

NRC INSPECTION MANUAL

IIPB

INSPECTION PROCEDURE 50090

PIPE SUPPORT AND RESTRAINT SYSTEMS

PROGRAM APPLICABILITY: 2509

50090-01 INSPECTION OBJECTIVES

01.01 To determine whether the technical requirements detailed or referenced in the facility Safety Analysis Report (SAR) associated with safety-related pipe support and restraint systems have been adequately addressed in the construction specifications, drawings, and work procedures.

01.02 To determine whether quality assurance (QA) plans, instructions, and procedures for safety-related pipe supports and restraints have been established in the facility QA Manual.

01.03 To determine through direct observation and independent evaluation of work, whether the licensee's work control system is functioning properly and whether the installation of safety-related pipe support and restraints are in compliance with NRC requirements, licensee commitments, and applicable codes.

01.04 To review samples of safety-related pipe support and restraint system records to determine whether the licensee is adequately preparing, reviewing, and maintaining a system of quality records; whether the records reflect work accomplishment consistent with NRC requirements and SAR commitments; and whether the records indicate any potentially generic problems, management control inadequacies, or other weaknesses that could have safety significance.

Inspection Schedule

May Be Started

Must Be Started

Before work is
20% complete

Must Be Completed

90 days following
completion of work

50090-02 INSPECTION REQUIREMENTS

02.01 Review of QA Implementing Procedures. Review the facility QA Manual and implementing procedures to determine whether:

- a. Adequate QA audit procedures have been established for this activity including scope and frequency of audits, audit criteria, reporting requirements, followup action, and resolution of findings by those audited.
- b. Provisions have been made to ensure that those engaged in conducting audits are qualified and have been adequately trained. Provisions must ensure that auditors do not have direct responsibility in the areas being audited.
- c. Means have been established to verify that technical requirements, including material and component specifications (including traceability and marking requirements for nuts, bolts and other fastener items), acceptance criteria, and required documentation are specified in design and procurement documents.
- d. Means have been established to verify that any significant design and field changes from approved drawings are adequately controlled and processed commensurate with the original design.
- e. Provisions have been established to ensure that quality requirements are met (including documentation that quality requirements of materials and components are met before installation or use) and that deviations, nonconformances, and defects are adequately documented and processed through to complete resolution.
- f. The licensee has established a program for ensuring that all craft, nondestructive examination (NDE), and inspection personnel associated with the installation of pipe supports and restraints have been trained, or otherwise qualified to the work procedures involved, with specific attention directed toward those engaged in the installation and testing of concrete expansion anchors.

02.02 Review of Work Procedures

- a. Determine whether procedures and instructions (e.g., drawings, specifications, manufacturers' instructions, etc.) pertaining to pipe supports and restraints have been reviewed and approved. Make this determination by reviewing an appropriate sample of work procedures.

The sample should include procedures and instructions for supports on large and small bore piping, and instrumentation lines.

- b. Determine whether work procedures incorporate the following:
 - 1. Controls to ensure that the type and classification of pipe support and restraint systems comply with approved drawings and/or specifications and meet licensee commitments.

2. Instruction and precautions to ensure that welding, cutting, forming, heat treating, and machining are performed in a manner that will prevent the impact properties of the material from being degraded below specified values.
3. Provisions for ensuring that required pre-installation and in-process inspections are performed at the appropriate time.
4. Means to ensure that bolts, nuts, and washers (including lubricant, if used) are of the proper type, size, and material with required identification markings, are correctly installed, and, where required, bolt pre-loading (torquing), minimum bolt embedment, and thread engagement criteria are imposed.

02.03 Observation of Work and Work Activities. By direct observation, interviews, and independent evaluation of work performance, work in progress, and completed work, determine whether activities relative to pipe support and restraint systems are being accomplished in accordance with NRC requirements, SAR commitments, and licensee procedures.

- a. Personnel Interviews (Installation Practices). Select six appropriate personnel engaged in the installation and testing of supports, snubbers, and shock suppressors and confirm performance of the following:
 1. Pre-installation checks are made to ensure hydraulic units are not installed if there is evidence of excessive leakage of hydraulic fluid (possible damage or deterioration of seals), physical damage, or corrosion of polished sliding surfaces.
 2. Pre-installation check on variable type supports are performed for obvious damage, rust, or other conditions that may interfere with their proper operation.
 3. Pre-installation checks are made to ensure that bolts, nuts and other fastener items are available and are of the correct type, size, and material with required identification markings.
 4. Any pre-installation field repairs or adjustments to the units are performed in accordance with the manufacturers' instructions and specifications to ensure that proper seal materials, replacement parts and fluids are used, and performance requirements are met.
 5. Installation equipment such as torque wrenches and other testing and measuring devices are properly controlled, calibrated, and adjusted at specified periods.
 6. Personnel engaged in the installation of safety-related pipe supports and restraints have received adequate training to perform special processes contained in relevant work performance and inspection procedures.

b. Installation Activities

1. Witness portions of the installation activities of 15 pipe support systems to verify the following:
 - (a) The latest issue (revision) of applicable drawings or procedures are available to the installers.
 - (b) Significant modifications to supports are approved by appropriate personnel before implementation.
 - (c) The use of jacks or rigging to pull piping into position for hanger installation or welding does not exceed cold spring allowances for that particular material, size, and length of pipe run.
 - (d) Clearances exist between the pipe and restraints are as specified.
2. Witness portions of the installation and testing of concrete anchor bolts for 15 component support elements (of various types and pipe sizes) to verify that anchor bolt type, diameter, embedment length, shoulder-to-cone measurements, and torque requirements meet installation requirements.

c. Dynamic Pipe Supports. Select a total of 15 installed snubbers, shock suppressors or restraints for at least three different load classifications and at various degrees of accessibility (easy or difficult accessibility), and determine by visual examination whether the following conditions meet applicable requirements:

1. Components are free from corrosion or other signs of deterioration.
2. Support plates, extension rods, and connecting joints are not bent, deformed, loose, or otherwise out of specification.
3. Bolts, nuts, washers, locking devices, and other fasteners are tight and secure and are of the correct type, size, and material with required identification markings. Where required, bolt tension specification requirements have been met through the use of properly calibrated bolt torquing wrenches and torque multipliers.
4. Bleed holes are open and free from foreign material.
5. Lubricants and sealants are applied as specified and there does not appear to be excessive leakage.
6. Seals are not deteriorated (if visually observable without dismantling).
7. Connecting joints, moving parts, piston shafts, seals, etc. are free from foreign material such as concrete, dropped paint, excessive dust and dirt or other material that may obstruct proper operation.

d. Rigid, Constant, and Variable Type Supports

1. Select a total of 15 installed spring hanger assemblies of three different load ratings and observe the following:
 - (a) Hanger rods for supporting 2-inch pipe are not less than 3/8-inch diameter and for 2-1/2-inch pipe or larger, not less than 1/2-inch diameter.
 - (b) Spring hangers are provided with indicators to show the approximate "hot" or "cold" position, as appropriate.
 - (c) Spring hangers enclosed in spaces that will be subjected to high ambient temperatures during reactor operation have suitable service ratings to accommodate the expected operating temperature range.
2. Select a total of 15 installed pipe support systems of different sizes (load rating) and at various degrees of accessibility. Determine by visual examination whether the following conditions exist:
 - (a) No deformation or forced bending is evident.
 - (b) No deterioration or corrosion is evident.
 - (c) Where pipe clamps are used to support vertical lines, shear lugs are welded to the pipe (if required by installation drawings) to prevent slippage.
 - (d) Movements of pipe due to vibration, thermal expansion, etc. will most likely not cause contact with other pipes, supports, equipment or components. (As best as can be determined following installation but before initial operation.)
 - (e) Sliding or rolling supports are provided with material and/or lubricants suitable for the environment and compatible, sliding contact surfaces.
3. Select at least eight small-bore or instrumentation lines that have been designed by a simplified seismic criterion. Determine by visual examination whether the following conditions meet applicable requirements:
 - (a) The functional restraint direction is proper and in accordance with the design drawings.
 - (b) The gaps between the piping and support appear adequate to allow thermal axial expansion.
 - (c) The gaps between the piping and support are not excessive for dynamic loads.

- e. Component Supports. Select a total of 20 installed component supports including at least 6 multiple pipe supports, and ascertain by visual examination whether the following conditions exist:
1. Component support elements are located and installed as specified on the drawings.
 2. The surface of welds meet applicable Code requirements. Check weld surfaces for grooves, abrupt ridges, valleys, undercuts, cracks, discontinuities, or other detrimental indications that appear to exceed Code limitations.
 3. Materials used in the construction of the component supports have been certified by reviewing material test reports or a certificate of compliance.
 4. Where special bolting materials are specified check for compliance with specifications including preload (torquing) requirements.
 5. Support clearances are as specified.
- f. As-Built Configuration
1. Select 10 as-built/final design pipe support structural drawings and compare several selected supports with the actual installation.

Discrepancies observed may result from in-process changes such as those initiated in the field. If in-process changes are involved, determine whether the licensee has properly controlled and documented these changes on a current basis for engineering review, approval, and subsequent incorporation into final as-built drawings.
 2. Select a total of 10 pipe anchor locations on the as-built drawings (piping 2-1/2 inches in diameter and greater). These anchor locations are designed to restrict individual pipe movement in all directions. Visually examine these 10 anchors and compare them with the drawings to ensure agreement as to their location and function.

02.04 Review of Records

- a. Review licensee/contractor requirements covering the span of records for piping supports and restraints. Determine the initiation point for those records sampled and, importantly, the effectiveness of those responsible for reviewing the records for accuracy and completeness and ensuring that the recorded information meets documentation requirements. To determine the effectiveness of the licensee/contractor system for documenting work in this area, review the records for three dynamic pipe supports or restraints and three fixed pipe supports in the following areas:
1. Type and classification of pipe support or restraint comply with appropriate drawings and specifications.

2. Location, spacing, and critical clearances meet licensee's specifications and have been verified by QA/QC inspection.
 3. The required scope of QA/QC inspections was met.
 4. Weld identification/location corresponds to respective weld card, drawing, work order, or other welding documentation.
 5. Welding material used corresponds to the material specified.
 6. Welders were qualified to the welding procedures used and welding procedures were qualified in accordance with Code requirements.
 7. The records confirm that for welding activities where attachments are welded directly to piping, the welding specifications used are the same or equivalent to the ones used for pipe welding including preheat, postweld-heat treatment, and nondestructive examinations.
 8. The examination records are complete and meet the NDE procedure requirements.
- b. Review the licensee/contractor system for reporting and dispositioning nonconforming materials, parts and components associated with pipe supports and restraints. Review approximately 10 nonconformance/deviation reports to determine whether:
1. The records adequately document current status of nonconformances and deviations.
 2. The records are legible, complete, and indicate that reports are promptly reviewed by qualified personnel for evaluation and disposition.
 3. The records are routinely being processed through established channels for resolution of the immediate problem as well as for generic implications.
 4. The records are being properly identified, stored, and can be retrieved in a reasonable time.
 5. Nonconformance reports include the status of corrective action or resolution.
 6. Resolution of nonconformances is appropriate and demonstrates good engineering practice.
- c. To determine whether qualified licensee, contractor, craft and inspection personnel are being utilized on those special processes associated with pipe support and restraint installation work, review a sampling of personnel qualification records (4 to 6, but no more than 10 records total) covering several different disciplines as follows:
1. Determine whether a system of personnel qualification records, meeting stated requirements, exists and is being maintained in current status.

2. Determine if the records are sufficient to reasonably support qualification in terms of certification, experience, proficiency, training, testing, etc., as applicable.
 3. Review the action taken by responsible licensee/contractor organizations to independently authenticate the employment, training, and qualification history of newly hired personnel.
- d. Review relevant portions of licensee and contractor audit reports concerning the installation of pipe supports and restraints. Review two to four reports to determine whether:
1. The required audits have been performed in accordance with schedule and functional areas in established audit plans.
 2. Audit findings have been reported in sufficient detail to permit a meaningful assessment by those responsible for corrective action, final disposition, and trending.
 3. The licensee/contractor has taken proper followup action on those matters in need of correction.

50090-03 INSPECTION GUIDANCE

General Guidance

- a. This procedure pertains to all safety-related pipe supports and restraint systems, i.e., reactor coolant pressure boundary piping and all other safety-related piping. Pipe supports include pipe hangers, restraints, supports, shock and sway suppressors, etc. that directly support the pipe. Pipe whip restraints, such as structural steel or concrete barriers that do not normally contact the pipe, are not covered by this procedure. Additionally, it should be noted that some welding inspections are included in this inspection procedure (IP). Assistance to the inspector in this area may be required. This matter should be considered during inspection preparation.
- b. Applicable portions of the SAR (3.2, 3.9 and 17.1) should be reviewed to determine licensee commitments relative to construction and inspection requirements before performing this inspection. The inspector should then utilize these SAR sections during the review of the licensee's implementing construction specifications, drawings, work procedures, and QA implementing procedures. Most of this review can be completed during inspection preparation after these procedures have been obtained from the site. The NRC inspector also should review applicable portions of ASME Boiler and Pressure Vessel Code, Section III, Division I, Subsection NF, Component Supports.
- c. It is recognized that the construction installation work associated with IP-50090 normally is carried out over an extended period of time, which will require a series of inspections to fully complete this procedure. Additionally, some licensee contracting arrangements may be such that several different contractors will be

involved in the installation work. If this is the case, selected parts of this procedure may have to be repeated in order to adequately cover the total effort. Regional evaluations and appropriate adjustments to this procedure are necessary to ensure inspection continuity during the extended period of time involved and to accommodate the various contracting arrangements encountered.

- d. Considerable impact on the development and structure of IP-50090 has resulted from a series of problems NRC has encountered in the area of pipe supports and restraints. These problems and concerns are best summarized in several IE bulletins, circulars, and information notices that have been issued over the years. These documents are listed in the reference section below. Information contained in these issuances should be of prime importance to inspectors during implementation of IP-50090, particularly to help understand the extent and variety of the problems, the details and nature of their occurrence, and expected licensee corrective action.
- e. Findings from this inspection activity should address each element as being satisfactory, being unresolved and requiring resolution, or being in violation and requiring correction. When significant inadequacies are identified indicating weakness within the responsible organization, the inspector should inform cognizant regional supervision. The issue should be addressed also at the appropriate level of licensee management.
- f. Particular attention should be given to the traceability of material and equipment to prevent the use of incorrect or defective materials, parts and components. The inspector should review 10 CFR 50, Appendix B, Criterion VIII, Identification and Control of Materials, Parts and Components, and applicable codes and specifications. The inspector should verify that measures have been established by the licensee for identification and control of materials, parts and components and for traceability to the approved design basis and to the source. The inspector should assure that required identification of the item is maintained by heat number, part number, serial number or other appropriate means, either on the item or on records traceable to the item, as required, and that required markings are on the item.

The inspector should note markings on material and equipment and verify that the markings represent material and equipment as specified by the design drawings and specifications. In the case of fasteners, compliance with the applicable material specification (e.g., ASTM or ASME material and grade) should be verified by required markings on bolts and nuts and certified material test reports or certificates of conformance as required by the applicable procurement drawings and specifications and/or by the applicable codes and specifications. In the case of vendor-supplied equipment assemblies containing fasteners, samples should be inspected to verify compliance with approved vendor drawings and specifications and other information such as materials used for equipment qualification tests and/or analyses. Caution should be exercised to ensure that the required markings on material and equipment, including fasteners, not only exist but that the markings indicate the correct material and grade as specified.

03.01 Specific Guidance

- a. Inspection Requirements 02.01a and b. Audit procedures and/or checklists for pipe supports and restraints systems should provide for checks of each type of system used and should, if possible, include representative samples from all suppliers of components. Audit procedures or criteria should address the qualifications needed by those performing the audits.
- b. Inspection Requirement 02.01f. The inspector should determine specific steps the licensee has taken, or plans to take, to ensure that only qualified personnel are permitted to perform work associated with the installation of safety-related pipe supports and restraints. This effort may tie in with the review of the licensee's audit plans specific to this area of work.
- c. Inspection Requirement 02.02b2. Most of the welding, cutting and forming operations covered by this procedure pertain to component support structures, support members and brackets, and do not require pre-heat-treatment or postweld heat treatment. However, those pipe supports, support flanges, or support brackets that are directly welded to safety-related pipe are subject to pre-heat and/or postheat treatment. Applicable heat treatment procedures are necessary for this type installation. Records of heat treatment (time, temperature) must be generated and reviewed for Code compliance.
- d. Inspection Requirement 02.03a. Interviews must be performed expeditiously so as to minimize the worker's time away from jobs in progress. Only those licensee/contractor employees who can provide first-hand knowledge or experience in the area of interest, and appears willing to share the information, should be interviewed.
- e. Inspection Requirement 02.03b thru f. Some inspections of supports and restraints may require the erection of scaffolds or long ladders. The NRC inspector should use judgment in regard to this type of assistance from the licensee or contractor. If possible, the NRC inspector should schedule inspections so that existing scaffolds, etc., could be used. In the event plant design features cause difficulty selecting certain types of support brackets, saddle supports and multiple pipe supports the inspector may choose the equivalent number of other Component Standard Supports for inspection and examination.
- f. Inspection Requirement 02.03b2. Refer to IE Bulletin No. 79-02 (and revisions), Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts, for additional information.
- g. Inspection Requirement 02.03e3. The material certificate and identification should meet the requirements of the applicable edition of ASME Code Section III, NCA-3800.
- h. Inspection Requirement 02.03f. The intent is to determine whether pipe support and restraint systems are being installed according to properly approved drawings--either the original design drawings or properly approved revisions; and, if revisions are in process, that these changes are properly handled in accordance with established procedures.

Appropriate standards can be used as a guide in this area. For example, ANSI N45.2.11 requires that where changes to previously verified designs have been made, design verification shall be required for the changes, including evaluation of the effects of those changes on the overall design.

Further, ANSI N45.2 states that records which correctly identify the as-built condition of items in the nuclear facility shall be maintained and stored for the life of the particular item while it is installed in the nuclear facility. Additionally, 10 CFR 50, Appendix B, Criterion III, states in part, that design and field changes shall be subject to the same design control procedures as the original design.

Numerous changes may be made to these supports during construction that are different from the original (SAR) design. Such changes will result in the accumulation of various types of design change documents and/or marked-up drawings. Since these changes reflect as-built conditions, they should be adequately controlled so they will be readily available for use with affected original design documents during future evaluation on the effect other design changes have on the overall design. Additionally, the as-built process should result in proper and timely updating of the original/master drawings and specifications to incorporate such changes.

The importance of accurate as-built drawings and their use in confirming that piping systems have been properly installed cannot be overemphasized in view of the problems encountered. Other NRC inspection procedures are relevant to as-built drawings. These are IP 37051, Verification of As-Built, which requires a review of plant as-built drawings one year before OL issuance; and IP 37993, Design Verification, and IP 37911, Plant Design for Protection Against Postulated Ruptures of High-Energy Piping in Fluid Systems Outside of Containment, which are intended for application at organizations where engineering and design functions are performed.

The latter procedure calls for inspections at engineering organizations engaged in design of fluid systems and is aimed, in large part, to ensuring that correct information is available and is used in the course of meeting system design requirements. As-built drawings of installed plant piping systems are necessary input to confirm the final piping analysis for the plant.

- i. Inspection Requirement 02.04. The inspectors should bear in mind that the NRC's inspection sample covers only a very small portion of the records involved. Thus, substantive errors or departure from requirements identified in NRC's sample, raise the issue of whether the licensee is adequately controlling the process. In this connection, particular attention should be given to reviewing the adequacy of those records dealing with the qualification of personnel and QA audits. Problems noted in these two areas should be viewed as prime indicators of the licensee's involvement in the work and the effectiveness with which the licensee maintains control over the work in progress.

03.02 Prevalent Errors and Concerns. This section is included to provide background on past problems of a generic nature that have been identified and certain areas that should be more closely scrutinized to give NRC early information on potential problems.

- a. Welders not properly qualified to applicable Code and records not properly maintained.
- b. Personnel qualification records, including indoctrination, training, examinations, and certifications either not being maintained, invalid, or nonexistent for some employees.
- c. Field design work (redesign, modifications) not being processed through appropriate review and approval route.
- d. Nonconformance reports not being processed fully in accordance with established procedures.
- e. Personnel assigned to licensee audit function not appropriately trained in the assigned audit areas nor independent from areas audited.
- f. Licensees and contractors conduct some audits on schedule but may postpone or omit others entirely. Although audits are carried out to some extent and may be adequately performed, in many instances the audit findings and recommendations are ignored or are filed without appropriate consideration or followup action.
- g. Refer to Appendix A of IE Bulletin 79-14 for additional problem areas. Other IE bulletins, circulars, and information notices listed below in the reference section of this IP contain additional relevant information about problem areas.

03.03 Definitions

Dynamic Pipe Supports. A pipe support assembly or restraint with a hydraulic or mechanical control unit designed to prevent unrestrained pipe motion during an earthquake; or vibratory pipe movements brought on by water hammer, steam hammer, pump start/stop, or safety and relief valve actuation. Thermal expansion of piping is not restrained by dynamic supports (snubbers, shock suppressors, etc.).

Rigid, Constant, and Variable Type Supports. Pipe support assemblies used for mounting pipes without hydraulic or mechanical control units (hangers, base supports, saddle supports, spring hangers, sliding and rolling supports, etc.).

Component Supports: Metal elements which transmit loads between plant components and the building structure and whose function includes carrying the weight of components or providing them with structural stability.

Component Standard Supports: Pipe support assemblies consisting of one or more units usually referred to as catalog items and generally mass produced (anchors, guides, restraints, rolling or sliding supports, spring hangers, snubbers, sway braces, vibration dampeners, clamps, etc.).

50090-04 REFERENCES

SAR, Chapters 1, 3, 5, 10, 14, and 17, including pertinent Codes and Standards referenced in these chapters

Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)"

END