
INSPECTION PROCEDURE 69020

INSPECTIONS OF SAFETY-RELATED ITEMS (AND SERVICES) DURING CONSTRUCTION OF NON-POWER PRODUCTION AND UTILIZATION FACILITIES

PROGRAM APPLICABILITY: 2550

This procedure provides guidance for inspection of work activities associated with the construction of Non-power Production and Utilization Facilities (NPUFs).

69020-01 INSPECTION OBJECTIVES

01.01 To determine if on-site construction of NPUFs is being accomplished in accordance with the construction permit, licensing basis, and other applicable quality, technical, and regulatory requirements.

01.02 To determine if the records reflect work accomplishment consistent with the construction permit, licensing basis, and construction specifications.

01.03 To determine if there are any potentially generic quality program problems that may warrant a follow-up quality assurance (QA) inspection.

69020-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 BACKGROUND

02.01.a The NRC will focus on direct inspections of construction activities at NPUFs when practical. The items listed in the appendices of this inspection procedure (IP) may be inspected via records review and observation of the as-built condition of the items when direct observation of construction activities is not practical. Each of the appendices to this IP may be performed separately and should be performed at the appropriate time during plant construction for the items being inspected. However, to gain efficiency, 2 or more appendices may be performed concurrently. Some portions of the appendices may not be applicable to some NPUFs. Additionally, efficiency gains may be realized by performing QA program implementation inspections (IP 69021) in conjunction with this IP. The overall NPUF inspection philosophy is described in detail in Inspection Manual Chapter 2550, "non-power production and utilization facilities (NPUF) licensed under 10 CFR Part 50: construction inspection program (CIP)."

- 02.01.b During the inspection planning process, the inspector should review the applicable portions of the construction permit, licensing basis including the Safety Analysis Report (SAR), the final design, and the construction specifications. Inspectors should also review the Quality Assurance Program (QAP) and the licensing basis for the QAP. Most NPUFs are expected to commit to ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors."
- 02.01.c As a part of the planning process, inspectors should ensure that the items selected for inspections are safety-related. If construction of safety-related items (and services) cannot be directly observed, then inspectors may conduct record review and observation of the as-built condition of safety-related items to fulfill the inspection requirements. If there are no safety-related items within the item type for the facility, then the associated appendix in this IP for that item type need not be completed.

02.02 INSPECTION GUIDANCE

- 02.02.a NRC inspections should include one or more of the following inspection techniques: (1) Direct inspection of in-process work activities, (2) Review of completed records of work activities, or (3) Independent assessment or inspection of completed work activities.
- 02.02.b Guidance for each type of item is provided in the appendices of this IP.
- 02.02.c Technical requirements are established by the final design of the facility. The final design is prescribed by a "flow-down" of technical requirements from the NRC-approved safety analysis report (SAR) to design specifications and drawings. The SAR and design output documents will usually reference industry codes and standards that provide specific requirements for the design, fabrication, assembly, and testing. Note that some facilities may use the term "license application," or "LA" instead of SAR. These terms are considered synonymous for this inspection procedure.
- 02.02.d Quality requirements are first defined by the licensee's QAP. The QAP description is reviewed and approved by the NRC staff. The applicable quality assurance program requirements are identified in the licensee's quality assurance program implementing documents. NPUFs will generally commit to and use ANSI/ANS 15.8, "Quality Assurance Program Requirements for Research Reactors," to develop their QAP description.
- 02.02.e This IP is not intended to implement a programmatic evaluation of Quality Assurance program effectiveness. This will be accomplished as part of QA inspections directed by IMC 2550. However, inspectors should familiarize themselves with the quality assurance program requirements in the facility's QAP

that apply to the work activity they are inspecting and, as applicable, evaluate the implementation of QA requirements directly applicable to the work activity being inspected.

02.03 ADDITIONAL GUIDANCE

02.03.a Direct Observation Techniques

Direct observation includes observing in-process construction-related activities such as fabrication, qualification, assembly, installation, inspection, examination, and testing to determine if the activity was performed in accordance with work control documents (e.g., applicable instructions, procedures, and/or drawings).

02.03.b Record Review:

Record review includes review of a sample of completed records to determine whether the construction-related work activity was performed in accordance with applicable instructions, procedures, and/or drawings. For the records reviewed, the inspectors should determine whether the records were (1) adequate to furnish identifiable and retrievable evidence of activities affecting quality, and (2) met other requirements prescribed by the licensee's record management program.

If possible, the inspectors should also perform a walk-down of the completed work activity associated with the records reviewed, to determine whether the as-built item conforms with the final design, construction documents, and the records reviewed.

02.03.c Independent Assessment/Inspection:

The inspectors may also conduct an independent assessment or inspection (walk-down, measurement, etc.) to determine whether the as-built item conforms to the final design.

02.04 INSPECTION COMPLETION

This inspection procedure is complete when the applicable appendices are completed once for the facility. Inspectors are not expected to complete every activity in the appendices of this IP. Instead, inspectors shall prioritize inspection activities during their visit to the site based on 1) importance of the activity to safety, 2) availability of the activity at the time of the inspection, and 3) available inspection resources. Inspectors may consult with their supervisor and/or NRC headquarters technical staff, if necessary, to prioritize inspection activities. It is not anticipated that multiple site visits will be necessary to complete an appendix to this IP. An appendix to this IP need not be completed if there are no safety-related items (or services) covered by that appendix at an NPUF, and the value of inspection in the area is low compared to the amount of resources required for inspection. This decision should be documented

69020-03 REFERENCES

NOTE: Additional references specific to Appendix A through Appendix M are included in the Reference section of that appendix.

10 CFR Part 21, "Reporting of Defects and Noncompliance."

10 CFR 50.55, "Conditions of construction permits, early site permits, combined licenses, and manufacturing licenses."

69020-04 PROCEDURE COMPLETION

The implementation of this IP will be complete when each of the applicable portions of applicable IP appendices has been completed once for the facility. Additional samples may be performed if NRC management has significant concerns regarding the quality of construction of the facility. Appendices that address items that are not applicable to a facility need not be performed for that facility.

69020-05 RESOURCE ESTIMATE

Each of the appendices of this IP contains resource estimates for execution of that appendix.

END

Appendices:

Appendix A: Foundations and Buildings

Appendix B: Structural Concrete

Appendix C: Structural Steel and Supports

Appendix D: Piping Systems

Appendix E: Pipe Support and Restraints

Appendix F: Mechanical Components

Appendix G: Electrical Cable

Appendix H: Electrical Components and Systems

Appendix I: Ventilation and Confinement Systems

Appendix J: Instrumentation and Control Systems

Appendix K: Structural Welding

Appendix L: Nuclear Welding

Appendix M: Fire Protection Systems

Attachment

Revision History for IP 69020

APPENDIX A

INSPECTION OF FOUNDATIONS AND BUILDINGS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A1-01 INSPECTION OBJECTIVES

01.01 To determine whether foundation work and related quality control activities for Seismic Category I (SC-1) and Seismic Category 2 (SC-2) structures are being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to foundation and building activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of SC-1 and SC-2 buildings meets the specified design requirements, specifications and drawings. For installation of concrete structures, also refer to Appendix B of this inspection procedure (IP). For structural steel components, also refer to Appendix C of this IP.

01.04 To determine that the implementation of the quality assurance program related to work activities associated with foundations and buildings is effective and to verify that deviations from requirements are appropriately resolved.

69020.A1-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the SC-1 and SC-2 buildings being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for foundation and building work on-site at the time of the inspection, with SC-1 work being preferable to SC-2 work when available. Inspectors should also coordinate this appendix with inspection of structural concrete (Appendix B of this IP), and structural steel and steel supports (Appendix C of this IP) for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to help determine which building(s) are to be inspected. Observation during in-progress construction of the buildings is desirable but not required. If necessary, inspectors may select completed foundations and buildings for inspection. Inspectors should not attempt to inspect all of the buildings on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of foundation and building construction arise.

Inspectors should collect licensee procedures, building specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should choose one or more SC-1 buildings and review the areas listed in 02.02 through 02.06 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 For the building(s) selected for inspection, review construction procedures, construction specifications, drawings, and other relevant design documents to ensure that they conform to the commitments contained in the licensing basis. Determine whether appropriate and adequate procedures in the following areas are compatible with the QA program and prescribe adequate methods to meet the construction specifications, where applicable.

- a. Excavation and subgrade preparation.
- b. Foundation verification.
- c. Placement of engineered fill and backfilling.
- d. Dewatering.
- e. QC inspection and testing.
- f. Instrumentation and settlement monitoring.
- g. Surveying.
- h. Engineering direction.
- i. Soil compaction and testing

02.03 If applicable to the project, perform a review of the results of the test-fill program before reviewing the implementing construction procedures, to verify that the fill procedures have been qualified. The implementing procedures should reflect the methods, equipment, materials, and conditions of the test-fill program.

02.04 Determine whether the licensee has an established audit program (including plans, procedures, and audit schedule) for assessing the adequacy of SC-I and SC-II work control functions, in the area of geotechnical/foundation activities, and for ensuring that examination, inspection, and test personnel associated with performing tests and inspections of geotechnical/foundation activities are qualified and/or certified to perform their assigned work.

02.05 Ascertain whether the following activities, if applicable, are being controlled and accomplished in accordance with the requirements of the documents reviewed in 02.02, above:

- a. Excavation and Subgrade Preparation.
 1. The excavation methods and sequence of operations should not be detrimental to the final foundation subgrade materials.

2. Unusual or changed conditions encountered during excavation of cavities, faults, pockets of unsuitable material, springs, seeps, boils, and protrusions, are noted, investigated, evaluated, and taken into consideration.
 3. The foundation subgrade should be free of organic or soft unsuitable material. Depressions or holes left by grubbing and stripping or excavation should be backfilled with suitable materials compacted and tested to the specified density and moisture content. Soil classification at the depth excavated for foundations should be verified and compared with the soil profile determined during subgrade explorations (bore holes, exploratory excavations, etc.). The occurrence of extraneous detrimental or unexpected soil may necessitate further investigation or evaluation/redesign. The finished grade should be as specified, meet compaction and density requirements, be protected from the elements, and be tested and inspected.
 4. Determine whether the stockpiling and segregation of excavated materials which are to be used as SC-I fill material are in accordance with specifications.
 5. The foundation subgrade treatment such as compaction, installation of foundation drains, or other methods should be properly controlled.
 6. Determine whether QC inspections are adequate with regard to scope, frequency, and inspector qualifications.
 7. The record-keeping activities should reflect the actual conditions encountered in the field and provide adequate documentation of work and inspections. Determine whether records are being maintained, reviewed, and approved as specified.
- b. Foundation Verification.
- Verify that geotechnical engineering direction is available. Foundation subgrades should be approved by an experienced geotechnical engineer before placement of engineered fill, mud mats, or structural concrete. Determine whether records are maintained to document approval of the final foundation subgrade. Records should include elevation, actual conditions, methods to achieve acceptable conditions, and inspection and test acceptance criteria and final acceptance results.
- c. Backfilling (Fill Materials and Compaction Control).
1. Specified lift thicknesses are adhered to and specified equipment is being used with the correct number of roller passes.
 2. Source material being used is identified and is traceable to an approved borrow source. The approved source material should meet design and earthwork specification requirements and have been properly qualified by an approved soils laboratory.
 3. Ensure that engineered fill or backfill is placed at the proper location and on approved foundation materials.

4. Verify that in-place density tests are being performed at the required frequency with properly calibrated instruments (including moisture content tests). If a nuclear density test is performed using a nuclear density gauge or Troxler, verify that the instrument has been calibrated and radioactive source leak checks have been performed.
 5. Samples for laboratory tests are being taken at the required frequency, chain-of-custody established, and the samples are adequately identified. Review the results of the required tests and compare results to design specification requirements and applicable standards.
 6. Inspection activities (QA and QC) are being performed as required by qualified and/or certified personnel. Review inspection documentation and verify that the records quantitatively define actual construction conditions and QC qualitative test results.
- d. Dewatering Systems. Note that 1 and 2 below represent good practice, but are not requirements unless specified in the site specifications.
1. Emergency power supply to ensure continuous dewatering system operation is being maintained and tested.
 2. Open excavations are protected from flooding by an adequate sump pump system.
 3. Piezometric surfaces are being defined by monitoring performed at the required frequency.
 4. Inspection and testing of system discharge should assure that sediment material is not being removed from the foundation.
- e. QCI Inspection and Onsite Testing Laboratory.
1. If applicable, the onsite laboratory has performed verification of laboratory personnel qualifications (education and experience) of testing and inspection personnel. Personnel qualification verifications must be supported by objective evidence documenting education and experience.
 2. Test results are being evaluated at an appropriate level and evaluation includes trend analysis.
 3. Observed testing standards conform to the procedures specified in the American Society for Testing and Materials.
 4. Testing apparatuses are calibrated at the required frequency and calibration traceable to a nationally recognized standard and calibration is in accordance with approved procedures.
 5. Records reflect the results of inspections, the actual field conditions, testing frequency requirements, acceptance criteria, and data calculations are checked.

- f. Instrumentation and Settlement-Monitoring Program.
 - 1. Number, location, and type of instruments are appropriate.
 - 2. Instrumentation and settlement-monitoring systems installed before start of activity being monitored.
 - 3. Instrumentation and settlement-monitoring systems are installed as specified, functioning properly, and protected against construction hazards.
 - 4. Operation and monitoring: operations are monitored at specified frequency to assure that construction activities have not made installed instrumentation inoperable.
 - 5. Calibration of measuring and testing equipment is maintained, logged and functionally checked.
 - 6. Recordkeeping activities: records reflect specified frequency of monitoring, data checks (e.g., supervisory review, engineering review), data evaluated and accepted. This is important in activities such as settlement monitoring. A comparison of the actual settlement data with those predicted can reveal problems at an early stage, enable the cause to be determined relatively early in the construction phase, or can cause design changes to be incorporated before the completion of extensive construction work.
- g. Surveying. The instruments are properly calibrated, and calculations are checked to assure accurate results.
- h. Engineering Direction. Engineering direction is available onsite to monitor geotechnical/foundation construction activities. The onsite engineering staff should be supplemented by an experienced geotechnical engineer to approve final foundation subgrade materials, monitor and review QC inspection and test results, and identify changed field conditions. The onsite engineering staff should be involved in disposition of nonconformance reports, and prepare engineering field change requests for approval by the engineering design agent or organization.
- i. Personnel Interviews. Informal interviews with field-craft and inspection personnel may be randomly conducted to determine how well employees know the requirements of their work activity. Ascertain whether a sufficient number of adequately qualified QA and inspection (QC) personnel are at the construction site, commensurate with the work in progress, and adequately performing their assigned duties through the established organizational structure.

02.06 Review the documentation generated for the geotechnical/foundation activities. Determine whether the licensee/contractor system for documenting safety-related work is functioning properly. Records should be legible, complete, reviewed by QC and/or engineering personnel, and readily retrievable.

- a. Receipt Inspection and Material Certification (if applicable). Applicable for materials purchased from offsite suppliers such as drainage materials,

geosynthetic fabrics, select fill materials, sand and gravel, instrumentation, and dewatering system components. Records confirm that required material characteristics, performance tests, civil soil tests, nondestructive tests, and other earthwork specification requirements were met.

- b. Installation Inspection. Records confirm that specified materials and components were installed as specified and that the required inspections were performed and acceptance criteria are defined.
- c. Nonconformance/Deviation Record. Records include current status of these items. Nonconformance reports include the status of corrective action or resolution, (e.g., determine whether adequate corrective action is being taken when moisture density test results are not within tolerance or acceptance criteria.
- d. Training/Qualification Records of Craft, QA, and Inspection (QC) Personnel. Records establish that QA/QC personnel are adequately qualified for their assigned duties and responsibilities and that craft personnel have been trained in their assigned tasks.
- e. QA Audits. Records establish that the required audits were performed and that deficiencies identified during audits were corrected, and that corrective action was such that repetition of the deficiency, or similar deficiencies, would be precluded.

69020.A1-03 ADDITIONAL GUIDANCE

03.01 Prevalent Errors and Concerns. Prevalent errors and recent concerns are areas in which the inspector should be alert to potential generic issues. These areas include:

- a. Insufficient compaction of foundation and backfill materials was identified at several sites, as described in IE Circular 81-08.
- b. Placement of fill for control of compaction requires control of ground-water levels.
- c. QC test results need to be reviewed and trended to assure that tests are performed in accordance with specification requirements, that the results are reasonable, that the results meet requirements, and that locations where samples/tests were obtained (location and elevation) can be accurately identified. Test deficiencies need to be entered into the corrective action program and evaluated by engineering personnel.
- d. QA audits should identify procedural inadequacies or the cause of repetitive nonconforming conditions.

03.02 Background Information. This information is to be used as reference material; however, the site specifications govern. The information may be valuable in discussions about the adequacy of the specifications.

a. Foundation Subgrade

1. Excavation. Unexpected conditions are frequently encountered, ranging from unfavorable deposits of materials not found in the exploratory program, to problems not identified in previous site studies.

Where unfavorable conditions are encountered, further exploration by test pits, borings, or other means are necessary to define the extent and nature of conditions. The effect of the unexpected conditions must be evaluated in relation to the original design. Examples of common unfavorable conditions frequently encountered are:

- (a) Highly compressible and low-strength soils;
 - (b) Collapsible soils - low-density soils that collapse when saturated;
 - (c) Old river channels;
 - (d) Cavities and solution features;
 - (e) Overhangs and surface depressions;
 - (f) Springs or artesian conditions; and
 - (g) Unstable excavation slopes because of unanticipated conditions.
2. Excavation materials are frequently used as engineered fill or backfill around and under SC-I and SC-II structures. The inspector should determine whether these materials have been qualified through explorations and testing by a soils testing laboratory and whether they are stockpiled in designated areas. Excavated materials to be used as SC-I and SC-II structural fill, should be excavated in layers, so that widely varying soil classes are not mixed. Some of the more common tests used for qualifying soils materials, and their associated standards, are:
 - (a) Moisture/density relationships, ASTM D-698 or D-1557;
 - (b) Soil-classification tests, ASTM D-2487;
 - (c) Particle-size analysis, ASTM D-422;
 - (d) Test for plastic limit and plasticity index, ASTM D-424; and
 - (e) Other Codes and Standards, as listed in ASME NQA-1.

A geotechnical engineer should control acceptance and qualification of excavated materials.

- b. Foundation Verification - Undisturbed Soil. A geotechnical engineer should approve soil subgrades before placement of engineered fill, mud mats, or structural concrete. Compaction is the usual method to treat or stabilize loose, disturbed, or unsuitable

- c. areas in soil subgrades. The inspector should determine whether appropriate sampling and testing procedures are included to verify the material in place is as specified. Common tests used to verify that foundation subgrades meet design specifications are listed in Appendix B, "Methods of Subsurface Exploration", of Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants."
- d. Backfilling. In some instances, preparation for foundations may consist merely of excavation and grading to appropriate dimensions. However, in many locations, the top layer of native site material may be too soft, or otherwise unsuitable, to properly support the structures. In this case, some special comp active effort may be required. Occasionally, adequate compaction may be achieved on the native material in place in conjunction with careful control of groundwater level. More typically, it will be necessary to remove the native material and fill the resultant excavation under carefully controlled procedures, in relatively thin layers, sequentially compacted.

Before placing engineered fills, materials and compaction requirements should be qualified by laboratory tests and test fills. Required moisture/density relationships for each material should be determined in accordance with either ASTM D-698 or ASTM D-1557. The inspector should be assured that the specified method is being used. Where impervious materials are used, qualification tests should include determination of the Atterberg Limits ("Liquid Limit, Plastic Limit and Plasticity Index", ASTM D-4318). Particle-size analysis should also be made, as specified by test methods in ASTM D-422 and ASTM D-1140.

Test fills for each material type should be made to determine lift thickness, type of compaction equipment, and number of passes to be used in compacting fills to specified densities.

In-process testing used to control fill placement, for the most part, will be density tests and moisture tests. Acceptance will be in terms of some percentage of the maximum dry density (usually 95 percent) and a moisture content within some percentage of optimum (usually 2 percent) as determined by ASTM D-698 or ASTM D-1557. Density tests may be made by test methods ASTM D-1556 (most common method used); ASTM D-2167; ASTM D-2922, or ASTM D-2937. Test-method ASTM D-2922, the nuclear method, must be calibrated against a reliable direct method.

Control of moisture content at time of compaction is extremely important, especially with materials having more than 12 percent passing a No. 200 sieve. Testing and research has demonstrated that variation of the moisture content of a material, at time of compaction, even though it has been compacted to the same dry density, has a wide-ranging effect on the shear strength, permeability, and consolidation characteristics of the material. Ultimate control of moisture should be by test-method ASTM D-2216, "Laboratory Determination of Moisture Content of Soil". Rapid methods, such as the "Speedy" and field stoves, are sometimes used to expedite operations, because of the time required for test-method ASTM D-2216. Where rapid methods are used, they should be calibrated against ASTM D-2216, and their variation taken into consideration in controlling moisture content of the fill. For example, if the specified moisture control is 2 percent of optimum and calibration checks show that the rapid method varies by 1 percent from ASTM D-2216, then field

control using the rapid method should be held to 1 percent of optimum. Field-stove methods should be limited to granular materials, with little or no fines, since experience shows results with impervious materials are erratic (probably because of driving off the water of hydration).

- d. Dewatering Systems. Some degree of groundwater control will be required, at least during site preparation and foundation placement. Groundwater removal may be required to properly compact the soil-bearing area. The design may require that groundwater be permanently maintained below some specified elevation.

Excavations and placement of fill and foundations must be in the dry state. Discharge outlets of dewatering systems should be monitored for sediment content, to assure that subgrades are not being undermined. Dewatering systems, if not properly designed, installed, and operated, can have an adverse effect on foundations. Improper design and operation can, and have, resulted in undermining of foundations through removal of sediment with the discharge water. The inspector should assure himself that careful consideration has been given to the impact that the installation, operation, shutting down, and decommissioning of the system will have on foundation design. Through observations, the inspector should satisfy himself that the system has been installed and is being monitored as specified. Piezometers or observation wells should be used in conjunction with the dewatering system, to monitor the groundwater surface and pore pressure beneath the subgrade and adjacent ground.

Acceptable methods for installation and maintenance of piezometers and observation wells are presented in the U.S. Army Corps of Engineers Manual, EM 1110-2-1908, 1972.

- e. Testing Laboratory. Acceptance of all earthwork onsite, including verification of soil foundations, engineered fill and backfill, for the most part, will be based on testing done by the site-soil laboratory. The inspector should routinely check the soils laboratory during inspections. The inspector should ensure that work is being done in accordance with specified methods and with specified equipment that is periodically calibrated for accuracy. Testing personnel should check data calculations for accuracy and the inspector should spot check them.

Qualifications of testing personnel should be checked by personal interviews, examination of certification records, and licensee's procedures and records, to verify contractor's qualification records.

- f. Instrumentation- and Settlement-Monitoring Programs. Instrumentation will, for the most part, consist of settlement monuments for monitoring settlement and piezometers, or well points for monitoring the groundwater surface and pore pressure. Specific guidance regarding their use, installation, and maintenance is presented in the U.S. Army Corps of Engineers Manual EM 1110-2-1908. The inspector should ensure that the instrumentation is installed as specified, is adequate for the intended use, and that accuracy of the data recorded is sufficient to provide needed information. The instruments should be monitored periodically, throughout construction, and, if needed, post-construction.

69020.A1-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A1-05 REFERENCES

Office of Inspection and Enforcement, IE Circular No. 81-08, "Foundation Materials", May 29, 1981.

U.S. Army Corps of Engineers, "Instrumentation of Earth and Rock-Fill Dams (Groundwater and Pore Pressure Observations)", Engineer Manual EM 1110-2-1908.

U.S. Army Corps of Engineers, "Soil Sampling", Engineer Manual EM 1110-2-1907.

U.S. Department of the Army, "Dewatering and Groundwater Control for Deep Excavations", Technical Manual TM 5-818-5.

U.S. Department of the Army, "Grouting Methods and Equipment", Technical Manual TM 5-818-6.

American Society of Testing and Materials, ASTM D-422, "Particle Size Analysis of Soils".

American Society of Testing and Materials, ASTM D-653, "Terms and Symbols Relating to Soil and Rock"

American Society of Testing and Materials, ASTM D-698, "Moisture-Density Relations of Soils".

American Society of Testing and Materials, ASTM D-1140, "Test for Amount of Material in Soils Finer than No. 200 Sieve".

American Society of Testing and Materials, ASTM D-1143, "Testing Piles under Axial Compressive Load".

American Society of Testing and Materials, ASTM D-1452, "Practice for Soil Investigations and Sampling by Auger Borings".

American Society of Testing and Materials, ASTM D-1556, "Test for Density of Soil in Place by the Sand-Cone Method".

American Society of Testing and Materials, ASTM D-1557, "Moisture-Density Relations of Soils".

American Society of Testing and Materials, ASTM D-1586, "Penetration Test and Split-Barrel Sampling of Soils".

American Society of Testing and Materials, ASTM D-2049, "Test for Relative Density of Cohesion less Soils".

American Society of Testing and Materials, ASTM D-2167, "Test for Density of Soil In place by the Rubber-Balloon Method".

American Society of Testing and Materials, ASTM D-2216, "Laboratory Moisture Content of Soil".

American Society of Testing and Materials, ASTM D-2487, "Classification of Soils for Engineering Purposes".

American Society of Testing and Materials, ASTM D-2488, "Practice for Description and Identification of Soils".

American Society of Testing and Materials, ASTM D-2922, "Tests for Density of Soil and Soil-Aggregate In place by Nuclear Methods (Shallow Depth)".

American Society of Testing and Materials, ASTM D-2937, "Test for Density of Soil In place by the Drive-Cylinder Method".

American Society of Testing and Materials, ASTM D-3017, "Moisture Content of Soil and Aggregate in Place by Nuclear Methods".

American Society of Testing and Materials, ASTM D-4253, "Test Methods for Maximum Index Density of Soils and Calculation of Relative Density"

American Society of Testing and Materials, ASTM D-4318, "Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils".

END

APPENDIX B

INSPECTION OF STRUCTURAL CONCRETE AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A2-01 INSPECTION OBJECTIVES

01.02 To determine whether structural concrete work and related quality control activities for Seismic Category I (SC-1) and Seismic Category 2 (SC-2) structures are being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to structural concrete activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of structural concrete structures meets the specified design requirements, specifications and drawings. For foundations and buildings, also refer to Appendix A of this inspection procedure (IP). For steel components, also refer to Appendix C of this IP.

01.04 To determine if the implementation of the quality assurance program related to work activities associated with structural concrete is effective and to verify that deviations from requirements are appropriately resolved.

69020.A2-02 INSPECTION REQUIREMENTS

02.01 Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with structural concrete construction activities at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify any weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for structural concrete work on-site at the time of the inspection, with SC-1 work being preferable to SC-2 work when available. Inspectors should also coordinate this appendix with inspection of foundations and buildings (Appendix A of this IP), and structural steel and supports (Appendix C of this IP) for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to determine what work activities are to be inspected. Observation during in-progress construction is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all structural concrete on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of structural concrete work activities arise.

Inspectors should collect licensee procedures, work activity specifications and work completion records in advance, if possible. If unable to review them in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.06 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review construction specifications related to structural concrete construction and ascertain whether the specified technical requirements conform to the commitments contained in the licensing basis. Review concrete construction procedures and verify that they specify provisions for adequate on-site engineering direction, are appropriate and adequate related to procurement and use of materials, specify adequate control of hold points, and provide adequate controls for design changes and incorporation of design changes into as-built drawings. Determine if appropriate and adequate procedures in the following areas are compatible with the QA program, and prescribe adequate methods to meet the construction specifications, where applicable:

- a. Qualification of materials (cement, water, aggregate, and admixtures).
- b. Concrete mix design.
- c. Concrete batch plant.
- d. Preplacement activities (concrete forms, rebar and splices, embedded items, cleanliness, and inspection).
- e. In-process testing of plastic concrete (slump, entrained air, temperature, unit weight, and cast cylinders).
- f. Concrete placement activities and inspection of concrete placement activities.
- g. Post-placement activities (adequate curing and identification and repair of defects).
- h. Evaluation and review of concrete test results.
- i. Engineering direction.
- j. Qualifications of QC personnel.

02.03 Ascertain whether the following applicable structural concrete construction activities are being controlled and accomplished in accordance with the requirements of the documents reviewed in 02.02, above:

- a. Qualification of materials - Review the qualification testing for the materials (cement, water, aggregate, and admixtures) selected for use in the concrete. Review the qualification tests for other hardware associated with structural concrete, such as reinforcing steel, rebar splices, curing compounds, embedded items, etc.
- b. Concrete mix design - Review the concrete mix designs, supporting material qualifications, and testing to be used in SC-I and SC-II structures. If more than three concrete mix designs are used, review a sample of the highest strength or most-used mixes, and the associated material qualifications.

- c. Concrete batch plant. Verify the following:
1. Batch plant has been inspected and certified to the appropriate standards. Scales and meters are calibrated at necessary frequency and to specified tolerances. Mixer-efficiency tests are being performed in accordance with American Society for Testing and Materials (ASTM) C-94 (or the committed standard in the licensing basis), at proper intervals. Batch plant is inspected to verify equipment performs properly - rotation speed, timing, and blade wear are not excessive. There should be no contamination of materials or concrete mix. Batch records are generated, controlled, and indicate placement location, mix, volume, date, time, and special instructions.
 2. Materials are properly qualified and traceable to approved sources. Storage and handling of materials are controlled:
 - (a) Cement (and fly ash, if used) are protected from moisture;
 - (b) Aggregate is not subject to excessive segregation of sizes or contamination from debris, dirt, other materials, or mixing with other sizes of aggregates;
 - (c) Admixtures are prevented from freezing; and
 - (d) There are provisions for production of concrete in hot weather (replacing water with ice in concrete mix) and cold weather (heating mix water).
 3. Batch water-quality requirements are met and water is adjusted to account for moisture-content of aggregates. Aggregate moisture-content tests are representative of actual stockpile conditions and are taken periodically, during daily concrete production.
 4. Concrete transporting equipment is suitable and in an acceptable condition.
- d. Preplacement activities (concrete forms, rebar and splices, embedded items, cleanliness, and inspection). Verify the following items have been implemented:
1. Reinforcing steel and embedment's, such as anchor bolts, water stops, or embedded plates, are installed in accordance with specifications, codes, drawings, and procedures. Reinforcing steel size, spacing, lap and mechanical splices, and embedment's, are located properly within the forms, are secured and clean (i.e., free from oil, paint, weak dried mortar, dried mud, loose rust, etc.) and have proper clearances. The areas where embedded plates with anchors such as Nelson studs are to be set in concrete should have sufficient concrete to provide bond and should not be excessively congested with reinforcing steel. Reinforcing steel bending is properly performed and controlled. Piping or conduit embedment's in or through concrete should be capped or plugged before to concrete placement.
 2. Mechanical Rebar Splices. Verify the following:
 - (a) Process (e.g., cadweld or bar-lock couplers) and crews are qualified.

- (b) Each splice is defined by materials used, location, crew, type of splice, and heat number (if applicable).
 - (c) Sampling and testing are performed at proper frequency and acceptance criteria are defined.
 - (d) Inspections are performed during and after splicing by qualified inspection personnel.
3. Preplacement planning and training have been completed, as required, to ensure good-quality construction, and to protect against unplanned construction joints.
 4. The placement has been cleaned and joint preparation is as specified in the construction specification. Locations of construction joints are as shown on the drawings. Forms are secure, leak-proof, and free from water, ice, or snow. The QC pre-placement inspection should be completed before any concrete is placed. Records should document that all preplacement inspections have been completed.
 5. The equipment to deliver concrete to the actual placement location is suitable and in an acceptable condition - conveyors, lines, pumps, buckets, etc. Ensure that there are enough concrete vibrators on hand, with extras on standby, for consolidating concrete. Sufficient access available to placement location for vibrator operators, concrete placement equipment, inspection personnel, and other craftsman. Adequate preparations for curing, protection from rain, and hot or cold weather protection are completed before the start of concrete placement activities.
- e. In-process testing of plastic concrete. The following items should be verified in the review of the testing program conducted during concrete placement:
1. Concrete is sampled at the proper frequency for determination of temperature, slump, air content, and unit weight.
 2. Taking of a sample and testing techniques conform to the procedures specified in applicable ASTM standards. Samples for pumped concrete are required to be obtained from the end of pump line, at point of placement.
 3. Test specimens (cylinders), for concrete strength testing are sampled at the required location and frequency. Cylinders are molded, handled, and cured in accordance with specified requirements. Curing boxes are available to properly store and cure cylinders for the first 24 hours, per the requirements of ASTM C-31 (if applicable).
 4. Testing apparatuses in the onsite laboratory used to perform testing on materials and plastic concrete are being calibrated at the required frequency. Observed testing conforms to the procedures specified in the applicable ASTM standards.

5. Personnel performing sampling and testing are trained and qualified.
 6. Concrete-testing personnel have authority to reject concrete batches not meeting specification requirements.
- f. Concrete placement activities.
1. Concrete batch tickets are reviewed for verification of proper mix, placement location, and amount of water, if any, withheld from the batch. The quantity of withheld water, also referred to as retempering water, is determined based on the maximum water-cement ratio. Time limit (normal maximum of 1.5 hours) between mixing and delivery has not been exceeded, and the total number of revolutions of the truck mixer does not exceed 300. (See ASTM C-94.)
 2. Specification temperature limits have been met.
 3. Addition of super water-reducing (super plasticizers) admixtures to concrete batches are controlled. When admixtures or withheld water are added after concrete is discharged from batch plant, remixing in the truck for a minimum of an additional 30 revolutions of the truck mixer is required to conform to ASTM C94, on uniformity of mix. After addition of super plasticizers or withheld water and remixing, slump tests should be performed to confirm the slump is within specification limits.
 4. Placement drop distances do not exceed specification requirements and do not result in segregation.
 5. Vibrators are approved, tested for frequency, and are used properly by trained individuals.
 6. Special attention is given to areas of high reinforcing or embedment steel congestion, to preclude areas of voids or honeycombing.
 7. Inspections during placement are performed as required and by qualified personnel.
 8. Records are produced, reviewed, and indicate mix, location, time placed, water additions, and temperature of the concrete mix and ambient conditions. Records reflect the results of inspections, the actual field conditions, testing frequency requirements, and that data calculations are checked.
- g. Post-placement Activities (adequate curing and identification and repair of defects)
1. Verify that curing is performed in accordance with specifications and procedures with regard to the method, materials, duration, and temperature (concrete and ambient). Verify that inspections (during curing and after form removal) are performed and documented in QC records.

2. Verify that concrete placements are inspected after form removal to identify any defects in concrete. Examples of defects are voids (honey comb), cold joints, excessive cracking, delamination's, excessive entrapped air voids (bug holes), or evidence of form-related defects such as sand streaking or inadequate bracing. All identified defects require documentation, evaluation, and repair, in accordance with the licensee's QA program.

h. Evaluation and Review of Concrete Test Results

Verify that the final inspection results after form removal, test results, and other information related to the placement (including deficiencies, defects, etc.) have been reviewed before acceptance of the placement, and that the as-built documentation is complete. Verify test results are evaluated at an appropriate level and evaluation includes trending analysis. All non-conforming conditions identified during concrete construction activities require documentation, evaluation, and repair, in accordance with the licensee's QA program.

i. Engineering Direction.

Verify that engineering direction is available, onsite, to monitor structural concrete construction activities. The onsite engineering staff should be supplemented by an experienced structural engineer to approve design changes, monitor and review QC test results, and identify changed conditions. The onsite engineering staff should be involved in disposition of nonconformance reports, and preparation of field change requests, for approval by the design-engineering organization.

j. Qualifications of QC Personnel

Verify that personnel qualifications (education and experience) of testing and inspection personnel have been verified by the employing organization. Personnel qualifications must be supported by documentation. Informal interviews may be conducted with QC inspection personnel to determine how well the QC inspectors know the requirements of their work activity. Ascertain whether a sufficient number of adequately qualified QC personnel are at the construction site, commensurate with the work in progress, and adequately performing their assigned duties through the established organizational structure.

02.04 Special Considerations - The following items should be incorporated in the inspection of concrete placements when appropriate (refer to American Concrete Institute standards for additional guidance):

- a. Hot and Cold Weather - Provisions for maintaining concrete temperature within specification must be provided. Hot and cold weather conditions must be defined, to avoid confusion.
- b. Pumping Concrete - Slump and air-content losses must be monitored to ensure placement and adequate consolidation. Samples for pumped concrete are required to be obtained from end of pump line, at point of placement.

- c. Large Placements - Planning sessions must assure consideration of all contingencies, [e.g., adverse weather, loss of power, concrete production delays (batch plant breakdowns)].

02.05 Determine whether the licensee has an established audit program (including plans, procedures, and schedule) covering the SC-I and SC-II work control functions, in the area of structural concrete construction activities. An audit program should review by examination of objective evidence that construction personnel who perform structural concrete construction work are qualified to perform their assigned work.

02.06 Review the documentation generated for structural concrete construction activities. Determine whether the licensee/contractor system for documenting safety-related work is functioning properly. The record-keeping activities should reflect the actual conditions encountered in the field and provide adequate documentation of work and inspections. Determine whether records are being maintained, reviewed, and approved, as specified. This is important in activities such as review of concrete strength. A comparison of the actual concrete strength can help in determining the reason for low strengths relatively early in the construction phase, before the completion of extensive concrete work. Records should include sufficient detail to document that: (1) rebar installation met requirements; (2) the concrete strength meets design requirements; (3) curing was adequate; and (4) repairs, if necessary, completed in accordance with design requirements. Records should be legible, complete, reviewed by QC and/or engineering personnel, and readily retrievable. Review a sample of the following records:

- a. Receipt Inspection and Material Certification.

Applicable for materials purchased from offsite suppliers, such as cement, concrete aggregate (sand and gravel), concrete admixtures, and reinforcing steel, splices, and other components. Records confirm that required material characteristics, performance tests, nondestructive test, and other specification requirements were met.

- b. Installation Inspection.

1. Records confirm that concrete production, concrete placement, and installation of components were performed as specified.
2. Records confirm that the required inspections (including concrete form removal) were performed and acceptance criteria defined.
3. Records indicate specified concrete strength was obtained.

- c. Nonconformance/Deviation Record - Records include current status of these items. Nonconformance reports include the status of corrective action or resolution e.g., if adequate corrective action were taken when concrete vibration was determined to be inadequate, or concrete strength-test results were not within acceptance criteria.
- d. Training/Qualification Records of Craft, QA, and QC Personnel - Records establish that QA/QC personnel are adequately qualified to perform their assigned duties and

responsibilities and that craft personnel have been trained in their assigned tasks. Records are complete and current and show which activities inspectors are qualified to perform.

- e. QA Audits - Records establish that the required audits were performed and that deficiencies identified during audits were corrected, and that corrective action was such that repetition of the deficiency, or similar deficiencies, would be precluded.

69020.A2-03 ADDITIONAL GUIDANCE

03.01 General Guidance.

The American Concrete Institute "Manual of Concrete Inspection" is a good reference, which may be used during the conduct of this inspection. However, the licensee's specific documents, which include specifications, drawings, and procedures, specify and control the construction and inspection processes.

Before any concrete placement, a specific technical review of concrete-mix designs and supporting material qualifications should be performed. The inspectors should also verify that the batch plant has been inspected and certified before placement of any safety-related concrete. QA/QC inspection and construction procedures should be reviewed and compared with the requirements of the applicable codes and construction specifications. The technical adequacy of implementing construction and QC procedures must be determined. For these reasons, this inspection procedure should be performed by an inspector who is able to evaluate civil engineering activities.

The licensee is responsible for implementing, or having implemented, the approved QA program and the commitments described in the licensing basis and construction application. The inspector must determine if this program is implemented in an adequate and manner for the work that is important-to-safety. QA/QC procedures must provide for effective inspections which will ensure that work is performed in accordance with specification requirements. Laboratory and field-testing procedures must provide for verification of correct material usage and correct selection of reference standards. The testing procedures should include a prohibition against contractor QC personnel from making a discretionary selection of inspection and testing parameters. Qualified personnel should review test results and determine if results are acceptable. Construction procedures must reference the required inspection hold points and must also address the QA/QC department stop-work authority.

Specific information about the licensee's plans and schedules for performing comprehensive audits and on-going surveillance of concrete construction activities should be reviewed during this inspection. Information should be obtained concerning audit procedures, schedules, scope, and auditor qualifications. Licensee onsite QA staffing and surveillance plans should ensure that QC activities are sufficiently monitored and evaluated. QA audits should identify procedural inadequacies and the root-cause of repetitive nonconforming conditions. Inspections should require verification of specified controls and should not be accomplished merely by surveillance. Evaluations should

result in an indication that all quality-related construction and inspections will be adequately performed by qualified personnel and will be based on appropriate criteria and further, that the results of inspections will be transmitted to responsible QA and management personnel.

03.02 Specific Guidance

Note: The numbering of the guidance below refers to specific subsections of 02, above.

02.01 Specific attention should be given to the QA program needs that may result from distribution of design and construction responsibilities. Examples of these needs may be: provisions for adequate onsite engineering direction; appropriate and adequate procedures related to procurement and use of materials; and adequate control of hold points.

02.02 The construction specification must translate design requirements into details sufficient to define the technical requirements for concrete construction activities. The specifications should provide for control of design changes and the issuance of design change notices. The review of procedures, specifications, and drawings should ensure that concrete construction and inspection activities are controlled and performed in accordance with applicable requirements. QA/QC procedures should specify acceptance-testing requirements and should specify the personnel and interface responsibilities required to define, control, and resolve field problems or design problems that are evidenced during construction. QA/QC procedures must provide for effective inspections that will assure that work is performed in accordance with specification requirements. The procedures should require verification of specified controls and should not be accomplished merely by surveillance. Laboratory and field-testing procedures must provide for verification of correct material usage, correct selection of reference standards, and should prohibit discretionary selection of inspection and testing parameters. Construction procedures must reference the required inspection hold points and must also address the QA department authority to stop work.

02.03a. Qualification of Materials

Chemical and physical tests for all materials used must indicate that specifications have been met. Testing should be performed at the required frequencies. Tests results may be provided by the manufacturers via certified materials test reports, or may be performed at an independent or in the onsite testing laboratory. Test results should be reviewed for the following materials:

- (a) Concrete-mix materials (cement, fly ash, sand, aggregate, water, admixtures, etc.) and all constituents used in other cement-like materials, such as gunite, grout, dry pack or manufactured materials such as epoxy;
- (b) Reinforcing steel;
- (c) Reinforcing splicing materials;
- (d) Waterproof membranes, water stops, joint materials and sealants;

- (e) Embedded mechanical items such as piping, conduit, mechanical and electrical penetrations (sleeves), sumps, drains, and grating material, etc.;
- (f) Off-the-shelf anchorage components and embedment's (bolts, hangers, inserts, etc.), and embedded structural steel items (shear connectors, embedded plates, etc.);
- (g) Materials used during construction such as for construction joint preparation, form-release agents, and curing compounds; and
- (h) Other structural concrete materials that may be used.

0203b. Concrete-Mix Design

A concrete-mix design must be completed for each type/strength of concrete mix to be used in SC-I and SC-II structures. The mix design must be completed using the qualified materials (see 02.03a, above), sufficiently in advance of the planned concrete-placement start dates, to demonstrate that the concrete mix will satisfy the job requirements for slump, air entrainment, strength and any other specified parameters. Test cylinders need to be molded, cured and tested to demonstrate that the required design requirements will be achieved within the specified time period (e.g., 7, 28, or 90 days). It is not an acceptable practice to attempt to base the final concrete design strength on incomplete test results (e.g., estimating the 28-day strength, based on results of test cylinders tested at ages of 7 and 14 days). If the sources of materials used in the concrete are changed, new mix designs need to be qualified, before placement into SC-1 and SC-2 structures.

02.03c. Concrete Batch Plant

Concrete batch plants providing concrete for use at nuclear facilities must be certified under the NRMCA program. This certification provides evidence that a registered professional engineer has reviewed the facility and has seen evidence that certain necessary capabilities exist to produce quality concrete. Any other batch-plant certification should include the inspection attributes, listed in the NRMCA checklist, which are used to inspect the facility before any recommendation for certification. As part of the certification process, concrete uniformity testing must be performed in accordance with ASTM C-94, at periodic intervals. Verify that the batch plant scales have been calibrated through their full range of use on the project. Water meters and admixture dispensers also require calibration. During observation of concrete batching operations, verify that the scales rezero after each batch.

Materials need to be properly stored at the batch plant. Non-conforming or unqualified materials are required to be segregated from qualified materials. Storage of cement and admixtures require control so that shelf life is controlled

and older materials are used before recently received materials. Cement and fly ash are required to be protected from moisture. Generally, cement should be used within 180 days of manufacture. Admixtures must be used within the shelf life specified by the vendor.

Admixtures need to be protected from freezing. An adequate supply of all materials needs to be available at the batch plant, to complete the placement, with sufficient reserves of materials to make up for concrete batches that may be rejected because of noncompliance with specification requirements.

Potable water is generally suitable for making concrete. However testing (chemical analysis) of the water should be performed to verify that it does not contain impurities that may be detrimental to the concrete or reinforcing steel. Also, concrete should be batched using site water and compared to concrete batched using distilled water. In this test, the normally accepted standard is that the site water is deemed acceptable if samples batched from site water do not result in a reduction in strength of more than 10 percent less than samples batched using distilled water. The moisture content determination of aggregates is an important test to accurately calculate the total water in each batch of concrete. Fine and coarse-aggregate-moisture-content testing needs to be performed periodically, throughout daily concrete production. Frequency of testing will be determined based on weather conditions and variations in the moisture content.

Trucks used to transport concrete from the batch plant to the job site need to be inspected to ensure that they are clean and free from dirt/debris and/or water which could become mixed with, and contaminate, the concrete. Truck mixers need to be certified in accordance with NRCMA standards. The certification process also requires concrete uniformity testing in accordance with ASTM C-94, at periodic intervals, if mixing of the concrete is performed in the trucks, or water or other ingredients are added to the concrete batch after the concrete is discharged from the batch plant. Verify that the drum revolution counters are operable and reset after each batch is discharged.

02.03d. Preplacement Activities

Storage of reinforcing steel should be examined to verify that storage conditions are adequate to ensure that rebar will not become contaminated with materials such as mud, excessive rust, grease, oil, etc., which could affect the bonding of the rebar and concrete. Completed reinforcement placement should be checked for size, spacing, splice locations, bending, proper clearances from face of forms or excavated surfaces (i. e., verify rebar will have minimum required cover, in addition to the correct "d" distance), and anchorage. Reinforcing steel needs to be free from oil, grease, paint, loose rust, dried mud, weak mortar, etc. The steel needs to be firmly held within the forms (usually tie wire is used), to prevent the rebar from being displaced by movement of the plastic concrete, or by other construction activities, such as concrete vibration, or by movement of construction personnel in the form areas. Particular attention needs to be

directed to installation of column ties, stirrups, and dowels. Verify that other hardware items to be embedded in the concrete placement are clean, properly located, and firmly anchored. Verify that pre-placements of electrical and instrument grounding grids and embedded connection plates are correct. Also, verify proper testing of the building ground mat.

Review the mechanical splicing instructions issued by the vendor. This document usually specifies the proper performance of all mechanical splicing operations. Ascertain whether it is being used.

1. Cadwelding

When Cadwelding operations are being performed, verify that specified materials (sleeves, powder, and packing) are properly stored, and that Cadwelding fixtures are in good condition. The reinforcing steel to be Cadwelded should be cleaned shortly before Cadwelding, to remove all non-adherent rust. The reinforcing steel ends should be aligned and butted within the tolerances specified, using the spacers provided with the cadweld kits.

Observe the placement of sleeves and the use of a marking system to ensure centering. When the firing is completed and packing removed, examine the sleeve and reinforcing steel to ensure that metal is showing at the vent (no slag at the tap hole), and each end of the sleeve shows proper fill (allowable void area not exceeded).

Ascertain whether each Cadweld sleeve is identified. By interviews with two Cadwelding inspectors, ascertain whether they are familiar with the details of Cadwelding requirements; also determine whether inspection of Cadwelding conforms to the specified frequency, whether inspection (QC) records are being maintained, and whether records are traceable to installation location, and identification of the cadwelder (craftsman).

2. Other types of mechanical splices, (e.g., Bar-Lock splices, if used)

Verify that the NRC has approved use of the type splice. Review the CAR, SER, and manufacturer's instructions to determine specific installation and testing requirements. Review the laboratory test data used to qualify the splices and verify that the licensee's installation procedures will result in an installed configuration that will reflect the laboratory testing conditions. Typical inspection parameters for all types of mechanical splices require cleanliness of the ends of the rebar to be spliced, verification of adequate embedment of the rebar ends, within the splicing sleeve, and verification that the sleeve is centered over the ends of both bars to be spliced. Identification of each splice and the craftsman/crew who completed the splice is also generally required. All craftsmen are required to be trained. All splices require inspection and acceptance by qualified QA/QC inspectors. A testing program will normally be specified to ensure the splices fabricated at the job site meet design requirements.

The area where concrete is to be placed needs to be clean and free of debris. Materials such as sawdust, wood, dried mortar, tie wire, and other debris need to be removed from the forms before placement of concrete. Access ports are usually provided in the forms to permit cleaning and inspection. Water jets and/or compressed air should be used for cleaning.

Forms must be well secured and braced so they will not be displaced by the fresh concrete or concrete-placement activities. The permitted rate of rise of the fresh concrete needs to be specified to avoid excessive loads on the forms caused by hydraulic forces from the fresh concrete.

Otherwise, there could be form failures (blow-outs) resulting in injuries to construction personal and/or damage to safety-related structures or components. Inspection personnel must inspect pre-placements within a timeframe that represents the actual conditions before the placement. Quality control pre-placement inspections must not be unnecessarily rushed by advancing concrete work, especially during large slab or basemat placements. When possible, verify the actual as-built condition of reinforcing steel, with respect to the engineering drawings. If deviations exist, verify that proper engineering evaluations have been performed. Records need to document that all pre-placement construction and inspection activities have been completed. Concrete surfaces (joints) on which additional concrete is to be placed should be roughened, and all loose materials removed to ensure good bonding of the new concrete to existing concrete.

The joints should be kept damp for a specified period, usually 12 to 24 hours, before concrete placement. There should be no standing water in the forms.

In addition to having adequate equipment available to complete the concrete placement, extra equipment, such as vibrators, concrete trucks, and concrete pumps need to be available. Enough personnel need to be available, to fill in; and to keep concrete placement personnel from becoming fatigued by long work hours, which could lead to errors and substandard construction. Necessary equipment needs to be available to form construction joints on short notice, in case of an unforeseen stoppage of the concrete placement. Equipment needs to be available to protect the new concrete from all weather conditions, including rain, heat and cold.

02.03e. Placement Activities

The practice of withholding water at the batch plant and then tempering at the point of placement should take into account the results of air content and slump measurements taken at the point of placement. Efficient radio communications between the batch plant and field QC testing personnel will minimize the need for water tempering at the point of placement and thus result in more uniform batching. Check time (90 minutes max) of concrete receipt for truck transported, centrally mixed concrete, and number of truck-mixer revolutions (300 max). Also, verify the amount (quantity should be documented) of water added, if permitted,

and re mixing (minimum 30 revolutions).

Concrete should not strike forms or bounce against reinforcing bars causing segregation of aggregates from the mix.

There should be a sufficient number of vibrator operators and, preferably, some spare vibrators, should be checked for proper operation, before starting to place concrete. Vibrators less than (3 inches) diameter are generally designed to operate at about 7000-8000 vibrations per minute, when immersed in concrete. Large vibrators, used in heavy-section concrete placement, operate at about 6000 vibrations per minute. Vibrators less than (3 inches) in diameter can be operated by one man; (4 inches) or larger vibrators are two-man tools. Proper vibrator operation involves duration of vibration, distance between vibrator insertions, and depth of insertions. The vibrators should be handled and operated vertically and never "cast" away from the operator horizontally and then retrieved. Concrete should be placed horizontally, in about (12 inch) layers, and never allowed to pile much higher in one area of the form than another. The vibrator should penetrate through the new concrete well into the previously placed layer, to avoid any "layer-cake" effect. Occasional contact of a vibrator with the forms is permissible, and with the reinforcement is desirable. Form vibration is generally not desirable, and care should be taken that reinforcement is not displaced by vibrators, or by people walking on the steel. Vibrators should not be used to move concrete laterally. Any excess water in the forms should be removed and not permitted to mix with the concrete.

02.03f. Post-placement Activities

The concrete needs to be protected from damage and properly cured. Proper curing requires keeping the surface of the concrete moist, and, in cold weather, warm, so that hydration of the cement continues until the concrete achieves design strength. Curing can be accomplished using moisture (water sprays, etc.) or by use of a curing compound. However curing compounds should not be used on construction joints unless they are removed prior to the next placement. Curing compounds used on construction joints may act as a bond breaker and result in successive placements not achieving good bond. Minimum curing times should be specified in the construction records. Formation of ice (freezing of the curing water) on surfaces of the concrete during the curing period should not be permitted. Forms need to remain in place for the period specified in the procedures. The time to remove the concrete forms is often based on achieving a minimum concrete strength.

Defective areas in concrete should be repaired as soon as possible after the forms are removed. Design engineering approval should be obtained for all concrete repair methods. It is not acceptable to repair concrete defects by merely plastering over them with mortar. Concrete defects need to be cut to a depth to expose sound concrete and filled with concrete of the same strength as that in the structure. Repair of defects are usually classified as cosmetic if they are shallow surface defects, and structural if they extend to a depth below the

outer layer of rebar. Locations of concrete defects and repair methods need to be documented in licensee inspection records. Note that areas repaired are required to be protected from the elements and cured to achieve adequate design strength.

02.03g Evaluation and Review of Concrete Test Results

This portion of the inspection may require subsequent follow-up, to determine that final inspection, evaluation, and acceptance are being controlled and accomplished in accordance with QA/QC requirements. Final inspection procedures should include verifying embed locations and identification of any defects and required repairs. Review the results of compressive strength determinations. Verify that results are being evaluated in accordance with ACI 214, Recommended Practice for Evaluation of Compression Test Results of Field Concrete". During this portion of the inspection, also review the results of strength tests on mechanical reinforcing steel splices.

Records should be verified to show that mix specified was delivered and placed. Structural drawings or specifications will indicate the design concrete strength. Evaluate the licensee's trending analysis of nonconforming items and determine if generic items are being identified and corrected.

02.03h Qualification of QC Personnel

Particular attention should be directed toward the qualification of personnel and their work performance. In the past, at some projects, there was a tendency for some organizations to hire untrained personnel residing near the site who had no prior work experience in concrete materials testing or inspection, train them, and certify them. Although the individuals were trained and certified, in some instances inexperience of personnel and the lack of depth of knowledge was been found to be detrimental to an effective QA/QC program. Changing of personnel between different jobs and turnover of personnel can also result in problems.

In determining the adequacy of QA/QC staffing; the effectiveness of their activities must be considered. Insufficient or unqualified personnel, or inadequate management, may result in inadequate inspections of concrete-construction activities. Capabilities and effectiveness, rather than only the number of personnel, are the principal criteria to be used.

02.04a During periods when concrete is to be placed or cold weather is expected during the curing time, provisions must be made to keep the concrete above [40 degrees Fahrenheit (F)], preferably in the range of [(50 to 60 degrees F)]. If concrete is being mixed or transported in weather below (40 degrees F), the ingredients may be pre-warmed so that the temperature of the concrete after placement is elevated to account for losses. Heating the water is the most effective and most easily controlled technique, but the aggregate must not be frozen. The water should not be so hot as to cause "flash set" of the cement

during mixing; that is, the temperature of the mortar should not exceed (100 degrees F). If hotter water is required to warm the aggregate, the water and aggregate may be mixed before addition of cement. If the aggregate is heated, close control must be exercised, and the aggregate must be frequently checked for variations in moisture content caused by local variations in heating.

Direct fired heaters may produce carbon dioxide, in the exhaust fumes, forming calcium carbonate on the surface of fresh concrete. Also, use of chemicals should not be permitted to accelerate the concrete set times in cold weather.

Where the ambient temperature during concreting rises much above (70 degrees F), consideration must be given to the effect of high temperatures on the concrete. Although concrete cured at temperatures up to (100 degrees F) gives higher early strength, with little degradation of long-term strength, high temperatures during mixing, transportation, and placement can be seriously detrimental. The most obvious effect is that the concrete requires more water for work ability or the use of additives. A less obvious effect is the need for special attention to curing, because the higher temperature increases water evaporation from the concrete.

Exposure to strong summer sun can raise the temperature of ingredients, equipment, forms, etc., far above the air temperature. If this occurs, provisions should be made for appropriate shades or screens, and the equipment, forms, and metallic embedment's, etc., should be wetted just before concrete placement. If the ambient temperature is high enough so that the bulk temperature of freshly mixed concrete exceeds (80 degrees F or 90 degrees F), consideration should be given to some method of cooling the ingredients, such as chilling the water, or using ice. If ice is used, it must be crushed or flaked so that all the ice is melted by the time mixing is completed.

03.02 Prevalent Errors and Recent Concerns

- a. This section is included to provide background, for inspectors, on past structural concrete problems that have been identified and on certain areas that should be more closely scrutinized, so as to give NRC early information on potential problems. The following are potential problems identified as concrete-related violations at previous projects. (Note - These are not listed in order of their perceived importance to safety.)
 1. Inadequate QA/QC records documenting concrete work activities.
 2. Improper use of vibrators.
 3. Exceeding allowable time to place concrete.
 4. Improper sampling of aggregates.
 5. Improper curing of concrete test cylinders.
 6. Exceeding allowable concrete temperatures.
 7. Materials improperly certified.
 8. Concrete cylinder compression test records exceed allowable coefficient of variation.

9. Improper splicing practices (reinforcement cleaning, alignment, gage marks, thread damage, and inadequate swaging force, etc.).
10. Inadequate concrete curing. Samples of concrete not taken where and when required.
11. Excessive doses of concrete admixtures.
12. Inadequate cleanliness of placement.
13. Omission of reinforcing steel, incorrect spacing of reinforcing steel, and/or improper anchorage (failure to firmly tie the rebar) of the steel.
14. QC inspections not done conscientiously.
15. Excessive drop of concrete.
16. Batch plants improperly qualified.
17. Improper repair of concrete defects.
18. Intentional violation of work procedures by craft personnel to avoid rejection of their work, or to simplify their work. Examples included melting of tie wire into ends of completed cadwelds, unauthorized addition of water to concrete, and covering concrete defects (honeycomb) with mortar to prevent detection by QA/QC inspectors
19. Construction personnel and supervision intimidation of QA/QC inspectors.

69020.A2-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A2-05 REFERENCES

ANSI/ANS 15.8-1995, "Quality Assurance Program Requirements for Research Reactors."

Code of Federal regulations 10 CFR Part 21, "Reporting Defects and Noncompliance."

American Concrete Institute (ACI)

ACI 116, "Cement and Concrete Terminology."

ACI 117, "Standard Specification for Tolerances for Concrete Construction and Materials."

ACI 211.1, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete."

ACI 212.1, "Admixtures for Concrete."

ACI 212.2, "Guide for Use of Admixtures in Concrete."

ACI 212.4, "Guide for Use of High-Range Water-Reducing Admixtures (Superplasticizers) in Concrete."

ACI 214, "Evaluation of Strength Test Results of Concrete." ACI 221, "Guide for Use of Normal Weight and Heavyweight Aggregates in Concrete."

ACI 301, "Specifications for Structural Concrete."

ACI 304, "Guide for Measuring, Mixing, and Placing Concrete."

ACI 304.2, "Placing Concrete by Pumping Methods."

ACI 305, "Hot Weather Concreting."

ACI 306, "Cold Weather Concreting."

ACI 308, "Guide to Curing Concrete."

ACI 309, "Guide for Consolidation of Concrete."

ACI 311, "Recommended Practice for Concrete Inspection."

ACI 311.1, "ACI Manual of Concrete Inspection."

ACI 311.4, "Guide for Concrete Inspection."

ACI 311.5, "Guide for Concrete Plant Inspection and Testing of Ready Mixed Concrete."

ACI 315, "Details and Detailing of Concrete Reinforcement."

ACI 318, "Building Code Requirements for Structural Concrete."

ACI 347, "Guide to Formwork for Concrete."

ACI 349, "Code Requirements for Nuclear Safety-Related Concrete Structures."

ACI 359, "Code for Concrete Reactor Vessels and Containments, Section III, Division 2."

ACI 503, "Use of Epoxy Compounds with Concrete"

ACI 503.4, "Standard Specification for Repairing Concrete with Epoxy Mortar."

ACI 504, "Guide to Sealing Joint in Concrete Structures."

ACI 530-02, "Building Code Requirements for Concrete Masonry Structures."

American Welding Society (AWS)

AWS D1.1, "Structural Welding Code."

AWS D1.4, "Structural Welding Code - Reinforcing Steel."

American Society for Testing and Materials

ASTM A-615, "Deformed Billet-Steel Bars for Concrete Reinforcement."

ASTM A-706, "Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement".

ASTM C-29, "Test for Unit Weight of Aggregate."

ASTM C-31, "Making and Curing Concrete Compressive and Flexural Strength Test Specimens in the Field."

ASTM C-33, "Standard Specification for Concrete Aggregates."

ASTM C-39, "Test for Compressive Strength of Molded Concrete Cylinders."

ASTM C-94, "Standard Specification for Ready Mixed Concrete."

ASTM C-109, "Standard Method of Test for Compressive Strength of Hydraulic Cement Mortar (Using 2-in. Cube Specimen)."

ASTM C-117, "Test for Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing."

ASTM C-127, "Test for Specific Gravity and Absorption of Coarse Aggregate."

ASTM C-128, "Test for Specific Gravity and Absorption of Fine Aggregate."

ASTM C-136, "Test for Sieve or Screen Analysis of Fine and Coarse Aggregates."

ASTM C-143, "Test for Slump of Portland Cement Concrete."

ASTM C-150, "Specification for Portland Cement."

ASTM C-171, "Specification for Sheet Materials for Curing Concrete."

ASTM C-172, "Sampling Fresh Concrete."

ASTM C-173, "Test for Air Content of Freshly Mixed Concrete by the Volumetric Method."

ASTM C-192, "Making and Curing Concrete Test Specimens in the Laboratory."

ASTM C-231, "Test for Air Content of Freshly Mixed Concrete by the Pressure Method."

ASTM C-260, "Standard Specifications for Air Entraining Admixtures for Concrete."

ASTM C-309, "Specification for Liquid Membrane - Forming Compounds for Curing Concrete."

ASTM C-494, "Standard Specification for Chemical Admixture for Concrete."

ASTM C-566, "Standard Method of Test for Total Moisture Content of Aggregate by Drying"

ASTM C-642, "Test for Specific Gravity, Absorption, and Voids in Hardened Concrete."

ASTM D-512, "Test for Chloride Ion in Industrial Water and Industrial Waste Water."

ASTM D-1888, "Tests for Particulate and Dissolved Matter in Water."

U. S. Army Corps of Engineers, Handbook for Concrete and Cement, Published by US Army Corps of Engineers Waterways Experiment Station, Vicksburg, Miss.

NRC Publications

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.29, "Seismic Design Classification".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.136, "Materials, Construction, and Testing of Concrete Containments".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.199, "Anchoring Components and Structural Supports in Concrete."

National Ready Mixed Concrete Association (NRMCA)

NRMCA, "Concrete Plant Standards of the Concrete Plant Manufacturers Bureau."

NRMCA, "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau."

Others

Concrete Manual, published by the Bureau of Reclamation.

Publications of the Portland Cement Association.

For information and standards for studs (proprietary name: Nelson Studs), which are used to secure embedded item such as pipe sleeves and plates, to concrete structures, refer to Chapter 8, "Stud Welding", Volume 2 of the Welding Handbook, Seventh Edition, published by the American Welding Society.

END

APPENDIX C

INSPECTION OF STRUCTURAL STEEL AND SUPPORTS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A3-01 INSPECTION OBJECTIVES

01.01 To determine whether work related to structural steel and supports for Seismic Category I (SC-1) and Seismic Category 2 (SC-2) structures are being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee's system for preparing, reviewing, and maintaining records relative to structural steel and supports activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of SC-1 and SC-2 structures meets the specified design requirements, specifications and drawings. For work related to foundations and buildings, also refer to Appendix A of this inspection procedure (IP). For work related to concrete structures, also refer to Appendix B of this IP.

01.04 To determine that the implementation of the quality assurance program related to work activities associated with structural steel and supports is effective and to verify that deviations from requirements are appropriately resolved.

69020.A3-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with structural steel and supports activities at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for structural steel and supports work on-site at the time of the inspection, with SC-1 work being preferable to SC-2 work when available. Inspectors should also coordinate this appendix with inspection of foundations and buildings (Appendix A of this IP), and structural concrete (Appendix B of this IP) for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to determine what work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all structural steel and supports on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of structural steel and supports work activities arise. Inspectors should collect licensee procedures, work activity specifications and work completion records in advance, if possible.

If unable to review them in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.06 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review the construction specifications related to structural steel and supports activities and ascertain whether the specified technical requirements conform to the commitments contained in the licensing basis. Determine whether appropriate and adequate procedures in the following areas are compatible with the QA program and prescribe adequate methods to meet the construction specifications, where applicable:

- Receipt inspection and storage
- Use of specified materials and components;
- Installation and erection; and
- Inspection, testing, non-destructive examination (NDE), and records.

02.03 Determine whether the licensee has an established audit program (including plans, procedures, and schedule) covering the SC-I and SC-II work and control functions in the area of structural steel and supports activities and for ensuring that examination and inspection personnel associated with structural steel and supports activities are qualified to perform their assigned work.

02.04 Ascertain whether the following applicable structural steel and supports activities are being controlled and accomplished in accordance with the requirements of the documents reviewed in Section 02.02, above:

- a. Receipt Inspection and Storage. Verify that the following items have been implemented:
 1. Receipt inspections: Verify the acceptability of specification requirements.
 2. Storage: Verify that controls, markings, protection, and segregation are maintained.
- b. Use of Specified Materials and Components. Verify the following:
 1. Type and grade of materials are as indicated in specifications and drawings.
 2. Certificates of conformance or mill test reports meet the proper specifications or physical and chemical requirements, including impact tests, if required.
- c. Installation and Erection. Verify that the following items are implemented:
 1. The component or support is being erected in accordance with the most current specifications and drawings.
 2. The layout crew's instruments and tapes are calibrated.

3. Fit-up and alignment meet the tolerances in the specifications and drawings.
4. Components are being properly handled (including bending or straightening).
5. Specified clearances are being maintained.
6. Edge finishes and hole sizes are within tolerances.
7. Anchor bolts, embedded weldments, liner plate anchors, concrete anchors, and studs are of the proper material and grade and have been properly located, and tested and examined.
8. For bolted connections: bolts, nuts, and washers are of the specified type and grade; torque wrenches are calibrated in accordance with approved procedures; other test and measuring equipment used in the bolting process are calibrated; and thread engagement is as specified.

For friction type connections, ensure that the craft personnel follow the procedures properly, so that the bolts will have the required bolt tension. For instance when the turn-of-nut method is used, make sure enough bolts are brought to a “snug tight” condition, to ensure that the parts of the joint are brought into good contact with each other.

For sliding-type connections, ensure the craft personnel follow the procedures properly so that the bolts are not over-tightened and so that bolts are not at the end of slots, preventing movement of the connection.

- d. Inspection, Testing, NDE, and Records. For inspection, testing, NDE, and records, verify the following items:

1. Inspections are performed at the specified frequency, in accordance with appropriate codes, specifications and procedures, and adequate acceptance criteria are specified.
2. Accurate records are developed in accordance with procedures.
3. Proper and calibrated equipment is used as required.
4. Personnel conducting testing and NDE are qualified as required.

02.05 Review the documentation generated for the structural steel and supports activities. Determine whether the licensee/contractor system for documenting safety-related work is functioning properly. Records should be legible, complete, reviewed by QC and/or engineering personnel, and readily retrievable. Review a sample of the following records:

- a. Receipt Inspection and Material Certification (if applicable). Applicable for materials purchased from offsite suppliers. Records confirm that required material characteristics, performance tests, nondestructive test, and other specification requirements were met.
- b. Installation Inspection. Records confirm that specified materials and components were installed as specified and that the required inspections were performed and acceptance criteria are defined.
- c. Nonconformance/Deviation Record. Records include current status of these items. Nonconformance reports include the status of corrective action or resolution.

- d. Training/Qualification Records of Craft, QA, and Inspection (QC) Personnel. Records establish that QA/QC personnel are adequately qualified for their assigned duties and responsibilities and that craft personnel have been trained in their assigned tasks.
- e. QA Audits. Records establish that the required audits were performed and that deficiencies identified during audits were corrected, and that corrective action was such that repetition of the deficiency, or similar deficiencies, would be precluded.

02.06 Review the construction and QC procedures generated from the specifications and determine their adequacy with respect to prescribing adequate methods for achieving the construction specification requirements, including handling and storage of materials.

69020.A3-03 ADDITIONAL GUIDANCE

03.01 General Guidance.

QA/QC procedures must provide for effective inspections that will ensure that work is performed in accordance with specification requirements. QA audits should identify procedural inadequacies and the root cause of repetitive nonconforming conditions. Inspections should require verification of specified controls and should not be accomplished merely by surveillance. Laboratory and field testing procedures must provide for verification of correct material usage, correct selection of reference standards, and should prohibit contractor or QC personnel from discretionary selection of inspection and testing parameters. Qualified personnel should review and determine if the results of testing are acceptable. Construction procedures must reference the required inspection hold points and must also address the QA/QC department stop-work authority.

03.02 Specific Guidance

Note: The numbering of the guidance below refers to specific subsections of 02, above.

- 02.04a The licensee may perform varying degrees of acceptance inspection, as part of its vendor shop-surveillance program. Results of these inspections should be reviewed.
- 02.04c Connection joints in structures are usually the area of installation problems and also are generally not given the same engineering attention as other structural steel items. Therefore, it is important to select, for review, a few connections in each structure or support reviewed in Section 02.04, above.
- 02.06 QA/QC procedures must provide for effective inspections that will ensure that work is performed in accordance with specification requirements. QA/QC inspection should require verification of specified controls and should not be accomplished merely by surveillance. Construction procedures must reference the required inspection hold points and also must address the QA Department's authority to stop work.

The items selected for review during this inspection should include the following, as appropriate for the specific site design:

1. Control of Specific Materials.

- (a) Steel plates and shapes;
- (b) Pipes and tubes;
- (c) Forgings and castings;
- (d) Bolts and studs;
- (e) Weld filler-metal
- (f) Coatings; and
- (g) Other related materials.

2. Control of Specific Processes or Activities.

- (a) Heat treatment;
- (b) Impact testing;
- (c) Examination;
- (d) Repair;
- (e) Cutting, forming, bending, and aligning;
- (f) Erection and bracing;
- (g) Welding (for cross flange welding on loaded members, be sure that the procedures or engineering evaluations ensure that the structural integrity of the loaded beams or columns affected will not be compromised.);
- (h) Radiography;
- (i) Other NDE methods;
- (j) Bolting (ensure that the procedures will provide the required bolt tension. For instance, when the turn-of-nut method is used, the procedures should make sure enough bolts are brought to a “snug tight” condition so that the parts of the joint are brought into good contact with each other.);
- (k) Post weld heat treatment;
- (l) Local leakage testing;
- (m) Inspection; and
- (n) Documentation of inspection and testing.

03.03 Prevalent Errors and Concerns

Prevalent errors and recent concerns are areas in where the inspectors should be alert to potential generic issues. These areas include:

- a. Storage of structures and support components should ensure that contact with ground surfaces is avoided.
- b. Inattention to damage and normal wear and tear of protective coverings may lead to substandard or unacceptable weather protection. The licensee’s maintenance of protection (canvas or plastic covering) should be reviewed.

- c. In the area of maintenance of material identification, damage by handling or weather frequently makes paper tags illegible. Paper tags are usually considered to be inadequate.
- d. The use of galvanized bolts and nuts in bolted connections may require thread lubricant, to ensure that minimum torque or pretension requirements are met. There may be frequent adjustments of the minimum torque value.
- e. Piece-work traceability of structural steel and American Society of Testing and Materials (ASTM) A325/A490 bolting material has been a problem in the recent past.
- f. Deficient alignment or fit-up for welded connections has caused improper welding practices.
- g. There have been instances of cutting or edge finishes not being in accordance with specifications or drawings.
- h. Instances of weld undercut have gone undetected by QC inspections.
- i. Uncalibrated torque wrenches have been used. There should be provisions for the evaluation or reverification of the activities performed by the uncalibrated torque wrench since the last calibration.
- j. Difficulties in using the turn-of-nut method, for bolted connections, in defining the initial "snug-tight" condition, and inadequate gauge marks to determine amount of additional turns after "snug-tight." Actual observation may be the only means of verifying the proper implementation the turn-of-nut method.
- k. NRC personnel, through independent sampling of bolted connections using calibrated torque wrenches, found that high strength bolted connections do not meet project requirements for proper bolt tension.
- l. Welding across the flange of loaded members without engineering evaluation is only to be done under controlled conditions.

69020.A3-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A3-05 REFERENCES

American Concrete Institute (ACI), ACI 349.1R-91, "Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures."

ACI 349-97, "Code Requirements for Nuclear Safety-Related Concrete Structures."

ACI 349.2R-97, "Embedment Design Examples."

American National Standards Institute/American Institute of Steel Construction (ANSI/AISC), ANSI/AISC N690-1994, "Specifications for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities."

American Society of Civil Engineers (ASCE), ASCE 4-98, "Seismic Analysis of Safety- Related Nuclear Structures and Commentary."

ASCE 7-98, "Minimum Design Loads for Buildings and Other Structures."

American Welding Society (AWS) D1.1, "Structural Welding Code."

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor- Supported Equipment or Components."

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis."

ANSI/AISC N690, Specification for Safety-Related Steel Structures for Nuclear Facilities

END

APPENDIX D

INSPECTION OF PIPING AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A4-01 INSPECTION OBJECTIVES

01.01 To determine whether work associated with safety related piping is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee's system for preparing, reviewing, and maintaining records relative to piping activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of piping meets the specified design requirements, specifications and drawings. For pipe supports and restraints, also refer to Appendix E of this inspection procedure (IP).

01.04 To determine that the implementation of the quality assurance program related to work activities is effective and to verify that deviations from requirements were appropriately resolved.

69020.A4-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report and be familiar with the safety-related piping systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUFs are generally expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for piping work being conducted on-site at the time of the inspection. Inspectors should also coordinate this appendix with Appendix E, "Pipe Supports and Restraints."

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all piping on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of piping work activities arise. Inspectors should collect licensee procedures, work activity specifications and work completion records in advance, if possible. If unable to review them in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.11 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is

limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Determine whether licensing basis and Quality Assurance Program commitments relating to the following specific activities associated with safety-related piping are adequately addressed in procedures included or referenced in the QA manual(s).

- a. Purchase documents identifying material specifications and any special requirements, including material test reports/certification of the following (as applicable):
 1. chemical composition
 2. physical characteristics
 3. nondestructive examination results
 4. heat treatment history (if applicable)
 5. welding of prefabricated sections
- b. Receipt inspections, including provisions for ensuring:
 1. piping materials are in conformance with purchase specifications, including special requirements
 2. marking, identification, and storage level classifications
 3. as-received cleanliness and protection
 4. receipt inspection reports are generated as required
 5. disposition of nonconforming items
- c. Inspections covering storage and issuance of the piping and related appurtenances including provisions for:
 1. segregation of sizes and types of material
 2. storage identification
 3. storage conditions/protection
 4. confirmation of issue of specified material
- d. Handling of the piping and related appurtenances to ensure protection from physical damage or contamination while handling.
- e. Installation of the piping and related appurtenances to verify that the following meet applicable requirements:
 1. location
 2. grinding, cutting, bending, etc.
 3. piping system tolerances
 4. cold spring
 5. installation records to be generated during installation
 6. type, size, location and adjustment of hangers, bellows, restraints, snubbers
 7. clearances to prevent interference
 8. hydrostatic testing (where required)
 9. hold points

- 10. removal of arc strikes
- f. Design changes, including field changes, to ensure proper review and coordination among participating design organizations.
- g. Inspection and work performance for cleaning piping, including provisions for:
 - 1. cleaning materials - conformance to specifications, concentration, temperature, and use
 - 2. cleanliness criteria and measurement methods
 - 3. removal and installation of metering devices, orifice plates, valve internals, etc., that are removed from system to facilitate flushing
 - 4. installation and removal of fine strainers, blind flanges, temporary piping and dams
 - 5. record-keeping requirements

02.03 Review the licensee/contractor's plans and schedules to audit compliance with and effectiveness of the QA/QC requirements associated with safety-related piping, including (but not limited to) design, procurement, receipt/storage, installation, and testing.

02.04 Determine whether licensee/contractor management has an established program for ensuring that all personnel involved in the above mentioned activities are suitably proficient, skilled, or otherwise qualified by experience or training to perform their assigned duties.

02.05 If possible, observe activities relative to safety-related piping, such as handling; cleanliness control; installation of pipe spools, fittings, and bellows; cutting; grinding; bending; supporting; cleaning and flushing; hydrostatic testing; and quality-related inspections.

02.06 For those activities selected for observation (in 02.05, above) determine whether the following requirements, as applicable, are met:

- a. conformance with construction/installation specifications
- b. personnel are adequately qualified by certification, experience or training
- c. conformance with inspection (QC) and work performance procedures
- d. conformance with record-keeping requirements
- e. identification and control of material
- f. control of nonconforming items

02.07 Determine whether piping runs are (or are being) installed as required by applicable specifications, field drawings, and procedures.

02.08 Determine whether there have been significant design changes subsequent to the issuance of approved installation drawings. Review the implementation of the licensee's/contractor's design control measures, including the necessity for a revised stress analysis, as appropriate, to determine whether design control procedures were properly followed.

02.09 Determine whether records meet requirements related to:

- a. Confirming that required material characteristics, performance tests, environmental qualification tests, nondestructive tests, and other specification requirements were met.
- b. Confirming that the selected components were installed as specified.
- c. Confirming that the required inspections were performed.

02.10 Review a nonconformance/deviation report to sample system effectiveness and determine if the procedures are being adequately implemented.

02.11 Determine whether appropriate qualification requirements are in place for licensee/contractor craft and inspection personnel being employed on safety-related piping installation work.

69020.A4-03 ADDITIONAL GUIDANCE

03.01 General Guidance

The purpose of the inspection requirements in Section 02 of this procedure is to determine whether the licensee/contractor(s) activities, other than welding and NDE, have met QA program requirements for piping receipt, fabrication, erection, inspection, and testing of safety-related piping systems.

The licensee/contractor procedures involved may vary from contractor to contractor, and may take many forms, such as formal procedures, instructions, checklists, drawings, etc. Review the inspection procedures/lists and compare with the requirements in the applicable codes and construction specifications. Evaluation should indicate whether adequate quality-related inspections are established and are based on appropriate criteria, and further, whether the results of the licensee/contractor's inspection will be transmitted to responsible quality assurance and management personnel. The NRC inspector must determine if the licensee controls are adequate and are properly implemented in a timely manner.

03.02 Specific Guidance

For clarification, "Material Test Report" is a generic expression meaning a report of test results to confirm that material, chemical and physical properties are consistent with the applicable specification. Vendor terms used, which can be identified with the expression "Material Test Report," include:

- a. Ladle analysis (sample of molten metal)
- b. Check analysis (sample of solidified metal)
- c. CTR (Chemical Test Report or Certified Test Report)
- d. MTR (Material Test Report - usually includes chemical and physical tests)

- 03.03 The generic terms CTR and MTR should not be confused with the term "Certification." A "Certification" is a document issued in lieu of actual quality documentation records stating that the quality requirements contained in specifications and purchase orders have been met.
- 03.04 "Quality Release Form" and "Certificate of Equipment" are examples of generic designations for forms used by manufacturers to serve as certifications of quality (in lieu of original quality documentation) for components and equipment.
- 03.05 The inspector should bear in mind that NRC's sample covers only a very small portion of the records involved. Thus, substantive errors or departure from requirements raise the issue of whether the licensee is adequately controlling the process.
- 03.06 The qualifications of those engaged in quality sensitive or special processes related to pipe installation, inspection and testing work should be sampled for an assessment of compliance with licensee commitments. Also, depending on the type and extent of design engineering work being performed at the site, it may be appropriate to review the qualifications of certain key individuals assigned to this design area.
- 03.07 A piping run, for purposes of this procedure, is meant to be a particular section of piping, for example: a piping section between components or major supports or relief valve discharge piping. The intent of requirement 02.07 is to determine whether piping is 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.
- 03.08 Prevalent errors and concerns. This section is included to provide background for inspectors on what past problems of a generic nature have been identified and is for information only.
- a. The status of protective measures at the time of site receipt and initial storage of piping and piping system components.
 - b. Adequacy of dunnage for piping and piping system components during storage. Dunnage treated with fire retardants may expose pipe to excessive levels of halogens and chlorides.
 - c. Continued adequacy of such things as end caps for piping and protective coverings for weld prep areas.
 - d. Weather protection in the form of canvas or plastic covering. (In most deficient cases, the original protective covering was adequate, but inattention to damage and normal "wear and tear" led to substandard or unacceptable protective covers.
 - e. Storage areas located on sandy soil require special attention to avoid the entry of wind-driven sand particles into piping components.

- f. Improper location of storage. In some instances, storage locations are selected without consideration for construction traffic patterns, or possible falling objects and/or missiles.
- g. Inadequate or illegible piping identification. (Damaged by handling and/or environment.)
- h. Stability of work force or QA/QC personnel and the attitudes in work crews and relations between construction personnel and QA/QC personnel.
- i. Power grinders used for weld preparation of pipe that result in violation of minimum wall thickness.
- j. Piping runs containing mud, sand, and other foreign material.
- k. Incorrect size orifices installed in pump recirculation lines.
- l. Surfaces for welding not properly free of paint, oil, rust, or other material that is detrimental to welding.
- m. Drawings or other records fail to show evidence of actual piping components installed in pipeline or are not a current revision.
- n. Piping changes without proper design change authorization.
- o. Repairs of linear indications on pipe spool pieces not properly performed as to testing for wall thickness and blending uniformly into the surrounding surfaces.
- p. Controls over the installation/removal of cleaning and flushing devices are inadequate.
- q. Refer to IE Bulletin 79-14 for additional concerns relating to as-builts.

69020.A4-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A4-05 REFERENCES

10 CFR Part 21, "Reporting Defects and Noncompliance"

ASME B31.3-2002, Process Piping

END

APPENDIX E

INSPECTION OF PIPING SUPPORTS AND RESTRAINTS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A5-01 INSPECTION OBJECTIVES

01.04 To determine whether work activities associated with safety-related pipe supports and restraints is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to pipe supports and restraints activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of pipe supports and restraints meets the specified design requirements, specifications, and drawings. For installation of safety-related piping, also refer to Appendix D of this inspection procedure (IP).

01.04 To determine that the implementation of the quality assurance program related to work activities associated with pipe supports and restraints is effective and to verify that deviations from requirements are appropriately resolved.

69020.A5-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related piping systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUFs are generally expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for pipe supports and restraints work on-site at the time of the inspection. Inspectors should also coordinate this appendix with inspection of safety related piping (Appendix D of this IP) for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the pipe supports and restraints on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of pipe supports and restraints construction arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible.

If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.05 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review of QA Implementing Procedures

Review QA Manual and implementing procedures associated specifically with pipe supports and restraints, to determine whether the commitments in the approved QAP are being implemented as follows:

- a. Adequate QA audit procedures have been established for this activity, in accordance with, the approved QA Plan including: (1) scope and frequency of audits; (2) audit criteria; (3) reporting requirements; (4) follow-up action; and (5) 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, nonconformance's, 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. Specific attention should be directed toward those engaged in the installation and testing of concrete expansion anchors, if these are used.

02.03 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 various-size piping, and instrumentation lines.

- b. Determine whether work procedures incorporate the following:
 - 1. Controls to ensure that the type and classification of pipe supports and restraints 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, as discussed in Section 02.03a, 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.

02.04 Observation of Work and Work Activities

By direct observation, interviews, or independent evaluation of work performance, works in progress, and/or completed work, determine whether activities regarding pipe support and restraint systems are being accomplished, in accordance with NRC requirements, the licensing basis, and licensee procedures.

- a. Pre-installation Activities.
 - 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. (Not required if hydraulic snubbers are not used.)
 - 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 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 pipe supports and restraints have received adequate training to perform special processes contained in relevant work performance and inspection procedures.

b. Installation Activities

1. If installation activities are on-going at the time of the inspection, observe portions of the installation activities to verify the following:
 - (a) The latest issue (revision) of applicable drawings or procedures is available to the installers.
 - (b) Appropriate personnel approve significant modifications to supports, 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 existing between the pipe and restraints are as specified.
2. If installation activities are on-going at the time of the inspection, observe portions of the installation and testing of concrete anchor bolts for component-support elements to verify that anchor-bolt type, diameter, embedment length, shoulder-to-cone measurements, and torque requirements meet installation requirements.

c. Dynamic Pipe Supports

Inspect installed restraints (if possible, select different load classifications and at various degrees of 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. Inspect installed spring-hanger assemblies covering 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 facility operation have suitable service ratings to accommodate the expected operating-temperature range.
 2. Inspect installed pipe supports 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 from vibration, thermal expansion, etc., will most likely not cause contact with other pipes, supports, equipment, nor components. (As best as can be determined after 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. Inspect 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

Inspect installed component supports, including, if possible, 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 surfaces 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. Obtain 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. Determine 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 anchors and compare them with the drawings, to ensure agreement as to their location and function.

02.05 Review of Records.

- a. Review licensee and 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 or contractor system for documenting work in this area, verify that:
 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 licensee QA/quality control (QC) inspection.
 3. The required scope of licensee 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, post weld-heat treatment, and NDE examinations.
 8. The examination records are complete and meet the inspection and/or NDE procedure requirements.
- b. Review the licensee/contractor system for reporting and dispositioning non-conforming materials, parts, and components, and their process for installation deficiencies, associated with pipe supports and restraints. Determine whether:
 1. The records adequately document current status of nonconformance's and deviations.
 2. The records are legible, complete, and indicate that reports are promptly reviewed by qualified personnel for evaluation, disposition, and prioritization.
 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 used on those special processes associated with pipe support and restraint installation work, review a sampling of personnel qualification records 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. 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 follow-up action on those matters in need of correction.

69020.A5-03 INSPECTION GUIDANCE

03.01 General Guidance.

This procedure pertains to pipe supports and restraints in SC-I and SC-II systems. 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.

Considerable impact on the development and structure of this IP has resulted from a series of problems NRC has encountered at nuclear power plants in the area of pipe supports and restraints. These problems and concerns are best summarized in Inspection and Enforcement (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 may be beneficial to the inspectors during implementation of this IP.

The inspectors 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 inspectors 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., (American Society for Testing and Materials or American Society of Mechanical Engineers (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.

03.02 Specific Guidance

- a. Sections 02.02a 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. Section 02.02f. The inspectors 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 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. Section 02.03b2. 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 post-weld heat treatment. However, those pipe supports, support flanges, or support brackets that are directly welded to safety-related piping may be subject to preheat and/or post-heat treatment. Applicable heat treatment procedures are necessary for this type of installation. Records of heat treatment (time, temperature) must be generated and reviewed for Code compliance.
- d. Section 02.04b2. Refer to IE Bulletin No. 79-02 (and revisions), "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts," for general information.
- e. Section 02.04e3. The material certificate and identification should meet the requirements of the applicable Code/Standard.

- f. Section 02.04f. The intent is to determine whether pipe supports and restraints are being installed according to properly approved drawings -- either the original design drawings or properly approved revisions. If revisions are in process, these changes are properly handled in accordance with established procedures.

Appropriate standards can be used as a guide in this area. In general, 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. For example, ANSI/ANS 15.8 states that "changes to verified designs shall be documented, justified, and subject to design control measures commensurate with those applied to the original design."

Changes may be made to these supports, during construction, that are different from the original 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.

- g. Section 02.05. The inspectors should bear in mind that the NRC's inspection sample covers only a small portion of the records involved. Thus, substantive errors, or departure from requirements identified in the 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.

03.03 Prevalent Errors and Concerns

This section is included to provide background on past problems of a generic nature that have been identified at nuclear power facilities. This section is for information only.

- 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 follow-up 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 information about problem areas.

03.04 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 the actuation of a water hammer, steam hammer, pump/start/stop, or safety and relief valve. 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 that transmit loads between plant components and the building structure 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.).

69020.A5-05 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A5-06 REFERENCES

U.S. Code of Federal Regulations, Title 10, Part 21, “Reporting of Defects and Noncompliance.”

American Society of Mechanical Engineers, ASME B31.3-2002, “Process Piping.”

American Welding Society, AWS D1.1, “Structural Welding Code.”

American Society of Civil Engineers, ASCE 4-98, "Standard Seismic Analysis of Safety-Related Nuclear Structures."

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," October 1973.

American National Standards Institute/American Institute of Steel Construction, (ANSI/AISC) N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities (SC I)."

The following references describe problems at nuclear power facilities and are for background information only:

Inspection and Enforcement Bulletin, (IE) Bulletin 73-03 (and revision), "Defective Hydraulic Shock Suppressors and Restraints."

Inspection and Enforcement Bulletin, (IE) Bulletin 73-04 (and revision), "Defective Bergen-Paterson Hydraulic Shock Absorbers."

Inspection and Enforcement Bulletin, (IE) Bulletin 73-07, "Failure of Structural or Seismic Support Bolts on Class 1 Components."

Inspection and Enforcement Bulletin, (IE) Bulletin 74-03, "Failure of Structural or Seismic Support Bolts on Class 1 Components."

Inspection and Enforcement Bulletin, (IE) Bulletin 75-05, "Operability of Hydraulic Shock and Sway Suppressors."

Inspection and Enforcement Bulletin, (IE) Circular 76-05, "Hydraulic Shock and Sway Suppressors."

Inspection and Enforcement Bulletin, (IE) Circular 76-07, "Damaged Components of Bergen-Paterson Hydraulic Test Stand."

Inspection and Enforcement Bulletin, (IE) Bulletin 78-10, "Bergen-Patterson Hydraulic Shock Suppressors Accumulator Spring Coils."

Inspection and Enforcement Bulletin, (IE) Information Notice 79-01, "Bergen-Paterson Hydraulic Shock and Sway Arrestors Reported Failures."

Inspection and Enforcement Bulletin, (IE) Bulletin 79-02 (and revisions), "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts."

Inspection and Enforcement Bulletin, (IE) Bulletin 79-07, "Seismic Stress Analysis of Safety-Related Piping."

Inspection and Enforcement Bulletin, (IE) Information Notice 79-10, "Nonconforming Pipe Support Struts."

Inspection and Enforcement Bulletin, (IE) Bulletin 79-14 (and revisions), "Seismic Analysis for As-Built Safety-Related Piping Systems."

Inspection and Enforcement Bulletin, (IE) Circular 79-25 (and supplement), "Shock Arrestor Strut Assembly."

Inspection and Enforcement Bulletin, IE Information Notice 79-28, "Overloading of Structural Elements Due to Pipe Support Loads."

Inspection and Enforcement Bulletin, (IE) Bulletin 81-01 (and revision), "Surveillance of Mechanical Snubbers."

Inspection and Enforcement Bulletin, (IE) Circular 81-05, "Self-Aligning Rod End Bushing for Pipe Supports."

Inspection and Enforcement Bulletin, (IE) Information Notice 82-12, "Surveillance of Hydraulic Snubbers."

END

APPENDIX F

INSPECTION OF MECHANICAL COMPONENTS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A6-01 INSPECTION OBJECTIVES

01.05 To determine whether work activities associated with safety-related mechanical components is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to mechanical component activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of mechanical components meets the specified design requirements, specifications, and drawings.

01.04 To determine that the implementation of the quality assurance program related to work activities associated with mechanical components is effective and to verify that deviations from requirements are appropriately resolved.

69020.A6-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related mechanical components being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for mechanical components work on-site at the time of the inspection.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the mechanical components on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of mechanical component construction arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.08 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review construction documentation (specifications, drawings, and work procedures) and QA procedures to determine whether they appropriately and adequately assure that specific activities associated with safety-related mechanical components are controlled and performed according to NRC requirements, the licensing basis, and the approved QA Plan. In particular, ascertain whether provisions have been established to assure that:

- a. Procurement documents incorporate the technical and quality requirements in the material requisition. This includes identification of material specifications and, if required, performance test requirements.
- b. Receipt inspections are adequate and capable of detecting damage or out-of-specification conditions, including adequacy of performance testing, etc. Also, provisions are in place to prevent nonconforming equipment and materials from being installed and used.
- c. Installation, testing, and inspection activities meet applicable specifications and established procedures.
- d. Specially trained personnel are used whenever complex or unusual activities are involved.
- e. Specifications and installation procedures for motor-operated valves provide detailed information relative to the setting of torque switches, limit switches, and limit-switch bypasses.
- f. Post-inspection cleaning, preservation, and inspection requirements have been established before needed.
- g. Record-keeping requirements are established and clearly indicate those responsible for record generation; and provisions exist for their review by appropriate management personnel.
- h. Design changes, including field changes, are properly reviewed and coordinated among affected design and engineering organizations.

02.03 Select representative safety-related mechanical components to inspect. The sample may contain materials handling, fluid transport, or fluid systems components (including, process vessels, tanks, and enclosures). Observe work performance, partially completed work, and/or completed work on these components, as appropriate. Review the pertinent quality-related records for the components selected, or a similar selection of components if more appropriate. Determine whether the following activities, for each of the above selected components, meet applicable QAP requirements:

a. Receipt Inspection.

1. Adherence to receipt inspection procedures. Records confirm that required material characteristics, performance tests, nondestructive tests, environmental qualification tests, and other specification requirements are met.
2. Receipt inspection and storage records indicate that, where appropriate, defective or incorrect components, parts, and materials are controlled and prevented from installation and possible use.
3. Documentation has been prepared and maintained as required by receipt inspection and documentation storage instructions.

b. Storage, Handling, and Protection.

1. Storage environment and protection of components (protective covers, caps, preservatives, desiccants, heaters, inert gas blankets, etc.) are in accordance with manufacturer's instructions and/or established procedures.
2. Implementation of special storage and maintenance requirements such as rotation of motors, pumps, lubrication, insulation testing (electrical), cleanliness, etc.
3. Performance of licensee/contractor surveillance activities and documentation thereof are being accomplished at required frequency.

c. Installation.

1. Installation requirements such as proper location, placement, orientation, alignment, mounting (torqueing of bolts and expansion anchors), flow direction, tolerances, and expansion clearance are met.
2. Precautions to prevent damage during placement/mounting are adhered to, where appropriate.
3. Availability and usage of specially trained personnel and equipment where required to meet component manufacturer=s instructions.
4. Torque switches, limit switches, and bypass switches on valves have been properly installed, adjusted and checked out, in accordance with established instructions and procedures. Integrated system checks could be a potential focus of inspection.
5. Appropriate drawings and work procedures are available to installers. Installation requirements, construction drawings, specifications, and work procedures are technically adequate and of the latest approved issue.
6. Hold points are observed, when required.

7. Design changes relevant to the work being observed have been appropriately processed through required review and approval routes.
 8. Preparation and maintenance of installation and inspection records are adequate.
- d. Protection and Maintenance after Installation.
1. Inspection activities, including scope and frequency, are being performed according to instructions.
 2. Protection provided as required, including protection against adverse temperature, humidity, flooding, and foreign materials, such as dirt, dust, bottles, cans, and general debris.
 3. Lubrication, rotation, and electrical resistance checks are being performed, as required.
 4. Records are being maintained on the status of installed components.
 5. Appropriate stamps, tags, markings, etc., are in use to prevent oversight of required inspections, completion of tests, acceptance, and the prevention of inadvertent operation.

02.04 Select representative as-built/final design system drawings and compare portions of these drawings with the actual installation. Discrepancies observed may be caused by in-process changes, such as those initiated by the design organization, or 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 base or engineering review, approval, and subsequent incorporation in final as-built drawings.

02.05 Select one or more workers engaged in work activities associated with installation and inspection of mechanical components and confirm or discuss the following:

- a. Qualifications of those engaged in component installation and inspection work appear adequate and commensurate with the work in progress.
- b. Ability to perform their assigned duties and assume their assigned responsibilities.
- c. There is adequate time allocated to the QC function to study installation specifications and instructions and to perform the required component inspections.
- d. An appropriate level of independence exists between QA/QC and construction (i.e., organizational freedom to identify nonconforming conditions and document their existence).
- e. Adequate management support for QA/QC functions.

- f. Effectiveness of management's control over component installation work as may be evidenced through the performance of audits (or their arrangements to have others conduct audits) including follow-up of audit findings.

02.06 Determine whether qualified licensee/contractor, engineering, craft, and inspection personnel, associated with safety-related component installation work are being used, by reviewing a sampling of personnel qualification records, including different disciplines, as follows:

- a. Determine whether a system of personnel qualification records meeting stated requirements exists and is being maintained in current status.
- b. Determine if the records are sufficient to reasonably support qualification in terms of certification, experience, proficiency, training, testing, etc., as applicable.
- c. Review the actions taken by responsible licensee/contractor organizations to independently authenticate the validity of critical qualification statements.

02.07 Review the licensee/contractor system for reporting and dispositioning nonconformances associated with the procurement, installation, and testing of safety-related mechanical components, to determine whether:

- a. Records adequately document current status of nonconformance and deviations.
- b. The sample of records is legible and complete, and indicates that reports are promptly reviewed by qualified personnel.
- c. Records are routinely being processed through established channels, for resolution of the immediate problem, as well as generic implications.
- d. Corrective actions are appropriate to the circumstances and are appropriately prioritized.
- e. Records are being properly identified and stored, and can be retrieved in a reasonable time.
- f. Nonconformance reports include the status of corrective actions or resolutions and actions to prevent recurrences.

02.08 Determine whether the licensee has an established audit program (including audit plans, procedures, and schedules) covering work and control functions in the area of safety-related component installation. Sample the audit output for the components, processes, and work being followed in the inspection effort.

69020.A6-03 INSPECTION GUIDANCE

03.01 General Guidance

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 inspectors should review the QAP procedures associated with “Identification and Control of Materials, Parts, and Components,” and applicable codes and specifications, for additional guidance. The inspectors should verify that the licensee has established measures for identification and control of materials, parts, and components, and for traceability, to the approved design basis and to the source. The inspectors should ensure 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 inspectors 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., (American Society for Testing and Materials) or (American Society for Mechanical Engineers) 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.

03.02 Specific Guidance.

Note: The numbering of the guidance below refers to specific subsections of 02, above.

- 02.02b Material-storage procedures should include the requirements that components be identified; properly segregated by type; provided protection from physical or contamination damage, during handling and storage; and that controls for component withdrawal are provided, to ensure proper issuance.
- 02.03 Components selected should be representative of the type of plant components involved in materials-handling, fluid transport, and fluid systems.
- 02.07 Review selected nonconformance and deviation reports in detail. Specifically, determine whether the corrective action initiated appears likely to preclude repetition. The reviewer should be particularly watchful for nonconformance reports signed off without adequate explanation, or reports that have been closed before being fully processed in accordance with procedures.

Also, if components with reported nonconforming conditions are permitted to be installed, NRC inspectors should confirm that the licensee's control system effectively tracks the condition until resolved.

02.08 Inspectors should determine if audits have been planned and carried out in accordance with an announced schedule. Qualification of auditors should be verified to ensure that they are fully qualified for the assigned areas.

03.03 Prevalent Errors/Concerns.

This section is included to provide background for inspectors on past problems of a generic nature.

- a. Documentation not kept current.
- b. Inspection documentation signed off by persons other than the inspectors actually responsible for the recorded information.
- c. Nonconformance report system deficient in that reports could be destroyed, filed away, or otherwise signed off, without proper resolution or accountability of action taken.
- d. Weather protection degradation due to inattention to damage and normal "wear and tear," leading to substandard or unacceptable protection provisions.
- e. Improper installation and adjustment of motor-operated valve torque switches, limit switches, and bypass switches. Applicable specifications and instructions have not been adequate to ensure proper installation, adjustment, and check-out.
- f. Inspection procedures, instructions, and acceptance criteria lack clarity, and in some cases are difficult to find and use.
- g. Licensee audit reports containing adverse findings and recommendations without appropriate follow-up and resolution.

69020.A6-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A6-05 REFERENCES

U.S. Code of Federal Regulations, Title 10, Part 21, "Reporting of Defects and Noncompliance."

END

APPENDIX G

INSPECTION OF ELECTRICAL CABLE AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A7-01 INSPECTION OBJECTIVES

01.06 To determine whether work activities associated with safety related electric cable is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to electric cable activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of electric cables meets the specified design requirements, specifications, and drawings. For installation of electric components and systems, also refer to Appendix H of this inspection procedure (IP).

01.04 To determine that the implementation of the quality assurance program related to work activities associated with electric cables is effective and to verify that deviations from requirements are appropriately resolved.

69020.A7-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related electric cable systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for electric cable work on-site at the time of the inspection. This appendix may be coordinated with Appendix H of this IP for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the electric cables on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of electric cable installation arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.10 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Procedure Review. Review the construction specifications and procedures for electrical cable and ascertain whether the specified technical requirements conform to the statements contained in the licensing documents. Determine whether the commitments in the approved QAP are being implemented, as follows:

- a. Adequate QA audit procedures have been established for this activity in accordance with the approved QAP including: (1) scope and frequency of audits; (2) audit criteria; (3) reporting requirements; (4) follow-up action; and (5) 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, acceptance criteria, installation methods, 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 and that those deviations, non-conformances, and defects are adequately documented and processed through to complete resolution.
- f. Provisions have been established to ensure that construction drawings incorporate the most recent design requirements. (Note: Field change requests should be reviewed to determine if there are field conditions that have not been adequately anticipated during the design process.)
- g. The licensee has established a program for ensuring that all craft, nondestructive examination, and inspection personnel associated with the installation of electrical cable have been trained, or otherwise qualified for the work procedures involved.

02.03 Specific Technical Review Areas. Determine if procedures covering work and inspection activities in the following areas are appropriate to the activity and are technically adequate:

- a. Receipt Inspection Procedures (IPs). Receipt inspection and related procedures provide means to ensure the following:

1. Received components are as specified, properly identified and controlled or otherwise noted.
 2. Input from other groups or other organizations to be used during receiving inspection activities are obtained and properly used, such as the results of source inspections, environmental qualification tests, and other required quality tests.
 3. Procurement requirements, such as qualification tests (seismic, environmental, etc.), functional tests, certificate of conformance, and other quality tests (material, physical, and chemical), have been successfully completed, or status of how and when such requirements will be satisfied is documented and adequately controlled.
- b. Storage Procedures. Storage procedures provide means to ensure the following:
1. The proper storage environments (as specified by the construction specifications and the manufacturers) are established for the various types of electrical components and meet applicable storage-classification levels, regardless of the location of the stored component.
 2. Storage inspection procedures require initial verification of storage conditions and periodic verifications for the duration of the storage period. They must also ensure that special and in-place storage requirements are met.
- c. Work Procedures. Work procedures are established to ensure the following:
1. NRC requirements and licensing document commitments are properly translated into the work procedures (construction specifications, drawings, and work instructions) for adequate control and installation of electrical cable and associated items. Areas to review should include, but are not limited to, the following:
 - (a) Raceway completion (edge softeners, bushings, supports, grounding, routing location, pull fittings, pull cords, identification, sharp edges, etc.) and condition (free of debris) before use.
 - (b) Cable/ busway type and size.
 - (c) Cable temperature (if stored in cold weather).
 - (d) Cable splices (where allowed).
 - (e) Pulling attachments, lubricating compounds, and tension (including calibration of tension devices).
 - (f) Bending radius (during and after installation).

- (g) Cable identification/ color coding/ imprinted information.
- (h) Cable routing.
- (i) Separation and independence.
- (j) Segregation (power, control, data instrument).
- (k) Cable supports (grips).
- (l) Handling of cable and termination materials to ensure protection from damage and contamination (includes protection of cable ends from moisture).
- (m) Protection of cables from adjacent construction activities.
- (n) Hold points.
- (o) Termination activities such as:
 - (1) Application of materials (lugs, tapes, stress cones, connectors, punch down blocks, terminal blocks, etc.).
 - (2) Use of calibrated torque wrenches and crimping tools.
 - (3) Termination preparation procedures (insulation stripping, compression tools, labeling, polishing (fiber optics)).
- (p) Raceway loading.
- (q) Fire barriers and seals as required.
- (r) Less than maximum tensile force applied pulling (cable tensile rating).
- (s) Shield grounding (as applicable).

2. Interface controls are adequate when multiple contractors are involved.

d. Inspection Procedures. Inspection procedures have been established to ensure the following:

- 1. Positive identification of the cable system and/or activity to be inspected and the specific inspection method(s) to be used.
- 2. All safety-related aspects of construction specifications, drawings, and work instructions are included in the scope of planned inspections.

3. The technical aspects of inspection requirements and acceptance criteria are sufficient to determine whether installation, testing, maintenance, and protection conform to applicable design and construction specifications.
 4. Records of initial and follow-up inspections include the specific results of the inspection. This should include the specific characteristics being inspected (or the actual measured values), the inspectors' determination of acceptability, and identification of any non-conformances found.
- e. Construction Testing Procedures Inspection Guidance. Procedures for safety-related cable system and component testing provide means to ensure that:
1. Cable systems and components to be tested and the related test procedures are properly identified and controlled. Procedures specify which construction tests are to be performed on each component requiring testing.
 2. Proper type of test equipment (range, accuracy, etc.) is specified.
 3. Type of data to be recorded and method of reporting results.
 4. Review and evaluation of test results by qualified personnel.
 5. Resolution of discrepancies.
 6. Special conditions or testing, prerequisites, sequence, precautions, etc., and acceptance criteria are specified and meet requirements.
- f. Personnel Qualifications Verification. A program has been established for ensuring that all craft, examination and inspection personnel associated with safety-related electric cable systems are trained and qualified to perform their assigned duties. The program includes:
1. The proper use of installation equipment (tension devices, pulling compounds, etc.).
 2. The proper handling, supporting and protection of cables and cable segments stored in place.
 3. Approved methods for cable end protection.
 4. Identification of requirements for the installation of safety-related cables.
 5. Approved methods for cable termination and splices.
 6. Approved methods for fiber optic/data cable termination and inspection.
- g. Change-Control Procedures. Procedures have been established to control design and field changes for cable systems and ensure the following:

1. Retrieval of voided drawings and specifications at work sites is controlled.
2. Field changes are subject to adequate design control and are incorporated into the as-built records.
3. Coordination among participating design and construction organizations is adequate.

02.04 Inspection of Cable Systems and Components.

Choose a sampling of safety-related cables. The sampling may include power, control, and data cables (fiber optic, communications, coax, twisted, multi-conductor, twisted, and shielded). The sampling may also be from a variety of locations, uses and types (e.g.: (1) large motors; (2) diesel generators; (3) motor-operated valves; (4) solenoid valves; (5) control centers; (6) control room panels and cabinets; (7) local panels and cabinets; (8) coaxial and triaxial connectors; (9) fiber optic connectors; and (10) stress-cone terminations).

02.05 Inspection Activities.

- a. Receipt Inspection. Evaluate portions of receipt inspection activities pertaining to the electric power, control, data cables and associated items selected for inspection. Determine whether receipt inspection activities are being controlled and performed in accordance with the licensee's commitments and procedures.
 1. Components and receiving documents are properly identified.
 2. Physical conditions (damage, deterioration, etc.) are documented.
 3. Documentation related to quality requirements (e.g., results of functional and qualification testing) received with cables and associated items is reviewed and meets the requirements. Where qualification testing of cables and associated items to be placed in a harsh environment is not a requirement of the specification, determine what means will be used to ensure that applicable environmental qualification will be satisfied.
 4. Control of nonconforming cables and associated items, is conducted in accordance with applicable procedures and meets requirements.
 5. Adequately, qualified personnel are available to perform the receipt inspection function.
- b. Storage. Observe and evaluate storage activities and conditions for the selected components. Determine whether:
 1. Electric power, control, data cables and associated items are stored in the proper storage level designation.

2. Cables, busways and associated items are properly identified.
 3. Storage conditions (temperature, humidity, cleanliness, etc.) and requirements are controlled and monitored as directed by the applicable procedures and by the manufacturer's specifications.
 4. Licensee and contractor inspection and monitoring activities are being performed in accordance with procedural requirements.
 5. Nonconforming cables and associated items placed in storage are identified and/or segregated as required.
 6. In-place storage requirements are satisfied.
 7. Adequately qualified personnel are available to perform the required storage functions.
- c. In-Process Installation. If installation is in progress during the inspection, evaluate in-process installation to determine if the licensee is following their procedures pertaining to the components and associated items selected in the appropriate subsections of Section 02.02. Inspect a sampling of the following attributes:
1. The latest approved revision of applicable construction specifications, drawings, and/or construction procedures are available and used by the installers. (Verify later that pull card data are consistent with the latest cable tabulation sheets.)
 2. Cables, busways, associated materials, and pulling compounds are as specified.
 3. Pulling attachments and tensions used are acceptable.
 4. Cable temperature is acceptable before handling and installation.
 5. Raceway completion and condition are adequate before cable is installed.
 6. Cables are protected from sharp edges, hostile environments, and adjacent construction activities (especially welding and cutting activities).
 7. Cable routing is correct.
 8. Separation criteria for physical independence are maintained.
 9. Segregation is maintained (e.g. power, control, and instrument).
 10. Cable identification is preserved.
 11. Proper bending radius is maintained (during and after installation).

12. Less than maximum tensile force is applied for pulling based on cable tensile rating
13. Cable and other conductor supports are provided.
14. Cable entry to terminal point is acceptable.
15. Shields are grounded per construction drawings and specifications.
16. Torque wrenches and crimping tools are in proper working order and properly calibrated.
17. Jumpers are controlled.
18. Terminations are of the correct type and properly located.
19. Shield terminations for I&C cables are installed in accordance with the appropriate detail drawing requirements, using the appropriate lead connections.
20. Shields for cables rated 5KV and above are terminated with appropriate materials, including voltage stress relief devices that do not compromise the integrity of the cable's shield or insulation system, in accordance with project design standards.
21. All cable shields are grounded appropriately per the project document requirements.
22. Tightness of connections is acceptable.
23. Appropriate scaffolding, walkways, and climbing aids are used in lieu of cable trays, conduits, etc.
24. Cabinets, control centers, cable trays, junction boxes, etc. are maintained free of debris (periodically cleaned).
25. Coiled cables are properly secured (i.e., not draped from cable trays, lying on floor, coil supported by single tie wire, etc.).
26. Un-terminated cable ends or un-terminated instrument cable shielding are properly protected (i.e., moisture protection), if required.
27. Specified fire barriers, compartment boundary seals, and fire-retardant materials are being installed or applied, where specified.
28. Electricians are properly qualified.
29. QC inspectors are properly qualified and are present and performing their assigned tasks, when required, during handling and installation activities.

30. Non-conformances are identified and handled in accordance with procedures, including adequate justification for use-as-is disposition.
 31. Installation and inspection activities are being documented during the activity.
- d. Completed Work. Evaluate the completed installation of cables and associated selected items.
1. Busway, cable, wire, and termination materials (lugs, tapes, stress cones, splice kits, connectors, terminal blocks, etc.) are as specified.
 2. Cable routing is as specified on latest approved drawings.
 3. Cable identification is preserved and located where specified.
 4. Bending radius is as required.
 5. Required separation criteria for physical independence are maintained.
 6. Segregation is maintained (power, control, and instrument).
 7. There is no evidence of damage to cable.
 8. Terminations are properly located and made (entry, tightness, etc.) and are of the correct type.
 9. Cable supports are provided and are adequate.
 10. Cables are protected from sharp edges, hostile environments, and adjacent construction activities (welding, etc.).
 11. Cable tray, conduit, etc. are adequately protected and not being used as ladders, walkways, etc.
 12. Clearances between cable and adjacent components such as piping, ducts, and supports are as specified.
 13. Cabinets, panels, cable trays, junction boxes, etc. are maintained free of debris (periodically cleaned).
 14. Specified fire barriers, compartment boundary seals and fire-retardant materials are installed or applied, where required.
 15. Specified inspections are made by qualified personnel.
 16. Documentation of completed installation and inspection activities is properly completed, in a timely manner.

17. Nonconforming conditions are identified and handled in accordance with approved procedures, including adequate justification for use-as-is disposition.
 18. Conductive grease and electrical contact lubricant (NO-OX-ID) has been applied to power connectors as required by construction drawings and specifications.
- e. As-Built Verification. When electrical power, control, and data cables, and associated items, as selected in appropriate subsections of Section 02.02, are completely (or essentially) installed and inspected, the latest revisions (as-built, if available) of installation drawings pertaining to the cables and items selected for verification. Review construction specifications and other applicable work instructions referenced by the drawings. Compare the actual installation with the above drawings and associated documents.
1. Before performing the above, verify the number and status of outstanding design changes on the selected drawings and related specifications.
 2. 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 for engineering review, approval, and subsequent incorporation into the final as-built drawings.
- f. Cable Testing. If possible, observe a sampling of the following cable-testing activities applicable for the sample selected in the appropriate subsections of Section 02.02:
1. High potential tests on high-voltage power cables and 4160-volt cables.
 2. Insulation resistance tests.
 3. Continuity tests.
 4. Connector termination opacity test on...after cable.
 5. Connection resistance testing on DC battery connectors.
 6. Fiber optic cable testing
 - (a) Acceptance testing prior to installation
 - (b) Pre-installation: continuity test
 - (c) Post-installation: continuity test
 7. Determine whether the following requirements are being met for the above tests (as applicable):
 - (a) Use of and compliance with the proper procedure

- (b) Calibration of the test equipment is current and test personnel qualified to use the equipment.
- (c) Results are properly and accurately recorded.
- (d) Test results are within specifications limits or discrepancies are identified for resolution.

02.06 Record Control and Review. Review licensee and contractor requirements covering the control of records for safety-related electrical cable, terminations and associated items.

- a. Ensure requirements determine who prepares each quality-related record, who reviews the records for accuracy, and who ensures that the recorded information meets requirements.
- b. Evaluate the information obtained above and determine whether the established record-management system satisfies licensing document commitments.

02.07 Work and Inspection Records. Review and evaluate pertinent quality records in a sampling of the areas listed below. Determine whether: (1) adequate preparation; control, review, and evaluation of these records have been made; (2) they reflect that appropriate requirements have been met; and (3) the system of records is functioning properly. If possible, the selection should include records associated with: (1) various safety related power, control, signal, data and instrument cables (including thermocouple wire); (2) cable connectors, splices, and support grips; (3) terminations, lugs, NO-OX-ID compound tapes, and pulling compounds; and (4) fire barriers, seals and retardants. The records selected should represent a diversity of cable and associated items and include some cable and terminations located inside the process facility.

- a. Receipt Inspection Records. Select records applicable to the receipt of lots or shipments.
- b. Storage Records. Select records applicable to the storage, and storage inspection of lots or groups of cables and associated items.
- c. Installation Records. Select records applicable to the installation and inspection of several cables and associated terminations for risk important components.
- d. Cable-Testing Records. Select records applicable to the testing of cables, several of which shall be located inside process buildings.
- e. Raceway Loading Records. Review and evaluate records applicable to raceway loading for cable trays and cable conduits.
- f. Personnel Qualification Records. Review and evaluate records applicable to the qualification and training of inspectors and craftsmen.
- g. Change-Control Records. Review and evaluate design field change records.

02.08 Nonconformance and Deviation Reports. For the inspection, review and evaluate a sampling of reports applicable to non-conformances or deviations in cables, terminations and cable system installation. Determine whether:

- a. Records are legible, complete, and promptly reviewed by qualified personnel.
- b. Reporting requirements of 10 CFR Part 21 were recognized during evaluation and appropriate action was taken where necessary.
- c. Records have been routinely processed, evaluated in a timely manner and controlled through established channels, for resolution of the root-cause as well as the immediate problem.
- d. Records are properly identified and stored, indicate current status, and can be retrieved in a reasonable time.
- e. Non-conformance reports include the status of corrective action or resolution, and adequate justification is provided for use-as-is disposition.

02.09 Audit Records. Review and evaluate licensee and electrical contractor audit records. Determine if:

1. Audits have been performed in accordance with the schedule and functional areas established in the audit plan.
2. All elements of the QA program applicable to cable systems are being audited periodically.
3. Auditing organizations and personnel are independent of the work being audited.
4. Licensee is informed of the results of the electrical contractor(s) audits.
5. Audit records are sufficient to verify that the intended purpose and scope of the audits were achieved.
6. Audit findings have been reported in sufficient detail to permit a meaningful assessment by those responsible for corrective action, final disposition, and trending.
7. The licensee and contractor have taken proper and timely follow-up action on those matters in need of correction.

69020.A7-03 INSPECTION GUIDANCE

03.01 General Guidance.

- a. The term “cable” includes all conductors such as fiber optics wires, cables, and bus

bars. The term “termination” refers to all electric-conductor terminations such as lugs, splices, connectors, and terminal strips that directly contribute to the electrical continuity of the circuit. Terminations also include potheads, bushing, stress cones, taping, compounds, and other devices or techniques that directly contribute to the continuity of the electrical insulation system.

- b. Determine specific licensee procedural and work-instruction commitments relative to construction and inspection (QC) requirements for electric cables and terminations. The inspector should then utilize the above information during review of the licensee’s construction specifications, drawings, work, and inspection procedures to determine whether the licensing document requirements are adequately translated into the appropriate documents.
- c. To be adequate, procedure control activities such as receipt, storage, installation, inspection, calibration and testing should contain sufficient detail to ensure that the specific work steps which affect the functioning of the installed equipment will be performed properly. These work steps are to be identified and adequately controlled. While reviewing procedures, be aware of, and look for, inadequacies that could lead to construction deficiencies and/or indicate an inadequate management-control system.

03.02 Specific Guidance.

Note: The numbering of the guidance below refers to specific subsections of 02, above.

- a. Section 02.03. For the purpose of this IP, the term “work procedures” includes construction specifications, drawings, and work instructions. (Procedures describing methods of fabrication, construction, and/or installation are sometimes called construction procedures.)
- b. Section 02.03.a.
 - 1. Verify that requirements contained in the approved quality assurance program document, or other applicable licensing commitments, have been adequately translated into the licensee’s receipt inspection procedures, including provisions assuring that:
 - (a) Cable, busways (power, control, and data), and termination materials are in conformance with purchase specifications including special requirements.
 - (b) Adequate marking and identification are provided.
 - (c) As-received cleanliness and protection are adequate.
 - (d) Receiving inspection reports are complete.
 - (e) Control and disposition of non-conforming items are adequate.

2. The licensee should identify and describe all safety-related cables and associated items that must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or subsequent to an accident. Where environmental qualification testing or other qualification provisions are specified, the licensee shall establish means to ensure that the results of this testing are documented, reviewed, and determined to be acceptable. This is a particularly significant area for NRC review.
 3. Inputs from other groups or other organizations (e.g., source inspection results or other required quality tests) to be used during receiving inspection activities are properly used.
 4. Procurement requirements such as qualification tests, certificate of conformance, functional tests and other quality tests (material, physical, and chemical) have been successfully completed or status of how and when such requirements will be satisfied is documented and adequately controlled. Fire barriers and cable-penetration seals may require qualification. The tests and criteria can be found in the American Society of Testing and Materials (ASTM) E 814 and/or American National Standards Institute/Underwriters Laboratory Inc. (ANSI/UL 1479).
 5. Samples of received electric power, control, and data cable, termination material and related items are subjected to detailed dimensional checks or other inspection to ensure conformance with the purchase specification.
- c. Section 02.03.b.
1. Special storage requirements are typically specified by the manufacturer or an industry standard, committed to by the licensee. The requirements should include such things as taping or sealing cable ends, controlling material and cable or cable reel identification, maintaining proper ambient temperature, separation from nonconforming items, and placement on dunnage.
 2. Cable and termination materials may be released for installation on the merits of certifications if the organization involved has established satisfactory program control and audit requirements in this area (ANSI N45.2.1.3). However, certifications do not release the licensee from having other records for operation and for the life of the facility.
- d. Section 02.03.c. Appropriate and adequate construction specifications and other work instructions for a particular activity should be approved and available before that activity is started.
- e. Section 02.03.c.1.(a). The procedure should require QC acceptance of raceway installations before routing cable.
- f. Section 02.03.c.1.(b). Some method or procedure should be established to assure that the cable is properly qualified for the environment in which it is to be located.

- g. Section 02.03.c.1.(d). Splices in certain locations, such as raceways, may not be allowed. Refer to RG 1.75 and licensee commitments.
- h. Section 02.03.c.1.(i). Refer to the following for information pertaining to separation and independence: RG 1.75; and the Institute of Electrical and Electronic Engineers (IEEE) Standard (Std) 384.
- i. Section 02.03.c.1.(p). Procedures should require verification that loading requirements (both thermal and mass) are not exceeded in final cable routings in trays, busways, conduits, etc. This verification should include review of actual cable routing, cable routing records, and design calculations.
- j. Section 02.03.c.1.(q). Only specified materials should be used for fire barriers, fire stops, and fire retardants; and installation should be in accordance with approved procedures.
- k. Section 02.03.d.
 - 1. The licensee or contractor procedures involved will differ from site to site and may take various forms, such as formal procedures, instructions, checklists, drawings, etc. Review the IPs and compare with the applicable requirements and construction specifications. Evaluation should indicate whether adequate quality-related IPs are established and are based on appropriate criteria, and further, whether the results of the licensee's inspection will be transmitted to responsible QA and management personnel.
 - 2. Provisions should include procedures for monitoring or surveillance of installed cables by inspection (QC) personnel. They should ensure that maintenance requirements are satisfied and that adequate protection is provided against possible damage from adjacent construction activities, including construction traffic. (Where protective means used during construction may affect proper operation, provisions should be provided for timely removal.)
- l. Section 02.03.e. This item does not include preoperational testing. Construction testing generally verifies that certain components pass specific tests as required but is not a test of system capability, especially systems that include non-electrical equipment. The intent of this requirement is to determine whether adequate QA procedures have been established to assure that the required testing is satisfactorily completed and corrective action, if required, is properly performed. Procedures for cable system and component testing provide means to ensure that:
 - 1. Required construction testing is controlled and performed, as specified, using qualified personnel.
 - 2. Cable systems and components to be tested are properly identified, along with tests to be conducted.
 - 3. Proper type of test equipment (range, accuracy, calibration, etc.) is specified.

4. Test parameters (e.g., voltage level) are according to standards and manufacturer's recommendations.
5. Special conditions of testing, prerequisites, sequence, precautions, etc., and acceptance criteria, are specified and meet requirements.
6. Type of data to be recorded and method of reporting results are specified.
7. Qualified personnel evaluate test results.
8. Discrepancies are resolved.

03.03 Prevalent Problems and Concerns. The inspector should be alert to problems of a generic nature, such as:

- a. Adequate procedures or other means have not been established to assure and document that all safety-related (and if applicable, IROFS) systems have met applicable criteria, or to specifically document non-conformances.
- b. IPs does not include adequate inspection requirements and acceptance criteria.
- c. Inadequate means to control location and status of electric cable and components - especially during removal for repair or replacement.
- d. Inadequate procedures to control the evaluation, approval and use of field changes. (The licensee or contractor also should establish means to assure that only the latest approved field changes and other revisions or changes are being used for installation and inspection activities.)

69020.A7-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A7-05 REFERENCES

National Electrical Manufacturers Association NEMA WC 55-1992, "Instrumentation Cables and Thermocouple Wire."

National Electrical Manufacturers Association, NEMA WC 57-1995, "Standard (Std) for Control Cables."

National Electrical Manufacturers Association, NEMA WC 70-1999, "Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy."

National Electrical Manufacturers Association, NEMA WC 71-1999, "Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy."

National Electrical Manufacturers Association, NEMA WC 74-2000, "5-46 kV Shielded Power Cable for Use in the Transmission & Distribution of Electric Energy."

National Electrical Manufacturers Association, NEMA WC 53-2000, "Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation and Portable Cables for Test."

National Fire Protection Association 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials."

Institute of Electrical and Electronic Engineers Std 383-2003, "Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations."

Institute of Electrical and Electronic Engineers Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits –Description."

Institute of Electrical and Electronic Engineers Std 690-1984, "IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations."

Institute of Electrical and Electronic Engineers Std 400-2001, "IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems."

Institute of Electrical and Electronic Engineers Std 1143-1994, "IEEE Guide of Shielding Practice for Low Voltage Cables."

Association of Edison Illuminating Companies CS8-00, "Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV."

Electrical Training Course for U.S. Nuclear Regulatory Commission Inspectors, Unit III, "Design and Installation of Electrical Cable Systems in Nuclear Power Plant."

Electric Power Research Institute EL-5036, Power Plant Electrical Reference Series, Volume 4 - Wire and Cable, Section 4.5, "Installation, Termination, and Testing."

END

APPENDIX H

INSPECTION OF ELECTRICAL COMPONENTS AND SYSTEMS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A8-01 INSPECTION OBJECTIVES

01.07 To determine whether work activities associated with safety related electrical components and systems is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to electrical components and systems activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of electrical components and systems meets the specified design requirements, specifications, and drawings. For installation of electric cable, also refer to Appendix G of this inspection procedure (IP).

01.04 To determine that the implementation of the quality assurance program related to work activities associated with electrical components and systems is effective and to verify that deviations from requirements are appropriately resolved.

69020.A8-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related electrical components and systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the licensing basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for electrical components and systems work on-site at the time of the inspection. Inspectors should also coordinate this appendix with inspection of electrical cable (Appendix G of this IP) for efficiency, if possible.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the electrical components and systems on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of electrical components and systems construction arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the

on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.11 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review of QA Implementing Procedures. Review QA Manual and implementing procedures associated specifically with electrical component and systems, to determine whether the commitments in the approved QA Plan are being implemented, as follows:

- a. Adequate QA audit procedures have been established for this activity in accordance with the approved QA Plan including: (1) scope and frequency of audits; (2) audit criteria; (3) reporting requirements; (4) follow-up action; and (5) 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), 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 deviations, nonconformance's, 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 electrical components and systems have been trained, or otherwise qualified to the work procedures involved.

02.03 Specific Technical Review Areas. Review a sampling of procedures as they relate to electrical components and systems. Determine whether the procedures cover work and inspection activities in the following areas, are appropriate to the activity, and are technically adequate:

- a. Receiving-Inspection Procedures (IPs). Receiving inspection and related procedures provide means to ensure the following:

1. Received components are as specified, properly identified and controlled - or otherwise noted.
 2. Input from other groups or other organizations to be used during receiving inspection activities are obtained and properly used, such as the results of source inspections, environmental qualification tests, and other required quality tests.
 3. Procurement requirements, such as qualification tests (seismic, environmental, etc.), functional tests, and other quality tests (material, physical, and chemical), have been successfully completed, or status of how and when such requirements will be satisfied is documented and adequately controlled.
- b. Storage Procedures. Storage procedures provide means to ensure the following:
1. The proper storage environments (as specified by the construction specifications and the manufacturers) are established for the various types of electrical components and meet applicable storage-classification levels, regardless of the location of the stored component.
 2. Storage-inspection procedures require initial verification of storage conditions and periodic verifications (internal preservation, motor and generator-shaft rotation, insulation-resistance tests, etc.) for the duration of the storage period. They must also ensure that special and in-place storage requirements are met.
- c. Work Procedures. Work procedures are established to ensure the following:
1. NRC requirements and licensing commitments are properly translated into the work procedures (construction specifications, drawings, and work instructions) for adequate control and installation of electrical components and associated items. Areas to review shall include, but are not limited to, the following:
 - (a) Electrical components are identified, located, oriented, and supported as specified.
 - (b) Physical separation and independence requirements of redundant components are met.
 2. Interface controls are adequate when multiple contractors are involved.
 3. Procedures cover special handling, installation, and maintenance requirements, including those pertaining to protection, preservation of internal cleanliness, and maintenance of component-qualification requirements. For example, all covers, seals, plugs, internal preservatives, and protective coatings are left intact until installation and/or use, as appropriate.
- d. Handling Procedures. Handling procedures are established to ensure that the following handling activities and conditions are controlled and performed, as required during

receipt, storage, and installation of large electrical equipment:

1. Attachment points,
2. Use of rigging,
3. Positioning,
4. Special handling requirements, and
5. Temporary covers.

e. Inspection Procedures. “IPs” are established to ensure the following:

1. All safety-related aspects of construction specifications, drawings, and work instructions are included in the scope of planned inspections.
2. The technical aspects of inspection requirements and acceptance criteria are sufficient to determine whether the components and their installation, testing, maintenance, and protection conform to applicable design and construction specifications.
3. Records of initial and follow-up inspections include the specific results of the inspection. This should include the specific characteristics being inspected (or the actual measured values), the inspectors’ determination of acceptability, and identification of any nonconformance’s found.

f. Construction-Testing Procedures. Procedures are established to ensure that special conditions of testing electrical components (prerequisites, sequence, special handling, removal, precautions, etc.) are included and described in proper detail, as required to conduct and monitor the work performed, including the following:

1. Equipment and systems to be tested and the related test procedures are properly identified and controlled. Procedures specify which construction tests are to be performed on each component requiring testing.
2. Proper type of test equipment (range, accuracy, etc.) is specified.
3. Type of data to be recorded and method of reporting results.
4. Review and evaluation of test results by qualified personnel.
5. Resolution of discrepancies.

g. Change-Control Procedures. Procedures have been established to control design and field changes and ensure the following:

1. Retrieval of voided drawings and specifications at work sites is controlled.
2. Field changes are subject to adequate design control and are incorporated into the as-built records.

3. Coordination among participating design and construction organizations is adequate.

02.04 Inspection of Electrical Systems and Components.

Select a sample of electrical systems and components for inspection. Inspection should be accomplished by observation and evaluations of both in-process and completed work if possible. Sample selection should be based on importance to operational safety.

Before inspecting selected items, review the specifications, drawings, work procedures, QA/QC procedures, and work schedules applicable to the systems or components selected for inspection.

02.05 Inspection Activities. Perform a sampling of the following activities as they apply to electrical components and systems.

- a. Receiving Inspection. Observe and evaluate portions of receiving-inspection activities pertaining to the electrical components and systems selected for inspection in the appropriate subsections of Section 02.02, above. Determine whether receiving-inspection activities are being controlled and performed in a manner that will ensure applicable requirements are satisfied in the following areas:
 1. Identification appears on components and in receiving documents.
 2. Physical conditions (damage, deterioration, etc.) are indicated.
 3. Documentation regarding quality requirements (e.g., results of functional and qualification testing) received with components is reviewed to, and meets, requirements. Where qualification testing of components to be placed in a harsh environment (e.g., inside containment) is not a requirement of the specification, follow-up with the licensee to determine what means will be used to ensure that applicable environmental qualification will be satisfied.
 4. Nonconforming components.
 5. An adequate number of qualified personnel are available to perform the receiving-inspection function.
- b. Storage. Observe and evaluate storage activities and conditions for the components selected in the appropriate subsections of Section 02.02. Determine whether:
 1. Components are stored in the proper storage-level designation.
 2. Components are properly identified.
 3. Storage conditions (temperature, humidity, cleanliness, etc.) and requirements

are controlled and monitored as directed by the applicable specification and by the manufacturer's specifications.

4. Licensee and contractor inspection and monitoring activities are being performed in accordance with procedural requirements, if in progress during NRC inspection.
 5. Nonconforming items placed in storage are identified and/or segregated as required.
 6. In-place storage requirements are satisfied.
 7. An adequate number of qualified personnel are available to perform the required storage functions.
- c. Handling. As inspection scheduling permits, determine whether handling activities are being controlled and performed as specified when large electrical components are being moved during receipt, storage, and installation.
- d. In-Process Installation. If possible, observe and evaluate in-process installation pertaining to the components and associated items selected in the appropriate subsections of Section 02.02. Determine whether:
1. The latest approved revision of applicable construction specifications, drawings, and/or construction procedures are available and used by the installers.
 2. The components are as specified, such as type, size or rating, and material.
 3. The components are installed in the proper location and orientation by qualified craft personnel using suitable equipment and tools.
 4. Associated mounting hardware, supports, and anchors are of the type (welded, bolted, etc.,) and material specified, and are properly located.
 5. The required component identification is properly established or maintained.
 6. Installed components are adequately protected from damage by adjacent construction activities.
 7. Licensee and contractor inspections are performed or scheduled to be performed, before "covering up" the work to be inspected; QC hold points are observed.
 8. Inspection activities are completed in a timely and proper manner by qualified personnel.
 9. Documentation of installation and inspection activities is completed in a proper and timely manner.

10. Nonconformance's are identified and handled in accordance with established procedures. Where corrective action is being taken, determine whether it meets the appropriate requirements.
- e. Completed Work. Evaluate the completed installation of electrical components and associated items selected in the appropriate subsections of Section 02.02. Determine whether:
1. Components are installed in accordance with design, construction specifications, and work procedures; components are at the correct location, configuration, and orientation.
 2. Specified materials are used.
 3. Bolts, anchors, weldments, other fasteners, and supports are as specified and properly mounted and secured.
 4. Protective coatings, softeners, bushings, and other specified materials have been used as specified.
 5. Equipment and item identifications have been maintained.
 6. Equipment and components are protected from hostile environments, such as high-pressure pipe, rotating equipment, and non-seismically supported equipment.
 7. Electrical components, such as conduit, tray, motors, and power distribution centers maintain specified physical and electrical separation and independence between redundant components.
 8. Statuses of completion, maintenance, and readiness for pre-operational testing are indicated or otherwise documented.
 9. Adequate actions or provisions have been taken and/or maintained (as needed) to ensure that the validation of the environmental qualification of components is maintained.
- f. As-Built Verification. When electrical components and associated items, as selected in appropriate subsections of Section 02.02, are completely (or essentially) installed and inspected, review construction specifications and other applicable work instructions referenced by the drawings or otherwise applicable to the installation. Compare the actual installation with the above drawings and associated documents. For each drawing selected, determine whether several components shown on the drawing are of the type specified (function, range, qualification, material, etc.) and whether they have been installed, located, oriented, supported, protected, etc., in accordance with this drawing.

1. Before performing the above, verify the number and statuses of outstanding design changes on the selected drawings (and related specifications).
 2. 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 for engineering review, approval, and subsequent incorporation into the as-built drawings.
- g. Construction Testing. If possible, observe construction-testing activities for the electrical components selected in the appropriate subsections of Section 02.02. Determine whether:
1. The latest revisions of applicable test procedures and/or specifications are available at the work location and used by personnel performing the testing.
 2. Properly identified, traceable, and calibrated measuring and test equipment are used.
 3. Equipment or components are able to obtain the degree of accuracy and tolerance specified, or otherwise meet specified requirements.
 4. Required testing results are recorded during the activity; not after the testing has been completed. (Where test results are immediately available to the NRC inspectors, note whether they are within specified limits.)
 5. Components that have been tested are adequately identified as to their statuses, (i.e., specified requirements have been met or deficiencies noted).
 6. Personnel performing the testing are properly qualified.
 7. Test personnel adhere to any special handling or removal requirements.
 8. Test discrepancies are properly identified for resolution.

02.06 Record Control and Review. Review licensee and contractor requirements covering the span of records for safety-related electrical components and associated items.

- a. Determine who prepares each quality-related record, who reviews the records for accuracy, and who ensures that the recorded information meets requirements.
- b. Evaluate the information obtained above and determine whether the established record-management system satisfies CAR commitments.

02.07 Work and Inspection Records. Review and evaluate pertinent quality records in the areas listed below. Determine whether: (1) adequate preparation, control, review, and evaluation of these records have been made; (2) the records reflect that requirements have been met; and (3) the system of records is functioning properly. The selection shall include records of diverse safety-related electrical systems and components, from a

sampling of areas of the plant such as: (1) raceway and raceway supports; (2) switch gear and associated breakers; (3) emergency diesel generator and electrical auxiliaries; (4) transformers; (5) motors; (6) dc systems; (7) motor control centers; (8) electric valve operators; and (9) containment-penetration assemblies.

- a. Receiving-Inspection Records. Review and evaluate a selected sample of receiving-inspection records, and determine whether:
 1. Receiving-inspection documents properly and uniquely identified received electrical components and associated items.
 2. Applicable engineering and functional specifications (regarding size, type, material, etc.) of received items and components were met or otherwise noted.
 3. The required electrical component characteristics, material, performance tests, environmental and seismic qualification tests, nondestructive tests, and other specification requirements were met or otherwise noted.
 4. Original records or certification system met requirements of applicable criteria.
- b. Storage Records. Review and evaluate a selected sample of storage records, and determine whether the records reflect that:
 1. Specified storage conditions and requirements were maintained (e.g., internal preservation, shaft rotation, insulation-resistance tests).
 2. Storage inspections were properly made at specified intervals.
 3. Records of nonconforming items in storage areas were properly maintained.
- c. Installation Records. Review and evaluate a selected sample of quality records pertaining to installation activities, and determine whether these records reflect the following:
 1. Most recent and approved design and construction documents were used during installation.
 2. Specified electrical components and associated items were installed in the location specified or otherwise noted.
 3. Materials and methods used for supports and anchors (including welds) met applicable specifications.
 4. Qualified personnel performed, recorded, reviewed, and evaluated required inspections.
 5. Inspection records were complete and satisfy documentation requirements.

6. Physical separation and independence requirements were met.
 7. Required protection was provided after installation.
- d. Construction-Testing Records. Review and evaluate a selected sample of construction-testing, and determine whether:
1. Required tests were performed as required.
 2. Records indicate that approved procedures were followed.
 3. Test equipment was periodically checked and calibrated as specified.
 4. Test data and results were properly documented and evaluated, and corrective action, if required, was taken.

02.08 Personnel-Qualification Records. Review and evaluate a selected sample of craft and QC qualification records and determine whether:

- a. The system of craft and inspection personnel qualification records meets stated requirements and is being maintained in a current status.
- b. The records are sufficient to reasonably support qualification in terms of certification, experience, proficiency, training, testing, etc., as applicable.
- c. Responsible licensee/contractor organizations have acted to independently authenticate the record material.

02.09 Nonconformance and Deviation Reports. Review and evaluate a selected sample of nonconformance and deviation reports, and determine whether:

- a. Records are legible and complete, and qualified personnel promptly review them.
- b. Reporting requirements of 10 CFR Part 21 were recognized during evaluation and appropriate action was taken where necessary.
- c. Records have been routinely processed, timely evaluated, and controlled, through established channels for resolution of the root-cause, as well as the immediate problem.
- d. Records are properly identified and stored, indicate current status, and can be retrieved in a reasonable time.
- e. Nonconformance reports include the status of corrective action or resolution, and adequate justification is provided for use-as-is disposition.

02.10 Change-Control Records. Review and evaluate a selected sample of change-control records, and determine whether:

- a. Records associated with design and field changes, as well as related work and IP changes, reflect that timely review and evaluation of design and field change documents have been performed by personnel who are qualified.
- b. Records of periodic inspections ensure that only the most recent approved documents, including design changes, were used in the field.
- c. Design changes are subject to adequate design control, including consideration of the impact of the change on the overall design and on as-built records.
- d. Records of nonconformance's to design requirements include preparation of a nonconformance report even if the nonconformance is resolved through the design-change process.

02.11 Audit Records. Review and evaluate a selected sample of licensee and contractor audit records pertaining to electrical components. Determine whether:

- a. Audits have been performed in accordance with the schedule and functional areas established in the audit plan.
- b. Audit records are sufficient to verify that the intended purpose and scope of the audits were achieved.
- c. Audit findings have been reported in sufficient detail to permit a meaningful assessment by those responsible for corrective action, final disposition, and trending.
- d. The licensee and contractor have taken proper and timely follow-up action, on those matters in need of correction.
- e. Auditing organization and personnel are independent of the work being audited.

69020.A8-03 INSPECTION GUIDANCE

03.01 General Guidance.

- a. Electrical components and systems consist of those elements of the facility that are designed to supply, use, control, transform, condition, or interrupt electric power. This IP applies, but is not limited, to the following safety-related electrical components and associated items: (1) raceways; (2) raceway hangers and other supports; (3) switchgear; (4) motor control centers; (5) transformers; (6) batteries and racks; (7) battery chargers; (8) inverters; (9) motor-generator sets; (10) circuit breakers; (11) relays; (12) electrical penetration assemblies; (13) motors; (14) motor operators on valves; (15) electrical-control panels; (16) local cabinets; (17) limit switches; (18) solenoid valves; (19) emergency power system for principal safety-related loads, and (20) other protective devices.
- b. Applicable portions of the licensing basis should be reviewed during inspection

preparation. Determine specific licensee procedural and work instruction commitments relative to construction and inspection requirements for electrical components and systems. The inspectors should then use the above information during the review of the licensee's construction specifications, drawings, work, and IPs, to determine whether the above requirements are adequately translated into the appropriate documents.

- c. To be adequate, procedure-control activities, such as storage, installation, inspection, and testing, must contain sufficient detail to ensure that the specific work steps that affect the functioning of the installed equipment will be performed properly. These work steps are to be identified and adequately controlled. While reviewing procedures, the inspection should be aware of, and look for, inadequacies that could lead to construction deficiencies and/or indicate an inadequate management-control system.
- d. Penetration assemblies, as covered by electrical IPs, refer to assemblies installed in a containment-structure opening (sleeve, nozzle, or barrel) and not to the opening itself. The containment opening is considered to be a part of the containment structure.

03.02 Specific Guidance.

Note: The numbering of the guidance below refers to specific subsections of 02, above.

- a. Inspection Requirement 02.03. For the purpose of this IP, the term "work procedures" includes construction-specifications, drawings, and work instructions. (Procedures describing methods of fabrication, construction, and/or installation are sometimes called construction procedures.)
- b. Inspection Requirement 02.03a. The SAR should identify and describe all safety-related components that must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or subsequent to an accident. Where environmental-qualification testing or other qualification provisions (such as seismic) are specified, the licensee shall establish means to ensure that the results of this testing are documented, reviewed, and determined to be acceptable. If this is not performed when components are received, the procedures should specify the organization that will be performing this review and the controls to ensure that all such documentation requirements are satisfied before the component is placed in use. This is a particularly significant area for NRC review.
- c. Inspection Requirement 02.03b.
 - 1. U.S. Nuclear Regulatory Commission, Regulatory Guide (RG) 1.38 [American National Standards Institute (ANSI) N45.2.2] (or equivalent requirements) relative to storage are applicable here.
 - 2. Depending of the licensee's QAP, electrical components may be released for installation on the merits of certifications if the organization involved has established satisfactory program control and audit requirements in this area.

However, certifications do not release the licensee from having other records for operation and for the life of the plant.

d. Inspection Requirement 02.03c.

1. Appropriate and adequate construction specifications, procedures, and other work instructions for a particular activity are required to be approved and available before that activity is started.
2. Model number and type (only) are not considered to be adequate identification. Procedures should specify a unique identification number, along with the model number and name of manufacturer. Adequate (positive) identification is important because similar-looking electrical components can be significantly different with respect to rating, output, material, etc. Safety-related electrical components should be listed in the SAR.
3. Anchor bolts holding or mounting electrical components should be of the type, size and length specified. Provisions should exist to prevent indiscriminate cutting of reinforcement steel during the drilling of anchor holes.

e. Inspection Requirement 02.03e.

1. The licensee/contractor procedures involved will differ from site to site and may take various forms, such as formal procedures, instructions, checklists, drawings, etc. Review the IPs and compare with the applicable requirements and construction specifications. Evaluation should indicate whether adequate quality-related IPs are established and are based on appropriate criteria, and, further, whether the results of the licensee's inspection will be transmitted to responsible QA and management personnel.
2. Provisions should include procedures for monitoring or surveillance of locally mounted components by inspection (QC) personnel. They should ensure that maintenance requirements while "stored in place" are satisfied and that adequate protection is provided against possible damage from adjacent construction activities, including construction traffic. (Where protective means used during construction may affect proper operation, provisions should be provided for timely removal.)

f. Inspection Requirement 02.03f. NRC inspectors who are knowledgeable in the area of electrical systems, in general, and testing, in particular should inspect this area.

1. The SAR and the QAP should include or reference general testing requirements, and work procedures should provide detailed instructions. In addition, the QA manual should include general surveillance procedures relative to testing, [i.e., activities should be monitored (inspected or audited, as appropriate), in accordance with established procedures]. These procedures should include verification of the following:

- (a) Data sheets (or equivalent) are being used as specified.
 - (b) Testing procedures are current and approved for use; ranges, accuracies, etc., are specified.
 - (c) Testing techniques are appropriate for the component to be tested.
 - (d) Controls are included for removal and handling of components during testing activities.
2. Test data/records should include:
- (a) Specific identify of the component tested.
 - (b) The specific identity of the measuring and testing equipment used to perform the testing.
 - (c) Identity of the technician performing the test and date of test.
 - (d) Approval signature of responsible individual.
 - (e) Acceptance criteria.
3. Certificates of calibration should be available at the site for test instruments used to perform tests. These certificates should show that the standards used to establish the accuracy of the test instruments are traceable to a nationally recognized standard. Procedures should require that the performance and accuracy of test equipment are demonstrated by periodic checking.
4. This item does not include preoperational testing. Construction testing generally verifies that certain components perform as intended, but it is not a test of system capability.
5. Typical tests that may be required include insulation resistance, continuity, battery load, and breaker trips.
6. The licensee is required to provide information, relative to protection of the safety-related portions of the onsite AC power system from certain fault conditions. Significant aspects of this protection include: (1) manual and automatic interconnections between buses, buses to loads, and buses to supplies, and capability of components to withstand anticipated fault conditions; (2) interconnections between safety-related and non-safety-related buses; (3) circuit protection network (e.g., selective trip), including setting criteria, protection for overvoltage, under voltage, and frequency; and (4) load-shedding devices.

One method to determine the adequacy of these protective systems and devices includes a relay-coordination study. If applicable, the inspectors should

determine whether provisions are established to ensure that adequate procedures are available for this activity. The results of this study should be evaluated by qualified personnel to ensure acceptability of the results.

03.03 Prevalent Problems and Concerns. The inspectors should be alert to problems of a generic nature, such as:

- a. Adequate procedures or other means have not been established to ensure and document that all safety-related electrical components and subsystems have met applicable acceptance criteria or are nonconforming in specific areas.
- b. IPs do not include adequate inspection requirements and acceptance criteria.
- c. Inadequate means to control location and status of electrical components; especially during removal for repair, modification, or replacement.
- d. Inadequate procedures to control the evaluation, approval, and use of field changes. (The licensee/contractor should establish means to ensure that only the latest approved field changes and other revisions or changes are being used for construction and inspection activities.)

69020.A8-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020-05 REFERENCES

Code of Federal Regulations, 10 CFR Part 21, "Reporting Defects and Noncompliance."

END

APPENDIX I

INSPECTION OF VENTILATION AND CONFINEMENT SYSTEMS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A9-01 INSPECTION OBJECTIVES

01.08 To determine whether work activities associated with safety related ventilation and confinement systems is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to ventilation and confinement system activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of ventilation and confinement systems meets the specified design requirements, specifications, and drawings.

01.04 To determine that the implementation of the quality assurance program related to work activities associated with ventilation and confinement systems is effective and to verify that deviations from requirements are appropriately resolved.

69020.A9-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related ventilation and confinement systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for ventilation and confinement system work on-site at the time of the inspection

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the ventilation and containment systems on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of ventilation and confinement systems construction arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.05 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Adequacy and Effectiveness of Construction-Implementing Work Procedures.

- a. Verify that contractor/subcontractors, with responsibilities for installing safety-related ventilation and confinement systems, have approved procedures describing the administrative controls and work processes to be implemented to ensure construction activities have been accomplished according to design requirements.
- b. Verify that procedures prescribe adequate methods, of quality control (QC) inspection, to ensure that the as-built condition of safety-related ventilation and confinement systems meets specified engineering requirements and drawings. As part of the assessment of the QC inspection procedures (IPs), ensure the procedures include or reference appropriate quantitative or qualitative acceptance criteria for determining that the prescribed activities have been accomplished satisfactorily.
- c. Verify that contractors have established procedures for ensuring that craft and inspection personnel performing construction work on safety-related ventilation and confinement systems are qualified to perform their assigned work.

02.03 Adequacy and Effectiveness of Construction Work and Work Activities. By direct observation, record review, and/or independent evaluation of work performance, work-in-progress, and/or completed work, determine whether activities regarding ventilation and confinement systems are being accomplished in accordance with NRC requirements, the licensing basis, SAR commitments, the QAP, and licensee procedures and specifications.

- a. Installation Activities.
 1. If work is in progress at the time of the inspection, witness a sample of the installation activities of safety-related ventilation and confinement systems, to verify the following:
 - (a) The latest issue (revision) of applicable drawings or procedures is available to the installers and is being used.
 - (b) Modifications to supports are approved by appropriate personnel before implementation.
 2. If work is in progress at the time of the inspection, witness a sample of the installation and testing (if required) of concrete anchor bolts, to verify that anchor-bolt type, diameter, embedment length, shoulder-to-cone measurement, and torque requirements (where applicable), meet installation requirements.
 3. Determine whether required inspection activities are in process and observe a sample for adequacy. In particular, determine whether QC inspection of welder

qualification procedures and welding of supports is conducted.

b. Major Construction Activities.

1. Receipt.

Review a sample of receipt-inspection reports for major components of ventilation and confinement systems and verify receipt-inspection requirements have been implemented.

2. Storage.

Review a sample of receipt reports for High Efficiency Particulate Apparatus (HEPA) filter system procurement and other types of Heating Ventilation and Air Conditioning (HVAC) system material (e.g., scrubbers, fans, dampers, weld filler metal, fasteners, and expansion anchors). Verify conformance with storage administrative controls and technical requirements.

3. Fit-up and Alignment.

Inspect a sample of bolted connections and verify the following:

- (a) The bolted connections conform to procedure- or drawing-established tolerances for mutual parallelism and axial alignment.
- (b) Layout instruments are calibrated. Equipment and instruments used for in-process monitoring and inspection should be calibrated to standards traceable to industry-recognized criteria. Calibration and control measures are not applicable for rulers, tape measures, levels, and other such coarse-measurement devices that provide accuracy, as received from the manufacturer.

4. Edge Finish.

Inspect a sample of flanges and supports that are ready for welding and verify that the flange faces and edges conform to procedure/specification requirements.

5. Anchor Bolts, Embedded Weldments, and Plate Anchors.

Inspect a sample of anchor-bolt installations and verify the installations conform to established procedure requirements.

6. Bolted Connections.

Inspect a sample of bolted connections and verify that the installations and inspection activities conform to established requirements. Verify that torque wrenches used for these bolted connections had been calibrated as required by the construction specification.

7. Welded Connections.

Inspect a sample of welded connections in an HVAC system and verify they conform to established requirements for weld identification, use of appropriate welding procedure(s), and control of welding materials, etc.

c. As-Installed Equipment.

Observe a sample of the completed installation of the following equipment for proper location, configuration, identification, and damage. The basis for this determination shall be the SAR system description, piping and instrumentation diagrams (P&IDs), specifications, and installation drawings. Select from the list below.

1. Seismic support for ductwork;
2. Ductwork;;
3. Isolation dampers;
4. Recirculation test loops around fans and isolation dampers;
5. Radiation, smoke, and toxic chemical monitor;
6. Pressure-drop instrumentation across filter banks;
7. Instrumentation for the detection of excess ambient temperature;
8. Fresh air intake elevation from grade level;
9. Fans and motors;
10. Air handling units;
11. Exhaust vents; and
12. Filters.

02.04 Adequacy and Effectiveness of the Training and Qualification of Personnel. Inspect a sample of qualification records. Verify that craft, testing, and QC personnel involved in performing confinement and ventilation-system construction and inspection activities are qualified to perform their job functions.

02.05 Adequacy and Effectiveness of the System of Records. Inspect a sample of records. Verify that records for installing and testing safety-related ventilation and confinement systems are as specified, reviewed by the contractor for accuracy and assurance; and the recorded information meets project requirements, has been approved, and stored and maintained sufficient to support technical and contractual requirements.

- a. Review licensee/contractor documentation requirements covering work performed for ventilation and confinement systems. Determine the effectiveness of the document review systems by comparing records against requirements for accuracy and completeness.
- b. Review a sample of nonconformance reports for items of the ventilation and confinement systems.
- c. Review relevant portions of licensee and contractor audit reports concerning the installation of ventilation and confinement systems.

69020.A9-03 INSPECTION GUIDANCE

For each of the inspection elements, the inspectors should: (1) obtain a copy of the contractor's procedures and the related industry codes and standards to which the contractor has committed; (2) become familiar with the contents of the procedures and standards; and (3) assess whether the procedures and their implementation adequately conform to the applicable commitments.

Suggested sample selections are included in the section below. Follow the suggestions or choose samples more appropriate for the inspection, based on construction progress, completion of contractor's QA/QC reviews, or inspectors experience. Use judgment in determining sample selection, focusing on examining the most important aspects of the particular activity being inspected. The intent is to establish a high level of assurance the end product meets requirements.

03.01 General Guidance.

- a. Description of the ventilation and confinement systems is contained in the facility's SAR. The inspectors should then use the SAR sections during the review of the licensee's implementing construction specifications, drawings, work procedures, and QA implementing procedures. The inspectors also should review the documents listed in the reference section of this procedure for in-depth technical details needed for the inspection.
- b. 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 inspectors should review the licensee's/contractors implementing procedures that correspond with applicable QAP requirements, codes and specifications. The inspectors should verify that the licensee has established measures for identification and control of materials, parts, and components, and for traceability to the approved design basis and to the source. The inspectors 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.

- c. The inspectors 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., American Society for Testing and Materials 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.

3.02 Specific Guidance.

- a. Adequacy and Effectiveness of Construction-Implementing Work Procedures. The inspectors should review the implementing and QC IPs for ventilation and confinement construction. Verify the procedures have been approved and specify the work processes, adequate QC inspections and methods, and management controls for the major construction activities. Ensure the major construction activities are completed according to drawing and procedure requirements and include or reference appropriate quantitative or qualitative acceptance criteria.
- b. Receiving. The inspectors should select a sample of procurement documents regarding: (specifications and drawings, various components such as HEPA filters, prefilters, and spark arrestors). Verify that these documents specify the shape, size, dimension, and material type and grade, and the Certificate of Conformance certifies the components meets the construction, material, test, and qualification requirements.
- c. Storage. The inspectors should ensure storage and warehousing procedures for ventilation and confinement system components, and/or the procurement documents reviewed require the following:
 - 1. Access is controlled to the storage area to maintain the quality of the materials received.
 - 2. An adequate marking system is used to maintain the identity of material in storage.
 - 3. Material is protected from the environment and weather, as appropriate. Structural steel for supports is protected from corrosion.
 - 4. Nonconforming material is segregated.
 - 5. Motors, dampers, and heaters are checked to ensure wrappings are not disturbed and items are not removed from storage without proper authority.

6. HEPA filters and adsorbers are stored in their original cartons in an environmentally controlled room.
- d. Fit-up and Alignment. The inspectors should ensure construction procedures or drawings for ventilation and confinement systems require flange faces to conform to established tolerances for mutual parallelism and axial alignment.
- e. Edge Finish. The inspectors should ensure construction procedures for ventilation and confinement system provide criteria for the following:
 1. Flange-face surface finish.
 2. Surface finish of weld preparations.
- f. Anchor Bolts, Embedded Weldments, and Plate Anchors. The inspectors should assess whether the contractor's construction procedures for ventilation and confinement systems adequately address the following:
 1. The minimum edge distance for bolts, studs, or bars with shear loading.
 2. Expansion-anchor testing.
- g. Bolted Connections. The inspectors should ensure construction procedures for ventilation and confinement systems require the following:
 1. Maximum and minimum-edge distance for slotted, oversized, and standard bolt holes for bolted steel-duct support structures.
 2. Maximum and minimum hole size for standard, oversized, short-slotted, and long-slotted holes for bolted connections for bolted steel-duct support structures.
 3. Minimum spacing requirements for bolt holes for bolted steel-duct support structures.
 4. Installation of locking devices for fasteners and threaded joints (except for high-strength bolts); engagement of the threads of all bolts or studs for the full length of the thread in the nut (unless approved by the engineer); and conformance of bolting material to drawing requirements.
 5. Calibration of torque wrenches.
 6. Use of beveled washers to compensate for situations where the surface of the bolted part in contact with the bolt head has a slope greater than 1:20 with respect to the plane normal to the bolt axis.
- h. Welded Connections. The inspectors should review the construction procedures for welding material greater than, or equal to 0.125-inches thick. In addition, assess whether the contractor's procedures adequately address the following:

1. Identification of welders and weld operators who are welding on steel-duct support structures;
 2. Weld procedure and welder qualification; and
 3. Control of welding material.
- i. Material Physical Dimensions and Tolerances. The inspectors should ensure construction procedures or drawings for ventilation and confinement systems require acceptable dimensioning and tolerances for the following:
1. Length, elevation, material thickness, joint and seam joining, and span for ducting and supports.
 2. Requirements that the taper of duct transitions be at least five units in length for each one unit in diameter change.
- j. Nondestructive Examination. The inspectors should review the construction procedures for ventilation and confinement systems, in accordance with the applicable IP. In addition, assess whether the contractor's procedures adequately address the following:
1. Visual inspection of production welds according to the visual inspection criteria of American Welding Society (AWS) D1.1 or D1.3, or other code or standard as specified in the licensee's SAR and/or QAP.
 2. Requirements for visual-inspection proximity of view, qualification of visual-inspection personnel, and the contents of visual-inspection reports.
 3. Inspection sampling for full-penetration and partial-penetration welds on structural steel-duct or equipment supports.

03.03 Adequacy and Effectiveness of Construction Work and Work Activities. Before performing work observation inspections in the field, review the applicable procedures and industry standards to ensure familiarity with the requirements and acceptance criteria pertinent to the planned observations. During field observations, the inspectors should carry a copy of the appropriate sections of the contractor's procedures and industry standards, pertinent to the planned observations, and verify work is being accomplished using procedures of the proper revision.

Examples of the major construction activities for safety-related HVAC systems are listed in Section 02.03. Verify the construction work implemented in the field conforms to the contractor's construction and IPs.

During the field observations, the inspectors should interview and obtain the names of a sample of the craft and QC personnel performing the observed activities, to assess whether their knowledge of the job and procedures is satisfactory. The sample size will be determined by the number of contractor personnel performing the activity. Information

on these same personnel will be used pursuant to Section 03.04, below, to determine the adequacy of their experience, training, and qualification, including documentation.

03.04 Adequacy and Effectiveness of the Training and Qualification of Personnel. The inspectors should interview a sample craft and QA/QC personnel involved in activities related to the safety-related ventilation and confinement systems and verify the personnel are sufficiently knowledgeable of procedure requirements. The inspectors should also review the training and qualification records for those individuals to determine if they meet the requirements.

03.05 Adequacy and Effectiveness of the System of Records. The inspectors should select a sample of records generated during the conduct of HVAC system receiving, storage, fit-up and alignment, bolting, welding, and testing activities and records of qualification for those craft and QA/QC personnel selected during the performance of Section 02.03, above. Verify the records selected for examination were approved by proper authority and were stored and maintained in such a manner as to demonstrate conformance with procedural requirements.

69020.A9-04 RESOURCE ESTIMATES

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A9-05 REFERENCES

American Society of Mechanical Engineers, (ASME), ASME AG-1, "Code on Nuclear Air and Gas Treatment," (1991).

American Society of Mechanical Engineers, ASME B31.3, "Process Piping," (1998).

American National Standards Institute, American Society of Mechanical Engineers, ANSI/ASME N509, "Nuclear Power Plant Air Cleaning Units and Components," (1980).

American National Standards Institute, American Society of Mechanical Engineers, ANSI/ASME N510, "Testing of Nuclear Air-Cleaning Systems," (1980).

American Welding Society, AWS D1.1, "Structural Welding Code," (1998).

American Welding Society, AWS D1.3, "Structural Welding Code - Sheet Steel," (1998).

American Welding Society, AWS D9.1, "Sheet Metal Welding Code," (1998).

American National Standards Institute, ANSI N690, "Specification for the Design, Fabrication, and Erection of Safety-Related Steel Structures for Nuclear Facilities," (1994).

American National Standards Institute, ANSI/ANS 8.1, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," (1988).

American Society for Heating Refrigeration and Air Conditioning Engineers (ASHRAE), "Design Guide for Department of Energy Nuclear Facilities," (1988).

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.100, Rev. 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," (1988).

U.S. Nuclear Regulatory Commission, Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants," (1973).

END

APPENDIX J

INSPECTION OF INSTRUMENTATION AND CONTROL SYSTEMS AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A10-01 INSPECTION OBJECTIVES

01.01 To determine whether work activities associated with safety related instrumentation and control systems is being performed in accordance with the licensing basis, construction specifications, drawings, and work procedures.

01.02 To determine whether the licensee system for preparing, reviewing, and maintaining records relative to related instrumentation and control system activities is functioning properly, and to determine whether the records reflect work accomplishment consistent with specifications and procedures.

01.03 To verify that the as-built condition of related instrumentation and control systems meets the specified design requirements, specifications, and drawings.

01.04 To determine that the implementation of the quality assurance program related to work activities associated with related instrumentation and control systems is effective and to verify that deviations from requirements are appropriately resolved.

69020.A10-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related instrumentation and control systems being constructed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for related instrumentation and control system work on-site at the time of the inspection.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the instrumentation and control systems on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of instrumentation and control system construction arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.12 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 QA Procedure Review. Review commitments and procedures covering the scope of documents to be prepared for assuring the quality of I&C systems that are designated as safety-related

- a. Determine whether the installation procedures for safety related I&C systems are consistent with the QA program and licensing document commitments.
- b. Determine whether responsibility assignments for procedures preparation, review and approval, include groups with necessary technical expertise.
- c. Determine whether licensee individuals or contractors that review and approve quality records are required to have the necessary technical expertise to ensure that the information to be recorded meets applicable requirements.
- d. Determine whether construction drawings incorporate the most recent design requirements.

02.03 Specific Technical Review Areas. Determine whether procedures covering work and inspection activities in the following areas are appropriate for the activity and are technically adequate:

- a. Receipt Inspection Procedures (IPs). Receipt inspection and related procedures provide means to ensure that:
 1. Material is in good condition, not damaged in shipment and that shipping and handling requirements have been met.
 2. Inputs from other groups or other organizations to be used during receiving inspection activities are properly utilized; such as the results of source inspections, environmental qualification tests, and other required quality tests.
 3. Procurement requirements such as qualification tests, certificate of conformance, functional tests and other quality tests (material, physical and chemical) have been successfully completed or status of how and when such requirements will be satisfied is documented and adequately controlled.

- b. Storage Procedures. Storage procedures provide means to ensure that:

The proper storage environments (as specified by the construction specifications and the manufacturer's instructions) are established for the various types of I&C system components and meet applicable storage classification levels regardless of the location of the stored item.

- c. Work Procedures. Work procedures are established to ensure that:
1. Licensing document commitments are properly translated into the work procedures (construction specifications, drawings and work instructions) for adequate control and installation of safety-related I&C system components and associated items.
 2. Interface controls are adequate when multiple contractors are involved.
 3. Procedures cover special handling, installation, termination, and maintenance requirements, including those pertaining to protection, preservation of internal cleanliness, and maintenance of component qualification requirements. For example, all covers, seals, plugs, internal preservatives, and protective coatings are left intact until installation and/or use, as appropriate.
- d. Inspection Procedures. QC IPs is established to ensure that:
1. All safety-related aspects of construction specifications, drawings, and work instructions are included in the scope of planned inspections.
 2. The technical aspects of inspection requirements and acceptance criteria are sufficient to determine whether the components and their installation (including terminations and interface seals), calibration, test, maintenance, and protection conform to applicable design and construction specifications.
 3. Records of initial and follow-up inspections include the specific results of the inspection. This should include the specific characteristics being inspected (or the actual measured values), the inspector's determination of acceptability, and identification of any nonconformance(s) found.
- e. Construction Testing and Calibration Procedures. Procedures are established to ensure that special conditions of testing and calibration of process instruments (prerequisites, sequence, special handling, removal, precautions, etc.) are included and described in proper detail as required to conduct and monitor the work performed. For example, if density compensation is required for a liquid level instrument, the proper technique for density correction should be included in the calibration procedure.
- f. Change Control Procedures. Procedures have been established to control design and field changes to ensure that:
1. Retrieval of voided drawings and specifications at work sites is controlled.
 2. Field changes are subject to adequate design control processes and are incorporated into the as-built records.

02.04 Follow-up Procedure Review. For work in progress or completed, review a selected sample of the procedures addressed in Sections 02.02 and 02.03, above, and note significant changes made (revisions, deletions, additions, etc.). Determine whether the changes are appropriate and whether regulatory requirements and licensee commitments remain in these procedures.

02.05 Inspection of Systems and Components.

a. General.

1. Inspection of selected components and associated items of the instrument systems listed below may be accomplished by observation, record review and/or independent evaluation of in-process and/or completed work.
2. Sample selection should be based on importance to operational safety and should include redundant components and a diversity of components and locations if practical.
3. Before inspection of selected items, review the specifications, drawings, work procedures, QA/QC procedures and work schedules applicable to the systems and components selected for inspection. Below are examples of types of samples the inspector(s) may use during this inspection:

(a) Emergency Control System.

- (1) For each of the activities in Section 02.06, select process variables which are used by the emergency control system to mitigate the consequence of a hazardous occurrence.
- (2) Complete the inspection requirements of subsections 02.06.b through 02.06.f for components pertaining to the process variables selected for that subsection.

(b) Safety Related Display Instrumentation.

- (1) For each of the activities in Section 02.06.d, select process variables which are displayed to provide information to the operator so that required manual safety actions can be taken using the emergency control system.
- (2) Complete the inspection requirements of subsections 02.06.b through 02.06.f for components pertaining to the process variables selected for that subsection.

(c) Emergency Control System.

- (1) Select process variables which are used by the emergency control system to mitigate the consequence of a hazardous occurrence.

- (2) Complete the inspection requirements of subsections 02.06.a through 02.06.f for the instrument components and associated items pertaining to the emergency control system variable selected.

(d) Safety Related Display Instrumentation.

- (1) Select process variables which are displayed to provide information to the operator so that required manual safety actions can be taken using the emergency control system.
- (2) Complete the inspection requirements of subsections 02.06.b through 02.06.f for components pertaining to the process variable selected for that subsection.

02.06 Inspection Activities.

- a. Receipt Inspection. Observe and evaluate a sample of receipt inspection activities pertaining to instrumentation components and associated items selected in the appropriate subsections of Section 02.05. Determine whether receiving inspection activities are being controlled and performed in a manner which will ensure that applicable requirements are satisfied in the following areas:
 1. Components and receiving documents are properly identified.
 2. Physical condition (damage, deterioration, etc.).
 3. Documentation relative to quality requirements (e.g., results of functional and qualification testing) received with components and associated items is reviewed and meets the requirements. Where qualification testing of components to be placed in a harsh environment is not a requirement of the specification, review existing documentation that establishes acceptance criteria and environment requirements that define what means will be used to assure that applicable environmental qualification will be satisfied.
 4. Control of nonconforming components.
 5. Adequate number of qualified personnel are available to perform the receiving inspection function.
- b. Storage. Observe and evaluate a sample of storage activities and conditions for the inspection samples selected in appropriate subsections of Section 02.05. Determine whether:
 1. Components are stored in the proper storage level designation.
 2. Components are properly identified.

3. Storage conditions (temperature, humidity, cleanliness, etc.) are controlled and monitored as specified.
 4. Licensee and contractor inspection and monitoring activities are being performed in accordance with procedural requirements.
 5. Nonconforming items placed in storage are identified and/or segregated, as required.
 6. In-place storage requirements are satisfied.
 7. An adequate number of qualified personnel are available to perform the required storage functions.
- c. In-Process Installation. If in-process work is occurring at the time of the inspection, observe and evaluate portions of the in-process installation activities for the inspection sample selected in appropriate subsections of Section 02.05. Determine whether:
1. The latest approved revision of applicable construction specifications, drawings, and/or procedures are available and used by the installers.
 2. The components are as specified, such as: type, range, proof pressure/rating and material.
 3. Associated mounting hardware and supports are of the type and material specified and properly located.
 4. The components are installed in the proper location and orientation by qualified craft personnel using suitable equipment and tools.
 5. The required component identification is properly maintained or established.
 6. Licensee and contractor inspections are performed, or scheduled to be performed, before closing out the work to be inspected.
 7. Inspection activities are timely and properly completed by qualified personnel.
 8. Installed components are adequately protected from damage by adjacent construction activities.
 9. Nonconformance issues are identified and handled in accordance with established procedures. Where corrective action is being taken, determine whether it meets the appropriate requirements.
- d. Completed Work. Observe and inspect the completed installation of I&C system components for the samples selected in subsections of Section 02.05. Determine whether:

1. Location, configuration and installation (including mounting and anchoring) are in accordance with the latest approved design or construction specifications and drawings.
 2. Specified instrument components and associated items have been used.
 3. Components have been correctly and permanently identified.
 4. Cleanliness requirements have been maintained or otherwise satisfied.
 5. Installed equipment is adequately protected from adjacent construction activities and protective coatings, plugs, bushings, and other materials have been used as specified.
 6. Instrument components and associated items, such as sensing lines and power supplies; maintain physical and electrical independence between redundant parts.
 7. Protection systems and normal plant control systems are adequately separated and isolated from each other.
 8. Nonconforming components or conditions have been identified and controlled in accordance with approved procedures.
 9. Status of completion, maintenance, and readiness for pre-operational testing is indicated or otherwise documented.
 10. Adequate actions or provisions have been taken or maintained (as needed) to ensure that the validation of the environmental qualification of instrument components is maintained.
 11. Wiring and terminations, including grounding, are installed in compliance with construction drawings and specifications.
- e. As-Built Verification.
1. When I&C system components as selected in appropriate subsections of Section 02.03, are installed and inspected, obtain the latest revision (as-built, if available) of instrument and installation drawings.
 - (a) Review construction specifications and other applicable documents referenced by drawing or otherwise.
 - (b) Compare the actual installation of the components selected with the drawings.

2. Before performing items (a) and (b) above, verify the status of any outstanding design changes on the selected drawings (or related specifications).
 3. 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 for engineering review, approval, and subsequent incorporation into the final as-built drawings.
- f. Construction Testing and Calibration. Observe a sample of construction testing and calibration activities for applicable components from the sample selected in subsections of Section 02.03. Determine whether:
1. The latest revisions of applicable procedures and/or specifications are available at the work location and used by personnel performing the testing and calibration.
 2. Properly identified, traceable and calibrated measuring and test equipment are used.
 3. Equipment or components calibrated are able to obtain the set point, degree of accuracy, and/or tolerance specified or otherwise noted.
 4. Required testing and calibration results are recorded during the activity, not after the work has been completed.
 5. Components are adequately identified as having been tested or calibrated.
 6. Personnel performing the testing and calibration are properly qualified.
 7. Test and calibration personnel adhere to any special handling or removal requirements.

02.07 Record Control and Review. Review licensee and contractor requirements covering the scope of records for safety related I&C system components.

- a. Determine who prepares each quality-related record, who reviews the records for accuracy and who ensures that the recorded information meets requirements.
- b. Evaluate the information obtained above and determine whether the established record management system satisfies QA Program and licensing document commitments.

02.08 Inspection Records. Review and evaluate a sample of pertinent quality records. Determine whether: (1) adequate preparation, control, review, and evaluation of these records have been made; (2) they reflect that regulatory requirements have been met and (3) the system of records is functioning properly. The selection should include records of components in safety control subsystems, emergency control system, sensors, and safety parameter displays, if applicable.

a. Receipt Inspection Records.

1. Receipt inspection documents properly and uniquely identified received instrument components and associated items.
2. Applicable engineering and functional specifications (regarding size, type, material, etc.) of received items were met or otherwise noted.
3. The required instrument component characteristics, material, performance tests, environmental and seismic qualification tests, nondestructive tests, and other specification requirements were met or otherwise noted.
4. Original records or certification system met requirements of applicable criteria.

b. Storage Records.

1. Required storage conditions were maintained. (Note: Verification of these conditions may require verification of log sheets recording the ambient conditions or through the use of recorders.
2. Storage inspections were properly made at specified intervals.
3. Records of nonconforming items in storage areas were properly maintained.

c. Installation Records.

1. Most recent and approved design and construction documents were used during installation.
2. Specified instrument components and associated items were installed in the location specified or otherwise noted.
3. Materials and methods used for supports and anchors (including welds) met applicable specifications.
4. Required inspections were performed, recorded, reviewed, and evaluated by qualified personnel.
5. Inspection records were complete and satisfied documentation requirements.
6. Physical separation and independence requirements were met.
7. Required protection was provided after installation.
8. Verify that required special installation procedures were implemented.

d. Construction Testing and Calibration Records.

1. Required tests and calibrations were performed as required.
2. Records indicate that approved procedures and equipment were used.
3. Test equipment was periodically checked and calibrated as specified.
4. Test data and results were properly documented and evaluated, and corrective action, if required, was taken.

02.09 Training/Qualification Records. Review and evaluate a sample of personnel qualification records and determine whether:

- a. A system of craft and inspection personnel qualification records meets stated requirements and is being maintained in a current status.
- b. The records are sufficient to reasonably support qualification in terms of certification, experience, proficiency, training, testing, etc., as applicable.
- c. Action has been taken by responsible licensee organizations to independently authenticate the record material.

02.10 Nonconformance and Deviation Reports. Review and evaluate a sample of nonconformance and deviation reports, and determine whether:

- a. Records are legible, complete and promptly reviewed by qualified personnel.
- b. Appropriate reporting requirements were recognized during evaluation and appropriate action was taken where necessary.
- c. Records have been routinely processed, timely evaluated, and controlled through established channels for resolution of the root cause as well as the immediate problem.
- d. Records are properly identified, stored, indicate current status, and can be retrieved in a reasonable time.
- e. Nonconformance reports include the status of corrective action or resolution, and adequate justification is provided for use-as-is disposition.

02.11 Change Control Records. Review and evaluate a sample of change control records, and determine whether:

- a. Records associated with design and field changes, as well as related work and inspection procedure changes, reflect timely review and evaluation by qualified personnel and are of the type approved for that purpose.

- b. Records of periodic inspections assure that only the most recently approved documents, including design changes, were used in the field.
- c. Design changes are subject to adequate design control, including consideration of the impact of the change on the overall design and on as-built records.
- d. Records of nonconformity to design requirements include preparation of a nonconformance report even if the nonconformance is resolved through the design change process.

02.12 Audit Records. Review and evaluate a sample of licensee and instrument contractor(s) audit records associated with instrumentation and determine whether:

- a. Audits have been performed in accordance with the schedule and functional areas established in the audit plan.
- b. Audit records are sufficient to verify that the intended purpose and scope of the audits were achieved.
- c. Audit findings have been reported in sufficient detail to permit a meaningful assessment by those responsible for corrective action, final disposition, and trending.
- d. The licensee and contractor has taken proper and timely follow-up action on those matters in need of correction.
- e. Auditing organizations and personnel are independent of the work being audited.
- f. All elements of the QA program are being audited periodically.

69020.A10-03 INSPECTION GUIDANCE

03.01 General Guidance.

- a. I&C system components consist of those elements that are designed to measure, monitor, transmit, modify, display, alarm, record and/or control various plant variables or conditions. This IP, and other instrumentation IPs, apply, but are not limited, to the following safety related instrument components and associated items: sensors, transmitters, isolators, signal conditioners, controllers and other actuating devices, recorders and other printing devices, indicators, alarms, switches, logic devices, interlocks, bypasses, instrument valves, fittings, tubing, instrument air supplies, internal power supplies or regulators, protective devices, control boards, racks, panels, cabinets, supports, anchor and mounting hardware, communication devices, multiplexers, data concentrators, engineering workstations, human-machine interface devices (e.g., displays), interconnecting means for integrity and applicability, and network management devices and tools.

- b. During inspection preparation, applicable portions of the licensing documents should be reviewed by the inspector to determine specific licensee procedural and work instruction commitments relative to construction and inspection (QA) requirements for I&C system components. The inspector should then utilize the above information during review of the licensee's construction specifications, drawings, work, and IPs to determine whether licensing document requirements are adequately translated into the appropriate documents.
- c. Procedures that control activities such as receipt, storage, installation, inspection, calibration, testing, and software modification, upgrading, and/or patching must contain sufficient detail to assure that the specific work steps which affect the functioning of the installed equipment will be performed properly. These work steps are to be identified and adequately controlled. While reviewing procedures, be aware of and look for inadequacies that could lead to construction deficiencies and/or indicate an inadequate management control system.
- d. In addition to observing whether specific instrument components and associated devices are as specified (properly identified, located, mounted, etc., as required), it is important also to ascertain whether certain components or conditions do not exist where prohibited. For example, instrument components are not exposed to potential hazards from other construction activities. Because of the complexity of digital components, and the potential for interconnection between safety components and between safety and non-safety components, the inspector should consider these issues during the inspection. Although the safety sensor may be hardwired to the controller, the controller may be communicating over a digital bus with other controllers, the operator, or an annunciator system. Also, some sensors are "smart" in that they have on-board diagnostics and calibration tables, so, even though they are "hardwired," they could still be using some communication link with the controller (e.g., HART superimposes digital monitoring and command signals on an analog 4-20mA signal).

03.02 Specific Guidance.

- a. Section 02.02. The expertise of the inspector is important for the proper completion of the inspection. Inspectors should have a general knowledge of and background in QA and knowledgeable of the technical requirements associated with instrumentation systems.
- b. Section 02.03. For the purpose of this IP, the term "procedures covering work" includes construction specifications, drawings, and work instructions. (Procedures describing methods of fabrication, construction or installation are sometimes called construction procedures.)
- c. Section 02.03.a.
 - 1. Receiving IPs should reflect the requirements that the licensee has committed to in their QAP.

2. The licensee should identify and describe all safety-related I&C components which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or after an accident.
 3. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, the licensee shall establish means to assure that the results of this testing are documented, reviewed, and determined to be acceptable. If this is not performed when components are received, the procedures should specify the organization that will be performing this review and the controls to ensure that all such documentation requirements are satisfied before the component is placed in use.
 4. The inspector should also be aware of memory-related integrated circuit chips (Programmable read only memory (PROMs), flash memory, etc.) that have certain versions of application code (i.e., specific version of firmware). The inspector should verify that the configuration management program is tracking these versions - not just firmware, but all electronic devices that may have embedded processors, memory, etc. In addition, for safety related electronic components, the inspector should verify that the supplier or licensee followed the supply chain to ensure no unauthorized replacements have occurred.
 5. Instrument components may be released for installation on the merits of certifications of conformance if the organization involved has established a satisfactory program control and audit requirements in this area. However, certifications of conformance do not release the licensee from having other records (such as environmental or seismic qualification records) for operation and for the life of the plant.
- d. Section 02.03.b.
1. Special storage requirements are typically specified by the manufacturer or an industry standard. The requirements should include such things as identification and markings on I&C components, protective covers, preservatives, etc.
 2. The inspector should verify that the storage procedures have provisions for initial and periodic inspection of storage conditions for components which have special storage requirements. Procedures should be available for conducting periodic "storage inspections" of components which have been installed during the time period between installation and turnover to the operations staff.
 3. The inspector should consider verifications of proper firmware, component versions, and verify that unauthorized substitutions have not been made (This is over and above certain environmental considerations, e.g., humidity and temperature for electronic components.)
- e. Section 02.03.c. Procedures should be reviewed to ensure that technical requirements in the licensing document are reflected in construction specifications, drawings, work

instructions, and work procedures. Areas to review shall include, but are not limited to, the following:

1. I&C system components (type, range, accuracy, materials, etc.) are identified, located, oriented, and supported as specified by design.
2. Physical separation and independence requirements of redundant components are met.
3. Instrument sensing lines are sloped to meet applicable requirements. Instruments connected to chemical processes for which it is not feasible to use direct sensing lines might be connected via armored capillary tubing and/or diaphragm seals which have been appropriately protected from potential damage from construction or operating activities. Appropriate and adequate construction specifications, procedures and other work instructions for a particular activity are required to be approved and available before that activity is started.

f. Section 02.03.c.3.

1. It is not considered adequate identification to include only the instrument model number and type. Procedures should specify a unique identification number, along with the model number and name of manufacturer. Adequate (positive) identification is important because similar-looking instrument components can be significantly different with respect to range, output signal, etc. Safety-related instrumentation should be listed in the licensing document.
2. Anchor bolts holding or mounting instrument components should be of the type, size and length specified. Provisions should exist to prevent indiscriminate cutting of reinforcement steel during the drilling of anchor holes.
3. Procedures should be established to ensure that independence and separation requirements of safety-related functions from normal control functions are met, especially safety functions that provide protection against normal control system malfunctions. This separation should include electrical and data communication isolation. (Note: Given the high automation in new facilities, data communication isolation should be verified from both a random failure and a cyber security perspective.)
4. Means should be established, such as procedures or checklists, to ensure that redundant sensing lines are protected from common mode failures. That is, redundant lines will not fail from a single accident; especially an accident or failure for which they are supposed to provide protection.
5. Evaluate sensitivity to grounding connections and lightning protection system down comers.

g. Section 02.03.d.

1. Section 02.03.d.2. Review the IPs and compare with the requirements in the applicable codes and construction specifications. Evaluation should indicate whether adequate quality-related IPs are established and are based on appropriate criteria, and further, whether the results of the licensee's inspection will be transmitted to responsible quality assurance and management personnel.
2. Section 02.03.d.3. Provisions should include procedures for monitoring or surveillance of locally mounted instruments by inspection (QC) personnel. They should ensure that maintenance requirements while "stored in place" are satisfied and that adequate protection is provided against possible damage from adjacent construction activities, including construction traffic. (Where protective means used during construction may affect proper operation, provisions should be provided for timely removal.)

h. Section 02.03.e. This area is to be inspected by an inspector who is knowledgeable in the area of instrumentation in general and calibration and testing in particular.

The licensee should reference general testing and calibration requirements, and work procedures should provide detailed instructions. Additionally, the QA manual should include general surveillance procedures relative to the calibration of process instruments, i.e., calibration activities should be monitored (inspected or audited, as appropriate) in accordance with established procedures.

1. These procedures should include verification of the following:
 - (a) Calibration data sheets (or equivalent) are being used as specified.
 - (b) Calibration ranges and accuracies are current and approved for use. (Accuracy requirements should be defined.)
 - (c) Calibration and instrument setting procedures are current and approved for use, including identification of any special calibration test equipment or test equipment minimum accuracy specifications needed for safety related instruments. Such specifications should be consistent with the project instrument set point and loop accuracy procedure requirements.
 - (d) Calibration techniques are appropriate for the component to be calibrated. For example, if density compensation is required for a liquid level instrument, the proper technique or correction for density should be included in the calibration procedure. Although density compensation is a basic requirement for accurate level measurement, it is periodically overlooked for water-calibrated instruments.
 - (e) Controls for removal and handling of components during calibration.

2. Calibration data records for process instruments should include information and data specified by industry standards which the licensee is committed to such as:
 - (a) Specific identity of the instrument calibrated.
 - (b) The specific identity of the measuring and test equipment used to perform the calibration.
 - (c) The “as-left” calibration data.
 - (d) Date of calibration.
 - (e) Identity of the technician performing the calibration.
 - (f) Calibration schedule documentation review.
 - (g) Approval signature of a responsible individual. Certificates of calibration should be available at the site for measuring and testing equipment used to perform these calibrations. These certificates should show that the standards used to establish the accuracy of the test equipment are traceable to a nationally recognized standard. Procedures should require that the performance and accuracy of test equipment are demonstrated by periodic checking.

This item does not include pre-operational testing. Construction testing generally verifies that certain components perform as intended, but it is not a test of system capability.

- i. Section 02.05.a.3.(c). Examples of process variables used by the emergency control system are some manual and automatic controls for power distribution, ventilation, and seismic isolation systems. Associated and interrelated devices include signal conditioning components, isolation devices, interlocks, bypasses, selector switches, resets, overrides, instrument tubing, racks, panels, and their supports, instrument wiring and wiring terminations. The licensing documents should include the specific variables, as well as the logic and devices, used in the system.

Examples of sensors which provide information to automatic controllers are devices for measuring/monitoring temperature, mass, physical dimension, component identification bar codes, and machine tool positions.

Examples of controllers which are required to mitigate accidents are the safety controllers and emergency controls. The licensee should specify the specific variables, as well as the logic and logic devices used in the system.

- j. Section 02.06.a. Receipt inspection activities should be inspected for compliance with procedures identified and/or reviewed during inspection.

1. The licensee should identify and describe all instrument components which must operate in a hostile environment (e.g., high radiation, temperature, humidity) during or subsequent to an accident. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, receiving inspection activities should include verification that required testing has been satisfactorily completed.
 2. All required documentation may not be received with the components. If not, the inspector should at this time determine that the licensee is following their system for identifying, controlling, and maintaining the status of the required documentation. This system should ensure eventual documentation of satisfactory completion of required testing.
- k. Section 02.06.b. Storage activities should be inspected for compliance with procedures identified and/or reviewed during inspection.
1. Control of storage conditions for equipment stored in place usually requires special effort. The inspector should note whether the procedurally required storage conditions are being maintained.
 2. Readily visible and permanently marked tags or other identifying scheme should be used for all nonconforming components and materials, and records relative to the nonconformance should be available at the site and readily retrievable.
- l. Section 02.06.c. Because of the uncertainties associated with scheduling of in-process installation inspections, it is expected that the scope of these periodic inspections will vary considerably. The intent is to observe the more important installation activities for a variety of instrumentation components and associated items during the time such activities are in progress.
1. Section 02.06.c.1. While reviewing construction specifications and drawing, also look for missing or inappropriate approvals.
 2. Section 02.06.c.2. Drawing and construction specifications used in the field should be reviewed periodically to ensure that the most recent approved revisions are used and components are as specified.
 3. Section 02.06.c.3. For some of the supports and anchorages, the inspector should directly measure or otherwise independently verify that requirements pertaining to such items as location of equipment, location of supports, and bolt size are as specified.

During installation of equipment, anchorage holes are sometimes drilled in concrete structures. Indiscriminate cutting of reinforcing steel should not be allowed. Verify the adequacy of procedures to ensure the activity is not included

The inspector should ensure that proper welding requirements, from codes and standards that the licensee has committed to, are specified and controlled.

Standards may include American Welding Society (AWS) D1.1, Structural Welding Code, for welding of supports. Instrument tubing welds are generally in accordance with welding code requirements associated with the system or component being monitored, e.g., American National Standards Institute (ANSI) B 31.3, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, as appropriate. The inspector should verify that the construction specifications and drawings specify the welding requirements to be used.

4. Section 02.06.c.4. "Qualified craft personnel" means those employees who have achieved suitable proficiency to do their assigned tasks by appropriate training and/or previous experience and who understand the installation procedures, drawings, and specifications necessary for their work.
5. Section 02.06.c.7. The observation of inspection (QC) activities should include in-process and final inspections.

"Timely and properly completed" includes performing the proper inspections at the specified frequency and sequence.

A sample of QC inspectors should be interviewed to determine whether they are familiar with the quality requirements associated with the instrumentation being inspected, what construction specifications and other criteria are used to determine acceptance, how their inspection results are recorded, etc. The intent is to determine the effectiveness of instrumentation inspection personnel and management systems for indoctrination, training, and qualification of personnel.

m. Section 02.06.d.

1. Section 02.06.d.1. Some instrument lines, racks, panels, and their supports, or other anchoring means are required to meet seismic requirements. (The licensing document should indicate where applicable.) If specified for lines, racks, or panels selected for inspection, ascertain whether these requirements are met.

If the installation is different from approved drawings and specifications, determine whether the change is adequately documented and forwarded for review and approval.

2. Section 02.06.d.2. Sometimes similar instrument components are put in identical cases. The inspector should ascertain whether the various components inspected are as specified. This can be done by observing the name plate for identification numbers. For example, the model number may be the same on two components, but the ranges and identifying numbers will be different.
3. Section 02.06.d.3. The inspector should ascertain whether component identification is adequate. The installed instrument components should be uniquely

identified on the component itself, the installation records, calibration records, and inspection records.

4. Section 02.06.d.5. Temporary protection during construction is generally required. Protection from overhead construction activities, especially welding and concrete placement, warrants special attention. Additionally, protection from inadvertent damage during plant operation and maintenance must be adequate and properly installed. Because it can be easily damaged, instrument tubing requires special attention. This is especially important when instrument tubing runs are part of a safety system that may be damaged by an event or accident for which the safety system is supposed to provide protection.
 5. Section 02.06.d.7. Safety functions are to be independent of normal plant control functions, especially safety functions that provide protection against control malfunctions.
 6. Section 02.06.d.8. The intent is to verify that nonconforming conditions are identified and result in the initiation of appropriate nonconformance documentation. Where revisions are made, verify that they are in accordance with approved corrective action dispositions.
- n. Section 02.06.e. The intent is to determine whether instrument components and associated items are being installed according to properly approved drawings and changes, such as engineering, design, field change requests, and changes to correct nonconforming conditions. As this inspection requirement is to verify "as-built" systems, a new sample should be selected if it is found that extensive rework is in progress. However, the NRC inspector should verify that the changes are properly handled in accordance with established procedures.

Changes may be made to instrument systems during construction that are different from the original design. Such changes will result in the accumulation of various types of design change documents. Since these changes reflect as-built conditions, they should be adequately controlled and available for future evaluations 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 master drawings and specifications to incorporate such changes. Thus, an excessive number of accumulated changes not incorporated into the as-built records and affected analyses should be pursued. The NRC inspector should determine how the licensee ensures that the effect of each subsequent change will be adequately evaluated.

- o. Section 02.06.f. The inspector should review the specified calibration requirements and procedures before observing these activities. If special requirements are specified, such as density compensation during liquid level instrument calibration, the inspector should determine whether these requirements are being adhered to.

If calibration activities are in progress, determine whether the most recently approved calibration information is being used, and whether required procedures are being

adhered to. The values of instrument ranges and zero set points are sometimes changed after receipt of the instruments at the site. The inspector should assure (by selective sampling) that current data are used for checking and calibrating instruments, and that these changes are within the limits of the instrument components involved.

As these inspection requirements cannot be done until testing and calibration activities are in progress, inspection in this area should be scheduled accordingly.

Final calibration and trip settings may be done later, usually during pre-operational testing or during startup preparation.

The intent of these requirements is to verify that nonconforming conditions associated with instrument components and systems are identified by the licensee and result in the initiation of the appropriate nonconformance documentation and corrective action.

- p. Section 02.08.a. Where environmental qualification testing, or other qualification provisions (such as seismic) are specified, records should be available to verify that required testing has been satisfactorily completed. If these records are not available at the time of component receipt, the inspection records should identify the need for subsequent receipt and review of these documents.

It is important to ensure that qualification testing has been successfully completed. Qualification documents should be reviewed to substantiate that the equipment is qualified to applicable standards and to the appropriate environment.

- r. Section 02.08.b. Control of storage conditions for equipment stored in place usually requires special effort. The inspector should note whether the specified storage conditions are reflected in the storage inspection records.
- s. Section 02.08.c. Licensee and contractor inspection personnel should use checklists or other means to ensure proper identification of installed equipment. Checklists or records of inspection should be generated during the inspection, and these records should be readily retrievable for review by the NRC inspector. "Properly installed" means that the installation meets applicable NRC requirements and licensee commitments, including specified separation or installation of protective barriers. The as-installed inspection records should match the applicable requirements. In order for the inspector to ensure that the records reflect actual conditions (identification, instrument range, location, etc.), some instrument components selected should be the same as those selected in Section 02.02 of this procedure. (If the installation differs from the approved installation documents, a nonconformance report and a design change should have been generated.)

During installation of equipment or supporting components for the equipment, anchorage holes are sometimes drilled in concrete structures. The work and/or inspection records should indicate (or at least infer) that no indiscriminate cutting of reinforcing steel was done during drilling of anchor holes.

Installation and inspection records must contain sufficient detail to permit identification of the specific revisions or change notices used in these activities. Permanent records must provide a clear audit trail to any applicable change or nonconformance documentation. See also subsection 02.02.a.3 above.

- t. Section 02.08.d. In addition to the records indicating satisfactory testing and calibration, the records should reflect that the range, response time, etc., for instrument components are appropriate for postulated accident conditions as well as for normal operating conditions. The procedures for testing and calibration should contain the necessary criteria.

Where special requirements are necessary, such as density compensation during liquid level instrument calibration, the records should reflect that such requirements were adhered to.

- u. Section 02.10. The sample size and diversification of selection should be sufficient to determine whether the system used to handle and control nonconformance issues is working in an effective manner.

The effectiveness of the management control system in this area can be determined, in part, by how adequately and promptly the root cause of nonconforming activities are identified and corrected.

- v. Section 02.12. Audit records should reflect that adverse audit findings were promptly evaluated and corrected in an adequate manner. The root cause involved should be identified to preclude repetition.

03.03 Prevalent Problems and Concerns. The inspector should be alert to problems of a generic nature, such as:

- a. Adequate procedures or other means have not been established to assure and document that all safety related I&C components have met applicable acceptance criteria or to identify and document non-conformances in specific areas.
- b. IPs do not include adequate inspection requirements and acceptance criteria.
- c. Inadequate means to control location and status of instrumentation components - especially during removal for calibration, modification, repair or replacement.
- d. Inadequate procedures to control the evaluation, approval and use of field changes. (Means should be established also by the licensee or contractor to assure that only the latest approved field changes and other revisions or changes are being used for installation and inspection activities.)

69020.A10-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 64 hours of on-site inspection (Two inspectors for one week). Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A10-05 REFERENCES

American National Standards Institute (ANSI)/Instrument Society of American (ISA). ANSI/ISA-67.04.01-2000, "Set points for Nuclear Safety-Related Instrumentation."

ANSI/ Institute of Electrical and Electronic Engineers (IEEE) Standard (Std.) 336-1985, "IEEE Standard Installation, Inspection, and Testing Requirements for Power Instrumentation, and Control Equipment at Nuclear Facilities."

ANSI/IEEE 802.3 Standards Series, "IEEE Standards for Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications."

IEEE Std 384-1992, "Standard Criteria for Independence of Class 1E Equipment and Circuits."

IEEE Std 344-1987, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations."

IEEE Std 518-1982, "IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources."

IEEE Std 1023-1988, "IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations."

IEEE Std 1050-1996, "Guide for Instrumentation and Control Equipment Grounding in Generating Stations."

ISA-S12.13-Part 1-1995, "Performance Requirements, Combustible Gas Detectors."

ISA RP12.13-Part II-1987, "Installation, Operation, and Maintenance of Combustible Gas Detection Instruments."

NUREG-0700, "Human System Design Review Guidelines," NRC

NUREG-0800, Standard Review Plan, Branch Technical Position HICB-11, "Guidance on the Application and Qualification of Isolation Devices," NRC

NUREG-0800, Standard Review Plan, Branch Technical Position HICB-17, "Guidance on Self-Test and Surveillance Test Provisions," NRC

Regulatory Guide (RG) 1.118, Revision 3, "Periodic Testing of Electric Power and Protection Systems," NRC

RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," NRC

RG 1.75, Revision 2, "Physical Independence of Electric Systems," NRC

RG 1.100, Revision 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," NRC

RG 3.17-1974, "Earthquake Instrumentation for Fuel Reprocessing Plants."

END

ATTACHMENT K

INSPECTION OF STRUCTURAL WELDING AT RADIOISOTOPE PRODUCTION FACILITIES

69020.A11-01 INSPECTION OBJECTIVES

01.01 To determine if the structural welding activities performed at the site are done in accordance with safety analysis report (SAR) commitments.

01.02 To determine whether the licensee's structural welding practices, specification, and procedures meet the requirements of codes committed to in the licensing basis and contract requirements.

01.03 To review a sample of records to determine whether they are prepared, evaluated, and maintained in accordance with applicable licensing basis commitments and/or QAP requirements.

01.04 To determine that welding practices, specifications, procedures, production equipment, and existing licensee quality control systems are adequate for the production of sound welds.

69020.A11-02 INSPECTION REQUIREMENTS

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related structural welding being performed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for related instrumentation and control system work on-site at the time of the inspection.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the safety-related structural welding on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of safety-related structural welding arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.7 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Base Material and Filler Metal Compatibility for Welding

- a. Verify that base metals and welding filler materials combinations are as those listed in Table 4.1.1 of the AWS D1.1 Code, or other licensing basis and/or QAP commitment.
- b. Evaluate base material/filler metal combinations other than those listed in Table 4.1.1, or other licensing basis and/or QAP commitment, to determine the suitability of application.
- c. Verify that welding materials are clearly identified at all times and that the contractor/licensee has established adequate controls to assure proper dispersion and handling of welding materials.
- d. Verify that the contractor/licensee has effective procedures or his practice adequately controls moisture pickup of low hydrogen electrodes. The maximum out of oven exposure time should conform to the requirements stated in Table 4.5.2 of the AWS Code, or other licensing basis and/or QAP commitment.
- e. If the contractor/licensee uses a single system for welding material control, verify that this system is conservative and meets the requirements for the most restrictive application.

02.03 Welding Procedures

- a. Verify that the contractor/licensee or fabricator has established procedures or instruction for preparation, qualification approval/certification, distribution and revision of welding procedure specifications (WPS).
- b. If the contractor/licensee uses AWS prequalified welding procedures, verify that those procedures meet all requirements stated in the Table E1 of the AWS D1.1 Code, or other licensing basis and/or QAP commitment.
- c. For welding procedures other than those being prequalified in accordance with the requirements stated in Appendix E of the AWS D1.1 Code, verify that the procedure qualifications meet the requirements of Section 5, Part B of the AWS Code, or other licensing basis and/or QAP commitment.
- d. Review two welding procedures (WPS) from each welding process used in production welding and verify conformance with items b or c as applicable.
- e. Verify that the procedures mentioned in d above has been qualified in accordance with Section 5 of the AWS Code, or other licensing basis and/or QAP commitment, and that the supporting procedure qualification records (PQR) are on file.
- f. Review PQRs for the above procedures and verify that each PQR lists the essential variables for the specific welding process or processes covered and that the values or ranges of these variables are consistent with those permitted by the WPS and within

the limits of Section 5 of the AWS Code, or other licensing basis and/or QAP commitment.

- g. Verify that all mechanical tests required by Section 5 of the AWS Code, or other licensing basis and/or QAP commitment, (including notch toughness when applicable) have been completed and are properly documented in the PQR.
- h. Verify that the PQR has been certified by the contractor/ licensee and that the mechanical test results meet or exceed the minimum AWS Code requirement, or other licensing basis and/or QAP commitment.
- i. Verify that any changes or revisions of the WPS essential variables are supported by requalification of the original WPS or a new WPS.
- j. Verify that any changes in the WPS nonessential variables are properly identified and documented either as revisions to the original WPS or a new WPS.

02.04 Welder Qualifications

- a. Verify that the manufacturer has established procedures for qualification of welders and welding operators in accordance with Section 5, Parts C and D of the AWS Code, or other licensing basis and/or QAP commitment. These procedures should include adequate provisions to preclude falsification of welders and welding operator's qualifications.
- b. If practical, sample welders taking the qualification tests and confirm by positive identification that the person welding the test weldment is indeed the person being qualified.
- c. Verify that the manufacturer has a workable system for maintaining a continuous record of the qualification status of all welders and welding operators and that this system is effectively utilized and accurate.
- d. Verify by review of a sample of qualification status records that welders and welding operators performing production welding have been and are currently qualified to weld under the respective procedures.

02.05 Production Welding.

Survey a sample of ongoing welding activities and select typical in-process operations representing different welding process procedures and joint configurations for detailed review. Perform the following verifications:

- a. Verify that welding procedures, detailed drawings and instructions, if applicable, and weld data sheets are at the work station or readily available.

- b. Verify that the WPS assignment is in accordance with the applicable AWS Code requirements, or other licensing basis and/or QAP commitments. This is accomplished by comparing the essential variables of the WPS to the production weld.
- c. Verify that the welding technique and sequence requirements are specified.
- d. Verify that the base metals, welding filler materials, fluxes, gases and backing materials are of the specified type and grade, have been properly inspected, tested, and identified and are traceable to test reports or certifications.
- e. Verify that weld joint geometry is as specified and that surfaces to be welded have been prepared, cleaned, and inspected in accordance with applicable procedures of instructions.
- f. Verify that parts to be welded are assembled and held in place within specified gap and alignment tolerances and verify that the alignment is within limits allowed by the AWS Code, or other licensing basis and/or QAP commitments.
- g. Verify that gas purging, if specified, is used in accordance with the applicable procedure and that protection is provided to shield the welding operation from adverse environmental conditions.
- h. Verify that preheat, if specified, is in accordance with applicable procedures requirements.
- i. Verify that the technique of each welder is in accordance with the welding procedure.
- j. Verify that welding electrodes are used only in the positions and with the electrical characteristics specified in the welding procedure.
- k. Verify that shielding gas flow and composition is as specified in the WPS.
- l. Verify that shielding gas flowmeters indicate the gas type for which they are applicable and have appropriate conversion factors if a different gas or gas mixture is used for work under review.
- m. Verify that welding equipment, including power cables and gas used for automatic welding have been calibrated in accordance with applicable procedure requirements. n. Verify that interpass temperature is controlled in accordance with specified requirements.
- o. Verify that interpass cleaning, grinding (especially starts and stops) and peening are conducted in accordance with applicable procedure.
- p. Verify that backgouging, if applicable, is performed as specified.
- q. Verify that temporary attachments, arc strikes and weld splatter are removed and inspected.

- r. Verify by direct observation and/or record review that repairs are conducted in accordance with specified procedures.
- s. Identify a sample of welders and welding operators involved in joint fit-up, welding and weld repair for qualification review per 02.03 above.
- t. Verify that all production welding equipment is in such condition as to enable qualified welders to follow the production welding procedures and be able to duplicate the results obtained in the procedure qualification.

02.06 Preheat and Post Weld Heat Treatment

- a. Verify that approved procedures are available for weld joint preheating when required by a welding procedure specification. These procedures should specify acceptable preheating methods and provide requirements for monitoring and recording preheat temperature before, during, and if specified, after welding until post weld stress relief.
- b. Sample in-process preheating to verify that preheat control procedures are being following in production welding.
- c. Verify that the preheat used in production welding is within the limits specified by the welding procedure, and in accordance with Table 4.2 of the AWS Code, or other licensing basis and/or QAP commitments.
- d. Verify that approved procedures are available for the conduct of post weld heat treatment and that the fabricator has a system capable of meeting the heating and cooling rates, metal temperature, temperature uniformity and control limits specified in paragraph 4.4 of the AWS Code, or other licensing basis and/or QAP commitments.
- e. If furnace heating is used, verify that furnace atmosphere is controlled as specified in approved procedure.
- f. Review a sufficient sampling of PWHT operations (in-process and records) to assure that the stress relief heat treatment meets the requirements stated in Section 4 of the AWS Code, or other licensing basis and/or QAP commitments.
- g. Verify that temperature control is exercised on in-process components which are required to be maintained at preheat or other specified temperature for extended time periods while waiting for further processing.
- h. Examine cumulative stress-relief records for typical welds and verify that the total time and temperatures meet the AWS code requirements, or other licensing basis and/or QAP commitments.

02.07 Examination and Inspection of Welds

- a. Select welds produced by different welding processes, procedures, and combination of procedures, and verify by visual examination that the following characteristics conform to the applicable AWS Code and fabricators welding procedure requirements:
 1. Weld surface finish and appearance.
 2. Transitions between welds of different diameters and wall thicknesses.
 3. Weld reinforcement.
 4. Shape and size of fillet and socket welds.
 5. Joint configurations of structural supports.
 6. Removal of temporary fabrication aids, arc strikes and weld spatter.
 7. Finish-grinding or machining of weld surface.
 8. Absence of surface defects including cracks, laps, lack of penetration, lack of fusion, porosity, slag, oxide film and under-cut exceeding prescribed limits.
- b. Verify that approved procedures are available for the nondestructive examination of the weld when required by the AWS Code and/or contract requirements.
- c. Verify that the fabricator's nondestructive procedures meet the AWS Code and/or contract requirements.
- d. Verify that the fabricator's welding inspectors are certified in accordance with the requirements of the AWS Code, or other licensing basis and/or QAP commitments.
- e. Verify that the fabricator's inspection of welds meet the requirements stated in Section 6 of the AWS Code, or other licensing basis and/or QAP commitments.

69020.A11-03 INSPECTION GUIDANCE

General Guidance. The IE inspector performing the inspection under this procedure should be thoroughly familiar with the requirements contained in AWS Structural Welding Code, or other licensing basis and/or QAP commitments. The knowledge of welding, welding operations, their applications, limitations, and evaluations is essential for this inspection. The intent of this procedure is to review of the overall welding activities taking place at the construction site on safety-related items.

- a. Preparation for Inspection. Prior to performing an inspection in accordance with the requirements of this procedure the IE inspector should review the following:
 1. NRC requirements.
 2. Licensees' commitments relative to Code editions; e.g., which Code edition applies to this site.
 3. Applicable portions of the SAR.
 4. Licensees' special requirements contained in their welding and purchasing specifications.

5. The number and scope of each welding contractor performing work at the site.
 6. Licensees' programs and procedures pertaining to the subject.
 7. Applicable portions of the QA Manual.
 8. Licensees' commitments relative to welding and associated activities.
- b. Review of Welding Specification and Procedures. The inspector may perform the following reviews:
1. Identify contractors or fabricators performing AWS welding at the site.
 2. Identify which welding processes are used at the site and perform a review of all welding procedures used in production welding in accordance with the applicable paragraphs of section 02 of this procedure.
 3. Determine whether the welding procedures being used meet all of the AWS Code and additional licensing basis requirements (if any). Establish whether the use of these procedures will result in the production of sound weld suitable for intended application.
- c. Work Observations. The IE inspector may select for work observation a sample of welds comprising a combination of structures and AWS welding contractors associated with the work. The selected welds should also represent a cross section of the production activities in terms of welding processes used (SMA, TIG, etc.) and materials to be welded (high strength steel, carbon steel, etc.). Considerations such as physical location, difficulties to weld and limited accessibility should be also incorporated in the sample selection.
2. Record Review. The IE inspector may review relevant documentation related to randomly selected welds for each welding process used at the site (e.g., SMA, TIG, MIG, etc.). Same considerations as those stated in c above are applicable. It is preferable that the welds identified for record review are not the same welds identified for work observation. However, certain circumstances may necessitate the use of some of the welds sampled in c above (e.g., a contractor/licensee has completed only three welds to date and all three welds need to be included in the sample to provide meaningful statistical representation).

69020.A11-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A11-05 REFERENCES

AWS Structural Welding Code.

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

Regulatory Guide 1.29, Seismic Design Classification

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

Regulatory Guide 1.50, Control of Pre-Heat Temperature for Welding of Low-Alloy Steel

Regulatory Guide 1.58, Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel

Regulatory Guide 1.71, Welder Qualification for Areas of Limited Accessibility Welding Handbook, Volume 1, Fundamentals of Welding, AWS Welding Inspection, AWS

END

APPENDIX L

INSPECTION OF NUCLEAR WELDING AT NON-POWER PRODUCTION AND UTILIZATION FACILITIES

69020.A12-01 INSPECTION OBJECTIVES

01.01 To determine whether the licensee's welding specification and procedures meet applicable ASME Code, regulatory, and contract requirements.

01.02 To determine through direct observation whether welding activities are performed in accordance with the ASME Code and safety analysis report (SAR) commitments.

01.03 To review a sample of records to determine whether they are prepared, evaluated and maintained in accordance with the ASME Code, applicable commitments and/or requirements.

01.04 To determine that welding specifications, procedures, production equipment and established licensee quality control systems are adequate for the production of sound welds.

69020.A12-02 INSPECTION REQUIREMENTS

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the safety-related nuclear welding being performed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for related instrumentation and control system work on-site at the time of the inspection.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the safety-related nuclear welding on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of safety-related nuclear welding arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.7 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Base Material and Filler Metal Compatibility for Welding

- a. Verify that base metal and welding filler material combinations are appropriate for the application.
- b. Evaluate base material/filler metal combinations to determine the suitability of application.
- c. Perform the following verifications related to control and handling of welding materials:
 1. Verify that the contractor/licensee has established procedures and instructions for purchasing, receiving, storing, disbursing, and handling of welding materials including welding electrodes, filler material, consumable inserts, fluxes, and gases.
 2. Review sufficient sampling of welding material purchasing and receiving records to verify that these operations are conducted in accordance with approved procedures or instructions.
 3. Verify that welding material storage procedures, contain requirement for environmental (moisture) control, specify appropriate holding and baking temperatures and out-of-oven exposure time for each class of materials, and that actual practice follows these requirements.
 4. Verify that there are effective procedures for limiting electrode moisture pickup and maintaining identification after the welding materials are issued to the welder and that these procedures are strictly enforced.
 5. If the contractor/licensee uses a single system for welding material control, verify that this system is conservative and meets the requirements for the most restrictive application and personnel involved are knowledgeable of the system, including material designations.
 6. Verify that welding materials are clearly identified at all times in accordance with approved procedures and that identification of acceptable material is retained throughout storage handling and use until the material is actually consumed in the process.
 7. Verify that the method for disbursement of welding materials is effective and controlled in accordance with approved procedures and the unused welding materials are scrapped or recycled in accordance with special provisions which include maintaining identification and rebaking of coated electrodes when applicable.
 8. Verify by examination of representative records or direct observation that ASME Code required tests are performed on each lot of covered, flux cored or bare electrodes, rod, or wire, for each heat of consumable inserts and for each combination or bare electrodes and dry blend of flux mix to be used for welding.

02.03 Welding Procedures

- a. Verify that the contractor/licensee has established adequate procedures or instructions for preparation, qualification approval/certification, distribution and revision of welding procedure specifications (WPS).
- b. Select welding procedures (WPS) from each welding process or combination of processes used for ASME welding applications and verify conformance with procedures referenced in a, above.
- c. Verify that the WPSs (b above) define all essential variables, supplementary essential variables and nonessential variables in accordance with the applicable editions of Section III and IX of the ASME Code.
- d. Verify that each of the above procedures has been qualified in accordance with Section III and IX of the ASME Code and that the supporting procedure qualification records (PQRs) are on file.
- e. Review PQRs for the above procedures and verify that each PQR lists the essential variables for the specific welding process or processes covered and that the values or ranges of these variables are consistent with those permitted by the WPS and are within the limits of Section IX of the ASME Code.
- f. Verify that all mechanical tests required by Section III and IX of the ASME Code (including notch toughness when applicable) have been completed and are properly documented in the PQR.
- g. Verify that the PQR has been certified by the contractor/licensee and that the mechanical test results meet or exceed the minimum ASME Code requirements.
- h. Verify that in making procedure test plates for butt welds of heavy section materials with 80,000 psi or higher tensile strength, consideration has been given to the effect of angular, lateral and end restraints of the weldment (ASME Section III-NX-4320).
- i. Verify that any changes or revisions of the WPS essential variables are supported by requalification of the original WPS or a new WPS.
- j. Verify that any changes in the WPS nonessential variables are properly identified and documented either as revisions to the original or a new WPS.
- k. Verify that, whenever applicable, the WPSs comply or meet the intent of Regulatory Guides referenced in Section 03 of this procedure.

02.04 Welder Performance Qualification

- a. Verify that the contractor/licensee has established procedures for qualification of welders and welding operators in accordance with Section III and IX of the ASME Code.

These procedures should include adequate provisions to preclude falsification of welders and welding operator's qualifications.

- b. If practical, sample adequate number of welders taking the qualification tests and confirm by positive identification that the person welding the test weldment is indeed the person being qualified.
- c. Verify that the contractor/licensee has a workable system for maintaining a continuous record of the qualification status of all welders and welding operators and that this system is effectively utilized and accurate.
- d. Verify by review of the qualification status records that welders and welding operators performing production welding have been and are currently qualified to weld under the respective procedures.

02.05 Production Welding

- a. Survey ongoing welding activities and select typical in-process operations representing different welding processes, procedures, and joint configurations for detailed review. Perform the following verifications:
 - 1. Verify that work is conducted in accordance with a "traveler" or similar document which coordinates and sequences all operations, references procedures or instructions, establishes hold points, and provides for production and QC signoffs. This document should be available at the work station.
 - 2. Verify that welding procedures, detailed drawings and instructions if applicable, and weld data sheets are at the work station or readily available.
 - 3. Verify that the WPS assignment is in accordance with the applicable ASME Code requirements. This is accomplished by comparing the essential variables of the WPS with the production weld.
 - 4. Verify that welding technique and sequence requirements are specified.
 - 5. Verify that the base metals, welding filler materials, fluxes, gases, and backing materials are of the specified type and grade, have been properly inspected, tested, and identified and are traceable to test reports or certifications.
 - 6. Verify that weld joint geometry is as specified and that surfaces to be welded have been prepared, cleaned, and inspected in accordance with applicable procedures or instructions.
 - 7. Verify that parts to be welded are assembled and held in place within specified gap and alignment tolerances and verify that the alignment is within limits allowed by the ASME Code.

8. Verify that temporary attachments such as bridging bars or fit-up clips have been attached by qualified welders, in accordance with qualified WPS.
9. Verify that gas purging, if specified, is used in accordance with the applicable procedure and that protection is provided to shield the welding operation from adverse environmental conditions.
10. Verify that preheat, if specified, is in accordance with applicable procedures requirements.
11. Verify that the technique of each welder is in accordance with the welding procedure.
12. Verify that welding electrodes are used only in the positions and with the electrical characteristics specified in the welding procedure.
13. Verify that shielding gas flow and composition is as specified in the WPS.
14. Verify that shielding gas flowmeters indicate the gas type for which they are applicable and have appropriate conversion factors if a different gas or gas mixture is used for work under review.
15. Verify that welding equipment, including power cables and gas lines, is in good condition and that ammeters and voltmeters used for automatic welding have been calibrated in accordance with applicable procedure requirements.
16. Verify that interpass temperature is controlled in accordance with specified requirements. The interpass temperature for welding austenitic stainless steels and high nickel alloys should not exceed 350 _F.
17. Verify that interpass cleaning, grinding (especially starts and stops) and peening are conducted in accordance with applicable procedure.
18. Verify that backgouging, if applicable, is performed as specified.
19. Verify that temporary attachments, arc strikes and weld splatter are removed and inspected in accordance with specified procedures.
20. Verify that the process control system (travelers) have provisions for weld repairs and that approved procedures or instructions are available which describe or reference acceptable methods of defect removal and weld repair.
21. Verify by direct observation and/or record review that repairs are conducted in accordance with specified procedures.

This verification should include:

- (a) Review of weld repair consistent of mechanical removal of surface defects with no rewelding.
 - (b) Review of repair involving metal removal by chipping, grinding or machining followed by rewelding.
 - (c) Review of a repair involving metal removal by thermal cutting or gouging followed by rewelding.
22. Verify that any repairs to the base metal are properly documented in a special report as required by Section III of the ASME Code (NB 4132). Verify that any repairs of modifications to ASME Code-stamped components are properly documented in a special report as required by ASME Sections III and XI.
23. Identify all welders and welding operators observed during inspection of joint fit-up, welding and weld repair for qualification review per 02.03 above.
24. Verify, if applicable, that no peening has been done on the root and surface layer of the weld or base metal at the edges of the weld.
25. Verify that the contractor/licensee has a periodic preventive maintenance program for welding equipment used for welding safety-related materials.

02.06 Preheat and Post Weld Heat Treatment

- a. Verify that approved procedures are available for weld joint preheating when required by a welding procedure specification. These procedures should specify acceptable preheating methods and provide requirements for monitoring and recording preheat temperature before, during and, if specified, after welding until post weld stress relief.
- b. Sample sufficient number of in-process components to verify that preheat control procedures are being followed in production welding.
- c. Verify that the preheat used in production welding is within the limits specified by the welding procedure.
- d. Verify that approved procedures are available for the conduct of post weld heat treatment and that the fabricator has a system capable of meeting the heating and cooling rates, metal temperature, temperature uniformity and control limits specified in Section III of the ASME Code. The procedures should cover furnace as well as local heating if both methods are used in production.
- e. If furnace heating is used, verify that furnace atmosphere is controlled as specified in approved procedure.
- f. Review a sufficient sampling of PWHT operations (in-process and records) to assure that the following items are satisfied.

1. Verify that components are instrumented to provide time-temperature recordings for the duration of the entire heat treatment cycle (both furnace and local HT).
 2. Verify that sufficient thermocouples are used to measure the anticipated hottest and coldest temperatures of the weld during holding at temperature and to measure temperature variation within any 15-foot interval of weld length during heating or cooling. This variation must not exceed 250 °F.
 3. Verify that the PWHT temperature and holding time is specified, is adhered to and is consistent with ASME Code (NX-4600) requirements based on the material type and wall thickness.
 4. Verify that the maximum initial furnace temperature, heat up and cool-down rates are specified, are adhered to and are consistent with the ASME Code (NX-4600) requirements.
- g. Verify that procedures are available for conduct of intermediate or "non-code" stress relief of in-process components if such treatments are used in component fabrication.
 - h. Verify that temperature control is exercised on in-process components which are required to be maintained at pre-heat or other specified temperature for extended time periods while awaiting further processing.
 - i. Verify that measures are taken to avoid sensitization of austenitic stainless steel and high-nickel alloys during stress relief treatments. This generally involves provisions which preclude furnace stress-relieving of austenitic stainless steel components or parts and limit their exposure to sensitization temperature range (800-1500 °F).
 - j. Examine cumulative stress-relief records for typical component welds and verify that the total time at temperature does not exceed that permitted by Section III of the ASME Code based on the welding procedure qualification records.

02.07 Examination of Welds

- a. Select welds produced by different welding processes, procedures, and combination of procedures, and verify by visual examination that the following characteristics conform to the applicable ASME Code and fabricators welding procedure requirements:
 1. Weld surface finish and appearance. Include inside diameter of pipe welds when accessible.
 2. Transitions between components of different diameters and wall thickness.
 3. Weld reinforcement.
 4. Shape and size of fillet and socket welds.

5. Joint configurations of permanent attachments and structural supports to clad components.
 6. Removal of temporary attachments, arc strikes and weld spatter.
 7. Finish-grinding or machining of weld surface – verify absence of wall thinning.
 8. Absence of surface defects including cracks, laps, lack of penetration, lack of fusion, porosity, slag, oxide film and undercut exceeding prescribed limits.
- b. Verify that approved procedures are available for the nondestructive examination of the weld when required by the ASME Code and/or contract requirements.

69020.A12-03 INSPECTION GUIDANCE

General Guidance. The inspector performing the inspection under this procedure should be thoroughly familiar with the requirements contained in Sections III and IX of the ASME Code. The knowledge of welding and techniques, their applications, limitations and evaluations, is essential for this inspection. The intent of this procedure is to achieve an in-depth review of the overall welding activities taking place at the construction site.

- a. Preparation for Inspection. Prior to performing an inspection in accordance with the requirements of this procedure, the inspector should review the following:
1. NRC requirements.
 2. Licensees' commitments relative to applicable Codes and standards; e.g., which Addenda of the ASME Code applies to this site.
 3. Applicable portions of the SAR.
 4. Licensees' programs and procedures pertaining to the subject.
 5. Applicable portions of the QA Manual.
 6. Licensees' commitments relative to welding and associated activities.
- b. Review of Welding Specification and Procedures. The inspector may perform the following reviews:
1. Identify contractors or fabricators performing welding at the site.
 2. Identify which welding processes are used at the site and perform a review of all welding procedures used in production welding in accordance with the applicable paragraphs of Section 02 of this procedure.
 3. Determine whether the welding procedures being used meet all of the ASME Code and additional contract requirements (if any). Establish whether the use of these procedures will result in the production of sound welds suitable for the intended application.

- c. Work Observations. The inspector may select for work observation a sample of welds composed of a combination of systems and welding contractors associated with the work. The selected welds should also represent a good cross section of the production activities in terms of welding processes used (SMA, TIG, etc.) and materials to be welded (stainless steel, carbon steel, etc.). Considerations such as physical location, difficulties to weld and limited accessibility should be also incorporated in the sample selection.
- d. Record Review. The inspector may review relevant documentation related to a sample of randomly selected welds for each ASME subsection (e.g., NB, NC, ND, etc. For subsection NG, "core support structures", the sample size can be reduced at the discretion of the inspector). Same considerations as those stated in c above are applicable. It is preferable that the welds identified for record review are not the same welds identified for work observation.

69020.A12-04 RESOURCE ESTIMATE

This inspection procedure is expected to take 32 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A12-05 REFERENCES

ASME Boiler and Pressure Vessel Code Section III and IX

Regulatory Guide 1.31, Control of Ferrite Content in Stainless Steel Weld Metal.

Regulatory Guide 1.44, Control of the Use of Sensitized Stainless Steel

Regulatory Guide 1.50, Control of Preheat Temperature for Welding of Low-Alloy Steel

Regulatory Guide 1.58, Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel

Regulatory Guide 1.71, Welder Qualification for Areas of Limited Accessibility

Regulatory Guide 1.85, Materials Code Case Acceptability ASME Section III Division 1

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

END

APPENDIX M

INSPECTION OF FIRE PROTECTION SYSTEMS UNDER CONSTRUCTION AT RADIOISOTOPE PRODUCTION FACILITIES

69020.A13-01 INSPECTION OBJECTIVES

01.01 To verify that the installation or modification of fire protection systems are being accomplished in accordance with applicable codes, standards, and licensee commitments.

69020.A13-02 INSPECTION REQUIREMENTS

02.01 Preparation: Inspectors should review the facility description in the safety analysis report (SAR) and be familiar with the fire protection system work being performed at the site. Inspectors should also be familiar with the licensee's Quality Assurance Program (QAP) and the basis for the QAP (NPUF licensees are expected to commit to the QAP requirements of ANS/ANSI 15.8, "Quality Assurance Program Requirements for Research Reactors"). It is not the objective of this IP to verify the adequacy of the licensee's QAP, but inspectors should be prepared to identify potential weaknesses in the licensee's QAP for future inspections. Inspectors should complete this appendix by inspecting the attributes listed in this appendix for related instrumentation and control system work on-site at the time of the inspection.

Inspectors should contact the licensee prior to the on-site inspection to determine which work activities are to be inspected. Observation of in-progress work is desirable but not required. If necessary, inspectors may select completed work activities for inspection. Inspectors should not attempt to inspect all of the fire protection system work on the site, but may expand the inspection if time allows, or if significant concerns with the licensee's control of fire protection system arise. Inspectors should collect licensee procedures, construction specifications, and work completion records in advance, if possible. If unable to review these documents in advance of the on-site inspection, then the licensee should be notified that these documents, and any other relevant documents, should be available when the inspector(s) arrives at the site.

Inspectors should review the areas listed in 02.02 through 02.4 to the extent practical, and may use their judgment in determining which areas to concentrate on, if time is limited. However, inspectors should gain an understanding of the licensee's program to the extent necessary to determine if the licensee conforms to regulatory requirements.

02.02 Review of Procedures. Verify that specifications, drawings, work instructions and IPs have been established that will assure the technical adequacy of the following activities pertaining to fire protection systems. Verify that these documents comply with licensee commitments.

- a. Procurement. Review the design and purchase specifications and drawings to assure that specific technical requirements and commitments contained in the safety analysis report (SAR) have been translated into vendor purchase documents. Verify the following:
 1. Fire protection equipment associated with the fire-suppression systems specified in the SAR (as noted below) have been identified and specified in procurement documents:
 - (a) Water-based suppression systems (pre-action, wet-pipe, dry-pipe, water-spray, and deluge systems);
 - (b) Carbon-dioxide systems;
 - (c) Standpipe systems; and/or
 - (d) Portable fire extinguishers.
 2. Materials, such as pipes, pipe joints, mains, anchors, valves, and clamps meet specifications.
 3. Fire pump(s) and associated controls and wiring conform to National Fire Protection Association (NFPA) 20 standards, and/or other licensing basis commitments.
 4. Appropriate design and fabrication codes and standards [NFPA; American Water Works Association (AWWA); American National Standards Institute; American Society for Mechanical Engineers] requirements have been identified or specified in procurement documents.
 5. Critical dimensions are specified. (Size and location of water supplies, size and location of all piping, and the depth to which they are to be buried, etc.)
 6. Fire hydrants comply with NFPA or AWWA criteria, and/or other licensing basis commitments.
- b. Receipt Inspection. Verify that receipt inspection instructions require: (a) inspections for damage; (b) conformance to purchase specifications (including any special requirements); (c) proper identification and tagging; and (d) receipt of proper supplier/vendor documentation.
- c. Storage. Verify that site storage procedures provide for proper identification, handling, cleanliness preservation, protection from adverse weather, and other physical damage and QC.
- d. Installation. Verify that the fire suppression systems, as specified in the licensing basis, have been properly installed and that installation work procedures provide adequate instructions for the following (if applicable):

1. Installation work is to be done by fully experienced responsible persons.
2. There are procedural controls of rigging and handling activities, to prevent damage to pipes, fittings, valves, and other equipment.
3. Proper locations of valves, hydrants, mains, etc., are clearly identified.
4. Fire-pump installation complies with NFPA-20. Separation and protection are in accordance with SAR commitments and Regulatory Guide 3.16, and/or other licensing basis commitments.
5. Dimensional checks are specified for levelness, alignment, clearances, etc.
6. Proper restraints are provided for all tees, plugs, caps, bends, and hydrant branches.
7. Installation of hydrants is in compliance with NFPA 24, and/or other licensing basis commitments.
8. Proper backfill methods are specified.
9. Water-tank installation is in accordance with NFPA 22 standards, and/or other licensing basis commitments.
10. Proper flushing and hydrostatic testing of the fire-loop water piping are specified.

02.03 Observation of Work and Work Activities.

- a. Visually examine a sample of pipes, fittings, valves, and hydrants before installation. Plain ends shall be inspected with special attention, since these ends are most susceptible to damage. Verify that commitments in the licensing basis are being met in the following areas:
 1. Cleanliness;
 2. Configuration of loop and appurtenances, relative to drawings;
 3. Obvious defects, such as cracks and dents, are identified and evaluated for suitability for use; and
 4. There are provisions for proper identification of components.
- b. Observe work activities or completed work during the installation of the fire loop (if applicable). Verify the following items:
 1. Components are installed with proper location and orientation.
 2. All specified anchors are in proper places.

3. No apparent damage was done to fire-loop components during installation.
 4. Ongoing work is being performed in accordance with approved procedures.
 5. There is adequate QC inspection coverage.
- c. If possible, observe portions of construction-completion testing (hydrostatic testing and fire-pump performance testing). If testing cannot be observed, examine records of completed tests.

02.04 Review of Records. Verify that a sampling of the following QA records indicate that applicable commitments have been met:

- a. Receiving inspection records.
- b. Shop fabrication records.
- c. Installation records.
 1. Leveling, alignment, clearances;
 2. Anchoring installation;
 3. Backfill and soil composition;
 4. Cleanliness;
 5. Flushing;
 6. Hydrostatic test; and
 7. Fire pump full load operational and automatic starting tests.
- d. Nonconformance Reports, if any; and
- e. QA Audits.

69020.A13-03 INSPECTION GUIDANCE

03.01 Definition. A “Fire Loop” is a main water-piping loop for fire protection, usually feeding hydrants, standpipes, and other fire-protection systems and components. Fire loops are provided to permit feeding hydrants and other components and systems, from at least two directions, for redundancy.

03.02 Applicable portions of the SAR should be reviewed to determine licensee commitments relative to construction and inspection requirements, before review in this area. Inspectors should determine which versions of the industry codes and standards the licensee has committed to in the SAR or other docketed correspondence. They should obtain copies of those documents and become familiar with those industry codes and standards during inspection preparation.

69020.A13-04 RESOURCE ESTIMATES

This inspection procedure is expected to take 24 hours of on-site inspection. Inspection preparation, including SAR review, review of applicable codes and standards, and licensee quality assurance procedure review, is not included in this estimate.

69020.A13-05 REFERENCES

National Fire Protection Association, (NFPA), NFPA 13, 14, 22, and 25, and/or other applicable referenced NFPA standards, American Water Works Association, American National Standards Institute and American Society for Testing and Materials codes.

END

Attachment 1 – Revision History for IP 69020

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment and Feedback Resolution Accession Number (Pre-Decisional, Non-Public)
N/A	ML15083A168 12/14/15 CN 15-029	Initial issuance to provide guidance for the safety-related items and services during construction of non-power and utilization facilities.	Briefing for inspectors, prior to performing inspection covered by this IP.	ML15189A134