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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

June 3, 1999

NRC GENERIC LETTER 99-02: LABORATORY TESTING OF NUCLEAR- GRADE ACTIVATED CHARCOAL

Addressees

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this generic letter to:

(1) Alert addressees that the NRC has determined that testing nuclear-grade activated charcoal to standards other than American Society for Testing and Materials (ASTM) D3803-1989, "Standard Test Method for Nuclear-Grade Activated Carbon," does not provide assurance for complying with the current licensing basis as it relates to the dose limits of General Design Criterion (GDC) 19 of Appendix A to Part 50 of Title 10 of the Code of Federal Regulations (10 CFR) and Subpart A of 10 CFR Part 100.

(2) Request that all addressees determine whether their technical specifications (TS) reference ASTM D3803-1989 for charcoal filter laboratory testing. Addressees whose TS do not reference ASTM D3803-1989 should either amend their TS to reference ASTM D3803-1989 or propose an alternative test protocol and provide the information discussed in the requested actions.

(3) Alert addressees of the staff's intent to exercise enforcement discretion under certain conditions.

(4) Request that all addressees send the NRC written responses to this generic letter, relating to implementation of the requested actions.

Background

Safety-related air-cleaning units used in the engineered safety features (ESF) ventilation systems of nuclear power plants reduce the potential onsite and offsite consequences of a

radiological accident by adsorbing radioiodine. To ensure that the charcoal filters used in these systems will perform in a manner that is consistent with the licensing basis of a facility, most licensees have requirements in their facility TS to periodically test (in a laboratory) samples of charcoal taken from the air-cleaning units.

The NRC's and the nuclear industry's understandings of the appropriate laboratory tests for nuclear-grade charcoal have evolved over the years since the issuance of Regulatory Guide (RG) 1.52, "Design, Testing, and Maintenance Criteria for Postaccident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," which is referenced in many plant TS. It was initially assumed that high-temperature/high-relative-humidity (RH) conditions were the most severe. Later, with more testing experience, it became clear that the most conservative test is at low temperature/high humidity. The use of outdated test protocols or inappropriate test conditions can lead to an overestimation of the charcoal's ability to adsorb radioiodine following an accident.

Problems associated with the performance of the laboratory test of charcoal under inappropriate test conditions were discussed in Attachment 1 of Information Notice (IN) 86-76, "Problems Noted in Control Room Emergency Ventilation Systems." Attachment 1, "Summary of Control Room Habitability Reviews," noted that charcoal was being tested at much higher temperatures than any expected during the course of an accident, and that the performance of the laboratory test at that temperature can result in erroneously high efficiency measurements.

In 1982, the American Society of Mechanical Engineers (ASME) Committee on Nuclear Air and Gas Treatment (CONAGT) conducted an inter-laboratory comparison test using ASTM D3803-1979 and found that seven U.S. laboratories and eight foreign laboratories obtained vastly different results when testing samples of the same charcoal. After efforts to resolve the differences failed, the NRC contracted with EG&G at Idaho National Engineering Laboratory (INEL) to assess the problem. As a result of this assessment, the NRC issued IN 87-32, "Deficiencies in the Testing of Nuclear-Grade Activated Charcoal." Through IN 87-32, the NRC informed licensees of deficiencies in the testing of nuclear-grade charcoal, specifically noting serious problems with the capabilities of the testing laboratories and with the testing standard (ASTM D3803-1979). The NRC contractor detailed the specific problems in its technical evaluation report, EGG-CS-7653, "Final Technical Evaluation Report for the NRC/INEL Activated Carbon Testing Program." Specifically, EG&G reported that ASTM D3803-1979 had unacceptable test parameter tolerances and instrument calibration requirements, and that ASTM D3803-1979 was nonconservative in not requiring humidity pre-equilibration of used charcoal. The information notice indicated that the protocol developed by EG&G could be utilized for performing the laboratory test until the D-28 committee responsible for ASTM D3803 revised the standard. The committee completed the revision and issued it in December 1989. The problems associated with the testing laboratories were resolved after the number of U.S. firms performing such tests dropped from seven to the current two.

On April 29, 1993, representatives from ASME and CONAGT met with the NRC staff to express their concerns about laboratory testing of charcoal. CONAGT discussed the variation in

laboratory test results obtained (methyl iodide penetration) when temperature, RH, face velocity, bed depth, test protocol, and impregnate were varied. CONAGT stated that the 1989 version of ASTM D3803 is the only acceptable test method for TS applications and compared the results of laboratory tests performed using the 1986 version of ASTM D3803 (which is the 1979 version with editorial changes) to results using the 1989 version. The results from the 1986 protocol showed significantly higher iodine-removal capabilities than the results from the 1989 version.

In addition, CONAGT indicated that testing charcoal at temperatures greater than 30 °C [86 °F] almost always results in the charcoal meeting the TS acceptance criteria, even when the charcoal is deficient. To support this premise, CONAGT presented the results of laboratory tests conducted at temperatures of 30 °C [86 °F], 80 °C [176 °F], and 130 °C [266 °F]. The data show significant increases in iodine-removal capabilities as the test temperature increases. CONAGT indicated that all systems located outside of containment should be tested at 30 °C [86 °F], which is more representative of the limiting accident conditions. Tests conducted at 80 °C [176 °F] or 130 °C [266 °F] are inappropriate because tests at these temperatures result in the regeneration of the charcoal. As the temperature of the charcoal is increased, there is an increase in the reaction rate, which results in the charcoal being able to adsorb more iodine than it could at lower temperatures. Therefore, testing at the elevated temperatures results in an overestimation of the actual iodine-removal capability of the charcoal, and testing at 25 °C [77 °F] or 30 °C [86 °F] gives results that represent a more realistic assessment of the capability of the charcoal. CONAGT concluded its presentation by stating that the major problems associated with the laboratory test of charcoal are the designation of the test protocol and the TS that designate the test to be performed.

On November 6, 1996, the staff visited the two remaining laboratories that test nuclear-grade activated charcoal, NCS Corporation and NUCON International, Inc. Both laboratories have resolved the poor reproducibility problem identified in the EG&G report by performing all tests with calibrated equipment that is capable of maintaining the tight tolerances of the test parameters as specified in ASTM D3803-1989. Tight tolerances are very important when tests are performed at high RH, because slight variations in RH result in unacceptably large differences in the tested efficiency of the charcoal.

Discussion

Although some licensees have changed their TS to reference the latest testing standard (ASTM D3803-1989), many still use outdated standards and/or test conditions that may overestimate the capability of the charcoal in their ESF systems. As a result, the ability of the charcoal filters in these systems to perform in a manner consistent with the licensing basis for the facility may be in question.

The licensees of four plants (V.C. Summer, Davis-Besse, Oconee, and Brunswick) determined that the tests they performed were not in compliance with their TS and submitted emergency TS amendments (see Enclosure 1 for details). As a result of the emergency TS changes, the staff has performed an internal survey of the TS of operating plants to determine whether other

plants have the potential for similar compliance problems. The survey indicated that at least one-third of operating reactor licensees may be out of compliance with their TS because, although the plants' TS reference RG 1.52 or American National Standards Institute (ANSI) N509-1976, "Nuclear Power Plant Air-Cleaning Units and Components," the licensees may have used later versions of the standards for the laboratory tests of their nuclear-grade charcoal in order to achieve more accurate testing results. On the basis of this survey, the staff established the following four groups of plants:

(1) plants in compliance with their TS that test in accordance with ASTM D3803-1989

(2) plants in compliance with their TS that test in accordance with a test protocol other than ASTM D3803-1989

(3) plants not in compliance with their TS that test in accordance with ASTM D3803-1989

(4) plants not in compliance with their TS that test in accordance with a test protocol other than ASTM D3803-1989

Licensees in Group 1 have TS that require charcoal to be tested in accordance with ASTM D3803-1989, which adequately demonstrates the capability of the charcoal. As discussed in Enclosure 1, the staff considers ASTM D3803-1989 to be the most accurate and most realistic protocol for testing charcoal in ESF ventilation systems because it offers the greatest assurance of accurately and consistently determining the capability of the charcoal. For example, it requires the test to be performed at a constant low temperature of 30 °C [86 °F]; it provides for smaller tolerances in temperature, humidity, and air flow; and it has a humidity pre-equilibration.

Licensees in Group 2 have TS that require charcoal to be tested in accordance with test standards other than ASTM D3803-1989. On the basis of available laboratory test results for more than 50 charcoal samples, there were significant differences in filter efficiencies for about 15 to 20 percent of the tested samples when comparing the test results from ASTM D3803-1979 and ASTM D3803-1989. When the charcoal samples were tested in accordance with ASTM D3803-1979, they appeared to have high efficiencies. However, when the same charcoal samples were tested in accordance with ASTM D3803-1989, significant reduction in efficiency was noted. Depending on the system arrangement, this reduction in filter efficiency can result in calculated doses to the control room operators exceeding the GDC 19 limits by as much as a factor of 1.5 to 2. For pressurized-water reactors (PWRs) with secondary containments and for all boiling-water reactors (BWRs), this reduction in filter efficiency can result in offsite doses from a filtered pathway increasing by as much as a factor of 10 to 15. As a result, the testing of nuclear-grade activated charcoal to standards other than ASTM D3803-1989 does not provide assurance for complying with the plant's licensing basis as it relates to the dose limits of GDC 19 and Part 100.

In addition, the staff has determined that ASTM D3803-1989 should be used for both new and used charcoal because it allows for accurately monitoring the degradation of the charcoal over time. The original rationale for testing used and new charcoal differently was the belief that a long equilibration period would regenerate the used charcoal by removing contaminants adsorbed by the charcoal during normal plant use. However, an EG&G technical evaluation report, described in Enclosure 1, demonstrated that this is not true. As a result, ASTM D3803-1989 specifies testing both used and new charcoal in the same manner.

Currently, before shipping, suppliers test most new charcoal with the ASTM D3803-1989 protocol at 30 °C [86 °F] and 95 percent RH in addition to the test protocol and test conditions the addressee records on the purchase order. The results from the new charcoal tested via ASTM D3803-1989 present a solid baseline for the initial capability of the charcoal. Using ASTM D3803-1989 to test used charcoal is a very accurate and reproducible method for determining the capability of the charcoal. By comparing the results of the tests performed on used charcoal with the baseline test performed on new charcoal, the addressee can be certain of the charcoal's level of degradation.

Analyses of design-basis accidents assume a particular ESF charcoal filter adsorption efficiency when calculating offsite and control room operator doses. Licensees then test charcoal filter samples to determine whether the filter adsorber efficiency is greater than that assumed in the design-basis accident analysis. The laboratory test acceptance criteria contain a safety factor to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle. Because ASTM D3803-1989 is a more accurate and demanding test than older tests, addressees that upgrade their TS to this new protocol will be able to use a safety factor as low as 2 for determining the acceptance criteria for charcoal filter efficiency (see note in Enclosure 2 for further discussion). This safety factor can be used for systems with or without humidity control because the lack of humidity control is already accounted for in the test conditions (systems without humidity control test at 95 percent RH and systems with humidity control can test at 70 percent RH). The staff has previously approved reductions in the safety factor for plants adopting the ASTM D3803-1989 standard on a case-by-case basis. (The staff plans to make conforming changes to RG 1.52.)

The licensees that received emergency TS changes were in Groups 3 and 4. Licensees in Groups 3 and 4 have TS that require charcoal to be tested in accordance with RG 1.52 or ANSI N509-1976, and are not in compliance with their TS because the specified test protocol cannot be successfully completed as discussed in Enclosure 1. These licensees are either (1) testing in accordance with the desired ASTM D3803-1989 (Group 3) or (2) using earlier revisions of ASTM D3803 or an older standard, which they believe are acceptable (Group 4). The staff does not have confidence that the results from RG 1.52 or ANSI N509-1976 meet the intent of the TS, which is to ensure that the doses are within the required limits. Therefore, licensees in these groups have not adequately demonstrated compliance with their licensing basis as it relates to the dose limits of GDC 19 and Part 100.

The staff believes that (1) conflicting guidance, (2) complex and ambiguous standards, and (3) licensee belief that using later versions of the ASTM D3803 standard would satisfy TS

requirements, contributed to confusion regarding charcoal testing. These factors may explain why licensees did not adopt ASTM D3803-1989 (see Enclosure 1 for further discussion). In addition, on the basis of the available laboratory test results, the staff believes that most charcoal in use is not degraded to an extent that would adversely affect control room habitability or public health and safety. This confidence in charcoal performance, the low probability of a design-basis accident and the conservatism inherent in the design-basis dose calculations, including the conservatism in the design-basis source term, justify the time frames for the resolution of this matter. Therefore, the staff intends to exercise enforcement discretion, consistent with Section VII.B.6 of the Enforcement Policy, for all addressees in Groups 2, 3, and 4, provided that

- A TS amendment request referencing ASTM D3803-1989 or an alternate test protocol is submitted to the NRC within 180 days of the date of this letter;

- At the next required laboratory surveillance test of a charcoal sample that is 30 or more days after the date of this generic letter, charcoal samples are tested in accordance with ASTM D3803-1989 or all of the charcoal is replaced with new charcoal that has been tested in accordance with ASTM D3803-1989. In all cases, the results should meet the acceptance criterion that is derived from applying a safety factor as low as 2 (see the note in Enclosure 2) to the charcoal filter efficiency assumed in the addressee's design-basis dose analysis; and

- The charcoal samples continue to be tested in accordance with ASTM D3803-1989, in lieu of the current TS-required laboratory testing, until the TS amendment is approved by the NRC.

Licensees in Group 2 have been complying with their TS by testing their charcoal in accordance with their TS. Therefore, enforcement discretion is not required for past surveillance testing. However, the staff will exercise enforcement discretion for licensees in Group 2 to eliminate unnecessary testing of charcoal samples to both ASTM D3803-1989 and the current TS testing protocol during the period of time between issuance of the generic letter and approval of the TS amendment.

Requested Actions

1. Within 180 days of the date of this generic letter, submit a written response to the NRC describing your current TS requirements for the laboratory testing of charcoal samples for each ESF ventilation system including the specific test protocol, temperature, RH, charcoal bed thickness, total residence time per bed depth, and penetration at which the TS require the test to be performed. If your current TS specifically require laboratory testing of charcoal samples in accordance with the ASTM D3803-1989 protocol at 30 °C [86 °F], and you have been testing in accordance with this standard, then you only need to address this requested action (i.e. no TS amendment or additional testing is required).

2. If you choose to adopt the ASTM D3803-1989 protocol, submit a TS amendment request to require testing to this protocol within 180 days of the date of this generic letter. The request should contain the test temperature, RH, and penetration at which the proposed TS will require the test to be performed and the basis for these values. If the system has a face velocity greater than 10 percent of 0.203 m/s [40 ft/min], then the revised TS should specify the face velocity. Also, indicate when the next laboratory test is scheduled to be performed. (Enclosure 2 is a sample TS that the NRC considers acceptable.)

3. If you are proposing an alternate test protocol, address the attributes discussed below and submit a TS amendment request to require testing to this alternate protocol within 180 days of the date of this generic letter. The request should contain the test temperature, RH, and penetration at which the proposed TS will require the test to be performed and the basis for these values. If the system has a face velocity greater than 10 percent of 0.203 m/s [40 ft/min], then the revised TS should specify the face velocity. Also, indicate when the next laboratory test is scheduled to be performed.

   The following information should be submitted for staff review to determine the acceptability of the alternate protocol:

   1. summary of the test method
   2. precision of the method
   3. description of the test apparatus along with tolerances
   4. parameter specifications
   5. material requirements
   6. hazards
   7. preparation of the apparatus before initiation of the test
   8. calibration requirements of the test equipment
   9. test procedure
   10. manner of calculating penetration and error
   11. repeatability and reproducibility of the results for 1 percent and 10 percent penetration and the penetration at a 95 percent confidence interval for charcoal tested at 70 percent RH and at 95 percent RH

12. bias associated with the method

13. results from at least two laboratories which demonstrate that the alternate test protocol achieves results that are consistent with, or more conservative than, results associated with ASTM D3803-1989.

The demonstration identified in Item 13 above should be based upon a series of tests comparing the alternate test protocol and ASTM D3803-1989, and it should apply to both new and used charcoal tested at 70 percent RH and at 95 percent RH. If an addressee chooses to test its charcoal samples at actual accident conditions which are different from the test conditions specified in ASTM D3803-1989, then that test should be treated as an alternate protocol. At least two laboratories should be used in determining the acceptability of the alternate protocol. One laboratory should be used to develop the alternate protocol and the other to demonstrate the repeatability and reproducibility of the alternate protocol. The two laboratories should be able to demonstrate that the alternate protocol is at least as conservative as ASTM D3803-1989, and should be able to perform the ASTM D3803-1989 test and achieve repeatable and reproducible results

4. At the next required laboratory surveillance test of a charcoal sample that is 60 or more days after the date of this generic letter, test your charcoal samples in accordance with ASTM D3803-1989 or replace all of the charcoal with new charcoal that has been tested in accordance with ASTM D3803-1989. In all cases, the results should meet the acceptance criterion that is derived from applying a safety factor as low as 2 (see the note in Enclosure 2) to the charcoal filter efficiency assumed in your design-basis dose analysis and the charcoal samples should continue to be tested in accordance with ASTM D3803-1989, in lieu of the current TS-required laboratory testing, until the TS amendment is approved by the NRC.

5. Addressees who choose not to do the above actions are requested to notify the NRC in writing of their decision, as soon as a decision is reached but no later than 60 days from the date of this generic letter. The 60 day written response should also discuss (1) addressee plans to pursue a proposed alternative course of action (including the basis for establishing its acceptability), (2) the schedule for submitting that proposal for NRC staff review (that proposal should be submitted to the NRC no later than 180 days from the date of this generic letter), and (3) the basis for continued operability of affected systems and components until such time that the proposed alternative course of action is approved by the NRC.

Address the written response to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555-0001. In addition, send a copy to the appropriate regional administrator.

Reasons for Requested Information

This generic letter requests that addressees submit information. The requested information will enable the NRC staff to make a determination that addressees are testing the nuclear-grade activated charcoal of their ESF ventilation systems in accordance with a suitable testing standard to ensure that the charcoal filters are capable of performing their required safety function and that the licensing bases of their respective facilities regarding onsite and offsite dose consequences continue to be satisfied.

The NRC erroneously assumed that existing charcoal filter test protocols other than ASTM D3803-1989 would be sufficient to assure accurate and reproducible results. In fact, the available laboratory test results demonstrate that existing test protocols other than ASTM D3803-1989 do not provide accurate and reproducible test results and may overestimate the capability of the charcoal. Therefore, the requested information is necessary for the NRC staff to make an accurate assessment of the charcoal filter capability, in order to assure compliance with the plant's licensing basis as it relates to the dose limits of GDC 19 and Part 100, including commitment to the resolution of TMI Action Plan Item III.D.3.4.

Backfit Discussion

Appendix A to 10 CFR Part 50, "General Design Criteria (GDC) for Nuclear Power Plants," and the plant safety analyses require and/or commit that licensees design and test safety-related structures, systems, and components to offer adequate assurance that they can perform their safety functions. Specifically, GDC 19 of Appendix A to 10 CFR Part 50 specifies dose limits to ensure that control room operators are provided with adequate radiation protection under accident conditions. Following the accident at Three Mile Island (TMI), TMI Action Plan Item III.D.3.4, "Control Room Habitability Requirements," as specified in NUREG-0737, "Clarification of TMI Action Plan Requirements," required all licensees to perform evaluations and identify appropriate modifications to ensure that control room operators are adequately protected from the release of radioactive gases and that the nuclear power plant can be safely operated or shut down under design-basis accident conditions (GDC 19). When modifications were proposed by licensees, the NRC issued orders confirming licensee commitments. As a result, all licensees are required to meet the dose limits of GDC 19. In addition, Subpart A of 10 CFR Part 100 specifies reference dose values that can be used in evaluating the suitability of proposed sites for nuclear power plants with respect to potential reactor accidents that could result in the release of significant quantities of radioactive fission products. The expectation is that the site location and the engineered safety features included as safeguards against the hazardous consequences of an accident, should one occur, ensure a low risk of public exposure. In this regard, licensees commit to dose limits that can be used as the basis for assessing the performance of safety-related structures, systems, and components. Accordingly, to ensure continued compliance with facilities' licensing bases, as they relate to the dose limits of GDC 19 and Part 100, a valid test protocol is necessary.

The actions requested in this generic letter are considered compliance backfits under the provisions of 10 CFR 50.109(a)(4)(i). The compliance exception addresses, inter alia situations where the licensee has failed to meet known and established Commission standards because of mistake of fact. See 50 FR 38103 (September 20, 1985). The NRC erroneously assumed that existing charcoal filter test protocols other than ASTM D3803-1989 would be sufficient to assure accurate and reproducible results. In fact, the available laboratory test results demonstrate that existing test protocols other than ASTM D3803-1989 do not provide accurate and reproducible test results and may overestimate the capability of the charcoal. Therefore, the proposed backfit, which would apply only to used charcoal filters, is necessary for accurate assessment of the charcoal filter capability, in order to assure compliance with the plant's licensing basis as it relates to the dose limits of GDC 19 and Part 100, including commitment to the resolution of TMI Action Plan Item III.D.3.4. The NRC staff has adopted a new staff position by endorsing the ASTM D3803-1989 testing standard for referencing in plant TS because ASTM D3803-1989 is the only available testing standard the staff is aware of that provides accurate and reproducible test results. In accordance with the provisions of 10 CFR 50.109(a)(4)(i), regarding compliance backfits, a full backfit analysis was not performed. However, an evaluation was performed in accordance with NRC procedures, including a statement of the objectives, the reasons for the requested actions, and the basis for invoking the compliance exception, and is reflected in this backfit discussion.

Federal Register Notification

A notice of opportunity for public comment was published in the *Federal Register* on February 25, 1998. Comments were received from 18 licensees, 2 industry organizations, 2 charcoal testing laboratories, and 1 individual. The staff considered all comments that were received, including comments received as late as May 26, 1998. Copies of the staff evaluation of these comments are available in the Public Document Room.

Paperwork Reduction Act Statement

This generic letter contains information collections that are subject to the Paperwork Reduction Act of 1995 (22 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB), approval number 3150-0011, through August 31, 2000.

The public reporting burden for this collection of information is estimated to average 250 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The U.S. Nuclear Regulatory Commission is seeking public comment on the potential impact of the collection of information contained in the generic letter and on the following issues:

(1) Is the proposed collection of information necessary for the proper performance of the functions of the NRC, including consideration of whether the information will have practical utility?

(2) Is the estimate of burden accurate?

(3) Is there a way to enhance the quality, utility, and clarity of the information to be collected?

(4) How can the burden of the collection of information be minimized, including consideration of the use of automated collection techniques?

Send comments on any aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch, T-6 F33, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011), Office of Management and Budget, Washington, D.C. 20503.

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Attachments:
(1) Background Information on the Laboratory Testing of Nuclear-Grade Activated Charcoal
(2) Sample Technical Specifications
(3) List of Recently Issued NRC Generic Letters

BACKGROUND INFORMATION ON THE LABORATORY TESTING OF NUCLEAR-GRADE ACTIVATED CHARCOAL

Charcoal Testing Requirements

Analyses of design-basis accidents assume a particular engineered safety features (ESF) charcoal filter adsorption efficiency when calculating offsite and control room operator doses. Licensees then test charcoal filter samples to determine whether the filter adsorber efficiency is greater than that assumed in the design-basis accident analysis. The laboratory test acceptance criteria contain a safety factor to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle.

Guidance on the frequency of, and the test method for, the laboratory testing of charcoal appears in various documents, including all revisions of Regulatory Guide (RG) 1.52, "Design, Testing, and Maintenance Criteria for Postaccident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," and other NRC documents on plant technical specifications (TS). Guidance on the laboratory test protocol appears in such standards as American National Standards Institute (ANSI) N509, "Nuclear Power Plant Air-Cleaning Units and Components"; ANSI N510, "Testing of Nuclear Air-Cleaning Systems"; Military Specification RDT M 16-1T, "Gas Phase Adsorbents for Trapping Radioactive Iodine and Iodine Components"; and American Society for Testing and Materials (ASTM) Standard D3803, "Standard Test Method for Nuclear-Grade Activated Carbon."

All of the standards describe a pre-equilibration period, a challenge period, and an elution period. During the pre-equilibration (pre-sweep) period, the charcoal is exposed to a flow of air controlled at the test temperature and relative humidity (RH) before the challenge gas is fed through the charcoal. The pre-equilibration period ensures that the charcoal has stabilized at the specified test temperature and RH for a period of time, which results in the charcoal becoming saturated with moisture before it is challenged with methyl iodide. During the challenge period, air at the test temperature and RH with radio-labeled methyl iodide is injected through the charcoal beds to challenge the capability of the charcoal. During the elution (post-sweep) period, air at the test temperature and RH is passed through the charcoal beds to evaluate the ability of the charcoal to hold the methyl iodide once it is captured.

The ASTM D3303-1989 standard has two additional testing periods that are not required by other standards: the stabilization period and the equilibration period. During the stabilization period, the charcoal bed is brought to thermal equilibrium with the test temperature before the start of pre-equilibration. During the equilibration period, air at the test temperature and RH is passed through the charcoal beds to ensure the charcoal adsorbs all the available moisture before the feed period. During this period, the system is more closely monitored than in the pre-equilibration period to ensure that all parameters are maintained within their limits.

Depending upon the plant's TS, typical test temperatures are usually one of the following: 25 °C [77 °F], 30 °C [86 °F], 80 °C [176 °F], or 130 °C [266 °F]. In addition, the TS usually require that the test be conducted at 70 percent RH if the ESF system controls the RH to 70 percent or less, or at 95 percent if the RH is not controlled to 70 percent.

The standard technical specifications (STS) and many plant-specific TS specify Regulatory Position C.6.a of RG 1.52, Revision 2, as the requirement for the laboratory testing of the charcoal. Regulatory Position C.6.a refers to Table 2 of RG 1.52. Table 2 references Test 5.b of Table 5-1 of ANSI N509-1976, "Nuclear Power Plant Air-Cleaning Units and Components." Test 5.b references the test method from paragraph 4.5.3 of Military Specification RDT M 16-1T, "Gas Phase Adsorbents for Trapping Radioactive Iodine and Iodine Components" (date not indicated), but specifies that the test is to be conducted at 80 °C [176 °F] and 95 percent RH with preloading and postloading sweep at 25 °C [77 °F]. This test is referred to as the "25-80-25 test." The essential elements of this test are as follows:

- 70 percent or 95 percent RH
- 5-hour pre-equilibration (pre-sweep) time, with air at 25 °C [77 °F] and plant-specific RH
- 2-hour challenge, with gas at 80 °C [176 °F] and plant-specific RH
- A 2-hour elution (post-sweep) time, with air at 25 °C [77 °F] and plant-specific RH

The latest acceptable methodology for the laboratory testing of the charcoal is ASTM Standard D3803-1989, "Standard Test Method for Nuclear-Grade Activated Carbon." ASTM D3803-1989 is updated guidance based on an NRC verification and validation effort regarding ASTM D3803-1979, which is updated guidance based on RDT M 16-1T. The essential elements of the ASTM D3803-1989 test are as follows:

- 70 percent or 95 percent RH
- 2-hour minimum thermal stabilization, at 30 °C [86 °F]
- 16-hour pre-equilibration (pre-sweep) time, with air at 30 °C [86 °F] and plant-specific RH
- 2-hour equilibration time, with air at 30 °C [86 °F] and plant-specific RH
- 1-hour challenge, with gas at 30 °C [86 °F] and plant-specific RH
- 1-hour elution (post-sweep) time, with air at 30 °C [86 °F] and plant-specific RH

The major differences between the ANSI N509-1976 and ASTM D3803-1989 standards for charcoal testing are as follows:

MAJOR DIFFERENCES	ASTM D3803-1989	ANSI N509-1976
Pre-Equilibration (Pre-Sweep) Temperature	30 °C [86 °F]	25 °C [77 °F]
Challenge Temperature	30 °C [86 °F]	80 °C [176 °F]
Elution (Post-Sweep) Temperature	30 °C [86 °F]	25 °C [77 °F]
Total Pre-Test Equilibration	18 hours	5 hours
Tolerances of Test Parameters	Smaller	Larger

As stated above, ASTM D3803-1989 challenges the representative charcoal samples at 30 °C [86 °F] rather than at 80 °C [176 °F]. The quantity of water retained by charcoal is dependent on temperature, and less water is retained as the temperature rises. The water retained by the charcoal decreases its efficiency in adsorbing other contaminants. At 30 °C [86 °F] and 95 percent RH, charcoal will retain about 24 to 25 weight-percent water. At 80 °C [176 °F] and 95 percent RH, charcoal retains only about 19 to 20 weight-percent water

Because most charcoal is anticipated to be challenged at a temperature closer to 30 °C [86 °F] rather than 80 °C [176 °F], the lower temperature test condition of ASTM D3803-1989 will yield more realistic results than would a test performed at 80 °C [176 °F].

ASTM D3803-1989 specifies a test temperature of 30 °C [86 °F] for both the pre- and post-test sweep rather than 25 °C [77 °F]. There is little difference in the adsorption behavior of charcoal between these two temperatures. A temperature of 25 °C [77 °F] is more conservative; however, the increase from 25 °C [77 °F] to 30 °C [86 °F] does not represent a significant variation in the test results.

ASTM D3803-1989 provides results that are reproducible compared to RDT M 16-1T because it has smaller tolerances on various test parameters, and it requires that the charcoal sample be pre-equilibrated for a much longer period. The longer pre-equilibration time is more conservative because it will completely saturate the representative charcoal sample, which ensures reproducibility of the results by having every charcoal sample begin the test at the same initial conditions. Therefore, testing in accordance with ASTM D3803-1989 will result in a more realistic prediction of the capability of the charcoal.

TS Testing Reference

Laboratory tests of the charcoal are typically required (1) once every refueling outage, (2) when certain events occur that could adversely affect the ability of the charcoal to perform its intended function, and (3) following a defined period of ESF system operation. The TS require demonstration by laboratory testing that the charcoal is capable of performing at a level greater than that assumed in the NRC staff's safety evaluation report. If it fails to perform at that level, the charcoal must be replaced.

The determination of the appropriate test conditions, test protocol, and acceptance criteria for laboratory testing of nuclear-grade activated charcoal is frequently not a straightforward process. It sometimes requires a complex journey through a number of documents to ascertain the appropriate test conditions, test protocol, and acceptance criteria. As described earlier, if the plant has STS, the STS reference Regulatory Position C.6.a of RG 1.52 for the requirements for the laboratory testing of charcoal. Regulatory Position C.6.a refers to Table 2 of the regulatory guide. Table 2 references Test 5.b of Table 5-1 of ANSI N509-1976. Test 5.b from Table 5-1 references the test method from paragraph 4.5.3 of RDT M 16-1T (date not indicated), but specifies that the test is to be conducted at 80 °C [176 °F] and 95 percent RH with pre-loading and postloading sweep at 25 °C [77 °F]. This test is referred to as the "25-80-25 test."

Also contributing to the potential confusion are the various ways in which TS are written, and conflicting NRC guidance on testing, particularly NRC letters to the nuclear industry and NRC papers presented at national conferences. This problem arose from the evolving understanding of what constituted an appropriate test. At various times, the NRC has stated that the newest version of a standard can be used and the test can be conducted at a temperature of 30 °C [86 °F]. At other times, the NRC indicated that the TS are requirements and that the tests must be performed at the 25-80-25 conditions. In various forums, the NRC has also stated that a technical argument may be made for using the newer standard. However, in

some instances when newer standards were utilized to demonstrate conformance with the TS, the NRC required licensees to submit TS amendment requests because the newer standards were not referenced in the TS. Therefore, it is understandable that licensees may be confused about laboratory testing protocols, testing conditions, and acceptance criteria. As a result, many licensees are not testing charcoal in accordance with their TS, although the tests they conduct may be more conservative than the tests required by the TS.

Additionally, the 25-80-25 test has difficulties in that none of the protocols in any version of RDT M 16-1T or ASTM D3803 addresses performing the laboratory test at multiple temperatures as required by ANSI N509-1976. If the test protocol described in paragraph 4.5.3 of RDT M 16-1T (1973) is followed verbatim, a thermal step change must be made after the 5-hour pre-equilibration period to increase the temperature from 25 °C [77 °F] to 80 °C [176 °F] for the challenge period. The problem with such thermal step changes is that they result in condensation forming on the charcoal. The condensation of free water in the sample bed is cause for aborting the test, according to the 1977 version of RDT M 16-1T and subsequent versions of ASTM D3803. Therefore, the 25-80-25 test cannot be performed pursuant to any existing test protocol.

Because paragraph 4.5.3 cannot be followed verbatim, a few licensees have changed the 25-80-25 test to thermally equilibrate the charcoal before introducing the challenge gas. Following the pre-sweep conditioning at 25 °C [77 °F], the bed temperature is raised to 80 °C [176 °F] before introducing the challenge gas. Although such testing does not cause condensation in the test rig, it is not acceptable because the results are not easily reproducible, and even when the test is successfully completed, the results may not be conservative.

Section 2 of ANSI N509-1976 states for the various documents that supplement ANSI N509 that the issuance of a document in effect at the time of the purchase order shall apply unless otherwise specified. In the case of charcoal, the purchase order date could be considered the date that the charcoal is procured. Therefore, TS that have the STS wording may allow the licensee the flexibility to use a more recent laboratory protocol than the 1973 version of RDT M 16-1T, depending on the procurement date for the charcoal, without a TS change. However, although the flexibility of protocol selection exists, the requirement to perform a 25-80-25 test for those plants that have TS that reference either Revision 1 or Revision 2 of RG 1.52, Table 5-1 of ANSI N509-1976, or ANSI N510-1975 can only be relieved by license amendment.

Categorization of Plants

Since February 1996, the staff has issued three emergency TS changes to licensees that had determined that the tests they performed were not in compliance with their TS because the required testing standards and test protocols did not support a test in which the temperature is changed as required by the TS. If the temperature in the test apparatus is changed from 25 °C [77 °F] to 80 °C [176 °F] during the test without modifying the test protocol, water condenses on the charcoal, thereby causing the test to be aborted (to fail). The emergency TS changes were issued for the V.C. Summer, Davis-Besse, and Oconee facilities. The details of these TS changes are discussed below.

On February 10, 1996, the licensee for the V.C. Summer Nuclear Station, South Carolina Electric & Gas Company (SCE&G), requested an emergency TS change. The systems involved were the control room emergency ventilation system and the fuel handling building exhaust system. On February 10, 1996, the NRC granted the emergency TS change. The emergency TS change was requested because SCE&G had determined that laboratory tests of the charcoal of the control room ventilation system and the fuel-handling building system had not been performed in compliance with the V.C. Summer TS. The laboratory test performed for V.C. Summer was a 25-25-25 test in lieu of the 25-80-25 required by its TS. The licensee had been performing the 25-25-25 test because, in consultation with its testing laboratory, it concluded that performance of the 25-80-25 test would result in condensation on the charcoal and, thus, an invalid test.

On March 29, 1996, the Toledo Edison Company requested an emergency TS change for the Davis-Besse plant. The systems involved were the hydrogen purge, the shield building emergency ventilation, and the control room. The TS for Davis-Besse required the laboratory test to be performed in accordance with RG 1.52, Revision 2. In this case, the licensee was performing a 30-30-30 test using the testing protocol of ASTM D3803-1979 in lieu of the 25-80-25 test. On March 29, 1996, the NRC granted the emergency TS change to allow the 30-30-30 test.

On April 2, 1996, Duke Power Company requested an emergency TS change for the Oconee Nuclear Station. The systems involved were the reactor building purge, the spent fuel pool ventilation, and the penetration room ventilation. The TS for Oconee required the laboratory test of charcoal to be performed in accordance with ANSI N510-1975 and Method C of ASTM D3803-1979, which requires the performance of the test at 130 °C (266 °F) and 95 percent RH. However, the licensee was actually performing a 30-30-30 test using the test protocol of ASTM D3803-1989. The NRC granted an emergency TS change on April 2, 1996, to permit the 30-30-30 test.

In each of these cases, the test performed to demonstrate compliance with TS provided results that the staff considered closer to reflecting the capability of the charcoal than the test required by the TS. In addition, the licensees believed that using the newer standard would satisfy their TS requirement. Their bases for this belief were the limitations of the test referenced in RG 1.52, their interpretation of ANSI N509 as allowing the use of later versions of the test protocol, and some of the guidance provided by the NRC. In the case of Oconee, the test actually performed is the test that the staff believes is the appropriate one, ASTM D3803-1989. However, because these tests had not been conducted in compliance with the plant's TS, each licensee would have had to shut down its plant or remain in a cold-shutdown mode until the test required by the TS could be successfully performed, or until the TS were amended.

On March 21, 1996, Carolina Power & Light Company flew a charcoal sample from the Brunswick standby gas treatment system (SGTS) to its testing laboratory in Ohio for the performance of the 25-80-25 test to comply with the Brunswick TS before restart of an idle unit. The Brunswick TS required that the laboratory tests be performed in accordance with Revision 1 of RG 1.52. Previously, the licensee directed its testing laboratory to perform an 80-80-80 test. To perform the 25-80-25 test, the laboratory equilibrated the charcoal to 80 °C [176 °F] before introducing the challenge gas. The licensee has not requested a TS change for Brunswick to correct the problem and is awaiting guidance from the NRC.

As a result of the emergency TS changes, the staff has performed an internal survey of operating plant TS to determine whether other plants have the potential for similar problems with compliance. The survey indicated that at least one-third of operating reactor licensees may not be in compliance with their TS because they reference the flawed 25-80-25 testing protocol and may have used later versions of the standards for the laboratory tests of their nuclear-grade charcoal. On the basis of this survey, the staff established the following four groups of plants:

(1) plants in compliance with their TS that test in accordance with ASTM D3803-1989

(2) plants in compliance with their TS that test in accordance with a test protocol other than ASTM D3803-1989

(3) plants not in compliance with their TS that test in accordance with ASTM D3803-1989

(4) plants not in compliance with their TS that test in accordance with a test protocol other than ASTM D3803-1989

The licensees in Group 1 have TS that require charcoal to be tested in accordance with ASTM D3803-1989, which adequately demonstrates the capability of the charcoal. The licensees in Group 2 have TS that require charcoal to be tested in accordance with test standards other than ASTM D3803-1989. The licensees that received emergency TS changes were in Groups 3 and 4. Licensees in Groups 3 and 4 have TS that require charcoal to be tested in accordance with the 25-80-25 test.

SAMPLE TECHNICAL SPECIFICATIONS

For Plants With Improved Standard Technical Specifications

C. Demonstrate for each of the ESF systems that a laboratory test of a sample of the charcoal adsorber, when obtained as described in [Regulatory Guide 1.52, Revision 2], shows the methyl iodide penetration less than the value specified below when tested in accordance with ASTM D3803-1989 at a temperature of 30 °C [86 °F] and the relative humidity specified below.

ESF Ventilation System	Penetration	RH
[ ]	see note below	see note below

Note: The use of any standard other than ASTM D3803-1989 to test the charcoal sample may result in an overestimation of the capability of the charcoal to adsorb radioiodine. As a result, the ability of the charcoal filters to perform in a manner consistent with the licensing basis for the facility is indeterminate.

ASTM D3803-1989 is a more stringent testing standard because it does not differentiate between used and new charcoal, it has a longer equilibration period performed at a temperature of 30 °C [86 °F] and a relative humidity (RH) of 95% (or 70% RH with humidity control), and it has more stringent tolerances that improve repeatability of the test.

$$\text{Allowable Penetration} = \frac{[100\% - \text{Methyl Iodide Efficiency* for Charcoal Credited in Licencee's Accident Analysis}]}{\text{Safety Factor}}$$

When ASTM D3803-1989 is used with 30 °C [86 °F] and 95% RH (or 70% RH with humidity control) is used, the staff will accept the following:

Safety factor ≥ 2 for systems with or without humidity control.

Humidity control can be provided by heaters or an NRC-approved analysis that demonstrates that the air entering the charcoal will be maintained less than or equal to 70 percent RH under worst-case design-basis conditions.

This value should be the efficiency that was incorporated in the licensee's accident analysis which was reviewed and approved by the staff in a safety evaluation.

For Plants With Older Technical Specifications

Each engineered safety features (ESF) ventilation system shall be demonstrated OPERABLE:

a. At least once per 18 months or (1) after any structural maintenance on the HEPA filter or charcoal adsorber housings, or (2) following painting, fire, or chemical release in any ventilation zone communicating with the system by:

   1) Verifying, within 31 days after removal, that a laboratory test of a sample of the charcoal adsorber, when obtained in accordance with Regulatory Position C.6.b of Regulatory Guide 1.52, Revision 2, March 1978, shows the methyl iodide penetration less than [see note in preceding section titled "For Plants With Improved Standard Technical Specifications"]% when tested in accordance with ASTM D3803-1989 at a temperature of 30 °C [86 °F] and a relative humidity of [see note in preceding section titled "For Plants With Improved Standard Technical Specifications"]%.

b. Within 31 days of completing 720 hours of charcoal adsorber operation, verify that a laboratory test of a sample of the charcoal adsorber, when obtained in accordance with Regulatory Position C.6.b of Regulatory Guide 1.52, Revision 2, March 1978, shows the methyl iodide penetration less than [see note in preceding section titled "For Plants With Improved Standard Technical Specifications"]% when tested in accordance with ASTM D3803-1989 at a temperature of 30 °C [86 °F] and a relative humidity of [see note in preceding section titled "For Plants With Improved Standard Technical Specifications"]%.

LIST OF RECENTLY ISSUED GENERIC LETTERS

GENERIC LETTER	SUBJECT	DATE OF ISSUANCE	ISSUED TO
99-01	Recent Nuclear Material Safety and Safeguards Decision on Bundling Exempt Quantities	5/3/99	All materials licensees.
98-01, Supp. 1	Year 2000 Readiness of Computer Systems at Nuclear Power Plants	1/11/99	All holders of operating li licenses for nuclear power Plants, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
98-05	Boiling Water Reactor Licensees Use of the BWRVIP-05 Report To Request Relief From Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds	11/10/98	All holders of operating licenses (or construction permits) for BWRs, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
98-04	Potential for Degradation of the Emergency Core Cooling System And the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment	07/14/98	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

OP = Operating License
CP = Construction Permit
NPR = Nuclear Power Reactors

(2) Is the estimate of burden accurate?

(3) Is there a way to enhance the quality, utility, and clarity of the information to be collected?

(4) How can the burden of the collection of information be minimized, including consideration of the use of automated collection techniques?

Send comments on any aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch, T-6 F33, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011), Office of Management and Budget, Washington, D.C. 20503.

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

[Orig. /s/'d by S.F. Newberry]

for David B. Matthews, Director
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Office of Nuclear Reactor Regulation

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Attachments:
(1) Background Information on the Laboratory Testing of Nuclear-Grade Activated Charcoal
(2) Sample Technical Specifications
(3) List of Recently Issued NRC Genric Letters

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