ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

May 19, 1976

Honorable Marcus A. Rowden
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: REPORT ON NUCLEAR REACTOR INSPECTION

Dear Mr. Rowden:

In response to a request from the Commission in early 1975, the Advisory Committee on Reactor Safeguards established an Inspection and Enforcement Subcommittee to review and comment on the adequacy, scope, and possible redirection of the Nuclear Regulatory Commission's Office of Inspection and Enforcement (NRC-IE). This action was also in response to recognition of a need for greater attention to these matters as a result of the boiling water reactor (BWR) pipe cracking problem. The scope of the Subcommittee's evaluation program was directed primarily to those matters pertaining to portions of commercial nuclear power plants covered by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Sections III and XI. While an attempt was made to develop some information pertaining to fire inspection practice, the depth of the review was somewhat limited. The Committee also had limited opportunity to review inspection and enforcement aspects of instrumentation and controls, concrete containments, rotating machinery, heat transfer equipment, and preoperational testing.

A review of these matters was completed by the Committee during its 193rd meeting, May 6-8, 1976. The subject was also a matter of discussion with the NRC Staff during the 191st meeting of the Committee, March 4-6, 1976, and at meetings of the Inspection and Enforcement Subcommittee held in Washington, D. C., on August 13, October 1, and November 21, 1975. Members of the Subcommittee and invited experts visited the pressure vessel facilities of Combustion Engineering, Inc., in Chattanooga, Tennessee, on January 23, 1976, and a Subcommittee meeting was held that same day. A Subcommittee meeting was also held on February 20, 1976, in Chicago, Illinois, to discuss inspection procedures with personnel from Commonwealth Edison Company and Region III NRC-IE. During this review, the Subcommittee had the benefit of discussions with representatives from code groups, insurance companies, electric utilities, nondestructive testing organizations, the National Board of Boiler and Pressure Vessel Inspectors, and of the documents listed.

The problem of terminology in the inspection and examination of nuclear components is recognized as relatively complex. Therefore, the Committee is attaching a glossary of terms used, or directly interacting with

terms cited, in this report to minimize confusion concerning the meaning intended for specific terms. Most definitions were derived from the ASME Boiler and Pressure Vessel Code, but are considered applicable to other areas of concern in electrical components, instrumentation, structures, and fire prevention. There should be a clear differentiation between examination and inspection. The Committee will use the terminology indicated in the attached glossary, where the "examiner" conducts the nondestructive or destructive tests whereas the "inspector" is responsible for such items as the validation of test methods and calibration procedures, qualification of examiners, monitoring and/or auditing the tests, and reviewing the records. While terminology such as testing, checking, etc. is used in lieu of examination by other groups, "examination" will be used herein regardless of the components considered.

The Committee recognizes that the National Aeronautics and Space Administration (NASA) and Federal Aviation Administration (FAA), and various other federal agencies use combined examiner-inspector approaches. However, this type of arrangement is ineffective unless the inspection agency can provide its own examination facilities at the point of inspection. In the case of the nuclear industry, this is impractical because of the need to utilize the owner's operating personnel and equipment for the examination program. It is possible for the inspection agency to perform some types of examination, but these should be primarily confirmatory actions to establish that the examination procedures are appropriate to the need.

In evaluating the requirements for inspection and examination of nuclear facilities, the Committee considered the relevance of the practices of NASA, FAA, and other organizations who have rigorous requirements for environmental testing of components, including extensive life testing under environmental conditions, as a part of their inspection requirements. For short-lived space vehicles and high speed aircraft, where there is no latitude to determine performance adequacy prior to use under extreme conditions, stringent performance verification is necessary before operational use. In the case of nuclear power reactors, performance verification is achieved partly by environmental tests, partly by a series of plant preoperational tests, and partly by closely controlled tests during low power operation and the period of gradual increase of power to the operating level. This procedure allows ample opportunity to expose most inadequacies of design or construction.

An examination of various foreign codes relevant to the inspection of pressure boundary components did not reveal substantive differences or potential improvements that could be incorporated into appropriate

United States codes or standards. The fundamental differences between codes are too great to permit a quantification of the pluses in one code versus the minuses in another. Until differences in philosophy can be resolved, there appears to be only limited opportunities for combining the best features of the relevant French, German (Federal Republic of Germany), Japanese, United Kingdom, and United States codes.

An increased effort between the NRC and appropriate code or standards groups to develop better criteria and codes or standards comparable to the ASME Nuclear Codes for fire prevention, for electrical systems, and for other safety-related components, is desirable. Current requirements often are ill-defined and amorphous so the "inspector" lacks adequate criteria to determine acceptability. Until these criteria are better defined, there will continue to be confusion concerning acceptable limits as evaluated by the NRC-IE organization.

A well-defined Quality Assurance (QA) Program developed by all responsible parties for design, construction, and operation is essential if there is to be a coordinated and meaningful inspection program by the Third Party (authorized inspector) and the Fourth Party (NRC-IE). Such a program provides criteria for the evaluation of the relevant components or systems. An inevitable result of a good QA program is the identification of some inadequate quality or erroneous work by an effective inspection and enforcement activity since lack-of-perfection is implicitly indicated by the need for inspection. The adequacy of workmanship should be evaluated on the basis of frequency of occurrence of unacceptable results and repetition of substandard results rather than on the basis of isolated incidents. The principle of in-depth safety protection is predicated on the assumption that even though one or more lines of safety defense may break down, simultaneous failure of all lines of defense has a sufficiently low probability of occurrence to make its consequences an acceptable safety risk. Cooperative efforts leading to an improvement in QA such as the activities of the Coordinating Agency for Supplier Evaluation (CASE) should be encouraged. The Committee recognizes the need to validate QA programs through review of appropriate documentation. However, inspections should represent a balance between direct inspection of equipment and facilities and review of documents since the best way to assess an organization's attitude is through direct observation during construction or operation of a facility.

With regard to the problem of detection of stress corrosion in piping that initiated this report, its ultimate solution will depend to a major degree on better nondestructive examination techniques and on more clearly

defined standards for such examinations. The Committee is aware of the joint efforts by industry, the Electric Power Research Institute, the Nuclear Regulatory Commission, and the Energy Research and Development Administration to improve nondestructive examination procedures on austenitic stainless steel and hopes such efforts will lead to appropriate improvements. With regard to examination procedures, such as those presented in the American Society for Nondestructive Testing document, SNT-TC-1A, modifications are desirable but may need to await the results of experimental programs.

The Committee believes that the NRC Office of Inspection and Enforcement can be more objective if its personnel, while being responsible for inspection, are not responsible for the performance of the examination and testing activities. It is not necessary to perform the work in order to establish that examination practices are appropriate. The Committee believes that if the NRC-IE organization has a suitable staff of experts in inspection and examination practices and monitors the use of these practices at important installations, it will provide the most effective inspection program. Further, conflicts between the NRC Staff and other government-authorized inspectors required by mandatory codes followed in the United States will be avoided. For example, the cases of intergranular stress corrosion cracking (IGSCC) in BWR piping were identified by operating personnel retained by the licensee and used during routine plant operation. It would be totally impractical to obtain comparable timely response under such conditions if the NRC Staff had to perform these examinations and inspections before the safety implications could be evaluated.

It is necessary to recognize that the qualifications of both "inspectors" and "inspection specialists", whether employees of an "authorized inspection agency" or NRC-IE, will vary with the type of inspection. For example, the qualifications of an "authorized inspector" on a construction project, where ASME, Section III, is applied, will differ markedly from the qualifications of an "inspector" on an operating nuclear power plant who is required to audit and evaluate by ASME, Section XI. Because this difference is not generally recognized, some "inspectors" may lack necessary qualifications.

In the inspection of the pressure boundary, where ASME, Sections III and XI are comprehensive codes with well-defined responsibilities for examination and inspection, it should be possible to enhance NRC-IE activities by giving ASME more authority while holding them accountable. A specific suggestion would be to modify Article NA-4000 of ASME, Section III, to conform more closely to 10 CFR 50, Appendix B, and by requiring an upgrading of the qualifications of the "authorized inspector" through rigorous application of the American National Standards Institute, ANSI-626 series on

Quality Assurance. To a degree, the preceding has been accomplished, but further improvements may be possible and should be explored.

A fertile area for improving the reliability and scope of inspections is through improved interactions between Third Party (authorized inspector) and Fourth Party (NRC-IE) inspectors and acceptance by Fourth Party of Third Party inspections, subject to audit. Each of the levels of inspection and each of the inspection parties would have its capabilities strengthened and its duties better delineated. The NRC-IE Staff could concentrate its efforts on making certain that this is the case so that it can use the results of these inspections as a basis for safety evaluation.

"Authorized inspectors" employed by inspection agencies, inspectors employed by the owner or his agent, and NRC-IE personnel have different levels of capabilities and responsibilities. To some degree the responsibilities overlap and this situation has some advantages as well as disadvantages as applied to the ASME codes. The situation is less clear with respect to operational inspection, fire prevention, and instrumentation and controls. The level of expertise available to the several inspection sources is not fully defined and may be inadequate. The responsibilities and capabilities of the various inspection organizations need further review and evaluation.

The enforcement policy of the NRC-IE should be such as to encourage responsible reporting of unsatisfactory conditions of significance to public health and safety. Penalty systems should be directed toward those having responsibility for organizing and implementing inspection and examination functions (e.g., owner-management, architect-engineer (A-E) management when designated under owner-A-E contract, insurance agencies when designated by owner-contract, constructors and suppliers when designated by recognized codes, standards, and regulations or by owner-contract).

A potential limitation pertinent to both Third Party (authorized inspectors) and to Fourth Party (NRC-IE) inspection personnel is the inability of a single person to cope with the tremendous detail in a code such as ASME, Section III, where familiarity with design, construction, materials, and examination is required. A viable solution is a strong cadre of "inspection specialists" in both the "authorized inspection agency" and the NRC-IE organization. Such specialists are essential where problems arise that exceed the capabilities of online "inspectors". Competencies among "authorized inspection agencies" vary with some being stronger than

others. The Committee believes that the NRC-IE organization needs to increase its Staff in this area through direct hires or through increased use of consultants.

The existing level of staffing and capabilities in the NRC-IE organization probably needs to be expanded. The capabilities of NRC-IE could be used more effectively if some of the duties now performed by its personnel were performed by "inspection agencies" not in the employment of the NRC. However, regardless of this, there appears to be a definite need for more expertise in the NRC-IE organization to serve as a cadre of supporting personnel when important safety matters arise requiring resolution. Further, the inspection capabilities need to include fire protection, instrumentation and controls, rotating machinery, and various operational test activities as well as matters covered by the ASME Boiler and Pressure Vessel Code.

The Committee believes that the problems identified above are amenable to solution, and positive programs leading to resolution of these items should produce substantive improvements in the inspection process.

Sincerely yours,

Dade W. Moeller

Dade W. Moeller
Chairman

Attachment:
Glossary of Terms

References:

1. Letter, dated February 17, 1976, E. L. Kemmler, The Hartford Steam Boiler Inspection and Insurance Company, to the Honorable Abraham Ribicoff, concerning the inspection of nuclear plants by insurance companies
2. "NELPIA and MAERP Inspection Guide for Boiler and Machinery Inspection Property Insurance Association," Burt C. Proom, July 1975, Nuclear Energy Liability Property Insurance Association and Mutual Atomic Energy Reinsurance Pool
3. American National Standards Institute (ANSI), "Qualifications and Duties for Authorized Nuclear Inspection," ANSI N626.0, 1974
4. "Qualifications and Duties for Authorized Nuclear Inservice Inspection," ANSI N626.1, July 2, 1975
5. "Qualifications and Duties for Authorized Nuclear Inspection (Concrete)," ANSI N626.2, July 1975

References Continued:

6. Technischer Ueberwachungs-Verein Rheinland (TUV), "Requirements for the Design and Execution of a Quality Assurance Program for Nuclear Installations," Report No. 932/7411, July 17, 1975
7. Letter, dated October 17, 1975, G. E. Weldon to R. Minogue, concerning a national nuclear fire code
8. "International Guidelines for the Fire Protection of Nuclear Power Plants," National Nuclear Risks Insurance Pools and Association, 1974 Editions
9. Joint Hearing - The Joint Committee on Atomic Energy of the United States and the Committee on Government Operations of the U. S. Senate, Ninety-fourth Congress, Nuclear Regulatory Commission Action Requiring Safety Inspection Which Resulted in Shutdown of Certain Nuclear Power Plants, February 1975
10. ASME Boiler and Pressure Vessel Code, Section III - Nuclear Power Plant Components, 1974 Edition
11. ASME Boiler and Pressure Vessel Code, Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components, 1974 Edition
12. Letter, dated October 27, 1975, Institut Fur Reaktorsicherheit Der Technischen Ueberwachungs - Vereine (IRS-TUV) to Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Washington (Battelle, Northwest), concerning inspection and enforcement information from Sweden
13. Letter, dated July 11, 1975, IRS-TUV to Battelle, Northwest, concerning inspection and enforcement information from Sweden, ("Wes und Geschichte der Technischen Ueberwachungs - Vereine", G. Wiesenack 1971)
14. Topical Report on Coordinating Agency for Supplier Evaluation, January, 1976

ATTACHMENT

GLOSSARY

The following definitions are those used in ASME, Section III and ASME, Section XI; however, they are considered to be generally applicable to all classes of components, examinations, and inspections. (Note: "NA-____" refers to ASME, Section III, "IWA-____" refers to ASME, Section XI, and "*" refers to usage by the ACRS Inspection and Enforcement Subcommittee)

AUDITS - NA-4900

A comprehensive system of planned and periodic audits shall be carried out by the Certificate of Authorization holder's organization to assure compliance with all aspects of the Quality Assurance Program and to determine the effectiveness of the Program.

AUTHORIZED INSPECTION AGENCY - NA-5111

An Authorized Inspection Agency is one designated as such by the appropriate legal authority of a State or Municipality of the United States or a Province of Canada. The agency employs the Authorized Inspectors who perform inspections required by this Section. The agency may be a State of the United States or a Province of Canada or an insurance company authorized to write boiler and pressure vessel insurance.

CERTIFICATE OF AUTHORIZATION - NA-8112

An Owner, Engineering Organization, Manufacturer, or Installer may apply to the American Society of Mechanical Engineers, upon forms issued by the Society, for a Certificate of Authorization for the scope of work which he intends to perform.

CLASSES - CODE*

Construction rules are specified for items which are designated Code Classes 1, 2, 3, CS and MC. These code classes recognize the different levels of importance associated with the function of each item as related to the safe operation of the nuclear power plant. For example, Class 1 includes, but is not limited to, components making up the primary coolant boundary.

CODE*

Those safety laws, rules, and regulations pertaining to systems or components (e.g., pressure vessels) contained in the laws of States, Municipalities, Federal Government, etc. The ASME Boiler and Pressure Vessel Codes are a specific example. They are mandatory.

CODE - ASME III - NA-1110

The rules of this Section constitute requirements for the construction of nuclear power plant items such as vessels, storage tanks, piping, pumps, valves, and core support structures, and component supports, for use in or containment of, portions of the nuclear power system of any power plant.

CODE - ASME XI - INTRODUCTION/FOREWORD

Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components of the ASME Boiler and Pressure Vessel Code is addressed to provide rules for the examination, testing, and inspection of Class 1, 2, and 3 components and systems in a nuclear power plant. Application of this Section of the Code begins when the requirements of Section III, Rules for Construction of Nuclear Power Plant Components, have been satisfied.

CONSTRUCTION - NA-1110 FOOTNOTE

Construction is an all-inclusive term comprising materials, design, fabrication, examination, testing, inspection, and certification required in the manufacture and installation of items.

ENFORCEMENT AUTHORITY - IWA-2110(e)

Denotes a regional or local governing body such as a State or Municipality of the United States or Canadian Province empowered to enact and enforce boiler code legislation.

EXAMINATION - IWA-2110(a)

Denotes the performance of all visual observation and nondestructive testing such as radiography, ultrasonic, liquid penetrant, and magnetic particle methods.

EXAMINATION TECHNIQUES - IWA-2200

Methods, techniques, and procedures for the inservice inspections are titled visual, surface, and volumetric. Each term describes a general method permitting a selection of different techniques or procedures restricted to that method to accommodate varying degrees of accessibility and radiation levels, and the automation of equipment to perform the examinations.

EXAMINER - IWA-2110(a)

The individual(s) performing all visual observation and nondestructive testing such as radiography, ultrasonic, liquid penetrant, and magnetic particle methods.

EXAMINER - QUALIFICATIONS - IWA-2300

a) Personnel performing nondestructive examination operations shall be qualified with a procedure prepared in accordance with SNT-TC-1A for the applicable examination technique and methods.

b) For nondestructive examination methods not covered by SNT-TC-1A documents, personnel shall be qualified by the Owner or his agent to comparable levels of competency by subjection to comparable examinations on the particular methods involved; for example, leak testing. The practical portion of SNT-TC-1A shall be performed using the Owner's procedure(s) on part(s) representative of the Owner's plant.

FLAW INDICATION -IWA-2110(c)

Denotes the evidence or signal obtained by application of a nondestructive examination that may reveal the presence of a flaw. Flaw indications include cracks, slag inclusions or segregates, aligned or clustered porosity, lack of weld penetration, lack of weld fusion, and laminations or combinations thereof.

INSPECTION - IWA-2110(b)

Denotes verifying the performance of examinations by an Inspector representing a State, or Municipality of the United States, Canadian Province, Authorized Inspection Agency, or other enforcement authorities having jurisdiction over the nuclear power components at the plant site.

INSPECTION AGENCIES - NA-3520

Organizations having agreements with Owners, Engineering Organizations, Manufacturers or Installers to provide inspection of nuclear power plant items or their installation.

OFFICE OF INSPECTION AND ENFORCEMENT*

The office under the Nuclear Regulatory Commission responsible for inspection of nuclear facilities (see Regulatory authority).

INSPECTION - FIRST PARTY (OWNERS)*

Denotes verifying the performance of examinations by an inspector who represents, and is employed by, the owner of the facility.

INSPECTION - SECOND PARTY (MANUFACTURERS)*

Denotes verifying the performance of examinations by an inspector who represents, and is employed by, the manufacturer.

INSPECTION - THIRD PARTY*

Denotes verifying the performance of examinations by an inspector as defined in IWA-2130.

INSPECTION - FOURTH PARTY (NRC-IE)*

Denotes verifying the performance of examinations by an employee of the Nuclear Regulatory Commission's Office of Inspection and Enforcement as distinguished from an Authorized Inspector.

INSPECTION SPECIALISTS - NA-5113

Any Inspection Agency which has contracted to perform inspections required by this Section shall, in addition to Inspectors, maintain a staff of Inspection Specialists, each of whom has demonstrated his qualification by passing an examination acceptable to the Society in one or more methods of nondestructive examination and, in addition, the tests for Inspection Specialists given by the National Board of Boiler and Pressure Vessel Inspectors for knowledge of and familiarity with this Section.

INSPECTOR - IWA-2110(d)

Denotes an "Authorized Inspector" as defined in IWA-2130.

INSPECTOR - DUTIES (INSERVICE) - IWA-2120

a) It is the duty of the Inspector to witness or otherwise verify all the examinations and pressure tests required by this Division for Class 1, and for Class 2 components where required. The Inspector shall also make any additional investigations necessary to verify that all applicable requirements have been met.

b) It is the duty of the Inspector to assure himself that the nondestructive examination methods used follow the techniques specified in this Division. The Inspector shall also assure himself that the examinations are performed in accordance with written qualified procedures and by personnel employed by the Owner or his agent and qualified in accordance with SNT-TC-1A and IWA-2300. The duties of the Inspector include checking with his Inspection Specialists for the technical content and requirements of the examination procedures and the qualification procedures of nondestructive examination personnel.

c) It is the duty of the Inspector to assure himself that the inservice tests required on pumps and valves (IWP and IWV) have been completed and the results recorded.

d) It is the duty of the Inspector to assure himself that the examinations and tests required for Class 3 components and systems (IWD-1000) have been conducted and the results recorded.

e) The Inspector has the right at any time to require requalification of any procedure or operator when the Inspector has reason to believe the requirements are not being met.

f) The examination records shall be certified by the Inspector only after he has satisfied himself that all the requirements have been met and that the records are correct.

g) The Inspector shall review the repair program to determine compliance with the requirements of this Division.

h) It is the duty of the Inspector to assure himself that the welding procedures employed during the repair and the welding operators are qualified in accordance with IWA-4000 and that all nondestructive examination methods used comply with requirements in IWA-2200 and IWA-2300.

INSPECTOR - DUTIES (CONSTRUCTION) NA-5210

a) The Inspector who performs the detailed inspections in compliance with this Section shall witness or otherwise verify all examinations and make all inspections required by this Section. He shall also make any other inspections and witness or verify (including making measurements) any other examinations and additional investigations which, in his judgment, are necessary to ascertain whether the item being inspected has been constructed (NA-1110, Footnote 1) in compliance with the rules of this Section. Parts and piping subassemblies shall be in accordance with the accepted design drawings.

b) The duties of the Inspector shall not be interpreted by virtue of these rules to extend to any construction requirements beyond those of this Section which may be set forth in the Design Specification or on drawings. However, such requirements shall not result in construction which fails to conform with the requirements of this Section (NA-3252).

INSPECTOR - THIRD PARTY (AUTHORIZED) - IWA-2110(d)

Denotes an "Authorized Inspector" as defined in IWA-2130.

INSPECTOR - QUALIFICATIONS - IWA-2130(b)

Any Inspector who performs inspections required by this Division shall have first been qualified by written examination pursuant to the legislation or rules of a State of the United States, the legislation of a

Canadian Province, or the rules of another authority having jurisdiction over a nuclear power plant at the installation location and that has adopted this Division. The Inspector shall not be an employee of the Owner or his agent.

JURISDICTIONAL AUTHORITY*

That body in the State empowered by its legislature to enforce the laws of the State with respect to boilers, pressure vessels, and nuclear reactors. The title of the Chief Enforcement Officer is usually Chief Inspector.

MANUFACTURER - NA-3310

The organization or combination of organizations which constructs (NA-1110) any item to meet the Design Specifications and the requirements of the Code.

OPERATION*

Denotes status of a nuclear power system during the power generation (and ascent to power) stages.

OWNER - IWA-1400 FOOTNOTE

The organization responsible for the operation, maintenance, safety, and power generation of the nuclear power system.

QUALITY ASSURANCE - NA-4121

All those planned and systematic actions necessary to provide adequate confidence that all items manufactured or installed are in accordance with the rules of this Section.

Quality Assurance includes:

1) Quality Control Examination (NA-4122), which comprises the examinations of the physical characteristics of a material, components, part, or appurtenance and the acceptance standards associated with those examinations;

2) Quality Control Administration (NA-4123), which is the management and documentation which assures that the specified Quality Control examination is carried out.

REGULATORY AUTHORITY - IWA-2110(f)

Denotes a Federal Government agency, such as the United States Nuclear Regulatory Commission, empowered to issue and enforce regulations concerning the design, construction, and operation of nuclear power plants.

STANDARDS*

Those test methods, definitions, recommended practices, classifications, specifications, and other related material representing a common viewpoint to those parties concerned (producers, users, general interest groups). Unlike codes, standards are voluntary.