REGULATORY GUIDE 1.137, REV. 1

FUEL OIL SYSTEMS FOR STANDBY DIESEL-GENERATORS

A. INTRODUCTION

General Design Criterion 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that an onsite electric power system and an offsite electric power system be provided to permit functioning of structures, systems, and components important to safety. In addition, Criterion 17 contains requirements concerning system capacity, capability, independence, redundancy, availability, testability, and reliability. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants," to 10 CFR Part 50 establishes overall quality assurance requirements for the design, construction, and operation of structures, systems, and components important to safety. This regulatory guide describes a method acceptable to the NRC staff for complying with the Commission's regulations regarding fuel oil systems for standby diesel-generators and assurance of adequate fuel oil quality.

B. DISCUSSION

Working Group ANS 59.51 of Subcommittee ANS-50, Nuclear Power Plant Systems Engineering, of the American National Standards Committee N18, Nuclear Design Criteria, has prepared a standard that provides design requirements for the fuel oil systems for standby diesel-generators. This standard was approved by the American National Standards Committee N18 and

7902280372

its Secretariat, and it was subsequently approved and designated ANSI N195-1976 by the American National Standards Institute on April 12, 1976.

For proper operation of the standby diesel generators, it is necessary to ensure the proper quality of the fuel oil. Appendix B to ANSI N195-1976 addresses the recommended fuel oil practices. Although not a mandatory part of the standard, the staff believes Appendix B can serve as an acceptable basis for a program to maintain the quality of fuel oil, as supplemented by Regulatory Position C.2 of this guide.

C. REGULATORY POSITION

1. The requirement for the design of fuel oil systems for diesel-generators that provide standby electrical power for a nuclear power plant that are included in ANSI N195-1976, "Fuel Oil Systems for Standby Diesel-Generators,"[1] provide a method acceptable to the NRC staff for complying with the pertinent requirements of General Design Criterion 17 of Appendix A to 10 CFR Part 50, subject to the following:

a. Throughout ANSI N195-1976, other documents required to be included as part of the standard are either identified at the point of reference or described in Section 7.4, "Applicable Codes, Standards, and Regulations," or Section 11, "References," of the standard. The specific acceptability of these listed documents has been or will be addressed separately in other regulatory guides or in Commission regulations, where appropriate.

---

[1] Copies may be obtained from the American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60525.

b. Section 1, "Scope," of ANSI N195-1976 states that the standard provides the design requirements for the fuel oil system for standby diesel generators and that it sets forth other specific design requirements such as safety class, materials, physical arrangement, and applicable codes and regulations. The standard does not specifically address quality assurance, and in this regard ANSI N195-1976 should be used in conjunction with Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)," which endorses ANSI N45.2-1971, "Quality Assurance Program Requirements for Nuclear Power Plants," for the design, construction, and maintenance of the fuel oil system.

c. Section 5.4, "Calculation of Fuel Oil Storage Requirements," of the standard sets forth two methods for the calculation of fuel oil storage requirements. These two methods are (1) calculations based on assuming the diesel-generator operates continuously for 7 days at its rated capacity, and (2) calculations based on the time-dependent loads of the diesel generator. For the time-dependent load method, the minimum required capacity should include the capacity to power the engineered safety features. Applications that use the time-dependent load method to calculate fuel oil storage requirements will be reviewed on a case-by-case basis along with the calculations.

d. Section 7.3, "Physical Arrangement," of ANSI N195-1976 states that "the location of day tanks shall be as required by the diesel-engine manufacturer." In addition to this requirement, the day tanks should be located at an elevation to ensure adequate net positive suction head at the engine fuel pumps at all times.

e. Section 7.3 of ANSI N195-1976 states that the arrangement of the fuel oil system "shall provide for inservice inspection and testing in accordance with ASME Boiler and Pressure Vessel Code, Section XI, 'Rules for In-Service Inspection of Nuclear Power Plant Components'". [~~Although Section XI of the ASME Boiler and Pressure Vessel Code does not specify whether its provisions apply to fuel oil systems, they should be applied for the inservice inspection and testing program~~]For those portions of the fuel oil systems for standby diesel-generators that are designed to Section III, Subsection ND of the Code[~~:~~], an acceptable method of meeting the requirements of Section 7.3 is to ensure that the system arrangement would allow:

(1) Pressure testing of the fuel oil system to a pressure 1.10 times the system design pressure at ten year intervals. In the case of storage tanks, recommendations of the tank vendor shall be taken into account when establishing the test pressure.

(2) During the pressure test, visual examination shall be conducted for evidence of component leakages, structural distress, or corrosion. In the case of buried components, a loss of system pressure during the test shall constitute evidence of component leakage.

f. Section 7.3 of ANSI N195-1976 states that adequate heating shall be provided for the fuel oil system. Assurance should be provided that [~~for~~] the fuel oil can be supplied and ignited at all times under the most severe environmental conditions expected at the facility. This may be accomplished by use of an oil with a "Cloud Point" lower than the 3-hour

minimum soak temperature (Ref. 1) expected at the site during the seasonal periods in which the oil is to be used, and/or by maintenance of the onsite fuel oil above the "Cloud Point" temperature.

g. Section 7.5, "Other Requirements," of the standard states that "protection against external and internal corrosion shall be provided" for the fuel oil system. To amplify this requirement for buried supply tanks not located within a vault and other buried portions of the system, a [**waterproof**] protective coating and an impressed current-type cathodic protection system should be provided in accordance with NACE Standard RP-01-69 (1972 Revision), "Recommended Practice--Control of External Corrosion on Underground or Submerged Metallic Piping Systems."[2] In addition, the impressed current-type cathodic protection system should be designed to prevent the ignition of combustible vapors or fuel oil present in the fuel oil systems for standby diesel-generators.

h. Section 7.5 of the standard includes requirements for fire protection for the diesel-generator fuel oil system. The requirements of Section 7.5 are not considered a part of this regulatory guide since this subject is addressed separately in more detail in other NRC documents. Thus a commitment to follow this regulatory guide does not imply a commitment to follow the requirements of Section 7.5 concerning fire protection.

2. Appendix B to ANSI N195-1976 should be used as a basis for a program to ensure the initial and continuing quality of fuel oil as supplemented by the following:

---

[2]Copies may be obtained from the National Association of Corrosion Engineers, 2400 West Loop South, Houston, Texas 77027.

a. The oil stored in the fuel oil supply tank, and the oil to be used for filling or refilling the supply tank, should meet the requirements of Federal Fuel Oil Specification VV-F-800b (April 2, 1975), (~~ASTM-975-74~~) ASTM D975-77, "Standard Specification for Diesel Fuel Oils," or the requirements of the diesel-generator manufacturer, if they are more restrictive, as well as the fuel oil total insolubles level specified in Appendix B of the standard. [~~and~~] The "Cloud Point" (~~requirements-given-in-Regulatory-Position-C.2.b~~) should be less than or equal to the 3-hour minimum soak temperature (Ref. 1) or the minimum temperature at which the fuel oil will be maintained during the period of time that it will be stored. If test results for viscosity, water and sediment for fuel oil contained in the supply tanks exceed the limits specified in ASTM D975-77 the diesel should be considered inoperable. Fuel oil contained in the supply tank not meeting [~~these~~] remaining ASTM D975-77 requirements should be replaced in a short period of time (about a week).

b. Prior to adding new fuel oil to the supply tanks on-site samples of the fuel oil should be taken. As a minimum, prior to the addition tests for the following properties should be conducted:

(1) Specific or API gravity

(2) Water and Sediment

(3) Viscosity

(~~(3)--Cloud-Point~~)

(~~(4)--99%-Distillation-Temperature~~)

(~~The-fuel-oil-should-meet-the-requirements-of-ASTM-D975-74-for-the-latter two-analysis.--The-"Cloud-Point"-should-be-less-than-or-equal-to-the-3-hour~~

~~minimum-temperature-at-which-the-fuel-oil-will-be-maintained-during-the-period of-time-that-it-will-be-in-storage;)~~ Test results for the latter two tests should not exceed the limits specified in ASTM D975-77. Analysis of the other properties of the fuel oil listed in ASTM (~~D975-74~~) D975-77 should be completed within 2 weeks of the addition (~~transfer~~).

c. The periodic sampling procedure for the fuel oil should be in accordance with ASTM D270-1975, "Standard Method of Sampling Petroleum and Petroleum Products."[5]

d. Accumulated condensate should be removed from storage tanks on: (1) a quarterly basis;

(2) a monthly basis when it is suspected or known that the ground-water table is equal to or higher than the bottom of buried storage tanks; [~~and~~]

[~~3)--one-day-after-the-addition-of-new-fuel;~~]

e. Day tanks and integral tanks should be checked for water monthly, as a minimum, and after each operation of the diesel where the period of operation was 1 hour or longer. [~~Any~~] Accumulated water should be removed immediately. If it is suspected that water has entered the suction piping from the day or integral tank, the entire fuel oil system between the day or integral tank and the injectors should be flushed.

f. As a minimum, the fuel oil stored in the supply tanks should be removed, the accumulated sediment removed, and the tanks cleaned [~~in order-to-perform-the-ASME-Section-XI,-Article-IWD-2000,-"Examination~~

---

[5]Also designated ANSI Z11.33-1976. Copies may be obtained from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Requirements]," at [the-required] 10-year intervals. To preclude the introduction of surfactants in the fuel system, this cleaning should be accomplished using sodium hypochlorite solutions or its equivalent rather than soap or detergents.

g. Assuming an unlikely event should occur that would require replenishment of fuel oil without the interrruption of operation of the diesel-generators, the method of adding [additional] fuel oil should be such as to minimize the creation of turbulence of the accumulated residual sediment in the bottom of the supply tank since stirring up this sediment during the addition of acceptable new incoming fuel has the potential of causing the overall quality of the fuel oil in the storage tank to become unacceptable.

h. For those facilities having an impressed current-type cathodic protection system, cathodic protection surveillance should be conducted according to the follwoing procedures:

(1) At intervals not exceeding 12 months, tests should be conducted on each underground cathodic protection system to determine whether the protection is adequate.

(2) The test leads required for cathodic protection should be maintained in such a condition that electrical measurements can be obtained to ensure the system is adequately protected.

(3) At intervals not exceeding 2 months, each of the cathodic protection rectifiers should be inspected.

(4) Records of each inspection and test should be maintained over the life of the facility, to assist in evaluating the extent of degradation of the corrosion protection systems.

D. IMPLEMENTATION

~~[The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide:~~

~~Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of submittals for construction permit applications docketed after (Issuance date of Guide) (September 15, 1978, unless this guide is revised as a result of suggestions from the public or additional staff review.]~~

~~If an applicant wishes to use this regulatory guide in developing submittals for applications docketed on or before September 15, 1978, the pertinent portions of the application will be evaluated on the basis of this guide.~~

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of (1) all construction permit applications, (2) standard reference system preliminary design applications (PDA) or Type-2 final design applications (FDA-2), and (3) licenses to manufacture after (to be filled in at the time of issuance of the guide), except those portions of a construction permit application that:

a. Reference an approved standard reference system preliminary or final design (PDA or FDA), or applications for such approval.

b. Reference an approved standard duplicate plant preliminary or final design (PDDA or FDDA).

c. Reference parts of a base plant design qualified and approved for replication.

d. Reference a plant design approved or under review for approval for manufacture under a Manufacturing License, or applications for such approval.

REFERENCE

1. J. P. Doner, "A Predictive Study for Defining Limiting Temperatures and their Application in Petroleum Product Specifications," U.S. Army, Mobility Equipment Research and Development Center, Coating and Chemical Laboratory, Aberdeen Proving Ground, Maryland, CCL Report No. 316.

DISCUSSION OF PUBLIC COMMENTS ON REGULATORY GUIDE 1.137

Public comments on Regulatory Guide 1.137, "Fuel Oil Systems for Standby Diesel-Generators," dated January 1978, were received from those listed below, and a discussion of the comments follows:

J. E. Gilleland, Tennessee Valley Authority

E. P. O'Donnell, Ebasco Services, Inc.

L. C. Dail, Duke Power Company

S. D. Goodman, Gilbert/Commonwealth

D. Waremburg, Public Service Company of Colorado

S. L. Daltroff, Philadelphia Electric Company

J. L. Frewing, Portland General Electric

T. J. Sullivan, Consumers Power Company

T. E. Short, Omaha Public Power District

1. Mr. Gilleland comments that the position in Section 7.4 of ANSI N195-1976 that primarily requires adherence to the ASME Boiler and Pressure Vessel Code, Section III, is unduly restrictive relative to pressure rating requirements. For this reason, he comments that Section 7.4 of ANSI N195-1976 should not be made a part of the guide. For the same reason, he comments that the portion of Section 7.3 of ANSI N195-1976 that refers to the ASME B&PV Code, Section XI, should also not be made part of the guide. (Section 7.3 and Section 7.4 are

referred to specifically in the guide in Regulatory Positions C.1.a and C.1.e, respectively.)

Resolution: The staff considers that adherence to the ASME Boiler and Pressure Vessel Code, Section III, provides confidence that the fuel oil system will be properly designed and fabricated. However, as indicated in the implementation section of the Regulatory Guide, alternate design/fabrication criteria for the fuel oil system would be considered on a case-by-case basis. Regarding the applicability of ASME Boiler and Pressure Vessel Code, Section XI requirements to the fuel oil system, positions C.1.e. and C.2.f of the Regulatory Guide have been revised to delete reference to Section XI. Instead, test requirements which are equivalent to those specified in Section XI and which the staff feels are necessary to assure that the fuel oil system will perform its function have been included in position C.1.e.

2. Mr. O'Donnell comments that Ebasco does not believe that the scope of Regulatory Position C.1.e is adequately defined. He comments that the regulatory position would apply the inspection and testing requirements of ASME, Section XI, to diesel generator subcomponents already subjected to the inspection and testing of the diesel-generator as a component.

Resolution: As noted in the resolution to comment 1 above, position C.1.e. has been revised to include specific details of system testing in lieu of referencing Section XI of the ASME Code. Additionally, the staff considers that the portions of the fuel oil system to which ANSI N195-1976 and the guide apply are adequately defined in the scope of the ANSI standard.

3. Mr. Dail expressed concern that the guide implied that the Cathodic Protection System was safety related and, therefore, subject to requirements placed on safety systems.

Resolution: The purpose of the guide is not to categorize plant equipment but to specify quality standards for equipment whose function is important to plant safety. It is stated in Criterion 1 of Appendix A to 10 CFR Part 50 that: "Structures, systems and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with their importance to safety." Consistent with Criteria 1, the provisions specified in this guide concerning the cathodic protection system are considered to be those necessary to assure that the system performs its safety function. This does not imply, as the comment suggests, that the system is subject to the same requirements as other systems that perform safety functions.

4. Messrs. Dail, Goodman and O'Donnell commented that the provisions in Regulatory Position C.1.g that amplifies the requirements for protection against external corrosion are overly restrictive in failing to recognize that cathodic protection systems other than the impressed current-type may also be acceptable. Generally, they consider that the position should be expanded to include more flexibility in systems needed to provide cathodic protection.

Resolution: Use of cathodic protection systems other than the impressed current type are dependent on soil composition. U.S. Bureau of Standards publication PB 168350, Underground Corrosion, states that knowledge of soil is not necessarily of use to the corrosion engineer because of the disturbing effects of cuts, fills, pavements and buildings. Also, NACE Std. RP-01-69 (1972 Revision) states that one consideration influencing the selection of the cathodic protection system is "Stray current causing significant potential fluctuations between the pipeline and earth may preclude the use of galvanic anodes." This consideration is pertinent to nuclear facilities. On this basis the staff considers the impressed current cathodic protection system preferable. Other methods for cathodic protection may be acceptable, but would require more detailed evaluation on a case-by-case basis.

5. Mr. Waremburg in his comments questions the justification of the extensive testing program for fuel oils contained in Regulatory

Position C.2.a. He comments that the fuel oil tests proposed are extremely time-consuming and for some tests, necessitate sending a fuel sample to an outside laboratory for analysis. Further, he questions the need for all tests specified in Regulatory Position C.2.a based on the Public Service Company of Colorado's operating experience and based on periodic diesel generator inspection and testing requirements imposed by Technical Specifications.

Resolution: The staff considers that both performance testing of the diesel generators and maintenance of fuel oil quality are necessary to assure operation of the diesel to satisfy its intended safety function. With regard to the fuel oil sampling and analysis program presented in Regulatory Position C.2.a the staff does not consider the provisions excessive. It is recognized that not all of the analysis specified in the regulatory position can be done on site, and it is expected that many facilities will need to send samples off-site for analysis. However, testing laboratories that can conduct these analysis are readily available and analysis can be conducted at reasonable costs.

6. Mr. O'Donnell comments that Regulatory Position C.2.a should be either revised to reflect the fact that diesel generator manufacturer's recommendations on fuel oil specifications are often based on non- safety related considerations or reference to these recommendations should be deleted.

Resolution: Although the manufacture's recommendations may not be based on safety considerations, their recommendations most likely effect the performance of the diesel. In this regard they should be followed to assure the rated operability of the diesel.

7. Mr. Daltroff comments that sampling and testing the fuel oil every three months in accordance with ASTM D-2274-70 as required by Appendix B of ANSI N195-1976 is redundant with their (Philadelphia Electric Company) monthly testing in conformance to Technical Specification and ASTM D-975-68. Further, he comments that the ASTM D-2274-70 test would require a considerable amount of time to complete.

Resolution: It is recognized that the analysis of fuel oil for the properties specified in ASTM D-2274-70 would require several hours to complete. However, the staff considers that this analysis is important to assure that fuel is of a quality necessary to operate and maintain the diesel-generator. Further, the analysis specified in ASTM D-2274-70 are not redundant to any specified in ASTM D-975-68 and, to our knowledge, to other analysis specified in Technical Specifications.

8. Mr. Gilleland in his comments recommends that the Federal Fuel Oil Specification VV-F-8002 be included in Regulatory Position C.2.a

to permit additional flexibility as the requirements for the purchase of fuel oil.

Resolution: We agree with Mr. Gilleland's comment and have revised the regulatory position to include Federal Fuel Oil Specification VV-F-800a as one acceptable measure of fuel oil quality.

9. Messrs. Short, Waremburg, Sullivan, Frewing, O'Donnell expressed similar concern over problems imposed by Regulatory Positon C.2.b that addresses sampling and analysis of fuel oils prior to adding new fuel to the supply tanks. It was identified that to conform to the position would result in long delays (from several hours to several days) in off-loading the fuel. The primary concern expressed in the comments is that analysis of the fuel oil sample for the four properties specified in the position immediately prior to filling the supply tanks was excessive.

Resolution: The Regulatory Position has been re-evaluated. In the revised guide, analysis of the fuel oil sample for 90% distillation temperature and cloud point immediately prior to adding the fuel oil is no longer specified. Sampling and analysis provisions specified in the revised regulatory position should not result in long delays in off-loading of fuel oil by a fuel oil supplier.

10. Mr. Sullivan commented that Regulatory Position C.2.d.(3) that specifies that accumulated condensate be removed one day after the addition of new fuel was overly restrictive in light of the recommendations in regulatory position C.2.b for the sampling of new fuel.

Resolution: We agree with the comment and the position has been deleted.

11. Mr. O'Donnell commented that Regulatory Position C.2.e be revised to reflect the fact that the injector recirculation system can handle small amounts of water without harmful effects.

Resolution: The regulatory position has been revised by deleting the word "any" from the second sentence which now reads: "Accumulated water should be removed immediately." This change should remove the implication that even trace amounts of moisture need to be removed.

12. Mr. Sullivan commented that Regulatory Position C.2.f is incorrect in incorporating ASME Section XI Article IWD-2000 on the basis that they were written for water systems and are not applicable to fuel oil systems. He comments further that operational testing of diesel systems and compliance with other provisions of this guide should be sufficient. Mr. Waremburg adds that application of methods such as those in Regulatory Position C.2.f would result in considerable expense in the form of modifications.

Resolution: (See resolution to Comment 1)

13. Mr. O'Donnell comments that Regulatory Position C.2.g should be deleted on the bases that he considers it impossible to add fuel oil to a tank that is less than half full without stirring up sediment.

Resolution: Regulatory Position C.2.g specifies only that methods used for adding fuel oil when the DG is operating: "should be such as to minimize the creation of turbulence of accumulated residual sediment in the bottom of the supply tank." It is recognized that this task will be more difficult as the tank is emptied, but efforts still should be made to minimize the effect of turbulence. The regulatory position is more of a precautionary provision and does not imply that fuel should be added without any turbulence.