the Design of Hollow Circular Cross-Section Welded Attachments, Class 1
Code Case N-392	Procedures for Evaluation of the Design of Hollow Circular Cross-Section Welded Attachments, Class 2 & 3

1.4.3 Nuclear Regulatory Commission Guides.

Reg. Guide 1.84	Design and Fabrication Code Case Acceptability ASME, Section III, Division 1
Reg. Guide 1.85	Materials Code Case Acceptability, ASME, Section III, Division 1
Reg. Guide 1.124	Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports
Reg. Guide SC-708-4	Draft Regulatory Guide, Qualification and Acceptance Tests for Snubbers Used in Systems Important to Safety, February 1981

1.4.4 U. S. Department of Energy (DOE) Nuclear Energy (NE) Standards.

NE F 3-6T	Nondestructive Examination (Supplement to ASME Boiler and Pressure Vessel Code, Section V)
NE F 7-3T	Marking of Components and Parts

1.4.5 Other Reference Documents.

American Concrete Institute - ACI 349

Steel Structures Painting Council - SP-10

MIL-C-81302b Cleaning Compound Solvent D, TCTFE

1.5 Approvals. The purchaser's design specification produced in accordance with Annex A1 of this standard shall define the desired levels of purchaser approval of vendor design calculations and drawings.

2. GENERAL SNUBBER DESCRIPTION

2.1 General Snubber Description and Function. Snubbers (sometimes called shock or sway suppressors) are devices which provide restraint to a component or system during a sudden application of force but allow essentially free motion during normal thermal movement. In general, snubber design parameters are based on system thermal expansion and dynamic analysis plus any other special restrictions defined in the component or system design specification. The snubber function is usually accomplished by hydraulic or mechanical means.

Snubbers must be capable of allowing movements of a component resulting from thermal expansion or operating vibration, but, at the same time, be capable of restraining that component in case of seismic disturbances and transient dynamic forces. In addition, they must allow for superposition of these two modes of motion, as for example, in the case of a dynamic displacement force followed by a rapid thermal transient motion in the same direction. For this condition the snubber must be designed to release at an adequate rate from the restraint mode to accommodate subsequent thermally induced motion.

2.1.1 Hydraulic Snubber Description. Hydraulic snubbers transmit dynamic loads by preventing fluid flow from one chamber to another. Under compression, the fluid exits from the chamber through a flow device and flows to an accumulator/reservoir or back to the piston chamber on the backside of the piston. The body of the snubber is securely anchored to the building structure or the supported component. Snubbers can have single- or double-ended piston rods, depending on the design.

The flow-restraining device is designed to restrict the fluid passages when the flow rate exceeds a given limit. In a typical design, this closure is accomplished with a poppet valve. Activation occurs when the force caused by the fluid flow exceeds the spring force and the valve seats. With the valve closed, travel of the piston is dependent on the compressibility of the fluid and the magnitude of the external force. When the force on the piston rods is removed, the pressure on the valve is relieved, and the spring-loaded poppet valve opens again, returning the unit to its normal condition. Another poppet valve prevents rapid flow of fluid in the opposite direction.

If there is a long-term loading on the piston rod, a slow pressure-relief capability is built into the snubbers. This might consist of grooves in the seating surface of the poppet valve or an auxiliary orifice. Very slowly, this allows the snubber to bleed off the pressure within the hydraulic cylinder and to relieve the force on the supported piping component. The bleed rate is variable, and the maximum travel of the piston is limited.

Hydraulic snubbers are of steel construction, with seals generally of polymeric material, and the hydraulic fluid is usually a silicone oil that has been selected for its resistance to temperature and radiation.

2.1.2 Mechanical Snubber Description. Mechanical snubbers adjust to thermal motions by telescoping freely under slow motions. They contain devices that activate when the telescoping action occurs quickly. A variety of mechanical devices (springs, ball screws, rotating masses, etc.) are used to permit the axial telescoping and to control the axial velocity or the axial acceleration.

The snubber controls the motion of the supported element by providing a restraint sensitive to rapid acceleration or velocity. Important features of release for different types of mechanical snubbers are described below.

2.1.2.1 Acceleration Controlled Snubbers. After activation acceleration is encountered, the acceleration type snubber will continue to displace at a low-level constant acceleration permitted by its braking system.

2.1.2.2 Arresting-Type Snubbers. After activation acceleration is encountered, the arresting-type snubber will assume the function as a rigid strut and restrain any further displacement. It is designed to deactivate and allow thermal motion in either direction once the force is removed. After its initial activation, care must be taken to ensure the mechanism will deactivate and allow free thermal expansion motion during all plant conditions. Consequently, most of the current applications for this type snubber are for pipe whip restraint functions where only one activation is postulated during the plant life.

Sometimes during normal operation (system thermal growth) the frictional characteristics of the snubber combined with the growth of the component produce a slip-stick phenomenon which at times causes snubber activation. The active state of the snubber may continue after thermal growth ceases as a result of friction loads and undesirable release characteristics. The snubber characteristics should permit transition to the inactive state.

2.1.2.3 Velocity-Type Snubbers. After the activation velocity is encountered, the constant velocity-type mechanical snubber will continue to displace at a specified constant velocity.

2.2 Performance Requirements. Snubbers are used to restrain dynamic responses. Ideally, under steady or nearly steady loading the component or system supported by snubbers will move freely as if the snubbers do not exist. However, when a force is applied suddenly the snubber acts to resist dynamic motion of the component.

Five performance (functional) parameters which may affect snubber operability are the activation level, release rate, drag, dead band, and spring rate.

2.2.1 Activation Level. The activation level is that acceleration or velocity (depending on the snubber type) at which free motion of the snubber actuator or piston ceases and restricted motion begins (where the free motion of the supported component ceases). Certain snubber designs do not have a distinct activation level.

2.2.2 Release Rate. The release rate is that velocity of snubber movement under load after activation takes place. Since dynamic response is much less sensitive to release rate than to activation level, the primary reason for controlling this parameter is to minimize thermal expansion stresses that are created as a result of system thermal growth after the snubber was in an active state (e.g., the actuation of a safety relief valve discharge line).

2.2.3 Drag. The drag is the resistance in the snubber against an axial movement at a given velocity before activation. The force required for initial axial movement, or the breakaway load, is the maximum drag at zero velocity. The drag or breakaway loads are present in all snubbers and depending on the particular design, may be caused by sliding or rolling friction of components or viscous characteristics of fluids. Snubber drag loads are generally expressed as a percentage of rated load. Since restraint of free thermal growth can produce significant stresses, minimizing the drag is desirable.

During long periods of inactivity and long periods of vibrations, at or below the snubber's normal activation level, the breakaway loads associated with the snubber may increase to values much larger than the rated drag load. Since increased snubber drag or breakaway loads can have a significant effect on normal operating conditions (thermal expansion effects), placement of snubbers should be based on these considerations in addition to dynamic requirements.

2.2.4 Dead Band. Dead band should be kept to the minimum needed for good assembly practices. Larger values of dead band may significantly increase the impact loads on the snubber mechanism and affect the dynamic response of the supported system. However, one advantage to a larger "dead band" is that higher pipe vibration may be accommodated without unwanted activation of the snubber.

2.2.5 Spring Rate. The spring rate is a simplified expression of the load-displacement characteristics of the restraint system. The definition of spring rate has been extended to include the combined stiffness of all hardware including, but not limited to, clamps, extension tubes, end-fitting hardware, and piping cross section. The spring rate may vary as a function of the frequency and the magnitude of the applied load.

As an outgrowth of current design practice, the overall stiffness of the snubber assembly is often not controlled by the snubber stiffness but rather by the stiffness of associated hardware such as clamps, pins, extension tubes, etc. Accordingly, for evaluating overall snubber assembly stiffness, the method selected for evaluating snubber stiffness (frequency or nonfrequency dependent) may have minimal effect on calculated overall stiffness.

2.3 Attachment Requirements. The design specification shall define the jurisdictional boundaries of the component support. The snubber shall be attached to the building structure by structural attachment and at the component by a pipe clamp or other special component attachment. Appendix X1, Section X1.2.2, describes the stiffness requirement that should be considered during design.

2.3.1 Structural Attachments. The welds or bolts attaching the structural attachments to the building structure shall meet the requirements of Subsection NF of the Code.

Concrete expansion anchor bolts shall meet the requirements of ACI-349 - Appendix B.

The jurisdictional boundary shall be specified in the design specification for each design application.

Several examples of determining the jurisdictional boundary between building structure and the component support are given in Fig. NF-1131-1 of Subsection NF of the Code.

2.3.2 Component Attachments. For nonintegral attachments of component supports to the components, the jurisdictional boundary between the component and the support shall be the interface surface. Examples of jurisdictional boundaries for both integral and nonintegral attachments of supports to components are shown in Fig. NF-1131-1 of Subsection NF of the Code.

The weld attaching the support to the component and the integrally attached material fall within the jurisdiction of the component and not the component support. This is especially important when considering fracture toughness and nondestructive examination requirements. Code Cases N-122 and N-318 contain procedures for the evaluation of design of attachments on Class 1, 2, and 3 piping, while Code Cases N-391 and N-392 cover hollow circular cross-section welded attachments.

Precautions to ensure axial retention of the attachment should be provided if the snubber is not normal to the pipe or component longitudinal centerline. In addition, local stresses within the attachment and component shall be considered. These loading conditions shall consider extremes of snubber swing angle and applicable clamp preloaded (if applicable).

When the snubber line of action is offset from normal to the pipe center line by more than 5 degrees, trunnion attachments, integral attachments, or shear lugs adjacent to the clamp shall be installed on the pipe or component unless analysis or test indicates that the installed clamp will maintain position under dynamic conditions.

Consideration shall be given to the temperature effect on the snubber unit.

2.4 Installation Requirements. Snubber location, tolerance(s) and jurisdictional boundaries shall be clearly defined on the construction drawings.

The preinstallation storage conditions shall be described in the design specification and the purchase documentation. Storage and handling shall be in accordance with ANSI/ASME N45.2.2. Section 6 of this standard defines the storage and handling, installation procedures and location and tolerance requirements.

Snubber installation procedures shall include the following.

- (1) Installation in accordance with manufacturer's instructions.
- (2) Installation at the point in the system as specified by the installation requirements. Location tolerances should be specified in the piping or component drawings.
- (3) The line of action and swing clearance as specified by the installation requirements, including tolerances.
- (4) The hot and cold position of the actuator or travel.

Each snubber installation shall be shown on an approved drawing for use in inspection and replacement. The drawing shall, as a minimum, indicate the snubber location, type, size, stroke, and correct cold and hot settings to assure that the snubber will be at the desired position when the pipe is heated up.

Snubbers should be accessible for maintenance and inservice inspection. Snubber attachments should not unnecessarily obscure regions, such as pipe welds, subject to inservice inspection.

2.5 Material Requirements.

2.5.1 General. Materials for all items other than those exempted per 2.5.6 shall conform to Subsection NF and applicable Code Cases for the specific Code Class. Use of Code Cases must be submitted to owner for approval prior to use. In addition, Reg. Guides 1.84 and 1.85 contain restrictions which should be reviewed.

2.5.2 Documentation. Certificates of Compliance or Certified Material Test Reports shall be submitted to the owner. These shall include impact testing procedures and acceptance criteria where required by the design specification.

2.5.3 Marking Materials. Materials used for marking parts and assemblies shall be in accordance with NE F 7-3.

2.5.4 Impact Testing. If impact testing of materials is required by the design specification, it shall be in accordance with Code Subsection NF.

Primary load-bearing parts fabricated from ferritic materials shall be sufficiently ductile to permit safe handling at any temperature expected in service. Assurance that this requirement is satisfied shall be provided by the supplier as follows.

The material and welds shall meet the impact test requirements listed in NF-2300 of the Code at the lowest temperature specified.

2.5.5 Weld-Filler Materials. The selection and testing of weld-filler materials shall be in accordance with Code Subarticle NF-2000. Shielded metal arc welding of carbon and low alloy steels shall be performed using low hydrogen electrodes conforming to ASME SFA 5.1. Welding of austenitic stainless steel shall be performed using electrodes conforming to ASME SFA 5.9 or SFA 5.4. Dried electrodes shall not be used if exposed to ambient conditions for more than eight hours. These requirements or vendor-proposed alternatives are to be a part of the vendor's welding procedure.

2.5.6 Exemptions. The requirements of 2.5.1 through 2.5.5 do not apply to seals, springs, hydraulic fluids, wear shoes, lubricants, retaining rings, and bearings. The materials for these items shall be compatible with other materials used in construction of the snubbers. They shall not adversely affect snubber performance during the environmental conditions (temperature, humidity, radiation, etc.) given in the design specification. The vendor's drawings submitted for approval shall show the specifications applied to seals, etc., used for purchase and maintenance of materials for these non-Code items.

2.6 Maintenance Requirements. Maintenance activities that may affect the performance of the snubber to satisfy its intended function shall be completed in accordance with written procedures. The manufacturers shall specify those maintenance requirements needed to keep the snubber operable.

Methods for determining that maintenance and inspection can be reasonably performed must be called out in the design specification. An example of this is a means of determining that the proper fluid level for a hydraulic snubber can be maintained.

2.7 Testing Requirements. All snubbers that are constructed to the rules of Subsection NF shall have testing requirements. Snubber qualifications may include load-rating tests. Testing shall be performed to determine the mode of snubber failure. The mode of failure or item which fails first shall be defined by the snubber manufacturer. The snubber manufacturer shall submit its generic Qualification Test Program and Acceptance Test Program for approval.

This section describes the minimum functional and dynamic tests that must be performed. The tests shall be conducted in a manner to demonstrate that all parts of the assembly are capable of fully satisfying design requirements at all combinations of loading and environment. As a minimum, the unit shall be completely disassembled after all qualification testing is completed and examined for any conditions which might lead to premature failure to meet design requirements. This includes operational vibrations in the piping, seismic, or both loadings. If further testing is required, the purchaser shall review and approve the test program and procedures prior to conducting the additional tests. The results of the qualification tests shall be used to establish criteria for acceptance tests.

Records of testing shall be prepared and maintained in accordance with Section 5.3 of this standard.

2.7.1 Qualification Tests. The qualification of a snubber design shall be conducted by using a minimum of two prototypical units or two units randomly selected from the production line of the same design and rating. The design shall be qualified only when both units have passed the requirements set forth below. In the event that one or both units fail the requirements, the cause of failure shall be determined. The design shall then be revised according to the results of the failure analysis before it is again tested for qualification. Units used for qualification testing shall not be supplied as part of the purchased number of snubbers.

The qualification plan for functional parameters for snubbers shall, as a minimum, contain the following information.

- (1) Snubber descriptions and specifications
- (2) Snubber sampling requirements
- (3) Material data requirements
- (4) Mounting requirements
- (5) The aging simulation requirements
- (6) The service condition simulation requirements

- (7) Functional parameters and environmental variables to be measured.
- (8) Test and monitor equipment requirements.
- (9) The test sequence.
- (10) Special tests.
- (11) Limits or failure definition for the test.

Draft Reg. Guide SC-708-4, Appendix B, shall be used as a guide for the development of the qualification test plan and documentation required.

2.7.2 Acceptance Test. Every snubber shall be subjected to a final function test by the manufacturer to verify acceptability of the unit. Test data shall accompany the snubber shipment. Acceptance tests shall be conducted at ambient conditions at the vendor's facility. The capability of each design and size is to be demonstrated by the following.

- (a) Verify that the snubber operates freely over its total stroke.
- (b) Verify that the force required to initiate motion in either direction at any stroke extension is within acceptance limits.
- (c) Verify that the dead band, activation level and release rate are within acceptance limits.
- (d) Verify that all dimensions and manufacturing details on approved drawings have been met.

The acceptance test plan shall contain the following as a minimum.

- (1) Snubber description and specifications.
- (2) Manufacturing data.
- (3) Mounting requirements.
- (4) Functional parameters to be measured.
- (5) Test and monitor equipment requirements.
- (6) Test sequence.
- (7) Limits or failure definition for the test.

Draft Reg. Guide SC-708-4, Appendix C, shall be used as a guide for the development of the acceptance test and documentation required.

3. DESIGN AND ANALYSIS

3.1 General. Appendix XI contains nonmandatory guidelines which the analyst and designer may use for developing the theoretical models required to evaluate systems and components. Some parameter ranges described in Appendix XI may be considered as too restrictive relative to actual construction requirements and capabilities.

3.2 Definition of Loads. Loads acting on snubbers shall be evaluated for the purposes of 1) selecting snubbers; 2) providing guidance for snubber placement; 3) establishing structural integrity of components and support assemblies; and 4) ensuring operability during anticipated plant operational modes.

3.2.1 Thermal Movement. Anticipated thermal expansion movements shall be identified for potentially significant plant operating conditions (as a minimum, design motions shall be specified) for the purpose of 1) providing basis and usage for snubber usage; 2) defining stroke and clearance requirements (pipe whip restraints); 3) providing guidance for snubber placement; and 4) identifying special requirements resulting from thermal expansion combined with snubber activation.

3.2.2 Seismic. Seismic loadings shall be identified and evaluated for the purposes of 1) providing justification for snubber usage and placement; 2) identifying snubber response characteristic requirements (frequency, lost motion, stiffness, etc.); and 3) establishing load-rating requirements.

3.2.3 Operational Vibrations. Normal operating vibration loads such as those created by pumps, fluid flow, valve opening or closure, or any other sources shall be identified to establish fatigue requirements for snubbers. The number of cycles of loading, amplitude range and frequency shall be established for all snubber locations.

3.2.4 Impact Loads. Impact loads produced by steam and water hammer, pump start-up and shutdown, or other applicable dynamic loads on the component to which the snubber is attached shall be considered for the purpose of 1) justification of selection and placement; 2) establishing load requirements; and 3) establishing fatigue requirements, if applicable.

3.2.5 Pipe Whip. Pipe whip loads are based on postulated pipe breaks using appropriate criteria. Pipe whip loads are identified and evaluated for the purpose of 1) establishing snubber selection and placement, and 2) sizing supports.

3.2.6 Seismic Anchor Displacement. Since the relative displacement of the supported structure and its supported building structure affect the input loads to the system, dynamic interaction loads resulting from structural response shall be considered for the purpose of identifying true support loading.

3.2.7 Combined Loading Effects. Combinations of loadings presented in 3.2 shall be considered when a combination of events identified as part of plant operation cause combined loadings. Conditions such as lockup during a thermal transient and seismic disturbance, valve discharge during an earthquake, or others shall be considered.

3.3 Code Evaluation. Meeting the requirements of the Code, Subsection NF, for the snubber assembly including clamps, end-fitting hardware, transition tubes, etc., helps assure the structural integrity of component supports (snubber) but it may not assure the functional or operability requirements. These requirements for operability should be specified and met as defined in Annex A1.

3.3.1 General Design Requirements. There are three alternative design procedures which may be used for demonstrating acceptability of supports constructed to Subsection NF of the Code.

- (1) Design by analysis
- (2) Experimental stress analysis
- (3) Load rating

The evaluation of the support for the Design, Service Levels A, B, C, and D loadings shall be in accordance with Subsection NF of the Code.

3.3.1.1 Design of Class 1 Supports. Subsection NF of the Code considers three types of supports.

- (1) Linear Type
- (2) Plate and Shell Type
- (3) Standard Supports

The requirements for design of the type of support chosen are contained in Subsection NF of the Code.

In addition, restrictions for the design and analysis of Linear-Type supports shall include the following.

- (1) Addition of a tensile stress limit on all stress limits and using the lower allowable value of $0.5S_u$ or KS_y (K as defined in NF 3000).
- (2) Further limits on bearing stresses, stress range, and buckling strength which are needed to assure operability.
- (3) Elimination of the increase of allowable stresses for bolted connections and shear stresses when evaluated for Service Level C.

- (4) Compressive loads for Service Levels C and D events shall be limited to two-thirds the critical buckling load at temperature.
- (5) Rederivation of equations containing constants based on material properties which vary as a function of temperature [such as Young's Modulus (E), where E at service temperature is substantially different].
- (6) Thread-stripping shear shall be limited to 0.45 times the yield strength of the material for design and Service Levels A and B loadings.

3.3.1.2 Design of Component Support Bolts. The number and cross-sectional area of bolts required for the design condition specified are determined using the procedures of Subsection NF of the Code.

Additional bolting-design requirements are given in Reg. Guide 1.124, including various edge distance limitations and spacing requirements.

3.3.1.3 Design of Component Support Welded Joints. The permissible types of welded joints shall be limited to those contained in Subsection NF of the Code. The allowable stress limits are set forth in NF-3000 (Appendix X2).

The permissible type of welded joints used in component standard supports and connectors shall be as described for plate and shell or linear-type supports, as applicable. Temperature differences between the component and its support and, where applicable, expansion or contraction of a component produced by internal or external pressure, shall be considered.

3.3.1.4 Design of Class 2 and Class MC Supports. Rules presented in NF-3300¹, and NF-3250, 3350, 3450, 3550, and 3650² for the design of plate and shell-type, linear-type, and component standard support type Class 2 and MC supports.

For plate- and shell-type supports, the stresses due to weight and other sustained loads shall not exceed the allowable stress S for membrane stresses and 1.5 S for membrane plus bending stresses.

Bolting design for these components shall be in accordance with NF-3225². Class 2 and MC support welds and joint designs are slightly less restrictive than for Class 1 supports and shall be in

¹For constructions to the 1980 Edition of the Code up to and including the Summer 1982 Addenda.

²For constructions after the 1982 Summer Addenda of the Code.

accordance with NF-3426³. Specifically, weld for groove-welded T-joints, groove-welded corner joints, and fillet-welded T-joints may be intermittent instead of continuous.

3.3.1.5 Design of Class 3 Supports. Class 3 supports shall be designed in accordance with Subsection NF of the Code, using procedures for Class 2 supports. Allowable stresses to be used with a specific design procedure are as stipulated in Table NF-2121(a)-1. Welds and joint designs shall be in accordance with NF-3426³.

3.3.2 Service Level D Analysis. Appendix F of the Code provides general procedures applicable to components, and additional specific requirements, which may limit the applicability of the general rules. The severity of the postulated event for which Level D is applicable is such that limits need be placed only on primary stresses, so fatigue is not considered. However, compressive stability under static or dynamic conditions must be in accordance with paragraphs F-1370⁴ (NF-1332, 1333, and 1334)⁵.

3.3.3 Supplemental Criteria. The owner when preparing the design specification may require the use of alternative or supplemental criteria to assure the safety of the system.

4. FABRICATION REQUIREMENTS

4.1 Fabrication Procedures. Documents outlining fabrication operations shall be prepared and submitted as described in Sec. 5.1.

4.2 Resistance to Corrosion. Manufacturing operations shall not reduce the compatibility of materials in the snubbers with the environment described in the purchaser's design specification (Annex A1, also Sec. 2.5).

4.3 Fabrication Requirements.

4.3.1 General. All fabrication operations shall be in accordance with Code Subsection NF-4000, Code Cases N-71, N-249, and this standard. Where the materials or requirements to be employed in the manufacture of any part are not identified in this specification or a reference document, or the specification appears to conflict with a reference document, or the vendor takes exception to a specified material or requirement, the vendor shall submit his proposed material selections or requirements with supporting technical justification for purchaser approval prior to use.

³For constructions after and including the Winter 1982 Addenda.

⁴For constructions to the 1983 Edition of the Code and earlier.

⁵For constructions to the 1983 Summer Addenda of the Code and later.

4.3.2 Techniques. The vendor shall furnish with the procedures required by 4.1 sufficient technical documentation to prove the adequacy and feasibility of any new or unusual adaptations of established commercial manufacturing processes. This documentation shall serve as qualification of the process for the specific operation.

4.3.3 Machining. All machining operations, including cutting, bending, or forming, shall be in accordance with Code Paragraph NF-4210.

4.3.4 Welding. Welding procedures and qualifications shall be in accordance with the Code NF-4300 and Code Cases N-71 and N-249, as applicable. The vendor shall be responsible for satisfactory performance of all welding and weld qualification testing.

4.3.5 Heat Treatment.

4.3.5.1 Materials. All austenitic stainless steel shall be solution annealed and must meet the mechanical properties required by this standard. No other heat treatment will be required prior to manufacturing.

Ferritic materials may be heat treated (Code paragraph NF-2170) to enhance their impact properties. All heat treatment performed after receipt of the material by the vendor shall be in accordance with the written and qualified procedures.

Fracture toughness tests are required on structural materials used in supports for components which have been tested for fracture toughness unless the exemptions of the Code, Subsection NF, paragraph NF-2300 are applicable.

4.3.5.2 (b) Requirements of Thermal Cutting, Preheat, Interpass, and Post-Heat of Welds. All heating and cooling used during fabrication shall be in accordance with the Code.

- (1) The minimum preheat temperature shall be 60°F (15.6°C). This value also applies to any tack welding, flame or carbon arc-cutting.
- (2) For austenitic stainless steels, the maximum interpass temperature shall be 350°F (177°C).
- (3) The vendor's procedure must be qualified if post-weld heating is required.
- (4) A minimum of 1/8-in. (3.2 mm) material must be removed by machining following any thermal cutting or arc-gouging, except for low carbon, low hardenability steels. The 1/8 in. minimum material removed shall not be for materials with low hardenability if the purchaser approves.

4.3.6 Surface Finish. The vendor shall select fabrication processes to give the following minimum surface finishes.

- (1) Mating surfaces: 63 microinches or better. For sliding or rolling mating surfaces, a finish of 16 microinches or better may be required. The vendor drawing shall note the surface finish needed on each part to insure proper performance of the snubber.

NOTE: Surfaces of 16 microinches or better may be required if the design requires relative motion.

- (2) All other surfaces: 250 microinches or better.
- (3) Arc-strikes shall be removed by repair grinding and/or repair welding, if necessary.

Surface finish shall be determined in accordance with ANSI/ASME B46.1.

4.3.7 Repair by Welding. Repairs of base materials shall be in accordance with Code paragraph NF-2500. Welders and procedures to be used shall be qualified in accordance with Code paragraph NF-4000 for the process proposed.

4.4 Fabrication Cleanliness.

4.4.1 Requirements.

4.4.1.1 Acceptance Criteria for Cleanliness. Components submitted for final inspection shall be clean to the extent that no contaminants such as debris, shop dust, metal oxides, etc., are visible without magnification to a person with normal visual acuity; natural or corrected. The cleanliness of the surfaces shall be evaluated by wiping with a clean lint-free, unbleached cloth, either dry or moistened with technical-grade alcohol or acetone. A residual film is not permitted.

4.4.1.2 Rust on Stainless-Steel Surfaces. Rust and/or pitting are not acceptable on stainless-steel surfaces, and the cause of the rust shall be determined before proceeding with fabrication.

4.4.1.3 Cleaning of Surfaces to be Welded. All surfaces to be welded shall be prepared by a machining or grinding operation. The surfaces shall be free of all scale, foreign materials, lubricants, marking materials, or cleaning compounds.

4.4.1.4 Temper Film. Irridescent temper films, resulting from heat treatment and tightly adherent black oxide films that occur on the backside of welds, need not be removed.

4.4.1.5 Sensitized Stainless Steel. Austenitic stainless steel, which has been sensitized by exposure to temperatures of 800°F (427°C) to 1600°F (871°C), shall be re-solution annealed.

4.4.1.6 Heating. All surfaces subjected to temperatures above ambient during manufacturing shall be clean prior to heating.

4.4.1.7 Use of Lubricants. A cutting lubricant may be used during fabrication operations provided that the lubricant is fully removed after completion of all operations. The cutting lubricant must not be allowed to contact areas which cannot subsequently be cleaned; e.g., bolted joints.

Threaded, machined, and sliding surfaces shall be thoroughly lubricated as required prior to shipment. The general composition of lubricants must be approved by the purchaser. The vendor is to provide data to demonstrate the lubricant's satisfactory resistance to deterioration under the snubber service conditions.

4.4.2 Cleaning Processes.

4.4.2.1 Mechanical Cleaning. Mechanical cleaning tools such as grinding, polishing, filing, deburring, and brushing tools shall be clean and shall not have been used on aluminum, copper, lead or materials containing lead or lead compounds, or other low-melting-point materials. One set of tools, not previously used on carbon or low alloy steels, shall be used on stainless steel only.

Power-operated brushes shall not be used in cleaning areas that later will be liquid penetrant inspected unless that area is ground or machined prior to the inspection.

4.4.2.2 Abrasive Blasting. Abrasive blasting shall be used only when approved by the purchaser. Surfaces subjected to abrasive blasting shall be ground or machined, and examined by the liquid penetrant method.

4.4.2.3 Degreasing Requirements. Degreasing shall be accomplished using technical-grade acetone, alcohol, MEK, or TCTFE per MIL-C-81302b.

4.4.2.4 Detergent Cleaning. Austenitic stainless-steel surfaces containing no crevices and which are fully accessible and drainable may be cleaned with trisodium phosphate or other detergents approved by the purchaser. Detergent cleaning of ferritic steels by usually commercial practices is allowed.

4.4.2.5 Acid Cleaning. Acid cleaning shall be performed only with purchaser approval of procedures and application prior to use.

4.4.2.6 Drying. Drying, after completion of final cleaning, may be done by using still or forced, clean, dry, oil-free air or gas, in an oven, or by evacuation.

4.5 Protective Coatings.

4.5.1 Surfaces to be Coated, Vendor Procedure and Sketch. Except for stainless-steel members, all exposed parts except threaded, machined, and sliding surfaces shall be plated or painted to resist corrosion. Included in the vendor's procedure shall be descriptions of all cleaning methods and identification of the plating or paint to be used. The procedure shall also include a sketch of the apparatus showing which surfaces are to be top coated by the vendor.

4.5.2 Steel Surface Painting. Prior to application of a coating, the surface shall be prepared in accordance with SSPC Standard SP-10 to provide an anchor profile of 1 to 2 mils depth.

The primer and top coats shall be epoxy polyamide or approved alternate.

On all steel parts which are to be welded during installation, the weld preparation and the area within 2 in. of the weld are to be prime-coated by the vendor with "Deox-aluminate" (made by Special Chemicals Corp., Ossining, NY) or purchaser-approved alternate.

5. QUALITY ASSURANCE

5.1 Quality Assurance Program. The vendor and subcontractors shall establish, implement and maintain a quality assurance program in accordance with ASME Code Section III, NCA-3800, NCA-4000, NCA-5000 and NQA-1, Sections II-2, 7, 8, 9, 10, 11, 12, 13, 14, 15, and 17. The vendor shall assure that his design, fabrication, processing, examination, test and inspection activities are planned and conducted in accordance with procedures, instructions, checklists or other appropriate documented methods.

5.2 Qualifications. Personnel and procedure qualifications shall be in accordance with the requirements of the Code NF-5500 and this standard.

5.3 Records and Certifications.

5.3.1 General. Procedures for examination and testing must make provision for permanent documentation of results of all operations, tests, examinations and inspections identifiable to individual, serialized snubber (or parts).

Records must be maintained in accordance with Section III of the Code.

5.3.2 Nonconformances. Nonconforming items shall be dispositioned in accordance with the approved quality assurance program. All reports of nonconformance to Code requirements shall receive the authorized inspector's signed concurrence prior to submittal to the purchaser.

Nonconformance reports shall be maintained as part of the permanent records of the subassembly.

5.3.3 Certifications. A certificate of load-carrying capacity and minimum dynamic stiffness shall be furnished for each snubber. It shall be in the form of either a Certified Design Report in accordance with NCA-3550 of the Code, which will be reviewed by purchaser in accordance with NCA-3260 or a Certified Load-Capacity Data Sheet. The vendor shall prepare and submit Code Data Report Forms per NCA-8410 to cover each snubber (Sec. 3.3).

5.4 Marking and Identification. Traceability must be maintained throughout the entire life of the parts and assemblies. Optimum use shall be made of vendor's established model and part number systems. However, each assembly and separable part must be identifiable to permanent quality assurance records.

Materials used for marking shall be in accordance with Sec. 2.5

5.5 Examination.

5.5.1 Visual Examination.

(a) All parts and assemblies, including welded joints and repair welds, shall be visually inspected for compliance with the Code. Minor dents, scratches and gouges shall be faired out to a smooth surface so long as the minimum allowable dimensional requirements are met.

The smoothness of the finished surfaces shall be suitable for the proper interpretation of nondestructive examinations. Surface roughness is to be determined by visual comparison with a known standard.

(b) Butt welds shall have full penetration, completely filling the joint, and shall have no undercut. The purchaser shall specify all allowable limits of weld reinforcements. Each weld shall be uniform in width and size throughout its full length.

5.5.2 Nondestructive Examination. All nondestructive examinations shall be performed according to qualified procedures conforming to the requirements of NF-5000 of the Code and NE F 3-6T. Acceptance standards for these examinations shall be as given by NF-5300 of the Code.

5.5.3 Dimensional Control. Each completed part and assembly shall be measured and shown to be within the limiting dimensions of its approved drawings (Sec. 1.5).

5.6 Testing Requirements. The vendor shall perform qualification and acceptance testing and calibration in accordance with the Code and this specification before delivery. Modifications, repairs, and replacements made after completion of tests shall be subject to retest.

5.6.1 Procedures. The vendor shall provide procedures, instructions, and checklists that clearly describe the operations to accomplish the specified tests for completed subassemblies.

The criteria for acceptance shall be listed as an integral part of each procedure. All characteristics required to be reported by the Code, this standard or the purchase order shall be examined and the results recorded on drawings or other appropriate documents.

5.6.2 Qualification Tests. The vendor shall provide data from a qualification test of at least one of each size and type of snubber and use these data to certify the Load Capacity Sheet. This testing shall have been performed in accordance with Sec. 2.7.1.

5.6.3 Acceptance Tests. The vendor shall test each snubber as outlined in Sec. 2.7.2.

6. INSTALLATION

6.1 Storage and Handling.

6.1.1 Storage areas at the vendors facility or at the construction site shall meet the requirements of ANSI/ASME N45.2.2, Sec. 6.1.2, Level C as a minimum.

6.1.2 Each snubber made to this standard shall be cleaned, packaged, and packed to assure delivery in a clean, undamaged condition.

6.1.3 Design of packaging, packing, and provisions for storage shall be based on a maximum of two years in storage with no effect on snubber performance.

6.1.4 Lifting and handling devices used during shipping, storage, and installation shall have concurrence of vendor, purchaser and constructor that they minimize the hazard of physical damage from, any design-basis accident.

6.2 Installation Procedure.

6.2.1 Responsibilities. The vendor shall define limits and precautions which govern installation. The constructor shall prepare

and use written installation procedures which define mandatory sequences of operations; cleanliness control; quality assurance checks and hold points; safety precautions; and records to be maintained per this standard and all supplemental project requirements. The constructor shall obtain purchaser and owner concurrence on these procedures. Information from vendor operation and maintenance manuals (Sec. 6.4) shall be included in the constructor's procedure.

The constructor's quality assurance group shall verify that the installation is completed within the dimensional and technical specifications defined by this standard, subsidiary documents and drawings.

6.2.2 Cleanliness. Throughout shipping, storage and the entire plant construction period, the snubbers and all attachments shall be maintained per Sec. 4.4.1 and all supplemental project requirements. During installation of adjacent components, the snubbers shall be protected to maintain the proper level of cleanliness.

6.2.3 Welding. Welding directly onto the finished snubber mechanism is not permitted. For example, any welding on struts which attach the snubber mechanism to component or support must be done with the mechanism removed or fully isolated electrically and thermally.

6.2.4 Operations Before Installation.

6.2.4.1 Examination of Snubber Mechanism. Each snubber mechanism shall be visually examined before assembling extension struts and other hardware connecting to it. At this time the snubber shall be manually moved twice through its full travel. Any extraneous noises such as "grinding" or "rubbing"; and any measured, sudden change in frictional resistance during travel in either direction shall be brought to the attention of the owner.

6.2.4.2 Assembly of Snubber and Extensions. Extension struts, brackets and any other hardware needed to complete the installation to suit design documents shall be attached as specified by the snubber designer; by welding, bolting or combination. All threaded fasteners shall be mechanically locked in their final position in accordance with NF-4725.

6.2.4.3 Dimensional Control of the Assembly.

(1) After final assembly with its load-carrying extensions, each snubber shall be shown to meet the installation tolerances of Sec. 6.3 and the travel requirements of Sec. 6.2.4.3(2).

(2) Prior to installation each snubber shall be demonstrated to have enough linear movement available to permit movement of the

component relative to the support structure over the range from length-at-installation conditions (set point) to the maximum potential movement during plant operations. At least 1/2-in. (12.7 mm) additional motion shall be available at either end of the travel. The tolerance on the set point shall be $\pm 1/8$ in. (3.2 mm).

Note that the measurement of travel from set point must include consideration of potential for both snubber extension and contraction depending on the selection of installation and service loading conditions.

(3) The relative angular variation between the two mounting pins at the ends of the snubber assembly shall not be more than 5 degrees from the value used for design analysis (Sec. 6.3). In addition, freedom of movement of the snubber from cold to hot positions must not be impaired.

6.2.5 Installation. Actual attachment of the snubber to the component and support structure shall follow the detail procedure prepared in response to Sec. 6.2.1.

6.3 Location and Tolerances.

6.3.1 Snubbers shall be installed only at the locations designated in the approved component support-system drawings, certified stress report and other design documents appropriate to the project.

6.3.2 Each snubber shall be attached to the component it protects; and the other end of the snubber shall be attached to a stationary member of the structure supporting the component. Both the component and all attachments shall satisfy the requirements of Sections 2 and 3 of this standard, and shall meet the following installation tolerances.

6.3.2.1 Location. For piping, each clamp and structural attachment shall be within the lesser of 6 in. or one nominal pipe diameter of its planned location on the system design and analysis plan. The design orientation shall be maintained. For all other dimensions, tolerances shall be as shown on the approved design layout drawings.

6.3.2.2 Load/Snubber Alignment. Loads shall be imposed axially on the snubber within the tolerance established by the vendor. The effects of manufacturing and maximum allowable field location tolerances, including eccentricity and angular misalignment, should be included in the design process.

6.4 Operational and Maintenance Manual.

6.4.1 Scope. This section sets forth requirements for the preparation of an installation, operation and maintenance (O&M) manual by the vendor. Purchaser approval of all O&M manual information is required.

6.4.2 General Equipment Information. The manual shall contain a section of general information that will enable the user to easily and rapidly determine the physical and functional characteristics and the operational limitations of the equipment. This shall include: function, principles of operation, size, weight, list of parts, drawings or photographs, design operating data, and warranty.

6.4.3 The manual shall include vendor instructions for the following.

- (1) Handling
- (2) Packing, preservation, and unpacking
- (3) Transportation to the site
- (4) Receipt inspection, storage, and maintenance in storage
- (5) Installation and adjustments
- (6) Behavior of apparatus during testing, startup, and operation of plant
- (7) Preventive maintenance and troubleshooting
- (8) Corrective maintenance and checkout
- (9) Spare parts ordering
- (10) Disassembly and reassembly
- (11) Lubrication instructions
- (12) Service requirements

7. PRESERVICE AND INSERVICE INSPECTION

7.1 General. Preservice and inservice inspection and testing are critical elements of operability assurance programs for mechanical components. The following must be considered prior to installation.

- (1) Accessibility provisions for maintenance
- (2) Inservice inspection and testing
- (3) Repair or replacement criteria

The Code, Section XI, Inservice Inspection, and ANSI/ASME OM-4, "Examination and Performance Testing of Nuclear Power Plant Dynamic Restraints (Snubber)," shall be used for the periodic examination and testing of nuclear power plant equipment dynamic restraints (snubbers) from preservice inspection through the life of the plant.

The following surveillance requirements apply to all snubbers.

(a) Preservice operability testing shall be performed on all snubbers. Testing may be at the manufacturer's facility and shall be in accordance with ANSI/ASME OM-4.

(b) Preservice examination shall be made on all snubbers. This examination shall be conducted after installation following the initiation of hot functional tests and shall be in compliance with ANSI/ASME OM-4.

(c) Inservice inspection shall be performed in accordance with ANSI/ASME OM-4 and Section XI of the Code.

7.2 Procedures and Instructions. American National Standards Institute ASME OM-4, shall be used to develop procedures for preservice and inservice inspection and examination. Examination and tests shall be performed in accordance with written procedures. As a minimum, these procedures shall have provisions for the following.

- (1) Scope
- (2) References
- (3) Prerequisites
- (4) Precautions and limitations
- (5) Sequential actions to be followed
- (6) Test equipment required
- (7) Acceptance criteria
- (8) Data sheets
- (9) Personnel qualifications
- (10) Identification and disposition of nonconformances
- (11) Calibration requirements

ANNEX - MANDATORY

A1. DESIGN SPECIFICATION

A1.1 REQUIREMENT

Each project using this standard for design and application of snubbers shall prepare a design specification to consist of this standard's (including any modifications) technical requirements and administrative requirements in accordance with the following checklist and any other requirements unique to the project; e.g., assignment of responsibilities and requirements for design reviews and audits. The completed design specification must be certified by a registered professional engineer representing the purchaser to be correct, complete, and in compliance with the Code and this standard.

This standard provides guidelines and values which are considered to show currently accepted design practices and to supplement the requirements of the Code. Supportive documentation for any revision shall comply with the project's requirements.

A1.2 CONTENT OF DESIGN SPECIFICATION

The following sections of this Annex describe the information to be included in the project's design specification. The contents shall be in accordance with Appendix A of draft Regulatory Guide, Task SC-708-4, Qualification and Acceptance Tests for Snubbers Used in Systems Important to Safety, USNRC, February 1981.

A1.2.1 Scope. A brief statement of the project purpose and of the application of the snubbers. The application characteristics of each snubber shall be identified by listing whichever of the following descriptive terms are appropriate.

- (1) Seismic restraint
- (2) Dynamic force restraint
- (3) Relief valve restraint
- (4) Others, including combinations of the above

A1.2.2. Documents and Standards. In this section, list all documents specifically referenced in any part of the design specification. The listing must define applicable issue dates and amendments for each document.

A1.2.3 Technical Requirements. In this section, provide the necessary functional, design and fabrication requirements including numerical data as applicable. The following items are to be considered; others may be added as necessary. If this standard does not cover all project needs on any of these items, the design specification shall include all these needs.

A1.2.3.1 Design Requirements.

- (a) Specify the Code classifications of the following.
 - (1) Component being protected.
 - (2) Component supports including snubbers and attachments.
- (b) Locate jurisdictional boundaries for each Code classification and identify intervening elements.
- (c) Specify total dynamic loads and deflections along snubber line of action to be sustained without loss of functional capability.
 - (1) Cyclic mechanical loadings (forces, accelerations, vibration frequency, and total cycles) from system or seismic sources.
 - (2) Impact and impulse loadings from all sources.
 - (3) Thermal expansion and thermal transient movements.
- (d) Specify total dynamic loads and deflections transverse to the snubber line of action to be sustained without loss of functional capability.
 - (1) Cyclic mechanical loadings from system or seismic sources.
 - (2) Impact and impulse loadings from all sources.
 - (3) Thermal expansion and thermal transient movements.
- (e) Specify design service life.
- (f) Specify size and maximum load.
- (g) Specify mechanical features required; such as locking devices.
- (h) Specify structural and thermal design criteria from applicable codes and standards.
 - (1) Maximum allowable reactions and deflections at connections to building structural members.
 - (2) Allowable misalignments.
 - (3) Stiffness requirements of assembly, attachments, and supporting building structure.

- (4) Acceptable range of fundamental frequency of the snubber and attachments.

- (i) Specify interfaces with other systems and structures.

- (j) Specify all applicable loadings and event combinations (i.e., Design, Service Levels A, B, C, and D).

Al.2.3.2 Operational Requirements. The information listed below shall be identified to each possible normal and abnormal plant operating condition and to each test period of either snubber or plant. A histogram is to be provided of normal and abnormal conditions, with or without maintenance.

- (a) Operating Conditions.

- (1) Imposed loadings.
- (2) Extent of movement required.
- (3) Number of operating cycles the snubber must withstand.

- (b) Environmental Conditions.

- (1) Composition of ambient atmosphere
- (2) Temperature
- (3) Pressure
- (4) Humidity
- (5) Radiation Effects
- (6) Pipe vibration, pump and/or flow induced

Al.2.3.3 Functional Requirements. Acceptance limits shall be specified for the following parameters as a minimum.

- (a) Breakaway and drag forces at all operating conditions.
- (b) Dead band at all operating conditions.
- (c) Activation level (acceleration or velocity) at rated load and design temperature limits.
- (d) Release rate at increments up to the load at emergency conditions and design temperature limits.
- (e) Spring rates at design temperature limits and known increments of loading; include load-deflection characteristics if it varies as a function of frequency.
- (f) Travel at all operating conditions.

Al.2.3.4 Material Requirements. The material requirements unique to the project shall be specified. Lubricants and surface coating requirements shall be covered in addition to structural materials.

APPENDIX - NONMANDATORY

X1. DESIGN AND ANALYSIS GUIDELINES

X1.1 GENERAL

The design guidelines are intended to give assistance to the designer in choosing the proper type of snubber, correct orientation, and parameters that should be considered to adequately describe the response of the system.

The analytical guidelines are intended to give assistance to the analyst for assuring that system response may be obtained within acceptable limits for dynamic events. Snubber operability often degrades with time. Table X1 lists common causes of snubber degradation.

X1.2 DESIGN GUIDELINES

The design guidelines are intended to focus on the snubber. As stated in Sec. 3.1, this data should be used for guidance only. Deviations from the parameter ranges is expected but should be justified.

Specific items that are addressed include snubber assembly stiffness guidelines, sizing requirements, allowable mismatch for multiple snubber support applications, and cautionary statements regarding specific design details.

X1.2.1 Snubber Selection. General criteria to be considered in the selection of size and type of snubber to be used for a particular application are addressed in this section.

Consideration should be given to the most common failure mode of the type of snubber to be selected. A free or unlocked failure mode will not affect thermal expansion stresses but renders the snubber ineffective as a seismic restraint. A fixed or locked failure mode does not affect the ability to function as seismic restraint; however, excessive thermal stresses may be imposed on the piping as a result of this failure mode.

Snubber selection should initially be based on the type, magnitude of loading, and stiffness expected at each snubber support location. Loadings to be considered for the selection of snubbers besides seismic events should also include those due to pump and flow-induced pipe vibration, system thermal transients, and system fluid transients (e.g., water or steam hammer, valve discharge, (etc.)).

If low frequency or sustained loadings are anticipated, a locking, type snubber should be considered provided that thermal expansion effects after lockup are not critical. If thermal expansion movement is anticipated following or during snubber activation, a snubber capable of load release after activation (release rate) may be needed.

The ability of a snubber to function under anticipated environmental effects such as temperature, humidity, radiation, vibration, or other, should be considered. The ability of the snubber to function under repeated activations resulting from normal plant operations such as turbine trip, valve activation, pump operation, and system vibration, etc., should also be considered.

X1.2.2 Stiffness Requirements. Minimum support stiffness requirements are needed to maintain system response within acceptable limits. The support stiffness is the effective or combined stiffness of all the hardware between the geometric center of the component/pipe being supported and the location of the seismic input. Support stiffness should be based on, but not limited to, snubber, snubber extension, flexibility of structural members, clamp/fittings and component distortion and mechanical attachments to the building structure.

X1.2.3 Snubber Orientation. The snubber should be oriented or restrained so that misalignment between the clamp and snubber shall not cause rotation of the clamp relative to the snubber during loading unless restraining devices are used.

X1.2.4 Failure Modes to be Considered. The following failure modes should be considered.

- (1) End fitting/clevis static rupture
- (2) Snubber internals static rupture
- (3) Snubber static buckling
- (4) Snubber dynamic instability
- (5) Snubber wear, etc., as a result of fatigue

The effect of lateral vibration and its fundamental frequency should be considered relative to the axial dynamic stiffness and load. The compressive load of the snubber assembly should be limited to the maximum load permitted by 1 through 4 above.

For Service Level D loadings (Faulted Conditions), guidance of the Code, Section III, Division 1, Appendix F, Paragraph F-1370 may be used.

X1.3 SNUBBER COMBINATIONS

Multiple small snubbers used at one point of restraint in place of a single large snubber, and multiple snubbers used as axial restraints on a long pipe run are addressed in this section.

X1.3.1 Multiple Snubber Supports. A multiple snubber support exists when more than one snubber is used at a support location to apply restraint in a given direction. Specific problems to be addressed with multiple snubber supports include the following.

- (1) Snubber load sharing

- (2) Effects on system response of replacing a single large snubber with several smaller snubbers
- (3) Effects of snubber mismatch on component of system stresses

Load sharing is a strong function of mismatch of lost motion and end fitting clearances and a lesser function of mismatch of activation level and release rate.

Xl.3.1.1 Clearance/Lost Motion. The differential clearance/-lost motion between any two snubbers should not exceed .02 in. (.51 mm).

Xl.3.1.2 Activation Level. The differential between any two snubbers should not exceed 10 in./min. (.42 cm/sec) or .005 g (.049 m/s²), or 50 percent of the smallest activation level.

Xl.3.1.3 Release Rate. The differential between any two snubbers should not exceed 10 in./min. (.42 cm/sec) or .005 g (.049 m/s²), or 100 percent of the smallest release rate. The maximum release rate should not be less than 4 in./min. (.17 cm/sec) or .001 g (.0098 m/s²).

Xl.3.1.4 Load Sharing. The peak snubber load should be assumed to be 1.2 times the average snubber load (total support load divided by the number of snubbers).

Xl.3.2 Axial Restraints. Snubbers should not be used at more than one point of restraint on straight pipe runs to absorb an axial dynamic force unless simultaneous activation is provided.

Xl.3.3 Snubber in Series. Snubbers in series can be used only if all single snubber requirements are met by the paired assembly. Any series configuration should be demonstrated by test prior to its use.

Table Xl. Common Causes for Degradation in
Snubber Operating Characteristics

Cause	Stiffness	Activation	Release	Dead Band	Friction
Wear				M	M
Corrosion					H,M
Viscosity	H				
Temperature	H	H	H		
Entrapped Air	H	H	H	H	
Contamination					H,M

H = Hydraulic Snubber

M = Mechanical Snubber

APPENDIX - NONMANDATORY

X2. REFERENCES

X2.1 AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE, SECTION III, DIVISION 1, SUBSECTION NF

Allowable stress limits for welded joints. References within NF-3000 of the Code for allowable design stress intensities and stress limits are as follows:

- A. For construction up to the 1980 edition of the Code through the Summer 1982 Addenda:

<u>Class</u>	<u>Plate & Shell Type Supports</u>	<u>Component Supports</u>	<u>Linear Supports</u>
1	NF-3291.1	NF-3293.1	NF-3292.1
2 & MC	NF-3391.1	NF-3393.1	NF-3392.1
3	NF-3391.1	NF-3393.1	NF-3392.1

- B. For constructions after the 1980 edition of the Code, Summer 1982, beginning with the Winter 1982 Addenda:

<u>Class</u>	<u>Plate & Shell Type Supports</u>	<u>Standard Supports</u>	<u>Linear Supports</u>
1	NF-3226	NF-3426	NF-3324.5
2 & MC	{ NF-3226.2 NF-3256.2	NF-3456	NF-3324.5
3	NF-3266	NF-3556	NF-3324.5

X2.2 U. S. DEPARTMENT OF ENERGY (DOE) NUCLEAR ENERGY (NE) STANDARDS

NE F 3-2T	Calibration Program Requirements
NE F 3-15T	Requirements for Inspection of Dimensional Characteristics
NE F 5-1T	Cleaning and Cleanliness Requirements for Nuclear Components
NE F 7-2T	Packaging, Packing, and Marking of Components for Shipment and Storage
NE F 8-1T	Preloaded Threaded Fasteners and Closures

X2.3 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI-Y-14 Drafting Manual

ANSI B1.1 Unified Screw Threads

X2.4 NUCLEAR REGULATORY COMMISSION GUIDES

1.26 Quality Group Classifications and Standards for Water-,
 Steam-, and Radioactive-Waste-Containing Components of
 Nuclear Power Plants

1.28 Quality Assurance Program Requirements (Design and
 Construction

1.29 Seismic Design Classification

1.31 Control of Ferrite Content in Stainless Steel Weld Metal

1.38 Quality Assurance Requirements for Packaging, Shipping,
 Receiving, Storage, and Handling of Items for Water-
 Cooled Nuclear Power Plants

1.44 Control of the Use of Sensitized Stainless Steel

1.67 Installation of Overpressure Protection Devices

1.88 Collection, Storage, and Maintenance of Nuclear Power Plant
 Quality Assurance Records

1.130 Service Limits and Loading Combinations for Class 1 Plate-
 and-Shell-Type Components Supports

X2.5 OTHER REFERENCES

Manufacturers Standardization Society of the Valve & Fitting Industry
(MSS) SP-58, Pipe Hangers and Supports Materials and Design

Manufacturers Standardization Society of the Valve & Fittings Industry
(MSS) SP-69, Pipe Hangers and Supports, Selection and Application

Uniform Freight Classification Rules

National Motor Freight Classification